The individual parameter

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to my father

Contents

List of Figures

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Nothing is more adequate than the famous saying: "If I have seen further it is by standing on the shoulders of Giants" (Newton, 1675). What I like most about it is that it doesn't even assert that the subject indeed "saw further" than any of his predecessors, which is something I don't want to claim to have achieved either. But I really stood on the shoulders of giants, and there are quite some people who supported me trying to stand there, and even more who helped me climbing. Without specifying what they did to help me, I want to express my gratitude to all of the following wholeheartedly:

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1 Introduction

The pretheoretical notion of meaning is a multifaceted thing. There are many quite different ways in which a statement like 'the utterance of φ by α in the circumstances c means that ψ' can be spelled out. From a more theoretical perspective, the enterprise of explaining a wide variety of meaning-related phenomena is undertaken by differentiating several notions of meaning, each of which may be studied more or less independently of the others. Usually, phenomena related to linguistic meaning are categorized as being (more or less) semantic or pragmatic in nature, that is, some phenomena are said to be closely related to the circumstances of utterances, happen to vary with different occasions of use, or are not conventionalized, while other phenomena seem to be highly conventionalized, intimately tied to lexical meanings and syntactic structure, and remain (more or less[1]) constant over all occasions of use (cf. Gutzmann, 2017, for an excellent survey along these lines). It goes without saying that the exact demarcation line was under heavy discussion from the very start, and still continues to be one of the most discussed topics in the literature (cf. the discussion revolving around a more pragmatic conception of semantics argued for in especially Recanati, 2004 and Recanati, 2010 and a minimal conception of semantics defended in Cappelen and Lepore, 2005 and Borg, 2004; Borg, 2012). However the line is drawn, each of these categories in itself comprises several different strands of investigation. On the pragmatic side of the spectrum these go under the labels 'speech act theory', 'theory of conversational implicatures', etc. to name just the most classical. On the semantic side of the spectrum, the most general labels may be 'theory of informativity', 'theory of reference', etc. Usually, in dealing with semantic phenomena, instead of talking about meanings of expressions in general (in contrast to, say, the conversational impact of an utterance), the official parlance is to talk about different *aspects* of meaning. These are captured by different *semantic values* like, e.g. extensions, intensions, etc., developed solely to represent exactly one of these aspect of meanings. This allows a precise characterization of the topic of investigation and at the same time avoids possible misunderstandings and confusions right from the start.

One of the phenomena frequently under discussion is *indexicality*. Under a quite common description, indexicality names the *context dependency* of certain expressions, e.g., first person pronouns. The meaning (referent) of *I* varies with utterance contexts. If, e.g., Donald Trump uses *I*, the pronoun refers to him, while it refers to Kermit the Frog when he uses the pronoun. Characterized this way, indexicality clearly shares one feature of pragmatic meanings and one feature of semantic meanings: the referent of the pronoun varies with context, but this variation is also lexically triggered, i.e.

[1] There are pragmatic processes that "overwrite" literal meaning completely. But the literal meanings can still be accessed as a kind of "fallback position" if necessary.

conventionalized.

In the first chapter, the focus lies on dependencies exhibited by aspects of meanings in general, that is, the dependencies that are integral parts of the conception of extensions and intensions.[2] For a start: The extensions of sentences, their truth values, depend on circumstances of evaluation. Although there are sentences whose truth value doesn't vary at all—logical truths and contradictions—the vast majority of sentences display this behavior. So when the truth value of a sentence is determined, this sentence has to be evaluated against whatever these circumstances may be. This observation about a certain kind of dependency usually lies at the core of semantic theories, because it provides a direct link between meanings and truth: If two sentences receive different truth values although they are evaluated against the same circumstances, they cannot mean the same, whatever the conception of meaning or circumstances may be. This observation is sometimes dubbed the *Most Certain Principle* after Cresswell (1982, p. 69).

The extensions of parts of sentences also display this kind of dependency. For example, the extensions of definite descriptions (in a certain use) are said to be their *referents* that are situated in or make up circumstances. Thus, if one starts at the sentential level, the general dependency on circumstances of evaluation trickles down to its sub-sentential parts. Viewed the other way round, the dependencies displayed by the extensions of the constituents of a sentence add up when these extensions are combined according to the syntactic structure. This process, the composition of semantic values, is usually understood as combining the semantic values of the constituents and nothing more, such that the value of a complex expression is determined by the values of its parts (and the mode of composition). This is called the *Principle of Compositionality* and it is assumed to hold for every *semantic* value natural language expressions are assigned. How this is spelled out in detail depends on the particular conception of the dependency the semantic value is taken to encode.[3]

When dealing with indexicality, other semantic values, namely intensions or contents are analyzed as being dependent as well. Intensions are usually modeled as abstractions from extensions. Thus, the intension is understood as the entity that is evaluated against circumstances and the result of this evaluation is what is called the extension. The intension therefore encodes the way in which the extensions depend on circumstances of evaluation. Mostly, this is modeled by making intensions functions from circumstances

[2] In the literature, a subset of these dependencies have been called 'objective' parameters of context, in contrast to more 'subjective' features (cf. Borg, 2004, 29ff. where the terminology is attributed to DeRose, 1992). The former are usually understood to be intersubjectively available, while the latter sometimes are thought to be accessible only to certain parties of a conversation directly, although everybody involved is able to understand and therefore to reconstruct their influences. As with the distinctions above, the exact demarcation is frequently under heavy discussion—an issue that will be ignored here.

[3] Moreover, the extension of e.g. predicates or common nouns are often just construed as *contributions* to the extension of the expressions they are contained in. That is, e.g., the extension of predicates is construed to be a function from individuals (the extension of proper names and certain definite descriptions) into truth values (the extension of sentences). With this value assignment, compositionality is guaranteed. See T. E. Zimmermann (2006) and T. E. Zimmermann (2012a) for more on this.

into extensions, although this move isn't necessary. The dependency need not necessarily be functional, and evaluation need not necessarily be functional application. Regardless of these technical details, intensions too are conceived as being dependent. A very prominent account of the general dependency of the content of sentences on circumstances is dubbed *Context Theory* and was laid out especially in Kaplan (1989b). There are two observations that lie at the heart of this theory of dependency, namely, first, the existence of a certain kind of expression—indexicals—whose semantic value on the one hand definitely depend on circumstances of evaluation, but this dependency, on the other hand, cannot be the same kind of dependency as displayed by extensions in general. And, secondly, the existence of different kinds of trivialities, called 'logical truth' or 'analyticity' on the one hand and 'a priori truth' or 'validity' on the other (cf. Kripke, 1972). Both of these observations led Kaplan to conclude that there exists a third semantic value that stands in the same relation to intensions as they stand to extensions, which he called *character*. Thus, analogously, characters encode the way in which the intensions of expressions depend on circumstances of evaluation themselves.[4] As already said, this dependency often is understood as dependency on *utterance contexts*, that is, the circumstances relevant for this kind of dependency are usually identified with the circumstances in which these expressions are uttered. This steps over the line of the semantic/pragmatic divide, alluded to above, rendering the Kaplanian enterprise a (formal) pragmatic theory instead of a semantic one. But, firstly, as long as nothing hinges on this categorization, that is, as long as nothing is made dependent on this distinction (like Recanati, 2004; Recanati, 2010 does in linking certain processes to one part of the divide only), this stepping over the line isn't of much consequence. Then this whole topic, whether the kind of theory developed by Kaplan is better categorized as semantic or pragmatic, isn't of much relevance. And secondly, the following chapter attempts to show that the straightforward identification of contexts as circumstances on which the values of indexicals depend with utterance contexts leads to all kinds of problems once a certain conception of validity is adopted. As will be seen, in order to retain a well-behaved logic of indexicals it seems best to individuate contexts without reference to utterances at all. That is, the *contexts* in *Context Theory* are taken to be determined on other grounds. This notion of context thus not necessarily indicates a step in the direction of pragmatic meaning. Apart from this, issues revolving around the semantic/pragmatic divide are left out of the picture.

On a side note, it should be pointed out that this strand of theorizing not only develops a notion of dimension that accounts for several different (but arguably related) kinds of dependency but also makes some detailed suggestions for an account of some uses of certain expressions, among which definite descriptions and pronouns are of highest

[4]Strictly speaking, this is a mere stipulation since no argument to the end that the dependency of intensions and the dependency of extensions both are dependencies on the same kind of entities has been given. And, to be fair, even though both 'sources' share some structure in Kaplan (1989b), they are not of the same kind. This is different in T. E. Zimmermann (1991) and T. E. Zimmermann (2012b) and, following him, also here, where, under the influence of Lewis and Stalnaker, both—contexts and indices—are derived from one kind of entity only, namely situations. Thus, in a sense, the 'sources' of dependencies are the same.

relevance for what follows. It is mostly because of these expressions that the focus is put on dependency.

There are several other semantic theories that focus on these expressions as well but aim to model quite different uses of them. While the Kaplanian theory covers deictical uses of pronouns and definites, these theories are more concerned with the way in which, among other things, anaphoric expressions receive their values. To be precise, closely related to anaphoric uses, are the so called E-type pronouns as well as bound pronouns, which are also taken into consideration. All of these uses are described in terms of dependency too. The truth values of sentences containing pronouns used in one of these ways are said to be dependent on (among other things) other expressions used in the same discourse (though not necessarily in the same sentence). This in turn is better understood as a dependency on the (semantic) contribution of a certain class of expressions that is modeled by discourse referents, sequences of individuals, or (minimal) resource situations,[5] to name just a few. Crucial to this kind of dependency is that these values are built up from the discourse preceding the sentences in question in a systematic way. Thus, arguably in contrast to the kind of dependency lying at the heart of a Kaplanian characterization, this constitutes yet another source semantic values of certain expressions may depend on. Given these very sparse characterizations, the most general question to tackle is whether these three kinds of dependencies are independent of one another, or whether one kind can be subsumed under another. As will be seen, despite constituting different dimensions in Kaplanian context theory, the kind of things intensions depend on are basically the same as the kind of things extensions are dependent upon. That is, both dependencies are modeled as relating semantic values to circumstances of evaluation, one (i.e. contexts) being somewhat more restricted than the other (indices). But the third kind of dependency doesn't seem to be of this kind. Of course, loosely speaking, the dependency displayed by, e.g., anaphoric pronouns can be subsumed under the label 'context dependency' as well, but this notion of context seems to be rather different from the notion of context used to model the dependency of indexicals. Thus, at least at first glace, the conclusion that this kind of dependency is irreducible to the other kind(s) seems inevitable. This is reinforced in the next section, where the criteria for assuming the existence of parameters of evaluation are discussed.

Nevertheless, in recent (and not so recent) years, several attempts to treat all of these kinds of dependency along the same lines have been undertaken. That this is done even though the first semi-theoretical discussion sketched above seems to entail that an enterprise like this is fundamentally wrong-headed, may be due to the simple fact that different uses of pronouns and definite descriptions are never accompanied by formal distinctions.[6] That is, the diagnosis that one, say, morpho-syntactically specified object

[5] This is at best misleading. Actually, the situation semantics' account of pronouns, which are understood as definite descriptions in disguise, does not operate with contributive and dependent expressions. Rather, the values of disguised as well as overt definite descriptions are obtained by evaluating them against highly restricted circumstances, i.e., circumstances restricted by the linguistic material that makes up the antecedent, so called minimal situations. This result on the first impression looks like binding but is in fact nothing but covariance.

[6] This seems to be partly wrong as can be seen in Schwarz (2009), where two formally distinct definite

has different uses seems to be fine. But the theoretical situation is that these uses are broadly associated with two different mechanisms that have next to nothing in common. And this leads to a rather unsatisfactory if not suspicious practice, namely, that several distinct ways to understand the semantic values of pronouns have emerged from these different theories. The difference in theoretical coverage thus finds an analogy in the semantic contribution of pronouns (and definite descriptions). So one gets the impression that a generalization is missed here. Assuming that this is the case, something must be wrong with the way in which dependencies are modeled in general, or with the ways in which it is tried to marry these different theories.

In the following, the arguments surrounding the different sources and the technical implementation of dependency are presented in more detail. The first chapter deals with *Context Theory*. It presents different but related ways of modeling dependency after the main motivations for going *Two-Dimensional* are discussed. The second chapter deals with *Dynamic Semantics* in a broad sense. The way in which anaphoric expressions depend on their antecedents is characterized and the three main techniques of dealing with this kind of dependency are introduced. The ultimate goal is to develop a framework that does both families of theories justice while trying to avoid viewing expressions playing major rôles in both merely as ambiguous.

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articles are correlated with two different uses. But for pronouns, this statement seems to be correct.

2 Dependencies in Context Theory

2.1 Varieties of Dependencies

2.1.1 Truth conditions and Situations

Consider the following (toy) examples:

(1) a. Peter is asleep.
    b. Peter is awake.

Sentences like (1a) and (1b) are not true or false simpliciter, they are true or false regarding certain circumstances or facts of the matter. Intuitively speaking, (1a) may have been true five minutes ago while (1b) was false, but something changed since then and now (1a) is false while (1b) is suddenly true. This intuition cannot be explained if one assumes that the truth value of sentences is fixed once and for all.[1] Thus, one has to develop the means to account for this insight somehow. One key ingredient to such an account is a clearer notion of *circumstances*. They should come out as something that has the potential to change (within the past five minutes) so that that change can be said to affect the truth values of (1a) and (1b). There are several options. Usually, the notion of a possible world is invoked. In a popular parlance (due to Lewis (1973, p. 84) and Stalnaker (1976, p. 66)) possible worlds may be understood as "ways our world might be". But these entities may turn out to be "too large" to do the job properly, since a whole world may contain several instances of sleeping Peter as well as instances of him being awake.[2] Alternatively, smaller entities like world parts or situations or

[1] One would then be forced to assume that part of what has changed within the last five minutes somehow affected the sentences, so that in reality, there are two different albeit very similar sentences under discussion here. This strange possibility is discarded without further argumentation.

[2] This glosses over many important details. Possible worlds were put to use for modal logic first and later introduced into semantics most famously in the works of Lewis, Kripke, and Montague. Already there, various interpretations of this notion have been entertained. The mainstream among semanticists seems to be to adopt a rather non-philosophical usage of the term, which avoids making substantial claims about the metaphysical nature of possible worlds (even though this isn't possible) and use them merely as a common framework in which semantic analyses are expressed. I try to pursue this strategy here, too. Still, some remarks and decisions will have to be made here and there. I hope that the characterizations are sparse enough to be compatible with next to any metaphysical position out there.

Concerning the "size" of possible worlds, it is argued in Cresswell (1988) (cf. Cresswell (1991) for a German translation that is easier to access) that worlds need not be as 'big' as one might be inclined to think. Instead, worlds can just consist in a small room (without a house around it), a short lifespan (or time interval), and very few individuals. On the other hand, situations sometimes need to be as 'big' as a full-fledged world. Something similar seems to hold in Situation Theory, where worlds are understood as upper bounds of the part-whole relation, see below.

states of affairs (or events) are drawn upon. Just to have a main level of ontology, I will assume that *situations* are the entities to go with. They are in turn understood as arbitrarily large spatiotemporal slices of whole worlds, that is, if needed, a situation can be unpacked into a tuple consisting of the possible world it is a part of, its maximal temporal and maximal spatial extension within this world (see section 2.2.1). The set of possible worlds is $\mathcal{W}$, that of times (time-individuals) is $\mathcal{T}$ and the set of spatial locations (location-individuals) is $\mathcal{P}$.[3] The set of situations is coined *LS* for *L*ogical *S*pace. Conceived this way, worlds can be characterized as situations, too, namely as situations (which may have parts) that are not part of larger situations.[4] And parthood among situations can be characterized as being spatio-temporally contained in another while belonging to the same world.

This makes it possible to understand extensions of expressions as being dependent on *LS*; so regarding (1), the change that is caused by Peter's behavior boils down to a difference between situations. According to one situation, s_1, (1a) may be true, but (1b) may be false, while according to a slightly different situation s_2 (1a) may be false and (1b) may be true true. If so, s_1 and s_2 differ in at least one of their three aspects (to be represented in a tuple; *parameter* later on), that is, could represent the same world at different times or places, or different worlds restricted to the same spatiotemporal location.[5] Needless to say, the truth value of (1) does not necessarily change with respect to two different situations, because what it expresses could (still) be true at a different world, at a different time, or a different place.[6]

The way situations are understood here is definitely not as *Situation Theory* (cf. Barwise (1988), Barwise and Perry (1983) and also Kratzer (1989) and Kratzer (2007), and, following her, e.g. Elbourne (2005) and Elbourne (2013) and Schwarz (2009)) has it. Barwise even warns the reader against such a narrow notion of situation. In Kratzer

[3]These have to be individuals instead of pure degrees of temporal duration or spatial extension in order to avoid possible but unintended conflations of situations within the same world (say, the café this sentence is written in for five minutes starting at 6pm vs. the very same café with the same temporal duration starting 7pm, assuming that nothing has changed in terms of individuals present; thanks to Frank Sode for making me understand this). Apart from that, these individuals do not occur only in their respective worlds, but live a trans-world life. This is assumed to make it possible to fix, e.g., the temporal parameter of a situation, while varying others, without thereby necessarily having to leave the realm of situations. For type e individuals which are made coordinates of tuples below, such a trans-world identity is assumed as well, but this is only for ease of exposition. I am convinced that it should be possible to rewrite everything done here with type e individuals in terms of counterparts.

[4]A characterization of worlds as maximal situations is found, e.g., in chapter 11 of Barwise (1988), but must have older roots in Situation Theory. This can't be done here, because if situations are identified with tuples starting with a world parameter and worlds are situations themselves, it follows that the tuples representing worlds are unfounded. To avoid this, neither the identification of situations with tuples nor the identification of worlds with situations is undertaken here. Instead, appropriate mappings between these sets are provided or simply assumed.

[5]To be honest, this is a stipulation. In section 2.2.1 this stipulation is spelled out more precisely.

[6]If one doubts that it is possible to freely vary the time of evaluation because (1) is in present tense, then the first indexical is discovered right here. One should then jump to section 2.1.3 where this phenomenon is described, even though tense isn't touched upon there nor anywhere else in this text, apart from footnote 17 on page 24.

(1989), situations are individuated by tuples of individuals and properties, and the same holds in older versions of Situation Theory, even though the terminology is not settled there. E.g. what is a situation in Kratzer (1989) is an *infon* or a *fact* in Barwise (1988);[7] situations support infons, but seem to be 'larger' entities overall. However, especially Kratzer's situations are so fine-grained that they make a difference between, e.g., the very rotation of this ball at this very time and this very place and its specific way of becoming warmer at the same time and the same place. Of course, it is possible to distinguish these two properties on the type level, like Carnap and Montague (cf., e.g. Carnap, 1947; Montague, 1970b) do; namely as functions from individuals into propositions or functions from LS into sets of individuals. But if the ball rotates around its own axis and becomes warmer simultaneously, this happens within the same situation. So, there is only one situation involved, and not two. These subtle differences carry over to the characterization of parthood. Mostly, it is viewed as a given, but the repercussions of parthood on other relations, be it between situations, infons, or mixed relations, usually are not. The part-whole relation used here doesn't work like that, since by definition it reduces to parthood of world-mates in the temporal and spatial domain. Note that situations, even in Situation Theory, can be as large as, say, Europe in May 2017 in some particular world w. Thus, the problem of the entities making sentences like (1) true being too large doesn't go away. But it is at least guaranteed that there are entities for which sentences like these come out true. Barwise and Kratzer discuss whether one should assume *persistence*, i.e. the claim that a sentence S is true at a (complex) situation s as soon are there is a (minimal) part s' of s, at which S is true simpliciter (or, adopting Barwisian terminology, whether a situation that hosts another situation as a part has to support the same infons (facts) or not). For problems with this notion, cf. Zweig (2006), among others.

Even though the truth values of whole sentences seem to covary with situations, their truth conditions need not necessarily be built from them.[8] This quick identification of truth conditions with situations (such that, e.g. intensions are modeled as functions from LS into truth values, or as subsets of LS characterized by such functions) is not justified by the observation made with regard to (1), and cannot be justified by such observations alone. It remains perfectly possible that the truth values of sentences covary with something else which in turn might have something in common with situations, or even varies with them. What has to be taken into consideration, then, is the possibility that situations affect sentences only indirectly, mediated by a kind of "in-between" entity. Furthermore, if it is possible to show that there are examples whose truth conditions cannot be described in terms of situations, then one needs to watch out for other entities. These have to relate to situations somehow, to account for the initial plausibility of the (traditional) identification of truth conditions with (characteristic functions of) subsets of LS.

Thus, the real problem is the individuation of the entities from which truth conditions

[7] Kratzer also uses the term "fact" when it comes down to single situations.

[8] Cf. T. E. Zimmermann (2011, p. 763) for a related argument concerning the identification of truth conditions and *meanings*.

have to be defined, whether or not the supposed individuation relates them to situations, and how exactly. These questions are tackled by tracking the variation among truth values as closely as possible. This should give some information about the very nature of the entities truth conditions are to be built from, and how these relate to situations. Of course, if any difference between situations leads to a difference between these mysterious “hidden entities” with which truth values covary, Occam’s Razor demands doing without them, since they are redundant.[9] Only if covariation between situations and these entities is not completely harmonious, an argument for their existence and usefulness is made. Needless to say, one then might ask which good situations actually serve and whether it is possible to do without them. Of course, one might also call into question the assumption that there is only *one* “hidden entity” in between situations and truth values. Regarding the first objection, situations are taken to be innocent but intuitive representations of what affects the truth values of sentences, here. So they serve as clear representatives of what there (possibly) is. Regarding the second objection, it may indeed be possible that more than one “layer” of (distinct) entities is needed. But it might also turn out that such a move renders one of the other layers or situations superfluous—as suspected in the first objection. This of course is no argument against the very possibility of such a construction. This is no surprise since these matters shouldn’t be decided apriorily. Instead, careful investigation is needed. But the default hypothesis should be that there is at most one mediating entity, if any. If it turns out that this very entity in reality is a confused representation of two or more distinct sources, as the second objection has it, this can be regarded as progress.

The rest of this section is devoted to uncover the form of the “hidden entities”, presenting common ways to describe the dependency of truth values of complete sentences and standard arguments for *double indexing.* After this a subsection then addresses the question of individuation by comparing two (extreme) ways of singling out the appropriate entities.

2.1.2 Double indexing

If one reflects upon what the extension of indexicals should be, one might come up with equations like the following:

(2) a. the extension of *I* is the utterance-producing individual—the ‘utterer’, ‘author’, ‘speaker’, or ‘agent’.
b. the extension of *here* is the spatial location where the extension of *I* produces the utterance.
c. the extension of *now* is the temporal location where the extension of *I* produces the utterance.

These are completely reasonable assumptions, and any theory of the meaning of indexi-

[9] At least, as long as their ontological status is conceived to be ‘lower’ as that of situations. That is, if these “hidden entities” can be established on independent grounds, what needs to be exlucded from the theory of truth conditions are situations. I owe this point to Ede Zimmermann (p.c.).

cals should try to capture them somehow.[10] From the truth of (2) one might get tempted to infer that the following equations have to be true, too, because the *descriptive content* of the indexicals on the left seem to be completely captured by the respective definite descriptions (if one overlooks that the descriptive content of *I* is not as clear as one might like it to be):

(3) a. the extension of *I* = the extension of *the utterer/author/speaker/agent*
b. the extension of *here* = the extension of *the place where the agent utters something*
c. the extension of *now* = the extension of *the moment in time in which the agent utters something*

Like the definite description on the right side of the equation in (3), the extensions of indexicals seem to vary with (something which covaries with) circumstances: if, e.g. Peter uses *I*, its extension is Peter; if Mary uses *I*, its extension is Mary, etc.[11] The same holds for the definite descriptions on the right side of the equations: if Peter uses *the speaker*, he at least can refer to himself; also Mary, etc., although, admittedly, it seems strange to express oneself that way. If one attributes this strangeness to a pragmatic effect (e.g. a violation of the Gricean Maxim of Manner, since Peter could have used the much shorter *I* instead of *the speaker*, or (as pointed out to me by Ede Zimmermann) Heim's *Maximize Presupposition*), it doesn't contradict the equations.

One of the most crucial observations regarding the behavior of indexicals is that (3) is wrong. To see this, indexicals and their alleged paraphrases are put in intensional constructions. The former, unlike the latter, do not seem to get bound in these contexts.[12] Therefore, something is wrong with the equations in (3):

(4) a. I am now talking to you.
b. The speaker is talking to the addressee at the time of utterance.

(5) a. Peter thinks that I am now talking to you.
b. Peter thinks that the speaker is talking to the addressee at the time of utterance.

[10] However, it is argued below that they cannot be regarded as general characterizations of the *meaning* of indexicals. This is so because of the reference to an utterance in (2a) on which all extensions mentioned in (2) are made dependent since the extension of (2a) makes its way into the characterizations of the other extensions. Below, it is argued that the extension of indexicals is independent of any utterances, and thus, (2) can only be regarded as partial description of their meaning; namely as their meaning qua being *uttered*.

[11] To reiterate, below it is argued that no hypothetical *usage* of any indexical is needed for it to have a referent. Hence, this way of describing the semantic values of indexicals is as preliminary as before.

[12] There are instances where this seems to happen, but these constructions seem to be exceptional rather than the rule. Cf. Schlenker (2003). What needs to be kept separate are so-called "fake indexicals" (Kratzer, 2009; Rullmann, 2004), that is, expressions which look like indexicals but need to be understood as being bound; e.g. *my* under one reading of *Only I did my homework (and everybody else didn't do his homework).* Kratzer's assumption is that these expressions receive the syntactic feature set which they spell out morphologically from their binder (*Only I* or *I*) in contrast to "real" indexicals, which introduce these features into the derivation themselves. This stance is adopted here as well.

The sentences in (4) seem to be equivalent, that is, they seem to have the same truth value in every circumstance. Despite the fact that no one would use (4b) to express this proposition, nothing else seems to get lost if one assumes that (4b) is the correct paraphrase of (4a). But this is not the case in (5), where the alleged equivalence is lost. (5a) may be false because Peter doesn't think that Fritz (the actual speaker) is talking to Mary (the actual addressee) at 11:55 o'clock on Thursday, the 7th of April 2016 (the actual time). But this thought may be enough for one reading of (5b)—namely its de dicto reading—to be true since Peter may believe that Fritz is the speaker, Mary his addressee and the time is as mentioned. Thus, under this reading, the definite descriptions in (5b) can be bound within the intensional environment introduced by the attitude verb, while the indexicals in (5a) don't. (5a) has no reading corresponding to the de dicto reading of (5b).

The conclusion that has to be drawn from this is pretty straightforward: although the kind of entities indexicals and non-indexical (or absolute) expressions are dependent upon are related (or even the same), the way in which these expressions depend on these entities differs at least in one respect: however indexicals exactly depend on (something that covaries with) circumstances, this dependency is not caught within intensional environments like the way in which absolute expressions are dependent upon (something that covaries with) circumstances.

Arguments like these can be repeated for other indexicals like *yesterday*, *here*, *tomorrow*, etc. with the same result. This observation is usually met with what is called *double indexing*, which means that the extensions of all expressions are formally made dependent upon two different sources. One source is systematically bound in environments like (5), while the other source, on which the indexicals are made to depend, remains free in all environments.[13] That all expressions are made dependent on two sources is merely due to compositionality: instead of having just one source of dependency for indexicals and absolute expressions and working around it in case of indexicals in intensional environments, both kind of expressions are assigned a second source, even though absolute expressions do not depend on anything over and above the source that possibly gets bound. So absolute expressions are not really dependent on the newly introduced source, while indexicals are not dependent on the first, but only on the second source alone. For better reference, the source which indexicals are dependent upon is called the *context*, while the one that (possibly) gets bound in intensional environments is called the *index*. Thus indexicals are context-dependent and absolute expressions are index dependent. Note that this way of introducing this terminology does not (yet) make a substantial claim about what contexts and indices are. It just fixes a matter of speaking. To be of any use, the notions of *context* and *index* need to sharpened. To this end, two things need to be done: (i) investigating which parameters of dependency have to be

[13]...at least if one accepts Kaplan's (1989) *Ban on Monsters*. Taking de re-interpretations and the so-called "Bäuerle" or "third" readings (after Bäuerle (1983) and von Fintel and Heim (2011, ch. 8)) into account, it is safer to weaken this claim by inserting *can be* for *is*. That is, one expression can be free in an intensional environment without necessarily being context-dependent. Thus, not all sources are bound in intensional environments. See section 4.1.1 for more on the ban on monsters and section 4.1.4 for "Bäuerle readings".

provided by contexts and indices; and (ii) elaborating on how contexts and indices are individuated. The first issue will be tackled mostly with the aid of Lewis (1980), while the second one goes back to the formal definitions of Kaplan (1989b).

2.1.3 Restricting and escaping dependencies

Which aspects of indices and contexts are relevant for the truth value of a given sentence is an empirical question. According to Lewis (1980)[14], the most natural way is to look for expressions that can easily be understood as modifying the dependency on a given aspect in question.[15] So the question is how contexts and indices have to look like to make the following sentences true:

(6) a. Somebody coughed.
b. Somebody coughed in Vienna.
c. Somebody coughed on January, 21st, 2015.
d. Somebody coughed in Vienna on January, 21st, 2015.

(6d) is true at an index i iff i is such that some person coughed in Vienna (location) on January, 21st, 2015 (time-interval) in a certain world w; (6c) is true at an index i iff i is such that somebody coughed on January, 21st, 2015, in an arbitrary but specific spatial location in a particular world w; (6b) is true at an index i iff i is such that somebody coughed in Vienna (location) at some time-interval (in the past) in a particular world w; and (6a) seems to be true at an index i iff somebody coughed at some time-interval (in the past) in an arbitrary but specific location in an arbitrary but specific world w. The addendum "in the past" derives from the past tense of the main verb. Hence, indices that make (6d) true, also make (6a-c) true, and all indices that make either (6b) or (6c) true, also make (6a) true, while there are indices that make (6b) true but (6c) false, and vice versa. On the other hand, there are indices that make (6a) true while falsifying (6b-d).

The truth conditions of sentences thus seem to directly appeal to certain aspects of indices, namely their world, their time and their spatial location. But as can also be seen given the right linguistic material, this appeal can be narrowed to specific times or locations. Truth conditions can even become independent of certain aspects altogether:

(7) a. Nowhere was anybody coughing.
b. Somebody was always coughing.

[14]Kaplan (1989b, 511, fn. 35) follows the same kind of reasoning:

> "Recall that in a particular formal theory the features of a circumstance must include all elements with respect to which there are content operators, and the aspects of a context must include all elements with respect to which there are indexicals. Thus, in a language with both the usual modal operators '$\Diamond$', '$\Box$', and an indexical modal operator 'it is actually the case that' will contain a possible world history feature in its circumstances as well as an analogues aspect in its contexts."

[15]The way this is put here makes this a pretty vague affair, since it is by no means clear what it means for a construction to be "easily understandable" in such and such way. Thus, the case isn't decided *just* empirically, but empirically, given a certain analysis.

c. Necessarily, somebody was coughing.

Disregarding tense, the extensions of these sentences are independent of the location-, time- or world-aspect of indices, respectively, because of the presence of *nowhere*, *always* and *necessarily* in the sense that, e.g., the truth value of (7c) does not vary with the world-aspect of any index, but is either true or false with respect to all of them.[16] The same holds for (7b) with respect to time-aspect and for (7a) with respect to location-aspects. This doesn't mean that the underlying sentence (namely (7) without any adverb, i.e. (6a)) is independent of the aspects in question. Its truth value covaries with each of them, potentially. The adverbs are taken taken to *shift* the parameters, which means that the sentences themselves must at least technically be dependent upon them. Otherwise, the shifters wouldn't have anything to bite on. Hence, the semantic values of the sentences in (7) are taken to come about like this:

(8) a. Nowhere + (6a)
b. Always + (6a)
c. Necessarily + (6a)

Thus, (6a), which is taken to depend on all aspects mentioned so far, is modified further in (8), and (partial) independence is achieved by this modification.[17]

The other sentences in (6), on the contrary, still depend on all aspects of indices—and not just in the technical sense, even though the range of aspects that are relevant for their truth values is narrowed down to those fulfilling the descriptive content of *in Vienna* or *January 21st, 2015*. Thus, the dependency is merely *restricted*, but not escaped altogether. This restriction can be understood in the same format as (8), that is, as (6a) modified by *in Vienna*, and *on January, 21st, 2015*, or both, respectively.

In the very same sense, indexicals also restrict the dependency on certain aspects to a particular range:

(9) a. Somebody coughed here.
b. Somebody coughed yesterday.

[16] This needs to be qualified if quantification in general, and quantification over worlds in particular, is mediated by accessibility relations, e.g. to account for different modal flavors. If so, then the set of worlds quantified over is and remains dependent on the initial world. Thus, different initial words may give rise to different domains of (modal) quantification and thereby still induce a dependency between the initial world and the truth value of the quantified sentence. Then, the notion of being a shifter needs to be reformulated, simply because modifying a sentence with *necessarily* doesn't suffice to achieve relative independence. Shifting then does not escape dependencies, even though a variable the embedded constituent is relativized to get bound.

[17] There is a different way to think about this. (8) implies that tense only then behaves indexically if the derivation leaves it untouched; hence, tense is no indexical under all circumstances, but only if it surfaces unmodified. Understood this way, tense morphology behaves similar to definite descriptions and third person pronouns. Alternatively, the sentence underlying (8) and (6) is assumed to enter the composition tenselessly. It could receive the appropriate tense-morphology via some agree-like mechanism. Understood this way, embedded and unembedded tense are two distinct phenomena which happen to be realized similarly morphologically, like fake indexicals and indexicals, see fn. 12, page 21. This approach would therefore need to assume that (6a) doesn't underlie, say, (7c). This matter is left open.

c. Somebody actually coughed.

For determining a truth value for (9a), one needs to know what *here* refers to, since (9a) seems to be true at an index i iff the world w of i is such that nobody coughed *at the place* "here" *refers to* at any time in the past in w. If *here* refers to, e.g., Vienna, (9a) has the same truth value as (6b) at the index i. If it refers to Frankfurt, (9a) has the same truth conditions as *somebody coughed in Frankfurt* at i, etc. And similarly for *yesterday* with respect to times in (9b) and *actually* with respect to worlds in (9c). Although, one must admit, there are different readings for the latter as well, e.g.

(10) It could have been that everyone rich was actually poor,

taken from Lewis (1986), where *actually* doesn't seem to refer back to the world-aspect of the context, but just adds some emphasis to the reference to the counterfactual world introduced by the conditional. Hence, it is argued that *actually* may not have to refer to the actual world, but just to the world-aspect of the next higher index, cf., e.g., Stalnaker (2014) for a recent claim like that. Recently, Yalcin (2015) has argued against any 'shifty' account of *actually*. Hence, the support for a world-parameter in the context is rather sparse.

The other parameters are better motivated, since apart from *here* and *yesterday*, there are further indexicals like *now*, which can, given the right referent, yield sentences similar to (6c), or, combined with (9a), similar to (6d). Thus, there is more than one expression whose behavior can be explained by assuming a particular parameter in contexts. To be completely sure, one would need to show that, e.g., *today* and *now* really address the same parameter, that is, that they vary under the same circumstances. Albeit intuitively correct, this isn't entirely trivial, because *now* varies much more frequently than *today*, even though there is some leeway due to vagueness. *Now* is affected by every change in time, regardless how slight, while *today* isn't—simply because *today* refers to the very same day on many occasions while *now* easily 'shifts' from one occasion to the other. But assuming so at least explains why whenever two contexts supply different referents for *today*, they also yield two semantic values for *now*. Hence, there is at least some motivation.

What may be taken as further motivation for grouping several expression together as addressing one and the same parameter, and hence for a world-aspect in contexts, is that, to a certain extent, indexicals and adverbs compete for the same 'slot', so to speak, not only syntactically, but also semantically:

(11) a. ?Never, people give in today.
b. ?Everywhere, mushrooms grow here.
c. ?Necessarily, children actually age.

If there are interpretations, they are not as literal as they should be. It is possible to understand the indexicals in a more "frame setting" manner. I.e. *today* in (11a) can be understood similarly to *nowadays*, such that it somehow serves as restrictor for *never*. Likewise (11b), which seems to have a reading that is roughly paraphrasable as *over here,* *mushrooms grow everywhere*. And (11c) can be understood with *actually* just adding some emphasis (Yalcin, 2015, a.o.):

(12) a. ?Today/nowadays/yesterday, people never give in.
b. Here/over there, mushrooms grow everywhere.
c. Actually, children necessarily age.

But trying to understand these examples with the indexicals contributing their referents in the position they overtly occupy is not easy, if possible at all. This is easily[18] accounted for if, e.g. *mushrooms grow* only depends on one location-parameter, addressed by both, *everywhere* and *here* in (12b). All one must then prohibit to rule out sentences like (12) is vacuous quantification (in the case at hand, *everywhere* quantifies vacuously, because *here* occupies the location parameter). Interestingly, indexicals and adverbial (or adjectival) shifters aren't completely incompatible, as (13) shows. These sentences seem to have readings according to which the indexicals first restrict the realm of aspects to a certain (spatial, temporal, or modal) range, from where the shifting can proceed.[19]

Also, restricting oneself to indexicals presumably addressing the same parameters, it isn't easy to iterate modification at all:[20]

(13) a. #People now give in today.
b. #Now, people give in today.
c. #Here, mushrooms grow over there.
d. #Over there, mushrooms grow here.

So, the existence of, e.g., spatial, temporal or modal adverbs like the ones in (7), or the modifiers in (6) are evidence for the analysis in (8) (and something similar for the other sentences in (6)) and thus for the dependency of (some tenseless variant of) (6a) on those aspects. And since (9) can be understood in the same way, viz. (14), this statement extends to indexicals as well.

(14) a. Here + Somebody coughed.
b. Yesterday + Somebody coughed.
c. Actually + Somebody coughed.

Thus, returning to the terminology introduced above, whatever *contexts* exactly are,

[18] That is not to say that this is the only explanation available. There might as well be some simple syntactic reason.

[19] Although, one must admit, some similar looking combinations do not work even though different aspects are concerned, while some others do. There seem to be more, possibly syntactic factors involved:

(i) a. #Always, smoking actually causes cancer.
b. Sometimes, it actually rains here.
c. Sometimes, it rains even here.
d. Here, it never rains.

[20] All of these examples may be ruled out on syntactic grounds, e.g. in terms of competition for the same positions in the tree. But this doesn't explain why examples like (12) are fine.

Lewis's criterion for the existence of contextual parameters is the existence of *indexicals* that are most naturally understood as directly referring to a particular aspect, and, analogously, his criterion for the existence of *index-parameters* is the existence of absolute expressions that are best understood as modifying (shifting) the dependency on the respective aspect. One difference between indexicals and absolute expressions is that they rely on different sources ('double indexing') and thus modify one and the same parameter in different ways. *Here* relocates the source where a location-parameter receives its value from to the context, while *in Vienna* restricts the range of index-location-parameters to those being in Vienna. Note that both criteria make the existence of parameters a language-specific matter in the sense that the very existence of a particular class of expressions is used as their cornerstones. Thus, if there are languages that do not employ any indexical expressions, then these languages do not need contexts like English (or German) needs them; and if they employ only a subset of the English indexicals, their contexts have fewer parameters. The same holds, mutatis mutandis, for absolute expressions and indices.[21] Without such a criterion, it is not clear which parameters should be associated with contexts at all. Since there are many possible ways to define what contexts are, and also many possible ways in which expressions might be judged context-dependent, contexts would then be lists of arbitrary parameters.

Given this criterion, first and second person pronouns indicate a context-parameter for individuals as well.

(15) a. I am a lumberjack.
b. You are a lumberjack.

This carries over to their plural counterparts as in (16a) and (16b).

(16) a. We are lumberjacks.
b. You are lumberjacks.

Third person pronouns (in demonstrative or deictic uses) may also serve as evidence for an additional parameter, as can be seen in (17a) and (17b).

(17) a. She is a lumberjack. *deictic* use
b. They are lumberjacks. *deictic* use

In all of these cases one has to know what *I*, *you*, or *she* refers to in order to derive the truth value at a given situation.[22] In this respect, these expressions seem to behave like

[21] "Expressions" is meant to include functional elements, since at least tense seems to count as indexical, too, while mood partly exemplifies the behavior of index-dependent expressions. But this complicated matter is not discussed here.

[22] The way the theory is developed here, it doesn't represent what Kaplan calls the "Corrected Fregean Theory of Demonstratives", which is the view he himself favors, but his "Indexical Theory of Demonstratives"; cf. Kaplan (1989b, p. 528), and below 2.3.5. He elaborates quite a bit on the shortcomings of a historic alternative, which he dubs "Fregean Theory", in which the demonstrated object is determined not by the context, but the index. Here is his summary (Kaplan, 1989b, p. 517):

> "My theory, the direct reference theory, claims that in assessing the proposition in counterfactual circumstances it is the actual demonstratum—in the example, Paul—that is the relevant individual.

here, *now*, *yesterday*, etc, and thereby have to be categorized as indexicals as well. Thus, contexts may need to provide sources for the values of these expressions, too. And they need to provide them independently of each other, since all personal pronouns can occur within one sentence without necessarily having the same value. Otherwise, (18a) would mean the same as (18b), contrary to fact:

(18) a. I told you to shave his dog.
b. I told myself to shave my dog.

Thus, by the same logic as above, individuals serve as parameters as well, and contexts need to provide the means to trace them individually. For the moment, the discussion of parameters justified by personal pronouns is left at this stage. The issue is picked up again in section 2.3.5, after a variety of accounts is discussed. But one thing is done away with right away:

Taking the conclusions of the Lewisian reasoning for granted, what about a sentence like *somebody coughed* (= (6a))? If regarding shifting operators as evidence for parameters is correct for sentences like the ones in (7), then *somebody* in (6a) should be taken as an argument in favor of an *individual*-parameter in indices, since it binds individual variables sentence-internally. And there is not only *somebody*, but *everybody*, *most girls*, *no reasonable dictator*, and so on. By strict parallel reasoning this implies that sentences without quantifiers over individuals (or other means of modification) should be dependent on this *individual* parameter. Also, the structure of the examples would have to be of the same kind as the quantification Lewis uses to illustrate shiftiness. But this doesn't seem to be correct, since ordinary quantification over individuals like in (19) cannot be reduced to an operator and an embedded sentence, simply because there is no embedded sentence:

(19)	a.	Somebody sleeps.	Somebody + sleeps
	b.	Everybody is a lumberjack	Everybody + is a lumberjack
	c.	Every man loves a woman	Every man + a woman + loves

Needless to say, *sleeps*, *is a lumberjack*, and *loves* are predicates or relations, but not sentences. Therefore, the difference to the examples in (6) or (7) seems to consist in a purely syntactic notion of sentences. Since in type logical parlance, the embedded sentences in (7) (cf. (8)) are of a type (σt), where σ stands in either for the type of time, place, or world, respectively, or for a tuple consisting of all of them. On the other hand, why should the type of predicates, (et), be an exception? Or, put differently, why shouldn't e belong to the tuples σ as well? From a syntactic point of view, there is

The Fregean theory claims that the proposition is to be construed as if the sense of the demonstration were the sense of the demonstrative. Thus, in counterfactual situations it is the individual that would have been demonstrated that is the relevant individual. According to the direct reference theory, demonstratives are rigid designators. According to the Fregean theory, their denotation varies in different counterfactual circumstances as the demonstrata of the associated demonstration would vary in those circumstances. [...] [W]ith respect to the problem of associating propositions with utterances the direct reference theory is correct and the Fregean theory is wrong."

a difference. Usually, functions with type (σt) are completely *saturated*, that is, they do not need another expression to be self standing sentences. Functions with type *(et)* are not, meaning that they aren't sentences as long as they are not complemented with the right number of nominal expressions.[23] So, if e is added to σ, it seems that two kinds of dependency are conflated, namely (semantic) dependency of the semantic values and syntactic dependency (saturation). If one wants to keep these two dependencies distinct—e.g. to explain why (6a) can stand on its own—, the parallelism between expressions of type (σt) and expressions of type *(et)* falls apart.

One might want to repeat this reasoning with predicates that have some of their argument slots saturated by third person pronouns, since the resulting expressions indeed are sentences from a syntactical point of view, although they might be conceived to be unsaturated from a semantic point of view. That is, sentences employing (free) third person pronouns might be conceived as fulfilling all the criteria to be subject of an analysis like (8) or (19). But if one examines the natural-language counterparts of such structures, one immediately sees that this leads nowhere:[24]

(20) a. *Somebody, he sleeps. Somebody + he sleeps.
b. *Everybody, he is a lumberjack. Everybody + he is a lumberjack
c. *Every man, a woman, he loves her. Every man + a woman + he loves her

But, firstly, for (19) to be an exact parallel of (8), (8) would need to have the following form:

(21) a. Nowhere + somebody coughed there
b. Always + somebody coughs then
c. Necessarily + somebody coughed *world-pronoun*

But natural-language counterparts of (21), if expressible at all, are as ungrammatical as (20):

(22) a. *Nowhere, anybody coughed there.
b. *Always, somebody coughs then.

And, secondly, one might argue as follows: it is at least misleading to conclude from (20) that overt pronouns cannot be bound, since there are uses of third person personal pronouns that receive a bound interpretation, namely:

[23]Considering the contributions of nominals, the foregoing in plainly wrong. Sortals like *woman* have the same type as intransitive verbs, namely *(et)*, but these argument slots aren't overtly filled with some other expressions as it is the case for verbs. These slots are taken care of by determiner extensions. Thus, the type *(et)* doesn't express the need for saturation univocally, or at least not in the same sense for verbs and nouns.

[24]There are instances of (i) which seem to be fine:

(i) a. Peter, he sleeps.
b. This man, I like him.

However, these only work with referential expressions, it seems. On a side node, (20) is pretty close to the way in which quantifying-in is described in Montague (1970a).

(23) a. No man believes that he owns a shitty car.
b. Every farmer who owned a sheep that he disliked sold it on the market.

Crucially, what seems to be required to be 'shifted' in this way is that the pronouns are embedded in an unambiguously sentential environment, be it a *that*-clause as in (23a), or a relative clause as in (23b). Thus, it seems, if it is guaranteed by surrounding syntactic material that a clause is formed, then third person personal pronouns might be understood as spelling out a shiftable parameter. But (23a) and (23b) are by no standards parallel. While (23a) indeed embeds a full clause, (23b) only contains a (nested) relative clause in which, presumably, *he* gets bound by *who* and then combined with *farmer*, before the determiner *every* attaches to the complex noun. Thus, (23b) doesn't have the structure Lewis requires. Likewise, (23a) doesn't have the structure, either, since *no man* doesn't attach to the embedded sentence directly. What forms a constituent with the sentence is the attitude verb. Thus, (23) as a whole doesn't show that (20) is wrong. This might be taken to show that attitude verbs (or complementizers) and relative pronouns are expressions that bind overt pronouns, but it doesn't establish that adnominal quantification over individuals and adverbial quantification over times, locations, or worlds are parallel.[25]

2.2 Varieties of Two-Dimensionalism

Taking stock, a *context* has to contain at least the parameters listed in 1, while an *index* at least contains the ones listed in 2

1. *world, time, location, agent, addressee(s), demonstrated object(s), ...*
2. *world, time, location, ...*

That contexts (for English) contain world-, time, and location-parameters is justified by *actually*, *now*, and *here*; and the individual-parameters listed afterwards in 1 are justified by *I*, *you* (singular) and *she* (used deictically). That an index contains world-, time, and location-parameters is justified by *necessarily*, *always*, and *nowhere* (and more). Thus, indices share some, but not all of the structures that make up contexts. And this is desirable, since, generally speaking, it should be possible to evaluate a sentence at its context. That is, the truth value of a sentence in a context at that very same context should be derivable. To this end, contexts should contain at least all index-parameters (Kaplan, 1989b, 511, fn. 35; cf. T. E. Zimmermann, 1991).

After having argued for double indexing, (i.e. the differentiation between *context* and *index*) and after illustrating ways to argue for the existence of several parameters spread across contexts and indices, it is now time to turn to the question of individuation. There are several ways to work these observations into a theory, and different answers underlie several accounts in the literature. The main task is to decide how contexts (and indices)

[25] Not to mention the 'anti-locality'-effect that requires a pronoun and its "binder" not to be coarguments of the same (lexical) expression. See section 3.5 below.

are individuated. In the interest of minimizing commitment, two things were avoided in the foregoing sections: (i) to identify the parameters the extensions of expressions seem to be directly dependent upon with aspects of situations, and (ii) to use the term *utterance* in the description of the dependency of indexicals.

As self-evident as the identification in (i) may seem, it should not be made without further consideration. There are some vital differences between several accounts in the literature, as to whether contexts and indices should be individuated on the basis of situations or not. T. E. Zimmermann (1991) and T. E. Zimmermann (2012b), for example, mostly operates on this assumption, but also gives an argument, why this may be not the right way to go for indices—thereby following Lewis (1980), who basically argues that only contexts should be derived on the basis of situations, even though he doesn't do so explicitly. Kaplan's solution to this problem is slightly different. He defines contexts solely on the basis of pure combinatorics of (freely varying) parameters. Thus, his notion of context is the most abstract, but arguably the most general as well. But to see the reasons why he (probably) made this decision, it is instructive to consider other, maybe more intuitive situation-based solutions first.

Related, but not entirely the same, is the question (ii) whether the dependency exhibited by indexicals should be described in terms of utterances or not. An utterance-based treatment of indexicals usually means that the notion of context is defined as being (a representation of) an utterance-situation, i.e. a situation in which something is uttered. *Utterance* usually is not understood literally but is taken to cover any token-producing procedure in the widest sense possible, e.g. saying and writing as well as thinking. Thereby, the questions in (i) and (ii) are related. This doesn't mean that it isn't possible to avoid the notion of utterances (however understood) while maintaining that situations individuate contexts (although the other way round might be untenable). Put the other way round: deciding on situations as the basis of contexts still leaves open the question whether (possible) utterances should enter the definition of contexts or not. If so, a follow-up question is whether there should be further restrictions on utterances of particular sentence-tokens. E.g., as von Stechow (1979) (and following him Kupffer (2001) and Kupffer (2014), see also T. E. Zimmermann (1997)) has it, a context *for* an expression φ is a situation in which a token of φ is produced. This is different from the setup covered in most detail in T. E. Zimmermann (1991) and T. E. Zimmermann (2012b), and it is definitely not a path Kaplan has taken. This will be discussed in much more detail in section 2.3.

Two things will be done in the following. First, varieties of situation-based approaches are reviewed. Basically, this serves as an opportunity to introduce some technicalities and terminology. When this has been done, arguments are considered that imply that this way of setting up context theory restricts the set of possible contexts way too much. Thus, the simple situation-based approach is temporally abandoned in favor of an approach which stems from free varying parameters upon which some constraints are put. Arguments for and against several of these constraints are considered. The overall conclusion will be that situation-based contexts and indices are the way to go, even though the ultimate form of the overall system isn't quite as one might expect from the first review of situation-based systems.

2.2.1 Situation-based contexts and indices

Possibly the most straightforward characterization of contexts is this: “A context is a location—time, place, and possible world—where a sentence is said.” (Lewis, 1980, p. 21) This initial statement then may be further qualified by limiting assumptions like ignoring contexts in which more than one person is saying (or *uttering*) a sentence. That is, the underlying assumption is that other parameters apart from the situational core can be derived on the basis of it.[26] This is not to say that situations—this is taken to be the meaning of “location” in the quote above—in which more individuals are uttering sentences do not qualify as contexts as well, but to avoid messiness from the get-go, this might do for the moment. Other assumptions with the same function concern the audience (or addressees) of the utterance as well as the number of objects pointed at while producing a sentence token: for a first exposition, these are taken to fulfill uniqueness-conditions as well. The difference between speaker and addressee on the one hand, and demonstrated-object on the other lies in their existence conditions: the existence of a speaker and a (possibly non-distinct) addressee are taken to be a necessary condition for contexts, unlike the existence of a demonstrated object. Intuitively, what matters at first is whether someone is talking (to somebody) or not. Whether he or she points at something (or intends to refer to something within the vicinity) is secondary. In the following, this ranking is accommodated by distinguishing *contexts* and *demonstrative contexts*, where the latter make a (proper) subset of the former. Another limiting assumption (to be dropped later) is that demonstrative contexts are contexts in which at most one act of demonstration takes place.

In the following[27], functions written with small caps, Sp, Ad, Dem, stand in for speaker/agent- addressee- and demonstrated object-*parameters*, respectively: they take situations as arguments, and map them to the individuals playing the respective rôles. Since situations are understood as spatio-temporal slices of worlds, each of these relations is assumed to be sensitive to all of these coordinates, i.e. both to the world the situation belongs to and to the spatio-temporal location, which may be taken to consist of a time and a location. These are also called the (situational) *core* in the following, in contradistinction to other coordinates, which consist of individuals. Ad and Dem are special insofar as they require a situation and a speaker (or agent) within it, who then needs to address or point at somebody or something in the situation. This could be made explicit, e.g. by having Ad and Dem take two arguments, but since agents and utterance-situations are supposed to stand in a one-one correspondence, this dependency is hidden in the constants Ad or Dem themselves. $\exists! x P(x)$, as usual, is short for $\exists x(P(x)\ \&\ \forall y\ P(y) \rightarrow x = y)$.

[26] The passage from Lewis continues (Lewis, 1980, 27f.):

> “That is not to say that the only features of context are time, place, and world. There are countless other features, but they do not vary independently. They are given by the intrinsic and relational character of the time, place, and world in question.”

[27] The technical apparatus is adapted from T. E. Zimmermann (2012b), although some notational changes have been made.

(24) a. $\textsc{Sp}(s) := \begin{cases} x & \text{iff } \exists! y : y \textit{ utters} \text{ something in } s \ \& \ y = x \\ \#_e & \text{otherwise} \end{cases}$

b. $\textsc{Ad}(s) := \begin{cases} x & \text{iff } \exists! y : y \text{ is addressed by } \textsc{Sp}(s) \text{ in } s \ \& \ y = x \\ \#_e & \text{otherwise} \end{cases}$

c. $\textsc{Dem}(s) := \begin{cases} x & \text{iff } \exists! y : \textsc{Sp}(s) \text{ points at } y \text{ in } s \ \& \ y = x \\ \#_e & \text{otherwise} \end{cases}$

Among the set of possible situations, *LS* (*L*ogical *S*pace) for short, K is the (sub-)set of contexts and dK is the (sub-)set of demonstrative contexts:

(25) a. $K := \{s \in LS : \textsc{Sp}(s) \neq \#_e \ \& \ \textsc{Ad}(s) \neq \#_e\}$

b. $dK := \{s \in K : \textsc{Dem}(s) \neq \#_e\}$

Obviously,

(26) $dK \subseteq K \subseteq LS.$

In general, for any expression A, the character of A is a function from K into A's intension, while A's intension is a function from LS into its extension. This of course needs to be made way more precise (i.e., the functions just mentioned have to be defined in terms of the sets in (25)). To illustrate the sort of statement that emerges from such a theory for complete sentences, whose extensions are taken to be truth-values, the following clauses are sufficient:

(27) For any declarative sentence S:

a. The *character* of S—$\|S\|$—is a function from K into the set of characteristic functions of subsets of LS.

b. The *intension* of S at a context $k \in K$—$\|S\|^k$—is a function from LS into truth-values.

c. The *extension* of S at a context $k \in K$ and a possible situation $s \in LS$—$\|S\|^{k,s}$—is its truth value wrt. s and k.

First and second person pronouns are dependent upon the output of Sp and Ad, and deictically used third person pronouns on Dem. Thus, their extensions can be given as follows:

(28) a. $\|\text{I}\|^{k,s} = \textsc{Sp}(k)$ defined iff $k \in K$, $\#_e$, otherwise

b. $\|\text{you}\|^{k,s} = \textsc{Ad}(k)$ defined iff $k \in K$, $\#_e$, otherwise

c. $\|\text{she}\|^{k,s} = \textsc{Dem}(k)$ defined iff $k \in dK$, $\#_e$, otherwise

The descriptive content of *I* therefore is exhausted by the speaker-parameter. Given the rather abstract interpretation of *utterance*, this doesn't lead to the same extension as *the speaker* (evaluated at the same context), since token-production doesn't coincide with speaking. It may be assumed that the natural-language predicate *agent* has an interpretation loose enough to claim $\|\text{I}\|^{k,s} = \|\text{the agent}\|^{k,k}$ (for any $k \in K$ and $s \in LS$), but this is an empirical question on whose answer none of the following depends.

Other indexicals are dependent on those aspects of the situational core that are hidden within the notation: either functions along the lines of (24) for the spatial or temporal location and the world are defined as well, or the situations are 'unpacked' to the very same end. This will be done in 2.2.3 below.

One can think of characters as a certain kind of matrix which will be called *character table* in the following. These are two-dimensional representations similar to the ones Stalnaker uses to represent his propositional concepts, namely matrices in which every line corresponds to a utterance situation (an element of K) while columns correspond to all kinds of situations (elements of LS). In the case of a sentence character, each line gives the proposition expressed by that sentence in the context on the left. Since $K \subseteq LS$, character tables are idealized rectangles, but no squares. If the columns are conventionalized in such a way that they start with those situations that are also utterance situations from the left, and if the order of utterance situations from left to right is the same as the order of utterance situations from top to bottom, a square of utterance situations is singled out which has a diagonal that comprises only those values that an expression receives evaluated twice at the same context. $\|A\|^{k,k}$ is this diagonal, for any $k \in K$. This representation justifies talking about *diagonals*, namely the values on the geometric diagonal of the square formed by the elements of K. Why this is important will become clear in a moment.

K	K				$LS \backslash K$			
	k_0	k_1	k_2	$\dots$	s_0	s_1	s_2	$\dots$
k_0	$\|A\|^{k_0,k_0}$	$\|A\|^{k_0,k_1}$	$\|A\|^{k_0,k_2}$	$\dots$	$\|A\|^{k_0,s_0}$	$\|A\|^{k_0,s_1}$	$\|A\|^{k_0,s_2}$	$\dots$
k_1	$\|A\|^{k_1,k_0}$	$\|A\|^{k_1,k_1}$	$\|A\|^{k_1,k_2}$	$\dots$	$\|A\|^{k_1,s_0}$	$\|A\|^{k_1,s_1}$	$\|A\|^{k_1,s_2}$	$\dots$
k_2	$\|A\|^{k_2,k_0}$	$\|A\|^{k_2,k_1}$	$\|A\|^{k_2,k_2}$	$\dots$	$\|A\|^{k_2,s_0}$	$\|A\|^{k_2,s_1}$	$\|A\|^{k_2,s_2}$	$\dots$
$\dots$		$\dots$				$\dots$		

Figure 2.1: The character table for A

Another difference between the situation-based approach developed here and the formal system of Kaplan (1989b) is that Kaplan doesn't make use of a clause like (28c). That is, he does not avail himself of a demonstrated-object aspect or parameter at all (apart from the fact that if he did, he couldn't make use of DEM, since he doesn't ground his notion of context in situations). He takes demonstrations to enter the semantic machinery by way of *dthat*, which he sometimes calls "demonstrative surrogate" (Kaplan, 1989a, p. 581). He admits (in the passage just mentioned) that its description and its definition in Kaplan (1989b) are two different things. He originally intended *dthat* to be a directly referential term that delivers a demonstrated object, i.e. something which may be modeled here as being directly dependent on the value of DEM, but he defines *dthat* as a rigidifying operator that isn't even referential. As an operator, it is one of two *diagonalization*-operators (or 2d-operators) possible in the kind of setup developed here. The other one, just for the sake of completeness, is put to use in Stalnaker (1978). Both are known from the literature on 2-dimensional modal logic (e.g. Segerberg (1973)). They can be defined as follows:[28]

(29) Two 2d-Operators: For all $k \in K$, $s \in LS$:

a. $\|\triangledown A\|^{k,s} = \|A\|^{k,k}$, if defined. Kaplan's (1989) '*dthat*'

b. $\|\triangleright A\|^{k,s} = \|A\|^{s,s}$, if defined. '†' in Stalnaker (1978)

Using character tables, one can visualize the output of these operators as in Figures 2.2 and 2.3. The first one represents the effect of Kaplan's *dthat*-operator: The values formerly (in Figure 2.1) listed on the diagonal (namely $\|A\|^{k_0,k_0}$, $\|A\|^{k_1,k_1}$, ...) are now found in each column (and on the diagonal). This is different in the second table, where the effect of Stalnaker's operator is represented. There, the former diagonal is found in each row (and again on the diagonal).

K	K				$LS\backslash K$			
	k_0	k_1	k_2	...	s_0	s_1	s_2	...
k_0	$\|A\|^{k_0,k_0}$	$\|A\|^{k_0,k_0}$	$\|A\|^{k_0,k_0}$	...	$\|A\|^{k_0,k_0}$	$\|A\|^{k_0,k_1}$	$\|A\|^{k_0,k_0}$	...
k_1	$\|A\|^{k_1,k_1}$	$\|A\|^{k_1,k_1}$	$\|A\|^{k_1,k_1}$	...	$\|A\|^{k_1,k_1}$	$\|A\|^{k_1,k_1}$	$\|A\|^{k_1,k_1}$	...
k_2	$\|A\|^{k_2,k_2}$	$\|A\|^{k_2,k_2}$	$\|A\|^{k_2,k_2}$	...	$\|A\|^{k_2,k_2}$	$\|A\|^{k_2,k_2}$	$\|A\|^{k_2,k_2}$	...
...		...				...		

Figure 2.2: The character table for $\triangledown A$

K	K				$LS\backslash K$			
	k_0	k_1	k_2	...	s_0	s_1	s_2	...
k_0	$\|A\|^{k_0,k_0}$	$\|A\|^{k_1,k_1}$	$\|A\|^{k_2,k_2}$	...	$\|A\|^{s_0,s_0}$	$\|A\|^{s_1,s_1}$	$\|A\|^{s_2,s_2}$	...
k_1	$\|A\|^{k_0,k_0}$	$\|A\|^{k_1,k_1}$	$\|A\|^{k_2,k_2}$	...	$\|A\|^{s_0,s_0}$	$\|A\|^{s_1,s_1}$	$\|A\|^{s_2,s_2}$	...
k_2	$\|A\|^{k_0,k_0}$	$\|A\|^{k_1,k_1}$	$\|A\|^{k_2,k_2}$	...	$\|A\|^{s_0,s_0}$	$\|A\|^{s_1,s_1}$	$\|A\|^{s_2,s_2}$	...
...		...				...		

Figure 2.3: The character table for $\triangleright A$

Both operators take one of the two sources of dependencies as a point against which an expressions gets evaluated twice; (29a) chooses the context, while (29b) chooses the index. (29b) might fail to denote because A hosts indexical expressions. If s is in $LS\backslash K$, then these expressions do not receive a value. The right part of the character table then is filled with $\#_e$. (29a) also might fail to denote because $k \in K$ doesn't necessarily supply

[28] The notation is not standard, but it may be the best to remember which operator does what. If the triangle points downwards this means that the diagonal proposition is written in every column of the character-table. Hence, the effect of *dthat*. If the triangle points to the right, the diagonal proposition in written in every line, hence the effect of the other operator; cf. the following character tables.

a demonstrated object. Thus, if there is a demonstratively used expression within A, the 'longer' contexts in dK are needed. But this does not eradicate the whole left part of the respective character table, but only occasionally leads to rows filled with $\#_e$. *dthat* has the effect of evaluating even absolute A against the context, yielding an interpretation that might be associated with direct reference.[29] E.g. if A is a definite description like *the German chancellor*, which normally is assumed to be index-dependent only,[30] *dthat A* rigidifies it and thereby forces an interpretation can be paraphrased by *the actual current local German chancellor* (cf. Kaplan's remark 10 (1989, p. 550)). This paraphrase is intended to highlight the fact that under *dthat*, all parameters are assigned a contextually determined value; here the assumption is that *actual*, *current*, and *local* are indexicals that depend on the world-, time-, and place-parameter of the context, respectively.

Kaplan doesn't treat demonstrated objects (or demonstrations) within the formal system of Kaplan (1989b), but only elaborates on (both of) them in the main text, where he opts for a different solution to the problem of demonstratively used expressions—a solution which utilizes a Fregean account of demonstra*tions* with a two-dimensional twist. Roughly,[31] deictically used pronouns are thought to be incomplete. What they need to do their job is a demonstration in their context. This demonstration needs to be Fregean in the sense that it comes with sense and reference: a *manner of presentation* and a *demonstratum*, a demonstrated object (although the latter may be possibly empty). Kaplan draws an analogy with definite descriptions. As seen above, if modified by *dthat*, the latter receive an interpretation according to which the (unique) individual fulfilling the descriptive part has to exist and is therefore picked from the context. This thought may be taken further to account for demonstratively used definite descriptions. And given some further assumptions—like treating the contribution of demonstrations like definite descriptions like *the brightest heavenly body visible*[32]—, this may then be extended to all kinds of deictic expressions.[33] *Dthat*, understood as the semantic contribution of the demonstratively used expression then could take the contribution of the demonstration as argument and rigidify it, as definite descriptions are rigidified above. Thus, the *complete* contribution of a demonstratively used *that* is

(30) a. *dthat* [the brightest heavenly body visible]
b. the brightest heavenly body now visible from here (Kaplan, 1989b, p. 526)
c. Venus

[29] This is only partly as indented as Kaplan later (Kaplan, 1989a, p. 579) admits.

[30] To be precise, what is thought to be dependent on the world-, time-, and location-parameter of the index is the nominal predicate *German chancellor*. A description like *the German chancellor* inherits its restrictor's depencencies, even though the definite article does not depend on any parameter whatsoever. This is also captured by Kaplan's formal semantics (1989, p. 545).

[31] The following is a pretty condensed representation of Kaplan's theory of demonstratives. There is much more to say once one starts to spell out the details. This is not done here, neither in the present section nor in section 2.3.5, simply for the reason the invocation of demonstrations is claimed to be damaging the whole theory. For the arguments, see below.

[32] Or just the predicate, if one makes *dthat* a variable-binding operator like *the*, cf. Kaplan (1989a, 579, fn. 29).

[33] This seems to be the agenda behind Roberts (2002) and Roberts (2004).

(30b) is the rigidified paraphrase, and (30c) may be the demonstratum, given the right context.

This view, if correct, makes individual parameters as sources of demonstrated objects redundant. The same can be said about the version of *dthat* Kaplan uses in most parts of the main text, where it is construed as a demonstrative surrogate. *Dthat* there is treated as directly referential itself and not as a combination of *dthat* with an appropriate argument as above. The contribution of the demonstration or definite descriptions then are just "attention directors" which leave no traces in the content of the expression themselves. Yet, again, this account would make the parameter-based treatment of demonstratively used expressions useless.

On the other hand, the parameters might also be *defined* the way Kaplan intends *dthat* to work. So, it's possible to resort to a clause like the following (similarly to (29c)) without any loss of substance.[34]

(31) $\|dthat\|^{k,s} = \text{Dem}(k)$ defined iff $k \in dK$, $\#_e$ otherwise

But even if he adopted (31), it remains unclear how this helps in accounting for deictic uses of demonstratives, (third person) pronouns, and definite descriptions. After all, it is simply not clear how these uses are to be derived on the basis of (31) and their characters, which should be absolute in case of descriptions and pronouns, accounting for their non-deictic uses as well. Not to speak of the issue of integrating Dem and Kaplan's remarks on the informativity of sentences in which more than one demonstrative happens to occur. However, the question how deictic uses are integrated is postponed for the moment but to be picked up again in section 2.3.5.

Independently of this question it should be clear that it is desirable to have operators like (29) available, and hence that the individuation of contexts and indices should be guided by the possibility to have them.

2.2.2 Situation-based but parameterized

This variant of the situation-based approach is nothing but a standardization (cf. T. E. Zimmermann, 2012b, 2399ff.).

Contexts in the sense of (25) are exactly those situations among all possible situations to which Sp and Ad each assign exactly one individual (although not necessarily the same one).

(32) Let ρ be the function which assigns to elements of LS the number of their parameters (starting with 0 onward) so that for any $s \in LS$:

[34] That is, one needs to add, the variant of the theory he calls "Indexical Theory of Demonstratives". The theory Kaplan defends in the main text assumes that the semantic work is basically done by demonstra*tions*. Demonstrations are conceived of as mandatorily accompanying demonstratives. Depending on how one spells out the function Dem, everything Kaplan wants from demonstrations might be made compatible with the present approach. Here, it just serves as the source for the demonstrated object, which is why the present theory is not exactly the version Kaplan favors.

$$\rho(s) = \begin{cases} 3 & \text{iff} \quad s \in dK \\ 2 & \text{iff} \quad s \in K \backslash dK \\ 0 & \text{iff} \quad s \in LS \backslash K \end{cases}$$

(33) For any $s \in LS$, let $\pi(s)$ be a set of ordered pairs of natural numbers and situational-parameters—$\pi(s) \subseteq \{n \in \mathbb{N} : 0 \leq n \leq \rho(s)\} \times LS \cup \mathcal{D}$—such that :

a. $(0, s) \in \pi(s)$;
b. $(1, \textsc{Sp}(s)) \in \pi(s)$; if defined, that is, if $1 \leq \rho(s)$
c. $(2, \textsc{Ad}(s)) \in \pi(s)$; if defined, that is, if $2 \leq \rho(s)$
d. $(3, \textsc{Dem}(s)) \in \pi(s)$. if defined, that is, if $3 \leq \rho(s)$

These sets are nothing but sequences. Thus, if s is a situation but no context ($LS \backslash K$), $\pi(s)$ just characterizes $\langle s \rangle$, whereas if it is a context (that is, in K), $\pi(s)$ is a tuple with at least three components, namely $\langle s, \textsc{Sp}(s), \textsc{Ad}(s) \rangle$, depending on whether s also is in dK or not. If it is, $\pi(s)$ is even longer, viz. $\langle s, \textsc{Sp}(s), \textsc{Ad}(s), \textsc{Dem}(s) \rangle$. For ease of reference, the following sets of sequences—the sets of parameterized situations, contexts, and demonstrative contexts, respectively—are singled out:

(34) a. $\Sigma := \{\sigma : \exists s \in LS : \sigma = \pi(s)\}$
b. $\Gamma := \{\sigma : \exists s \in K : \sigma = \pi(s)\}$
c. $d\Gamma := \{\sigma : \exists s \in dK : \sigma = \pi(s)\}$

From (34) is is clear that

(35) $d\Gamma \not\subseteq \Gamma \not\subseteq \Sigma$,

because the tuples differ in length. Compared to the version with implicit parameters, where the analogue of (35) holds, as witnessed by (26), this is inconvenient, but unavoidable. But since these sequences are defined as sets in (33), it is possible to state something similar. That contexts are a special kind of possible situations is now reflected in the fact that there is a subset of Σ—called $\Sigma^{\restriction K}$—such that each of its elements makes the start of an element of Γ.

For example, if $\kappa \in \Gamma$ is a parameterized context, then it has the following structure, where $s \in K$ is the context κ is a parameterized form of:

(36) a. $\langle s, \textsc{Sp}(s), \textsc{Ad}(s) \rangle$
b. $\{(0, s), (1, \textsc{Sp}(s)), (2, \textsc{Ad}(s))\}$

Thus, there is a parameterized situation σ within $\Sigma^{\restriction K}$ such that $\sigma \subset$ (36b), namely:

(37) a. $\langle s \rangle$
b. $\{(0, s)\}$

And the same holds for elements of $d\Gamma$ with respect to $\Sigma^{\restriction dK}$ or even $\Gamma^{\restriction dK}$. Hence, it is possible to single out the relevant subsets

(38) a. $\Sigma^{\restriction K} := \{\sigma \in \Sigma : \exists \kappa \in \Gamma : \sigma \subset \kappa\}$
b. $\Sigma^{\restriction dK} := \{\sigma \in \Sigma : \exists \kappa \in d\Gamma : \sigma \subset \kappa\}$

c. $\Gamma^{\restriction dK} := \{\sigma \in \Gamma : \exists \kappa \in d\Gamma : \sigma \subset \kappa\}$

with which an analogous statement can be made:

(39) $\Sigma^{\restriction dK} \subseteq \Sigma^{\restriction K} \subseteq \Sigma.$

The way things are set up, it is not possible for two sequences of the same length to be distinct just because the individuals are distinct, but the core is the same. Since if the core s is chosen in such a way that, e.g., Sp and Ad are defined, then there is only one possible sequence $\langle s, \text{Sp}(s), \text{Ad}(s)\rangle$, because Sp and Ad come with uniqueness-requirements. But it should be kept in mind that these uniqueness requirements are just built into the theory as limiting assumptions, and not because of a substantial claim about the nature of utterances. However, as long as these assumptions are in force, they have the effect that whenever parameterized situations (of the same length) are distinct, this is due to their being parameterized versions of different situations. Of course, the other factor that plays into this conjecture is that there is a one-one correspondence between elements of LS and elements of Σ. Thus, for every element κ of $d\Gamma$ or Γ, there is exactly one element σ of Σ, such that $\sigma \subset \kappa$, and thus, for every element of, e.g. $d\Gamma$, there is exactly one element in $\Sigma^{\restriction dK}$, etc.

(40) $\forall s, s' \in LS : \rho(s) = \rho(s') \rightarrow \pi(s) \neq \pi(s') \leftrightarrow s \neq s'$

This shouldn't come as a surprise since this formalization differs from the one above only on the surface. It only makes explicit what is implicitly assumed in the simple situation based approach, namely that contexts are individuated by the functions Sp, Ad, and (optionally) Dem, together with all the (limiting) assumptions that found their way into their formulation. This means that there must be a definition of diagonals in this setup. And there is, but it is a tad more complicated than before, because elements of one set of sequences are not easily substituted for elements of other sets. It is thus not possible to simply write $\|A\|^{\kappa,\kappa}$ (for any $\kappa \in \Gamma$) to define the *dthat*-operator. Intuitively, what one needs to find are those situations which are the situational core of contexts, that is, one needs a way to get rid of the additional contextual parameters to yield those situations that taken together with contexts make up the diagonal. To construct such an *Ersatz*-diagonal, one thus simply needs the following notational conventions:

(41) a. $\sigma^{\kappa} := \iota\sigma \in \Sigma : \sigma \subset \kappa$
b. $\kappa^{\sigma} := \iota\kappa \in \Gamma \cup d\Gamma : \sigma \subset \kappa \;\&\; \forall k' \in \Gamma \cup d\Gamma : \sigma \subset \kappa' \rightarrow \kappa' \subset \kappa$, if defined.

(41a) simply eliminates the coordinates that are in contexts but not in indices. (41b) picks the longest sequence within the contextual sequences starting with the index in question, if there is one. This guarantees that the argument slot for contexts in (42b) always gets all the parameters it needs:

(42) $\kappa, \kappa' \in d\Gamma \cup \Gamma$, $\sigma, \sigma' \in \Sigma$:
a. $\|\nabla A\|^{\kappa,\sigma'} = \|A\|^{\kappa,\sigma^{\kappa}}$, if defined
b. $\|\triangleright A\|^{\kappa',\sigma} = \|A\|^{\kappa^{\sigma},\sigma}$, if defined

The use of the (existence and) uniqueness-demanding ι-operator in (41) is guaranteed to work on the basis of (40).

Finally, this allows one to draw character tables even in this setup. To mimic the tables from 2.1 onwards, one has to put elements of $\Gamma \cup d\Gamma$ in every row, and elements of Σ in every column, starting with elements from $\Sigma^{\restriction K}$ or $\Sigma^{\restriction dK}$ such that the diagonal hosts all values $\|A\|^{\kappa,\sigma}$ such that $\kappa \subset \sigma$.

2.2.3 Decomposed cores

It is possible to spell out the situational core in much more detail, namely as being composed of a world-aspect, a time-aspect, and a location. Situations are understood as worlds restricted to specific spatio-temporal regions anyway, but this assumption is not reflected in the formalizations above. This decomposition still adds nothing new over and above the simple situation-based approach above, if done right. But it has the benefit of allowing for a more fine-grained account of shifting expressions like *never*, *everywhere*, *necessarily* as well as indexicals like *now*, *here*, and *actually*, because they can be rendered as operating on only one of the three newly introduced parameters. Indexicals come out as partial instances of *dthat*, namely as diagonalization operators in some, but not not all parameters. Shifting expressions can be said to create $\mathcal{T}$-, $\mathcal{P}$-, or $\mathcal{W}$-intensional environments.

For starters, instead of the sequences on the left side, the decomposed sequences on the right need to be considered:

(43)
a. $\langle s\rangle \rightsquigarrow \langle w_s, t_s, p_s\rangle$
b. $\langle s, \textsc{Sp}(s), \textsc{Ad}(s)\rangle \rightsquigarrow \langle w_s, t_s, p_s,\ \textsc{Sp}(s), \textsc{Ad}(s)\rangle$
c. $\langle s, \textsc{Sp}(s), \textsc{Ad}(s), \textsc{Dem}(s)\rangle \rightsquigarrow \langle w_s, t_s, p_s,\ \textsc{Sp}(s), \textsc{Ad}(s), \textsc{Dem}(s)\rangle$,

where w_s, t_s, and p_s are the world, the time, the place that make up the situation s. This notation is understood along the same lines as Sp, Ad, and Dem, namely as functions from situations to the aspects in question. Thus w_s is the value of a function that maps $s \in LS$ to the world it is a part of, etc. The set of sequences stemming from this reformation of LS is called $^*\Sigma$. (33) from above has to be altered as well:

(44) For any $s \in LS$, let $^*\pi(s)$ be a set of ordered pairs of natural numbers and situational-parameters such that:
a. $(0, w_s) \in {}^*\pi(s)$;
b. $(1, t_s) \in {}^*\pi(s)$;
c. $(2, p_s) \in {}^*\pi(s)$;
d. $(3, \textsc{Sp}(s)) \in {}^*\pi(s)$; if defined, that is, if $3 \leq {}^*\rho(s)$
e. $(4, \textsc{Ad}(s)) \in {}^*\pi(s)$; if defined, that is, if $4 \leq {}^*\rho(s)$
f. $(5, \textsc{Dem}(s)) \in {}^*\pi(s)$. if defined, that is, if $5 \leq {}^*\rho(s)$

For this to work, the numbering-function ρ (defined in (32)) has to start with 2 instead of 0:

(45) Let ${}^{*}\rho$ be the function which assigns elements of LS the number of their parameters (counted from 0 onward), that is if $s \in LS$:

$$^{*}\rho(s) = \begin{cases} 5 & \text{iff} \quad s \in dK \\ 4 & \text{iff} \quad s \in K\backslash dK \\ 2 & \text{iff} \quad s \in LS\backslash K \end{cases}$$

As already mentioned, without further provisions, two distinct situations s and s' might coincide on every parameter. That is, if there are differences between situations that do not manifest themselves in any parameter, $s \neq s'$ and ${}^{*}\pi(s) = {}^{*}\pi(s')$ are compatible. A case in point may be the following example from Kratzer (1989):[35]

> [I]f I am hungry and tired right now, does this mean that my being hungry right now and my being tired right now are one and the same situation? There may or may not be a universal corresponding to the property of being hungry. If so, there is a state of affairs, and hence a situation, consisting of the current time slice of my thin self and that universal. If there is also a universal corresponding to the property of being tired, there must be a state of affairs, and hence a situation, consisting of the current time slice of my thin self and that universal. The two states of affairs contain the same time slice of the same thin particular. But they contain different universals,and hence are different. [...] My being hungry and my being tired now have a chance to come out as distinct facts. What matters is that a situation doesn't have to contain thick particulars—particulars with all the universals they instantiate. Thin particulars may do. (Kratzer, 1989, 116f.)

Decomposition therefore might falsify (40) above, which means that the one-one correspondence between elements of LS and elements of ${}^{*}\Sigma$ is lost. This in turn means that ${}^{*}\Sigma$ isn't as fine-grained as LS. The loss in granularity might be taken to indicate that there is more to situations than being spatio-temporal slices of worlds, thus granting this point to Situation Theory. A possible way out then indeed consists in trying to ensure (40) by taking more parameters on board that reflect the assumed difference—e.g., properties, as Kratzer supposes.[36] This is not done here. Instead, it is assumed with Carnap and Montague that properties can successfully be described by functions

[35]Note that the very same problem occurs with events. Viz. the following passage from Maienborn (2011, p. 807):

"Lemmon [...] suggests that two events are identical just in case they occupy the same portion of space and time. This notion of events seems much too coarse-grained, at least for linguistic purposes, since any two events that just happen to coincide in space and time would, on this account, be identical. To take Davidson's [...] example, we wouldn't be able to distinguish the event of a metal ball rotating around its own axis during a certain time from an event of the metal ball becoming warmer during the very same time span. Note that we could say that the metal ball is slowly becoming warmer while it is rotating quickly, without expressing a contradiction. This indicates that we are dealing with two separate events that coincide in space and time."

[36]This is even compatible with the approach in T. E. Zimmermann (1991) and T. E. Zimmermann (2012b), where open lists of parameters are used in the hope that there are enough of them to ensure (40). Concerning the parameters he mentions explicitly, it remains to be a stipulation rather than a property of indices, though.

from individuals into sets of worlds (or, alternatively, functions from worlds into sets of individuals; or characteristic functions of either of them). Hence, if two properties are not identical, this difference then needs to be reflected in their not overlapping in at least one world, which only goes to say that there must be a difference in the world-parameter between the tuples individuating Angelika Kratzer's being hungry and the tuples individuating her being tired, even though they do not differ with respect to time ("right now") and place in the example at hand. Thus, to guarantee that every difference between two situations is reflected by least the world-parameter, one needs to suppose that the set of worlds in which Angelika Kratzer is hungry ("right now" at a concrete place) differs from the set of worlds in which Angelika Kratzer is tired ("right now" at the same place). This assumption doesn't seem to be completely out of the ordinary. But, as already said, it fails to individuate properties on a level as specific as Kratzer (and others) like(s) to have it, namely at the level of the individual situation itself. This is due to the possibility that one and the same tuple can instantiate both properties. This is more coarse-grained in the sense that there is no counterpart to the individual situation exemplifying nothing but Angelika Kratzer's being hungry (at the concrete spatial-temporal coordinate) in contrast to the individual situation exemplifying nothing but her being tired (at the same coordinate). If a situation, conceived as tuple of parameters, happens to exemplify more than one property, then this is what it does. The very existence of situations/tuples like these doesn't mean that the respective properties are somehow conflated. They aren't incompatible, that's all. To be clear, this means that it is not possible to use situations as they are understood here to the same effect as events are used in (Neo-)Davidsonian semantics or situations are used in Situation Theory. That is, they are not appropriately used as the individuals adverbial modifiers take as arguments (cf. modification with *slowly*/*quickly* as in fn. 35), nor as 'scenes' which are seen by individuals, that is, as the very object that verbs of perception take as arguments as in Barwise and Perry (1983), nor as 'facts' that can be utilized to deal with Gettier problems as in Kratzer (1989). These issues are left open here.

That being said, the starred variants of the sets of sequences now are:

(46) a. ${}^*\Sigma := \{\sigma : \exists s \in LS : \sigma = {}^*\pi(s)\}$ (the range of ${}^*\pi$)
b. ${}^*\Gamma := \{\sigma : \exists s \in K : \sigma = {}^*\pi(s)\}$
c. ${}^*d\Gamma := \{\sigma : \exists s \in dK : \sigma = {}^*\pi(s)\}$

With all the precautions mentioned in place, nothing in the newly adopted formulation (44) destroys the correspondence (40) between situations in LS (K, dK) and the sequences in ${}^*\Sigma$ (${}^*\Gamma$, ${}^*d\Gamma$). Hence, it is still possible to construct *ersatz*-diagonals by the same means as above. One just has to add * to every set mentioned in (41) and (42) to establish a similar notational convention and then define the diagonal operators as before. *Dthat* puts a tuple composed of the context's first three parameters into the second argument slot, while the other diagonal-operator takes the context based on the situation the tuple in the second argument slot is based on (if there is one) and puts it into the first slot.

For illustrative purposes, let us assume that a $^*k \in {^*\Gamma}$ based on an arbitrary $k \in K$ starts with the arguments w_k, t_k, and p_k. What the *dthat*-operator then does is putting $\langle w_k, t_k, p_k \rangle$ in the second slot:

(47) $\quad \|\nabla\, A\|^{*k,{^*\sigma}} = \|A\|^{*k,\langle w_k,t_k,p_k\rangle}$

The whole point of decomposing situations this way is that the lexical entries of certain indexicals can be viewed as partial variants of this operator. Assuming that $^*\sigma$ decomposes as $\langle w_s, t_s, p_s \rangle$, one yields the following (bold entries just highlight the change):[37]

(48) a. $\|\text{actually } A\|^{*k,{^*\sigma}} = \|A\|^{*k,\langle \mathbf{w_k},t_s,p_s\rangle}$
b. $\|\text{now } A\|^{*k,{^*\sigma}} = \|A\|^{*k,\langle w_s,\mathbf{t_k},p_s\rangle}$
c. $\|\text{here } A\|^{*k,{^*\sigma}} = \|A\|^{*k,\langle w_s,t_s,\mathbf{p_k}\rangle}$

as long as there are situations $s' \in LS$ that decompose as $\langle w_k, t_s, p_s \rangle$ (meaning that $w_{s'} = w_k$, $t_{s'} = t_s$, and $p_{s'} = p_s$), $\langle w_s, t_k, p_s \rangle$, or $\langle w_s, t_s, p_k \rangle$, respectively. Otherwise, the right hand side of the equations is undefined, because the tuples leave the realm of situations (i.e. tuples based on elements of LS), so to speak.

Something similar could be said regarding the other diagonal operator. That is, it is also possible to define $\triangleright$ as well as its partial variants. But apart from parallelism, there seems to be no use in doing so, since no natural language expression suggested itself as spelling out any of these operators, which is why this notational exercise is left for the reader.

Decomposition also provides a more fine-grained understanding of *shifting* expressions, because they can likewise be understood as manipulating only one out of many parameters. The following are just mentioned for illustrative purposes:

(49) a. $\|\text{necessarily } A\|^{*\kappa,\langle w_s,t_s,p_s\rangle} = \forall \mathbf{w} : \|A\|^{*\kappa,\langle \mathbf{w},t_s,p_s\rangle}$
b. $\|\text{always } A\|^{*\kappa,\langle w_s,t_s,p_s\rangle} = \forall \mathbf{t} : \|A\|^{*\kappa,\langle w_s,\mathbf{t},p_s\rangle}$
c. $\|\text{everywhere } A\|^{*\kappa,\langle w_s,t_s,p_s\rangle} = \forall \mathbf{p} : \|A\|^{*\kappa,\langle w_s,t_s,\mathbf{p}\rangle}$

Again, barring the possibility that a particular instance of any of the quantified (bold) variables in (49) leads to a tuple that does not represent a situation in LS, this amounts to quantifying over whole situations. To be sure, the domains for the universal quantifiers in (49) can be made dependent on the other parameters as well, to restrict quantification to situations proper:

(50) a. $\mathcal{W}_{t_s,p_s} = \{\mathbf{w} : \langle \mathbf{w}, t_s, p_s \rangle \in {^*\Sigma}\}$
b. $\mathcal{T}_{w_s,p_s} = \{\mathbf{t} : \langle w_s, \mathbf{t}, p_s \rangle \in {^*\Sigma}\}$
c. $\mathcal{P}_{w_s,t_s} = \{\mathbf{p} : \langle w_s, t_s, \mathbf{p} \rangle \in {^*\Sigma}\}$

[37] In (i), the expressions are given a lexical entry that makes them taking scope over their complements (A), while in (28), they are just treated as scopeless referential expressions. At the moment, nothing hinges on this difference. If the reader wishes to, he can propose lexical entries analogous to (28) for the expressions in (i) without any loss.

As can be seen, e.g. $\mathcal{W}_{t_s,p_s}$ is the set of all world-parameters that form a tuple determined by a situation, and similarly for $\mathcal{T}_{w_s,p_s}$, and $\mathcal{P}_{w_s,t_s}$. If the shifters in (49) and the indexicals in (48) are enhanced with these sets, variation in one parameter is restricted to the desired tuples. This is a severe restriction since arguably $\mathcal{W}_{t_s,p_s} \subset \mathcal{W}$ (and similarly for the other domains). Thus, at least some worlds (times, locations) are excluded once $\mathcal{W}_{t_s,p_s}$ ($\mathcal{T}_{w_s,p_s}$, $\mathcal{P}_{w_s,t_s}$) is implemented. But this restriction leads to a problem if those sets are empty for a particular selection of parameters, which happens to be the case in the following examples (T. E. Zimmermann, 1991; T. E. Zimmermann, 2012b):

(51) a. 16 billion years ago, it actually rained here.
b. 16 billion years ago, it actually didn't rain here.

Assuming that the actual world indeed is as old as current physics claims it is, namely 14.6 billion years, the (unlucky) combination of indexicals and shifters generates tuples that lie outside of the realm of possible situations, namely

(52) $\langle w_k, \mathbf{t}_k^{-16G}, p_k \rangle$ with $\mathbf{t}_k^{-16G} := \textsc{Year\_of}(t_k) - 16G.$

Thus, *it rained* and *it didn't rain* both are evaluated against no tuple at all, rendering both (51a) and (51b) wrong, if *16 billion years ago* employs an existential quantifier, roughly:

(53) $\exists \mathbf{t} \in \mathcal{T}_{w_s,t_s} : \mathbf{t} = \mathbf{t}_k^{-16G} \;\&\; \|A\|^{*\kappa,\langle w_s,\mathbf{t},p_s\rangle}$

Since situation-based tuples are taken to individuate meanings (characters), this means that both sentences counter-intuitively come out as synonyms, because they are assigned the same value for all situations there are. One might take this as indicating that empty domains of quantification (or restriction) need to be avoided somehow. This can be achieved by dropping the restriction on situation-based tuples (50) altogether, yielding (unrestricted) quantification over all parameters that form a tuple with the others, being it situation-based or not. This comes pretty close to the variety of two-dimensionalism endorsed by David Lewis.

2.2.4 Free but structured variation

Lewis doesn't talk about situations at all. But his contexts still are tuples consisting of a world, a time, and a location. These are not the only 'objective' features of context Lewis seems to acknowledge. He frequently mentions, among other things, standards of precision (as a parameter addressed by, e.g., *strictly speaking*). The crucial point for this section is not to reconstruct Lewis' views as adequately as possible. It therefore doesn't matter so much how exactly the Lewis-inspired way of individuating contexts laid out here ties in with, e.g., modal realism,[38] that is, other positions Lewis held. What matters

[38] Which seems to be reflected in passages like "But features of context do not vary independently. No two contexts differ by only one feature. Shift one feature only, and the result of the shift is not a context at all." Lewis (1980, p. 29). For why this might be so, see below. Note further that Lewis takes certain things he says in Lewis (1970) back in his 1980 article. So Lewis (1970) is neglected in

most is the way in which he describes the relations between contexts and indices. Lets hear him once more:

> Whenever a sentence is said, it is said at some particular time, place, and world. The production of a token is located, both in physical space-time and in logical space. I call such a location a *context*. That is not to say that the only features of context are time, place, and world. There are countless other features, but they do not vary independently. They are given by the intrinsic and relational character of the time, place, and world in question. The speaker of the context is the one who is speaking at that time, at that place, at that world. (There may be none; not every context is a context of utterance. I here ignore the possibility that more than one speaker might be speaking at the same time, place, and world.) The audience, the standards of precision, the salience relations, the presuppositions ... of the context are given less directly. They are determined, so far as they are determined at all, by such things as the previous course of the conversation that is still going on at the context, the states of mind of the participants, and the conspicuous aspects of their surroundings. (Lewis, 1980, p. 28)

In light of the discussion above, this little passage suggests that Lewis imposes some structure on contexts, partly with the help of limiting assumptions (although not "officially", but for convenience), as announced in section 2.2.1. Interestingly, not all contexts seem to satisfy existence presuppositions for speakers, audiences, etc., at least under the assumption that *utterance* in the part within round brackets receives an interpretation as wide as above. Lewis' view seems to be, then, that the speaker parameter is determined on the basis of the tuples he dubs contexts by something similar to the function Sp above, but without this being a function (since ultimately neither existence nor uniqueness is guaranteed). His contexts seem to be individuated on different grounds. On the other hand, at the very beginning of the quote, the determining feature of contexts seems to be that a sentence is said. Even if this is understood with *say* meaning *utter* in the technical sense, this doesn't quite fit with the optionality of speakers.

However, whatever contexts exactly are, shifting one of their parameters results in a mere index, that is, something which lacks the inherent connection between parameters that is essential to contexts. This position is reflected in Lewis' assessment of (54):

(54) a. If someone is speaking here, then I exist.
b. Forevermore, if someone is speaking here, then I exist.
c. Necessarily, if someone is speaking here, then I exist.

Lewis claims that there is no context which makes (54a) false (Lewis, 1980, p. 29). Either, it is a context in which someone speaks, then this very person will be the referent of *I* and therefore exist; or, it is a context in which no one speaks, in which case the antecedent of the conditional is false and the consequent undefined, so the whole sentence turns

the following.

out to be undefined (and not false).[39] But (54a)'s non-falsity at all contexts should not automatically lead to the non-falsity of (54b) or (54c) at all contexts. But if these sentences, which employ universal quantifiers over times and worlds, respectively, are just evaluated against contexts as well, this would be unavoidable. Lewis therefore proposes that shifting (quantifying over) one parameter leaves the realm of (possible) contexts and resides to *indices*. And indices, contrary to contexts, are mere combinations of several parameters that do not (necessarily) form contexts, that is, do not obey the structural conditions holding for contexts:

> The proper treatment of shiftiness requires not contexts but *indices*: packages of features of context so combined that they *can* vary independently. An index is an n-tuple of features of context of various sorts; call these features the coordinates of the index. We impose no requirement that the coordinates of an index should all be features of any one context. For instance, an index might have among its coordinates a speaker, a time before his birth, and a world where he never lived at all. Any n-tuple of things of the right kinds is an index. (Lewis, 1980, p. 29)

Hence, the most natural thing to assume is that in Lewis' system, contexts are individuated by situations, even though not necessarily by the same means as above, since there, *utterances* (in the broadest sense of the term) play a crucial rôle. Ignoring this complication for the moment, Lewisian contexts may be identified with a decomposed form of elements of K or dK, since he holds that the other coordinates are definable on their basis. Contexts thus are tuples of the form $\langle w, t, p\rangle$ (for any $w \in \mathcal{W}$, $t \in \mathcal{T}$, and $p \in \mathcal{P}$) that make the start of an element of either $^*\Gamma$ or $^*d\Gamma$ from above (i.e. elements of $^*\Sigma^{\restriction dK} \cup {}^*\Sigma^{\restriction K}$).[40] For the moment, assuming this will do, since the real topic of this section is the individuation of indices. The issues surrounding the individuation of contexts is postponed until section 2.3, where it is treated together with Kaplan's suggestions.

Indices, in the sense of Lewis, are not individuated by situations but defined purely structurally. That is, they are tuples of the same form as contexts which do not necessarily form an element of LS, but are one instance of any combination possible. Thus, $^*\Sigma$ repeated from above is not enough here, instead one has to work with the set dubbed LTS (short for *L*ogical *T*uple *S*pace) in (55b):

(55) a. $^*\Sigma := \{\sigma : \exists s \in LS : \sigma = {}^*\pi(s)\}$
b. $LTS := \mathcal{W} \times \mathcal{T} \times \mathcal{P}$

Again, obviously,

[39] Lewis doesn't spell this out as explicitly as above. It remains possible that his position is misconstrued here. This holds for his conception of contexts in general. It isn't clear what exactly is meant by his puzzling remark "not every context is a context of utterance" in the long quote above. If this means that there are speakerless contexts that nevertheless provide a referent for first-person pronouns, then the reconstruction of his assessment regarding (54a) isn't correct. (54a) could be true in speakerless contexts as well, since only the antecedent is wrong. But the question then is why he used the conditional in the first place. The very same point could've been made with the simpler *I exist*.

[40] If there are speakerless contexts, then elements of (a subset of) $^*\Sigma$ have to be used, instead.

(56) $\quad {}^{*}\Sigma^{\upharpoonright dK} \subseteq {}^{*}\Sigma^{\upharpoonright K} \subseteq {}^{*}\Sigma \subseteq \mathit{LTS}$

thus, the definition of diagonals, and hence of *dthat* is straightforward.

Returning to shifters, the tuples that result from manipulating one parameter only are elements of *LTS*. That is, ignoring all complications surrounding comparability, in addition to the situation-based frameworks above, there are more indices available here, namely precisely those indices in *LTS* that are not situation-based, that is, elements of ${}^{*}\Sigma$. And those elements of $\mathit{LTS} \setminus {}^{*}\Sigma$ seem to be needed to account for the difference in meaning of the two sentences in (51), repeated below:

(51) a. 16 billion years ago, it actually rained here.
b. 16 billion years ago, it actually didn't rain here.

In contrast to above, now there are indices that make the difference between the positive and the negative sentence in (51), but all of those reside in the set $\mathit{LTS} \setminus {}^{*}\Sigma$, that is, that part of the set of indices, that cover all those tuples that are not based on situations. Thus, the sentences still are at most false (if not undefined) at situation-based tuples, since using *LTS* doesn't magically create situations in which either of them is true. But, since characters and intensions are then to be defined as functions from *LTS*, its elements need to discriminate meanings; which they now do. On the other hand, it isn't quite clear whether this is an advantage over the previous accounts, since the meanings so defined overlap on the part of *LTS* that—intuitively—matters most, namely ${}^{*}\Sigma$, the set of situation-based tuples. On top of this, this way of defining indices hampers with shifters in a way that might not be desired. To see this, consider sentences like the following, repeated from above, including some shifter:

(7) a. Nowhere, anybody coughed.
b. Somebody always coughs.
c. Necessarily, somebody coughed.

The way, e.g., *always* is interpreted in situation-based approaches leads to (7b) expressing a proposition according to which every situation is such that somebody coughs at its time parameter. Without the restriction on situation-based indices, the proposition expressed demands (for it to be true at an index) that every index is such that somebody coughs at its time parameter; including those indices that are situation-based and those that aren't. Hence, the domain of quantification is as large as above's unrestricted versions of the shifters, repeated below, have it.

(49) a. $\|\text{necessarily } A\|^{*\kappa,\langle w_s,t_s,p_s\rangle} = \forall \mathbf{w} : \|A\|^{*\kappa,\langle \mathbf{w},t_s,p_s\rangle}$
b. $\|\text{always } A\|^{*\kappa,\langle w_s,t_s,p_s\rangle} = \forall \mathbf{t} : \|A\|^{*\kappa,\langle w_s,\mathbf{t},p_s\rangle}$
c. $\|\text{everywhere } A\|^{*\kappa,\langle w_s,t_s,p_s\rangle} = \forall \mathbf{p} : \|A\|^{*\kappa,\langle w_s,t_s,\mathbf{p}\rangle}$

It thus is possible, at least technically, that (7b) is false at an index, even though it holds for every situation-based index, obtainable by shifting the time parameter of the initial index, that somebody coughs at said parameter. That is, widening the domain of quantification in such a way thereby might lead to truth-conditions implausible from the view of situation-based approaches. The mechanism at work here is the same as in (51), where the truth conditional differences show only in the part of the domain that isn't situation-based. Hence, the more plausible treatment of examples like (51) might be said to come with the cost of rather implausible truth conditions for examples like (7b). This in itself is not a knockdown argument, of course, but it might be pointed out that a restriction of the domain of quantification to situation-based indices along the lines of (50), albeit possible, is not defensible without loosing the advantage in the treatment of (51). That is, if the effects of domain widening are tried to be attenuated by introducing domain restrictions like in (50), it isn't clear why a shifter like *sixteen billion years ago* shouldn't come with such a restriction as well. But this reintroduces the problem that motivated the introduction of non-situation-based indices in the first place. Thus, it seems, there is no nonstipulative partial revision after elements of $LTS \setminus {}^{*}\Sigma$ are included.

This concludes the survey of ways to set up context theory without even touching upon Kaplan's proposal.[41] What the present section has shown is that there are several paths to flesh out double indexing and having a proper definition of diagonals. Thus, the availability of certain techniques does not serve as an argument in favor of or against one of the setups discussed. The only thing that really was argued against was Lewis' suggestion to include indices that are not derived from situations. Their introduction either does not solve the issue they are motivated with, or draws a picture of quantification that isn't desirable. With this result in mind it is now time to turn to contexts once again. The next section reviews Kaplan's and Lewis' 'top-down' approach of contexts more closely. Their stipulations or constraints on tuples which need to be met in order to qualify as contexts are grouped together with those of others in order to discuss the outcome on a more general level. One thing still is possible, although not appealing: even though the realm of indices is restricted to those stemming from possible situations, it might turn out that tuples serving as contexts aren't. That is, if it is not possible to argue convincingly that contexts need to be based on situations as well, it might turn out that contexts are more than just a special sort of index. That is, if there are non-situation-based contexts, subsethood no longer holds. This is very undesirable from a technical point of view since diagonals then become unavailable. To avoid this, even if there are no further arguments other than the ease of defining diagonals, it might be the right thing to simply stipulate that contexts need to be restricted to situation-based tuples, just because of this.

[41] All of the previous setups are not Kaplan's way of defining context theory, since he doesn't use or even talk about situations in the precise sense it is used here (even though he uses *circumstances* and *occasions* in a related way). Like Lewis, he instead uses *LTS* to define the domain of indices, but singles out contexts by means of several stipulations.

2.3 On individuating contexts

2.3.1 Validity

A great deal is made out of intuitions regarding validity. This notion is so central, that one might characterize *Kaplanian* Context Theory as a doubly indexed semantics that makes the following statements true:

(57) a. *I am here now* is valid. (Kaplan, 1989b, p. 508)
b. *I exist* is valid. (Kaplan, 1989b, p. 540)
c. *I utter something* is not valid. (Kaplan, 1989a, p. 584)
d. *I am necessarily here now* is false. (Kaplan, 1989b, p. 509)
e. *That is identical with that* is informative. (Kaplan, 1989b, pp. 514, 529)

Validity is spelled out in two different ways. These two notions of validity capture two kinds of trivialities, namely first, the trivial flavor of sentences like *I exist*, which they undeniable possess, even though no individual necessarily exists; that is, *I necessarily exist right here and right now* is wrong. Thus albeit not being a tautology proper, the sentence sounds as trivial as a logical truth, if uttered. This is accounted for by demanding of trivial sentences in this sense to be true at all contexts. Sentences trivial in this sense are claimed to have a *tautological diagonal*. A further application consists in modeling Kripke's (1972) *truth* (of contingencies) *a priori*, which is identified with this sense of triviality. But this is a nontraditional notion of validity Kaplan employs. It doesn't capture, secondly, the tautological flavor of *Somebody is hungry or nobody is hungry*, which indeed is a tautology and should come out not just as true at all contexts, but as true at any index whatsoever; since it is impossible to falsify. This second, more Traditional notion of validity is (59).

Hence, the two notions in play seem to be these:

(58) For all sentences φ, and all contexts k: cf. Kaplan (1989b, p. 547)
$\vDash \varphi$ iff $\|\varphi\|^{k,k} = 1$

(59) For all sentences φ not containing indexicals, for any k: $\vDash_T \varphi$ iff $\forall i : \|\varphi\|^{k,i} = 1$

The qualification "not containing indexicals" in (59) makes sure that the sentences express the same proposition in every context, i.e. that they have what Kaplan calls a "stable" character (meaning that the choice for k above doesn't matter for the expression's intension).

For the sake of completeness, instead of saying that a sentence φ is valid with respect to (58), one can paraphrase this statement as *dthat* φ or *actually now here* φ being true. Likewise, instead of asking a sentence φ to be valid with respect to (59), one might also demand *necessarily always everywhere* φ to be true. The respective combinations of operators express basically the same as the definitions above. This is in line with the semantics of the operators laid out above (section 2.2.4). The only thing that bars taking these paraphrases as definitions is the possibility of indexicals already occurring in φ. The resulting iteration of indexicals was said to be excluded either syntactically or semantically in section 2.1.3 above

Especially with the help of (58), the statements in (57) are turned into constraints (cf. (61) and (62)) that have to be met by an index in order to qualify as a context. That is, in the following it is assumed that Kaplan's characterization of the first kind of triviality is essentially correct. To keep the argumentation manageable, *agent* is the only contextual parameter apart from worlds, times, and locations, that is considered for now. Afterwards, the others will be taken back on board, once it is clear how the following arguments translate into similar constraints governing their relation to situations.

Thus, technically speaking,

(60) Contexts are elements of $\mathcal{W} \times \mathcal{T} \times \mathcal{P} \times \mathcal{D}$, where $\mathcal{W}$ is the set of possible worlds, $\mathcal{T}$ is the set of times, $\mathcal{P}$ is the set of locations, and $\mathcal{D}$ is the set of individuals.

The coordinates of the tuples are referred to by w_c, t_c, p_c, and a_c, respectively. From the statements in (57), the following constraints can be obtained. This is done by substituting "is valid" by "is true in all contexts" in the sense of (58) and asking, how the several coordinates need to interact in order to fulfill the resulting requirement. The very last statement (57e) concerning multiple demonstratives in one sentence is neglected until section 2.3.5.

(61) Constraints on contexts:
If c is a context, w_c, t_c, p_c, and a_c are the world, time, location and agent of c, respectively, such that $\langle w_c, t_c, p_c, a_c \rangle = c$:

a. *Location Constraint*: a_c is located at p_c in w_c at t_c.
b. *Existence Constraint*: a_c exists in w_c at t_c (and p_c).
c. *Utterance Constraint*: a_c utters something in w_c at t_c.[42]

As witnessed by (57c), (61c) isn't endorsed by Kaplan, but it may be ascribed to Lewis. The other constraint (62b) is the assumption from the discussion of Lewis (1980) above. It cannot be ascribed directly to either author, as already mentioned, since neither makes use of situations. But it is supported indirectly, given that (62b), the constraint that demands concentration on world, time, and place-parameters which form a situation in *LS* follows from the existence constraint (61b), if it is assumed that it is not possible for individuals to exist at arbitrary tuples of parameters if these do not stem from situations in *LS*, which seems reasonable.[43,44] Hence, assuming (61b) is equivalent with

[42] Also possible are weaker versions of (61c) and (62a), with *somebody* or *something* in place of a_c. These will be touched upon along the way.

[43] Otherwise, there could be individuals 'living' in the gaps of *LS* only; like innumerably many real numbers 'live' in the gaps between integers.

[44] If one goes as far as Kupffer (2003), even (61a) and (61b) have to go, at least in their present form as mere stipulations on the structure of contexts. This doesn't mean that Kupffer regards *I exist* to be invalid, but he rightly observes that its validity in Kaplan (1989b) stems from (61b) only. His objection is, that (61b) shouldn't be stipulated just to guarantee that *I exists* turns out to be valid. There should be independent reasons for assuming it holds, and ideally one would be able deduce it so there would be no need for a stipulation.

concentrating on situation-based contexts. And, as pointed out above, if everything else fails, assuming it is the desired option for technical reasons.

(62) Further constraints imposed on contexts:
If c is a context, w_c, t_c, p_c, and a_c are the world, time, location and agent of c, respectively, such that $\langle w_c, t_c, p_c, a_c \rangle = c$:
a. *Sentence Constraint*: a_c utters a sentence in w_c at t_c.[45]
b. *Situation Constraint*: $\langle w_c, t_c, p_c \rangle$ form a situation in *LS*.

In the literature, (61c) or (62a) are sometimes paired with the following

(63) Constraint imposed on interpretation:
If φ is an expression and $\|\varphi\|$ is its character, and k is a context, then $\|\varphi\|^k$ is defined iff an instance of φ is uttered in k. k then is a context *for* φ.

This constraint is put to use by von Stechow (1979) (and, following him, Kupffer (2001) and Kupffer (2014)), and discussed in T. E. Zimmermann (1997), and may be conceived as suggested by Lewis (1980) as well. Abbreviating the set of contexts k such that "an instance of φ is uttered by a_k in k" by K^φ ($:= \{k : a_k$ utters a token of φ in k at t_k and $p_k\}$), one can rewrite its definedness condition as

(64) $\|\varphi\|^k$ is defined iff $k \in K^\varphi$.

Thus, in some systems, contexts are individuated by some constraints in (61) or (62), and interpretation is further restricted by (63). Others do not assume (63), and pick a different subset of constraints.

In the following, I will try to give some evidence in favor of or against several constraints in (61) and (62). This is done mainly by reviewing arguments from the literature. (63) will be discussed as well. Once the matter is settled, the temporarily neglected contextual parameters make a comeback while it is tried to draw the most general moral possible from the whole discussion.

It's easiest to start with the Location Constraint (61a). If it is in force when it comes to defining contexts, it has a severe impact on the evaluation of a sentence like (65):

(65) I am not here now.

Any *utterance* (in the non-technical sense of the word) of (65) is easily heard to be false. And this is in accordance with Kaplan's assessment, since he claims that its non-negated counterpart (57a) is valid. Thus, his claim is that (65) is wrong in every context, since it expresses something that contradicts the very structure he assigns to contexts via the Location Constraint (61b). But, as he points out himself (Kaplan, 1989b, 491, fn. 12), recorded on an answering machine, or, nowadays, written in an "out of office" auto reply, variants of this sentences are true. E.g., if an utterance of (65) is recorded on

[45] "A context is a location—time, place, and possible world—where a sentence is said." (Lewis, 1980, p. 21) *If someone is speaking here then I exist* is true at all contexts Lewis (1980, p. 29)

such a device by, say, Pete, and if this record is played in a concrete situation in which someone calls, while Pete is not at home, (65) seems to express that Pete is not at home at the time the caller called. That is, (65) is usually understood as being uttered by the original author (Pete) at the original place (which coincides with the place the recorded "utterance" originates, anyway). The only thing that is not standard, if anything, is *now*, which doesn't refer to the time of the recording, but to the time of playback.[46] But, to express such a proposition, the character of (65) needs to be evaluated against a context that shouldn't exist according to (61b) (assuming the analysis of *I*, *here*, and *now* as indexicals is correct). Thus, if utterances recorded on answering machines count as genuine utterances which express a literal meaning of (65), (61b) has to go.[47]

(61c) or even (62a), i.e. the constraints that make utterances necessary ingredients for contexts, are easily read into Kaplan (1989b) because of passages like these:

> In order to correctly and more explicitly state the semantical rule which the dictionary attempts to capture by the entry
>
> I: the person who is speaking or writing
>
> we would have to develop our semantical theory—the semantics of direct reference—and then state that
>
> (D1) *I* is an indexical, different utterances of which may have different contents
>
> (D2) *I* is, in each of its utterances, directly referential
>
> (D3) In each of its utterances, *I* refers to the person who utters it.
>
> (Kaplan, 1989b, p. 520)

Thus, it seems, Kaplan endorses something along the lines of (62a) or (61c). But that this cannot be is shown by the following two quotes that sum up his view concisely:

> Expressions containing demonstratives [i.e. indexicals, J.K.] will, in general, express different concepts in different contexts. We call the content expressed

[46] I favor (ia) over (ib), where (ia) is the German counterpart of *I am not here at the moment* while (ib) is the translation of (65). But this is not to claim that it is entirely impossible to use (ib) in the intended sense, but (ia) seems to be more appropriate precisely because it avoids the problematic indexical:

(i) a. Ich bin im Moment nicht da.
    b. Ich bin jetzt nicht da.

[47] For overviews of the "Answering Machine Puzzle" see Cohen (2013) and Cohen and Michaelson (2013) and the literature referenced therein. That one has to abandon (61b) if this puzzle is to be explained semantically is only implicitly stated in the former, but explicitly in fn. 3 of the latter. One might try to explain this pragmatically—cf. the brief and pretty skeptical remarks in Cohen and Michaelson (2013). To be sure, this approach would be compatible with the alleged contradictory reading of (65), but, as Cohen and Michaelson rightly point out, it doesn't seem to belong to the kind of things pragmatic processes are classically thought of being capable.

> in a given context the *Content* of the expression in that context. The Content of a sentence in a context is, roughly, the proposition the sentence would express if uttered in that context. This description is not quite accurate on two counts. First, it is important to distinguish an *utterance* from a *sentence-in-a-context.* The former notion is from the theory of speech acts, the latter from semantics. Utterances take time, and utterances of distinct sentences cannot be simultaneous (i.e., in the same context). But to develop a logic of demonstratives it seems most natural to be able to evaluate several premises and a conclusion all in the same context. Thus the notion of φ *being true in* c *and* [$\mathcal{M}$] does not require an utterance of φ. In particular, [a_c] need not be uttering φ in [w_c] at [t_c]. Second, the truth of a proposition is not usually thought of as dependent on a time as well as a possible world. The time is thought of as fixed by the context. If φ is a sentence, the more usual notion of the proposition expressed by φ-in-c is what is here called the Content of *now* φ in c. Kaplan (1989b, p. 546)

And, the already mentioned passage from *Afterthoughts:*

> As I carefully noted in *Demonstratives*, my notion of an *occurrence* of an expression in a context—the mere combination of the expression with the context—is not the same as the notion, from the theory of speech acts, of an *utterance* of an expression by the agent of a context. An occurrence requires no utterance. Utterances take time, and are produced one at a time; this will not do for the analysis of validity. By the time an agent finished uttering a very, very long true premise and began uttering the conclusion, the premise may have gone false. Thus even the most trivial of inferences, P therefore P, may appear invalid. Also, there are sentences which express a truth in certain contexts, but not if uttered. For example, 'I say nothing.'
> Kaplan (1989a, p. 584)

To forestall any confusion, this still is taken to mean that 'utterance' comprises thoughts as well as sentences written out, 'sayings', etc. Thus, *I* say *nothing* might not be the right example to talk about, since somebody can truthfully write or think such a sentence in a context without any theoretician being surprised. But if only this were the claim, then this wouldn't motivate the distinction between sentences-in-contexts and utterances. It might be better to modify the example to *I utter nothing* with the presumption that *utter* has the technical meaning it is assigned here. If this is felt to be unconvincing, because it isn't clear at all whether the natural language *utter* has this technical sense, one may compose a longer example like *I say nothing and I write nothing and I think nothing and ...* and go through the argument with this one.

Now if the constraint on interpretation (63) in connection with either constraint that requires the agent to utter something (namely (61c) or (62a)) is taken to constrain the theory, the last statement of the second quote is simply wrong, since utterances necessarily come into play. This holds even if one scraps (63) and just goes with either (61c) or (62a), since regardless whether *I utter nothing* is only evaluated (twice) against contexts in which this sentence is uttered or against all contexts, in which just *anything* is uttered, utterances make a tuple a context and therefore falsify *I utter nothing* straight away.[48] Kaplan's conviction that *I utter something* shouldn't turn out to be valid can be taken as one of the main reasons why he utilizes what is called "free parameterization" in T. E. Zimmermann (1991) and T. E. Zimmermann (2012b), i.e. the approach to filter out contexts out of arbitrarily generated tuples by means of constraints instead of working with a situation-based framework or something similar.

But if neither (61c) nor (62a) is assumed, it follows that the notion of *agent of a context* cannot be identified with the 'producer' of an utterance (as Sp has it), regardless how wide the notion of *utterance* is interpreted, since, again, as soon as something like this is done, *I produce no utterance* becomes not only invalid, but a contradiction; i.e. has the contradictory diagonal. Thus, given that it can be true, an individual then is an agent of a context c only in virtue of occupying the forth position in the tuple. There is no fact of the matter derivable from w_c, t_c, and p_c that makes one individual an agent and any other individual that happens to exist at the same tuple not.[49] That is, if the first three coordinates of a tuple are held constant, it follows that there exist as many contexts as there are tuples starting with these fixed coordinates and ending with an arbitrary individual. If (61b), the existence constraint, is assumed to hold, the first three parameters need to stem from a situation. In this setup, this has as a consequence that a sentence containing an indexical can express as many propositions in a situation (!) as there are individuals in that situation. Characters, so conceived, cannot be functions from *situations* into propositions, but must be relations. Still, they are functions from *contexts* into propositions. These two fall into one if (62a) and / or the limiting assumption incorporated into Sp are taken on board. Since then, only those tuples qualify as contexts whose first three coordinates form a situation and the last coordinate is the single individual who produces an utterance in that situation; hence the 'speaker' in the sense of Sp. This makes contexts and situations stand in a one-one correspondence, and the functional relation between contexts and propositions expressed carries over to a subset of *LS* and propositions.

If this is on the right track, at first glance it seems that (D1) through (D3) in the long quote on page 52, repeated below, are at best misleading if not downright wrong. Since the notion of an *agent* is virtually without content, but only a structural notion ('the individual in the fourth position of the tuple that forms a context'), it is a long way to a statement like (D3).

(D1) *I* is an indexical, different utterances of which may have different contents

(D2) *I* is, in each of its utterances, directly referential

(D3) In each of its utterances, *I* refers to the person who utters it.

(Kaplan, 1989b, p. 520)

[48] Although this isn't true if a weaker form, namely *somebody utters something at* w_c *and* t_c *and* p_c is chosen over (61c), since then, *I* doesn't necessarily refer to the utterer in question.

[49] *Pace* Lewis (1980), one might add.

On the other hand, these statements are misleading or wrong only if they are taken as constraints on the character of *I*. Taken as heuristic for the interpretation of *utterances*, they serve their purpose. But setting up an expression's character, and interpreting utterances are two kinds of things. This hiatus between the two tasks can be tracked throughout Kaplan (1989b), where it seems as if the main text proposes something completely different if not contradictory to the semantic machinery presented in its later sections. Most of the characterizations in the main text only then make sense if they are interpreted as heuristics for the interpretation of actual utterances. Note that if everything said above is correct, characters are, although pretty remote in terms of applicability, well suited to play their intended rôle in the concrete interpretation of an actual utterance. But they are not defined so narrowly. And they cannot be, as is corroborated by the preceding discussion as well as the following.

One might be disappointed by this assessment. What good should characters serve apart from managing the interpretation of utterances? So one might feel that the discussion is headed in the wrong direction. There is a way of defining characters in such a way that (D1)—(D3) above really are true statements concerning characters of indexicals, and not just heuristics for processing concrete utterances. All one needs to do is making contexts in which a sentence φ is uttered a necessary prerequisite for the applicability of the character of φ; and this is exactly what the constraint on interpretation (63) is designed for. At first glance, all it does is restricting the domain of interpretation to those contexts that intuitively matter the most, namely those in which the sentence in question is really uttered. But matters aren't as harmless as that. If adopted, (63) renders the characters of two different sentences (type-level) distinct, no matter which expressions they are built up from. I.e., the character of a sentence φ only is interpretable against $K^{\varphi} \subseteq K$, while the character of ψ is restricted to $K^{\psi} \subseteq K$; and given $\varphi \neq \psi$, it follows that $K^{\varphi} \neq K^{\psi}$, and thus, φ and ψ have not only different but disjoint domains of application, if it holds that there can only be one utterance per context.[50] This observation is made in T. E. Zimmermann (1997), where it is dubbed the *Less Certain Principle* (*LCP*).[51] Identifying truth-conditions and characters, the *LCP* can be phrased as follows:

(66) If φ and ψ are [different] sentences [on the type-level], then φ and ψ differ in truth-conditional meaning.

This has all kinds of fatal consequences. One concerns the very concept of validity. If distinct sentences (containing indexicals or not) make up the premise(s) and the conclusion of an argument, they cannot any longer be evaluated against the same contexts, since their domains mutually exclude one another. Thus, it is impossible to define validity in terms of truth of the conclusion at all contexts at which the premise are true. Or so it seems. The following section reviews two attempts at getting rid of some consequences of the *LCP* by Manfred Kupffer. Since this discussion leads further away from the main

[50] Which is a stronger claim than (61c) and (62a) make.

[51] In allusion to the *Most Certain Principle* in Cresswell, 1982, p. 69, according to which different truth values imply different meanings.

topic of investigation in this section, the reader may safely skip this part. The conclusion is that the best one can get seems to be the traditional notion of validity (59), that is, exactly not the kind of validity that is unique and special to Kaplanian context theory.

2.3.2 Digression: Getting rid of utterance dependency

The main problem treated in Kupffer (2001) is that it becomes impossible to define synonymy as sameness of characters, and thus to treat translations between different languages by supplying synonymous expressions if (63) is adopted. That is, the English (67a) and its German and French counterparts (67b) and (67c) cannot have the same character once (63) is adopted:

(67)
a. I am hungry.
b. Ich bin hungrig.
c. J'ai faim.

Because these three sentences differ syntactically, it follows from (63), as stated in the *LCP*, that they cannot have the same character.

Note that the indexical *I* is not necessary for this argument. The very same point can be made with any absolute expression, e.g., with *Peter is hungry* and its German and French counterparts (if these are understood as tenseless, otherwise, there still is an indexical).

This may not be beyond repair, as Kupffer (2001) tries to show. His strategy basically consists in setting up a structure-preserving map between utterances of (67a) and utterances of (67b) and (67c), respectively. Roughly, as expressions of different languages are brought into correspondence in dictionaries, certain *stipulations*, functions from utterances to utterances, associate *utterances* of the first word of (67a) and the first word of (67b), the second word of (67a) and the second word of (67b), etc. and, furthermore, utterances of *am hungry* with *bin hungrig* and utterances of the whole sentences. Thus, if utterances are structured along these lines (cf. Kupffer (2014)), and mappings (stipulations) like these are established, one can use them to define a notion of meaning, or semantic value, that is less dependent on utterances, while characters remain as dependent on utterances as (63) has it. Kupffer dubs these *ersatz*-characters obtainable through stipulations *weak meanings*.

Kupffer proceeds in two steps. First, utterance-dependent characters are relativized to *stipulations*, the technical term for mappings from utterances to utterances. Among them, so-called *admissible* stipulations for an expression α are those which map (sub-)utterances of occurrences of (sub-)expressions of α consistently onto (sub-)utterances of occurrences of (sub-)expressions; thus admissible stipulations are structure-preserving. For example, instead of taking just those contexts in which (67a) is uttered as the domain of (67a)'s character, Kupffer proposes to take those contexts plus all contexts that are 'reachable' by admissible stipulations. The weak meaning of (67a) thus is defined for all contexts in which either (67a), or any other sentence in (67) is uttered. Since identity is among the admissible stipulations, these can be quantified in the definition of weak meanings in a second step. The weak meaning or *ersatz*-character of an expression thus is a function from utterances into a set of entities x such that there exists an admissible stipulation that renders the utterance applicable for the (utterance-dependent Kaplanian) character and the result of this application is x. Hence the range of the character and the *ersatz*-character of, e.g., (67a) coincide. Utterances themselves aren't quantified, but this doesn't matter, since the utterances of expressions are mapped onto utterances of other (comparable) expressions. And this means that, given that there are no stipulations that map utterances of, say, *I* to utterances of expressions other than *je*, *ich*, etc. or vice versa, their weak meanings are defined for the same utterances. As a result one gains a notion of (weak) meaning according to which expressions of different languages (viz. their *ersatz*-characters) may coincide. If second and third person pronouns (in their deictical usage) are considered as well, they likewise have the same weak meanings as their counterparts in different languages, but different meanings than first person pronouns, since the system of stipulations governing their utterances are different, leading to different domains of application. Finally, synonymy may be defined as sameness of weak meanings and translation can be described in the classical way.

That this really works solely depends on the (non-)existence of stipulations, e.g., that only those mappings between utterances are considered that map utterances of *I* to utterances of *je*, no mappings that relate utterances of the English first person pronoun to, say, utterances of the French *yaourter*. Note that for this to work in the case of (67c), utterances of forms of *to be* have to be mapped onto utterances of the respective form of *avoir* and utterances of the adjective *hungry* onto utterances of the noun *faim*. Therefore, stipulations seemingly need to operate cross-categorically, and in some cases they need to associate expressions that have to be kept distinct in other cases, which makes their proper restriction quite complicated.[52] Unfortunately, in the form Kupffer presents the system of stipulations in his 2001-paper, claims about the (non-)existence of certain mappings are mere assumptions. He doesn't present a systematic way of consistently mapping utterances of *I* to utterances of *je* (and apologizes for this). However this is established, in a quite similar way it has to be established that there is no systematic mapping from utterances of one kind of personal pronouns to the other. So, the semantic machinery works as it should.

The weak meaning of a sentence φ is applicable to more contexts than those in which φ is uttered, but contexts still have to obey the utterance constraint (61c), that is, contexts still have to be individuated by utterances. And this alone isn't enough to describe the domain of the weak meaning or the *ersatz*-character of φ since it demands more of a context than that. What is needed is an utterance of either φ itself or a counterpart of φ in a different language. That is, for example, the contexts the *ersatz*-characters of the sentences in (67) is defined for are contexts in which either (67a) or (67b) or (67c) or

[52] The same problem emerges if mappings between two dialectal variants of the same sentence in German are considered, where the difference in the auxiliary verb doesn't affect the meaning at all:

(i) a. Viola ist geschwommen.
    b. Viola hat geschwommen.

. . . are uttered.

This means that the problem of defining synonymy between expressions of different languages can be solved, even if one endorses the interpretative constraint (63). But within one language synonymy still isn't accounted for. Arguably, for two synonymous words utterances of the first may have to be systematically mapped to utterances of the second, thus establishing the stipulation that this is the case. But active and passive variants of one of the same sentence may prove to be difficult:

(68) a. Beata helped Pete.
b. Pete was helped by Beata.

Utterances of expressions may be mapped upon themselves. Thus, the relevant sub-utterances of *Beata* in (68a) can be mapped onto sub-utterances of *Beata* in (68b). But, necessarily, utterances of (68b) involve sub-utterances of expressions for which there is no respective sub-utterance in (68a); e.g. (utterances of) which expressions of (68a) should (utterances of) *by* mapped to? Furthermore, to prohibit confusions in case there are more occurrences of the same indexical expressions, especially multiple occurrences of demonstratively used third person pronouns, Kupffer demands that stipulations need to preserve linear order. What is thereby avoided is that the utterances of the first occurrence of *that* in (69a) are mapped onto utterance of the second occurrence of *das* in (69b), and, mutatis mutandis, similarly for the second occurrence of *that*.

(69) a. THAT is taller than THAT.[53]
b. DAS ist größer als DAS.

This cannot be upheld in case of passive transformations, since subject and object get reversed:

(70) a. He helped him.
b. He was helped by him.

So, there is a dilemma. Either one refrains from preserving linear order and thereby opens Pandora's box with respect to examples like (69), or one leaves synonymy of active and passive variants of one and the same sentence unaccounted for.

Leaving this unsolved, it should be noted that the whole enterprise doesn't repair the issue concerning validity. Although Kupffer's weak meanings are broader in terms of applicability, there shouldn't be admissible stipulations that make it possible for the weak meanings of two arbitrary different sentences to share contexts. This is why these mappings do not play a role in Kupffer (2014), where he shows that *tokenreflexive semantics* (e.g. Garcìa-Carpintero, 1998, a.o.) and *occurrence dependent semantics* (e.g. von Stechow, 1979, a.o.) are basically equivalent. Both varieties are intended to deal with the problem of multiple demonstratives in one sentence referring to different objects. The first does this by assuming that contexts change throughout the interpretation process,

[53]Capital letters mark stress.

such that the context against which, e.g., the first occurrence of the demonstrative is interpreted is different from the context against which the second occurrence is interpreted, etc. All of this is needed to make it possible that two or more occurrences of seemingly the same expression are interpreted differently. The second variety achieves this by proposing that the context of evaluation remains constant throughout the interpretation process, but different occurrences of the same type of expression may receive different values *qua* being different occurrences. To cut a long story short, complete sentences are interpreted against large contexts containing different values for different occurrences of the same expression. The very occurrence thus determines, which parameter is addressed—however exactly this is made precise.[54]

The way these two frameworks are described here might give rise to the hunch that they are only notational variants of each other. Intuitively, the longer contexts occurrence dependent semantics needs to assume can be seen as being composed of several subcontexts which in turn are used by tokenreflexive semantics to model context change. In fact, this is exactly what Kupffer (2014) shows. It is possible to translate one framework into the other without any loss of substance. Thus, "whether context changes is totally a matter of theory." (Kupffer, 2014, p. 31) But this is not the point of this section (see 2.3.5 though). The point is that in his equivalence proof, Kupffer establishes what he calls the *metaphysics of utterances*. This is needed in order to spell out in detail what uttering a complex expressions φ means in terms of sub-utterances of sub-expressions of φ. This makes its impact onto the individuation of contexts, which is still thought to proceed via constraints compatible with (63). The proof then proceeds by couching both frameworks within the same emerging context theory, a theory where contexts are built (or analyzed) in accordance with the structure of utterances made in them. This very build-up of contexts is of interest here, since there is no principled reason to stop at the sentence-level.[55] Hence, there are contexts so large so as to comprise the utterance of a pretty long argument, structured in utterances of (the atomic) parts of the premises and utterances of conclusions. Evaluation then proceeds as indicated: every (basic) expression ψ_i is evaluated against the context individuated by ψ_i's utterance. But this still doesn't mean that the premises are all evaluated against the same contexts. All Kupffer can offer at this point is a definition of validity in terms of the conclusion (evaluated against those parts of the large context against which the whole arguments it interpreted) being true at all those worlds at which the conjunction of all premises (evaluated against their respective parts of the large context) are true—and thus something like the traditional (59).[56] Hence, it seems fair to conclude that a Kaplanian Logic of Indexicals is not possible once (63) along with suitable further constraints on contexts is adopted.

[54]In von Stechow (1979) it is assumed that different occurrences of one and the same expressions are kept apart by consecutive indexing. A suitable context has to contain at least as much parameters as there are occurrences of demonstratives. The order of parameters in context then is responsible for the very interpretation of the demonstratives.

[55]Thus, the Sentence Constraint (62a) is not adopted.

[56]Kupffer doesn't make the whole index explicit, but talks just about worlds in his 2014-paper. But this is just for convenience and not connected to a substantial claim. Making explicit other index-parameters and utilizing them in the definition of validity is totally compatible with what he says.

This means that there is a general tension between two goals: either contexts are individuated in such a way that it is possible to utilize the first sense of validity (58), or they are defined to meet the expectations one has about their rôle in determining what is said by concrete utterances. The former goal necessitates a more liberal stance towards the individuation of contexts, while the latter is more restrained about it. Assuming that there is some potential in either parsing theory or classical pragmatics, individuating contexts such that the Logic of Indexicals becomes possible seems to be the safer choice. Interpreting utterances surely is a complicated task, but it is not made impossible just because characters are defined over a larger domain. Instead, much of the hard work is done by determining (1.) which of several situations one inhabits at the same time is the most relevant; and (2.) which of the multiple possible contexts based on this situation is the most relevant. It is to be expected that these two steps are partly carried out in a try-and-error fashion, that is, by making some quick assumptions about the relevant context, carrying out the interpretation process and sticking to the results as long as nothing strange happens. Even if this is just the bare bone of a much more elaborated story, this certainly sounds like a realistic parsing strategy. And this is the ultimate reason why (63) should be rejected.

2.3.3 Kratzer-examples

A lot of evidence in favor of an utterance independent view on contexts is suggested by examples of written sentences or recorded utterances. This is because they persist through time and thus 'survive' their production context.

Suppose that there is a situation s in which a guy called Olaf silently and without a thought on his mind walks down the hallway of his school. Attached to his back is a sheet of paper on which the sentence *kick me* is written. Suppose further that this sheet was made by Lucie (in a different situation s') who also put it on Olaf's back. When Lucie wrote *kick me* (in s'), she presumably counted as the agent of the context in which *kick me* was written (namely $\langle s', \text{Lucie}\rangle$), but this original context is not recoverable when this sentence is encountered on the sheet on Olaf's back (in s). Since Olaf carries the sheet of paper on his back, *he* needs to be agent, since he is kicked when people decide to obey the order expressed. Hence, the context against which *kick me* is interpreted is $\langle s, \text{Olaf}\rangle$.

This is one of the most prominent examples of a variety of sentences first systematically investigated by Kratzer (in her thesis Kratzer (1978)). She concluded from examples like these that contexts cannot be individuated by agents uttering something at a specific spatio-temporal location in some possible world and, furthermore, that the notion of an AGENT cannot be defined by means of utterances either. This is due to the main feature of the example, namely that it doesn't matter for the interpretation of *kick me* who brought the token into existence.[57] She then proposes the following

[57] The relevant examples do not involve what has been called *generic* or *impersonal uses* of first and second pronouns, because they do not express generalities, which seems to be one crucial feature of these uses. Cf. Zobel (2014) and the references therein.

(71) *Agent Constraint*: a_c COUNTS as AGENT in w_c at t_c and p_c.

It is clear that this is less restrictive than any of the alternatives regarding the notion of agent or the individuation of contexts in play, but it isn't clear what this can be taken to exclude, if anything at all. So what the fact of the matter is that decides whether a given individual could possibly count as agent or not, isn't clear at all.

Usually, the sheet attached to Olaf's back is not understood as being the agent, but the person carrying it around, presumably because sheets of papers can't write anything on themselves. However, as other examples show, this cannot be the point. There are for instance stickers attached to advertising material reading *take me away* or *take me, I'm free*, and signs reading *eat me, I'm healthy* attached to fruits. Then there are the labels with *drink me* written on it attached to a potion and with *eat me* written on it attached to a cake in Alice in Wonderland (Carroll, 1960, pp. 31, 33). Moreover, *You can rent me* or *rent me now* or *I'm for rent* is sometimes written on transporters or cars, etc. The point of all these examples is that their intended interpretation requires to make non-sentient entities the agents of the contexts, even though they do not have the capability to produce the respective statements. A lot of these examples seem to come from advertisements. A drugstore company in Germany, for example, takes a variation of a Goethe quote as their slogan, where the best interpretation seems to be that an arbitrary customer plays the rôle of the agent:

(72) Hier bin ich Mensch, hier kauf' ich ein.
Here am I human, here buy I
Roughly: 'Here I am treated like a human, here I go shopping.'[58]

Arguably, also *here* works in this way: it does not refer to place where the inventor of the slogan or to some other kind of entity playing the rôle of an utterer is located, but picks arbitrary stores of the company, where in turn neither the original utterer nor a token of the sentence need to exists.[59] Similarly, *me* and *I* in the examples above do not refer to the stickers themselves but to the stuff they are attached to, but this time, contrary to Olaf, the stuff is as incapable of writing as they themselves are. (Kratzer, 1978) further mentions inscriptions on entrances of houses (see 2.3.5), on gravestones, and so on, which contain instances of *I* that do not refer to their producer, nor to the stuff they are engraved in, but to the owner of the house, the person who is buried in the ground, etc. Note that this means that agents do not need to be alive in the context they

[58]Taken from www.dm.de, retrieved on May, 11th, 2018. The Goethe quote this slogan is a play on is (Goethe, 1986, p. 36, line 940):

(i) Hier bin ich Mensch, hier darf ich's sein.
Here am I human, here allowed I it am.
'Here I am human, may enjoy humanity.' (Kaufmann, 1961, p. 133)

[59]The infamous *I want you for U.S. Army* on the poster by J.M. Flagg, which addresses itself to everybody who sees it, comes to mind, too. But that the addressee of a sentence is less fixed than the author, and that printed sentences address themselves to arbitrary readers are truisms on which building a substantial claim may forbid itself.

are the agents of. Hence, it seems that there are no limits; everything can count as agent given the right circumstances. But this does not necessarily amount to a falsification of the Existence Constraint (61b), since EXISTENCE, as used there, might as well have a rather technical meaning, as UTTERANCE does. Thus, nonexistence and not being alive are two different things.[60]

If this assessment is correct, then the net-effect of Kratzer's account is the same as described in the previous section: it seems that every constraint that requires or leads to a somewhat meaningful notion of an AGENT has to be dropped. There seems to be no fact of the matter that makes one individual in a situation an agent. Kratzer's Agent Constraint (71) doesn't really help, because there seem to be no limits. If being an agent amounts to nothing more than occupying a certain position in the context tuple, as suggested above, all of these uses are immediately derivable. These readings then come out as possible literal meanings of the sentences in question, simply because anything can be an agent according to this notion. Needless to say, the context (based on s') in which Lucie writes *kick me* may be the only *utterance* context out of all the contexts in which this sheet of paper exists. In all other contexts, there exists a token of this sentence and the respective agent does not utter it (or 'produce' it otherwise).[61]

2.3.4 Tacking stock

Overall, the Kratzerian examples as well as Kaplan's conception of validity point into the same direction. There doesn't seem to be a fact of the matter that determines, given a situation, who or what the agent of the situation is. Thus, there is no need for a sentence token-producing entity in order for a situation to determine a context. Nor are sentence tokens or utterances of sentences or little discourses. Nor does an agent need to occupy the spatial location that comes with the situational core. Therefore, out of all constraints listed in the previous sections (and repeated below) only the Existence Constraint seems to hold. At least it is desirable that it holds and there isn't any evidence that it doesn't. And this means that contexts stem from situations.

Constraints on contexts:
If c is a context, w_c, t_c, p_c, and a_c are the world, time, location and agent of c, respectively, such that $\langle w_c, t_c, p_c, a_c\rangle = c$:

(61a) *Location-Constraint*: a_c is located at p_c in w_c at t_c.

(61b) *Existence Constraint*: a_c exists in w_c at t_c (and p_c).

[60] This at first may sound weird, because it seems to empty the notion of existence. But, on the other hand, there needs to be a way to assign a semantic value to a sentence like *Somebody is dead*, which wouldn't be possible if existence as spelled out by the existential quantifier meant being alive. But it not easy to give a positive characterization of existence. Intuitively, to exist in a situation should be connected to exemplifying a (nontrivial, natural) property; but this is far from clear, either.

[61] Token should not be confused with *occurrences* in Kaplan's sense. That is, sentences-in-context are even wider interpreted by Kaplan, since there doesn't need to exist a token of the sentence type in a context for the sentence type to be interpretable against this context. No token need to exist in a context for a context to be a context. Cf. Garcìa-Carpintero (1998) for further remarks on this.

(61c) *Utterance Constraint*: a_c utters something in w_c at t_c.

(62a) *Sentence Constraint*: a_c utters a sentence in w_c at t_c.

(62b) *Situation Constraint*: $\langle w_c, t_c, p_c \rangle$ form a situation in *LS*.

(71) *Agent Constraint*: a_c COUNTS as AGENT in w_c at t_c and p_c.

If this is correct, then there are as many contexts of the form 'situational core + agent' as there are (existing) individuals in a situation. For illustrative purposes, suppose that $s \in LS$ is a situation in which only 3 individuals, namely a, b, and c, exist. If the conclusion is correct, then this situation gives rise to the following contexts:

(73) $\langle w_s, t_s, p_s, a \rangle$, $\langle w_s, t_s, p_s, b \rangle$, $\langle w_s, t_s, p_s, c \rangle$

To repeat, not all of these contexts may strike the interpreter of a concrete utterance (in s) relevant or appropriate. But part of figuring out what the utterance means consists in reducing the set of possible contexts in a situation to a minimum if not a single one.

This remains true even if the addressee-parameter is taken back on board. If somebody somehow knew the exact situation but failed to know which of the contexts of the situation is relevant, when overhearing an utterance with one or more occurrences of the singular second person pronoun, the interpreter may rightly think that the utterance is directed at only one out of the possible addressees, but he wouldn't know which one. S/he may have to make a choice out of the following contexts:

(74)
$$\begin{array}{lll} \langle w_s, t_s, p_s, a, a \rangle, & \langle w_s, t_s, p_s, a, b \rangle, & \langle w_s, t_s, p_s, a, c \rangle, \\ \langle w_s, t_s, p_s, b, a \rangle, & \langle w_s, t_s, p_s, b, b \rangle, & \langle w_s, t_s, p_s, b, c \rangle, \\ \langle w_s, t_s, p_s, c, a \rangle, & \langle w_s, t_s, p_s, c, b \rangle, & \langle w_s, t_s, p_s, c, c \rangle \end{array}$$

Since characters are functions from contexts, it is not possible to somehow derive that the singular *you* addresses several individuals at the same time, even though there are multiple possibilities of application in the situation at hand. The same, of course, holds for the referent of the first person pronouns. As long as characters are applied to only one of the many possible contexts in play, their values are singular. Even if s is a situation in which an individual speaks to a (relatively small) audience, the use of singular *you* means that its very referent is a single individual; it is just not immediately obvious, which one.

Of course, if plural pronouns are taken into consideration, the slots reserved for agents and addressees may possibly have to be occupied by plural individuals, or something similar, in addition to the single individuals listed above. This once again dramatically increases the number of contexts determined by a concrete situation, but, on the other hand, might at the same time be a first approximation of the vagueness *we* and plural *you* exhibit. Apart from the fact that the group referred to by *we* must include the agent, it is not clear how large this group exactly is. It possibly contains at least two individuals; otherwise, the use of *I* should be mandatory. Likewise for the second person.[62] Furthermore, it is possible to address only a subgroup of a larger audience.

[62] This might be managed by installing presupposition in the lexical meanings of the personal pronouns

And this possibility then must be reflected in the availability of appropriate contexts, containing proper parts of the audience as plural individuals. But, yet again, there is only one interpretation possible once a context is chosen for the application of the character. Thus, there is no unreasonable multiplication of readings.

One can also put it this way: if the interpreter knows exactly who's speaking, she fixes one slot of the relevant contexts. But this doesn't mean that she can pinpoint exactly one context. Neither does this mean that she can pinpoint one of the many situations she's in as being the relevant situation that determines the contexts she has to choose from. Thus, knowing who's speaking merely gives a first clue. Even if some of the other parameters are fixed, determining the situation on the basis of what the interpreter knows is nigh on impossible. And thus she may content herself with a couple of possibilities, all agreeing on the parameters she fixed, but varying in the parameter about which she doesn't have a clue. If, e.g., the location parameter is among those she can't determine, she will deem several contexts possible which value the location parameter slightly different, within a certain range partly governed by the fixed values for the other parameters. Hence she would not know exactly what *here* refers to, if it were contained in the utterance she has to interpret. Thence the impression of vagueness.

All of this carries over to third person singular pronouns in deictic usage. But, as will be shown in the next section, they are different insofar as it is possible to use several of them in one and the same sentence without necessarily referring to one and the same entity.

2.3.5 Demonstratives

Above it was assumed that deictically used third person personal pronouns and other demonstrative expression have to be accounted for by a distinguished context parameter dedicated exactly to providing their referents. This parameter was thought to be determined by a function DEM, repeated below, that, similarly to the parameters for other indexicals, represents a fact of the matter that determines the value of demonstratives in a situation.

(24c) $$\textsc{Dem}(s) := \begin{cases} x & \text{iff} \quad \exists! y : \textsc{Sp}(s) \text{ points at } y \text{ in } s \;\&\; y = x \\ \#_e & \quad\;\; \text{otherwise} \end{cases}$$

It is obvious that the value of DEM does not only depend on s, i.e., a particular combination of world, time, and location parameter (although the exact nature of this dependency is left implicit), but also on there being a value for SP for the same situation, i.e., the function that assigns agents to situations. Since the availability of such a function is called into question by what was said in the last section, the availability of DEM is undermined as well. As briefly pointed out above, the approach that utilizes DEM isn't the one Kaplan defends anyway, but nevertheless Kaplan held that something in the context (or the situation for that matter) helps determining the object referred to. In Kaplan (1989b) it is an accompanying pointing gesture that fixes the referent, while

by way of conditions of applications as in Heim and Kratzer (1998).

this gesture is viewed as a mere externalization of a referent-fixing speaker intention in Kaplan (1989a). However this materializes exactly, Dem could be modified to be useful in either account. Thus, it is not Dem as such that is the problem here, but rather whether it is possible at all to determine the content of demonstratively used pronouns on the basis of the context or the situation it stems from.

There are many reasons why Dem in its present form (24c) is inadequate. Its uniqueness condition (hidden in $\exists!$, cf. p. 32), for example, assumes that there can be only one demonstrated object per context and hence predicts that all deictic pronouns in a sentence refer to that very object. But, there are cases in which more than one deictically used pronoun makes its appearance within one sentence, and it is clear that more than one object is referred to:

(75) While HE came from the left and HE came from the right, HE stood at the corner, waiting for both.[63]

This phenomenon is not restricted to multiple demonstratively used third person pronouns as can be seen in sentences like the following (modeled after examples in T. E. Zimmermann 1991).

(76) a. YOU destroyed my pretty house. And YOU hid my sportster.
b. While YOU rebuild the house, YOU could get the motorcycle back.

Again, the occurrences of *you* are not (necessarily) interpreted as referring to the same individual in the sequence of sentences in (76a). And the same holds for the sentences in (76b), that is, the addressee of the second sentence is allowed to differ from the addressee of the first. Since (76a) is a small discourse made out of two sentences, the context of evaluation can change, so to speak, between the interpretation of the first and the second sentence: to derive the intuitively correct readings, one just needs to assume that the context the character of the first sentence is interpreted against, c_1, is not reused in interpreting the second sentence. Instead, a different context, c_2, could be used. The differences between c_1 and c_2 then make the difference in the value assigned to *you*. All of this is in line with what is said above. But this alleged 'context change' is of no help regarding (76b) unless one assumes that it can happen *while* (76b) is interpreted. Otherwise, due to the construction of characters and the way in which they determine the intensions to be combined in deriving the intension of the whole utterance, there is only one slot available for a context to enter. Thus, the two second person pronouns are predicted to be interpreted identically, contrary to fact. Among others, Kupffer (2014) points out that stress on the pronouns is necessary for the sentences to have the readings in questions. If they aren't stressed, there seems to be only one interpretation according to which the addressee has to be the same for both occurrences. Hence, neither sentence of (77) has a reading that the analogous sentences in (76) have.

(77) a. You destroyed my pretty house. And you hid my sportster.
b. While you rebuild the house, you could get the motorcycle back.

[63] Capital letters mark stress.

In view of this, Kupffer claims that the stressed second person pronouns in (76) are used deictically or *demonstratively*, which makes them parallel to the third person pronouns in (75), but different from the indexically used pronouns in (77). Note that stress isn't sufficient for such a use, though it does seem necessary (cf. de Hoop, 2003, for other readings).

Demonstrative uses are also possible with other indexicals, which is witnessed by the following example from Kaplan (he attributes this observation to Michael Bennett):

(78) In two weeks, I will be HERE [pointing at a city on a map.]
(adapted from Kaplan (1989b, p. 491))

With the point being that *here* doesn't refer to the location of any context of a situation against which this sentence is interpreted, but the location pointed at through the map. I.e., stressed *here* is used demonstratively as well.

And there are also examples with multiple occurrences of *here* within one sentence that do not (necessarily) refer to the same location-individual. If the following sentence is understood as being uttered while the speaker changes her spatial location, the stressed indexicals refer differently (although, they seem to refer to a location the speaker occupies in the moment she uses the indexical, thus, the following examples differ in this respect from (78)):

(79) HERE it is louder than HERE (Kupffer 2014, p. 31, crediting Peter Rolf Lutzeier)

Similarly, *today* and *now* can be used roughly in the same way:[64]

(80) a. $^{(?)}$TODAY, it's hotter than TODAY.
b. NOW, it's hotter than NOW.

Again, this seems to be only accounted for if the context is allowed to change in between:

> Why do we not need distinct symbols to represent different syntactic occurrences of "today"? If we speak slowly enough (or start just before midnight), a repetition of "today" will refer to a different day. But this is only because the context has changed. It is a mere technicality that utterances take time, a technicality that we avoid by studying expressions-in-a-context, and one that might also be avoided by tricks like writing it out ahead of time and then presenting it all at once. (Kaplan, 1989a, 586f.)[65]

[64] Interestingly, as pointed out to me by Manfred Sailer (p.c.), it seems that *now* doesn't receive the intended demonstrative interpretation in examples like the following even if the utterer points to several different dates in a calendar:

(i) #I want to visit you NOW, NOW, and NOW.

Thus, it seems, Kaplan's example (78) might involve more than just a mere demonstrative use of *here*. Sailer suggests to treat (78) on a par with the examples discussed in Nunberg (1995).

[65] This kind of example can be constructed for other indexicals as well. E.g., one can take the context sketched by Kaplan but use *yesterday* and *tomorrow*. The resulting sentences are pretty complicated

The reasoning behind these examples is the following: the utterance starts with the first (stressed) indexical on one day, and finishes with the second occurrence on another; hence, they refer differently. But somehow, even though one can easily get what utterances of (80) are supposed to mean, the sentences aren't that great. Maybe, this is due to the general oddness of referring to the very day that ended a couple of seconds ago by *yesterday*. E.g., if Peter is handed over a glass of sparkling wine close before midnight on New Year's Eve, and he wants to find out who it was (since he missed it) after the cheering and firework is over, it is a bit too pedantic if he phrases his question *Who gave me that sparkling wine yesterday?* Mutatis mutandis, the same holds for *tomorrow*. The use of these indexicals seem to require that some more time passes in between; although, strictly speaking, Peter's question expresses exactly what he wants to know.

Alternatively, one might tie the availability of demonstrative uses of temporal indexicals like *today* to their being directly referential to the temporal location of the context, in contrast to those that involve some kind of 'internal shift'.[66] Take *yesterday*, which picks the time-parameter from the context, but 'shifts' it to the previous day. This 'internal shifting' seems to make it incompatible with demonstrative uses. The same holds for *tomorrow*, and both are unlike *today* and *now*.[67] This internal shifting doesn't occur with personal pronouns, and hence they can be used deictically. A notable exception might be the first person pronoun. Kupffer (2014) notes that it is hard to come up with examples that contain multiple occurrences of *I* that refer to different individuals. He criticizes Kratzer's use of (81a) (taken from Theodor Fontane's *Die Brück' am Tai*) and offers (81b) as a better version (alluding to the biblical Magi):

(81) a. Ich komme vom Norden her. Und ich vom Süden. Und ich vom Meer.
I come from-the north . And I from-the south. And I from-the sea.
'I'll come frae the North. / And I frae the South. / And I frae the Forth.'
(Yuill, 1982, pp. 12–14, through Kupffer, 2001)

b. ICH bringe Weihrauch, ICH Myrrhe, und ICH Gold.
I bring frankincense, I myrrh, and I gold.

If one takes either of these as a single utterance by multiple speakers, then cases of demonstrative uses of *I* are found. What one needs are scenarios with appropriate utterances by multiple persons either at the same time or consecutively, Huey, Dewey,

to understand. They might even be worse than the original examples simply because they are so unnatural. From a Gricean perspective, it isn't quite clear why one would want to use such sentences at all.

(i) a. $^?$YESTERDAY, it was hotter than YESTERDAY.
b. $^?$TOMORROW, it will be hotter than TOMORROW.

[66] For the lack of a better term. This shouldn't be confused with the use of *shift* in section 2.1.3.

[67] Yet one must admit that *today* incorporates something like an 'internal shift' as well, since there needs to be a mapping from the context time to the respective day: and it is the latter to which *today* refers and not the former.

and Louie style. But these scenarios cast some doubt upon whether one really deals with only one utterance or several simultaneous or consecutive ones and this doubt doesn't really disappear with (81b) either. Another try consists in the following sentence, uttered in the same kind of scenario as (79):

(82) ?I [stressed] am happier than ME.

In order to avoid an interpretation that renders (82) trivially false, one has to interpret the two occurrences of the stressed indexical as referring to different individuals. At some level of conceptualization an individual differs from a previous version of herself, so one might argue that (82) somehow invokes reference to different time-slices as full individuals. But this might also indicate that this interpretation results from dealing with trivial (contradictory) content pragmatically, e.g. by Gricean means. Of course, the same can't be said about (80a) and its worse variants, and also doesn't seem to be true for (75), (76), and (79): there is something deviant about the former group of the examples, but the others are completely normal.

However, if examples of this kind really are grouped under the single header 'demonstrative usage', this suggests that the alleged 'context change' that obviously happens in the scenario Kaplan sketches is the way to account for demonstratively used second and third person pronouns as well. To be sure, it isn't necessary to take this route in order to derive the readings in question; but if not, one needs to explain what exactly the differences are.

As already noted in section 2.3.2, apart from Kaplan's suggestions, two ways of dealing with this problem are found in most of the literature, the approach utilizing context change throughout the interpretation process, i.e. tokenreflexive semantics, being one of them. In the other strand examples like (75) are taken to show that the interpretation of demonstratively used expressions depends on *occurrences* (not in Kaplan's but in Stechow's/Kupffer's sense) such that different occurrences possibly receive different values (esp. von Stechow, 1979). This essentially boils down to (i) a distinction (e.g. via indexation) of occurrences of (demonstratively used) expressions, and (ii) a multiplication of parameters as respective values. That is, if an demonstratively used expression β has several occurrences $\beta_1, \beta_2, \ldots$ within one sentence, the first occurrence may be interpreted against a contextual parameter γ_1 which is possibly different from γ_2, the parameter the second occurrence β_2 is interpreted against, and so on, and so forth. This basically means that contexts need to supply at least as many parameters as there are demonstratively used pronouns in a sentence. Since sentences are finite, but arbitrarily long, so will contexts need to be.

Alternatively, one may stick to the contexts as short as the elements of $d\Gamma$ and allow for at least as many context changes as there are demonstratively used expressions in a sentence. This is the gist of tokenreflexive semantics. The selection of contexts can be tied to the respective utterance of the demonstrative itself, if it is assumed that contexts are individuated by utterances, as the Utterance-Constraint (63) has it. But this takes on board all the shortcomings relating to validity pointed out above. On the other hand, if nothing is undertaken to restrict the realm of contexts relevant for the evaluation of a sub-expression of a sentence, the floodgates of overgeneration are opened. A sentence could presumably be interpreted against several completely different contexts, stemming from entirely different worlds, hosting different agents etc. As a result one would predict all kinds of wacky readings that do no exist. Maybe this is the reason why assuming (63) is so common. But even if one restricts oneself to only using 'basic contexts', i.e., contexts of the length of $d\Gamma$ (or$^{*}d\Gamma$), the evaluation of complete (complex) sentences can then be understood as involving larger contexts, namely contexts built from several basic ones, which are taken to be the relevant sub-contexts in the process. Thus, these large contexts are contexts (if they deserve this label at all) in which multiple demonstrations are allowed to occur and so several demonstrated objects need to be represented. Hence, regarding the number of parameters, one basically assumes the same kinds of contexts that occurrence-dependent semantics does. It is only the way to approach these contexts that is different, since they are not treated as given, but derived by some kind of summation operation '$\oplus$'. One individual singled out demonstratively then can be said to be available via the occurrence of a demonstratively used expression–thereby collapsing the two frameworks into one.[68]

Formally, contexts like these can be constructed by summing up 'basic' demonstrative contexts in which only one demonstrated object is present. These uniqueness-satisfying contexts are thus understood as basic elements, and as sub-contexts of the resulting larger contexts. To avoid totally wacky readings, the summation of contexts needs to be severely restricted. For example, the world-coordinate is not allowed to differ between two contexts summed, and neither are agent and addressee. Otherwise, these entities would multiply the slots of the resulting contexts, making it impossible to say which of the former world, agent, or addressee fulfills this rôle in the resulting context and which doesn't. Also, there need to be some constraints on the time- and location-parameter to avoid unconnected, i.e. spatially or temporally scattered contexts, e.g., put together by a time and location in France and a completely different time and a location on Mars. What also needs to be prohibited is that the demonstrated objects are multiplied without reason. If demonstrated objects are thought to be tied to specific times in the tuples somehow, they should be identified if the times of two contexts overlap, but they shouldn't be, if they don't. Needless to say, one can't generally identify slots occupied by the same object while summing up contexts, because one object could be demonstrated twice. But in case one object is tied to the same time in two contexts, the sum of these two contexts shouldn't contain this object twice. Mutatis mutandis, the same holds for spatial locations as well. The result of summing up two demonstrative contexts should still be a situation-based context, i.e., the tuple should start with an element of the situation-based subset of $\mathcal{W} \times \mathcal{T} \times \mathcal{P} \times \mathcal{D} \times \mathcal{D}$, because world, speaker and addressee of the original contexts need to be identical; yet the result can't be a demonstrative context in the sense of the basic contexts in all cases, since the uniqueness condition built into them is possibly violated. Hence, the merge operation on basic contexts makes it possible to generate *demonstrative* contexts in which the uniqueness condition doesn't hold in

[68]This basically is the way in which Kupffer could have put the intuitive base of his equivalence proof.

general (but the existence condition obviously does), even if Dem still constraints the set of 'basic' demonstrative contexts. Apart from that, there is another reason why it shouldn't be possible to leave the realm of situation-based contexts by summing up contexts. If this were allowed, the whole discussion from the previous paragraph would be rendered pointless. At least this assumption should take care of the majority of the constraints on times and locations (though not all of them). This also means that the limiting assumptions regarding agent and addressee could remain in force, if one desires so; it would thus still not be possible to generate contexts in which more than one individual counts as agent. But situations in which more than one person is talking give rise to a lot of (disjoint) contexts via sub-situations, so it should be possible to account for the characters of sentences even with respect to contexts determined by such 'crowded' situations.

If this is the case, summation can make use of the part-whole structure of situations assumed in section 2.1.1 in the following sense. If two situations are disjoint but exhaustive parts of a third one, and both situations determine a context each (even in the strong sense spelled out by the limiting assumptions), both contexts are sub-contexts of the context determined by the third, larger situation if all three contexts correspond on the purely contextual parameters.[69] Since all contexts are situation-based, relations between situations need to carry over to contexts as well (so making the situational core responsible for this is quite natural) unless the individuals in play block summation (by not being identical where they need to be). Hence, for contexts one might define the part-of relation (or subcontexthood) in the familiar way:

(83) α is a sub-context of β iff $\alpha \oplus \beta = \beta$

Intuitively, what matters most are sub-contexts which only differ with respect to time. That is, if the world and the spatial location parameter are the same, but one context is the temporal extension of the other context, the larger context created by summation comprises both basic contexts and is temporally connected. Under this configuration, summation should be defined, and the outcome therefore shouldn't exhibit temporal gaps. Thus, the larger context represents two (or more) consecutive demonstrations, differentiated by the time they occur, in an otherwise constant environment. Applying this to an example like

(84) HE says that HE is sick

one then—assuming a pretty simple analysis of *saying* for the sake of argument—might say with von Stechow (von Stechow 1979, p. 319):[70]

[69]On the same assumptions, this also holds pointwise for the contexts determined by situations according to the more liberal picture sketched in the last section. That is, not every combination of any two contexts determined by two sub-situations of a larger situation is a context determined by the larger one. But for every context determined by the first situation there is a context determined by the second one such that the former is a sub-context of the latter, provided that there are contexts of all three situations that match on the contextual parameters.

[70]The notation is tacitly adapted to fit the present representation. Von Stechow builds an indexical treatment of tense into this quote, witnessed by using t instead of t' in the last sentence. This

> The meaning of [(84)] is a function π which is defined only for such utterance indices $\langle w, t, p, \textsc{Ag}, \textsc{Ad}, \textsc{d}_1, \textsc{d}_2 \rangle$ of [(84)] such that there are [...] $\textsc{d}_1$ and $\textsc{d}_2$, each a male person or animal, such that at the subinterval t' of t where the first occurrence of he in [(84)] is uttered, $\textsc{d}_1$ is the object referred to by the token uttered, whereas at that subinterval t'' of t where the second occurrence of he in [(84)] is uttered, $\textsc{d}_1$ is the object referred to by the token uttered. For any such utterance index $\langle w, t, p, \textsc{Ag}, \textsc{Ad}, \textsc{d}_1, \textsc{d}_2 \rangle$ of [(84)] $\pi(w, t, p, \textsc{Ag}, \textsc{Ad}, \textsc{d}_1, \textsc{d}_2)$ is that proposition ρ such that for any $\langle w', t', p' \rangle$, $\rho(w', t', p')$ is true, if both $\textsc{d}_1$ and $\textsc{d}_2$ exist in w' at t and $\textsc{d}_1$ says in w' at time t and place p' that $\textsc{d}_2$ is sick at t and p'.

As can be guessed from this quote, von Stechow fully endorses a version of the constraint of interpretation (63) in demanding that the parts of (84) containing the demonstrative pronouns are interpreted against basic contexts in which the respective tokens are uttered. Hence, as assumed explicitly in Kupffer (2014), the large context is a context in which (84) is uttered, while the basic contexts are contexts in which parts of (84) are uttered. If contexts can thusly be structured with the help of a *subutterance* relation, the context change assumed in tokenreflexive semantics can be represented as tracking the utterances of individual words within one large context, and hence, tokenreflexive semantics can be given a form which makes it resemble this form of occurrence-dependence more closely.[71] Dividing one large context into sub-contexts is a lot easier if contexts in general are individuated via utterances of expression-tokens. Then there are contexts individuated by utterances of whole sentences, and their sub-contexts are determined by utterances of smaller expressions. Since utterances themselves take some time, they structure a succession of slightly different contexts quite naturally, as is demonstrated in Kupffer (2014).[72] Sure, whether context changes then is a matter of presentation. If the interpretation of an example like (84) is presented as utilizing several contexts (that could add up to a large context by means of summation), then context does change. If only the large context is taken into consideration, then context doesn't change while (84) is interpreted, although whenever a new part of the sentence is interpreted, a different part of the context may be selected. But, as discussed in section 2.3.2 above, this approach necessarily involves a version of (63) and thus is incompatible with the Kaplanian notion of validity and Kratzerian examples if the previous sections are correct.

Discarding (63) once again, an utterance-independent and more Kaplanian assumption to cope with multiple demonstratives is that contexts may supply more than one demonstrated object-parameter, not differentiated by an utterance (or the object itself), but by

complication can be ignored, though.

[71] Thus, for the individuation of basic contexts, there is no room for the Sentence Constraint (62b). Instead, the Utterance Constraint (61c) does this work. One might think of a *Word Constraint* analogous to (62b), but, as Kupffer (2014) points out, even this might be problematic in view of discontinuous expressions like *abso-bloody-lutely* or *if ... then*.

[72] As Ede Zimmermann rightly pointed out to me (p.c.), it still is not too clear how this kind of analysis can be adapted to account for written sentences, even if they are accompanied by other means of demonstrations like arrows and the like. This remains to be a problem for the more Kaplanian take suggested below.

(the time-intervals of) *demonstrations*. Instead of taking the time-interval from the utterances of the personal pronouns, as von Stechow does, Kaplan assumes that there need to be different tokens of demonstrations (or, as in Kaplan (1989a), referential intentions). Contexts can be thought of as being individuated roughly along the lines established by Dem without uniqueness. As already mentioned, the summation-operation simply allows for a circumvention of the uniqueness requirement anyway. One may just as well use the following variant of Dem right from the start:[73]

(85) $\text{Dem}(w, t, p, \text{Ag}, \text{Ad}) := \langle \text{d}_1, \ldots, \text{d}_n \rangle$ such that $\exists t_1 \ldots t_n \sqsubseteq t : t_1 \leq_{\mathcal{T}} \cdots \leq_{\mathcal{T}} t_n \ \& \ \forall i : 1 \leq i \leq n \rightarrow \text{Ag}$ DEMS d_i at $\langle w, t_i, p \rangle$.
Defined, if there is at least one such object, undefined otherwise, i.e. $\langle\rangle = \#_e$.

Demonstrative contexts are thus all the sequences starting like elements of $^*\Gamma$ (or $\mathcal{W} \times \mathcal{T} \times \mathcal{P} \times \mathcal{D} \times \mathcal{D}$, insofar as they are situation-based) for which Dem in its present form is defined and continuing with the output of Dem at the element of $^*\Gamma$ the tuple starts with. Hence:

(86) $^{**}d\Gamma := \{\sigma : \exists \kappa \in {}^*\Gamma \ \exists \delta : \text{Dem}(\kappa) = \delta \neq \#_e \ \& \ \sigma = \kappa\delta\}$,

where $\alpha\beta$ denotes the unique sequence which results from concatenating the coordinates of α with the coordinates of β, in that order. DEMS within the definition in (85) needs to be spelled out in more detail. As noted above (section 2.2.1), filling in the right details at this point enables one to defend a truly Kaplanian position while still having parameters available. That is, it is possible to put everything that Kaplan demands from demonstrations into this relation and thus arrive at a theory that is Kaplanian in spirit, even if it isn't in letter. Likewise, one can make DEMS contain the intention-based theory of his "Afterthoughts" (Kaplan, 1989a), where Kaplan revises the rôle of demonstrations completely, viewing them as mere externalizations of referent-fixing intentions of the agent. This isn't undertaken here, since it doesn't fit with the picture drawn of agents in the previous paragraphs. Especially in view of the Kratzerian examples one should be skeptic about the rôle of intentions in the framework. If, e.g., cakes need to count as agents to account for the Alice in Wonderland examples, then this casts pretty general doubts. Earlier Kaplan expresses some doubts about the rôle of agents in demonstrations as well:

> It is the agent of course who focuses your attention on the relevant local individual. But that needn't be done *by* anyone; we might have a convention that whoever is appearing on the demonstration platform is the demonstratum, or the speaker might take advantage of a natural demonstration of opportunity: an explosion or a shooting star. (Kaplan, 1989b, 525, fn. 47)

If this is correct, then there are at least some "demonstrated objects" which aren't brought into attention by reference-fixing intentions.

[73] This is a simplification insofar as demonstrations are only differentiated by times, and not also by spatial locations. Since individuals, pointing or not, cannot occupy two different locations at the same time, this seems reasonable.

Compared to ${}^{*}d\Gamma$, ${}^{**}d\Gamma$ is a mixed bag of tuples differing in length, since it contains all contexts in which some demonstration happens at some point. But note that ${}^{*}d\Gamma \subseteq {}^{**}d\Gamma$, since the original demonstrative contexts are just the special cases in which only one demonstration occurs.

To establish the link between demonstratives and demonstrated objects, one does not need an utterance of the sentences containing the former, but only a demonstration of the latter at a definite point or interval in time. However, this can be established without restricting contexts to contexts of utterances. All one needs to do is differentiate demonstrations by slight differences in their occurrence in time, thereby working them into a sequence of (possibly distinct, possibly identical) objects demonstrated, and then evaluate the first demonstrative within an expression against the first object of that sequence, the second against the second and so on. Of course, this presupposes that the demonstrative expressions are individuated grammatically. Thus, since contexts aren't split into sub-contexts until a basic context is found against which a part of a sentence containing only one demonstrative expression is evaluated, the main context stays intact. There is no context change or analysis of contexts into constitutive basic contexts, but in order to allow different occurrences of demonstrative expressions to refer differently, these occurrences have to be differentiated beforehand. Furthermore, one needs a definite linear order of occurrences to match the sequence of demonstrated objects in the newly defined demonstrative contexts ${}^{**}d\Gamma$. That is, the way in which demonstrative expressions are identified and brought into a linear order have to be treated independently of the question how contexts are to be individuated. However this turns out,[74] the general theory again is a form of occurrence dependent semantics, but this time, it doesn't fall within the vicinity of Kupffer's equivalence proof since it explicitly denies the individuation of contexts by utterances.

There are further differences. In particular, this way of doing things is less strict than the von Stechow/Kupffer approach, in the following sense. Let κ be a context in which Peter first points at his deskmate and then at his teacher, while uttering:

(87) HE is taller than HIM.

It is possible to ask what (84) (!) expresses in this context, which it is not in the utterance-based framework just presented. The answer is that (84) expresses the proposition that Peter's deskmate (in κ) says that Peter's teacher (in κ) is sick (which is false with respect to κ). Likewise, a context in which (84) is uttered can serve as a context against which (87) is interpreted. And there doesn't need to be an utterance to establish this. If another situation is imagined in which Peter silently, without a thought on his mind, without writing anything points at his deskmate and then at his teacher, then conforming to the liberal picture of the previous section, this situation determines at least one context according to which (84) expresses the same proposition as interpreted

[74] For some remarks, cf. section 3.5. It should be noted that, if one tackles this like von Stechow (1979), one first needs to answer the question which level of representation counts for the determination of the linear order. It might be the surface order, it also might be deep structure. Thanks to Ede Zimmermann who brought this point up in a conversation.

against κ.

So far, so good. But there are reasons to doubt the Kaplanian picture as well. Note that validity cannot play the same rôle in this argument, since

(88) I am pointing at THAT.

doesn't come out as valid in any account (and rightly so), because in all of them there are non-demonstrative contexts for which the character isn't defined. Thus, sentences involving demonstratively used expressions cannot have a tautological diagonal. So, one might try to find examples similar to the Kratzerian examples above.

The following sentences are part of an automatically generated announcement playing in certain regional trains approaching Freiburg main station:

(89) Nächster Halt: Freiburg im Breisgau, Hauptbahnhof. Dieser Zug
Next stop: Freiburg in the Breisgau main station. This train
endet dort.[75]
terminates there.

The point is that the second sentence starts with the (complex) demonstrative *this train*. The message is understood correctly if it is interpreted as referring to the (actual) train in which the announcement is made. The question who the agent is is quite interesting, even though the first person pronoun is not used at all. It may be the train in which the message is broadcast itself, although then the train would refer to itself by a demonstrative pronoun, which is quite unusual. Since it is an automatically generated message, it is not the conductor nor the ticket controller who produces the utterance; one of them may trigger it, though. The best guess might be the corporation that runs the train. However, neither is the train demonstrated by a pointing gesture, nor does a referential intention seem to be involved. Both are pretty unlikely simply because the agent seems to be disembodied and non-sentient. It is hard to ascribe one to the technician who presumably made the respective software program generate the announcement, since (s)he most likely had no idea which trains would eventually play that message. The most one can say is that (s)he might have had an intention to the end that the complex demonstrative refers to whatever train in which the announcement plays. On the other hand, the technician is a very unlikely agent in the first place. It is quite counter-intuitive to start a speech report with the phrase *then the technician said that ...*. Of course, the same holds for the corporation. Maybe the best way to describe the agent is to use *the voice*. However, it seems, none of the Kaplanian contexts is able to account for the demonstrative in (89).[76]

[75] This use of *dort* seems to belong to a southern dialect of German. I would use *da* instead. This isn't investigated any further.

[76] It may be possible to deal with at least some of these problems by allowing for agent-less contexts. Even though this necessitates cutting the internal relation between demonstratives and the agent as it is done below, it avoids the pressure of needing to characterize the agent in all possible contexts. One observation leads into this direction, namely the fact that the sudden use of first person expressions in these scenarios would be rather strange. However, this line of reasoning is not pursued any further.

Roughly the same point can be made with the following sentence that is usually found on labels on ATMs:[77]

(90) An diesem Gerät erhalten Sie folgende Noten:
At this machine, get you following notes
'At this ATM it is possible to draw money in the following notes'

Again, the point is the demonstrative *diesem Gerät.* The most plausible interpretation has it referring to the ATM the label is attached to. Again, no non-institutional individual suggests itself as the agent, and neither demonstrations nor reference fixing intentions seem to be in play. The labels arguably are mass produced somewhere and, again, originate with unlikely agents who have no idea what a particular label is attached to. Thus, it is not possible to 'borrow' referential intentions or demonstrative gestures from any source.

There are more examples of this kind, in fact, they seem to be quite frequent in the wild.[78] One example is even found in Kratzer (1978, p. 18). It is an inscription on a certain house. She doesn't talk about the demonstrative *dies Haus* though, but only elaborates on the first person pronouns (cf. section 2.3.3).

(91) Dies Haus ist mein, und doch nicht mein / Wer's vor mir war, s' war auch
This house is mine, and yet not mine / Who-it before me was, it was also
nicht sein, / Er ging hinaus und ich hinein / Nach mir wird's auch so sein.
not his, / he went out and I into / After me will-it too so be

So, it seems that there are many examples with which neither Kaplan (1989b) nor Kaplan (1989a) is able to deal.

What to make out of this? Again, it seems as if there is no fact of the matter like a demonstration or a referential intention that decides upon which object can be regarded as figuring as the value or the "demonstrated object"-parameter in a given context. If this assessment is correct, so needs to be the consequence of doing away with any constraint on demonstrative contexts to the effect that something specific needs to happen in a

Thanks to Ede Zimmermann for pointing this out to me (p.c.).

[77]It is possible to opt for a distribution of notes after one settled on the amount of money one wants to draw from the ATM. E.g., if one wants to draw 50€ from his or her account, he or she can choose between receiving one 50€ note, two 20€ and one 10€ note, and so on. But some ATMs do not contain all possible notes. Thus, e.g., small notes may not be available. Which notes an ATM hosts is announced by labels on which (i) is printed together with pictures of the notes available.

[78]To give just two more, (i) is a sentence often found on shirts worn by men with big bellies, and (ii) is from a common warning sign:

(i) Bier formte diesen wunderschönen Körper
Beer shaped this beautiful body

(ii) Aus Sicherheitsgründen wird dieser Raum ständig durch Kameras überwacht.
For safety-reasons be this room permanently by cameras surveilled.
'For reasons of safety, this room is under permanent video surveillance.'

situation in order to determine such a parameter. That is, all there has to be in order to value a demonstratively used expression is *some object or other* playing that rôle. The conclusion is that—as in the case of the value for first person pronouns—*any* object existing in a situation might do. Thus, neither in the form (24c) nor in the form of (85) can DEM be used to individuate contexts. Since contexts are nothing but elements of the situation-based subset of $\mathcal{W} \times \mathcal{T} \times \mathcal{P} \times (\mathcal{D})^2$, demonstrative contexts must be nothing but elements of the situation-based subset of $\mathcal{W} \times \mathcal{T} \times \mathcal{P} \times (\mathcal{D})^n$ for any $n > 2$. As Kaplan himself points out, as long as demonstrative expressions are individuated in such a way that different occurrences look for their value in different slots in a context, this is enough to ensure that sentences like *THAT is identical with THAT* (cf. (57e), p. 49) are informative:

> [J]ust as we can speak of agent, time, place, and possible world history as features of a context, we may also speak of first demonstratum, second demonstratum, ... (some of which may be null) as features of a context. We then attach subscripts to our demonstratives and regard the n-th demonstrative, when set in a context, as rigid designator of the n-th demonstratum of the context. Such a rule associates a character with each demonstrative. In providing no role for demonstrations as separable 'manners of presentation' this theory eliminates the interesting distinction between demonstratives and other indexicals. [...]
>
> If we consider Frege's problem, we have the two formulations:
>
> that [Hes] = that [Phos]
>
> $\text{that}_1 = \text{that}_2$
>
> Both provide their sentence with an informative character. (Kaplan, 1989b, 528f.)

But the passage continues, and Kaplan expresses some doubts about the second alternative, which is called the "Indexical theory of demonstratives":

> But the Fregean idea that that very demonstration might have picked out a different demonstratum seems to me to capture more of the epistemological situation than the Indexicalist's idea that in some contexts the first and second demonstrata differ.
>
> The Corrected Fregean theory, by incorporating demonstration types in its sentence types, accounts for more differences in informativeness as differences in meaning (character). It thereby provides a nice Frege-type solution to many Frege-type problems. (Kaplan, 1989b, p. 529)

Unfortunately, he doesn't go on to demonstrate what, according to his views, his "Corrected Fregean theory" is able to do that the "Indexical theory" isn't.

One may be tempted to argue that emphasizing written sentences or recorded utterances is the main cause for all the issues with Kaplanian or other (utterance-based) theories. This is certainly so. But the conclusion to be drawn shouldn't be that they ought to be ignored for the sake of an intuitive picture of contexts based on utterances, involving sentient agents, sometimes pointing at objects from a certain perspective. Contexts like these are a liability when it comes to the interpretation of written or recorded sentence-tokens outside their production situation, and if contexts are thus restricted, a lot of additional stories are needed in order to ensure that the respective characters get something they can work with. If, conversely, characters are defined over a realm of contexts individuated as liberal as they are construed here, there is no problem of having enough contexts, but the difficulties shift over to the interpretation of concrete utterances in concrete situations. Since there are so many contexts determined by a situation, it might become implausible that selecting one of them lies within the capabilities of an interpreter. But, as mentioned, this task may be made significantly easier if some of the former alleged constraints on contexts or interpretations are implemented as mere heuristics. That is, if only one person is speaking in a situation, it is quite natural to consider just those contexts in which this individual sits in the agent-slot; hence, the semantic value of *I* (if uttered) can be regarded as fixed to this very individual. If this individual occupies a certain spatio-temporal location, it is quite natural to consider this location as the value of the time- and location-parameter; fixing the semantic values of *now* and *here* if these expressions are uttered. If the utterance contains demonstratively used personal pronouns or other deictic elements and the agent points at an object in her surroundings while uttering the sentence, it is quite natural to consider those objects pointed at as the values of the demonstrated-object parameter. And if the utterance comprises more than one deictic expression or if there are several pointings, it is natural to consider contexts in which the objects pointed to are ordered in such a way that their order matches the order of demonstratively used expressions, thus fixing the values of *he*, *she*, or *this dog*. All of this doesn't have any influence on the number of contexts determined by a concrete situation. But contexts fulfilling most of these statements can be made the first choice for an interpreter in a situation. If something seems to be wrong with the resulting interpretation, the interpreter may look into contexts that fulfill fewer statements, and so on. This also works for most of the examples where indexicals are used demonstratively—with the notable exception of (78), (p. 66)—, since on this level, a notion of context-change is easily implemented:[79]

(79) HERE it is louder than HERE.

(80a) $^{(?)}$TODAY, it's hotter than TODAY.

(80b) NOW, it's hotter than NOW.

[79]Note that (i) context obviously does change in the description of the scenario Kaplan offers; and (ii) Kaplan links this phenomenon to (the interpretation of) utterances, since they take time to utter. If this is felt to be unconvincing, one can account for examples like these on purely semantic grounds by individuating context in such a way that they allow for "demonstrated-object"-parameters in the realm of times and spatial locations. Hence, $\mathcal{D}$ might be understood as covering entities of this sort as well. This issue is left open here in order to keep things manageable.

Thus, all the intuitions that lie at the basis of utterance-centered versions of context theory can make their comeback. Nothing in the individuation of contexts and characters speaks against it. This, then, may also be the key to the "Frege-type problems."

3 Dynamic Semantics

This chapter presents the other family of theories dealing with pronouns, i.e. *dynamic* theories of anaphoricity. The term *dynamic* is used in a rather unspecific way. It functions as a brand name for the theories to be reviewed without presupposing anything more meaningful than that. What the dynamism of a theory consists in is only mentioned in passing (if at all). Before the more theoretical aspects are entered, the ways in which person pronouns are bound are discussed in the first section. As it will turn out, there are at least two "modes" of binding, so to speak. One pretty local, syntactically driven one, and one non-local, "dynamic", semantic one. It is argued that in the second sense of binding (third person) pronouns behave in a way one expects from index-parameters under a Lewisian perspective. With this in mind, the first, very sparse instances of dynamic theories are reviewed and the general outline of the system to be developed is drawn. The third section goes into the intricate details of dynamic theories, especially their notion of *projection*, crucial for the understanding of their inner workings. The final section develops the first instance of the new proposal and shows how to deal with extensional environments. Intensional environments as well as full two-dimensionalism are implemented in the final chapter.

3.1 Binding Personal Pronouns

3.1.1 Anaphoricity

Third person person pronouns cannot only be used deictically. (1a) and (1d) employ *anaphoric* pronouns, while (1b) and (1c) *bound* ones.

(1)
- a. Michael is a lumberjack. He is OK.
- b. Michael thinks that he is OK.
- c. A lumberjack thinks that he is OK.
- d. A lumberjack slept all night. He had worked all day.

The second sentence in (1a) should mean the same as *Michael is OK* on the relevant reading. That is, the pronoun is not understood deictically, but *anaphorically* related to the proper name in the first sentence. One might blur this distinction by stating that the the proper name *Michael* in the first sentence of (1a) *introduces* the referent of the pronoun into the context, like a deictical use of a pronoun would. That this kind of approach does not work can be seen in (1d). The indefinite *a lumberjack* cannot be said to introduce such a referent, since, at least under various traditional accounts, indefinites do not refer at all.[1] But still, the pronoun in the second sentence likewise is anaphorically related to the indefinite in the first, giving rise to a reading paraphrasable as *a lumberjack who had worked all day slept all night.*[2] Note that simply repeating the indefinite in place of the pronoun in the second sentence gives the wrong truth conditions. Intuitively, starting the second sentence with *a lumberjack* breaks the anaphoric relation the pronoun stands in with the first indefinite, and thus makes the second sentence probably about a different lumberjack. So, a *syntactic* account along these lines is ruled out. This is different in (1a), where repeating *Michael* would yield a correct paraphrase, even though the resulting sentence may be ruled out or reinterpreted on pragmatic grounds. There are alternatives, though. In so-called *E-type* analyses, (personal) pronouns are understood as being internally complex expressions, basically abbreviating full-fledged definite descriptions. Paraphrases of (1a) and (1d) along these lines are given in (2). But note that paraphrasing (1c) in the same way doesn't seem to be possible, as the oddness of the sentences in (3c) and (3d) show. On top of that, no paraphrase seems to give the correct contents of any lumberjack's belief, since it is at least possible that a lumberjack doesn't know that he's a lumberjack; he thus doesn't have to refer to himself like that.

(2) a. Michael is a lumberjack. The lumberjack is Ok.
b. A lumberjack slept all night. The lumberjack that slept all night had worked all day.

(3) a. A lumberjack thinks that the lumberjack is OK.
b. A lumberjack thinks that the man is Ok.
c. A lumberjack thinks that the lumberjack that thinks is OK.
d. A lumberjack thinks that the thinking lumberjack is OK.

Even apart from bound pronouns, analyzing pronouns as full-fledged definite descriptions isn't without problems. The most pressing issue might be the question where the descriptive content of the descriptions stems from. As may be concluded from (2), it must be linguistic material determined from the preceding discourse.[3] But how exactly this comes about in case of cross-sentential anaphora isn't clear, since there are no syntactic relations to rely on.

The famous *donkey sentences* like in ((4)) show that covariation between an (indefinite) antecedent and pronouns has to be established without the help of syntactic relations like c-command.

[1]Although views like the following are quite common in Dynamic Semantics (e.g. Dekker, 2008, p. 105): "The underlying idea is that indefinite terms, like other terms, are generally used with referential intentions. A speaker may use an indefinite because the identity of the intended referent is not relevant, or because he does not have adequate means to identify that referent."
For an account working with *intended referents* as contributions of indefinites to the context, cf. van Rooij, 2001; van Rooij, 2006.

[2]This judgment is not universally shared. For a differing view, cf. Evans (1977) and Evans (1980), and Kadmon (1990).

[3]Cf. Elbourne (2005) and Heim (1990) for accounts along these lines.

(4) a. Every farmer who owns a donkey beats it.
b. If a farmer owns a donkey, he beats it.

The pronouns somehow manage to covary with an indefinite within the same sentence, but too deeply embedded to c-command them. Furthermore, these pronouns have an interpretation according to which they need to come out as universally quantified. That is, under one reading (the strong one), e.g. for (4b) to be true, it isn't enough for a farmer to beat only some of the donkeys s/he owns, but s/he needs to beat all of them. The same holds for (4a) under the strong reading. Both constructions seem to admit a second reading—the weak one—, according to which meeting the weaker requirement is enough for a farmer to serve as positive example. That sentences like these need to have such a reading is brought about by so-called *dime*-examples (cf. Schubert and Pelletier, 1989, Dekker, 1993b; Dekker, 1996):

(5) a. Every driver who has a dime in his pocket will put it in the parking meter.
b. If I have a dime in my pocket, I will put it in the parking meter.

Thus, this isn't a run-of-the-mill scope ambiguity, since the weaker reading cannot be obtained by raising the indefinite above the universal quantifier.[4]

Returning to (4b), it again seems to be possible to yield correct paraphrases by substituting pronouns for appropriate definite descriptions. For (4a), this doesn't seem to be correct, because the resulting sentence (6a) appears to talk about only those farmers who own exactly one donkey (cf. Heim, 1990, a.o.); something which (4a) doesn't do.

(6) a. Every farmer who owns a donkey beats the donkey (he owns).
b. If a farmer owns a donkey, the farmer beats the donkey.

The question how exactly third person pronouns and definite descriptions relate is postponed until section 3.4.2. The weak-strong ambiguity isn't pursued any further at all. These data are just presented in order to get a glimpse at what the dependency of anaphorically used pronouns consists in.

Inspired by Kamp (1981), Heim (1982), Groenendijk and Stokhof (1991), and Kamp and Reyle (1993), most accounts model this dependency of anaphoric pronouns in a particularly interesting way. Despite differences in technical detail, those (and many more) theories typically claim that the extensions of sentences containing pronouns are essentially relations between individuals instead of just truth values. For example, in Dekker (2012), truth values of sentences (containing pronouns or indefinites) are made dependent upon *sequences of individuals*. A typical description of this kind of dependency is as follows: Individuals are introduced into a sequence by (in-)definite descriptions and similar expressions. By storing those *contributions*, they are thus made available for later anaphoric 'reference'. Hence, anaphoric pronouns are interpreted as matching in value with the antecedent, albeit possibly not being in its (syntactically determined)

[4] There exists some accounts of weak readings based on choice functions, cf. Gawron et al. (1991), among others.

scope. That is, indefinites are translated by a formula like '$\exists x\varphi$', whereas the existential quantifier symbol is best understood as a kind of syntactic marker for treating the accompanying variable differently from those of pronouns. '$\exists x\varphi$' in turn is modeled as being true at a sequence $c\widehat{e}$, i.e. a sequence composed of an individual c and a (possibly empty) sequence of (possibly distinct) individuals $\widehat{e}$ (the notation is Dekker's (2012)) iff c verifies the embedded formula φ, i.e. $\varphi[x/c]$, the formula, where every (free) occurrence of x is substituted for c is true. c is then said to be the contribution of the existential quantifier. $\widehat{e}$ can be understood as storing the contributions of other expressions which are contained in the preceding sentences (possibly empty if there are none). Subsequent pronouns pick their antecedents from $c\widehat{e}$. Two sentences φ and ψ uttered one after the other in a discourse are interpreted as dynamically conjoined. φ may contribute further individuals which are put in front of the already established sequence $\widehat{e}$. Let φ's contribution(s) be abbreviated as $\widehat{c}$ (which can of course be empty if φ is contradictory or doesn't contain any existential quantifiers). The contribution(s) of ψ is written as $\widehat{a}$ and also put in front of the established sequence. If φ contains a (free) anaphoric pronoun, its value depends on $\widehat{e}$.[5] Pronouns in ψ can find their antecedents in $\widehat{ce}$, that is, in contributions already present in discourse before φ was uttered ($\widehat{e}$), or in contributions made by expressions within φ ($\widehat{c}$, if there are any). Except in very rare cases, it is not possible for pronouns sitting in φ to be dependent upon contributions originating in ψ. There are such cases of *cataphora*, but they seem to be restricted to referential expressions only.[6] Pronouns in sentences following $(\varphi \wedge \psi)$ can pick up any individual in $\widehat{ace}$, that is, either from the preceding discourse, or from contributions made by expressions within φ or (and that is $\widehat{a}$) from contributions made by expressions within ψ.

Consider a concrete example. In a discourse, the sentence (7a) is uttered, immediately followed by an utterance of (7b). Let the sequence of individuals introduced by the preceding discourse be $\widehat{e}$.

(7) a. A man was in the garden.
b. He sneezed.
c. A man was in the garden. He sneezed.

Since (7a) contains an indefinite that is, as usual, mapped onto a formula containing an existential quantifier, some individual m is contributed to the sequence, provided that m was in the garden. The second sentence (7b) doesn't add anything to the sequence, simply because it does not contain an expression that is translated into a formula containing an existential quantifier. But the pronoun can be interpreted as standing in for m, that very individual that is contributed by the existential quantifier. The choice is made by an index the pronoun carries. For example, assume that here the index is 1, which is

[5] If $\widehat{e}$ is empty, no antecedent is available in the preceding discourse.

[6] Except, interestingly, in some donkey-environments, as was pointed out to me by Ede Zimmermann. He gave the following example:

(i) a. If a lion is hungry, it can be dangerous
b. If it is hungry, a lion can be dangerous

understood as meaning that the pronoun chooses the element introduced latest into the sequence; thus, in this case, m, the contribution of the indefinite in (7a). Therefore, given a simplified translation of the sentences in questions, the little discourse in (7c) receives the following interpretation (where M, G, and S stand for translations of the extension of the respective predicates):

(8) $Mm \; \& \; Gm \; \& \; Sm$

After (7a) and (7b) are interpreted, the sequence of individuals consists of the concatenation of m and $\widehat{e}$, $m\widehat{e}$. This sequence can be passed on to help in the interpretation of further sentences yet to come. There is no need to claim that m is the only witness of the first sentence. There may be other ones. As long as the choice for m doesn't lead to falsehood of any further sentence, one can stick to it. But if, say, m doesn't sneeze, then one needs to go back to the initial sentence and choose a different witness n, and start over, if there is any. If there isn't, then the sequence of sentences (7c) cannot be true.

This back and forth between possible witnesses for existentially quantified formulæ is exclusive to the system Dekker puts forth in Dekker (2012), where he proposes a recursive definition that generalizes this mechanic to arbitrary sentences and sequences, couched in formulæ of Predicate Logic enhanced with the ability to deal with pronouns; *PLA*. This presentation is misleading insofar as *PLA* as well as other accounts consider all contributions simultaneously, so to speak, by using variables (or something variable-like) as contributions and considering sets of assignment functions as semantic values. This will be shown in detail in the upcoming sections. If x is such an entity, the translation of the sequence of sentences becomes (9a). It can then be said to be true if there is a witness that makes it true, i.e. (9b):

(9) a. $Mx \; \& \; Gx \; \& \; Sx$
b. $(\exists x)[Mx \; \& \; Gx \; \& \; Sx]$

The existential quantifier in (9b) can be said to stem from a definition of truth that can be set up along the following lines: (i) sentences have to be specified (syntactically) in terms of what and how many elements they put in front of a possibly empty sequence of contributions $\widehat{e}$. E.g., if a sentence of the form $\varphi \wedge \psi$ is considered, the contributions of φ are left-adjoined to $\widehat{e}$ first, and the result is passed on to ψ. Its contributions are left adjoined to this result. Hence $\varphi \wedge \psi$ yields a sequence of the form $\widehat{ace}$, where $\widehat{a}$ are the contributions of ψ, $\widehat{c}$ are the contributions of φ. The latter is interpreted against $\widehat{e}$ alone, ψ is interpreted against $\widehat{ce}$. All contributions can be empty, of length one, or of any other length. (ii) A sentence of the form $\varphi \wedge \psi$ can then be said to be true with respect to a sequence $\widehat{e}$ iff there exists a sequence $\widehat{g}$ such that the first part of $\widehat{g}$ stores the contributions of ψ, and the rest of $\widehat{g}$ stores the contributions of φ. $\widehat{ge}$ might be used further on, i.e. may play the rôle $\widehat{e}$ plays for the interpretation of $\varphi \wedge \psi$, namely as sequence the truth of further linguistic material is relativized on.[7]

[7] This basically describes the recursive definition of satisfaction and the truth-definition of Dekker (2012). Other accounts proceed similarly, even though there are differences in the technical details. The existentially quantified definition of truth was first stated in Kamp (1981).

As mentioned, how this comes about exactly will be shown in due course. For the moment it is enough to acknowledge that, technically speaking, anaphoric pronouns are made dependent on individuals, which make up a sequence, which in turn is manipulated by certain contributing expressions. If one assumes that there is no other way to manipulate said sequences, then anaphoric pronouns can be said to be dependent on (the contributions of) their antecedent expressions. The main question, making the connection to the previous chapter, is then, how this sequence-dependency relates to the kinds of dependencies already in place, i.e. whether these sequences can be understood as being part of the context, the index, or neither of them.

The way contexts are set up in the previous chapter makes some of them contain a sequence of individuals (possibly of length one). That is, there are contexts which start with the situational core, an individual interpreted as the agent of the context, an individual conceived of as the addressee, and possibly some further individuals understood as semantic values of demonstratives. So, one might be tempted to identify these contextual sequences following the addressee-parameter with the sequences Dekker uses to model anaphoricity. But there are two important reasons not to do so.

First (cf. Haas-Spohn, 1991), the interpretation of natural language sentences involves applying their characters to *one* out of several contexts determined by a concrete situation. Demonstratively used expressions thus are assigned one and only one individual as their semantic value; and they therefore can be said to *refer* to this individual *in* said context. And since there is only *one* context a sentence's character gets evaluated at, there remains only one referent, even though it possibly isn't clear to the interpreter which context exactly she is supposed to pick. If the sequence of individuals anaphoric pronouns are dependent upon is identified with a part of context, then there is no difference between anaphoric and deictic pronouns; both then can be said to refer to one and only one contextually determined individual. But this can't be right since anaphoric pronouns can choose indefinite expressions as their antecedents. This would mean that an anaphoric pronoun would refer to an individual even in case it is understood as being related to an indefinite expression. The contextually determined individual then needed to be understood as the contribution of the indefinite as well, which would make them referring expressions. But both assessments are wrong; indefinites do not refer and pronouns anaphorically related to indefinites do not refer either, but only covary with them.[8]

Second, one would need to think of contexts as being manipulable by expressions, in the sense that contexts could be lengthened by referential or indefinite expressions. Even apart from the unavailability of indefinite contributions, this would reintroduce a

[8]For a claim to the contrary see van Rooij (2001) and van Rooij (2006), where indefinites are taken to refer to the single entity speakers 'have in mind' while using them. These entities are no objective features of the context, but are given by a (speaker dependent) reference function. He nevertheless assumes that this function is given by the context and argues that the seeningly existential interpretation of indefinites can be derived via diagonalization. This monstrous account of indefinites would deserve a much more in-depth comparison to the approach defended here, but given these very sparse remarks it is already clear that it cannot be combined with the interpretation of Kaplan's *ban on monsters* defended in 4.1.1.

notion of context change through the back door, since contributions made in a sentence ψ shouldn't be available for the interpretation of pronouns in φ if a sentence of the form $\varphi \wedge \psi$ is interpreted. Thus, a context cannot be said to contain the contribution from the get-go, but needs to attain it in the course of a derivation.[9] Possibly, this comes in tandem with an utterance-based individuation of contexts. Admittedly, this doesn't seem to be so far-fetched given that anaphoricity is a phenomenon that requires other *expressions* and not just *individuals*. This is shown by the following minimal pair taken from Evans (1977) in (10), where (10a) only differs from (10b) in the usage of an indefinite expression:

(10) a. John has a wife and she hates him.
b. *John is married and she hates him.

Thus, *she* (understood anaphorically) can only be licensed by the use of an appropriate expression (indefinite or referential), but not by just being entailed (assuming that *John is married* really implies that John has a wife for the sake of argument). If this doesn't speak in favor of an utterance-based individuation of contexts, what else could? Furthermore, contexts involved in such a 'change' wouldn't really need to *change* in the sense that some value present in one context is different in the next one, but to be *lengthened* in the course of an interpretation. Thus, when it comes to interpreting an indefinite description, no value of the context used up to this point needs to be reverted, but a further value needs to be considered. If the initial context has length n, the interpretation of the indefinite necessitates resorting to contexts of length $n + 1$ that correspond in all parameters up to n to the original context. The $n + 1$st individual may then be said to be *accommodated* and the context of length n might be called a *subcontext* of the resulting one.

Hence, although contexts should not necessarily be individuated via utterances as long as indexical and deictic expressions are concerned (if the last chapter is on the right track), taking anaphoric expressions into consideration suddenly seems to demand exactly that. And although interpretation needn't involve context change to account for deictically used personal pronouns, their anaphoric use suddenly seems to demand exactly that.

Indices, on the other hand do not come with a sequence of individuals (yet). But this is not a reason to claim that the sequences anaphoric pronouns need cannot be paired with them to redefine the notion of an index in such a way as to make anaphoricity index-dependency. The mere possibility of course doesn't serve as a *positive* reason to do so. What can count as such a reason, according to the arguments given in section 2.1.3, is shiftability, i.e. constructions best analyzed as modification of a (syntactically complete) sentence addressing a parameter that must be part of the sequence anaphoric pronouns are dependent upon. But, as argued above, the only examples that seem to

[9] This isn't the best of arguments since if this were the only hurdle for an account of anaphoric pronouns in terms of context-parameters, employing a context-change semantics like the one sketched would be a very low price to pay.

point in this direction are of the following kind (= (23) in section 2.1.3)

(11) No man believes that he owns a shitty car.

Intuitively, under at least one reading (the homogeneous *de se* reading) the pronoun is bound; any instance of the quantificational expression *no man* needs to identify himself with the individual that is the semantic value of *he*, i.e. self-ascribe the *property* of owning a shitty car (Chierchia, 1989; Lewis, 1979a). But, as is argued above, the quantifier cannot be the shifter in the sense the criterion needs it to be, because (11) cannot be analyzed in the required format *shifter* + *complete sentence*. If anything, either the complementizer[10] or attitude verb[11] can be said to bind the overt pronoun. If the attitude verb can be understood as a shifter in this sense, everything is as it should be according to the Lewisian criterion, because it is easily thought of as sentence external. But if the complementizer is, this might not be uncontroversial. One might get away with claiming that the IP is the relevant syntactic domain which marks completeness in the relevant sense. Note that it isn't necessary for the *result* of the shifting configuration to count as a sentence in the syntactic sense. For Lewis, all that matters is that sentences fulfill a double rôle in the sense that they are part of the syntactic and compositional machinery when embedded, and at the same time the entities over which *truth-in-English* is defined when self-standing. But, apart from this question, it simply isn't clear, yet, whether *anaphoric* pronouns are bound in such constructions. Therefore, it isn't yet established that they really depend on the index. One can only conclude that whatever lies behind bound pronouns displays index-dependency. If it is further assumed that bound pronouns are formed from anaphoric pronouns, understood as index-dependent expressions, by attaching a special kind of shifter (complementizer/attitude verb, ...), then, indeed, (11) can count as evidence. Surprisingly, this connection is rarely made.[12] Mostly, people claim that once *de se* readings are introduced, the content of beliefs has to be formed from contexts (Kaplan, 1989b, sec. XX), possibly via diagonalization.[13]

But on the other hand, with the same right the following could be said: Overt non-

[10]There is some diachronic evidence that the German complementizer *dass* stems from the relative pronouns *das* (e.g. Axel-Tober, 2012, and the references therein). And in modern day English, they sometimes are even of the same form. It therefore doesn't seem too far-fetched to assume that they are similar insofar as both can bind an otherwise free parameter contained in the IPs they're attached to (but relative pronouns need some more 'distance', see below). But the complementizer is special (i) in that it would need to be able to bind even more parameters, since it then must be responsible for this being an intensional construction which involves binding an otherwise free world-parameter, and (ii), according to the orthodoxy, if it binds a pronoun, it always is interpreted as the "center" of a proposition. On the contrary, relative pronouns are only licensed when they bind a gap in the embedded sentence, but this gap doesn't receive any special interpretation.

[11]T. E. Zimmermann (1991, p. 205) points out that would contradict the analysis of attitude verbs as *propositional* attitudes.

[12]The whole section 4.1 of T. E. Zimmermann (1991) discusses this and the following dilemma that overtly bound personal pronouns pose to the two-dimensional theory of meaning and the notion of linguistic content.

[13]This, taken together with, e.g., the observations from Schlenker (2003), this is often taken to imply that even English involves so-called *Monsters*, that is, constructions in which the characters of embedded expressions are needed to derive the correct readings. More on this below, section 4.1.1.

deictical personal pronouns do not fall into either category of dependency developed within context theory. This is especially true if examples like (12) are taken into consideration:

(12) Every teacher loves his car.

The reading that is of interest here, is the so-called bound reading under which every teacher is in love with his own car, in contrast to the anaphoric (or even deictical) reading which arises with *his* understood as covarying with some other expression's contribution, such that every teacher loves the car of the(se) individual(s). By all standards, the possessive *his* is bound by the quantifying expression *every teacher*, i.e. the possessive covaries with the quantifier, and so does the car, because the whole expression *his car* then is dependent on the bound variable. Obviously, the quantifier is a *part* of the sentence, hence, is not attached *to* it and binds the possessive from the outside, like the pronouns in (11) are bound by sentence (or IP) external elements.[14] Thus, it seems, making binding of pronouns a matter of sentence-modification, like Lewis' criterion implies, fails in next to all cases. Pronouns seem to be bound freely, within one sentence at least, by quantificational expressions, and the fact that personal pronouns resist this kind of binding in some examples is the only thing that needs explanation. This assessment is corroborated by a striking parallelism. Both of the last two examples are ambiguous in the same way: (11) also has an interpretation according to which no man believes that some specific individual, referred to by *he*, owns a shitty car. Hence, both examples exhibit the bound vs. free ambiguity, whereas "free" either means anaphoric or demonstrative uses of the pronouns in question. This seems to be evidence enough to base a general theory of pronominal binding on. This general theory usually makes either full (coindexed) DPs or dedicated expressions β_n (to be interpreted as λ-prefixes) the binder of pronouns (be it possessive or personal), and models the latter as indexed variables in Logical Form. Thus, the examples from above are translated roughly as follows, leaving other binders and further (silent) arguments invisible:

(13) a. No man β_1 believes that x_1 owns a shitty car.
b. Every teacher β_1 loves x_1's car.

The respective other reading is obtained by contraindexing, that is, by having the binder carry a numerical index different from that of the respective pronoun.

Thus, on this picture, binding comes via coindexation and some structural constraint like c-command (which isn't justified yet). This picture can be extended to reflexives as well, thus, (14a) is rendered as (14b):

(14) a. Ahmet hated himself.
b. Ahmet β_1 hated x_1.

Hence, returning to the question of dependency, pronouns seem to interact with DPs

[14] That is, as long as one doesn't maintain that quantifiers have to raise to the left periphery via Quantifier Raising (QR), such that it attaches *to* the IP it originates in.

in a way that disqualifies them as being a parameter by Lewis' criterion. Binding is ubiquitous, not restricted to subordination of complete sentences and carried out by countless expressions that are part of the same sentence the pronouns are located in.

But, first, it is not necessary to demand that pronouns are *generally* or exclusively bound in sentence modification structures to establish that they behave as index-dependent expressions. Lewis just singles out this particular way of binding as a criterion for determining parameters of dependency. He does not claim that this needs to be the only way, and hence, the very fact that alleged parameters are bound in other constructions as well doesn't interfere with his criterion in any way. Thus what one needs to do is demonstrate that there are genuinely confirming cases, i.e. cases that cannot be explained away by other binding mechanisms. Then pronouns have to be analyzed as index-parameters by the same reasoning as in the last chapter. Furthermore, secondly, regarding the general theory of binding just sketched, there is some evidence suggesting that it might be too liberal. There is a different way to cut the cake, which can be made clear by looking at other possible accounts of reflexives.

3.1.2 Local Binding

According to classical binding theory (Chomsky, 1981, 188, and many others), reflexives and pronouns fall under two different conditions governing the distance of their potential antecedents:

(15) Binding Principles
 (A) A reflexive is bound in its binding domain.
 (B) A pronoun is free in its binding domain.
 (C) An R-expression is free.

In other words, reflexives need to be bound pretty locally (condition A), while pronouns can only be bound from a distance (condition B), or at least not locally. There are a lot of discussions around (15) regarding the exact demarcation of binding domains. For a start, it can be assumed to be the so-called *coargument domain*, i.e. the (smallest) projection of a verb containing all of its arguments, although things are far more complicated, cf. Büring (2005a) among many others.

Using a reflexive pronoun in the object position of a transitive predicate achieves two things: (i) one argument slot of the predicate is saturated, and (ii) whatever the argument of the semantic value of the resulting predicate is, it is put in both argument slots: the predicate is reflexivized. Since the predicate with which the reflexive combines provides two argument slots (which is typically captured by assigning it the type **e(et)**[15]) and the resulting predicate only needs one more argument for being a full sentence (which is captured by type **et**), at least two views on the rôle of reflexives are possible. Either, as assumed in (15), they serve as arguments like other noun phrases or determiner phrases

[15] Alternatively, for readers used to Heim and Kratzer's (1998) notation $\langle e, \langle e, t\rangle\rangle$. Outer brackets are omitted when possible.

(which means that they are assigned type **e**), or they are functions that take the predicate as their arguments, reducing the arity by making sure that whatever is the subject of the verb also serves as the object. In the latter case (in which case it has to be assigned the type $\mathbf{(e(et))(et)}$) the reflexive usually is dubbed *arity reducer* or *reflexivizer*. That is, if transitive verbs like *hate* are modeled as ("Schönfinkeled", or "Curryed") functions from individuals into functions from individuals into truth-values (cf. Heim and Kratzer, 1998, among many others), like in (16a), the two options for the reflexive to yield (16b) are (17a) and (17b):[16]

(16) a. $[\![\text{hate}]\!] = \lambda y_{\mathbf{e}}.\lambda x_{\mathbf{e}}.x \text{ hates } y$ — type $\mathbf{e(et)}$
b. $[\![\text{hates himself}]\!] = \lambda x_{\mathbf{e}}.x \text{ hates } x$ — type $\mathbf{et}$

(17) a. $[\![\text{himself}_n]\!] = x_n$ — type $\mathbf{e}$
b. $[\![\text{himself}]\!] = \lambda R_{\mathbf{e(et)}}.\lambda x_{\mathbf{e}}.R(x)(x)$ — type $\mathbf{(e(et))(et)}$

For the first option to work, n has to be the index used by the binder β in (14) (or, alternatively, by the subject itself), otherwise, ungrammaticality should ensue.[17] The second option doesn't require any indexing, since the reflexive is oriented to the subject position by design.[18] Thus, there is no way that it could fail making the subject of a transitive verb also its object. If *Ahmet* from above is assigned its referent ('a' below) as semantic value (which makes it an expression of type **e**), the derivation doesn't need to make use of (co-)indexing at all (tacitly assuming the familiar constructions and their interpretation rules):

(18)
$$
\begin{aligned}
& [\![\text{Ahmet hates himself}]\!] \\
= \; & [\![\text{hates himself}]\!] \; ([\![\text{Ahmet}]\!]) \\
= \; & [[\![\text{himself}]\!] \; ([\![\text{hates}]\!])] \; ([\![\text{Ahmet}]\!]) \\
= \; & [[\lambda R.\lambda x.R(x)(x)] \; (\lambda y.\lambda x.x \text{ hates } y)] \; (a) \\
= \; & [\lambda x.x \text{ hates } x] \; (a) \\
= \; & a \text{ hates } a
\end{aligned}
$$

If one tries to account for all forms of local binding in this fashion (i.e. for condition A of binding theory (15)), one has to posit an ambiguity for possessive pronouns, since they can be bound locally in examples like (12), and in this sense behave like reflexives, but, on the other hand, they are also able to refer back to an antecedent expression (and can even be used deictically), and pattern with personal pronouns in this sense. As already mentioned (fn. 12, page 21), the most famous reason to posit an ambiguity[19] is traditionally seen in examples like (19) whose two readings can be paraphrased like

[16]The first occurrences of bound variables, usually as part of the λ-prefix, are indexed with their type.
[17]Thus, as pointed out by Ede Zimmermann (p.c.), this kind of solution is not compositional on the level of extensions, contrary to the second option, which is.
[18]This way of accounting for reflexive pronouns stems from the vicinity of categorial grammar (it is formulated in Bach and Partee (1980)), but can be traced back to Quine's (1960) attempt to explain variables away. Cf. e.g. Jacobson (1999) and more recently Jäger (2005, p. 70) (in which this analysis is attributed to Keenan and Faltz (1985) and Szabolcsi (1989)) and Lechner (2012).
[19]Not to mention strict and sloppy identity readings, cf. Heim and Kratzer (1998, 254f.) for a start.

(19a,b):

(19) Only Peter helped his mother.
  a. Peter helped Peter's mother, and nobody else helped Peter's mother.
  b. Peter helped Peter's mother, and nobody else helped her mother.

What is usually (cf. Heim (1993) and Reinhart (1983b), a.o.) said is the following. The reading in (19a) results if the possessive anaphorically refers back to *Peter*, while the reading in (19b) is derived by binding the possessive and feeding the resulting predicate to the expression *only Peter*. Instead of the first reading, the possessive can also be anaphorically related to other expressions, as well. Cf. the following little discourse:

(20) Frank took the afternoon off because he had asked his friends to take care of his homework. As it turned out, *only Peter did his homework*.

The most natural reading available for the italicized sentence is the one which could be paraphrased as:

(21) Peter did Frank's homework, and nobody else did Frank's homework.

However, even if it is assumed that the possessive is ambiguous, it isn't yet clear how to assimilate its bound readings in the spirit of the reflexivizer approach.

The first step is to take into consideration that the possessive seems to sit in a determiner position. This indicates that its semantic contribution is not of type **e** but rather more complex. One possibility consists in the following formula, which gets assigned the type **(e(et))((e(et)) (et))**. It is thus designed to be the head of relational nouns like *mother* and to sit in object positions of transitive verbs.[20]

(22) $[\![\text{his}_{Det}]\!] = \lambda R_{\mathbf{e(et)}}.\lambda S_{\mathbf{e(et)}}.\lambda x_{\mathbf{e}}.(\mathbf{THE}y_{\mathbf{e}})[R(x)(y)](S(y)(x))$

The boldface quantifier has to be understood in a Russellian fashion. That is, the square brackets mark the material that is subject to the uniqueness condition, while its scope extends over the part in round brackets as well:

(23) $(\mathbf{THE}x)[P_{\mathbf{et}}(x)](Q_{\mathbf{et}}(x)) \Leftrightarrow (\exists x)[P(x) \;\&\; (\forall y)[P(y) \rightarrow x = y] \;\&\; Q(x)]$

With this lexical entry it is possible to derive the bound reading without further ado. This possessive takes its sister noun as first argument and yields a function which takes a transitive verb as argument to yield a predicate, i.e. a function which takes an expression of type **e** and returns a truth value. Internally, the possessive consists of a definite description-like quantifier that states existence and uniqueness of whatever the noun contributes.

In order to be combinable with, e.g. *car*, the following modificator can be assumed to transform sortals into relational nouns ('π' in Barker (2011, p. 1114)):

[20] This section improved greatly from several comments by Ede Zimmermann on an earlier version. Note further that this approach still is similar in spirit (but not in letter) to a variable-free approach. Cf. Jacobson (2014, ch. 15) for a way more fleshed out version.

(24) $\lambda P_{\mathbf{et}}.\lambda y_{\mathbf{e}}.\lambda x_{\mathbf{e}}.P(x) \wedge \textsc{Of}(x)(y)$

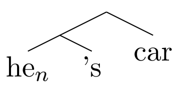
If applied to the contribution of a sortal noun like *car* this gives the Schönfinklized version of a relation Of between cars and the subject yet to come. Of might spell out possession, but it is possible that a different relation is salient (cf. Heim and Kratzer (1998), and especially Barker (2011)). This is an issue orthogonal to the matters at hand and ignored in the following. Thus, the reading that one obtains for an example like (12), repeated in (25a) is paraphrasable as (25b) (where the sub- or superscripts just indicate the binding relation):

(25) a. Every teacher$_i$ loves his$^i_{Det}$ car. = (12)
b. Every teacher$_i$ loves the car he$_i$ Ofs.

Generally, if one abstracts from the concrete subject, the following is the only outcome this version of the possessive is able to generate:

(26) $\lambda x.\ x$ loves the car x Ofs

Thus, this is the input for the bound reading. The anaphoric reading can be generated by assuming that the possessive is underlyingly complex, namely consisting of a structure like the following:

(27)


I.e., the “possessive pronoun” in this case spells out a personal pronoun sitting in the specifier of a *possessive construction*.[21] This construction is independently needed, as can be seen in (28). Note further that it needs to be capable of hosting more complex expressions, and is iterable:

(28) a. Peter likes Mark’s car.
b. Peter likes every farmer’s car.
c. Peter likes some blonde handsome guy’s car.
d. [[[Everyone$_i$’s mother]’s lawyer]’s dog] likes him$_i$. (Barker, 2012, p. 620)

For the sake of the argument it is assumed that the head *’s* carries the burden of structuring the semantic derivation, and that its contribution comes down to something like this:[22]

[21] That this decomposition makes sense morphologically merely is a coincidence. German *sein* doesn’t show any sign of being built out of *er* and a genitive. But this ambiguity needs to be stipulated for this language as well. In other languages, however, a version of possessive pronouns is even more transparently built that way. A case in point is Norwegian, see below.

[22] Of type $\mathbf{(e((e(et))((et)t)))}$. Again, this is only a first approximation which doesn’t work well with quantifiers in its specifier, nor when in object position, and doesn’t compose with with non-relational nouns in complement position. To solve the last issue, (24) needs to apply to non-relational nouns first. To deal with the second problem, case morphology might be utilized in the way as proposed in Keenan (1987). E.g., an accusative case morpheme of the following kind that is located on top of the DP might held responsible for resolving the type mismatch:

(29) $[\![\text{'}s]\!] = \lambda x_{\mathbf{e}}.\lambda R_{\mathbf{e(et)}}.\lambda Q_{\mathbf{et}}.(\mathbf{THE}z)[R(x)(z)](Q(z))$

As can be seen, the core of the formula is related to the lexical entry stipulated for the determiner version of *his* above. This head first combines with a (free) personal pronoun to result in a determiner that combines with relational nouns and transitive verbs afterward. The result can combine with the subject smoothly. If it is assumed that the pronoun that enters into this combination refers to Peter (via coindexation), then a reading paraphrasable as (30b) is derived from the input in (30a):

(30) a. Every teacher loves his_n car. ≈(12)
b. Every teacher loves the car Peter ($= [\![\text{his}_n]\!]$) OFS.

There are two things that require some more adaptation: First, the so derived possessive determiner can't stand in subject position. For this to work, it shouldn't have to wait for a subject, i.e. 'λx' in the formula in (29) above has to be eliminated. Secondly, it can't combine with quantifiers like *everyone* in (28d) without further ado, because it requires its first argument to be of type **e**, and the quantifier cannot take the possessive as an argument, because it isn't of the required type, either. There is thus still a lot of work to do. But these problems are orthogonal to the issues discussed here and therefore not pursued any longer.[23]

The whole point of this little exercise is the following: There is quite some evidence for stipulating an ambiguity of "possessive pronouns". Under one disambiguation, the pronoun turns out to be a determiner which is responsible for modifying a transitive verb in such a way that the subject is semantically duplicated. It is designed in such a way that the contribution of an expression in subject position claims its designated position in the argument structure of the transitive verb, and in addition to that, it also is used to determine the content of the whole argument in object position. Under the other disambiguation, roughly the same thing happens, but this time, the referent is contributed by a genuine pronominal part while the burden of structuring the derivation is carried by a possessive head. Importantly, the bound reading so construed doesn't require any indexing, let alone coindexing of the expression in subject position and the possessive. In this sense, the ambiguity treats the local binding part of the equation similar in spirit to the account of reflexives sketched above.

There is some cross-linguistic evidence for the ambiguity of possessive pronouns. Norwegian, for example, has an expression called *reflexive possessive* (glossed as "refl.-poss.") which is used to pick up the co-argument. If the possessive needs to refer back to another

(i) $[\![\text{ACC}]\!] = \lambda\wp_{\mathbf{(et)t}}.\lambda R_{\mathbf{e(et)}}.\lambda x_{\mathbf{e}}.\wp(\lambda y_{\mathbf{e}}.R(y)(x))$

To solve the first issue, a higher-order variant of (29) might be used. I owe these suggestions to Ede Zimmermann.

[23] One furthermore might try to analyze the reflexive possessive determiner (22) as combination of the possessive *'s* and the *reflexive pronoun*. This analysis neatly reduces the ambiguity of possessive pronouns to the distinction between personal and reflexive pronouns. This task isn't pursued either since it leads to a bunch of further (compositionality) questions.

expression anaphorically, a non-reflexive version has to be used:[24]

(31) Norwegian[25]

a. Hun ødelegger boka hennes.
She destroying book poss.
'She$_i$ is destroying her$_{*i/k}$ book'

b. Hun ødelegger boka si.
She destroying book refl.-poss.
'She$_i$ is destroying her$_{i/*k}$ book'

As can be seen, the locally bound reading is obtained by other means than the anaphoric, and they mutually exclude one another. The reflexive possessive cannot be contraindexed with the local subject and thus needs to be understood as subject-oriented as reflexives are claimed to be. The non-reflexive form, on the other hand, cannot be coindexed with the co-argument of the verb. Hence, it has to 'refer' to something else. Furthermore, in third person singular, the non-reflexive form transparently is built out of a personal pronouns (*han*/*henne*) and a possessor-*s*, yielding *hans*/*hennes*. The same holds for Swedish:

(32) Swedish[26]

a. Han talade med grannen om hans bil
He spoke with neighbor about poss. car
'He$_i$ spoke to the neighbor$_j$ about his$_{*i/j}$ car.'

b. Han talade med grannen om sin bil
He spoke with neighbor about refl.-poss. car
'He$_i$ spoke to the neighbor$_j$ about his$_{i/*j}$ car.'

The same contrast is also found in Russian, even though it is less transparent morphologically:

[24]Similar expressions sometimes are claimed to exists in German, too, viz.

(i) a. Ein Hund jagt seinen Schwanz.
A dog chases his tail.

b. Ein Hund jagt dessen Schwanz.
A dog chases d-his tail.

True, *dessen* in the second sentence can never relate to the subject (which is argued in Bosch et al. (2003) to be due to the tendency of d-pronouns to avoid topics, but cf. Hinterwimmer (2015) for some counterarguments and a more refined picture). The first sentence is as ambiguous as the English counterpart. On the other hand, (ib) sounds somewhat archaic, and the very fact that *dessen* is a d-pronoun may cast some doubt on the parallelism to Norwegian and the like.

[25]The example is taken from http://blogs.transparent.com/norwegian/your-norwegian-possessives/, retrieved on July, 15, 2017. This contrast is already mentioned in Dalrymple (1993) and Kratzer (2009), cf. especially Safir (2004) for more. Thanks to Kjell-Johan Sæbø and especially Helge Lødrup for help with the Norwegian data.

[26]Taken from http://swedishmadeeasy.com/sprakkansla-hans-eller-sin.html, retrieved on October, 2, 2017.

(33) Russian[27]

a. Petja ljubit ego zhenu.
Petja loves poss. wife.
'Petja$_i$ loves his$_{*i/k}$ wife'

b. Petja ljubit svoju zhenu.
Petja loves refl.-poss. wife.
'Petja$_i$ loves his$_{i/*k}$ wife'

Again, the anaphoric version is realized by a special expression (*ego*), different from the reflexive one (*svoju*) utilized for the bound reading.

If the same kind of ambiguity is assumed for English (and German) as well, the whole idea of non-reflexive personal pronouns being bound directly by DPs or NPs is somewhat weakened. Since there are expressions that are designed to be bound locally, it seems unlikely that personal pronouns should have the same capacity in all environments. If they had, there would be no use for a special expression for local binding.

Binding of reflexives and the determiner version of possessives is a different story: it is (i) strictly local, and (ii) the argument slots they occupy if bound by DPs cannot be occupied by overt personal pronouns. Thus, they are in complementary distribution. But there are well know examples where this breaks down, in e.g. so called *picture nouns*, so that the general picture is not without problems, independently of implementation:

(34) a. Every woman thinks [[pictures of herself] are on display]
b. Every woman thinks [[pictures of her] are on display]

(after Chomsky and Lasnik, 1993)

(34a) is unexpected from the present point of view since there is no locally realized binder for *herself* to receive its value from.

The reflexivizer picture patterns nicely with Kratzer's (2009) *fake indexicals* in the sense that grammatically depended expressions (apart from personal pronouns 'bound' within relative clauses or attitude reports) are semantically rendered as such: namely as expressions that need something to be complete, that is, are not as self-standing as free pronouns. Both reflexives and to-be-bound possessives introduce λ-prefixes and the syntacitc derivation needs to meet the so expressed dependency by bringing these expressions into the right position (if they do not start out at the right place).[28] Free personal pronouns, on the other hand, are self-sufficient from a syntactic point of view. They occur in places where they can be interpreted directly, because their interpretation isn't governed by syntactic relations at all; i.e. except some form of agreement and possibly coindexation, if that even counts. Thus, albeit being able to get bound they don't need to, and thus, there is no need to make them an unsaturated expression (in the sense that their dependency on the values of other expressions is reflected on the level of logical types). Consequently, as well as necessarily, there needs to be more than one kind

[27] I have to thank especially Dina Voloshina for help with the Russian data. I also had some discussions with Sascha Alexeyenko.

[28] One might claim that a part of the so-called *feature driven* movement is *type driven*.

of feature related mechanism. As Kratzer (2009) argues, the transmission of features to underspecified pronouns proceeds via local configurations like Spec-Head agreement, among others, and thus seem to operate on exactly those relations claimed to lie behind local binding in general; while anaphoricity is a long-distance phenomenon that does not involve structurally defined relations (e.g. the antecedent usually doesn't c-command the anaphoric expression, see below) and thus needs some kind of *Agree*-mechanism that is able to operate without being mediated structurally. But the delicate details of feature-transmissions, feature-deletion or the interpretation of ϕ-features in general are not the main topic here. Still, the environments in which personal pronouns do get bound are examined in the next section.

Before proceeding, two things should be mentioned. Firstly, the account of reflexives advocated here is not without problems. For example, there are syntactic problems with *himself* being a modifier rather than a referring expression, because it makes the following coordination rather dubious.

(35) Peter painted himself and Mary. Büring (2005a, 44, fn. 10)

This is easily accounted for if one assumes that *himself*, like *him*, denotes something of type **e**, because then, the coordination is homogeneous syntactically as well as semantically.

Also, there is a bit of leeway once a reflexive is used in a position where it cannot apply to a transitive verb directly. In (36), *himself* can both have *Gilbert* and *Spencer* as antecedent.

(36) Gilbert told Spencer about himself. Büring (2005a, p. 43)

Likewise, reflexives are found occupying any object position of ditransitives, and there they are allowed to corefer with any of the higher arguments. Sometimes, rather unusual situations need to be considered to get the intended readings, but apart from that, the sentences are fine:

(37) a. Sarah introduced herself to Peter.
b. Sarah introduced Peter to himself.
c. Sarah introduced Peter to herself.

Lechner (2012) claims that all of this is possible with the reflexivizer approach as well. But his largely movement-based story, utilizing the also not undisputed "tucking-in" operation, is too complicated to go into here. However, this falls out directly if the reflexive is modeled as a variable, coindexed with either of the proper names. Furthermore, Russian doesn't allow the reflexive possessive to be bound by an object. Only the non-reflexive form is possible in (38).[29]

[29] Dina Voloshina, p.c. The same holds in Polish. (Ewa Trutkowski, p.c.). For quite some time, this was assumed to hold for Norwegian, too, but see Lødrup (2008) for data showing the contrary.

(38) Petja vernul Mashe ejo mashinu.
Peter returned Maria her car.
'Peter returned her car to Maria.'

Thus, reflexive possessives seem to exist exclusively to be bound by the subject.[30] One might take this as evidence for postulating another form of the reflexive as well. As the non-reflexive possessives, this variant could be built from a personal pronoun as well and then claimed to be licensed in all environments non-reflexive possessives are licensed in Russian, Polish, the Scandinavian languages and so on.

Secondly, all languages with two possessive pronouns mentioned above do not behave as expected in the environment that informed the distinction the most.[31]

(39) Norwegian:[32]
a. Bare John hjalp moren sin
Only John helps mother refl.-poss.
b. Bare John hjalp moren hans
Only John helps mother poss.
'Only John helps his mother.'

(39a), the version with the possessive reflexive is as ambiguous as the English counterpart, while (39b), the one with the pronoun-based version, is ungrammatical if the possessive is coindexed with *John*; a classical violation of principle B of binding theory. If it nevertheless has to be interpreted, one only gets the strict identity reading, that is, the reading according to which no one else helps John's mother. Thus, the expectation that the two readings of *only John helps his mother* are associated with different pronouns isn't borne out. Roughly the same holds in Russian and in Polish.[33] In the latter, the non-reflexive possessive seems to be better:

(40) Russian:
a. Tol'ko Petja sdelal svojo domashnee zadanie.
Only Peter did refl.-poss. homely task.
b. ??Tol'ko Petja sdelal ego domashnee zadanie.
Only Peter did poss. homely task.

[30] This was Sascha Alexeyenko's opinion on the Russian data in our discussion.

[31] The following was already observed for Kildin Saami, an Uralic language, in M. Zimmermann and Karvovskaya (2010). But the phenomenon seems to be much more widespread than they acknowledge.

[32] Helge Lødrup, p.c.

[33] Dina Voloshina and Ewa Trutkowski, p.c., whereas the assessment of the Polish data is somewhat insecure. If German *dessen* is added to the picture, it patterns with these languages. That is, (i) is ambiguous between the strict and the sloppy reading, while (ii) is strictly ungrammatical if *dessen* is coindexed with *Peter*:

(i) Nur Peter hilft seiner Mutter.
Only Peter helps his mother.

(ii) Nur Peter hilft dessen Mutter.
Only Peter helps d-his mother

(41) Polish:

a. Tylko ja pomogłam swojej matce.
   Only I helped refl.-poss. mother

b. ?Tylko ja pomogłam mojej matce.
   Only I helped poss. mother.

If this carries over to English as well, the difference between the strict and sloppy interpretation cannot be due to the predicate, but must come about due to some other mechanism, be it alternative semantics or something else (cf. Sauerland, 1998, a.o. and, more recently, Mayr, 2012 and the references therein). This is further corroborated by the fact that the following is as ambiguous as the examples with reflexive possessives:[34]

(42) Only I cut myself.

a. I cut myself and nobody else cut me.
b. I cut myself and nobody else cut himself.

That is, if no ambiguity along the same lines for reflexives is postulated, as suggested above, one needs to find a different way to deal with (42) anyway.[35] And whatever one assumes to go on there, can be applied to examples with possessives as well. Albeit interesting, these topics aren't pursued here.

Generally speaking, one does not necessarily need to subscribe to the reflexivizer approach or the determiner extension proposed for possessives above to make the argument work. It also isn't necessary to stop coindexing reflexives with their antecedent coarguments. Neither does one need to give up binder expressions β and coindexed traces, e.g. for interpreting movement. It suffices for the argument to assume that the local kind of binding (presumably from A-positions) does not interfere with binding personal pronouns. The way presented here does exactly this by making indexing for local binding superfluous. But one doesn't need to take this route. One might still use binder prefixes and coindexed traces as long as personal pronouns aren't bound in the same environments as reflexives, and non-reflexive possessives aren't bound in the same environments

[34]Thanks to Kai Wehmeier for pointing this out to me. On the other hand, the ambiguity of (41) is denied in Spathas (2010).

[35]There are languages where exactly this seems to be happening. Cf. the following example taken from Sternefeld (2008). The sentence in a. only has the sloppy-identity reading, while the other one, featuring what seems to be an expression built from a pronoun and a reflexive, only allows for the strict reading:

(i) Japanese:

a. Jiro-dake-ga zibun-o nikunde-iru
   Jiro-only-nom self-acc hate-be

b. Jiro-dake-ga kare-zisin-o nikunde-iru
   Jiro-only-nom he-self-acc hate-be
   'Only John hates himself'

as their reflexive counterparts. This also can be achieved by simply using *two* sets of indices on variables, one kind for binding reflexives and reflexive possessives, another for binding overt personal pronouns and non-reflexive possessives.[36] All of this suffices to say that binding under c-command (and from A-positions into A-positions) is something different than the long distance binding examined in the next subsection. Alternatively, one may take the traditional route and stipulate different *binding conditions* for the two classes of expressions.

3.1.3 Binding Personal Pronouns

Distinguishing local and long distance binding seems to be on the right track. This strategy already is expressed in Dekker (2012) as well. Unfortunately, he doesn't draw the consequences for either binding theory or for the relation between bound, anaphoric and demonstratively used pronouns but claims that dynamic theories benefit if anaphoricity is delegated to an apparatus different from quantification. One quote summing up his view nicely is this:

> Adding [personal, J.K.] pronouns to the classical, static machinery does not interfere with it, and not with its quantificational apparatus. Whatever holds with respect to quantifiers, variables, and binding, continues to hold after we have introduced our new category of pronouns. (Dekker, 2012, p. 63)

If locally bound expressions are handled by a completely different mechanism than long-distance binding, this follows immediately. As suggested above, the existence of non-reflexive possessive pronouns points into this direction. And it further suggests that there is more to binding than coindexation of DPs with pronouns (under c-command). If this is correct, one expects to find examples that need a completely different treatment, even if compatible with binding theory (15). Two phenomena are discussed in the following. They show that there are indeed cases of bound personal pronouns that (i) aren't initiated by DPs alone, and (ii) are only possible at a longer distance.

For illustrative purposes, relative clauses are assumed to be built from a syntactically complete, i.e. fully saturated, IP, where the position to be relativized is occupied by a silent element. This position might be the starting point of the relative pronoun, which is syntactically raised to the initial position, or, alternatively, just a silent but coindexed element ("e_n"). The movement-based analysis guarantees coindexation, though. Nevertheless, this thesis stays neutral about this matter. Thus, a run-of-the-mill relative clause looks like this:

(43) relative pronoun$_i$ [$_{\text{IP}}$ ... e_i ...]

[36]For quantification, one can think of these two sets of indexed variables as corresponding to the inner and the outer index. What is meant by this is the distinction between the variables, e.g., a universal quantifier introduces and uses to saturate the argument positions of the predicates it takes as arguments; the *inner* index, and the discourse referent it introduces to allow for anaphoric relationships *beyond* its (syntactically determined) scope; the *outer* index.

Interestingly, personal pronouns are not allowed to be bound directly:

(44) Every man who$_i$ e_i met him$_{*i/k}$ was happy.

But what seems to be possible is to bind a personal pronoun inside a constituent relative of a relative clause, i.e. at a greater distance, e.g.:

(45) Every farmer who$_i$ e_i owns a donkey that$_j$ he$_i$ doesn't like e_j is sad.[37]

Furthermore, the prediction that languages with two possessives can only use the non-reflexive variant for this kind of binding is borne out. Here is a Russian example:[38]

(46)

Pjotr	znaet	kazhdogo	krest'janina,	u kotorogo	est'	osjol,	kotoryj	temnee
Peter	knows	every	farmer	that	has	donkey	that	darker

ego	teni.
poss.	shadow.

'Peter$_i$ knows every farmer$_j$ who has a donkey$_k$ which is darker than his$_{i/j/*k}$ shadow.'

If the non-reflexive variant is used, it has no choice but to 'refer' back to the donkey:

(47)

Pjotr	znaet	kazhdogo	krest'janina,	u kotorogo	est'	osjol,	kotoryj	temnee
Peter	know	every	farmer	that	has	donkey	that	darker

svoej	teni.
refl.-poss.	shadow.

'Peter$_i$ knows every farmer$_j$ who has a donkey$_k$ which is darker than his$_{*i/*j/k}$ shadow.'

Of course, this couldn't be different according to next to all existing theories of binding out there. As the traditional binding conditions (15) have it, personal pronouns must not be coindexed with any argument of the same verbal projection (paraphrasing one possible definition of "binding domain"), while reflexives must. From this the contrast between (46) and (47) immediately follows.

If the account of pronominal binding is correct, this sheds some light on the infamous *de re/de se* distinction.

(48) Kaplan thinks that his pants are on fire.

The sentence is ambiguous between a reading in which Kaplan has a belief about himself with and without (necessarily) recognizing himself. That is, scenarios in which the two

[37] This example is similar to one by Barbara Parttee (Partee, 1975, (60), p. 236):

(i) Every man who has lost a pen who does not find it will walk slowly.

I owe this suggestion to Ede Zimmermann.

[38] Dina Voloshina, p.c.

readings lead to different truth values usually involve some kind of reflection in a mirror, or other means of presenting a subject to itself in such a way that it is possible that it forms a belief about the individual so presented without necessarily believing something about itself. If it isn't, the belief is said to be *de re*, but if the subject recognizes himself in the mirror, then the belief is *de se*. One other way to put the same is that the subject, Kaplan in the present example, might report his belief using (49a), if it is *de se*, but uses (49b), if it is *de re* (Kaplan, 1989b, p. 533)

(49) a. My pants are on fire.
b. His pants are on fire.

Under several popular accounts (Lewis, 1979a, Chierchia, 1989; cf. Schlenker, 2011 for an overview), *de se-belief* doesn't take a proposition as its argument, but rather a property. Believing some state of affairs thus is understood as self-ascribing the property of being in a world (or situation) in which the state of affairs holds. *De re-belief*, on the other hand, can still be modeled as a relation to a proposition or, alternatively, as self-ascription of a property where the *center* of the belief isn't its subject. This makes the types homogeneous for both readings and it isn't necessary to stipulate an ambiguity of *believe*. If the complementizer *that* takes a (syntactically) complete IP and binds an individual variable (together with the world-parameter and possibly even more), *de se* readings result if the possessive is bound, while *de re* readings are derived by having *that* bind vacuously. Schematically, assuming for the moment that the complementizer is the binder:

(50) a. believe ($\textsc{That}_i$ his_i pants are on fire)
$\approx$ believe ($\lambda x_i.\ x_i$'s pants are on fire.)
b. believe ($\textsc{That}_i$ his_k pants are on fire)
$\approx$ believe ($\lambda x_i.\ x_k$'s pants are on fire.)

(50b) forms a (*de re*) belief about whatever x_k refers to. If k also is the index of the subject, then the *de re* reading of (48) is derived successfully:

(51) Kaplan_k believe ($\lambda x_i.\ x_k$'s pants are on fire.)

This kind of account is also entirely compatible with binding theory (15). This would mean that *de re* pronouns are bound by or anaphorically related to pretty distant expressions, while *de se* pronouns are bound by closer expressions; as said above, either the complementizer or the attitude verb. But the λ-prefix still isn't close enough to license the use of a reflexive. In fact, the Russian translation uses the non-reflexive possessive for both readings. The variant with the reflexive possessive is not grammatical:

(52) a. Kaplan dumaet, chto ego shtany gorjat.
Kaplan thinks that poss. pants burn.
b. *Kaplan dumaet, chto svoi shtany gorjat.

But things are not so easy. If the subject is a quantifier, something unexpected happens:

(53) Every man believes that his pants are on fire.

Following the options in (50), a *de se* construal needs to coindex the local binder and the pronoun, while a *de re* interpretation requires coindexing of *every man* and *his*:

(54) a. Every man β_k believes (λx_i. x_i's pants are on fire.)
b. Every man β_k believes (λx_i. x_k's pants are on fire.)

This is not possible, because this kind of approach predicts a sort of homogeneity among the believers: either, under the construal in (54b), every man has a mere *de re*-belief about his pants, i.e. none of them recognizes himself in the mirror; or, in case the index borne by the possessive is i as in (54a), everybody *de se*-believes that his pants are on fire, meaning that everybody recognizes himself in the mirror. Crucially, this is not correct.[39] In a scenario where some men do recognize themselves in a mirror, and thereby form a believe about themselves *as* themselves, while others fail to recognize themselves, and hence, form a believe about themselves but not *as* themselves, (53) is true, while neither of (54a) or (54b) is; assuming that (54b) encodes 'mere' *de-re* belief. Thus, whatever makes the distinction between *de re* and *de se* readings, it is not different logical forms, as (50) or (54) has it (cf. Reinhart (1990) for exactly this claim, as well as Anand (2006), Maier (2006), and Percus and Sauerland (2003a, among others) for accounts).[40] This means that (54a) cannot be the only way to generate a *de se* reading. But (54b) isn't a candidate either, given that *believe* takes a property as its argument in order to identify the abstracted position with the center of the believe-indices. Thus, neither coindexing with nor long distance binding of overtly realized (possessive) pronouns is able to derive mixed *de re*/*de se* predicates.

A common reaction can be presented as follows. *De se*-readings are a special case of *de re*-readings in the sense that the former entail the latter if true. Thus, doing away with special means to represent *de se*-readings immediately allows for mixed predicates.[41]

[39]This observation is often attributed to T. E. Zimmermann (1991), e.g. in Schlenker (2011), but he rejects authorship (cf. T. E. Zimmermann, 2012b, p. 2391). On the other hand, he mentioned the following example (p.c.) which might even pose a more serious thread to the analysis than the one in the text:

(i) John believes [de se] that his pants are on fire, but Mary does not [de re].

[40]One argument to the contrary comes from Percus and Sauerland (2003a) who claim that there need to be dedicated logical forms for *de se* readings. They base this on the observation that (i) is true in scenarios where Peter has a *de se* believe about himself, while every other relevant individual only has a *de re* believe about himself (if at all). Thus, one cannot simply paraphrase (53) as *every man* de se- *or* de re-*believes that his pants are on fire*, either:

(i) Only Peter believes that his pants are on fire.

See Anand (2006) for a discussion.

[41]This doesn't exclude the possibility that there are dedicated logical forms for *de se* readings that are employed in other constructions, though. One case in point are infinitival constructions, which differ

That is, the problem with (54b) is that the λ-prefix is assumed to stand in for the center; thus, since x_k is not bound in (54b), x_k can't be the center, and hence, (54b) derives a 'mere' *de re*-reading. But if the λ-prefix is done away with, and all pronouns are 'bound' e.g. by the complementizer or attitude verb irrespective of their index, mixed cases are the rule rather than the exception. But this means that the DP in the matrix clause doesn't bind the pronoun directly, as (54b) has it. Instead, another binder, either the attitude verb itself or a (silent) complementizer intervenes.[42]

This account is easily extended to exceptional case marking (ECM) environments like the following:

(55) a. No man wants every waitress to fry herself some fish.
b. No man wants every waitress to fry him some fish.
c. *No man wants every waitress to fry himself some fish.
d. *No man wants every waitress to fry her some fish.

The pattern in (55) might be readily explained if movement of *every waitress* from the subject position of the infinitive to the object position of the matrix clause is assumed, on pain of violating otherwise well-established island constraints on movement.[43] A reflexive in the infinitive can hook on the trace.[44] But this doesn't explain how *him* gets bound in (55b), at least, if one assumes that *no man* in subject position of the matrix clause doesn't do it by itself. Crucially, *him* can be understood *de se* as well as *de re*, as is the case above. Additionally, there are readings under which *him* (anaphorically or deictically) refers to some other individual (if it refers at all). So it is possible to contraindex *him* and its binder. If this is on the right track, this then is the same case as in (48) that doesn't work with dedicated LF approaches.

However, this doesn't mean that the λ-prefix based account is completely off the table. In fact, as claimed in e.g. Maier (2011), among others, it might still be the best account for dealing with PRO and logophoric pronouns in general, and thus a second 'road' to *de se*. To see this, consider infinitive embedding attitude verbs, e.g. object control verbs:

(56) a. No man told every waitress to wash him.
b. No man told every waitress to wash herself.
c. *No man told every waitress to wash himself.
d. *No man told every waitress to wash her.

Here, the subject of the infinitive is assumed to be PRO, which obligatorily needs to be controlled by the object *every waitress*. Again, this element in subject position is responsible for the felicity of *herself* in (56b) and the infelicity of *himself* in (56c). But, once again, the pronoun *him* in (56a) is without binder, if the hypothesis that DPs don't

from the current examples insofar as they do not feature overt personal pronouns. But even examples with overt pronouns might be assigned a dedicated *de se*-LF in other constructions, like, e.g. the example of Percus and Sauerland in the previous footnote.

[42] This roughly corresponds to mechanisms proposed in von Stechow (2002).

[43] This kind of example might be taken as overt realization of otherwise covertly proceeding *res*-movement.

[44] Cf. Büring (2005a)

bind *de re* pronouns directly is maintained. This again can be accounted for by the same means, i.e. by assuming that binding is carried out by the main predicate.

But there is a difference between PRO and *him* in that the latter may freely refer to any other individual (if used deictically or anaphorically related to a referring expression), while the former is not allowed to. Thus, there is something more forcing behind, say, coindexing PRO with the object position of *tell*. One might take this as indicating that PRO is more reflexive-like than pronoun-like and therefore should be modeled as a λ-prefix introducing expression, indicating its dependence on material outside of its clause. This in turn makes *tell every waitress* a predicate that needs to take a property as an argument; and hence, it is assigned a kind of dedicated *de se* LF as proposed in Chierchia (1989). The crucial question then becomes whether this LF really leads to a *de se* reading. But this is hard to tell since PRO in this case gets associated with the inner argument of *tell* and not with the subject position. Thus, this doesn't give rise to the common self-identification *as oneself* that gives *de se* readings a quality over and above mere *de re* readings. In this sense, it is misleading to call every property-based analysis of infinitives or other embedded sentences a *de se* LF. But this is just a terminological remark. It suffices to acknowledge that PRO behaves differently in the sense that it is strictly associated with some coargument of the attitude verb while (bound) pronouns may not. Thus, probably, it is even better to do away with PRO altogether and analyze infinitives as predicates, as it is done in Montague (1973), since then it is guaranteed that the argument ends up bound. This carries over to the next example as well.[45]

Whatever the exact details, it is also possible to apply this kind of analysis to ECM environments, if one wishes to do so. That is, instead of raising *every waitress* in (55) across the clause boundary, one might as well assume it starts in the matrix clause as an adjunct of the attitude verb. Then *wants every waitress* needs to be able to deal with a property, like *tell every waitress* above, because the subject position of the embedded clause has to contain a PRO instead of the trace. It would associate PRO with its adjunct and the personal pronoun with its grammatical subject.[46] This also predicts the pattern (55) since within the embedded clause, PRO and a trace do the same job in terms of licensing. E.g., *himself* would still be without local antecedent because of gender-mismatch and thus not bound (viz. (55c)).[47]

To summarize, there is some evidence that personal pronouns are 'bound' in exactly those kind of environments in which index-dependent expressions can get bound, namely when syntactically complete sentences are subordinated in order to form an attitude report out of them. Reflexives, on the other hand, seem exclusively bound locally. Possessives form a mixed class as long as they are conceived of as ambiguous, but if two versions

[45] I owe this point to Ede Zimmermann.

[46] Meaning: "with what the grammatical subject thinks who s/he is". This whole approach is compatible with an acquaintance-based approach (cf. Maier, 2006; Maier, 2009a; Maier, 2011; Percus and Sauerland, 2003a).

[47] One might add that this casts some doubt on analyses of univocally *de se* LFs involving so-called *res movement* out of the embedded clause into an adjunct position of the attitude verb (cf., e.g. Percus and Sauerland, 2003a) since once an adjunct is present, the PRO-containing infinitive isn't interpreted as in *de se* believes.

are distinguished, one falls in the same class as reflexives, and the other patterns with free personal pronouns. Hence, it seems, binding is either completely local, or on the sentential level (or even above, if nested relative clauses are taken into consideration). The *de se* data considered in this section serve their purpose, namely establishing that not all cases of bound pronouns can be traced back to the standard picture involving DPs or dedicated binder prefixes (β) and coindexed empty categories. Ultimately, DPs need to relate to *de se* and *de re* pronouns as well, even if it is just for feature-checking (and probably deletion), but these relations seem to be mediated by attitude verbs (or complementizers).

3.1.4 Problematic Cases

One might be tempted to draw the strongest conclusion possible, namely that personal pronouns are *only* bound at the sentential level, and reflexives are *only* bound locally.[48] But there are plenty of constructions other than the ones discussed so far that directly contradict this claim. One involves so-called long-distance reflexives:

(57) Italian (Chierchia, 1989, p. 24)

a. Pavarotti crede che i propri pantaloni siano in fiamme. only de se
P. believes that the self pants are on fire.

b. P. crede che i suoi pantaloni siano in fiamme. ambiguous
P. believes that the his pants are on fire.

Some of the alleged 'long distance' reflexives can be explained away by assuming that a silent subject is present in the subordinate clause, e.g. PRO in infinitives. But this is not plausible for (57a), since there is no 'empty' argument slot. Alternatively, one might treat this kind of reflexives as overt realizations of PRO.[49] If everything else fails, what is claimed here is perfectly compatible with the existence of reflexives which behave more like personal pronouns. Something similar to the ambiguity-hypothesis advanced for possessives in English may also be put forth for these expressions in other languages.[50]

Leaving reflexives aside, there is a huge amount of evidence against the other part of the strong claim, namely that personal pronouns *only* get bound via sentence-modification. It comes from all kinds of examples in which no subordination of (syntactically complete) sentences can be blamed. The constructions which make this possible include the following:

(58) a. [Each student$_i$'s advisor] bought a book from him$_i$. (after Barker, 2012, p. 620)

b. [Someone from every city$_i$] hates it$_i$ (Barker, 2012, p. 621)

[48] Overt personal pronouns in Japanese sometimes are said to be 'unbindable'. But see Yashima (2015) for a claim to the contrary.

[49] Recall that PRO is partially characterized as reflexive in, e.g. Chomsky (1981).

[50] Something along this line is proposed for the contrasting *zich* and *zichself* in Dutch. Cf. Cole et al. (2000) and Reinhart and Reuland (1993) among others.

c. [A small part of [every article]$_i$] undermined it$_i$. (Barker, 2012, p. 621)
d. Our staff keeps a watchful eye [on [every student]$_i$] and the books he$_i$ buys. (after Barker, 2012, p. 623)
e. The picture of his$_i$ mother that every soldier$_i$ kept wrapped in a sock was not much use to him$_i$. (Safir, 1999, p. 613)

In all of these cases a quantifier seems to take scope over the whole sentence from a position it shouldn't be able to reach via movement, because it overtly sits in a position that it isn't allowed to leave. Thus, the scope taking mechanism at work is not obvious. However this is achieved,[51] the mechanism seems to "catch" pronouns in these environments as well. These mechanisms of course interact with the binding procedure proposed here in that it makes possible more bound readings than binding on the sentential level alone would:

(59) [Each student$_i$'s advisor]$_j$ told every waitress to educate him$_{i/j}$.

The reading that involves indexing *him* with j is in line with what is said above, while *him*$_i$ has to be accounted for by whatever mechanism is proposed for (58a).

Other famous constructions contradicting the stronger hypothesis are wh-questions. E.g. (60b) contains a personal pronoun that receives a bound interpretation when it is pied-piped through wh-movement. Thus, it is unexpected from this point of view. The variant with a reflexive in the same position (60a) is not only possible, but seems to be easier to get (examples modeled after Büring, 2005a, p. 247; indexing is only used to indicate the relevant interpretation):

(60) a. Which pictures of himself$_i$ did Mary say that every boy burnt?
b. Which pictures of him$_i$ did Mary say that every boy burnt?

(60a) is usually taken to show that material pied-piped by wh-movement needs to reconstruct in order to be interpreted. This especially holds for the reflexive, since its binder is left in-situ. (60b) is not undisputed. This may be due to *him* being not good in base position:

(61) Mary said that every boy$_i$ burnt some pictures of himself$_i$/*him$_i$.

Also, the variant with the personal pronoun doesn't seem to be possible in German (after Büring, 2005a, p. 247):

(62) Wieviele Gedichte über sich$_i$/*ihn$_i$ wird jeder Dichter$_i$ noch schreiben?!
how many poems about self$_i$/*him$_i$ will every poet$_i$ still write
'How many poems about himself is every poet going to write?!'

If the official claim that personal pronouns are bound by attitude verbs at least in some cases is correct, it predicts a contrast in acceptability between (63a) and (63b):

[51] Cf. Barker and Shan (2008) and Barker and Shan (2014), Kobele (2010), Sailer (2015), and others for some ideas that do not involve the notorious Quantifier Raising (QR).

(63) a. Which picture of him did Mary say (that) every boy burnt?
b. Which picture of him did Mary say (that) every boy believed (that) Fritz burnt?

Unlike (63a), (63b) would provide a suitable binder for *him* in base position, namely *believe*, which would in turn mediate binding by the DP by identifying *him* with its argument in subject position. This would be the account of the following example, which seems to be better than (61):

(64) Mary said that every boy$_i$ believed that Fritz burnt some pictures of him$_i$.

Unfortunately, any theory operating with the classical Binding Conditions predicts the same, simply because the additional embedding provides a structure large enough to count as the domain within which *him* has to stay free ("Principle B" in the parlance of Chomsky (1981)), thereby improving the acceptability of the pronoun in its base position. Thus, examples like (63) cannot distinguish the weaker and the stronger hypothesis.

Furthermore, wh-movement seems to enable a pied-piped quantifier to bind a pronoun it is c-commanded by in its base position, if the quantifier is located in an adjunct (Safir (1999, 601f.), crediting also Higginbotham and Postal):[52]

(65) a. [Which book on every poet$_i$'s shelf]$_j$ is he$_i$ particularly proud of t$_j$?
b. [Which book on every poet$_i$'s shelf]$_j$ is his$_j$ mother most proud of t$_j$?
c. [Which book on every poet$_i$'s shelf]$_j$ t$_j$ gives him$_i$ lasting satisfaction?

(66) a. *[Which reviews of every poet$_i$'s book]$_j$ does he$_i$ try to forget t$_j$?
b. ??[Which analysis of every poet$_i$'s book]$_j$ is his$_i$ mother most afraid of t$_j$? (The Freudian one.)
c. ?[Which reviews of every poet$_i$'s book]$_j$ t$_j$ give him$_i$ the most satisfaction?

In structurally similar examples lacking a wh-element so that the quantifiers have to sit in their base positions binding is impossible irrespective of the argument-adjunct distinction, though.[53]

(67) (Safir, 1999, p. 602)
a. *He$_i$ is particularly proud of some book on every poets$_i$'s shelf.
b. *?His$_i$ mother reads at least one book on every poet$_i$'s shelf.

[52] All of the following examples are not possible in German, it seems:

(i) a. *Auf welches Buch im Regal von jedem Dichter$_i$ ist er$_i$ besonders stolz?
On which book on-the shelf of every poet is he particularly proud?
b. *Welche Besprechung eines Aufsatzes von jedem Dichter$_i$ versucht er$_i$ zu vergessen?
Which review a-GEN article of every poet tries he to forget?
c. *Die Besprechung welches Aufsatzes von jedem Dichter$_i$ versucht er$_i$ zu vergessen?
The review which-GEN article of every poet tries he to forget?

[53] Cf. Barker (2012) who argues against the relevance of this distinction. Most recently, Bruening and Al Khalaf (2017) experimentally verified that the argument-adjunct distinction doesn't play a rôle for Principle C violations.

c. ?Some book on every poet$_i$'s shelf means more to him$_i$i than money.

(68) (Safir, 1999, p. 601)

a. *He$_i$ tries to forget some review of every poet$_i$'s book.
b. *His$_i$ mother is most afraid of one analysis of every poet$_i$'s book.
c. ?Some review of every poet$_i$'s book is bound to upset him$_i$.

Thus, reconstruction in this case would undo a movement step that seems to license an otherwise hopeless indexing.

There seem to be other factors involved in binding personal pronouns sentence-internally. One might speculate that QR or other mechanisms are a crucial aspect of the story. Not just that it creates a c-command relation where there isn't one on the surface or at any stage in the derivation. More crucially at the moment, if the classical account of QR (May, 1977; May, 1985) is taken literally, it proceeds by modifying a syntactically complete sentence. That is to say that if QR is modeled as adjunction to at least IP, then sentences involving such a moved constituent by definition fall into the realm of Lewis' criterion for shifting constructions. On the other hand, QR so conceived cannot be as widespread a phenomenon as it is traditionally thought to be, since it isn't possible to "repair" (strong/weak) crossover structures like (69) by raising the quantifiers covertly to the initial position (70):

(69) a. *She$_i$ loves the mother of every waitress$_i$.
b. *His$_i$ mother loves every man$_i$.

(70) a. [every waitress]$_i$ she$_i$ loves t_i
b. [every man]$_i$ his$_i$ mother loves t_i

And finally, there are sentences where the quantifier seems to bind a pronoun from an A-position, not mediated by any further binder. At least, there is no immediate evidence for the necessity of QR in (71):

(71) Every spy shot the guy that kicked him.

This is of course expected from a traditional point of view and only a problem for the bold claim that personal pronouns are never bound from A-positions.

Taking stock, there is quite a lot of evidence that quantifiers bind personal pronouns directly, at least not necessarily mediated by relative pronouns or attitude verbs. Thus, it cannot be claimed with full generality that personal pronouns only behave as one would expect from Lewis' criterion. But, on the other hand, there are environments in which personal pronouns have been and need to be analyzed exactly so. If contained in sentences embedded under attitude verbs, their behavior is on a par with the index-parameters Lewis distinguishes. Thus, if these examples are taken to establish that these uses have to be separated from all the others, one needs a way to incorporate personal pronouns into Context Theory as index-dependent expressions. But this is easier said than done, because anaphoric pronouns complicate the picture in other respects not mentioned yet. To see this, the issues surrounding binding are abandoned (but briefly picked up again in section 3.5) in favor of a discussion of accounts that were set up to deal with anaphoric uses directly, namely *Discourse Representation Theory*, *File Change Semantics*, and *Dynamic Predicate Logic*. If personal pronouns really are overtly realized index-dependent expressions, then these accounts more or less missed a crucial part of the story, albeit accounting for phenomena Context Theory in the shape of Chapter 1 isn't able to tackle. A small glimpse at what this is is given in section 3.2.3. If all of this is on the right track, then there must be a way of relating both strands of theorizing—Kaplanian Context Theory and Dynamic Theories—in such a way, that everything is taken care of. This way is discussed in the last chapter.

3.2 Free variables and their interpretation

3.2.1 Indefinite articles as variables

The main motivation behind File Change Semantics (FCS) as presented in Heim (1982, ch. III) and Kamp's (1981), and Kamp and Reyle's (1993) Discourse Representation Theory (DRT) (as well as other dynamic semantics) is a perspective on the anaphoric use of pronouns in natural language, that can be summarized under the slogan "pronouns are variables". This view is complemented with a novel account of the semantics of indefinite noun phrases, which similarly can be referred to by the slogan "indefinite articles are variables".

To understand the reasons for that, a toy example will be considered.[54] A natural language sentence like (72a) traditionally receives an (oversimplified) interpretation which is equivalent to standard-predicate logic's (PL) (72b). The contribution of the indefinite article is understood as the driving force behind this interpretation, in two respects, namely by being made responsible for the structure of the whole formula, and (ii) by contributing an existential quantifier over individuals, that fills the argument-slots of the noun and the predicate. Thus, it is assigned a formula like (72c), where two lambda-prefixes indicate its unsaturatedness—its being in need of complementation by a noun and a predicate—, and prefigure a possible composition, described in terms of functional application. The encapsulated existential quantifier guarantees the intuitively correct interpretation. A sentence with an indefinite in subject position is true if at least one individual that has the property expressed by the noun also has the property expressed by the predicate. If the predicate also contains an indefinite, the story is a tad longer, but doesn't change substantially.[55]

[54] In the following, formulæ familiar from first-order predicate logic are used to illustrate Heim's and Kamp and Reyles's approaches. This is not true to the original sources in the sense that (i) Heim's notions are meant to apply to natural language's syntax, and not, as may be suggested here, to the syntax of a formal language into which natural language has to be translated first. This is the view held by Kamp and Reyle, so their notions apply to this intermediate level between natural language syntax and meanings, but this intermediate level isn't (a version of) PL. To compare these two approaches, these misrepresentations are condoned, because otherwise, talking about similarities and differences between the two takes even more effort.

[55] Maybe with the exception of predicative uses in, e.g., *Peter is a lawyer.*

(72) a. A man owns a dog.
b. $(\exists x_1)[Mx_1 \wedge (\exists x_2)[Dx_2 \wedge Ox_2x_1]]$
c. $\lambda P.\lambda Q.(\exists x_1)[Px_1 \wedge Qx_1]$ with Q, P being variables of type **et**

What this kind of interpretation cannot account for is the fact that (72a) can be continued with (73a). If one endorses the "pronouns as variables"-view, this sentence may be rendered as (73b), where *BATM* translates the complex predicate *bought at the main station.*

(73) a. He bought it at the main station.
b. $BATMx_2x_1$

The pronouns are translated by the same free variables that the existential quantifiers in (72b) introduced, i.e. *he* as x_1 and *it* as x_2, in the (naïve) hope that sameness variables leads to the desired interpretation. But this isn't the case. In PL-notation, what one wants to have is (74a), but what one does in fact get is (74b).

(74) a. $(\exists x_1)[Mx_1 \wedge (\exists x_2)[Dx_2 \wedge Ox_2x_1 \wedge BATMx_2x_1]]$
b. $(\exists x_1)[Mx_1 \wedge (\exists x_2)[Dx_2 \wedge Ox_2x_1]] \wedge BATMx_2x_1$

Although similar looking, there is a substantial difference between (74a) and (74b). In (74a), the translation of the second sentence is incorporated into the formula that serves as the interpretation of the first sentence. What this means is that the variables that are free in (74b)— x_1 and x_2—are located within the scope of the existential quantifiers in (74a), and thereby get bound. (74a) is true if there is at least one man such that there is at least one dog such that the former owns the latter, and the former bought the latter at the main station. This is what the sequence of sentences should come down to.

But this is not the interpretation of (74b). There, the variables are not bound but stay free, even though they bear the same names as the bound variables in the left conjunct of the formula. The scope of the existential quantifiers ends with the second bracket, meaning that everything on the right of it is out of its reach. Thus, the pronouns in the second sentence do not anaphorically refer back to the indefinite noun phrases of the first, but refer to whatever the interpretation device assign them as value.

Unfortunately, while (74a) represents what the meaning of this sequence of concrete sentences should be, (74b) parallels their syntactic structure. Traditionally, the scope of existential as well as other quantifiers is fixed within the clause they are contained in, as witnessed in (72c), where it is restricted to a small domain comprising noun and predicate, indicated by brackets. This can, but need not, amount to scope over a complete sentence; depending on whether the indefinite noun phrase is in subject position or not. But this is the maximum of what is possible with (72c). What one needs in order to make the "pronouns as variables"-idea work is even more. It seems as if the scope of the indefinites needs to be extended beyond their traditional maximum in order to bridge the gap between (74a) and (74b); at least this is one possible conclusion one can draw from the example.[56]

[56]Whatever the solution is, it needs to be exclusive to indefinites since it isn't possible to construct

One way to solve this issue is to complement the "pronouns as variables"-idea with an "indefinite articles as variables"-account. This idea questions the correctness of (72c) and proposes something different instead. To be concrete, when an indefinite like *a man* is translated, instead of $\exists x_1 M x_1$ (abstracting away from the λ-prefix for the moment), simply Mx_1 is used, where x_1 is the contribution of the article and M of the restrictor; similarly for *a dog*. Thus, instead of (74b), (75) is said to be the translation of the little discourse:

(75) $(Mx_1 \wedge Dx_2 \wedge Ox_2x_1) \wedge BATMx_2x_1$

The rationale goes as follows: the first conjunct, $Mx_1 \wedge Dx_2 \wedge Ox_2x_1$, uses the variables x_1 and x_2 for the first time in this small discourse. These first uses mimic the behavior of indefinite articles. The next conjunct does not employ fresh variables but elaborates on those already used. So, a pronominal behavior is witnessed. Thus, if one where able to guarantee that a fresh variable is used whenever an indefinite article has to be translated, while an old variable is employed if a pronoun is to be translated, then free variables mimic exactly the behavior of indefinite articles and pronouns. The first uses can be said to "introduce" these variables in restricting their possible values to those individuals, which satisfy the accompanying predicate, while the later, non-fresh uses simply elaborate on those individuals introduced.

For this story to work, one needs to overcome the following problem: Given that the assessment of (72a) that traditionally led to the translation into something equivalent to (72b) is correct, the interpretation of (75) therefore has to be equivalent to (72b) as well to be adequate truth conditionally. This is not a given; in fact, on the standard account of formuæ like (75), it is simply not true.

To make this precise, a small fragment of predicate logic (PL_0, in the following), just capable of forming basic sentences out of predicate constants and variables, and more complex sentences by conjunction, is considered. Its syntax can be defined as follows:

(76) *Syntax of* PL_0

a. For any $i \in \mathbb{N}$, if τ is of the form x_i, then $\tau \in \mathit{Var}$.

b. *Con* is the set of all predicate constants (usually $P, Q, R, \ldots$; in the following β serves as variable for elements of *Con*).

c. Let *Fml* be the smallest set containing all φ for which one of the following holds:

(i) If φ is of the form $\beta\tau_1 \ldots \tau_n$, β being a predicate constant, $\tau_1, \ldots, \tau_n$ being variables, then $\varphi \in \mathit{Fml}$

(ii) If $\psi, \chi \in \mathit{Fml}$, and φ is of the form $\psi \wedge \chi$, then $\varphi \in \mathit{Fml}$.

Usually, in a model theoretic interpretation following Tarski (1936) and Tarski (1944), formulæ containing free variables are excluded from the definition of truth as only so called *closed formulæ* are conceived as truth bearing entities. A formula in predicate logic is judged true iff it is verified by arbitrary (total) assignments, given a domain

parallel examples with, say, universal quantifiers.

of interpretation. Closed formulæ are assignment-independent as they do not contain (globally) free variables, so this move is understandable. There are just two options: either a closed formula expresses, so to speak, the set of all assignments, then it is true, or it doesn't, then it is false. This won't do for PL_0, since it has no means to bind free variables, i.e. quantifiers. Thus, formulæ like (75) need to be assigned truth values as well. So, if the standard convention[57] is applied to formulæ of PL_0, intuitively true sentences mostly express proper subsets of the set of all assignments, and they usually do, if they do not form a tautology (which isn't possible with the syntax pf PL_0 defined above, because there is no negation, yet). Thus, well-formed formulæ of PL_0 express *contingent* sentences, possibly verified by *some*, but not all assignments.[58]

To show how the traditional definition goes astray, the set of assignments (77), and the interpretation of formulæ (78) are defined. In all definitions, a model $\mathcal{M}$ consisting of a non-empty set of individuals M and an interpretation function I, i.e. $\mathcal{M} = \langle M, I\rangle$, is assumed. Also, here and in the following, a function $\vdash \bullet \dashv$ is utilized that maps statements onto truth values, such that it assigns 1 to true, and 0 to false statements.

(77) *Assignments*
$Ass := M^{Var}$

(78) *Verification and Truth of PL_0*
Let $\mathcal{M}$ be a model as defined above, and $f \in Ass$. $\|\bullet\|^{\mathcal{M},f}$ then is a function from syntactically well-formed expressions of PL_0 into semantic values such that:

a. $\|\tau\|^{\mathcal{M},f} = f(x_i)$, if τ is a variable of the form x_i, for any i;
b. $\|\beta\|^{\mathcal{M},f} = I(\beta)$, if $\beta \in Con$;
c. $\|\beta\tau_1 \dots \tau_n\|^{\mathcal{M},f} = \vdash \langle \|\tau_1\|^{\mathcal{M},f}, \dots, \|\tau_n\|^{\mathcal{M},f}\rangle \in \|\beta\|^{\mathcal{M},f} \dashv$, if $\beta \in Con$ and $\tau_1, \dots, \tau_n \in Var$;
d. $\|\psi \wedge \chi\|^{\mathcal{M},f} = \|\psi\|^{\mathcal{M},f} \cdot \|\chi\|^{\mathcal{M},f}$, if $\psi, \chi \in Fml$.
e. An assignment $g \in Ass$ verifies a formula $\varphi \in Fml$ iff $\|\varphi\|^{\mathcal{M},g} = 1$
f. A formula $\varphi \in Fml$ is true in a model $\mathcal{M}$ iff $\forall g \in Ass : \|\varphi\|^{\mathcal{M},g} = 1$

Armed with these definitions,[59] one can state that (75), repeated below, is true iff it is

[57]Which isn't much more than a convention, though. The (implicit) universal quantification over assignments in the definition of truth is justified on the grounds just mentioned, but it isn't necessary for the definition to work. An existential quantifier would amount to the same in standard PL. The rôle of the universal quantification is a bit overstated in what follows in order to make the contrast between PL and PL_0 sharper.

[58]For the argument presented below, it doesn't really matter whether this is the most accurate characterization of standard PL and its truth definition. E.g., there are other interpretations that allow open sentences to have truth values. As said above, if there is one assignment that verifies a closed formula, then all do, so in principle, the truth definition doesn't necessarily need to quantify universally over assignments but could use an existential statement as well.

[59]Which do not match Heim's (1982) account exactly, since she uses a more Tarskian modeling with infinite sequences of individuals in the rôle of assignment functions. The semantic value of a completely saturated predicate in her system is the set of all sequences that make the expression true. This is comparable to the set of assignments characterized by (78c) and (78d), once one abstracts

satisfied by all assignments, cf. (79a). That is, looking beyond PL_0, it is equivalent to standard predicate logic's (79b).

(75) $(Mx_1 \wedge Dx_2 \wedge Ox_2x_1) \wedge BATMx_2x_1$

(79) a. $\forall g \in Ass : (\|Mx_1\|^g \ \& \ \|Dx_2\|^g \ \& \ \|Ox_2x_1\|^g) \ \& \ \|BATMx_2x_1\|^g$
b. $(\forall x_1)(\forall x_2)[(Mx_1 \wedge Dx_2 \wedge Ox_2x_1) \wedge BATMx_2x_1]$

To put a long story short, the intended usage of formulæ containing free variables clashes with the model theoretic definition of truth imported from traditional PL-interpretation.

There are two roads to take from here. First, one can argue that the "indefinite articles as variables"-idea needs some further syntactic ingredient to work. Basically, one challenges the idea that (75) is the logical form of the little discourse (72a). This is undertaken in Heim (1982, ch. 2). Her interpretation process consists of the following: (i) indefinite articles and pronouns are translated as free variables, (ii) sentences in a discourse are subsumed under one syntactic node named T (for Text), (iii) a closure operator is applied:

(80) Adjoin the quantifier $\exists$ to T. (Heim, 1982, p. 92)

The first step is the main assumption under discussion. (ii) already is implicitly contained in (75) since it uses conjunction as part of the translation of indefinite articles as well as the means to translate a sequence of sentences into one discourse. Thus, T is nothing but a complex formula φ of PL_0. The new ingredient (iii) can be added to the syntax above as follows:[60]

(76) c. (iii) If $\varphi \in Fml$, $\exists\varphi$ also is.

For the purposes at hand, $\exists$ should be understood as unselectively binding every free variable in T,[61] that is, x_1 and x_2 in the case of (75). The closure operator therefore has

from f. To give a sketch, instead of (77), she uses (i), and (ii) replaces (78c), where $(a)_n$ denotes the individual in n-th position of a sequence $a \in Ass_{\mathrm{Heim}}$. (78d) simply becomes intersection.

(i) $Ass_{\mathrm{Heim}} := M^{\mathbb{N}};$

(ii) $\|\beta x_i \ldots x_j\|^{\mathcal{M}} = \{a \in Ass_{\mathrm{Heim}} : \langle (a)_i, \ldots, (a)_j \rangle \in \|\beta\|^{\mathcal{M}}\}$

The lift to sets of assignments as basic semantic values will be done later as well. But for the moment, the definitions in (78) are sufficient.

[60] This rule allows the syntactic derivation to continue after $\exists$ has been added to a formula, although $\exists$ seems to be needed only after every sentences of a discourse is collected under T. To rule this out, one has to introduce yet another syntactic category that distinguishes formulæ with $\exists$ from formulæ without it and doesn't participate in further syntactic derivations. Then truth needs to be redefined such that it only applies to formuæ containing $\exists$. This is tacitly assumed to be done.

[61] This is not the solution Heim (1982) endorses and, ultimately, rightly so. Once more complex examples involving adverbial quantification, negation, and quantification over individuals are considered, the interaction between any of these elements and $\exists$ only then can be captured, if $\exists$ is allowed to bind some, but not all free variables in its complement, so that there is something left for these other elements to bind. Thus, the unselective version proposed here only works because of the relative simplicity of examples under consideration. This changes soon enough.

to bind every variable in $F(\varphi)$ at once, which can be achieved by generalizing the idea of x_i-variants from predicate logic.[62] Existential quantification usually is interpreted as follows, where $x_i \in \mathit{Var}$ and $\varphi \in \mathit{Fml}$, and two assignments f and g are x_i-variants of each other—$f \sim_{x_i} g$—iff $\forall x_j \in \mathit{Var} \setminus \{x_i\} : f(x_j) = g(x_j)$:

(81) $\|\exists x_i \varphi\|^f \ = \vdash \exists g : f \sim_{x_i} g \ \& \ \|\varphi\|^g = 1 \dashv$

Instead of $\sim_{x_i}$, $\sim_V$ is used, where V is the set of free variables employed in φ, dubbed $F(\varphi)$ and defined in (84) below:

(82) a. $f \sim_V g$ iff $\forall i \in \mathit{Var} \backslash V : f(x_i) = g(x_i)$
b. $\|\exists \varphi\|^f \ = \vdash \exists g : f \sim_{F(\varphi)} g \ \& \ \|\varphi\|^g = 1 \dashv$

Quantification in PL frees the assignment (f in (81)) from the burden to come up with a satisfying value for the variable quantified over (x_i in (81)) by introducing related assignments to fulfill this job. If quantification is existential, it is enough for being true if at least one of these related assignments evaluates the variable (x_i) in such a way that the formula is assigned the truth value 1, regardless what the initial assignment (f) is. Existential quantification in the sense of (82b) frees the initial assignment from valuing every free variable in φ by basically the same mechanics. The only difference is that it does so for multiple variables at once.

Thus, if all of these adaptions are made, instead of (75), (83) is the formula that has to be interpreted:

(83) $\exists[(Mx_1 \wedge Dx_2 \wedge Ox_2x_1) \wedge BATMx_2x_1]$

And (83), contrary to (75), is compatible with the standard definition of truth (78f), that is, it does mean what one wants it to mean while (78f) is in charge.

On the other hand, introducing $\exists$ also means that, strictly speaking, indefinite articles and pronouns aren't free variables anymore, but bound by $\exists$. Thus, if the notion of a free variable is defined recursively on the syntactic structure of PL_0 (84) the following has to be done:

(84) *Free variables in* PL_0
If φ is an expression of PL_0, then $F(\varphi) =$
a. $\{x_i\}$, if φ is a variable of the form x_i, for any i;
b. $\emptyset$, if φ is a predicate;
c. $F(\beta) \cup F(\tau_1) \cup \cdots \cup F(\tau_n)$, if $\varphi \in \mathit{Fml}$ is of the form $\beta\tau_1 \ldots \tau_n$;
d. $F(\psi) \cup F(\chi)$, if $\psi, \chi \in \mathit{Fml}$ and φ is of the form $\psi \wedge \chi$.
e. $F(\varphi) = \emptyset$, if $\varphi \in \mathit{Fml}$ is of the form $\exists\psi$, with $\psi \in \mathit{Fml}$.

This in itself is no problem, though, since the account under discussion is not necessarily called "indefinite articles/pronouns as *free* variables" but "indefinite articles/pronouns

[62] This is not the only way to do this. Alternatively, one can understand $\exists$ as abbreviating a sequence of existential quantifiers so that every variable is bound by a selective version. This view is not pursued any further since it runs counter to the intended treatment of variables.

as variables" simpliciter. And $\exists$ as used in PL_0 is not introduced by indefinite articles like it is the case in (72c), so its introduction does not mean that the account returns to a more traditional stance concerning indefinites. Indefinite articles are treated as free variables as long as sentences are added to T. This allows for a more or less compositional process of interpretation. That is, $\exists$ closes off the whole discourse; making it impossible to add more open formulæ afterwards.[63]

3.2.2 Truth in FCS and DRT

Heim's (1982) second solution, namely FCS, as well as Kamp's (1981) DRT approach the problem differently. To start with DRT, simple sentences, that is, sentences composed out of indefinites, predicates, and pronouns, are translated into structures like the following (where φ is just a label for easy reference and not part of the formal object):[64]

(85) a.
$$\begin{array}{|l|} \hline x_1\ x_2\ x_3\ {\scriptstyle\varphi} \\ \hline Px_1 \\ Qx_2 \\ Rx_1x_3x_2 \\ \hline \end{array}$$

b. $U(\varphi) = \{x_1, x_2, x_3\}$

c. $C(\varphi) = \{Px_1, Qx_2, Rx_1x_3x_2\}$

d. $\langle\{x_1, x_2, x_3\}, \{Px_1, Qx_2, Rx_1x_3x_2\}\rangle$

The top part of the box φ is called it *universe*, $U(\varphi)$, given separately in (85b), while the lower part contains *conditions*, $C(\varphi)$, viz. (85c). Formally, the whole box, called "discourse representation structure" (DRS), is a pair of universe and conditions. (85a) is thus just a graphical representation of the more official (85d).

The syntax of this fragment of DRT—say, DRT_0, to give it a name—is definable like this:

(86) *Syntax of DRT_0*

a. *Conditions*
Con is the smallest set containing all ψ for which holds that: If ψ is of the form $\beta\tau_1 \ldots \tau_n$, then $\psi \in C$, for any predicate β and variables $\tau_1, \ldots, \tau_n$.

b. *DRSs*
φ is a DRS_0 iff φ is of the form $\langle U, C\rangle$, with $U \subseteq \mathit{Var}$ and $C \subseteq \mathit{Con}$.

[63] This just means that adjoining $\exists$ to T needs to be thought of as the final syntactic step before evaluation begins. If one attempts to add another formula to T after $\exists$ adjoined, one faces the problem (74) again.

[64] Of course, this is a huge simplification, in various respects. These structures are usually discussed in introductions and textbooks, but no one considers these to be the actual translations of natural language sentences because, among a vast amount of other things, tense is left out of the picture. In addition to that, a further simplification done here consists in leaving out identity statements that usually come with the interpretation of pronouns, as well as duplex conditions and negation. These are neglected in order to reduce the number of clauses that have to be considered in definitions of syntax and semantics of DRT, a sequence of which will be part of the discussion to follow.

This so far allows for arbitrary combinations of variables in U and conditions in C. To restrict the language under consideration to more useful structures, the following is needed as well:

(87) *Free variables in DRT_0*
If ψ is an expression of DRT_0, then the set of free variables employed in ψ—$F(\psi)$—is defined as follows:

a. If ψ is a variable of the form x_i, then $F(\psi) = \{x_i\}$
b. If ψ is a predicate, then $F(\psi) = \emptyset$
c. If ψ is a condition of the form $\beta\tau_1 \ldots \tau_n$, then $F(\psi) = F(\beta) \cup F(\tau_1) \cup \cdots \cup F(\tau_n)$.

With the help of the notion of free variables, a subset of the set of all DRSs in (86b) can be singled out:

(86) c. *Proper DRS*
φ is a proper DRS_0 iff φ is a DRS_0 of the form $\langle U(\varphi), C(\varphi)\rangle$, and $U(\varphi) = \left(\bigcup_{\psi \in C(\varphi)} F(\psi)\right)$

Read, the universe U of a proper DRS is only allowed to consist in exactly those free variables that are employed in formulæ in C.

Second, on the semantic side, a three-valued model theoretic interpretation of these DRSs is put forth. The semantic values of the predicates are dependent upon a model $\mathcal{M}$ consisting of a (nonempty) domain of interpretation M, an interpretation function I that maps predicate constants of arity n to $\wp(M^n)$, and, since they employ variables, a function f from the set of variables (that is, $\mathbb{N}$) into M, called "embedding" or "assignment". The variables in the universe of the topmost DRS are interpreted as instructions to extend the domain of the empty assignment $f^{\emptyset}$ in order to obtain a function that covers all free variables in the conditions. Conditions, interpreted as forming a conjunction if there is more than one, constrain these variables, that is, they restrict the relevant part of the variation to the extension of the predicates used.

Nowadays, the semantics of DRT usually is partial in order to distinguish between undefined extensions and proper falsehood. To implement undefinedness, one may use partial instead of total assignments. Thus, if the empty assignment is extended by a variable, the result is an assignment that accounts for this variable only. It is also possible to make a slightly different use of total assignment functions. This is done here. The set Ass, that is, the set of functions from all variables into M, is extended to $Ass_{+\#}$, i.e. the set of functions that also assign $\#_e$ to variables of the language, a 'dummy individual' of which no predicate (or its negation) can make any use (if no confusion can arise, the type-index is dropped). If an element g of $Ass_{+\#}$ assigns $\#_e$ to every variable except for those making up a subset G of the set of variables, from now on (maybe confusingly) dubbed *domain* of g, and also denoted by $D(g)$, it is said to be a member of Ass^G, the set of assignments that assign proper individuals only to members of G. These assignments $g \in Ass^G$ are also written as g^G, thus wearing their domain on their sleeves.

(88) *Assignments*

a. $Ass_{+\#} := (M \cup \{\#\})^{Var}$

b. $Ass^{X} := \{f \in Ass_{+\#} : \forall\tau : f(\tau) = \# \text{ iff } \tau \notin X\}$, where $X \subseteq Var$.

(89) *Extension of assignments*:
If g^G and h^H are assignment functions and V is a set of variables, then h *extends g by V*—$g \subseteq_V h$—iff $G \cup V = H$ and $g \subseteq h$, that is, g and h agree on all values in G.

Note that the second condition does not exclude the possibility that $G \cap V \neq \emptyset$, that is, that h extends g by a set of variables already in the domain of g. If τ is such a variable, then, since $g \subseteq h$, $g(\tau) = h(\tau)$, that is, the value assigned to τ by g is not changed by the extension. If V consists solely of variables also contained in G, or if V is the empty set, then $g \subseteq_V h$ boils down to identity:

(90) $g \subseteq_{\emptyset} h \Leftrightarrow g = h$

This is only the start of the story since undefinedness needs to infect more complex formulæ as well and thus it must be stated explicitly how this happens. Usually, definedness-conditions together with "positive" and "negative" semantic values are imposed on every expression of the formal language (cf. van den Berg, 1996). This will be done in section 3.4.1. For the moment it is enough to take partiality to arise from the "bookkeeping device" only, i.e. from not properly extending the domain to cover variables employed in subsequent formulæ. If only correct uses of the extension relation are considered, and if no variables outside the domain occur in any condition, no mention of the third value (undefinedness) needs to be made.

Tacitly assuming this, the following definitions give the semantics of DRT_0:

(91) *Verification and Truth of DRT_0*
Let $\mathcal{M}$ be a model consisting of a domain M and an interpretation function I, with $f \in Ass$. $[\![\bullet]\!]^{\mathcal{M},f}$ then is a function from syntactically well formed expressions into semantic values such that:

a. If τ is a variable of the form x_i, for any i, then $[\![\tau]\!]^{\mathcal{M},f} = f(x_i)$;

b. If β is a predicate constant, then $[\![\beta]\!]^{\mathcal{M},f} = I(\beta)$;

c. If $\psi \in Con$, then $[\![\psi]\!]^{\mathcal{M},f} = \vdash \langle [\![\tau_i]\!]^{\mathcal{M},f}, \ldots, [\![\tau_j]\!]^{\mathcal{M},f} \rangle \in [\![\beta]\!]^{\mathcal{M},f} \dashv$, if ψ is $\beta\tau_i \ldots \tau_j$;

d. An assignment f *verifies* a DRS_0 φ—$f \vDash_{\mathcal{M}} \varphi$—, iff φ is of the form $\langle U(\varphi), C(\varphi) \rangle$ where
(i) $f^{\emptyset} \subseteq_{U(\varphi)} f$ & (alternatively: $f \in Ass^{U(\varphi)}$)
(ii) $\forall\psi \in C(\varphi) : [\![\psi]\!]^{\mathcal{M},f} = 1$

e. A proper DRS_0 φ is true (in a model $\mathcal{M}$) iff $f \vDash_{\mathcal{M}} \varphi$, for some assignment f.

This, of course, is reminiscent of the model-theoretic interpretation of PL_0 outlined above. But, as will be seen in a moment, there is a big difference in the definition of truth (in a model). A formula in predicate logic is judged true iff it is verified by arbitrary (total) assignments, while a formula in DRT_0 already counts as true iff there exists at least one verifying assignment. Of course, PL_0 and DRT_0 are in close syntactic correspondence. They use the same set of basic expressions and combine them roughly in the same way. To overstate this point, lets say that if $\varphi \in \mathit{Fml}$, then $\mathit{EM}(\varphi)$ is the set of atomic formulæ employed in φ:[65]

(92) $$\mathit{EM}(\varphi) = \begin{cases} \{\varphi\} & \text{if } \varphi \text{ is of the form } \beta\tau_1 \dots \tau_n \\ \mathit{EM}(\psi) \cup \mathit{EM}(\chi) & \text{if } \varphi \text{ is of the form } \psi \wedge \chi, \text{ with } \psi, \chi \in \mathit{Fml} \end{cases}$$

As is then easily seen, for every (proper) DRS φ in DRT_0 there exists a *corresponding* formula ψ in PL_0—$\varphi \approx \psi$—employing the same basic expressions, and vice versa. All of this means is that for every DRS with a finite set of conditions, there is a conjunction of the same basic formulæ in PL_0.

(93) *Syntactic correspondence*

a. The variables and predicates of DRT_0 and PL_0 are the same.
b. $\varphi \approx \psi$ iff $\varphi \in \mathrm{DRS}_0, \psi \in \mathit{Fml}_{PL_0}$, $C(\varphi) = \mathit{EM}(\psi)$
c. $\forall\varphi \in \mathit{DRS}_0 \exists\psi \in \mathit{Fml}_{PL_0} : \varphi \approx \psi$
d. $\forall\psi \in \mathit{Fml}_{PL_0} \exists\varphi \in \mathit{DRS}_0 : \varphi \approx \psi$

To put this in a simpler fashion, the two languages outlined above, DRT_0 and PL_0, correspond on their syntactic material. That is, they employ the same predicates and variables, and arrange them in only slightly different ways. These two usages of the same building blocks do not amount to a substantial difference in terms of verification, as is corroborated by (94a);[66] but for truth, there is one, viz. (94b) and (94c).

(94) *Partial Semantic correspondence*

For any $\varphi \in \mathrm{DRS}_0$ and $\psi \in \mathit{Fml}_{PL_0}$ such that $\varphi \approx \psi$:

a. $\forall f : f \vDash_{\mathcal{M}} \varphi \leftrightarrow \|\psi\|^{\mathcal{M},f} = 1$
b. If ψ is true in $\mathcal{M}$ according to (78f), then φ is true in $\mathcal{M}$ according to (91e).
c. It is not the case that if φ is true in $\mathcal{M}$ according to (91e), then ψ is true in $\mathcal{M}$ according to (78f)

This reflects the major difference in the intended rôle of variables. In standard predicate logic (and PL_0), a formula like Px_i is given the interpretation $\|Px_i\|^{\mathcal{M},g}$ in order to provide a basis for the definition of, e.g. $\|\forall x_i Px_i\|^{\mathcal{M},g}$, that is, a different kind of statement, where the variable x_i doesn't occur freely, but is bound by an operator. There is no other use for formulæ containing free variables, and, as already pointed out, they mostly are not treated as truth value bearing expressions. This is not the intention behind DRT's (or any other dynamic semantics's) use of Px_i in the context of the structure in

[65] This definition is not able to distinguish between, e.g., $A(x)$ and $A(x) \wedge A(x)$, etc., because *EM* forms a set. But the same holds for DRT's conditions. So, since this doesn't do any harm, it is left as is.

[66] It is tacitly assumed that the interpretation of PL_0 is shifted to the three-valued system sketched above.

(85)[67]. Its rôle is to translate a natural language expression like, e.g. *a preacher*, *the preacher* or *she preaches*, as the "indefinite articles/pronouns as variables"-view has it. These translations, if taken together with the interpretation of the rest of the box, yield the correct contribution to the semantic value of the whole structure. It should be noted that in DRT's use, the variable x_1 is free, and it stays free, and it is available for the interpretation of the conditions of a DRS that make use of it. For this reason it is simply not adequate to use the interpretation PL assigns to Px_i.

Heim's (1982) FCS is similar in that an existentially instead of a universally quantified definition of truth is used. In fact, the similarities are even deeper since a simplified version of FCS (say, FCS_0) can be constructed from the solution in chapter 3 of Heim (1982) by adding something similar to DRT_0's projection rules for variables. This is not shown right away because, in fact, the way in which FCS is set up necessitates working with meanings, that is, functions from assignments, instead of extensions, as in (91). This is postponed until section 3.4.1. What should be noted here is that this solution works without adding a syntactic closure operator as employed in the previous section. It compensates this by adopting a definition of truth similar to that of DRT_0 in (91e), that is, a definition where every free variable is implicitly existentially quantified.

Basically, two types of theories about the meanings (or contributions) of free variables are on the market now: one where variables are quantified universally (PL_0) and another one where they are quantified existentially (DRT_0 and FCS).[68] The latter type of theory tries to make the analogy between free variables and indefinite articles and pronouns work, and thus has to overcome the problem of assigning the correct semantic values, which necessitates their deviation from ordinary predicate logic. But more is needed to cash the analogy out. If a sequence of natural language sentences like (95a) in their PL_0-representation is considered, one faces another problem even if the appropriate truth-definitions are in charge.

(95) a. A girl walks through the park. A boy crosses the street. She is singing. He is humming.

[67] That is, if quantification is still left out of the picture

[68] One might object that this comparison between languages is quite weird since syntax and semantics of formulæ used in PL_0 and DRT_0 are only symbolically related in the sense that merely the same symbols and letters are used to represent variables and predicates. Some of these similarities are, of course, no coincidence, but in general, one would fare better if these two languages are distinguished more precisely. If, e.g., PL_0-formulæ (and their interpretation) are distinguished from DRT_0-formulæ (and their interpretation), for example by language-indicating indices, there doesn't seem to remain a ground on which these two can be compared. That is, the formulæ used in either one of those languages simply don't have anything in common; their seeming syntactical correspondence is just a bad analogy.

This is definitely true. But so far, nothing has been said that contradicts this. The whole point of this comparison is to introduce a maybe oversimplified and/or fictional story that lets one see why the classic approaches to anaphoric pronouns are shaped the way they are. Since the theories outlined so far overlap on questions regarding the evaluation of open formulæ, such a comparison is justified.

b. $Gx_2 \wedge Wx_2 \wedge Bx_1 \wedge Cx_1 \wedge Sx_2 \wedge Hx_1$

c.
$$\begin{array}{|l|}\hline x_1\ x_2 \\ \hline Gx_2\ Wx_2 \\ Bx_1\ Cx_1 \\ Sx_2\ Hx_1 \\ \hline\end{array}$$

The indefinite articles in the first two sentences introduce, to use DRT's terms, discourse referents into the universe of discourse. The pronouns in subsequent sentences use these discourse referents as antecedents, that is, they pick the indefinite's contributions up and thus allow for further predications on those contributions. Intuitively, the first conjunct $Gx_2 \wedge Wx_2$ uses the variable x_2 for the first time in this small discourse; as does the second conjunct with x_1. These first uses constraint the verifying assignments to those which assign values to x_1 and x_2 that are elements of the respective predicates; thus, these uses mimic the behavior of indefinites. The next two sentences do not employ fresh variables, but elaborate on those already used. They may eliminate some candidates left from the initial restriction, but as long as some assignment renders the whole sequence true, there is no problem with this. So, a pronominal behavior is witnessed; the already restricted range of possible values of x_1 and x_2[69] is constrained even further.

Thus, if one were able to guarantee that whenever an indefinite has to be translated into PL_0, a fresh variable is used, while an old variable is employed if a pronoun is to be translated, then PL_0 endowed with DRT_0's and FCS's definition of truth works as well. This in itself is no surprise since DRT_0 as defined above is, in fact, nothing but PL_0 with a superficially different syntax and, and this is to be made precise, a translation procedure that operationalizes exactly what is needed here. This is the third aspect unique to dynamic languages that is absent from PL-like languages; namely that either the translation or interpretation necessarily proceeds stepwise. How this is implemented is the topic of section 3.3. Before this is tackled, a possible third way of interpreting the structures is briefly illustrated.

3.2.3 Outlook: Possible worlds semantics

Truth is not the only value natural language semantics is interested in. This is one reason why all examples considered so far are oversimplifications. Apart from truth (in a model with respect to an assignment) there is also the truth conditions or the information that a sentence expresses that semantics needs to account for. This value is usually modeled by introducing (and binding) another type of variable which was left out of the picture so far. The idea is that these variables of another type (or sort) make their way into the formalism through (the translation of) natural language predicates, as an attempt to model the kind of circumstantial dependency they exhibit. In what now follows, the implementation happens in the most straightforward (or naïve) fashion (which ultimately doesn't work out), by simply throwing in variables of a different type than x_i, namely s_i, for all $i \in \mathbb{N}$. They are intended to stand in for situations, that is, their values are

[69] "Possible" means nothing but "values that are assigned by assignments that possibly verify the whole discourse up to the point where we're at".

elements of the set of possible situations LS. So, endowing the translation of, e.g., (95a), with one of these variables of a new type yields (96a) with its counterparts in $\mathrm{DRT}_{0'}$ and $\mathrm{PL}_{0'}$ (to be defined below) in (96b) and (96c), respectively:

(96) a. $Gs_1x_2 \wedge Ws_1x_2 \wedge Bs_1x_1 \wedge Cs_1x_1 \wedge Ss_1x_2 \wedge Hs_1x_1$

b.
$s_1\ x_1\ x_2$
$Gs_1x_2 \quad Ws_1x_2 \quad Bs_1x_1 \quad Cs_1x_1 \quad Ss_1x_2 \quad Hs_1x_1$

The question is how DRT_0 and PL_0 have to be adapted to be able to treat formulæ like these correctly. They are modified to $\mathrm{DRT}_{0'}$ and $\mathrm{PL}_{0'}$, respectively, in the following way: First, the notion of a model has to be adapted to take care of the newly introduced variable. A model $\mathcal{M}$ now is a triple $\langle M, LS, I\rangle$, where M is a (non-empty) set of individuals, and LS is a (non-empty) set of situations. I now maps predicate constants of arity n to $\wp(LS \times M^n)$, the set of predicate intensions.[70] Predicates standing in need of saturation by n nominal arguments are mapped onto relations of arity $n+1$, since they now include a slot for situation variables. Assignments map variables into $LS \cup M$, where the s_i are mapped onto elements of LS and all other variables are assigned elements of M. Other than that, the interpretation rules are not altered, yet. Given these refinements, the respective definitions of truth yield these statements:

(97) a. According to (91e), (96b) is true iff
$\exists f : f^{\emptyset} \subseteq_{\{s_1,x_1,x_2\}} f \ \&\ [\![Gs_1x_2]\!]^{\mathcal{M},f} \ \&\ [\![Ws_1x_2]\!]^{\mathcal{M},f} \ \&\ \ldots\ \&\ [\![Hs_1x_1]\!]^{\mathcal{M},f}$

b. According to (78f), (96c) is true iff
$\forall f : \|Gs_1x_2 \wedge Ws_1x_2 \wedge \cdots \wedge Hs_1x_1\|^{\mathcal{M},f} = 1$

In contrast to the examples in the last section, there is another freely varying variable in the logical form to take into consideration. This very fact of course doesn't suddenly make the formula under consideration express a logical truth. So, PL_0's definition is as unsuited for the task at hand as it was before; it's still too strong. But on top of this, the outcome of DRT_0's definition of truth (97a) isn't the correct result either; it's way to weak this time, because the sentence in question is assigned truth if there happens to exist one possible world in which the statement is true. However, in possible worlds semantics, truth is conceived to be relative to possible situations, that is, sentences are true or false *at a situation*. What one wants to know, then, is whether a sentence *is* true or false, *given* a concrete situation. All this interpretation says is that the formula in question is verifiable, that is, no logical falsehood. Thus, both interpretations break down if situation variables are simply thrown into the formalism.[71]

[70] "Int" in Heim (1982).

[71] Viewed from the perspective of possible worlds semantics, (97) displays a strange mixture of theories, anyway. On the one hand, the very kind of entity that acts as 'source' for the assignment of truth-values in possible worlds semantics is introduced, but on the other hand, whether this statement is true or not ultimately depends on the model, or, more precisely, on M and LS, which vary with $\mathcal{M}$. But this should not be the case, at least regarding LS. In possible world semantics, there is only one such set of all possible situations LS and semantic values are relativized on its elements, and not elements of arbitrary variants of it, as it happens to be the case in (97). The differences

One might be tempted to draw the conclusion that DRT-like languages are therefore incompatible with possible worlds semantics. But that is too hasty. There are different ways in which one may proceed here, and they already have been proposed.[72] For example, it is possible to make the interpretation function "$[\![\bullet]\!]$" dependent on a situation variable in the semantic metalanguage such that, e.g., predicates are mapped onto sets of individuals relative to a free varying parameter s_m. At the moment, it is already relativized to models $\mathcal{M}$ and assignment functions f; why not add another parameter and work with $[\![\bullet]\!]^{\mathcal{M},f,s_m}$ in the following? This move allows one to have DRT_0's definition of truth together with its relativization on situational parameters, without having to deal with situation variables in the object language. All that needs to be done is to use a clause for atomic formulæ like the following:

(98) If $\psi \in C$ is of the form $\beta\tau_1 \dots \tau_n$, then $[\![\beta]\!]^{\mathcal{M},f,s_m} = I(s_m)(\beta)$

With this being added to the interpretation rules,[73] one can strip away the changes made above, since there is no need to make situation variables part of the object language. With the old definition of a model and the old interpretation rules, one arrives at the following clause instead of (97a), which ultimately depends on the value of s_m.

(99) $\exists f : f^{\emptyset} \subseteq_{\{x_1,x_2\}} f \;\&\; [\![Gx_2]\!]^{\mathcal{M},f,s_m} \;\&\; \dots \;\&\; [\![Hx_1]\!]^{\mathcal{M},f,s_m}$

iff $\exists f : f^{\emptyset} \subseteq_{\{x_1,x_2\}} f \;\&\; \vdash f(x_2) \in I(s_m)(G) \dashv \;\&\; \dots \;\&\; \vdash f(x_1) \in I(s_m)(H) \dashv$

This represents the extension of the example above at whatever situation s_m stands for, and from this, by abstraction, the set of possible situations where the sentence is true, the sentence's intension, can be defined as:

(100) $\{s \in LS : \exists f : f^{\emptyset} \subseteq_{\{x_1,x_2\}} f \;\&\; \vdash f(x_1) \in I(s)(G) \dashv = 1 \;\&\; \dots\}$

Hence, extensional *constructions* can work with $[\![\bullet]\!]^{\mathcal{M},f,s_m}$, the semantic value of whatever is enclosed in these brackets, while intensional constructions instead may use $\{s : [\![\bullet]\!]^{\mathcal{M},f,s}\}$ or a characteristic function thereof, depending on the concrete account of intensions.

With this shift of perspective, the notion of truth used above is abandoned in favor of

between model-theoretic interpretations and a possible-worlds account are discussed in much more detail in T. E. Zimmermann (2011), where it is shown that a more adequate possible-worlds account is not even easily emulated in a model-theoretic framework. But note that this is not the only issue here, and in fact, not even the most urgent to solve. The problem lies in the definition of truth in connection with the way (free) variables are interpreted. Thus, given the difference between possible worlds semantics and model-theoretic interpretations sketched here, it might be less surprising that the whole setting doesn't work out, but the reason for this lies elsewhere.

[72] Cf. Heim (1982), and, among many others, *Layered Discourse Representation Theory* (LDRT), as it is developed in (Geurts and Maier, 2003; Geurts and Maier, 2013). This is not the first instance of the usage of situation-dependent interpretation functions, but it is quite fitting as it is concerned with the same problems as the present chapter. LDRT is discussed in detail below, cf. section 4.2.2.

[73] Together with some rule that guarantees that the same meta-variable for situations is used in all clauses. Otherwise, situation variables may not match across formulæ. This issue is discussed in more detail below in section 4.2.3.

a more or less standard definition of truth at a world. Of course, the treatment of free variables has to be kept on board. One may now simply use the following formulation:

(101) φ is true at a situation s_m iff $\exists f : [\![\varphi]\!]^{\mathcal{M},f,s_m} = 1$

But if this step is undertaken, the whole set of definitions alluding to the individual parts of the model $\mathcal{M}$ look a bit atavistic. If truth ultimately depends on situations, and if the interpretation (that is, extension) of predicates ultimately depends on situations, like it is claimed here, then the domain of the model as well as the model theoretic interpretation function loose their sense as well. So, a redefinition of the semantics of DRT_0 is in order. The resulting theory is called DRT_1:

(102) *Semantics of DRT*$_1$
Let LS be the set of possible situations, M_{s_m} the set of individuals existing in a situation s_m (an element of LS), and f an assignment function. $[\![\bullet]\!]^{f,s_m}$ then is a function from syntactically well-formed expressions into semantic values such that:

a. If τ is a variable of the form x_i, then $[\![\tau]\!]^{f,s_m} = f(x_i)$, for any i, with $f(x_i) \in M_{s_m}$;
b. If β is a predicate constant, then $[\![\beta]\!]^{f,s_m}$ is a subset of M_{s_m};
c. If $\psi \in \mathit{Con}$, then $[\![\psi]\!]^{f,s_m} = \vdash \langle [\![\tau_1]\!]^{f,s_m}, \ldots, [\![\tau_n]\!]^{f,s_m} \rangle \in [\![\beta]\!]^{f,s_m} \dashv$, if ψ is of the form $\beta\tau_1 \ldots \tau_n$, for any n;
d. If $\varphi \in \mathrm{DRS}_1$, then $[\![\varphi]\!]^{f,s_m} = 1$ iff φ is of the form $\langle U(\varphi), C(\varphi) \rangle$ and (i) $f^{\emptyset} \subseteq_{U(\varphi)} f$, and (ii) $\forall \psi \in C(\varphi) : [\![\psi]\!]^{f,s_m} = 1$
e. A DRS_1 φ is *true* at a situation s_m iff $\exists f : [\![\varphi]\!]^{f,s_m} = 1$
f. A DRS_1 φ *expresses the proposition* $[\![\varphi]\!] = \{s : \exists f : [\![\varphi]\!]^{f,s} = 1\}$

So, syntactically, nothing has changed with respect to DRT_0, while semantically, all values expressed are relativized to a hidden parameter s_m.[74] This means that, adopting the usage of the term from Cresswell (1990) and others, the situation variable s_m serves as an *index* for syntactically well formed formulæ. DRT_1 is able to express extensions and intensions of expressions directly albeit its existential definition of truth.

Going back to the naïve approach from above, one may ask why it seemed that DRT-like languages are incompatible with object-language world variables. The discussion of $\mathrm{PL}_{0'}$ and $\mathrm{DRT}_{0'}$ (the languages with syntactically represented world variables briefly sketched above) appeared to lead to this conclusion because the standard truth definitions of both approaches didn't work out as desired; $\mathrm{DRT}_{0'}$'s definition was too weak, while $\mathrm{PL}_{0'}$'s definition was too strong. With DRT_1's definition in mind, this might have been too hasty. At the present point, neither of these definitions is in charge. Instead, a two-layered semantic system (i.e., a semantics utilizing extensions and intensions) working with indexical (hidden) situation-parameters is read off from still the same syntax (that

[74] That is, hidden from the perspective of the object language. Note the similarities to IL, the language used in Montague (1970b), where a world-parameter is hidden in non-logical constants and the extension-forming operator $^{\vee}$.

is, the syntax of DRT_0). But if the breakdown of DRT_0's standard truth definition is the only argument not to have situation variables in boxes, abandoning its truth-definition is reason enough to reconsider the argument. That is, if the truth-definition needs to be modified anyway as soon as intensional constructions are taken into consideration, why not in such a way that world variables can be made a part of the object language?

The first step is to consider $\text{DRT}_{0'}$ once again, but in more detail. In the following, it is assumed that it has a single situation variable s_0 at its disposal. This confinement to only one situation variable temporarily avoids the problem that all conditions belonging to a discourse have to be dependent on the very same situation variable to yield the intuitively correct interpretation.[75] If this isn't guaranteed somehow, then there won't be a proposition in the end.

(103) *Syntax of $DRT_{0'}$*
Let s_0 be the the single object language variable for possible situations, and all other symbols as above.

a. *Conditions*
Con is the smallest set containing all ψ for which it holds that if β is a predicate constant and $\tau_1, \ldots, \tau_n$ are variables, and ψ is of the form $\beta s_0 \tau_1 \ldots \tau_n$, then $\psi \in Con$.

b. *DRSs*
φ is a $\text{DRS}_{0'}$ iff φ is of the form $\langle U(\varphi) \cup \{s_0\}, C(\varphi)\rangle$, with $U(\varphi)$ and $C(\varphi)$ being subsets *Var* and *Con*, respectively.

c. *Proper DRS*
φ is a proper $\text{DRS}_{0'}$ iff φ is a $\text{DRS}_{0'}$, and $\left(\bigcup_{\psi \in C(\varphi)} F(\psi)\right) = U(\varphi)$.

The semantics are adapted to deal with this slightly changed input as well. To avoid confusion, s_0 is reserved as the object language's variable for situations. To refer to actual elements of LS, s_0's possible values, s_i, s with a numerical index will be used. As can be seen, close relatives of the definitions in (102e) and (102f)—truth-at-a-world and the proposition expressed in $\text{DRT}_{0'}$—can be used to define the same notions:

(104) *Semantics of $DRT_{0'}$*
Let *LS*, M_{s_i}, and f as above. $[\![\bullet]\!]^f$ then is a function from syntactically well-formed expressions into semantic values such that (suppressing reference to the model):

a. If τ is a variable of the form x_i, then $[\![\tau]\!]^f = f(\tau)$;
b. If τ is the variable of the form s_0, then $[\![\tau]\!]^f = f(\tau) = s_i$;
c. If β is a predicate constant of arity n, then $[\![\beta]\!]^f \subseteq \{\langle s_i, \vec{x}\rangle : s_i \in LS \;\&\; \vec{x} \in$

[75] This is obviously not correct if intensional constructions like attitude reports are taken into consideration that can host "multi-modal" clauses. Surprisingly, it is possible to treat them using one variable only—provided one allows for higher-order abstraction (cf. T. E. Zimmermann, 1989; T. E. Zimmermann, 2018, and Köpping and T. E. Zimmermann (2018) and Köpping and T. E. Zimmermann (2020)). See section 4.1.4 for a sketch of an account in the present framework.

$(M_{s_i})^n)\}$, for any n and i;

d. If $\psi \in Con$, then $[\![\psi]\!]^f = \vdash \langle [\![s_0]\!]^f, [\![\tau_1]\!]^f, \ldots, [\![\tau_n]\!]^f \rangle \in [\![\beta]\!]^f \dashv$, if ψ is of the form $\beta s_0 \tau_1 \ldots \tau_n$, for any n;

e. If $\varphi \in \text{DRS}_{0'}$, then $[\![\varphi]\!]^f = 1$ iff φ is of the form $\langle U(\varphi), C(\varphi)\rangle$ and (i) $f^{\emptyset} \subseteq_{U(\varphi)} f$, and (ii) $\forall \psi \in C(\varphi) : [\![\psi]\!]^f = 1$

f. A $\text{DRS}_{0'}$ φ is *true* at an assignment f iff $[\![\varphi]\!]^f = 1$

g. A $\text{DRS}_{0'}$ φ *expresses the set of indices* $[\![\varphi]\!] = \{f : [\![\varphi]\!]^f = 1\}$

This adaptation may be best described by the slogan "unify dependencies". Instead of having to consider two parameters, namely situations and assignments (in addition to models $\mathcal{M}$), one of them is subsumed under the other (without having to allude to $\mathcal{M}$). Thus, (104f) and (104g) are related to $\text{DRT}_{0'}$'s definitions by using the assignments in the way situations are used there. That nothing is lost can be made clear by going through an example:

(105) a. A man owns a dog.

b.

$s_0\ x_1\ x_2$
$Ms_0x_1\ Ds_0x_2$ $Os_0x_2x_1$

This DRS is true at an assignment f iff the following holds:

(106) $f^{\emptyset} \subseteq_{\{s_0,x_1,x_2\}} f$ & $[\![Ms_0x_1]\!]^f$ & $[\![Ds_0x_2]\!]^f$ & $[\![Os_0x_2x_1]\!]^f$ iff
$D(f) = \{s_0, x_1, x_2\}$ & $\langle f(s_0), f(x_1)\rangle \in [\![M]\!]^f$ & $\langle f(s_0), f(x_2)\rangle \in [\![D]\!]^f$ &
$\langle f(s_0), f(x_1), f(x_2)\rangle \in [\![O]\!]^f$

Consider the following assignment, $f_1(s_0) = s_1$, $f_1(x_1) =$ Hidesaburō Ueno, $f_1(x_2) =$ Hachikō, and obvious values for the predicates. Then the following formula is obtained, which only then is true (at f_1) iff all of the following statements are:

(107) Hidesaburō Ueno is a man in s_1 & Hachikō is a dog in s_1 & Hidesaburō Ueno owns Hachikō in s_1

The respective intension is obtained by abstracting from f_1:

(108) $\{f : D(f) = \{s_0, x_1, x_2\}$ & $\langle f(s_0), f(x_1)\rangle \in [\![M]\!]^f$ & $\langle f(s_0), f(x_2)\rangle \in [\![D]\!]^f$ &
$\langle f(s_0), f(x_1), f(x_2)\rangle \in [\![O]\!]^f\}$

This set is partially unfolded below:

f	$f(s_0)$	$f(x_1)$	$f(x_2)$	...
f_1	s_1	Hidesaburō Ueno	Hachikō	...
f_2	s_2	Hidesaburō Ueno	Hachikō	...
f_3	s_3	Hidesaburō Ueno	Hachikō	...
...	...	...	...	...
f_n	s_m	Barack Obama	Bo	...
f_{n+1}	s_m	Franklin D. Roosevelt	Fala	...
f_{n+2}	s_m	Manuel Guzman	Capitan	...
...	...	...	...	...

As the first three rows indicate, the values for individual variables can be pretty stable so that the assignments vary the situation alone. But as the next three rows show, the value of the situation variable can also coincide for different assignments. These assignments then go through all possible values of x_1 and x_2 such that the value of the former is a man who owns a dog that is the value of the latter. Crucially, the situations that are collected in this way are exactly those found in the traditional proposition in (109a). But the set in (108) can even more accurately be considered as a representation of a set of indices like (109b), from which the proposition in (109a) can be obtained via projection.[76]

(109) a. $\{s : (\exists x)(\exists y)[x \text{ is a man in } s \ \& \ y \text{ is a dog in } s \ \& \ x \text{ owns } y \text{ in } s]\}$
b. $\{\langle s, x, y\rangle : x \text{ is a man in } s \ \& \ y \text{ is a dog in } s \ \& \ x \text{ owns } y \text{ in } s\}$

As can be seen, this definition (104f) neither demands that every single assignment has to make the sentence true nor that the existence of one truthful assignment is enough to make the sentence true. Instead, by using set formation over assignments, one obtains a ‘proposition like’ object, namely something very similar to a set of indices; as desired.

That this line apparently hasn’t been pursued yet, can be attributed to the orthodox conclusion drawn from sentence embedding involving bound pronouns. As mentioned above, the index usually isn’t conceived of as including individuals.[77] Thus, using sets of assignments as representations of propositions may be considered too far fetched. But given the more Lewisian conclusion defended in section 3.1.3, personal pronouns behave like index dependent expressions at least in some environments, and thus indices need to contain individuals; making the present approach much more plausible.

All of this carries over to FCS, as presented above. The syntax of this version is special in the respect that it accumulates all basic sentences of a discourse under a single syntactic node T, for Text; sometimes also called “cumulative molecular formula”. Basic sentences are just combinations of variables and predicate constants, viz. DRT’s conditions. Thus, the syntax of FCS’s T is similar to that of DRT’s principal box. And the semantics can

[76]It is of course possible to arrange the components in (109b) differently. Crucially, the set in (109b) isn’t just a mere base for projection (leading to (109a)), but it contains all possible ways to make the sentence (105) true, and can thus be claimed to deserve a theoretical status as privileged as that of propositions. The exact relation between sets of assignments (108) and sets of indices as (109b) is tackled in section 4.1.2.

[77]This is not to say that this thought is completely new. See, e.g. Spohn (2008).

be easily adapted, too. Since Heim (1982) works with sets of assignments from the get-go, the extension to propositional values is even more natural. Taking a different version of $\mathrm{PL}_{0'}$ as syntactic basis, that is, basic PL_0-formulæ and a syntax rule to describe T plus a single object-language world variable s_0 as in $\mathrm{DRT}_{0'}$, the contents of formulæ in FCS[78] ($\mathrm{FCS}_{0'}$ in the following) can be defined as abstractions from the values $\mathrm{DRT}_{0'}$ assigns to syntactically corresponding formulæ. This isn't exactly the way Heim defines them, since she works with sets instead of (characteristic) functions, and with infinite tuples of individuals instead of functions from variables into semantic values,[79] but other than these rather cosmetic differences, everything is the same.

(110) *Syntax of* $FCS_{0'}$
Let all symbols be as above.
a. *Basic Sentences* (atomic formulæ)
BS is the smallest set containing all ψ for which it holds that if β is a predicate constant and $\tau_1, \ldots, \tau_n$ are variables, and ψ is of the form $\beta s_0 \tau_1 \ldots \tau_n$, then $\psi \in BS$.
b. T
φ is a T iff φ is of the form $\psi_1 \wedge \cdots \wedge \psi_n$, with n being a natural number and every $\psi_i \in BS$.

(111) *Semantics of* $FCS_{0'}$
Let W, M_{s_i}, and f as above. $[\![\bullet]\!]_{\mathrm{FCS}}$ then is a function from syntactically well formed expressions into semantic values such that:
a. If τ is a variable of the form x_i, then $[\![\tau]\!]_{\mathrm{FCS}} = \lambda f.\ f(x_i)$;
b. If τ is the variable of the form s_0, then $[\![\tau]\!]_{\mathrm{FCS}} = \lambda f.\ f(s_0)$;
c. If β is a predicate constant of arity n, then $[\![\beta]\!]_{\mathrm{FCS}} = \lambda f.\ \{\langle s_i, \vec{x}\rangle : w_i \in W\ \&\ \vec{x} \in (M_{s_i})^n\}$, for any n and i;
d. If $\varphi \in BS$ is of the form $\beta s_0 \tau_1 \ldots \tau_n$, for any n, then $[\![\psi]\!]_{\mathrm{FCS}} = \lambda f.\ \vdash \langle [\![s_0]\!]^f_{\mathrm{FCS}}, [\![\tau_1]\!]^f_{\mathrm{FCS}}, \ldots, [\![\tau_n]\!]^f_{\mathrm{FCS}}\rangle \in [\![\beta]\!]^f_{\mathrm{FCS}} \dashv$;
e. If $\varphi \in T$ is of the form $\psi_1 \wedge \cdots \wedge \psi_n$, then $[\![\varphi]\!]_{\mathrm{FCS}} = \lambda f.\ [\![\psi_1]\!]^f_{\mathrm{FCS}} * \cdots * [\![\psi_n]\!]^f_{\mathrm{FCS}}$;
f. $\varphi \in T$ is *true* at an assignment f iff $[\![\varphi]\!]^f_{\mathrm{FCS}} = 1$
g. $\varphi \in T$ *expresses the set of indices* $[\![\varphi]\!] = \{f : [\![\varphi]\!]^f_{\mathrm{FCS}} = 1\}$

As can be seen, the last two lines in (111) are basically the same as in $\mathrm{DRT}_{0'}$. With this, $\mathrm{FCS}_{0'}$ assigns (112) the very same semantic value that is encoded by the DRS in (105b) (repeated below):

[78] The informed reader will notice that the following definitions represent only one out of two aspects of FCS, namely what is called the *satisfaction set* of formulæ. The other component, the *domain* set is introduced and discussed in 3.3.4 below.
[79] As mentioned in fn. 59, page 111.

(105b) $\begin{array}{|l|}\hline s_0\ x_1\ x_2 \\ \hline Ms_0x_1\ Dw_0x_2 \\ Os_0x_2x_1 \\ \hline \end{array}$

(112) $Ms_0x_1 \wedge Ds_0x_2 \wedge Os_0x_2x_1$

Thus, if these values can be read off from DRT- or FCS-like structures in a systematic way, a first step in the direction of possible-worlds semantics and a 2D-Semantics has been made. Of course, at the present stage, this only works because there are several features (apart from the simplicity of the languages under consideration) that facilitate the outcome.

1. There are no individual variables to account for that stem from expressions other than indefinite articles like, e.g., truly (or globally) free variables introduced by deictically used pronouns. The assignments therefore do not wrongly value variables they are not supposed to account for.

   On the same note, the variables associated with the two indefinite articles are chosen such that they are distinct. This is quite common in DRT-like translations, but not a given. In DRT, it is guaranteed by a translation rule that might be dubbed "fresh variable" rule; in FCS, it is the infamous Novelty Condition that deals with this issue. Both are discussed below.

2. $\mathrm{DRT}_{0'}$ and $\mathrm{FCS}_{0'}$ only have a single situation variable s_0; and therefore, it is not possible that the contributions of the predicates differ in their reference to a situation. To put it in DRT's terms, there is no choice for all occurrences of situation variables but to add up to a single occurrence in the universe. If there are more situation variables, which is necessary for double indexing, every predicate potentially could introduce its own one and the assignments would then have to cover all of them, thus making it difficult to understand sets of assignments as representations of classical propositions.

In other words, in order for $\mathrm{DRT}_{0'}$ and $\mathrm{FCS}_{0'}$ to work in the intended ways, one has to control how variables in general, and situation variables in particular, are introduced, and how far they project. The 'official' formulations of DRT in Kamp (1981) and Kamp and Reyle (1993) and FCS in Heim (1982) cover the rules for the introduction and projection of individual variables to a great extent; thus, in the following sections, these rules are first examined and then generalized to cover other variables. That the confinements in 1. and especially 2. have to be dropped if one wants to account for context dependency is evident from the first chapter. Thus, there needs to be a more direct way to treat situation variables in a DRT- or FCS-like language. To develop this, the introduction and projection of variables will be investigated in the sections to follow.

3.3 The projection behavior of variables

It was mentioned above that first and non-first uses of free variables in formal languages seem to behave exactly like indefinite articles and pronouns in natural languages, which is why the "indefinite articles / pronouns as variables" idea is so appealing. Thus, indefinite articles are translated as contributing fresh free variables, even though traditionally they are translated as (equivalent to) existentially quantified expressions—adequately, in terms of truth conditions, but without accounting for anaphoricity. Thus, the novelty in comparison to traditional treatments of indefinite articles can be understood as a recategorization of variables that are introduced by their translation: as free instead of bound variables. In order to capitalize on the behavior of free variables, their interpretation has to be changed from a standard model-theoretic one into a DRT-like interpretation (if one refrains from adopting a closure operator like Heim does in the second chapter of Heim (1982)). This gives their translation the existential interpretation needed to derive the correct truth conditions. In the following, yet another sequence of formal toy languages is discussed in order to develop a syntactic characterization of the conditions of anaphoric readings. And more environments are considered, especially negation. In addition to that, another account of anaphoricity is introduced for comparison, namely DPL, as developed in Groenendijk and Stokhof (1991). Where DRT and FCS are syntax-heavy in the sense that they ultimately rely on syntactic well-formedness conditions to filter out unwanted formulæ, DPL uses a less syntax-laden approach, which, however, comes with a price. Finally, another language is briefly discussed, namely EDPL, as developed in Dekker (1996), which is a mixture of both accounts in that it takes its starting point in DPL and FCS, but seeks to explain the absence of certain readings syntactically as well.

For starters, the well-known projection rules of free variables in predicate logic are reviewed. As will be seen, indefinite articles and anaphoric pronouns seems to behave exactly like those free variables in terms of their projection behavior, while, as mentioned above, they also seem to be interpreted as existentially quantified variables, viz. in FCS's and DRT's truth definition. Hence in the following, possible projection rules for bound variables will be considered as well. Ultimately, indefinite articles and (anaphorically used) pronouns turn out to contribute neither free nor bound variables in the traditional sense, but, as will be said below, free variables of a different kind. Since this thesis ultimately aims for a description of (globally) free pronouns as free variables, and (globally) free pronouns facilitate different readings than anaphoric pronouns, this turns out to be as desired.

3.3.1 The projection behavior of variables in PL

In PL, free variables *project* in the composition; that is, if a formula is composed, in almost all cases, the free variables from all parts of the formula are collected into one set, which is the set of free variables of the resulting formula. The exception of course is quantification; the only case where the set of free variables is reduced.[80] This behavior of (free) variables usually is defined as in the following (and above as well), where *Var* is the set of terms, which for the time being are just the variables; *Con* is the set of predicate constants of any arity; *Pred* is the set of atomic sentences, composed of predicates and terms; *Neg* is the set of negated sentences, composed of sentences and the negation sign "¬"; *Conj* is the set of conjoined sentences, composed of two (possibly identical) sentences and the conjunction sign "∧"; and *Quant* is the set of existentially quantified sentences, composed out of the existential quantifier prefix "∃", a variable, and a sentence (where the term needs to occur). The set of well-formed formulæ S, making up the entire language which, for easy reference is now called $\mathcal{L}_F$, is the smallest set containing just the outcome of the combination rules:

(113) *Syntax of and free variables in* $\mathcal{L}_F$

Cat.	Expression σ	Preconditions	Set of free variables $F(\sigma)$
Var	x_n	$n \in \mathbb{N}$	$\{x_n\}$
Con	P	—	$\emptyset$
Pred	$Px_i, \ldots, x_j$	$x_i, x_j, \ldots \in Var, P \in Con$	$F(P) \cup F(x_i) \cup \cdots \cup F(x_j)$
Neg	$\neg\varphi$	$\varphi \in S$	$F(\varphi)$
Conj	$\varphi \wedge \psi$	$\varphi, \psi \in S$	$F(\varphi) \cup F(\psi)$
Quant	$(\exists x_n)[\varphi]$	$x_n \in F(\varphi), \varphi \in S$	$F(\varphi) \backslash F(x_n)$

In this language, in contrast to all languages considered in the previous sections, there aren't just free variables, but there are occurrences of bound variables as well. This, of course, is due to the presence of ∃, which is not part of the languages PL_0, $\mathrm{PL}_{0'}$, etc. Bound variables are characterized differently in $\mathcal{L}_F$. They do not have a projection mechanism; in fact, as soon as a variable is bound, it is removed from the set of free variables accumulated so far.

The other new syntactic construction is negation, introduced here to allow for later comparisons with DRT, FCS, and DPL. In $\mathcal{L}_F$, negation does not affect the projection of free variables; that is, intuitively speaking, the free variables in Px_1 and $\neg Px_1$ are the same, namely x_1.

A projection mechanism for bound variables in $\mathcal{L}_F$ is easily imaginable, but ultimately pointless, for various reasons: firstly, the information that a bound variable occurs in a formula doesn't have the same significance as the information that a free variable occurs in a formula. Free variables have a potential impact on interpretation that bound variables lack, because the values of free variables (and thus the values of the whole expression containing them) are assignment-dependent, whereas the values of bound variables (albeit technically still assignment-dependent) don't matter for the evaluation of the expression they are contained in. What does matter is whether it is possible

[80] Or "possibly reduced" if nothing is done to exclude vacuous quantification. This is done here by making the composition of an existential quantifier with a formula dependent on there being a free variable that thereby gets bound. Viz. the precondition $x_n \in F(\psi)$ in the last row of the following tabular.

to assign bound variable values such that these values (together with the values of free variables) and the interpretation of predicate expressions yield a non-empty set of assignments. Whatever the outcome is, the (virtual) values of bound variables are of no importance afterwards. Secondly, bound variables in one clause may be reused in the composition of different clauses, and there, they may occur bound or free, but the interpretation of the later instances are not affected by the interpretation of the earlier ones. The reverse is also true: the interpretation of bound variable isn't affected by later occurrences of variables of the same name. That means, the name of a bound variable hardly matters; it could have been another one (hence the possibility to rename bound variables *salva denotate*, as long as confusions among the bound variables are avoided and occurrences of free variables stay free).

For these reasons, the equivalence in (114) holds in $\mathcal{L}_F$, while the equivalences in (115) do not in general:[81]

(114) $(\exists x_1)[Qx_1] \Leftrightarrow (\exists x_2)[Qx_2]$

(115) a. $(\exists x_1)[Px_1] \wedge (\exists x_1)[Qx_1] \Leftrightarrow (\exists x_1)[Px_1 \wedge Qx_1]$
b. $(\exists x_1)[Px_1] \wedge Qx_1 \Leftrightarrow (\exists x_1)[Px_1 \wedge Qx_1]$
c. $Px_1 \wedge (\exists x_1)[Qx_1] \Leftrightarrow (\exists x_1)[Px_1 \wedge Qx_1]$
d. $Px_1 \wedge (\exists x_1)[Qx_1] \Leftrightarrow Px_1 \wedge Qx_1$

(114) simply shows that the name of a bound variable doesn't matter for the interpretation; thus closed formulæ which are so-called "alphabetic variants" of one another express the same meaning. That (115a) is not valid reflects the fact that bound variables are not identified across formulæ like free variables are. That (115b) and (115c) are not valid is due to scope taking being strictly clause bound in $\mathcal{L}_F$. An existential quantifier neither takes scope to the right of its clause (115b), nor to the left (115c). Thus, even though the same variable name is chosen in the right conjunct of (115b), the valuation of x_1 in Qx_1 is independent of the valuation of the bound variable in the left conjunct. This allows for later requantification over the same variable without any confusions, as the falsity of (115a) also shows. The same is displayed in (115d), where a free occurrence of x_1 precedes the existential quantifier. But, again, (re-)quantification in the right conjunct is in no way influenced by the free occurrence of a variable in the left.

To sum up: projecting the bound variables beyond the clause they are contained in serves no purpose in $\mathcal{L}_F$, since their identity does not matter and differences between them do not affect the interpretation of free or bound occurrences of the same variables, nor is their interpretation affected by a (bound or free) occurrence of the very same variable in other clauses. So, endowing PL with a projection mechanism for bound

[81] As Ede Zimmermann pointed out to me, the non-validity of formulæ in (115) might be simply due to the choice of the sentential conjunction '$\wedge$'. For example, a variant of (115a) with '$\vee$' instead of '$\wedge$' is a classic validity. The other formulæ are usually not discussed in PL textbooks, since open formulæ are only considered as input for quantified formulæ. Hence, whether or not any of the other equivalences hold for '$\wedge$' or other sentential connectors is left open in classical discussions. Yet, still, the formulæ in (114) and (115) would be valid if the projection behavoir was as described in the text.

variables simply plays around with syntactically determined properties of expressions that do not play a rôle in semantic interpretation.

All of this does not mean that a language like $\mathcal{L}_F$ is incompatible with such a projection mechanism. Intuitively, the set of bound variables is empty in case the formula is a term (that is, element of *Var*), a constant (that is, element of *Con*), and when it is composed by predication (that is, an element of *Pred*, e.g. (116a)). In none of these formulæ can a variable be bound, since there is no space for a quantifier to occur. Still quite intuitively, the set of bound variables $B(\alpha)$ for the following formulæ α seem to have to be these:[82]

(116)		Expression α	$F(\alpha)$	$B(\alpha)$
	a.	Px_1	$\{x_1\}$	$\emptyset$
	b.	$(\exists x_1)[Px_1]$	$\emptyset$	$\{x_1\}$
	c.	$\neg(\exists x_1)[Px_1]$	$\emptyset$	$\{x_1\}$
	d.	$(\exists x_2)[Rx_1x_2]$	$\{x_1\}$	$\{x_2\}$
	e.	$(\exists x_1)(\exists x_2)[Rx_1x_2]$	$\emptyset$	$\{x_1, x_2\}$
	f.	$(\exists x_1)[Px_1 \wedge (\exists x_2)[Qx_2]]$	$\emptyset$	$\{x_1, x_2\}$
	g.	$Px_1 \wedge (\exists x_1)[Qx_1]$	$\{x_1\}$	$\{x_1\}$
	h.	$(\exists x_1)[Px_1] \wedge Px_1 \wedge (\exists x_2)[Qx_2]$	$\{x_1\}$	$\{x_1, x_2\}$

There are some tricky but still straightforward cases, e.g. (116g) and (116h), where one and the same variable has free and bound occurrences, but overall, the categorization seems to be easy and correct. As can be seen comparing (116a) and (116b), the existential quantifier doesn't just delete the variable it comes composed with from the set of free variables of the expression it is attached to, but it adds it to the set of bound variables as well. This will be called *recategorization.* Variables stay free as long as no quantifier recategorizes them, which only happens when $\exists$ together with a variable comes into play via the relevant syntax rule. Thus, all variables start as free variables, and remain free in all other syntactic combinations. $\mathcal{L}_{FB}$—to give it a name—therefore is not a language in which the status (or category) of a variable is lexically specified (in the sense that free and bound variables form distinct sets), but one in which the syntactic configuration decides whether (an occurrence of) a variable stays free or is recategorized—something which also seems to be the case for pronouns in natural language. Neither variables in $\mathcal{L}_{FB}$ nor natural language pronouns wear their use on their sleeves: whether they are used freely or bound is a matter of linguistic context.

[82] Excluding problematic configurations like (115a), where only one variable is used in two different quantification structures.

(117) *Projection in $\mathcal{L}_{FB}$*

Cat.	Expression σ	$F(\sigma)$	$B(\sigma)$
Var	$x_n \in Var$	$\{x_1\}$	$\emptyset$
Con	$P \in Con$	$\emptyset$	$\emptyset$
Pred	$\beta\tau_1 \ldots \tau_n \in Fml$	$F(\beta) \cup F(\tau_1) \cup \cdots \cup F(\tau_n)$	$B(\beta) \cup B(\tau_1) \cup \cdots \cup B(\tau_n)$
Neg	$\neg\varphi \in Fml$	$F(\varphi)$	$B(\varphi)$
Conj	$\varphi \wedge \psi \in Fml$	$F(\varphi) \cup F(\psi)$	$B(\varphi) \cup B(\psi)$
Quant	$(\exists x_i)[\varphi] \in Fml$	$F(\varphi)\backslash\{x_i\}$	$B(\varphi) \cup \{x_i\}$

$\mathcal{L}_{FB}$ can be interpreted by standard rules which do not make use of the set of bound variables at all. In order to do so, one has to extend the above semantics of PL_0 by clauses coping with negation and existential quantification. The former is pretty easily stated. The latter is a bit more involved because $\mathcal{L}_{FB}$ is interpreted using partial assignments in the sense of (88) in section 3.2.2. That is, assignments used to interpret formulæ may or may not cover certain variables. But if they already cover a bound variable x_i, because other parts of a formula contain free occurrences of x_i, previously assigned values have to be thrown away (otherwise $\exists$ would loose its quantificational force). If they do not cover x_i, then they have to be extended by the new variable and an arbitrary value for it. Thus, an existentially quantified sentence is true iff there exists an x_i-variant of the assignment used to value free variables, whereby an assignment g is an x_i-variant of an assignment f—$f \sim_{x_i} g$—, iff $g = (f\backslash\{\langle x_i, f(x_i)\rangle\}) \cup \{\langle x_i, u\rangle\}$, for some individual $u \neq \#_e$.

(118) *Verification and Truth in $\mathcal{L}_F$*

Let $\mathcal{M}$ be a model as above. $\|\bullet\|^{\mathcal{M},f}$ then is a function from syntactically well formed expressions into semantic values such that:

a. $\|\tau\|^{\mathcal{M},f} = f(i)$, if $\tau \in Var$ is a variable of the form x_i, for any i;
b. $\|\beta\|^{\mathcal{M},f} = I(\beta)$, if $\beta \in Con$;
c. $\|\beta\tau_1 \ldots \tau_n\|^{\mathcal{M},f} = \vdash \langle\|\tau_1\|^{\mathcal{M},f}, \ldots, \|\tau_n\|^{\mathcal{M},f}\rangle \in \|\beta\|^{\mathcal{M},f} \dashv$, if $\beta \in Con$, and $\tau_1, \ldots, \tau_n \in Var$;
d. $\|\neg\psi\|^{\mathcal{M},f} = \vdash \neg\|\psi\|^{\mathcal{M},f} \dashv$, if $\psi \in Fml$;
e. $\|\psi \wedge \chi\|^{\mathcal{M},f} = \vdash \|\psi\|^{\mathcal{M},f}$ & $\|\chi\|^{\mathcal{M},f} \dashv$, if $\psi, \chi \in Fml$.
f. $\|(\exists x_i)[\psi]\|^{\mathcal{M},f} = \vdash \exists g : f \sim_i g$ & $\|\psi\|^{\mathcal{M},g} \dashv$, if $x_i \in Var$, and $\psi \in Fml$.
g. An assignment $g \in Ass^G$ verifies a formula $\varphi \in Fml$ iff $G = F(\varphi)$ and $\|\varphi\|^{\mathcal{M},g} = 1$
h. A formula $\varphi \in Fml$ is true in a model $\mathcal{M}$ iff $\forall g \in Ass^G : G = F(\varphi) \rightarrow \|\varphi\|^{\mathcal{M},g} = 1$

Note that $\mathcal{L}_{FB}$ is capable of dealing with free variables. They are interpreted classically, as universally quantified, viz. (118h). This will become important later on.

3.3.2 The projection behavior of variables in DPL

Returning to the equivalences in (114) and (115), repeated below, one of them, namely (115b) is of some importance in Dynamic Predicate Logic (DPL, Groenendijk and Stokhof, 1991).

(114) $(\exists x_1)[Qx_1] \Leftrightarrow (\exists x_2)[Qx_2]$

(115) a. $(\exists x_1)[Px_1] \wedge (\exists x_1)[Qx_1] \Leftrightarrow (\exists x_1)[Px_1 \wedge Qx_1]$
b. $(\exists x_1)[Px_1] \wedge Qx_1 \Leftrightarrow (\exists x_1)[Px_1 \wedge Qx_1]$
c. $Px_1 \wedge (\exists x_1)[Qx_1] \Leftrightarrow (\exists x_1)[Px_1 \wedge Qx_1]$
d. $Px_1 \wedge (\exists x_1)[Qx_1] \Leftrightarrow Px_1 \wedge Qx_1$

DPL is designed to solve the issue discussed with respect to (72a) in section 3.2.1 in a different way than all accounts reviewed so far. It assumes a direct translation of natural language sentences like (119) into a PL-like formal language but redefines the rôle of the existential quantifier.

(119) A man walked. He smiled.

The first sentence starting with the indefinite description "a man" is translated classically, by (120a), while the second sentence by something like (120b), where the free variable x_1 translates the pronoun "he".[83] The meaning of the little discourse in (119) is given in (120c). Of course, the main question DPL sets itself to solve is how this meaning is derived from the conjunction of the meanings of the two sentences (cf. (120d)) in a compositional fashion.

(120) a. $(\exists x_1)[Mx_1 \wedge Wx_1]$
b. Sx_1
c. $(\exists x_1)[Mx_1 \wedge Wx_1 \wedge Sx_1]$
d. $(\exists x_1)[Mx_1 \wedge Wx_1] \wedge Sx_1$

Insisting on this translation of the little discourse, while acknowledging that the interpretation assigned by DRT_0 and FCS is correct, one has to assume that natural language works differently with respect to (115b) than PL; meaning that the interpretation given above is not sufficient. The formulæ in (120) cannot be interpreted by the rules of $\mathcal{L}_{FB}$, since there, (120d) means something different than (120c), because the last occurrence of x_1 is not interpreted as being in the scope of $\exists x_1$. Exactly this is different in DPL.

Groenendijk and Stokhof achieve this by altering the interpretation of otherwise normal (that is, syntactically well-formed) PL formulæ in such a way that (115b) turns out to be a true equivalence. The assessment of the other equivalences in (115) is not affected, with the exception of (114), which cannot be preserved in DPL. This has to do with the fact that in a system like DPL, bound variables become meaningful in way they are not in PL.

[83] The syntactic difference to DRT_0's translation procedure in section 3.2.2 lies solely in the appearance of $\exists x_1$. What will be said below is that $\exists$ just marks the "first use" of a variable syntactically. This usage of the existential quantifier-symbol is adapted in 3.3.3.

First of all, the meanings of formulæ can no longer be functions from assignments to truth values—the kind of meaning one gets if one abstracts from the assignment functions in (118), which where used in $\text{FCS}_{0'}$—, but relations between assignments.[84] This does not do the trick yet, since this shift in arity alone can be undertaken for the interpretation of PL-formulæ as well, without changing anything substantial. But the way in which DPL makes use of these relations changes a lot, especially the status of the crucial equivalence (115b). The first argument stands in for a starting or input assignment, while the second argument marks output assignments, which may or may not be the same as the input, depending on the expressions evaluated against these assignments. As can be seen in (121), the first two interpretation rules assign subsets of the identity relation as meanings to expressions, that is, roughly, the set of all those pairs of assignments $\langle g, g\rangle$ such that g makes the expression true. These formulæ are called *tests*. They do not extend the input assignment, but just check whether it makes the enclosed statements true. This is not the case for the other two rules. There, pairs of assignments such that the second is an x_i-variant of the first and makes the sentences true, are collected.[85]

(121) *DPL Semantics*

$$
\begin{array}{lll}
\text{a.} & [\![Rx_1 \dots x_n]\!]^{\mathcal{M}}_{DPL} & = \lambda g.\lambda h. \vdash g = h \;\&\; \langle g(x_1), \dots, g(x_n)\rangle \in I(R) \dashv; \\
\text{b.} & [\![\neg\phi]\!]^{\mathcal{M}}_{DPL} & = \lambda g.\lambda h. \vdash g = h \;\&\; \neg\exists k : [\![\phi]\!]^{\mathcal{M},g,k}_{DPL} \dashv; \\
\text{c.} & [\![(\exists x_i)[\phi]]\!]^{\mathcal{M}}_{DPL} & = \lambda g.\lambda h. \vdash \exists k : g \sim_{x_i} k \;\&\; [\![\phi]\!]^{\mathcal{M},k,h}_{DPL}\} \neq \emptyset \dashv; \\
\text{d.} & [\![\phi \wedge \psi]\!]^{\mathcal{M}}_{DPL} & = \lambda g.\lambda h. \vdash \exists k : [\![\phi]\!]^{\mathcal{M},g,k}_{DPL} \;\&\; [\![\psi]\!]^{\mathcal{M},k,h}_{DPL} \dashv .
\end{array}
$$

Like $\mathcal{L}_{FB}$, DPL is a language that does not make use of a projection mechanism for bound variables. It can afford this even though they are meaningful outside their clauses, because existential quantification *resets* a given value when there is one. The information of which value to reset comes from the accompanying variable, not from the set of bound variables, so DPL is not forced to look into it. Its version of conjunction transfers possible recategorizations due to occurrences of existential quantifiers over to further conjuncts. Thus, there is a difference to the projection mechanism for variables in $\mathcal{L}_{FB}$. Bound variables of the left conjunct are substracted from the free variables of the right conjunct. This rightly empties the set of free variables of Qx_1, once it is conjoined to $\exists x_1 Px_1$.

To see how this works, a sample calculation of a shorter sentence is undertaken (for readability, the references to the language and the model are mostly omitted):

(122) $[\![(\exists x_1)[Px_1] \wedge Qx_1]\!]_{DPL}$

$= \quad \lambda g.\lambda h. \vdash \exists k : [\![(\exists x_1)[Px_1]]\!]^{g,k} \;\&\; [\![Qx_1]\!]^{k,h} \dashv$ by (121d)

$= \quad \lambda g.\lambda h. \vdash \exists k : [\![(\exists x_1)[Px_1]]\!]^{g,k} \;\&\; k = h \;\&\; k(x_1) \in I(Q) \dashv$ by (121a)

[84] Presented below in their Schönfinklized form.

[85] In its original formulation in Groenendijk and Stokhof (1991), DPL is defined for total assignments in a setting without the dummy-individual $\#_e$, but here, it works with total assignments that assign $\#_e$ to all but a finite set of variables. This difference is ignored until section 3.4.1.

$$\begin{array}{lll} = & \lambda g.\lambda h.\ \vdash [\![(\exists x_1)[Px_1]]\!]^{g,h} \ \&\ h(x_1) \in I(Q) \dashv & \\ = & \lambda g.\lambda h.\ \vdash \exists k:\ g \sim_{x_1} k \ \&\ [\![Px_1]\!]^{k,h} \ \&\ h(x_1) \in I(Q) \dashv & \text{by (121c)} \\ = & \lambda g.\lambda h.\ \vdash \exists k:\ g \sim_{x_1} k \ \&\ k = h \ \&\ k(x_1) \in I(P) \ \&\ h(x_1) \in I(Q) \dashv & \text{by (121a)} \\ = & \lambda g.\lambda h.\ \vdash g \sim_{x_1} h \ \&\ h(x_1) \in I(P) \ \&\ h(x_1) \in I(Q) \dashv & \\ = & [\![(\exists x_1)[Px_1 \wedge Qx_1]]\!]_{DPL} & \end{array}$$

As can be seen, in DPL, the scope of the (existential) quantifier is extended beyond its clause to the right; thus it is possible to bind occurrences of variables outside of its scope. This means that the projection behavior of variables in DPL is different from PL in this respect (cf. the underlined part in the following table). What is also different is the projection of bound variables below negation, which is left unspecified here but will be discussed in connection with DRT:

(123) *Projection in DPL* (preliminary and incomplete)

Cat.	Expression σ	$F(\sigma)$	$B(\sigma)$
Var	$x_n \in Var$	$\{x_1\}$	$\emptyset$
Con	$P \in Con$	$\emptyset$	$\emptyset$
Pred	$\beta\tau_1 \dots \tau_n \in Fml$	$F(\beta) \cup F(\tau_1) \cup \dots \cup F(\tau_n)$	$B(\beta) \cup B(\tau_1) \cup \dots \cup B(\tau_n)$
Conj	$\varphi \wedge \psi \in Fml$	$F(\varphi) \cup \underline{(F(\psi) \backslash B(\varphi))}$	$B(\varphi) \cup B(\psi)$
Quant	$(\exists x_i)[\varphi] \in Fml$	$F(\varphi) \backslash \{x_i\}$	$B(\varphi) \cup \{x_i\}$

The truth value of an expression relative to an input assignment g depends on the existence of an output.

(124) φ is true with respect to g in $\mathcal{M}$ iff $\exists h : [\![\varphi]\!]^{\mathcal{M},g,h}_{DPL} = 1$

Alternatively, truth can be defined as the non-emptiness of the *satisfaction set*, i.e. the set of input assignments that have an output.[86] Conversely, the so-called *production set* is the set of assignments which are an output of an assignment.

(125) a. Satisfaction set: $\backslash\varphi\backslash_{\mathcal{M}} = \{g :\ [\![\varphi]\!]^{\mathcal{M},g,h}_{DPL} = 1, \text{ for some } h\}$
b. Production set: $/\varphi/_{\mathcal{M}} = \{h :\ [\![\varphi]\!]^{\mathcal{M},g,h}_{DPL} = 1, \text{ for some } g\}$

This scope-extending mechanism is responsible for (114) not being true in DPL. Existentially quantified (contingent) formulæ φ that are alphabetic variants of each other still have the same satisfaction set (126a), but differ in their production set (126b), and therefore cannot be equivalent.

(126) a. For all $n, m : \backslash(\exists x_n)[\varphi]\backslash_{\mathcal{M}} = \backslash(\exists x_m)[\varphi[{}^{x_n}/{}_{x_m}]]\backslash_{\mathcal{M}}$
b. For all $n, m : n \neq m \rightarrow /(\exists x_n)[\varphi]/_{\mathcal{M}} \neq /(\exists x_m)[\varphi[{}^{x_n}/{}_{x_m}]]/_{\mathcal{M}}$

[86] Not to be confused with the satisfaction set in FCS, which is a set of assignments that make a statement true. Confusingly, the satisfaction set of a formula / file in FCS is nothing but a set of output-assignments relative to a preestablished set of input-assignments from the viewpoint of DPL. It therefore is a subset of the statement's production set in the sense of Groenendijk and Stokhof.

The production set shows in which way bound variables are more meaningful in DPL than in PL. If x_1 is used with an existential quantifier, free occurrence of x_1 in clauses to follow will be interpreted as bound by this quantifier (as long as there is no 'intervening' existential quantifier accompanied by the same variable: see below). If x_2 is used instead, then every free instance of x_2 will be interpreted in this way, while the interpretation of x_1 is unconstrained, and so on. Thus, for the status of any x_i in a formula to the right of a formula with an existential quantifier, it is important which numerical index is carried by the quantifier's variable. In this sense, the identity of the quantified variable matters.

Thus, this minimal pair does not express the same relation,[87] since the quantifiers have different effects on possible sentences containing free variables to follow.

(127) a. $[\![(\exists x_1)[Px_1]]\!]^{\mathcal{M}}_{DPL} = \lambda g.\lambda h. \vdash g \sim_{x_1} h \;\&\; h(x_1) \in I(P) \dashv$ $\neq$
b. $[\![(\exists x_2)[Px_2]]\!]^{\mathcal{M}}_{DPL} = \lambda g.\lambda h. \vdash g \sim_{x_2} h \;\&\; h(x_2) \in I(P) \dashv$

The falsity of the equivalences in (115) (except (115b), of course) is preserved in DPL. But this comes with a price; namely with an unexpected blocking effect that is a pure artifact of the theory. In (128a), it is not (necessarily) the case that the first occurrence of x_1 (in Px_1) and the last occurrence of x_1 (in Rx_1) in the left formula denote the same individual, which is how PL would have it. Rather, the formula is interpreted like the left formula in (128b), with the existential quantifier taking scope over the right conjunct. The same point can be made with respect to quantified formulæ in DPL, which are listed on the right.

(128) a. $Px_1 \wedge (\exists x_1)[Qx_1] \wedge Rx_1$ $(\exists x_1)[Px_1] \wedge (\exists x_1)[Qx_1] \wedge Rx_1$
b. $Px_1 \wedge (\exists x_1)[Qx_1 \wedge Rx_1]$ $(\exists x_1)[Px_1] \wedge (\exists x_1)[Qx_1 \wedge Rx_1]$

Thus, $(\exists x_1)[Qx_1]$ intervenes and thereby cuts through the relation between the free variables on its left and on its right (or bound variables on its left and free variables on its right). That this is completely artificial and solely depends on the (unfortunate) choice of the bound variable can be seen from the fact that in the following formulæ, the blocking effect is absent and the last occurrence of x_1 happily refers to whatever the first occurrence of this variable refers to:

(129) $Px_1 \wedge (\exists x_2)[Qx_2] \wedge Rx_1$ $(\exists x_1)[Px_1] \wedge (\exists x_2)[Qx_2] \wedge Rx_1$

Whenever a natural language sentence needs to be translated into a structure like one of the formulæ in (129), it may accidentally happen that its translation ends up being (128), if the translation mechanism is not instructed to avoid this, and thus, a blocking effect not observed in the original example occurs.[88]

[87] Under the assumption that, in a model $\mathcal{M}$, there are two distinct individuals a and b, and one of them does not bear P, while the other does—$a \notin I(P), b \in I(P)$—the following two assignments show the difference:

(i) a. $k_1 = \{\langle x_1, a\rangle, \langle x_2, a\rangle, \dots\}$, $k_2 = \{\langle x_1, b\rangle, \langle x_2, a\rangle, \dots\}$.
b. $(127a)(k_1)(k_2) = 1$; $(127b)(k_1)(k_2) = 0$.

[88] Visser argues in Visser (1998) that this result is not as unwelcome as it seems if one understands DPL

No survey of DPL would be complete without negation. It comes with the additional "dynamic" ingredient that it blocks the projection of bound variables. Neither of the following sentences is well-formed, due to the invocation of negation, either in form of sentential negation in (130a), or as part of the negative quantifier in (130b):

(130) a. #It is not the case that a man walks in the park. He whistles.
b. #No man walks in the park. He whistles.

The conclusion drawn from examples like these is that apart from negating its complement, negation also "clears" the set of existentially quantified variables that may recategorize free variables in conjuncts to their right.

There are two ways to represent this in projection rules. One is to simply claim that the set of bound variables has to be empty after combination with negation. This is the gist of the following projection rule:

(131)

Cat.	Expression σ	$F(\sigma)$	$B(\sigma)$
Neg	$\neg\varphi \in Fml$	$F(\varphi)$	$\emptyset$

This gets the job done insofar as this ensures that no variable is removed from the set of free variables of a conjunct if it is combined with a negated formula. But, on the other hand, this projection rule falsely describes formulæ like $\neg\exists x_1 Px_1$ in that it claims that there are no occurrences of bound variables.

For reasons like this, the sets of free and bound variables are not the only sets of variables put to use in DPL. Instead, Groenendijk and Stokhof (1991) distinguish three sets:[89]

- $F(\varphi)$, the set of *free occurrences of variables* in φ.
- $A(\varphi)$, the set of *active quantifiers occurrences* in φ.

as a model of *understanding*, that is, processing, instead of a model of what is understood, that is, semantics. He argues that this shift in perspective can shed some light on how natural language deals with its restricted means of expressing variables to gain the expressive power it has:

> Natural language simply does not employ variables-qua-syntactic-objects to realize the linking of the referents associated to anaphors. [...] [Instead] re-using the same 'variable,' like *subject* is quite plausible. Now, there must be something in the semantics to stop the unification of all subjects. (Visser, 1998, p. 27)

There won't be an argument to challenge Visser's perspective in the following. This aspect of variable management is left out of consideration.

Muskens (1996) argues that there are cases in which a quantified variable necessarily has to be requantified. His argument stems from his *Compositional DRT*, where whole boxes are possibly rearranged in the course of a derivation, thus serving as arguments for λ-terms (among other things). If a box containing an indefinite happens to be the argument of a λ-term which contains multiple occurrences of the variable it abstracts from, such a box is inserted into the formula multiple times in the course of functional application. This then results in multiple quantifications over the same variable. Muskens argues that λ-terms like these are unavoidable.

[89] What they in fact do is defining sets of *occurrences* of variables which are bound, free, or active in a formula. This means that they use a more fine-grained definition, which, among other things, captures the blocking effect discussed above. Going into these notions is not necessary for the purposes at hand.

- $B(\varphi)$, the set of *binding pairs* in φ.

These sets are defined by induction over syntactic complexity. The underlying syntax is that of standard DPL (or PL, for that matter). The objects used to model these notions are a bit more complex than variables, but this simplification can be done without any loss of substance.

(132) *Projection in DPL*

Cat.	Expression σ	$F(\sigma)$	$A(\sigma)$	$B(\sigma)$
Var	$x_n \in Var$	$\{x_1\}$	$\emptyset$	$\emptyset$
Con	$P \in Con$	$\emptyset$	$\emptyset$	$\emptyset$
Pred	$\beta\tau_1 \ldots \tau_n \in Fml$	$F(\beta) \cup F(\tau_1) \cup \cdots \cup F(\tau_n)$	$A(\beta) \cup A(\tau_1) \cup \cdots \cup A(\tau_n)$	$B(\beta) \cup B(\tau_1) \cup \cdots \cup B(\tau_n)$
Neg	$\neg\varphi \in Fml$	$F(\varphi)$	$\emptyset$	$B(\varphi)$
Conj	$\varphi \wedge \psi \in Fml$	$F(\varphi) \cup (F(\psi) \backslash A(\varphi))$	$A(\varphi) \cup A(\psi)$	$B(\varphi) \cup B(\psi) \cup (A(\varphi) \cap F(\psi))$
Quant	$(\exists x_i)[\varphi] \in Fml$	$F(\varphi) \backslash \{x_i\}$	$A(\varphi) \cup \{x_i\}$	$B(\varphi) \cup (F(\varphi) \cap \{x_i\})$

As can be made clear by looking through some examples, not only does F characterize the set of free variables in a formula intuitively correctly, B likewise correctly characterizes bound variables of a formula. Thus, these two sets contain exactly what one expects them to contain: the only difference to a possible standard-PL characterization lies in the status of the last occurrence of x_1 in $(\exists x_1)[Px_1] \wedge Qx_1$ (and similar examples); as discussed above. A, on the other hand, represents the dynamic behavior of existential quantifiers. It intuitively characterizes those quantifiers that are able to bind occurrences of "their" variables in conjuncts to their right; *active* quantifiers in DPL's terms. Negation, emptying this set regardless to which expression it is applied, therefore *deactivates* quantifiers, disabling them to bind into conjuncts to their right.

These sets can therefore be used to describe the conditions under which a variable gets bound syntactically:

- Firstly, either if a variable belongs to the set of free variables of a formula φ which gets combined with the existential quantifier accompanied by that variable. In this case, as in classical binding, the quantifier simply binds all occurrences of that variable in its scope.

- Secondly, if a formula ψ with a variable x_n among its free variables serves as the right conjunct in a conjunction whose left conjunct contains an active quantifier accompanied by that variable. In this case, the quantifier binds the variables "dynamically" outside its scope.

Furthermore, these sets can also be used to say precisely under which circumstances certain classical equivalences still hold—e.g., under which conditions conjunction is commutative. If φ and ψ are *tests*, that is, if they don't actively quantify, $\varphi \wedge \psi$ is equivalent to $\psi \wedge \varphi$ in DPL. Both formulæ have the same output on a given input. But even if they are not tests, this equivalence sometimes holds, namely under the condition that the active quantifiers of both formulæ are distinct, and the active quantifiers of one of them and the free variables of the respective other formula are distinct, and vice versa (cf. Groenendijk and Stokhof, 1991, p. 64):

(133) $A(\varphi) \cap A(\psi) = A(\varphi) \cap F(\psi) = A(\psi) \cap F(\varphi) = \emptyset \Rightarrow \varphi \wedge \psi \equiv \psi \wedge \varphi$

This is what Groenendijk and Stokhof want to accomplish with (132), and, needless to say, it works.

Other than that, DPL, like PL, does not make use of this syntactic device which more or less comes for free, and could prove useful. That PL does not use this device, in comparison, is understandable, given its lack of a meaningful notion of active quantifier and the resulting uselessness of distinctions between bound variables, as discussed above. But concerning DPL, it seems as if the mechanism could play a greater rôle in the formalism, precisely because the identities of bound (and active) variables are meaningful. Before this is done—in accordance with, among others, Dekker (1996)—, we will take a little detour via DRT, again. In the following it is shown that, once another slight variation of the above syntax is introduced, DRT can be presented in the same format.

3.3.3 The projection of Discourse Referents in DRT

Above, DRT has not been discussed with regard to its special syntax, but with the focus on its definition of truth. This is only one part of this system, the other being *accessibility*, defined structurally. Accessibility regulates whether a pronoun can receive an anaphoric interpretation or not. Indefinite articles and pronouns (among other expressions) are translated as variables in the construction algorithm that maps natural language syntax onto DRSs.[90] The variables that are introduced when a pronoun is translated have to be identified with accessible variables already in play, that is, already introduced by the translation of possible antecedents, e.g. indefinite articles. Not every variable already introduced is accessible: thus, there are configurations in which a pronoun cannot receive a bound interpretation.

In DRT the projection of variables (known as "discourse referents") is handled syntactically as well. Every DRS φ is a pair of a set of discourse referents—the "universe" $U(\varphi)$—and a set of conditions—$C(\varphi)$. Crucial to the projection mechanism is the use of full DRSs inside larger boxes. Every translation of a discourse starts with a principal box, the main DRS, into which everything that is to be translated from the syntactic structure of an expression used in this discourse is inserted. Some lexical elements, especially indefinites, contribute not only to the conditions, but to the universe; others trigger the insertion of subDRSs, that is, boxes within the principal DRS, e.g. negation

[90] This is different in FCS where the identity of variables is determined by natural language syntax. Thus, for FCS the choice between different variables corresponds to different LFs and thus is an instance of disambiguation. For DRT, the choice between different discourse referents is part of the resolution process, but the syntactical input is the same in all cases.

(134a), conditionals (134b), and generalized quantifiers (134c). Discourse referents introduced within such environments do not project to the main box, but are caught in the universe of the box they originate in.[91] For example, an indefinite under negation does not contribute its discourse referent to the main universe $U(\varphi)$, but only to the embedded universe $U(\psi)$ in (134a). The same holds for indefinites originating in the antecedence or consequence of conditionals, or inside of predicates quantified over. Their discourse referents are only accessible for material within the same box. Thus, pronouns outside of these boxes cannot be identified with discourse referents caught within them; the latter are inaccessible for the former.

(134) a. $\begin{array}{|c|}\hline U(\varphi)\\ \hline \vdots \\ \neg\ \begin{array}{|c|}\hline U(\psi)\\ \hline C(\psi)\\ \hline\end{array} \\ \vdots \\ \hline\end{array}$ b. $\begin{array}{|c|}\hline U(\varphi)\\ \hline \vdots \\ \begin{array}{|c|}\hline U(\psi)\\ \hline C(\psi)\\ \hline\end{array} \Rightarrow \begin{array}{|c|}\hline U(\chi)\\ \hline C(\chi)\\ \hline\end{array} \\ \vdots \\ \hline\end{array}$ c. $\begin{array}{|c|}\hline U(\varphi)\\ \hline \vdots \\ \begin{array}{|c|}\hline U(\psi)\\ \hline C(\psi)\\ \hline\end{array} \left\langle \begin{smallmatrix} Q \\ \tau \end{smallmatrix} \right\rangle \begin{array}{|c|}\hline U(\chi)\\ \hline C(\chi)\\ \hline\end{array} \\ \vdots \\ \hline\end{array}$

Once the translation is done, the evaluation of the resulting structure starts. And there, boxes within boxes at first glance seem to receive a special interpretation. For simplicity,[92] leaving DRT's account of conditionals (134b) and quantification in terms of duplex conditions (134c) aside, boxes which are introduced by negation are interpreted like other conditions as well in that they have to be verified by assignment functions. Hence, the following clause needs to be understood as belonging to the verification of conditions in a semantics like that of DRT_0, discussed above (viz. (91), on page 116). Their interpretation differs from that of other conditions in that it quantifies over extensions of a given assignment instead of checking whether this given assignment makes the condition true:

(135) An assignment f verifies a condition ψ of the form $\neg\chi$, χ being a DRS, iff there is no assignment g which extends f by $U(\chi)$ that verifies every condition in $C(\chi)$; $f \vDash_{\mathcal{M}} \neg\chi$ iff $\neg\exists g : f \subseteq_{U(\chi)} g \ \&\ \forall\xi \in C(\chi) : g \vDash_{\mathcal{M}} \xi$.

This is in line with DRT's interpretation of principal DRSs, because discourse referents in the embedded universe also receive an existential interpretation, only distorted by the embedding negation. The latter is due to the new rule introduced above, and the former is due to DRT's definition of truth, discussed above and repeated here for convenience.

(91e) *Truth in DRT*
Let φ be a proper DRS of the form $\langle U(\varphi), C(\varphi)\rangle$ and $\mathcal{M}$ a model. φ is true in $\mathcal{M}$ iff $\exists f : D(f) = U(\varphi)\ \&\ f \vDash_{\mathcal{M}} \varphi$.

[91] With the exception of discourse referents stemming from the translation of proper names.
[92] And because this discussion does not aim at DRT as defined in Kamp and Reyle (1993), but at a DPL-like reconstruction, cf., among others, Groenendijk and Stokhof (1991), Muskens (1996).

(136) a. $\begin{array}{|c|}\hline U(\varphi) \\ \hline C_1(\varphi) \\ \vdots \\ C_n(\varphi) \\ \hline \end{array}$ b. $\begin{array}{|c|}\hline \\ \hline \vdots \\ \neg\ \begin{array}{|c|}\hline U(\psi) \\ \hline C_1(\psi) \\ \vdots \\ C_n(\psi) \\ \hline \end{array} \\ \hline \end{array}$

a. $\exists f : D(f) = U(\varphi)\ \&$
$f \vDash_{\mathcal{M}} C_1(\varphi) \wedge \cdots \wedge f \vDash_{\mathcal{M}} C_n(\varphi)$

b. $\neg\exists g : f \subseteq_{U(\psi)} g\ \&$
$g \vDash_{\mathcal{M}} C_1(\psi) \wedge \cdots \wedge g \vDash_{\mathcal{M}} C_n(\psi)$

That the formula representing the meaning of the negated box contains a free occurrence of a variable for assignments f is due to its being categorized as a condition, that is, as part of a principal DRS. Negated boxes cannot stand on their own, but are always part of a principal DRS. For example, a simplified DRT translation of *it is not the case that a man sleeps* is not (137a), but something like (137b), and one translation of *A woman sleeps and it is not the case that a man harms her* is (137c):[93]

(137) a. $\neg\ \begin{array}{|c|}\hline x_1 \\ \hline Mx_1 \\ Sx_1 \\ \hline \end{array}$ b. $\begin{array}{|c|}\hline \\ \hline \neg\ \begin{array}{|c|}\hline x_1 \\ \hline Mx_1 \\ Sx_1 \\ \hline \end{array} \\ \hline \end{array}$ c. $\begin{array}{|l|}\hline x_2 \\ \hline Wx_2 \qquad\qquad Sx_2 \\ \neg\ \begin{array}{|l|}\hline x_1 \\ \hline Mx_1\ Hx_1x_2 \\ \hline \end{array} \\ \hline \end{array}$

If (137c) is interpreted, the main DRS triggers an extension of the empty assignment by x_2. Whatever the value this new embedding assigns to this variable is, it is passed down to the interpretation of the negated box. There, the assignment is extended once more, but only "virtually" so since the extension is quantified over in the interpretation rule for negation. Thus, the whole sentence can be satisfied by an assignment that accounts for one variable only, namely x_2, despite the fact that there are two occurrences of indefinites. Likewise, (137b) does not impose any extension upon the satisfying assignment and thus is true at the empty assignment if it is not possible to extend it in such a way that it assigns a sleeping man to x_1; this can be the case if the model $\mathcal{M}$ and, especially, the domain of individuals M happens not to contain such a man.

The boxes receive the same interpretations as the following PL-formulæ under their standard interpretation. Every variable occurring either in (137b) or (137c) receives an existential interpretation: variables in the main universe of (137c) because of DRT's

[93] Alternatively, the following might also be a reading, with negation scoping lower than in the main text. This is irrelevant to the point to be made there, which is why this structure is not commented upon any further:

(i) $\begin{array}{|l|}\hline x_1\ x_2 \\ \hline Wx_2\ Sx_2\ Mx_1 \\ \neg\ \begin{array}{|c|}\hline \\ \hline Hx_1x_2 \\ \hline \end{array} \\ \hline \end{array}$

definition of truth, all others because of the clause for negation.

(138) a. $\neg(\exists x_1)[Mx_1 \wedge Sx_1]$
b. $(\exists x_2)[Wx_2 \wedge Sx_2 \wedge \neg(\exists x_1)[Mx_1 \wedge Hx_1x_2]]$

But this means, viewed from PL's perspective, that all variables in (137) are bound variables. Although they may appear to be free, the boxes implicitly quantify over them; at least as long as the respective variables occur within the associated universe. The only locally free variable is x_2 inside the negated box in (137b). It is free with respect to the closest universe in that it has no occurrence there, but overall, it is bound, since there is a universe where it has an occurrence, and this occurrence within the universe is accessible from the point where x_2 is sitting. In DRT terminology, the negated box is not proper, or improper, while the whole DRS (137c) is proper. Improper DRSs are not allowed to be principal DRSs in the sense that only proper DRSs can be true (or false) according to (91e). This means that even if negation introduces boxes, it may be necessary to have some other universe over and above these boxes so that variables free under negation may have an additional occurrence in this universe. But this move makes negation necessarily a condition (since they can't be self-standing DRSs) and thereby necessitated structures like (137b) where an otherwise empty box is needed in addition to the translation of syntactic material just to assign it a truth-value.

Taking conditionals back into account, the pattern remains the same, despite appearance. The embedded boxes seem not to be interpreted uniformly existentially, the box representing the antecedence (ψ) is universally quantified, instead.

(139) a.
$$\begin{array}{|c|}\hline \\ \hline \vdots \\ \begin{array}{|c|}\hline U(\psi) \\ \hline C_1(\psi) \\ \vdots \\ C_n(\psi) \\ \hline \end{array} \Rightarrow \begin{array}{|c|}\hline U(\chi) \\ \hline C_1(\chi) \\ \vdots \\ C_m(\psi) \\ \hline \end{array} \\ \\ \hline \end{array}$$

b. $\forall g : f \subseteq_{U(\psi)} g \;\&\; g \vDash_{\mathcal{M}} C_1(\psi) \wedge \cdots \wedge g \vDash_{\mathcal{M}} C_n(\psi) \rightarrow$
$\exists h : g \subseteq_{U(\chi)} h \;\&\; h \vDash_{\mathcal{M}} C_1(\chi) \wedge \cdots \wedge h \vDash_{\mathcal{M}} C_m(\chi)$

But universal quantification can be presented as stemming from the interplay of existential quantification and negation as is well known from standard PL-equivalences. Using non-standard notation for illustration, (139a) can be written as (140a), because (139b) is equivalent to (140b):

(140) a.
$$\begin{array}{|c|}\hline \\ \hline \vdots \\ \neg \left(\begin{array}{|c|}\hline U(\psi) \\ \hline C_1(\psi) \\ \vdots \\ C_n(\psi) \\ \hline \end{array} \ \& \ \neg \begin{array}{|c|}\hline U(\chi) \\ \hline C_1(\chi) \\ \vdots \\ C_m(\psi) \\ \hline \end{array} \right) \\ \hline \end{array}$$

b. $\neg\exists g : f \subseteq_{U(\psi)} g \ \& \ g \vDash_{\mathcal{M}} C_1(\psi) \wedge \cdots \wedge g \vDash_{\mathcal{M}} C_n(\psi) \ \wedge$
$\neg\exists h : g \subseteq_{U(\chi)} h \ \& \ h \vDash_{\mathcal{M}} C_1(\chi) \wedge \cdots \wedge h \vDash_{\mathcal{M}} C_m(\chi)$

Thus, despite first impression, the interpretation of boxes still is existential.[94]

If there are globally free variables to account for, DRT is not able to do it, since, as it stands (cf. (91e)), a DRS is true iff there is an embedding covering exactly those variables contained in the main universe (that satisfies every condition), not more. Thus, this definition is not intended to work with improper DRSs. However, there is an easy fix for that—namely replacing the identity sign in $D(f) = U_K$ with an expression containing $\subseteq$—, it is not applied here. Instead, for the moment it is taken for granted that there is a principled difference between variables occurring in the universes of DRSs, and variables that are globally free in a DRS. The former, but not the latter, should receive an existential interpretation because they stem from the translation of indefinite articles, which traditionally, and correctly in terms of truth conditions, have existential force. But variables not bound by them ultimately go back to the translation of pronouns; and globally unbound pronouns should not be interpreted existentially bound, but as deictic, that is, referential expressions.

The upshot is that the comparison of DRT and standard PL in the first section of this chapter was misled by the parallelism between their truth definitions, which differ only in quantificational force. Once embedded boxes are taken into consideration, DRT does not look like a theory of free variables at all. This is because negation (and conditionals) mark the first instance in which DRSs are considered, in which true (locally) free variables are considered. This is the difference with respect to the first section, where the language under scrutiny isn't capable of employing subDRSs. Once these are considered, it is revealed that DRT doesn't cope with free variables at all. In fact, it now appears to be a theory of *active* variables in the sense of DPL and their projection.

This makes DPL a closer relative than it looked like above. Actually, DRT (endowed with negation) can be modeled on the syntax of $\mathcal{L}_{FB}$ from above. That is, even though it doesn't make its appearance in the graphical representation, in the following DRT is understood as having an existential quantifier symbol that recategorizes (truly) free variables as bound variables. This, together with DPL's extension of the projection rules,

[94] As long as duplex conditions are not part of the picture. When they are interpreted, sets are formed from the boxes on the left and right of the quantifier. This doesn't mean that the values of all variables are collected in the respective sets. It is only the values of the designated variable mentioned in the diamond that is subject to abstraction. All other variables are interpreted as illustrated above.

results in a more PL-like representation. The resulting language is dubbed DRT$_{FAB}$, to give it a label.

(141) *Semantics of* DRT$_{FAB}$
Let $\mathcal{M}$ be a model as above, and $\tau \in \mathit{Var}, \beta \in \mathit{Con}$, and $\psi, \chi \in \mathit{Fml}$. $[\![\bullet]\!]^{\mathcal{M}}_{\mathrm{DRT}_{FAB}}$ then is function from syntactically well formed expressions into semantic values such that (decorations on the brackets are dropped to improve readability):

a. $[\![\tau]\!] = \lambda h.\ h(x_i)$, if $\tau \in \mathit{Var}$ is of the form x_i, for any i;
b. $[\![\beta]\!] = \lambda h.\ I(\beta)$;
c. $[\![\beta\tau_1 \ldots \tau_n]\!] = \lambda h. \vdash \langle [\![\tau_1]\!]^h, \ldots, [\![\tau_n]\!]^h \rangle \in [\![\beta]\!]^h \dashv$;
d. $[\![\neg\psi]\!] = \lambda h. \neg\exists k : h \subseteq_{B(\psi)} k \ \&\ [\![\psi]\!]^k$;
e. $[\![\psi \wedge \chi]\!] = \lambda h. [\![\psi]\!]^h \ \&\ [\![\chi]\!]^h$;
f. $[\![(\exists\tau)[\psi]]\!] = [\![\psi]\!]$.

(142) A formula $\varphi \in \mathit{Fml}$ is true in a model $\mathcal{M}$ at an assignment f iff
$f^{\emptyset} \subseteq_{F(\varphi)} f \ \&\ \exists h : f \subseteq_{A(\varphi)} h \ \&\ [\![\varphi]\!]^{\mathcal{M},h} = 1$

As can be seen in (141f), the existential quantifier doesn't have a semantic effect. Its value consists solely in the value of its restrictor. But it makes a difference in the overall interpretation, as witnessed by truth having to be relativized to a different assignment (142) that values globally free variables before it is extended further to cover the recategorized variables as well. These, contrary to the former, receive an existential interpretation, while free variables refer to whatever the initial assignment f assigns them. Free assignments like f to which truth needs to be relativized are called *(external) anchor*.[95]

In principle, the formulæ can be written in a DRT-like format. Instead of the expressions alone, like in PL, and also instead of a single set of variables like the universe in 'official' DRT, DRT$_{FAB}$ uses a tuple consisting of the set of free, the set of active, and the set of bound variables together with the a set of conditions. DRT$_{FAB}$ can be made to look like DRT if one depicts them in the graphical notation. Thus, if α is an expression of DRT$_{FAB}$, its standard graphical representation in DRT-like format is $\langle A(\alpha), \alpha \rangle$. To make the comparison with original DRT more visually, an *involved* graphical representation making use of all three sets of variables defined in (132) is considered in the following. Material absent from the official DRT-formalism is drawn in dashed instead of solid lines:

(143)
$$\begin{array}{|c|}\hline A(\alpha) \\ \hline \alpha \\ \hline \end{array} \qquad \begin{array}{|c|}\hline F(\alpha) \\ \hline A(\alpha) \\ \hline B(\alpha) \\ \hline \alpha \\ \hline \end{array} \qquad \begin{array}{|c|}\hline F(\alpha) \\ \hline A(\alpha) \\ \hline B(\alpha) \\ \hline \alpha \\ \hline \end{array}$$

The box on the left is the 'official' DRT-representation of an expression α. The one in

[95] In Kamp and Reyle (1993) they are put to use in order to interpret proper names. Here, they will be utilized to represent contexts, see below. But at the moment, they are just there to come up with values for globally free variables.

the center is the representation used in the newly built DRT$_{FAB}$, which in the following is depicted as the box on the right.

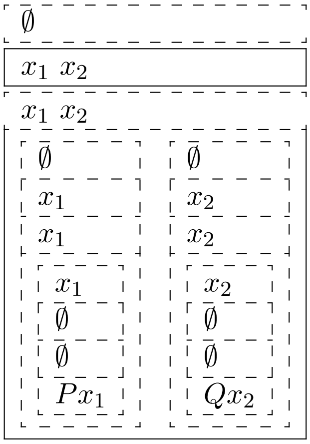
For example. A single condition that is to be inserted in a greater structure receives the following representation, where the official DRT-representation is on the left side, the involved DRT$_{FB}$-representation in the middle, and its interpretation on the right side (in interest of readability, the curly brackets used in DRT$_{FAB}$ are omitted in the DRT-like depictions; i.e. x_1 is used instead of $\{x_1\}$).

(144) Px_1 $\quad$ $\begin{array}{|c|}\hline x_1 \\ \hline \emptyset \\ \hline \emptyset \\ \hline Px_1 \\ \hline \end{array}$ $\quad$ $\lambda h.\ \vdash h(x_1) \in I(P) \dashv$

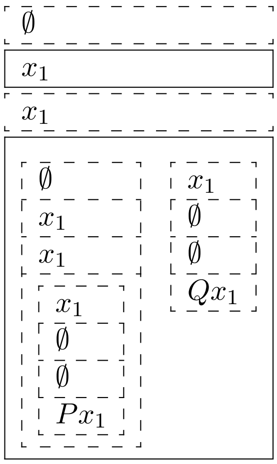
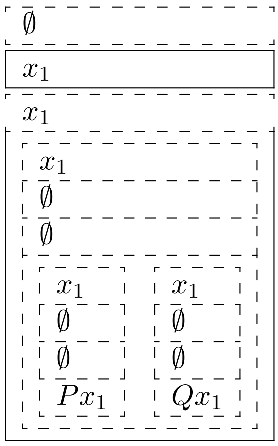
An existentially quantified expression like $(\exists x_1)[Px_1]$ contains the first example as a constituent, but its structure is not represented in official DRSs. What is represented is the universe that contains active variables, x_1 in the case at hand, if this expression is taken to be the whole discourse:

(145) $\begin{array}{|c|}\hline x_1 \\ \hline Px_1 \\ \hline \end{array}$ $\quad$ $\begin{array}{|c|}\hline \emptyset \\ \hline x_1 \\ \hline x_1 \\ \hline \begin{array}{|c|}\hline x_1 \\ \hline \emptyset \\ \hline \emptyset \\ \hline Px_1 \\ \hline \end{array} \\ \hline \end{array}$ $\quad$ $\lambda h.\ \vdash h(x_1) \in I(P) \dashv$

Nothing substantial changes if there is more than one existentially quantified formula in the mix. The following DRS on the left can be the abbreviation of several syntactically different DRT$_{FAB}$-formulæ, namely $(\exists x_1)[Px_1] \wedge (\exists x_2)[Qx_2]$, $(\exists x_1)(\exists x_2)[Px_1] \wedge Qx_2$, $(\exists x_1)(\exists x_2)[Px_1 \wedge Qx_2]$, and so on, whose interpretations are all the same, which is a happy consequence (and, of course, the desired one) of DRT's translation algorithm, which subordinates every piece of the natural language-input under the same universe. In syntactic terms, whichever formula is considered, it ends up with the same first two components—with the same sets of free and bound variables—, as any other alternative, given (132). To give an example, the first of above's formulæ is depicted in the following.

(146) $\begin{array}{|l|}\hline x_1\ x_2 \\ \hline Px_1 \\ Qx_2 \\ \hline\end{array}$  $\lambda h.\ \vdash h(1) \in I(P)\ \&\ h(2) \in I(P) \dashv$

If all occurrences of x_2 in any of the last examples are substituted for x_1, a serious weakness of DPL's projection behavior transferred to DRT and thus a problem for the interpretation algorithm is encountered. To see this, the following DRSs are considered first.

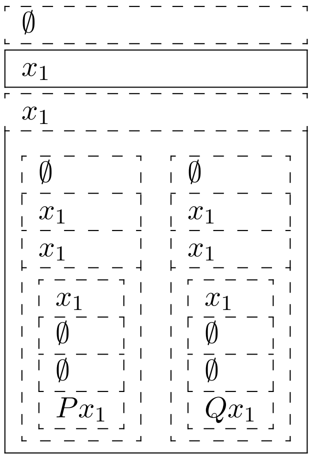
(147) $\begin{array}{|l|}\hline x_1 \\ \hline Px_1 \\ Qx_1 \\ \hline\end{array}$  

As can be seen, the DRS on the left hand side can be the abbreviation of two syntactically different of formulæ, namely $(\exists x_1)[Px_1] \wedge Qx_1$ and $(\exists x_1)[Px_1 \wedge Qx_1]$, which receive the same interpretation.This is the desired result.

(148)
$$
\begin{aligned}
& [\![(\exists x_1)[Px_1] \wedge Qx_1]\!]^{\mathcal{M}}_{\mathrm{DRT}_{FAB}} \\
= \quad & \lambda h.[\![(\exists x_1)[Px_1]]\!]^h\ \&\ [\![Qx_1]\!]^h \\
= \quad & \lambda h.[\![Px_1]\!]^h\ \&\ [\![Qx_1]\!]^h \\
= \quad & \lambda h. \vdash h(x_1) \in I(P) \dashv\ \&\ \vdash h(x_1) \in I(Q) \dashv \\
= \quad & [\![(\exists x_1)[Px_1 \wedge Qx_1]]\!]^{\mathcal{M}}_{\mathrm{DRT}_{FAB}}
\end{aligned}
$$

So far, so good. But upon reflection it turns out that the following box represents another equivalent structure. This equivalence is not as welcome as the other, but it also is a direct consequence of the projection mechanism in (132) and the way in which DRT extends assignments. The former simply unifies the sets of bound variables of two formulæ if they are conjoined, and thereby, unfortunately, identifies bound variables of the same name; like free variables are identified across formulæ in PL. On the semantic side, the extension-mechanism is compatible with a variable being already in use, although an assignment is extended by this very variable. If an assignment function—say, k—that already assigns a value to a specific variable—e.g. x_1—is extended—say, to k'—by a variable already in use—in this case, $\{x_1\}$—, because the formula that triggers this extension employs it as bound variable again, the resulting assignment (k') does not differ in its value for said variable (x_1) from the extended one (k). This is because extensions are defined as 1. union of the domain of the first assignment—k—and the universe of the box in question—$\{x_1\}$—, and 2. identity of values for all variables already covered—by k. Therefore, x_1 does not get requantified or reset as in DPL, but keeps its value assigned by the first assignment—namely k.

(149)



$$\begin{array}{cl} & [\![(\exists x_1)[Px_1] \wedge (\exists x_1)[Qx_1]]\!]^{\mathcal{M}}_{\mathrm{DRT}_{FAB}} \\ = & \lambda h.[\![(\exists x_1)[Px_1]]\!]^h \;\&\; [\![(\exists x_1)[Qx_1]]\!]^h \\ = & \lambda h. \vdash h(x_1) \in I(P) \dashv \;\&\; \vdash h(x_1) \in I(Q) \dashv \\ = & [\![(\exists x_1)[Px_1 \wedge Qx_1]]\!]^{\mathcal{M}}_{\mathrm{DRT}_{FAB}} \end{array}$$

This unfortunate consequence of the projection mechanism is an infamous problem in Heim (1982) as well, where it is done away with by the so-called “Novelty condition” (cf. Heim, 1982, 100, and below).

(150) *Novelty with respect to Logical Form*
An indefinite NP must not have the same referential index as any NP to its left.

As it stands, the Novelty Condition is not applicable to formulæ, since they lack the elaborate syntactic categorization natural language syntax appears to need. In order to apt (150) to purely formal examples, one needs to reformulate it somehow. Kamp and Reyle (1993) impose a constraint to the end that every expression that contributes to the universe has to introduce a “fresh” variable. This kind of solution is unsatisfactory to a certain degree, because it has a strong transderivational flavor. What is so transderivational about such a condition is the fact that it does not rely on local configurations. This seems to be even more difficult in DRT_{FAB}, since every expression comes with its own universe, with respect to which its variable is trivially “fresh”.[96]

[96] In the official DRT translation rules, every time an NP is translated a fresh variable is introduced. If

To approach a more local definition, one might try to block the problematic syntactic derivations by demanding that, whenever the sets active variables of two expressions are unified—which is what happens according to the projection rule for bound variables when two formulæ are conjoined into one—, no variable is allowed to get lost in the process; projection has to be "number preserving" in the sense that the number of active variables on either side of a conjunction have to add up. This boils down to the demand that active variables of two formulæ have to be distinct ("no shared element"), if they are to be conjoined. This only lets those derivations through in which no variables get lost due to unwanted identification. Therefore, it blocks the reuse of active variables as in $(\exists x_1)[Px_1] \wedge (\exists x_1)[Qx_1]$, but it does not block the derivation of $(\exists x_1)[Px_1] \wedge Qx_1$ because no active variable gets lost there. However, this still does not seal the deal, because of negation.

As seen above, the simplest assumption concerning negation is that it empties the universe for active variables of the expression it is attached to. This projection behavior guarantees that active variables under negation do not project to the principal box. And it reflects the fact that it is not possible to anaphorically refer back to embedded antecedents. Thus, the following structure (in the center of (151))—the involved representation of $\neg(\exists x_1)[Px_1] \wedge Qx_1$—cannot be interpreted such that it is equivalent to $\neg(\exists x_1)[Px_1 \wedge Qx_1]$ (on its right), which is intended. Unfortunately, it also doesn't receive its intended interpretation, where the first occurrence of x_1 is interpreted as bound, but the last occurrence as free variable. The interpretation it actually receives according to the rules given above is equivalent to the interpretation of $\neg Px_1 \wedge Qx_1$.[97] This is due to a kind of scope taking mechanism implicit in the projection rules and explicit in DRT_{FAB}'s definition of truth. Free variables are lifted over all conditions, because they are interpreted with respect to the single assignment truth is relativized to.[98] If a variable of the same name has a bound occurrence that is crossed in this way, like it happens to be the case in $\neg(\exists x_1)[Px_1] \wedge Qx_1$, this 'bound' variable inherits its value from the free occurrence, due to the extension mechanism DRT_{FAB} employs. This nullifies quantification in the sense that the existentially quantified variable gets restricted to the values assigned to the freely occurring variable; that is, it is interpreted free as well.

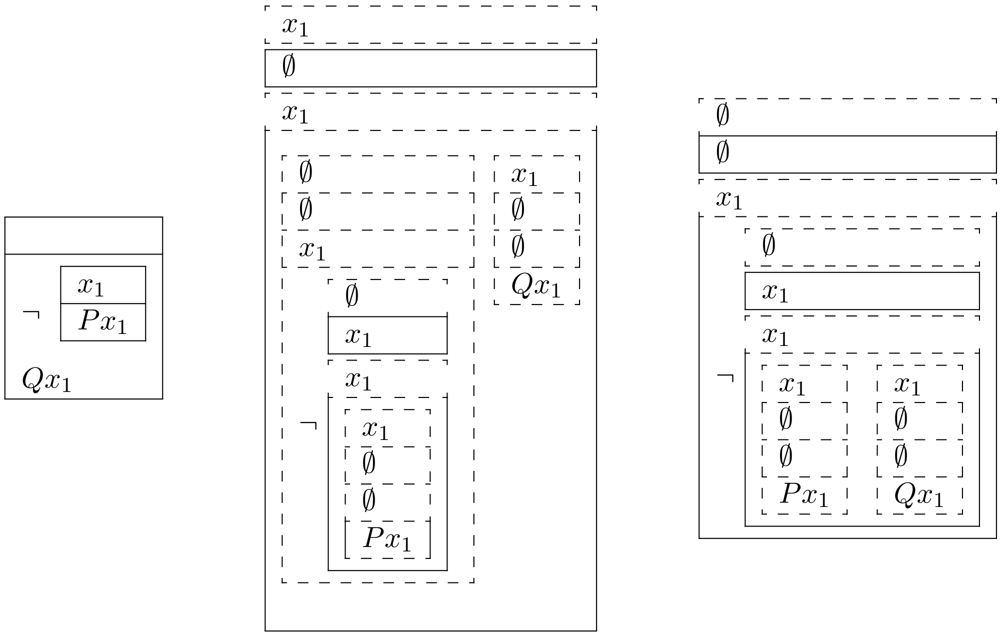
To see this, it is supposed that l is an assignment with the domain $\{x_1\}$. If (152) is applied to l, it says that there is no extension k of l by $\{x_1\}$ that values the variable x_1 in such a way that the value is in the extension of the predicate P, and the value l assigns to x_1 is in the extension of Q. But because l already contains 1 in its domain, possible instances for k boil down to l itself; thus resulting in the unwanted result (153).

---

the NP in question is a pronoun, then an identity-statement is added which links the newly introduced variable to an old one. Otherwise, the newly introduced variable is not linked to any other variable. In this sense, not only indefinites, but every NP contributes a "fresh" variable, see below.

[97] It should be noted that the following DRS is improper and therefore doesn't receive a truth value according to Kamp and Reyle's (1993) definition of truth. This sidesteps the problem mentioned in the text. Nevertheless, the problem haunting structures like (i) carries over to formulæ that should receive a truth value; and therefore, one shouldn't be satisfied with this solution. See (154) below for the relevant example.

[98] This problem is not solved if the order of assignment is reversed in the definition of truth, because that would turn free occurrences of a bound variable into bound variables as well.

(151) 

(152) $[\![\neg(\exists x_1)[Px_1] \wedge Qx_1]\!]^{\mathcal{M}}_{\mathrm{DRT}_{FAB}}$
$$= \lambda h.\ [\![\neg(\exists x_1)[Px_1]]\!]^h \ \&\ [\![Qx_1]\!]^h$$
$$= \lambda h.\ \neg\exists k : h \subseteq_{\{x_1\}} k \ \&\ k(x_1) \in I(P) \ \&\ h(x_1) \in I(Q)$$

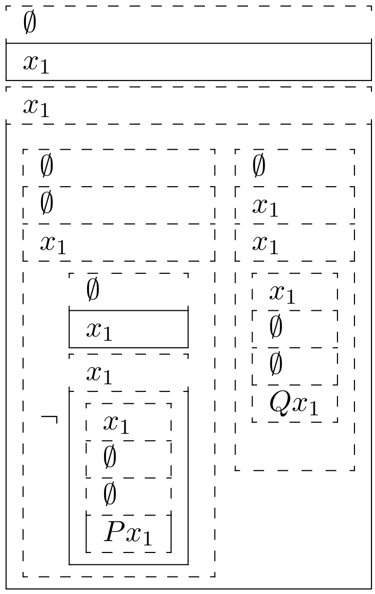
(153) $\vdash l(x_1) \notin P \dashv \ \&\ \vdash l(x_1) \in Q \dashv$

And since functions that do not cover x_1 from the get-go fail to come up with a value for Qx_1, functions like l are the only candidates for arguments of (152). $\neg(\exists x_1)[Px_1] \wedge Qx_1$ thus inevitably gets assigned the same value as $\neg Px_1 \wedge Qx_1$.

This is meant by "scope taking" above: in (132), negation has to block the projection of bound variables; or so is at least the most straightforward assumption. This in turn allows free variables originating in a different conjunct to outscope them. But this in turn leads to a configuration where the free assignment in the definition of truth has to take care of these free variables first; making it impossible to interpret bound occurrences really as bound variables, since the extension mechanism runs idle. This doesn't happen in DPL because there, existentially quantified variables are always requantified or resetted. That is, if there already is a variable of the same name in use, whatever the value is that it is assigned, it is thrown away when the quantifier is interpreted. This is the benefit of the blocking effect, one might say.

What is important about this example is that the local constraint sketched above, the "number-preserving" or "no shared element" constraint, is fulfilled in every single step of the syntactic derivation. No variables get lost due to unwanted identification. To be fair, this exact problem does not arise in original DRT, because formulæ containing globally free variables are excluded from the truth definition, anyway. But this isn't enough, either. A similar configuration is obtained when the free occurrence of x_1 in the last example is also quantified.[99] The following DRS on the left can be understood as the abbreviated representation of DRT$_{FAB}$'s expression standing for $\neg(\exists x_1)[Px_1] \wedge (\exists x_1)[Qx_1]$ on the right:

(154) $\begin{array}{|l|}\hline x_1 \\ \hline \neg \begin{array}{|c|}\hline x_1 \\ \hline Px_1 \\ \hline \end{array} \\ \\ Qx_1 \\ \hline \end{array}$



Without further going into details, in this case, the first quantifier, below negation, fails to quantify x_1 because the value of x_1 gets fixed by the freely scoping quantifier coming from the right conjunct. Again, no variable gets lost due to identification, that is, no two universes of conjoined expressions share an element, nor is it an improper DRS; still, the representation does not receive the correct interpretation. This time, the derivation is only blocked by the "fresh variable" rule, similarly to Heim's Novelty Condition (150); but again, the local constraint suggested as their more formal reconstruction fails to do its job successfully.

Dekker (1996) shows that there is a way to do better. His solution, albeit partial, consists in a more general form of "no shared element", adapted to three, instead of two sets of variables. To present his adaptation, Dekker works with EDPL, a functional formulation of DPL, involving a precisely defined ontology of so-called *states*, that is, sets of assignments with varying domains; thus, a partial semantics. The details of the semantic definitions are not of much interest at the moment, but the syntactic felicity conditions.

The main definedness-condition is the following:

(155) φ is defined iff $F(\varphi) \subseteq \overline{B(\varphi)}$,

where $\overline{A} := V \backslash A$, i.e. the complement of A on the set of variables.

[99] Either locally like in $\neg(\exists x_1)[Px_1] \wedge (\exists x_1)[Qx_1]$, or from further above, like in $(\exists x_1)[\neg(\exists x_1)[Px_1] \wedge Qx_1]$.

This can be understood with the semantics of DRT$_{FAB}$ in mind. Forbidden are quantified formulæ which reuse free variables, thus, formulæ with shared elements between the first and the third set of variables. What Dekker thereby achieves is a strict distinction between free and bound variables; and active variables as well since they are a subset of the bound ones. This doesn't seal the deal yet. Some construction rules, namely quantification and conjunction, have to come with their own definedness conditions, viz. the table below (cf. Dekker, 1996, p. 237):

(156) *Projection in EDPL*

Cat.	$\sigma \in Fml$	$F(\sigma)$	$A(\sigma)$	$B(\sigma)$	Conditions
Pred	$\beta\tau_1 \dots \tau_n$	$F(\beta) \cup F(\tau_1) \cup \dots \cup F(\tau_n)$	$\emptyset$	$\emptyset$	—
Neg	$\neg\varphi$	$F(\varphi)$	$\emptyset$	$B(\varphi)$	—
Conj	$\varphi \wedge \psi$	$F(\varphi) \cup (F(\psi) \backslash A(\varphi))$ V	$A(\varphi) \cup A(\psi)$ V	$B(\varphi) \cup B(\psi)$ V	If $(F(\varphi) \cup A(\varphi)) \subseteq \overline{B(\psi)}$ otherwise
Quant	$\exists x_i \varphi$	$F(\varphi) \backslash \{x_i\}$ V	$A(\varphi) \cup \{x_i\}$ V	$B(\varphi) \cup \{x_i\}$ V	if $x_i \notin B(\varphi)$ otherwise

If the conditions aren't met, the set of all variables V are put in all universes, instead of their "natural" projections, which leads to expressions failing the global definedness condition (155). In this way, the felicitous use of existentially quantified expressions is modeled. E.g., formulæ impossible to derive[100] in EDPL are, among others:

(157) a. $(\exists x_1)[Px_1] \wedge (\exists x_1)[Qx_1]$,

since it violates the definedness condition for conjunctions: $B((\exists x_1)[Qx_1]) = \{x_1\}$, and $F((\exists x_1)[Px_1]) \cup A((\exists x_1)[Px_1]) = \{x_1\}$, and $\{x_1\} \nsubseteq \overline{\{x_1\}}$;

b. $Px_1 \wedge (\exists x_1)[Qx_1]$,

since it violates the definedness condition for conjunctions, too: $B((\exists x_1)[Qx_1]) = \{x_1\}$, and $F(Px_1) \cup A((\exists x_1)[Qx_1]) = \{x_1\}$, and $\{x_1\} \nsubseteq \overline{\{x_1\}}$;

c. $(\exists x_1)(\exists x_1)[Px_1]$,

since it violates the definedness condition for quantification: $x_1 \in B((\exists x_1)[Px_1])$.

A formula like the following can be derived according to the conditions for conjunction laid out above,

d. $\neg(\exists x_1)[Px_1] \wedge Qx_1$,

since the set of active quantifiers in $\neg(\exists x_1)[Px_1]$ (which is empty) is a subset of the complement of the set of bound variables, which is the set of all variables, since $B(Qx_1) =$

[100] That is, strictly speaking, they are derivable, but the sets all get identified with the set of all variables; which ultimately leads to getting filtered out by (155). This is slightly different from the case in (id), because this example gets assigned its "natural" sets, but still doesn't make it.

$\emptyset$, and thus $\overline{B(Qx_1)} = \overline{\emptyset} = V$. But the whole formula doesn't meet (155), because the set of free variables, $\{x_1\}$, shares an element with the set of bound variables, also $\{x_1\}$.

Different, but related are (157e.) and (157f.), which are possible according to (155) and comply with the internal definedness conditions as well.

e. $\neg(\exists x_1)[Px_1] \wedge (\exists x_1)[Qx_1]$
f. $\neg(\exists x_1)[Px_1] \wedge \neg(\exists x_1)[Qx_1]$

(157f) is no problem for $\mathrm{DRT}_{\mathrm{FAB}}$ since it receives the intended interpretation. This is due to the interpretation rule for negation. The values tested there are not handed over to the "main" assignment that is existentially quantified in the clause for truth. But (157e) suffers from the same kind of "projection problem" as do the formulæ just discussed.

Therefore, EDPL still doesn't pattern with "official" DRT. If one takes its restriction to proper DRSs into account and interprets its "fresh variable" rule rigorously, the following statements on definedness are needed to ensure its proper functioning:

(158)

a.	$Px_1 \wedge Qx_1$ DPL✓ EDPL✓ DRT✗	b.	$Px_1 \wedge (\exists x_1)[Qx_1]$ DPL✓ EDPL✗ DRT✗	c.	$Px_1 \wedge \neg(\exists x_1)[Qx_1]$ DPL✓ EDPL✗ DRT✗
d.	$(\exists x_1)[Px_1] \wedge Qx_1$ DPL✓ EDPL✓ DRT✓	e.	$(\exists x_1)[Px_1] \wedge (\exists x_1)[Qx_1]$ DPL✓ EDPL✗ DRT✗	f.	$(\exists x_1)[Px_1] \wedge \neg(\exists x_1)[Qx_1]$ DPL✓ EDPL✗ DRT✗
g.	$\neg(\exists x_1)[Px_1] \wedge Qx_1$ DPL✓ EDPL✗ DRT✗	h.	$\neg(\exists x_1)[Px_1] \wedge (\exists x_1)[Qx_1]$ DPL✓ EDPL✓ DRT✗	i.	$\neg(\exists x_1)[Px_1] \wedge \neg(\exists x_1)[Qx_1]$ DPL✓ EDPL✓ DRT✗

Because DPL makes use of variants even if a variable that already occurred in a formula is existentially quantified again, none of the crucial formulæ is undefined. Dekker's EDPL deliberately renders some reuses of variables undefined, but not all of them, as can be seen in (158h) and (158i). When negation intervenes, it is possible to reuse any variable that is embedded below it, except as free variable, as (158g) shows. Negation does not have the same effect in DRT, though. There, given the way in which Kamp and Reyle (1993) seem to intend the usage of "fresh" variables, even if an indefinite is translated in a position below negation, its variable should not already have been used beforehand, and it should not be reused later, outside of the scope of negation. This at least seems to describe best what is happening in DRT. On the technical side, neither (158h) nor (158i) result in a non-intended interpretation in EDPL, even though it does not make use of variants (as DPL) but of extensions (as DRT). The extension triggered by existential quantifiers under negation are undone before it comes to interpreting other material, thus allowing a "fresh" extension by the same variable later on.

(158e) and (158f) are excluded by the internal condition that free and active variables in the first conjunct have to be distinct from the bound variables in the second. This condition cannot rule out the configurations (158h) and (158i), since, e.g. $F(\neg(\exists x_1)[Px_1]) \cup A(\neg(\exists x_1)[Px_1]) = \emptyset$, and therefore, whatever the bound variables in the second conjunct are ($\{x_1\}$, and $\emptyset$, respectively), this condition is fulfilled. Thus, the definedness conditions laid out by Dekker (following Heim (1982)) do not exactly match the Novelty Condition or DRT's "fresh variable" rule. To get this, in addition to Dekker's condition for conjunction, the following condition has to be assumed as well:

(159) $\quad B(\varphi)\backslash A(\varphi) \subseteq \overline{B(\psi)}$

Informally, this condition demands that bound but inactive variables (*inaccessible* discourse referents in DRT's terms) in the first conjunct be distinct from bound variables in the second. This rules out both formulæ in (158h) and (158i), because the set of bound but inactive variables of $\neg(\exists x_1)[Px_1]$ is $\{x_1\}$, but x_1 is used as bound variable in the second conjuncts, respectively. On the other hand, it does not further exclude formulæ (158a)—(158f), because in all cases the set of bound but inactive variables in the first conjunct is empty. Finally, it leaves (158g) untouched as well (it is undefined by Dekker's main definedness condition (155), anyway), because there, no bound variable occurs in the right conjunct. The proposed additional requirement (159) can be combined with Dekker's condition to form the following complex clause for conjunctions σ of the form $\varphi \wedge \psi$:

(160)
$$\left.\begin{array}{l} F(\sigma) = F(\varphi) \cup (F(\psi)\backslash A(\varphi)), \\ A(\sigma) = A(\varphi) \cup A(\psi), \\ B(\sigma) = B(\varphi) \cup B(\psi), \end{array}\right\} \text{if } (F(\varphi) \cup A(\varphi)) \cup (B(\varphi)\backslash A(\varphi)) \subseteq \overline{B(\psi)}, \text{ and}$$
$$F(\sigma) = A(\sigma) = B(\sigma) = V, \text{ otherwise}$$

Intuitively, bound variables in the second conjunct of a conjunction neither are allowed to coincide with free or active variables of the first conjunct, nor with inaccessible (that is, bound but not active) ones.[101] One thus may state an even more transparent rule that explicitly rules out what one intuitively does not want to happen:

(161) $\quad \varphi \wedge \phi$ is defined iff

a. $F(\varphi) \cup A(\varphi) \subseteq \overline{B(\psi)}$, and — free or active variables are not requantified
b. $B(\varphi)\backslash A(\varphi) \subseteq \overline{F(\psi) \cup B(\psi)}$ — inaccessible variables are not reused at all

The syntax of ordinary PL taken together with the projection behavior defined by Dekker with the refinement suggested here basically makes a DRT-like interpretation (141) work and thereby captures the basic facts of indefinites and pronouns; in so far as DRT is able to represent them correctly. That means, in a sense, that DRT's extension mechanism with the relation "$\subseteq_V$" at its core needs felicity-conditions to work properly in the first place. As is discussed above, if formulæ like $(\exists x_1)[Px_1] \wedge (\exists x_1)[Qx_1]$ are not excluded,

[101] On the other hand, it isn't clear whether negation should really block the projection of every bound variable in its scope. See the discussion at the end of this section.

the interpretation (141) assigns them an interpretation. That this isn't what one wants to get from formulæ like these (it comes out as $(\exists x_1)[Px_1 \wedge Qx_1]$, as is seen above) can only be said because $(\exists x_1)[Px_1] \wedge (\exists x_1)[Qx_1]$ is *intended* to represent something else, namely the semantic value of a small discourse like *Indef-P and Indef-Q*. In contrast, DPL does not need to rely on any projection principle. It can be endowed with some, like Groenendijk and Stokhof (1991) decided to, but it is optional in the sense that DPL's semantics does not need to refer to any of the sets of variables defined to assign the intended meanings to formulæ, or to get any extension relation to work in the way it is intended to. Maybe with one exception, namely the undesired blocking-effect described above.

Note finally that there are two differences in the projection rules with respect to (132), namely in the set of bound variables of conjunctions and existential quantifiers. Groenendijk and Stokhof's choice is to add a variable to the set of bound ones only in case there is actual binding going on, while on Dekker's account, it is put in there as soon as the existential quantifier makes its appearance. That makes the following difference: if a formula vacuously quantifies over x_1, x_1 only counts as active but not as bound according to (132). And if such a formula is conjoined with a formula in which x_1 doesn't make its appearance, x_1's status remains the same. Thus, x_1 only then counts as active and bound if it either is among the free variables of the formula the quantifier is attached to in the first place, or if it is a free variable a conjunct to follow. But this can be exploited in the derivation of a formula that should be excluded:

(162) $(\exists x_1)[Px_1] \wedge (\exists x_1)[Qx_2] \wedge Qx_1$

a. $(\exists x_1)[Px_1]$ and $(\exists x_1)[Qx_2] \wedge Qx_1$ cannot be conjoined when Dekker's definedness conditions are in charge, regardless whether his or Groenendijk and Stokhof's projection rules are used, because x_1 is bound in both conjuncts and therefore, the definedness-conditions for conjunctions are not met; but

b. $(\exists x_1)[Px_1]$ and $(\exists x_1)[Qx_2]$ can be conjoined under Groenedijk and Stokhof's account of projection, since the set of bound variables of the second conjunct is empty. Therefore, $(\exists x_1)[Px_1] \wedge (\exists x_1)[Qx_2]$ counts as well-formed, even according to (155).

c. $(\exists x_1)[Px_1] \wedge (\exists x_1)[Qx_2]$ and Qx_1 then can be conjoined, too, because the set of bound variables of the second conjunct is empty as well and the resulting formula doesn't violate (155).

This doesn't work with Dekker's projection rules, because (156) (not to speak of its advanced variant) already rules out (162b), since $(\exists x_1)[Qx_2]$ is said to contain a bound variable as well. This may be a bit of a stretch, intuitively, but isn't as bad as, e.g. proposing that $\neg(\exists x_1)[Px_1]$ does *not* contain a bound variable. So, one might have to live with it. Or, alternatively, one proposes a ban on vacuous quantification, which is what causes the problem in (162). That is, (162) is completely ruled out because $(\exists x_1)[Qx_2]$ is considered ill-formed.

3.3.4 The projection of Discourse Referents in FCS

Most of what is said about $\mathrm{DRT}_{\mathrm{FAB}}$ above carries over to FCS as well. FCS is nevertheless reviewed to some detail because Heim elaborates a bit more on felicity conditions. Her aim, among accounting for anaphoric pronouns, consists in predicting distributional differences between indefinite and definite descriptions as well; hence her famous Novelty-Familiarity theory, to be reviewed shortly. To show what this means, the first full form of "official" FCS is presented in the following. Basically, its contents take the shape of $\mathrm{FCS}_{0'}$ above, but stripped by the experimentally introduced world-variable:

(163) *Syntax of* FCS_0
Let all symbols be as above.

a. *Basic Sentences*
BS is the smallest set containing all ψ for which the following holds
(i) If β is a predicate constant and $\tau_1, \ldots, \tau_n$ are variables, and ψ is of the form $\beta\tau_1 \ldots \tau_n$, then $\psi \in BS$.
(ii) If $\psi \in BS$, then $\neg\psi \in BS$

b. T
φ is a T iff φ is of the form $\psi_1 \wedge \cdots \wedge \psi_n$, with n being a natural number and every $\psi_i \in BS$.

In addition to the interpretation rules, Heim also provides some kind of projection rules, which regulate the addition of variables to a *domain* of formulæ. These form a second ingredient of FCS ignored up to now. In its full form, every interpretation rule of FCS comes with in parts, one describing how the semantic value of an expression is calculated from the ones of its parts, and the other one being a universe-like set of variables that collects all free occurrences of variables employed.

One remark is in order: Heim does not work with partial assignments in the sense of section 3.2.2, where it is stipulated that assignments are total, but return individuals other than $\#_e$ only in finitely many cases. These cases are called the *domain* of the set of assignments there. She does work with total assignments and with a notion of domain, but her assignments do not return $\#_e$ in case they are applied to arguments not in their domain. That is, she does not make use of a 'dummy individual' at all; hence, being an assignment in her system means that the application to an argument not in the domain returns a random individual u. Thus, the domain in her account ($|\bullet|$ in the following) keeps a record of variables actually used, whose values therefore matter for the outcome of the interpretation, while every variable x_i not in the domain doesn't matter, although it is assigned an individual as well.

This doesn't mean that the gist of FCS cannot be represented in the now familiar format using partial assignments. The following semantics prove the contrary. But note that the notion of the domain becomes partially redundant because it does not contain more information than the assignments themselves:[102]

[102] The rules actually follow Dekker (1996). Note further that FCS in this form doesn't distinguish between variables that are anchored and variables that need to be interpreted existentially. This will

(164) *Semantics of FCS_0*
Let $\mathcal{M}$ be a model as defined above. $[\![\bullet]\!]^{\mathcal{M}}_{\mathrm{FCS}}$ applied to a set of assignments ('G') then is a function from syntactically well-formed expressions of FCS_0 into semantic values and $|\bullet|$ also applied to such a set is a function from syntactically well-formed expressions into sets of variables such that (again, decorations are suppressed):

a. If $\tau \in \mathit{Var}$ is of the form x_i, then
   (i) $|\tau|(G) = \{\tau\}$ $\quad (= F(\tau))$;
   (ii) $[\![\tau]\!](G) = \lambda f.f(\tau)$;
b. If $\beta \in \mathit{Pred}$, then
   (i) $|\beta|(G) = \emptyset$ $\quad (= F(\beta))$;
   (ii) $[\![\beta]\!](G) = I(\beta)$;
c. If $\varphi \in \mathit{BS}$ is of the form $\beta\tau_1 \ldots \tau_n$, then
   (i) $|\varphi|(G) = D(G) \cup |\beta|(G) \cup |\tau_1|(G) \cup \cdots \cup |\tau_n|(G)$ $\quad (= D(G) \cup F(\varphi))$;
   (ii) $[\![\varphi]\!](G) = \{f \in \mathit{Ass}^{|\varphi|} : \langle [\![\tau_1]\!]^f(G), \ldots, [\![\tau_n]\!]^f(G)\rangle \in [\![\beta]\!](G)\}$;
d. If $\varphi \in \mathit{BS} \cup T$ is of the form $\neg\psi$, then
   (i) $|\varphi|(G) = D(G)$;
   (ii) $[\![\varphi]\!](G) = \{g \in G : \neg\exists h \in \mathit{Ass}^{D(G)\cup|\psi|} : g \subseteq_{|\psi|} h \;\&\; h \in [\![\psi]\!](G)\}$;
e. If $\varphi \in T$ is of the form $\psi_1 \wedge \psi_2 \wedge \cdots \wedge \psi_n$, then
   (i) $|\varphi|(G) = |\psi_n|(\ldots|\psi_2|(|\psi_1|(G)))$;
   (ii) $[\![\varphi]\!](G) = [\![\psi_n]\!](\ldots[\![\psi_2]\!]([\![\psi_1]\!](G)))$.

Recall that $D(G)$ is the domain of the set of assignments. Thus, the assignments in G need to be homogeneous with respect to the variables accounted for.

(165) A set of assignments ('file') is called "true" iff it is non-empty.

(166) A formula φ is true with respect to a set of assignments ('file') G if $[\![\varphi]\!]^{\mathcal{M}}(G)$ is true, and false with respect to G if G is true but $[\![\varphi]\!]^{\mathcal{M}}(G)$ is not.

As can be seen by inspecting the clauses for the node T a little closer, the formulæ are basically interpreted from left to right. Starting with the leftmost basic sentence, it is evaluated against the set of assignments G, first, and the result of this evaluation again is a set of (possibly lengthened) assignments G', against which the next basic sentence is evaluated, and so on and so forth until the final basic sentence of the discourse is done. At every stage of this ongoing evaluation process it is possible that the set of assignments composed of the so-called "common ground" G and the basic sentences already evaluated is extended to cover variables newly introduced.[103] Given the (implicitly) restrained vocabulary of the fragment under investigation, these have to stem from the translation of indefinites. But there are not only newly introduced variables employed in

be implemented later.

[103] "Common ground" is put in quotation marks because it just serves as a synonym to *file*. That is, it is not necessarily used in the way, e.g., Stalnaker (2002) uses the term. The relation to such a more substantial notion of *common ground* is not discussed here. It is just introduced because Heim suggests that there are some connections. But for the issues pursued here, it would be enough to use *file*.

the formulæ. E.g., when a pronoun makes its appearance, an already introduced variable has to be reused. Hence, the unification of sets of variables in the (i)-part of (166c).

Whether a variable has to be new or not still is regulated by the Novelty Condition, repeated here:

(150) *Novelty with respect to Logical Form*
An indefinite NP must not have the same referential index as any NP to its left.

This is a syntactic notion of Novelty which could be identified with DRT's "fresh variable" rule and treated in the form of definedness conditions per construction as above. Note that both rules allow intra-sentential as well as discourse-wide applications. A more formal representation of FCS's implementation therefore would have to concern itself with the formation of basic sentences (163a), to capture the former, and with T-formation (163b) to capture the latter kind of application. Something similar of course holds for DRT as well.

Heim employs a second notion of novelty on the basis of $|\bullet|$, which she calls "Novelty with respect to the file" in contradistinction to "Novelty with respect to Logical Form" which is identified with the syntactic sense of (150). Equipped with a notion like "Novelty with respect to the file", one can try to give a semantic (or pragmatic) categorization of Novelty. This is where the step-wise interpretation routine kicks in. For the moment, the intra-sentential application of (150) is left aside.[104] Alternatively, one might use a more fine-grained syntax that allows a stepwise interpretation of basic sentences, together with a stepwise enrichment of the domain of the set of assignments ("files"), to apply "Novelty w.r.t. files" to intra-sentential cases.

First and foremost, a variable x_i is new with respect to a set of assignments G ($\subseteq Ass^{D(G)}$), if $x_i \notin D(G)$. It follows that if $x_i \notin D(G)$, but $x_i \in F(\varphi)$ for some formula φ, then x_i in φ is new with respect to G. This allows one to formulate Novelty on the basis of files:

(167) *Novelty with respect to files*
Any variable x_i used to translate an indefinite in φ needs to be new with respect to the domain $D(G)$ of the file G ($\subseteq Ass^{D(G)}$) φ is interpreted against.

If a variable x_i is new with respect to logical form in the sense of (150), it also is new with respect to the discourse, in the sense of (167), given that there is no way for a variable to enter $|\bullet|$ other than being syntactically introduced. And given that it is not possible to violate Novelty within a basic sentence, the reverse also holds, namely that x_i has to be new with respect to Logical Form if it is new with respect to G. This conclusion is warranted by Heim because (i) of the design of the interpretation rule for Texts, which forces a left-to-right interpretation of the basic formulæ as well as a left-to-right enrichment of the set of variables used (thus, if one starts with an empty domain, the only way in which a variable name can make its way into it is by being introduced by an

[104] It will be covered with the help of further principles governing the use of variables, namely *Binding Theory*, see below, section 3.5.

indefinite); and (ii) because of the assumption that intra-sentential coindexing is ruled out on independent grounds. Therefore, all things considered so far, either formulation of Novelty, (150) as well as (167) will do. That is, the form of the interpretation rules allows for a semantic account of Novelty, independent of syntactic definedness conditions. Pronouns, on the other hand, need to find themselves in the domain to be interpretable. That is, variables translating pronouns need to be "familiar" in the sense that they are already part of the respective domain.

This neat picture is distorted somewhat when more definites, most notably definite descriptions, are taken into consideration. Heim assumes (as do Kamp and Reyle) that they are translated by variables as well. Like pronouns, and in contrast to indefinites, they have to be "familiar" in Heim's terminology, but, in contrast to pronouns, in a slightly different way. That is, she assumes that a definite description can only be used felicitously, if (i) its variable name is already part of the domain of the set of assignments the sentence containing it is evaluated against (cf. (168a)), or (ii) its descriptive content is entailed by this set (or both). "Familiarity" therefore is ambiguous between these two cases, and definite descriptions can make use of both ways. They either behave like anaphoric pronouns (168a) or as variable-introducing terms with existence and uniqueness presuppositions (168b):

(168) a. Then I saw a man entering the room. He / The man (who I saw entering the room) stared right at me.
b. The president of the USA introduced me to the queen of England.

For the sake of argument, let (168b) be the first utterance in a novel (or something with a similar status) such that the domain of the "common ground" cannot be assumed to contain any variable names whatsoever. Neither definite description in (168b) can then be analyzed as picking up a variable. Thus, both would have to introduce their own. But this is usually claimed to be possible only if it is part of the "common ground" that there in fact is only one king of France and only one queen of England. That is, the file needs to entail that all assignments evaluate the variable a definite introduces by the same individual, namely (at the time of writing) *Donald Trump* and *Elisabeth II*, respectively. In contrast, the domain of the file after interpreting the first sentence of (168a) necessarily contains a variable, namely the variable that is introduced by the indefinite *a man*. The definite description in the second sentence, like a pronoun, is able to pick up this variable, which establishes a further predication on whatever value is introduced by the indefinite in the first sentence. There seems to be an additional requirement such that the descriptive content of the definite fits in some way (e.g. using *the rabbit* in place of *the man* fails to establish the required relation), but other than that, the definite behaves much like the pronoun. And this obviously includes a relaxation of the uniqueness requirement observed in (168b). The first sentence of (168a) is compatible with the existence of more than one man (in a situation), and it is even compatible with more than one man entering the room (unseen by the speaker, maybe, since it would be misleading to use (168a) if the speaker saw more than one man entering the room). Therefore, the set of assignments that results from interpreting this sentence contains all assignments with the indefinite's variable in their domain that assign any value compatible with the lexical material to it. After evaluating the second sentence, in which the definite is contained, the domain isn't changed, but the set of assignments might be reduced. Thus, if the value of the variable introduced by the indefinite is, say, *Martin*, according to some assignment in the file, this assignment and a forteriori the very same value might figure in the file obtained by interpreting the second sentence. But this holds for any other assignment which assigns, e.g., *Jeroen* to said variable. Thus, taking all possible values of the variable into consideration, the set of assignments at no point entails that there is only one possible value for the variable in question.

To state this more precisely, one needs a definition of entailment from files. To this end, the notion of extension by a set of variables is generalized from a relation between single assignments (cf. (89), repeated from above), to a relation between an assignment and a set of assignment (169), and then to a relation between sets of assignments (170). The symbol used to denote all of these relations is '$\subseteq_V$,' with V being a set of variables, because this relation is their common core, even though they differ in their types:[105]

(89) *Extension of assignments*:
If g^G and h^H are assignment functions and V a (possibly empty) set of variables, then h extends g by V—$g \subseteq_V h$—iff $G \cup V = H$ and $g \subseteq h$ holds, that is, g and h agree on all values in G.

(169) An assignment g^G has an extension by V in a (nonempty) set of assignments $H' \subseteq Ass^H$—$g \subseteq_V H'$—iff $\exists h' \in H' : g \subseteq_V h'$

(170) A set of assignments $G' \subseteq Ass^G$ has extensions (by V) in a set of assignments $H' \subseteq Ass^H$—$G' \subseteq_V H'$—iff $\forall g' \in G' : g' \subseteq_V H'$

To understand these definitions more clearly, two cases have to be distinguished: first, the set of variables V mentioned in all three definitions could be a (possibly empty) subset of G. As pointed out above, for (89) this has the effect that the relation boils down to an identity statement between the assignments in question. For (169), this means that the relation boils down to set membership, while (170) reduces to subsethood. Secondly, if V is no subset of G, the second assignment in (89) matches the first in all values assigned to members of G, and introduces random values for members of $H \backslash G$. For (169) this means that every set of assignments with the right domain that contains at least one extension of the input-assignment in the sense of (89) itself stands in the relation to it. In (170), this relation is generalized to a relation between sets of assignment, such that each element of G' has an extension in H'. This last relation basically encodes the dynamic version of entailment:[106]

[105] All of these definitions are taken from Dekker (1996). In Heim (1982), a definition on the basis possible worlds is given, which will be implemented eventually, but is not discussed at the moment. The attentive reader will have noticed by this point that the set of assignments alone is not capable of reflecting truth-conditions. Implicitly, the model $\mathcal{M}$, or, to be more precise, the domain M does most of the work.

[106] Entailment as relation between formulæ can be defined on the basis of (i) along the following lines.

(171) *Entailment from files*:
A set of assignments $G' \subseteq Ass^G$ entails a formula φ iff there exists a (possibly empty) set of variables V such that $G' \subseteq_V [\![\varphi]\!](G')$

Thus, a set of assignments entails a formula φ iff the set of assignments that results from interpreting φ contains extensions for every element of G'; that is; no assignment is lost in the process. If φ does not contain any new variable with respect to the domain of G' (that is, G), this boils down to subsethood, which is the defining characteristic of entailment in static semantics.[107]

Given this, it is possible to describe what happens when a definite (disregarding the issues around uniqueness for the moment) is licensed by a set of assignments: either it reuses an element from the domain, or its descriptive content already is anticipated, i.e. entailed by the file. This basically means that the evaluation of the definite just adds another variable to the domain, without reducing the number of assignments in play. These two possibilities overlap, of course, without being equivalent. If an already introduced variable is reused in the translation of a definite description, it can as well be the case that the descriptive content of the definite description is entailed by the set of assignments as well. But this is not necessarily so, since the reused variable need not be associated with the exact descriptive content of the definite. Maybe it is associated with a superset of it, which still guarantees the description to work. The definite then is *informative*, thus not entailed, in the sense that it supplies additional information about the antecedent:

(172) Johnny Depp went broke. The actor lost all of his money to his ex-wife.

Even though Johnny Depp is pretty famous, it isn't necessarily true that any "common ground" entails that he is an actor. Thus, there might be discourses (or participants thereof) for which the second sentence in (172) carries the new information that Depp is an actor. This hardly leads to the rejection of the utterance because of a non-felicitous use of the definite article. Rather, the "common ground" is silently adapted so that this information holds. This phenomenon is called *accommodation*.[108] Accommodation thus is taken to explain cases in which a definite seems to be felicitously used without either of both conditions being met. Heim gives the following examples (Heim, 1982, p. 239):

(173) a. Watch out, the dog will bite you.

Let $\varphi \in T$ such that φ comprises just the premises, and $\chi \in BS \cup T$ the conclusion. φ entails χ iff evaluating φ against the set of the empty assignment $\{f^\emptyset\} = Ass^\emptyset$ yields a set of assignments that entails χ according to (i). Or, more directly, φ entails χ iff the following holds:

(i) $[\![\varphi]\!](\{f^\emptyset\}) \subseteq_V [\![\chi]\!]([\![\varphi]\!](\{f^\emptyset\}))$

[107] It should be clear that this definition implicitly quantifies over $\mathcal{M}$ universally as well.

[108] This silent addition of a premise to the "common ground" seems to be the original meaning of the term. Recently another even more technical sense of "accommodation" has emerged, namely, roughly put, as description of a movement-like operation of definite descriptions and other expressions. More on this below.

b. The sun is shining.
c. John read a book about Schubert and wrote to the author.

One might argue that any reasonable "common ground" entails there being exactly one sun (which on the other hand would exclude anything bigger than earth's solar system from being a topic in a discourse), but the dog in (173a) and the author of the book about Schubert in (173c) hardly can likewise be argued to be part of any "common ground" whatsoever.[109]

Be this as it may, neither case falsifies anything that was said about the two notions of Novelty above. If a definite is anaphorically related to an earlier expression, it needs to reuse its variable. And if there is no variable in the domain it reuses, it is licensed solely on the basis of entailment. Whichever variable is chosen for the description's translation in the second case, it is new with respect to the file, which makes it new with respect to the Logical Form as well. Thus, the two senses of the Novelty Condition still are equivalent. But Heim makes use of the first way to license definite descriptions, namely by reusing a variable in the assignment's domain, to account for demonstratively used definite descriptions as well. Since they pattern with personal pronouns,[110] which only allow this way to be licensed, this is the only choice. This move assimilates deictic uses like in (174a) to anaphoric uses in (174c), and likewise for pronouns (viz. (174b) and (174d)).

(174) a. Hey look, the woman [pointing gesture] carries a cat around.
b. Hey look, she [pointing gesture] carries a cat around.
c. A woman enters the room. The woman carries a cat around.
d. A woman enters the room. She carries a cat around.

But this opens different ways for variable names to enter the domain of a file, besides being explicitly introduced by indefinites. And therefore, the two notions of Novelty drift apart: now there can be variable names in the domain of a file without having been used in the translation process. Therefore, Novelty with respect to a Logical Form (150) doesn't entail Novelty with respect to a file (167) anymore (but vice versa, given something like Binding Theory). From this it follows that the syntactic way of defining Novelty (150) is not sufficient to constrain the translation of indefinites. Not because they are suddenly able to reuse a variable that figures in a basic sentence to their left (this still isn't possible), but because their translation could accidentally use a variable which represents a contextually given individual. This would then result in a demonstrative interpretation of an *indefinite*, which seems to be impossible based on examples like the following.

[109] (173c) might be eliminated from this list by assimilating it to anaphoric uses, arguing that the noun *author*, being relational, comes with an additional argument slot which behaves anaphorically and happily finds an antecedent in the indefinite *a book about Schubert*. For an account along these lines see Dekker (1993a).

[110] Maybe with the exception of *it* that, for some reason, doesn't seem to have deictic uses. Abbott (2002) suggests that this possible function of *it* is delegated to pronominal *that* and that the availability of this latter expression blocks deictic uses of *it* in return.

(175) a. Look. The clown [pointing] squirts water from his flower.
b. #Look. A clown [pointing] squirts water from his flower.[111]

Heim therefore consequently proposes a formulation of all felicity-conditions on the basis of domains of files alone:

(176) *Extended Novelty-Familiarity-Condition*: (Heim, 1982, p. 238)
For φ to be felicitous with respect to a file $G' \subseteq Ass^G$ it is required for every DP_i in φ that:
a. if DP_i is [–definite], then $x_i \notin G$
b. if DP_i is [+definite], then
(i) $x_i \in G$, or
(ii) if DP_i is a formula, G' entails DP_i.

DPs and their uses are thereby characterized along the following lines:

(177) Heimian Typology of (In-)Definites

Expression DP_i	Use	Felicity condition
Definite article + N	Anaphoric	$x_i \in G$
	Demonstrative	(+ Entailment)
	Presuppositional	Entailment
	(possibly involving accommodation)	
Personal pronoun	Anaphoric	$x_i \in G$
	Demonstrative	$x_i \in G$
Indefinite article + N		$x_i \notin G$

This characterization is not just a neat way to summarize but also of explanatory value. As can be seen, wherever a pronoun is felicitous, a definite description also is, at least with respect to indexing. The descriptive material needs to fit the antecedent as well, otherwise, the anaphoric relation isn't established. This second criterion possibly is an effect of the entailment condition as well. On the other hand, the felicity condition of indefinites renders them unsuited for anaphoric and demonstrative uses. One might further ask whether the use of indefinites should be labeled "presuppositional", too, but this is not done here. A possible account stemming from (177) may deem the lack of descriptive material pronouns in contradistinction to definite descriptions exhibit responsible for the lack of "presuppositional" uses, that is, uses in which the expressions are self-standing (introducing an own variable) and maybe even induce uniqueness presup-

[111] To be fair, examples like (175b) are not totally out, presumably because it is possible to separate the pointing from the interpretation of the indefinite. One may argue that the pointing is directed to the complete scene instead of just the individual, even though it is hard to imagine how to test this kind of hypothesis. For the point that is about to be made here it is crucial that the indefinite is not allowed to pick variables from the contextually determined part of the domain as well (since this would run counter to the Novelty Condition), and hence, cannot used demonstratively. This might be stretch if *Hey look, a clown [pointing].* (Ede Zimmermann, p.c.) is considered, but the kind of strategy just suggested possibly carries over to this case as well.

positions, as mentioned above. Thereby, one would also capture the fact that pronouns cannot be accommodated and inevitably render a sentence bad if there is no antecedent, again contrary to definite descriptions:

(178) a. Sarah cycles. *It is blue.
b. Ramona rides a bike. It is blue.
c. Sarah cycles. The / her bike is blue.

But what does this do to the projection of variables? If the whole discussion above did not start with indefinites and pronouns, but with definite description and pronouns, then the following pattern would have emerged as the one to derive (using ℩ in place of $\exists$ to avoid confusion):

(179)

a.	$Px_1 \wedge Qx_1$ ✓	b.	$Px_1 \wedge (\text{℩}x_1)[Qx_1]$ ✓	c.	$Px_1 \wedge \neg(\text{℩}x_1)[Qx_1]$ ✓
d.	$(\text{℩}x_1)[Px_1] \wedge Qx_1$ ✓	e.	$(\text{℩}x_1)[Px_1] \wedge (\text{℩}x_1)[Qx_1]$ ✓	f.	$(\text{℩}x_1)[Px_1] \wedge \neg(\text{℩}x_1)[Qx_1]$ ✓
g.	$\neg(\text{℩}x_1)[Px_1] \wedge Qx_1$ ✗	h.	$\neg(\text{℩}x_1)[Px_1] \wedge (\text{℩}x_1)[Qx_1]$ ✗	i.	$\neg(\text{℩}x_1)[Px_1] \wedge \neg(\text{℩}x_1)[Qx_1]$ ✗?

A similar line of reasoning would then have come to the conclusion that the only thing that needs to be avoided is that a definite in the second formula of a conjunction reuses an inaccessible variable of the first one; a claim much weaker than Dekker's main definedness criterion (155):[112]

(180) $\varphi \wedge \phi$ is defined iff $B(\varphi)\backslash A(\varphi) \subseteq \overline{B(\psi)}$

This is as fine as the conclusion drawn in the last section, but the crucial question of course is how to characterize formulæ containing mixtures of quantifiers like $(\exists x_1)[Px_1] \wedge (\text{℩}x_1)[Qx_1]$. And this is the real problem of the discourse-syntactic approach, since it then needs a way to categorize variables based on their accompanying quantifiers. Not that this is impossible. One could distinguish definite and indefinite variables by splitting B into $B^{\text{℩}}$ and $B^{\exists}$, and, e.g., state the definedness conditions of conjunctions like this:

(181) $\varphi \wedge \phi$ is defined iff
a. $F(\varphi) \cup A(\varphi) \subseteq \overline{B^{\exists}(\psi)}$
b. $(B^{\text{℩}}(\varphi) \cup B^{\exists}(\varphi))\backslash A(\varphi) \subseteq \overline{(B^{\text{℩}}(\psi) \cup B^{\exists}(\psi))}$

This would work as well as the alternative proposed below. But note that the neat graphical DRT-like representation would be even more involved, to say the least.

Alternatively, one may utilize a slightly different approach. Instead of trying to describe

[112] Again, that is not even clear once plurals are taken into consideration. See the remarks on inaccessible variables below.

projection in terms of felicity conditions on logical connectives and quantifiers, one may also try to "hardwire" the relation of quantified variables to the ones already in play by utilizing different extension relations. That is, taking DRT's relation '$\subseteq_V$', of which it was said above that it only then describes the use of indefinites correctly if felicity conditions are in charge, and comparing it to the pattern of definites in (179), it is immediately obvious that it fares quite well. Since '$\subseteq_V$' is compatible with the variables in V already being in the domain of the assignment on its left or not, it correctly models the the first two rows of (179). What it doesn't get are inaccessible variables. Apart from that, DRT's and FCS's standard extension relation seems to be better suited for describing the way definite descriptions relate to the domain. For indefinites, a stronger relation '$\subset_V$' may be defined, differing from '$\subseteq_V$' only in one crucial detail, namely that it doesn't allow the variables in V already be in the domain of the assignment to be extended:

(182) *Strict extension of assignments*:
If g^G and h^H are assignment functions and V a (possibly empty) set of variables, then h strictly extends g by V—$g \subset_V h$—iff $G \cap V = \emptyset$, $G \cup V = H$, and $g \subseteq h$ holds, that is, g and h agree on all values in G.

This then correctly describes the part of (158), repeated below, that does contain '$\exists$' but not negation:

(158)

a.	$Px_1 \wedge Qx_1$ ✓	b.	$Px_1 \wedge (\exists x_1)[Qx_1]$ ✗	c.	$Px_1 \wedge \neg(\exists x_1)[Qx_1]$ ✗
d.	$(\exists x_1)[Px_1] \wedge Qx_1$ ✓	e.	$(\exists x_1)[Px_1] \wedge (\exists x_1)[Qx_1]$ ✗	f.	$(\exists x_1)[Px_1] \wedge \neg(\exists x_1)[Qx_1]$ ✗
g.	$\neg(\exists x_1)[Px_1] \wedge Qx_1$ ✗	h.	$\neg(\exists x_1)[Px_1] \wedge (\exists x_1)[Qx_1]$ ✗	i.	$\neg(\exists x_1)[Px_1] \wedge \neg(\exists x_1)[Qx_1]$ ✗

If negated formulæ are ignored for a second, then these two relations embody an account of novelty and familiarity with respect to the file.[113] They thus do not need to rely on any syntactic characterization of projection. If there weren't negation. It was already hinted that it is disputable whether negation really should block the projection of active variables or not. On the one hand, there are a lot of examples that suggest exactly this, as mentioned above. But there are exceptions as well.

The most general exception are proper names (or, more generally, rigidly designating expressions). They seem to escape allegedly inaccessible environments effortlessly:[114]

[113] That there are several possibilities to define the extension of assignments of course was already noticed. E.g., close cousins of both, '$\subseteq_V$' and '$\subset_V$' are found in van den Berg (1996). But it seems they weren't put to use in this fashion yet. E.g. van den Berg continues to use '$\subseteq_V$' to translate indefinites as well.

[114] It should be mentioned that this assessment is challenged by Neo-descriptivists like Geurts (e.g. Geurts, 1997) based on examples like the following. These examples have drawn some attention because of their straightforward compatibility with van der Sandt's (1992) binding theory of presuppositions.

(183) a. Julia didn't hurt Romeo. She missed him.
b. It is not the case that Romeo bought a present for Julia. He completely forgot her birthday.
c. Every man saw Julia at the party. Her dress caught quite some attention.

This is accounted for in DRT by stipulating that proper names project their variable to the principal DRS, from where they are accessible for every anaphoric expression in a discourse, regardless where they originate. This assumption poses a further problem since the contribution of proper names shouldn't be interpreted as existentially quantified, unlike every other variable that ends up in a box. This is why DRT makes use of *anchors* in the first place.

But there are two problems with this assumption. First, if definite descriptions are used (co-)referentially, they behave exactly like proper names in this respect. Thus, the assumption should be extended to cover *referential* expressions in general. Secondly, even the contribution of indefinites embedded under negation can be picked up again in some cases. This seems to be generally possible if the anaphoric expression is plural.

(184) It is not the case that a dog crossed the street.
a. *It stayed on the right side.
b. They (all) stayed on the right side.

(185) Anna didn't buy a Ferrari.
a. *It was too expensive.
b. They were too expensive.

Judging from (184) and (185), the correct generalization seems to be that negation blocks the projection of *singular* discourse referents, but collects all the singular instances of the indefinite in its scope into a pluralized value which can serve as antecedent for subsequent plural pronouns. But this doesn't account for (183) as well as cases with overt *double negation* (Groenendijk and Stokhof, 1991, p. 91):

(186) It is not true that John doesn't own a car. It is red, and it is parked in front of his house.

Some therefore propose to "open up" negation in some way or other. The most radical proposal is from van den Berg (1996) who flat out allows the projection of singulars. To explain e.g. (185b) he assumes a weak/strong-ambiguity of the indefinite. The

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This discussion is not pursued any further.

(i) If a child is christened 'Bambi', then Disney will sue Bambi's parents.

(ii) [Context: The electoral process is under attack, and it is proposed, in light of recent results, that alphabetical order would be a better method of selection than the present one. Someone supposes that 'Aaron Aardvark' might be the winning name and says, "If that procedure had been instituted, Ronald Reagan would still be doing TV commercials, and]
Aaron Aardvark might have been president"

former project singular variables but the latter pluralized ones. (cf. Brasoveanu, 2008, who elaborates on this assumption) The question then of course is why neither (184) nor (185) can employ a weak indefinite. Krahmer and Muskens (1995) on the other hand, deal with double negation examples by allowing to "reactivate" once deactivated variables. To this end, they complement the set of active variables (or *a*ctive *d*iscourse *r*eferents; ADR) with a set of passive, i.e. deactivated variables (PDR). The latter set is empty for most formulæ, except the ones headed by negation. The set of passive variables of a negated sentence is the set of active variables of its unnegated counterpart, while the set of active variables of a negated sentence is the set of passive variables of its constituent sentence. So, a single negation sign still deactivates the variables of its complement, but stores them for later reactivation. This can done by putting another negation in front of it. Assuming that the constituent sentence projects only one active and no passive variable, the modification by negation alters the projection along these lines:

(187)

Formula	ADR	PDR	
φ	$\{x_i\}$	$\emptyset$	(by assumption)
$\neg\varphi$	$\emptyset$	$\{x_i\}$	
$\neg\neg\varphi$	$\{x_i\}$	$\emptyset$	and so on

This straightforwardly accounts for examples with double negation and anaphoric singular pronouns.[115] This account is not intended to deal with plural anaphora though.

Another class of examples that may be relevant for the discussion of negation are constructions that allow *telescoping* (cf. Poesio and Zucchi, 1992; Roberts, 1989):

(188) Every girl gave every boy a present. She put it on his desk.

This is relevant for the current discussion under the assumption that universal quantification is defined through negated existential quantifiers as in standard predicate logic. This isn't necessarily the case in dynamic semantics, see e.g. Dekker (1996) where different ways do handle quantification are presented. But even if it doesn't influence the conception of negation, it constitutes an interesting datum on its own.

Anyway, pairs like the following (taken from Wang et al. (2006)) show that there is more to this than just a question of projection:

(189) Every hunter that saw a deer shot it.

[115] Furthermore, it as straightforwardly captures so called "bathroom sentences" (i) (first mentioned in Geach (1962), although not yet featuring a bathroom, see also Roberts (1989) and Geurts (1999), among others) which can be treated as the paraphrase in (ii), involving double negation, suggests:

(i) Either there is no bathroom in this house, or it is in a funny place.

(ii) If it isn't the case that there is no bathroom in this house then it is in a funny place.

On the other hand, it doesn't account for Krahmer and Musken's intuition (also reported by van Rooij (2001) and van Rooij (2006)) that (186) conveys that John owns exactly one car. The account sketched below (section 3.4.3) does, though, without stipulating a difference in the pronouns as van Rooij assumes.

a. (?)It died immediately.
b. *He intended to kill it.

That (189a) kind of works while (189b) is bad often is ascribed to the different *Rhetorical Relations* (Asher and Lascarides, 2003) these sentences stand in to the first sentence. (189a) describes the RESULT of the action described by (189), while (189b) attempts to give some BACKGROUND. The second sentence in (188), on the other hand, ELABORATES on the first one, making the interpretation of singular pronouns easier (Wang et al., 2006).

Finally, there are cases often dubbed *quantificational subordination*, as they seem to be on a par with *modal subordination* (again, cf. Roberts, 1989):

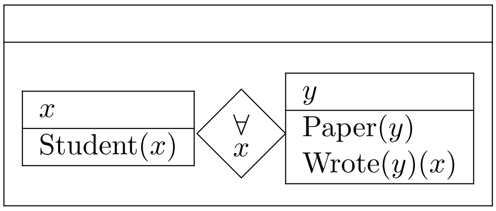
(190) a. Every student wrote a paper. They submitted it to a journal.
b. A thief might break into the house. He would take the silver.

Intuitively, a quantificational element, *would* with widest scope in (190b) and *they* interpreted distributively in (190a) allows for a singular pronoun if its antecedent is introduced under a somewhat similar quantifier (*might* in (190b) and *every student* in (190a)) in the original sentence. However, plural pronouns are better (according to the survey in Wang et al. (2006)) in all of these environments; except in case of modal subordination (but this exact configuration isn't tested in said survey):

(191) a. Every girl gave every boy a present. They put them on their desks.
b. Every hunter that saw a deer shot it. They died immediately.
c. Every hunter that saw a deer shot it. They intended to kill them.
d. Every student wrote a paper. They submitted them to a journal.

Thus, letting even negated sentences project some pluralized discourse referent seems mandatory, since their felicity doesn't seem to depend on the kind of rhetorical relation involved.[116] To illustrate what is meant by this, consider the first sentence of (191d). As DRT has it, it is possible to extract a plural discourse referent out of the duplex condition that represents the universal quantifier. As is briefly shown in section 3.3.3, quantification looks like (192) in Kamp and Reyle (1993):

(192)

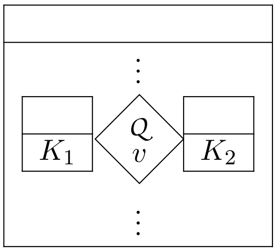


The plural discourse referents used by the plural pronouns in (191) are derived by the so-called *abstraction rule* whose applicability is bound to duplex conditions. Roughly, in a box like (193a), the optional insertion of another box as in (193b) is allowed which

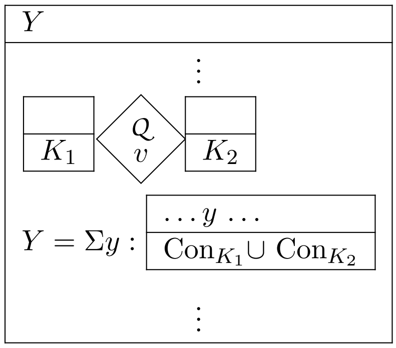
[116] Needless to say, a discourse can suffer from the sentences standing in the wrong rhetorical relation and thus sound weird completely independent of the choice of anaphoric pronouns. These cases obviously have to be left aside.

contains a clause that sums the values of a designated discourse referent introduced either in K_1 or K_2 while interpreting all others as usual, namely as existentially quantified. If more than one pluralized discourse referent is needed, more of these boxes can be inserted:[117]

(193) a.



b.



The availability of such a rule accounts for plural anaphora with quantificational antecedent as well as anaphora with antecedents that should be inaccessible according to the the standard interpretation, since they are embedded too deeply in duplex conditions. However, as it stands, it has nothing to say about the cases in which only negation seems to hinder singular anaphors from picking their antecedent. This will be changed in section 3.4.3, where a version of negation that is coupled with DRT's abstraction-operator is proposed.

Those cases that allow for singular pronouns to pick up a variable that is too deeply embedded partly are explained away by having a different structure. E.g., the mechanism in Roberts (1989) (and to a certain degree the ones in Asher and Lascarides (2003) as well) treat (188) as if the second sentence gets attached to the deepest constituent. (194) may serve as an illustration, even though it cannot be said to capture the exact reading (188) has. The point is, the second sentence is literally subordinated under the quantifier in the first sentence. There the singular pronouns are of course felicitous.

(188) Every girl gave every boy a present. She put it on his desk.

(194) Every girl [gave every boy a present by putting it on his desk]

This concludes the sections dealing with projection. It took a long way before a way was found to define the growth of the domain solely in terms of two different relations, one being the one DRT most prominently uses to give the semantics of (sub-)DRSs, and one stricter version of it. Both relations are already known, but they weren't put to use in the way they are here, namely as the core of two different kinds of quantifiers that mimick the behavior of definite and indefinite descriptions as close as possible. The principles lying behind these two relations are basically taken from the "discourse syntactic" approach that describes the projection behavior of variables with the help of

[117] Note further that this rule still projects a referential discourse referent Y if y abstracted over is referential, since under all plural ontologies the sum of an individual and itself—$a \oplus a$—is the individual—a—again.

different sets of variables. Once deactivated or inaccessible variables are done away with, it is seen that all there needs to be are those two relations that only differ in whether or not variables already in play are allowed to be reused.

3.4 Intensional FCS with partial states

In this section a multitude of things are done at the same time:

1. FCS is brought into the EDPL format mentioned above. That is, it is given roughly the same syntax as (D)PL, but the interpretation is relativized to sets of assignments instead of assignments simpliciter.

2. FCS is endowed with only one of the two quantifiers, namely $\exists$. Ɑ is added in section 3.4.2. One difference between the two lies in the extension relations; other differences are motivated by their truth conditional and presuppositional profile. This is discussed in this section as well.

3. The first version of intensional FCS treats negation roughly as in original FCS (and DPL). This assignment is discussed and ultimately liberated in section 3.4.3, where a variant is proposed that allows for the projection of variable names introduced in the embedded sentence, but pluralizes their values along the way with the help of a DRT-like *abstraction* operator.

4. The shape FCS now takes is that of a three valued language, because it states some conditions on the domains of assignments by virtue of a dedicated semantic value, denoted by $[\![\bullet]\!]^d$. These conditions are all formulated on the basis of this d-value and a file G it is applied to. Thus, in this sense, the d-values correspond to the domain-related clauses in original FCS. But they do more. They allow to collect the demands put on the domain of files on the basis of the syntactic form of the formulæ, and thereby to say precisely which file meets them. Usually, in such systems, the contributions of expressions to both genuine truth values have to be given an explicit definition in form of a positive ($[\![\bullet]\!]^+$) and a negative value ($[\![\bullet]\!]^-$). These values taken together have to lie in and exhaust the d-values for each expression individually, for the whole language to count as classical, i.e. two-valued.

5. Situation variables are now considered to be part of the syntax. This means that FCS is lifted to represent intensions. To indicate this change, v_i is used in place of x_i in the following definitions. In principle, the language so defined should be able to have something to say about many more phenomena than talked about so far. But the discussion of modality and especially attitude reports is postponed until the final chapter, whereas time and tense related phenomena are disregarded throughout this thesis. For the moment, the set of assignments figuring in the definition are not restricted to the ones containing only one situation variable in their domain (or the corresponding variables necessary for describing 'unpacked'

cores in the sense of section 2.2.3). But this needs to be done at some point if (sets of) assignments are to represent (sets of) indices in the manner sketched in section 3.2.3. This restriction is also tackled in the final chapter, but for the following, it needs to be assumed to hold.

3.4.1 Managing partiality

Instead of distinguishing multiple sets of variables by their origin and posing different filters for well-formedness, one might also try out several different extension mechanisms. The extension relation (89) univocally used for all kinds of expressions in DRT gives exactly what one needs for definites (once Binding Theory is implemented, see below). Additionally, a stronger relation (182), demanding the variable to be "fresh" is utilized as well:

(89) *Weak Extension of assignments*:
If g^G and h^H are assignment functions and V a set of variables, then h extends g by V—$g \subseteq_V h$—iff $G \cup V = H$ and $g \subseteq h$ holds, that is, g and h agree on all values in G.

(182) *Strict extension of assignments*:
If g^G and h^H are assignment functions and V a (possibly empty) set of variables, then h strictly extends g by V—$g \subset_V h$—iff $G \cap V = \emptyset$, and $g \subseteq_V h$.

In the following, β' denotes the intension of the predicate β assigned by the (implicit) interpretation function. I.e. β' is a set tuples where the first position is occupied by the situational core of an index, and all following positions occupied by individuals represent the argument structure.

(195) Intensional FCS with partial states

a.
$$\begin{array}{lcl} [\![\beta\upsilon_0 \ldots \upsilon_n]\!]^d(G) & = & \{g \in G : g(\upsilon_0) \neq \# \ \& \ \ldots \ \& \ g(\upsilon_n) \neq \#\} \\ [\![\beta\upsilon_0 \ldots \upsilon_n]\!]^+(G) & = & \{g \in G : \langle g(\upsilon_0), \ldots, g(\upsilon_n)\rangle \in \beta'\} \\ [\![\beta\upsilon_0 \ldots \upsilon_n]\!]^-(G) & = & \{g \in G : \langle g(\upsilon_0), \ldots, g(\upsilon_n)\rangle \notin \beta'\} \end{array}$$

b.
$$\begin{array}{lcl} [\![\varphi \wedge \psi]\!]^d(G) & = & [\![\psi]\!]^d([\![\varphi]\!]^d(G)) \\ [\![\varphi \wedge \psi]\!]^+(G) & = & [\![\psi]\!]^+([\![\varphi]\!]^+(G)) \\ [\![\varphi \wedge \psi]\!]^-(G) & = & [[\![\psi]\!]^-([\![\varphi]\!]^+(G))] \cup [[\![\psi]\!]^+([\![\varphi]\!]^-(G))] \cup [[\![\psi]\!]^-([\![\varphi]\!]^-(G))] \end{array}$$

c.
$$\begin{array}{lcl} [\![\neg\varphi]\!]^d(G) & = & \{g \in G : [\![\varphi]\!]^d(\{g\}) \neq \emptyset\} \\ [\![\neg\varphi]\!]^+(G) & = & \{g \in G : [\![\varphi]\!]^+(\{g\}) = \emptyset\} \qquad \text{preliminary} \\ [\![\neg\varphi]\!]^-(G) & = & \{g \in G : [\![\varphi]\!]^+(\{g\}) \neq \emptyset\} \end{array}$$

d.
$$\begin{array}{lcl} [\![(\exists\upsilon)[\varphi]]\!]^d(G) & = & [\![\varphi]\!]^d(\{h : \exists g \in G : g \subset_{\{\upsilon\}} h\}) \\ [\![(\exists\upsilon)[\varphi]]\!]^+(G) & = & [\![\varphi]\!]^+(\{h : \exists g \in G : g \subset_{\{\upsilon\}} h\}) \qquad \text{preliminary} \\ [\![(\exists\upsilon)[\varphi]]\!]^-(G) & = & [\![\varphi]\!]^-(\{h : \exists g \in G : g \subset_{\{\upsilon\}} h\}) \end{array}$$

To see how this works, consider the $[\![\bullet]\!]^+$-value in (195a). It gives the all familiar clause for atomic sentences.[118] For any non-empty set of assignments as input, there are two possible outcomes: In case the domain of the assignments cover all variables employed in the sentence, the output either is a non-empty subset of G, if there are cases that make the statement true (or even G itself in case it holds for all assignments in G), otherwise, G reduces to the empty set. This last outcome also is the result if the domain doesn't cover all variables used, since neither $\langle \dots g(\upsilon_i) \dots \rangle \in \beta'$ nor $\langle \dots g(\upsilon_i) \dots \rangle \notin \beta'$ are true if $g(\upsilon_i) = \#$ (for any g, υ_i, and β'). Since all possible arguments of $[\![(195a)]\!]^+$ are defined to be homogeneous with respect to the variables covered, there can't be any other output than the empty set, if at least one variable is not taken care of, or the same set again, if all variables are in the domain. This more or less directly carries over to the more complex sentences as well, except for the possible extension of the input-set's domain. For example, the strict extension relation that makes its appearance in the formulation of $[\![(\exists\upsilon)[\varphi]]\!]^+$ in (195d) is responsible for the function returning $\emptyset$ if υ_n already is part of G's domain. Hence, there are two cases to distinguish: the empty set as the result of the set of input assignments having an insufficient domain, and the empty set as the result of the sentence being evaluated expressing falsity with respect to all possibilities in the common ground. The latter case should count as a regular output of $[\![\bullet]\!]^+$- (and $[\![\bullet]\!]^-$-) values, while the former should not receive the same interpretation. That is, if the empty set is the output because there are variables unaccounted for (or there is an attempt at "requantification"), it doesn't represent a set of indices. It is merely the "bookkeeping device" that goes astray. This is where the $[\![\bullet]\!]^d$-values come into play. These clauses describe how undefinedness arises in simple or complex formulæ. For any non-empty set of assignments as input, the $[\![\bullet]\!]^d$-value for basic sentences (195a) returns the empty set as soon as the 'dummy individual' $\#_e$ makes its appearance as value of a variable employed. This will be the case the variable is not in the argument's domain.[119] If all variables are properly accounted for, the output is the same as the input. Again, this more or less carries over to the d-values of more complex formulæ. (195d) adds the condition that υ can't be part of G's domain, and the whole procedure extends G's domain. All of what was just said only holds if the initial argument G isn't empty. If it is, everything collapses, since there is no way to add assignments. Thus, whatever the formula, all three of its values return the empty set if it is fed to them. For the truth conditional values $[\![\bullet]\!]^+$ and $[\![\bullet]\!]^-$, this represents the breakdown of logical entailment once the "common ground" is emptied out by the addition of a logical (or "conversational") falsehood. If a contradiction is accepted in a conversation, everything is possible.[120] But it would be a overreaction to exclude the empty set from the set of possible arguments of positive and negative values altogether, since $\emptyset$ is a possible

[118] Identity between variables can be thought of as being among them. It can be given a dedicated symbolism, but ultimately, it shouldn't differ in terms of definedness conditions as well as in terms of the derivation of positive and negative value from normal, situation dependent predicates.

[119] Thus, the definition of assignments as total functions that assign $\#_e$ to all but an finite set of variables helps formulating conditions on the basis of the values of variables instead of their syntactic form.

[120] This breakdown corresponds to what happens in model theory if the empty domain is considered to be a universe. Since this special case is somewhat "neurotic", it usually is excluded in the definition of models.

outcome of the evaluation of a sentence after all. E.g., if (196a) is calculated, $\emptyset$ should not just be the outcome of the whole procedure, but the input for $[\![Qx_i]\!]^+$ as well:

(196) a. $[\![(Px_i \wedge \neg Px_i) \wedge Qx_i]\!]^+(G)$
b. $[\![(Px_i \wedge \neg Px_i) \wedge Qx_i]\!]^d(G)$

But this isn't mirrored in the d-values. (196b) should count as defined for G if G's domain hosts x_i, and it does, because the output of $[\![Px_i \wedge \neg Px_i]\!]^d(G)$ isn't $\emptyset$ but G in this case (assuming G isn't empty from the start).

(195b) and (195c) basically give the truth tables for conjunction (weak Kleene conjunction, cf. (197a)) and standard DPL-negation (weak Kleene negation, cf. (197b)). It isn't possible to simply define a negated sentence to be defined if its constituent sentence is. This is because the constituent sentence may contain quantifiers that extend the domain. These extensions shouldn't project beyond negation; as the dynamic orthodoxy has it. In this sense, (195c) doesn't do justice to the discussion at the end of section 3.3.4. Negation will be revisited later on.

(197) a.

$\wedge$	1	0	#
1	1	0	#
0	0	0	#
#	#	#	#

b.

$\neg$	
1	0
0	1
#	#

This system is enough to describe the intended way of handling undefinedness, as van den Berg (1996) shows, simply because the 'dummy individual' # is maximally contagious. If it is the value of a variable in a constituent sentence, there is no way for the main sentence to yield a value different from the empty set, regardless how it is structured. Thus, formulæ in which an unlicensed variable occurs are beyond repair. This is reflected in the following convention:

(198) An expression α is *defined* with respect to a file G iff $[\![\alpha]\!]^d(G) \neq \emptyset$.

Since the definedness condition of basic sentences just is about the variables in the formula and the domain of the file, no substantial statement is made if a formula is called (un-)defined. If an expression isn't defined, both its positive and its negative value are empty. As can be shown by simple induction, the proper values are subsets of the d-value and do not overlap. Thus, non-appropriate assignments are simply ignored. This is not done for the version just presented, because it will be changed constantly in what follows.

A further notion that comes in handy later on is that of a domain of variables that ensure definedness. It is easily defined from the $[\![\bullet]\!]^d$ values given in (195). The only thing that needs to be added is a minimality requirement to the end that the smallest of all possible sets of variables is returned:

(199) A set of variables $\mathcal{D}[\alpha]$ is the minimal domain of an expression α in FCS iff:
$\mathcal{D}[\alpha] \in \{V : [\![\alpha]\!]^d(Ass^V) \neq \emptyset\}$ and $\forall X' \in \{V : [\![\alpha]\!]^d(Ass^V) \neq \emptyset\} : \mathcal{D}[\alpha] \subseteq X'$.

Similarly, the domain of variables actually made use of in an expression α, the *minimal range*, so to speak, is:

(200) A set of variables $\mathcal{R}[\alpha]$ is the minimal range of an expression α in FCS iff $[\![\alpha]\!]^d(Ass^{\mathcal{D}[\alpha]}) \subseteq Ass^{\mathcal{R}[\alpha]}$.

Thus, for an atomic sentence Bsx_i, the domain comes out as $\{s, x_i\}$, while for an existentially quantified statement $(\exists x_i)[\varphi]$ the domain is $\mathcal{D}[\varphi]\backslash\{x_i\}$, since x_i is added in the process. For constructions known as *tests* in DPL, domain and range coincide. This is always the case for atomic and negated sentences in FCS, and can be the case for conjunctions, depending on the status of the sentences conjoined. In contrast, if $\mathcal{D}[\varphi] \neq \mathcal{R}[\varphi]$, at least one variable is newly introduced within φ. In contrast to $\mathcal{D}[(\exists x_n)[\varphi]]$, $\mathcal{R}[(\exists x_n)[\varphi]]$ contains x_n (along with every variable contained in $\mathcal{D}[\varphi]$). Thus $\mathcal{D}[(\exists x_n)[\varphi]] \neq \mathcal{R}[(\exists x_n)[\varphi]]$ holds generally. Thus, the dynamic part of the language is characterized as well.

An existentially quantified formula either serves as the translation of noun phrases like *a sheep* or as the translation of full sentences with an indefinite in subject position. I.e., either the sentence φ it attaches to must differentiate between restrictor and nuclear scope, as the traditional formulæ assigned to indefinites usually do, or it just represents the nuclear scope. That is, an indefinite article might be assigned a formula like (201a) or (201b), with P being the placeholder for the restrictor, and Q the one for the nuclear scope, respectively.

(201) a. $(\exists x_n)[Px_n \wedge Qx_n]$
b. $(\exists x_n)[Px_n] \wedge Qx_n$

At the moment, the two formulæ are equivalent, so it doesn't really matter.[121]

3.4.2 Definite articles

What should the logical forms of definites be? Apart from utilizing the weaker of the two extension relations, nothing has been established so far. Definites shouldn't be modeled in such a way that its restrictor is treated as given, e.g. by demanding that the current file entails its content, *pace* Heim (1982) and Heim (1983), since this demand is too much for intensional FCS. To see this, an intuitively correct way of defining entailment in FCS is considered. Such a definition bases itself on the notion of entailment from a file. Informally, a file entails a formula if no assignment is lost when the formula is added. It may not be the same set of assignments anymore, due to possible extensions of the domain. But, every assignment in the file needs to be preserved in the sense that there needs to be at least one descendant of it in the file after the update. If G' is the starting file, and φ is the formula, for every element of G' needs to have a continuation in $[\![\varphi]\!]^+(G')$, assuming $[\![\varphi]\!]^d(G') \neq \emptyset$. If φ is a test, $[\![\varphi]\!]^+(G')$ has the same domain as G

[121] The claims about the language made in this section of course require a much more thorough formal backup. But since (195) is only the first instance of what is developed in this chapter and in Chapter 4, especially in sections 4.2.3 and following, this isn't complied with. See the remarks in section 5.2 about some problems that indicate why this ultimately might even be impossible.

if defined. If φ isn't a test, then the domain G must be extended. Hence, what is needed here is a relation that is relativized to a set of variables V that covers both cases. In case $V = \emptyset$, it must boil down to subsethood, while for nonempty V it must state that for every assignment on the left, there is at least one V-extension on the right. Generally, V can be characterized precisely as containing those variables that are added in the course of the interpretation, i.e. those variables in the domain of $[\![\varphi]\!]^+(G')$ that weren't present in the domain of the input file G. Hence, using the notions of domain and range: $\mathcal{R}[\varphi] \backslash \mathcal{D}[\varphi]$ minus the variables in G. Hence, entailment can be stated as follows:

(202) *Entailment from files*
A set of assignments $G' \subseteq Ass^G$ entails a formula φ iff
$[\![\varphi]\!]^d(G') \neq \emptyset$ and
$\forall g \in G' \exists h \in [\![\varphi]\!]^+(G')$ such that $g \subseteq_{\mathcal{R}[\varphi] \backslash (\mathcal{D}[\varphi] \cup D(G'))} h$.

Entailment between formulæ then can be defined using this definition, by substituting, e.g., $[\![\psi]\!]^+(G'')$ for G' (for some G'').

Endowing definites with a condition such that their restrictor needs to be entailed, first, doesn't fit with using files to represent a set of indices, since this would require every index to satisfy whatever is put in the restrictor. The restrictor would have to preserve the whole set of input assignments G' and thus express some kind of logical truth. And secondly, apart from this problem, the entailment condition also raises the bar for examples like the following (cf. Heim, 1983), which constitute *Heim's problem* (cf. Aloni (2001) and Dekker (2012) for treatments):

(203)
a. A fat man pushes his bicycle.
$\approx$ A fat man pushes the bicycle he owns.
b. $(\exists x_1)[Msx_1] \wedge (\daleth x_2)[Bsx_2 \wedge Osx_1x_2] \wedge Psx_1x_2$

If it is assumed that the part in square brackets on the right of $\daleth$ needs to be entailed in the sense just defined, this means that every assignment contained in the file handed over to the definite description needs to have an extension in the file that results from updating it with the variable and the restrictor. The entailment-requirement thus is a function from two files into one: its first argument is the output of the indefinite in (203b), G', to give it a name, and its second argument argument is the update by the definite quantifier and its restrictor, i.e.:

(204) $[\![Bsx_2 \wedge Osx_1x_2]\!]^+(\{h : \exists g \in G' : g \subseteq_{\{x_2\}} h\})$

This is the file that results from (weakly) extending the input file by x_2 and restricting its values to those that verify the restrictor. As argued in the last section, this seems to be the contribution of definite articles, modeled as introducing $\daleth$ into a formula.

The following is a stepwise description of the interpretation of (203b) up to the point where the hypothetical entailment condition kicks in:

1. x_1 is added to the domain of G, the input for the whole formula in (203b);

2. The values of x_1 in the resulting set are restricted to men. This file possibly contains several values for x_1 per situation (or, more generally, per input-assignment).

3. This file is then updated by x_2, which is further restricted to bikes that are owned by the value of x_1 in the respective assignment. (cf. (204))

4. This file then is tested against an entailment condition that demands that every assignment in the input (i.e. after 2. is carried out) survives the updated carried out under 3. But this can only be fulfilled if every fat man introduced in step 1 and 2 stands in the *own* relation to a bike.

Hence, the presupposition derived is that every fat man owns a bicycle. Suppose that among the assignments in the input-file there is one which values s with s_1, a situation with three fat men—a, b, and c—out of which just two—a and b—own one bike each. This file, sketched in (205a) is written as in (205b), i.e., the files domain is written in the first column and all following columns represent one assignment each:

(205) a. $$\left\{ \begin{array}{c} \vdots \\ \{\langle s, s_1\rangle\}, \\ \vdots \end{array} \right\};$$

b.

s	$\ldots$	s_1	$\ldots$

After the steps 1 and 2 are carried out, the following file (G) is reached:

(206) a. $$\left\{ \begin{array}{c} \vdots, \\ \{\langle s, s_1\rangle, \langle x_1, a\rangle\}, \\ \{\langle s, s_1\rangle, \langle x_1, b\rangle\}, \\ \{\langle s, s_1\rangle, \langle x_1, c\rangle\}, \\ \vdots \end{array} \right\}$$

b.

s	$\ldots$	s_1	s_1	s_1	$\ldots$
x_1	$\ldots$	a	b	c	$\ldots$

(206) is the file that serves as input for the definite description, hence, it is the file that needs to entail its restrictor. According to (202) this means that every assignment in (206) has to survive the following update: x_2 is introduced into the domain by the definite quantifier and then restricted to those values that satisfy its restrictor. Given the assumptions about s_1 above, the following file results:

(207) a. $$\left\{ \begin{array}{c} \vdots, \\ \{\langle s, s_1\rangle, \langle x_1, a\rangle, \langle x_2, d\rangle\}, \\ \{\langle s, s_1\rangle, \langle x_1, b\rangle, \langle x_2, e\rangle\}, \\ \vdots \end{array} \right\}$$

b.

s	$\ldots$	s_1	s_1	$\ldots$
x_1	$\ldots$	a	b	$\ldots$
x_2	$\ldots$	d	e	$\ldots$

As can be seen, the assignment mapping x_1 to c doesn't make it because c doesn't own a bike in s_1. As the hypothetical entailment requirement has it, (206) is now compared to (207), and since not every element of (206) finds a continuation in (207), the update

(207) is infelicitous. This is far too strong in two respects:[122]

1. Suppose s_1 is the only situation assigned to s in the input file in which not all fat man own a bike. The procedure just sketched doesn't just eliminate all assignments featuring s_1, but rejects the file as a whole, simply because the of the presence of the three assignments in (206).

2. The update shouldn't even be a problem for the situation s_1 alone, since it shouldn't be necessary to conserve all possible alternatives of x_1 to continue. As in all other extensional constructions the derivation should just keep the true continuations and move on.

The second point constitutes *Heim's problem* proper. The first comes with the intensional lift implemented by having FCS operating with an s-variable. These problems can be solved simply by dropping the hypothetical entailment-requirement without replacement. With respect to s_1, (207) is exactly what one wants: the procedure keeps all assignments that satisfy the restrictor and eliminates all those that don't. Thus, if the requirement isn't in force, everything turns out as it should.

Apart from this, what is still absent is the uniqueness requirement mentioned earlier. Traditionally, e.g., coming from a Russellian formulation like (208), uniqueness was implemented as another restriction on the value of the variable (apart from the restrictor).

(208) $(\exists x)[Px \wedge (\forall y)[Py \rightarrow x = y] \wedge Qx]$

Read: there exists (at least) one individual that satisfies the restrictor P and it is at most one individual that satisfies the restrictor P and this individual Qs.

One of the most pertinent problems with such a view is that the uniqueness condition seems to be absent in some uses of definite descriptions. Recall (172) from above:

(172) Johnny Depp went broke. The actor lost all of his money to his ex-wife.

The second sentence doesn't express or imply that there is only one actor. It may suggest that there is only one *relevant* or *salient* actor at the moment, but it suggests nothing as strong as (208).

The absence of a (strong) uniqueness condition in cases like (172) is partly explained by the anaphoric capacity built into the definite quantifier ᗡ. Since it is allowed to reuse variables already in play, and since it obviously does that in the last example, one might argue that coreference with *Johnny Depp* is enough to satisfy the second ingredient of (208). That this cannot be the full story is easily seen with examples like the following:

(209) Every owner of a cat lets the feline ruin his life.

[122] This general result also holds if the uniqueness condition defined below is applied immediately after step 3.

Here, the definite description doesn't corefer simply because its antecedent doesn't refer. Instead, the antecedents' value vary with the universal quantifier. Furthermore, the indefinite possibly introduces several cats per owner. Thus, the sentence doesn't imply that every individual in the universal quantifier's domain owns exactly one cat.[123]

If this is the correct description of the data, it is difficult to see why there aren't any signs of a violation of the uniqueness condition. Thus, there is more to uniqueness than just allowing for one individual to satisfy the restrictor.

Like the entailment condition, the uniqueness condition can also be implemented as a function from two files into another one. Returning to (203), it even makes use of the same arguments as above. That is, the same procedure as above is carried out up to the third step. Then, the hypothetical uniqueness requirement has to compare (206) and (207), repeated below, and check for each element of (206) separately whether (207) introduced just one individual. If this is the case, then uniqueness is satisfied. But this can't be all. (207) doesn't continue every element of (206), since (206) still contains an assignment that assigns c to x_1. This alternative is abandoned because the individual doesn't own a single bike. If this constituted a reason for the uniqueness condition to fail, then this condition would be as demanding as the entailment-requirement just argued against. Thus, the notion of uniqueness has to be relativized to only those assignments in (206) that are continued in (207); namely the first and the second of the depicted ones.

(206)

s	$\dots$	s_1	s_1	s_1	$\dots$
x_1	$\dots$	a	b	c	$\dots$

(207)

s	$\dots$	s_1	s_1	$\dots$
x_1	$\dots$	a	b	$\dots$
x_2	$\dots$	d	e	$\dots$

Furthermore, for this to work, the relation has to be given an "address" to look at, i.e. a variable. This must be the variable of the definite under which the individual that is subject to the uniqueness condition is introduced—x_2 in the example at hand. Informally, the uniqueness condition demands that there is only one value of the variable per input assignment in the output.

To make this more precise, let's give the uniqueness condition on files, relative to a variable name, a definition:

(210) Uniqueness condition: For any files A, B:
$\text{UNIQUE}_{\{\upsilon\}}(A)(B) =$
$\{h \in B : \exists g \in A\ \exists V : g \subseteq_V h\ \&\ (\forall h' \in B)[g \subseteq_V h' \rightarrow h(\upsilon) = h'(\upsilon)]\}$

A and B are placeholders for (206) and (207), respectively. The condition in (210) collects all assignments in (207) that continue an assignment in (206) by assigning one and the same individual to the variable in question. Since all of the depicted assignments in (207) are the only continuations of the depicted assignments in (206), uniqueness is satisfied. Furthermore, it isn't a problem that the third assignment in (206) is abandoned because the condition in (210) primarily looks through (207) and only needs (206) to look for the basis out which the assignments have grown. It wouldn't even be a problem

[123]There are some claims to the contrary in some cases, most notably found in Kadmon (1990).

if there were an assignment in (207) that didn't continue an assignment in (206). But since (207) is derived from (206) by (204), this cannot happen anyway.

To see an example where the uniqueness condition rejects assignments in the second file, consider other parts of (206) and (207) not yet depicted:

(211) a.

s	…	s_2	s_2	…
x_1	…	f	g	…

b.

s	…	s_2	s_2	s_2	s_2	…
x_1	…	f	f	g	g	…
x_2	…	h	i	j	k	…

This displays a group of assignments that value s with s_2, another situation in which two men—f and g—exist who own two bikes each. The uniqueness condition (210) should not keep any of assignments in (211b) depicted. And it doesn't. While it is true that the leftmost assignment in (211b) continues the leftmost assignment in (211a), it is not true that all assignments in (211b) that also continue this assignment assign the same value to x_2. Thus, neither the first nor the second assignment in (211b) qualifies. The same holds for the other two assignments in (211b), this time with respect to the second assignment in (211a). Thus, s_2 as a situation doesn't make it, because of the uniqueness condition.

So far, so good. What remains to be shown are two things: how the uniqueness condition reacts if (i) the variable of the definite already is in play, and (ii) if the restrictor doesn't make use of other individual variables already in play.

The first point is pretty straightforward: if the definite description comes with a variable already in play, the weak extension relation runs idle, i.e. boils down to identity. Recall the definition of the weak extension relation:

(89) *Weak Extension of assignments*:
If g^G and h^H are assignment functions and V a set of variables, then h extends g by V—$g \subseteq_V h$—iff $G \cup V = H$ and $g \subseteq h$ holds, that is, g and h agree on all values in G.

If there isn't any new variable in V then $G \cup V = G = H$ and the assignment on the right side isn't "longer" than its counterpart on the left. But the subset relation between g and h still has to hold, and this means that h has no choice but to agree with g on every value of any variable in their domain. From this it follows that the uniqueness condition (210) doesn't have anything to bite on. It looks through the set of (potential) output assignments and checks whether they assign the same value to the dedicated variable if they continue the same input assignment. But since no two output assignments continue the same input assignment, this condition is trivialized. Thus, anaphorically used definite descriptions act as if no uniqueness requirement was enforced at all, even though it is. This is once again due to the fact that set of (potential) output assignments is derived on the basis of the set of input assignments. The only thing that can happen in case the domain isn't extended is that the set of output assignments is a subset of the set of input assignments. But this doesn't constitute a problem, as already mentioned above.[124]

[124] Applied to the Johnny Depp-example (172) above this means that alternatives in which Johnny Depp

The second point also comes out as expected. Consider the following variant of the previous example:

(212) A fat man pushes the bicycle.

What distinguished (212) from the previous example is that the definite description comes with a sparser restrictor. The only variables used are the situational core and x_2, the variable introduced by the definite (newly, for the sake of argument). Thus, (212) receives the following representation in FCS:

(213) $(\exists x_1)[Msx_1] \wedge (\iota x_2)[Bsx_2] \wedge Psx_2x_1$

As can be guessed, the bicycles that are introduced as values of x_2 now do not depend on any relation to the fat men introduced earlier. Thus, they are introduced on the basis of the value of s alone. Whether this leads to output assignments the uniqueness condition accepts depends on the situation. Let us assume two values for s, namely s_3 and s_4. The first situation contains only one bike (b_1), whereas the second contains two (b_2 and b_3). For the sake of argument the men are the same as in in the last example. Thus, (214a) is the output of the indefinite, and (214b) is the intermediate output of the definite that serves as argument for the uniqueness condition:

(214) a.

s	...	s_3	s_3	s_4	s_4	...
x_1	...	f	g	f	g	...

b.

s	...	s_3	s_3	s_4	s_4	s_4	s_4	...
x_1	...	f	g	f	f	g	g	...
x_2	...	b_1	b_1	b_2	b_3	b_2	b_3	...

By the same reasoning as before, the uniqueness condition lets all assignments pass that map s to s_3 while it rejects those that assign s_4 instead. This time, this is because there is more than one bicycle with respect to the situation that necessarily figures as a value of x_2. Thus, the second and the third assignment in (214a) have multiple continuations in (214b) with different values for x_2. These assignments are cut. This is as the Russellian view working with (208) has it. Note that the assignments being more fine-grained than the situation doesn't have any impact on this result. In other words, if the restrictor of the definite description just depends on the situational core of the 'common ground', the only guarantee for the procedure to succeed is the uniqueness of the value of the dedicated variable relative to the situational core. If the restrictor consists in nothing but a lexical predicate as above , then it doesn't matter whether the input assignments are coarse-grained or more fine-grained.

The only kind of configuration that leads to false results for examples like (213) is depicted in (215):

is no actor are dropped (silently) once the second sentence is interpreted, assuming that the definite description indeed reuses the variable introduced by the proper name in the first sentence.

(215) a.

s	...	s_1	s_1	s_1	s_2	s_2	...
x_1	...	a	b	c	a	b	...

b.

s	...	s_1	s_1	s_1	s_2	s_2	...
x_1	...	a	b	c	a	b	...
x_2	...	d	e	f	g	h	...

If (215b) was the second argument of the uniqueness condition, and (215a) the first, then it would be satisfied. But crucially, (215b) is not derivable from (215a) by (204). Either there are multiple bikes in the situation that is the value for s, then (215c) doesn't vary enough; or there is only one bicycle in the situation, then (215c) varies too much. Therefore, this possibility cannot be exploited to generate a meaning too weak to be desirable.

For an example like the initial (203), (215) is fine. x_1 could be the contribution of an indefinite article to the left of the definite (possibly in a different sentence) that is picked up in the definite's restrictor. Then (215b) exhibits exactly what one would expect. The definite introduces different individuals with respect to every assignment contained in (215a)—hence, something like (215b) should fulfill the uniqueness condition (wrt. x_2), which it does.

Even though the uniqueness condition in (210) seems to fulfill all of its duties, there might be viable alternatives. The condition in (216) is one of them:

(216) $\text{UNIQUE}(A)(B) =$
$\{h : \exists g \in A\ \exists V\ g \subseteq_V h\ \&\ h \in B\ \&\ (\forall h')[g \subseteq_V h'\ \&\ h' \in B \rightarrow h = h']\}$

This condition might be called the *unselective* variant of the uniqueness condition (210). It demands there to be only one assignment per successful input assignment, indefinites in the restrictor of definites would be impossible. If there is more than one individual fulfilling the indefinite's restrictor in a situation paths split, so to speak. This is displayed in (206) that resulted from an indefinite update of a fresh file. There is *one* situation—s_1—and several individuals—a, b, and c—and combinations thereof constitute different assignments. Thus, an indefinite only then could felicitously be placed inside the restrictor of a definite if it contributed only one individual (per assignment), i.e., when it doesn't introduce multiple paths simultaneously.

One reason to propose such a strong condition is found in claims like the following (esp. Higginbotham, 2006). It has been observed that sentences like (217a) are worse than their alternatives (217b):

(217) a. The man in a red hat is well dressed.
b. The man in the red hat is well dressed.

If this is true, then the strong requirement that there needs to be at most one continuation of an input-assignment seems to be the right way to go. Thus, the stronger condition (216) immediately accounts for the contrast in (217), contrary to the selective variant (210). But there are other examples that suggest otherwise: (217c) is completely fine, which it shouldn't be if definite articles came with the strong uniqueness condition under consideration:

(217) c. The farmer who owns a goose has to take care of it.

Actually, despite (216), the results of a survey presented in Champollion and Sauerland (2011) suggests that the reverse is true. It seems that the indefinite in (217c) is even slightly better than in (217a). This rules out a repair strategy that moves the item in question above the definite syntactically, which would fix the issue created by (216). This might be true for (217a), which is compared to Inverse-Linking structures in Champollion and Sauerland (2011), but can't be for (217c) because the relative clause is an island. Thus, in (217c), it is quite certain that the indefinite is interpreted *in situ*—and thus, this configuration should be ruled out by (216). Since this doesn't seem to be the case, this constitutes are reason to stick to the original (210).

Summarizing, the positive contribution of a definite article can be written as:

(218) $[\![\text{Ɑ} v[\varphi]]\!]^{+}(G) = \textsc{unique}_{\{v\}}(G)([\![\varphi]\!]^{+}(\{h : \exists g \in G : g \subseteq_{\{v\}} h\}))$

Traditionally, it remained a mystery why a uniqueness condition more or less obviously at work when definites are used non-anaphorically doesn't seem to apply when they are. This is partly due to situation variables not being available in the (sets of) assignments. Or, more precisely, it is due to indices being thought of as not containing individuals. A discourse-new definite description with a restrictor that doesn't make use of any material apart from the situational core should introduce a unique individual with respect to the core. That is, in systems that keep situations s and assignments f separate, uniqueness is checked with respect to s alone. But if the restrictor contains variables already in play, including the variable that accompanies the definite quantifier, uniqueness seems to be checked with respect to both s and f, i.e. $\langle s, f\rangle$. Since combinations of one situation with several distinct assignment functions count as representations of several indices with the same situational core, uniqueness with respect to an index seems to be the right notion. On the other hand, this notion is not as fine-grained as in Situation Theory. There, the relevant notion is that of a minimal situation—a situation containing only what is needed to make a statement true. Since subsequent statements extend this minimal situation constantly when a sentence is evaluated, a once fulfilled uniqueness condition would be violated when checked against the extended situation. This leads to undesired consequences, such that the uniqueness condition sometimes needs to be checked against larger, container-like situations, all further minimal situations that need to be considered are parts of.[125] With a definition of uniqueness like (210) paired with a conception of indices that allows for individual parameters, together with the lax extension relation assumed for definites gives the right granularity.

Assigning definites the lexical entry in (218) also makes the usual predictions when embedded under quantifiers:

[125] These cases are dubbed *larger situation uses* in Schwarz (2009).

(219) Every fat man sold the donkey he didn't like.

This is not yet interpretable due to the lack of rules to deal with quantifiers. For the moment, just assume the following:

(220)
$$\begin{aligned}
&[\![\mathrm{Det}\upsilon\ \varphi\ \psi]\!]^{+}(G) = \\
&\quad \{g \in G : [\mathcal{D}] \quad (\{a : \exists h' \in [\![\varphi]\!]^{+}(\{h : g \subset_{\{\upsilon\}} h\})\ \&\ h'(\upsilon) = a\}) \\
&\qquad\qquad\qquad\quad (\{a : \exists h' \in [\![\psi]\!]^{+}([\![\varphi]\!]^{+}(\{h : g \subset_{\{\upsilon\}} h\}))\ \&\ h'(\upsilon) = a\})\ \},
\end{aligned}$$

where $[\mathcal{D}]$ denotes a (generalized) determiner in its Schönfinklized form, e.g. subsethood in case of *every*, disjointness for *no*, etc. This scheme disregards the "external dynamics" of determiners in the sense that it doesn't introduce any plural discourse referents for further reference. Also, it is only able to generate weak readings for donkey sentences. But it is only used to make the following point that isn't affected by the weak/strong ambiguity. If this is applied to the example in (219), it yields the following:

(221)
$$\begin{aligned}
&\{g \in G : \{a : \exists h' \in [\![Msx_1]\!]^{+}(\{h : g \subset_{\{x_1\}} h\})\ \&\ h'(x_1) = a\} \subseteq \\
&\{a : \exists h' \in [\![(\daleth x_2)[Dsx_2\ \&\ \neg Lsx_2x_1]\ \&\ Ssx_2x_1]\!]^{+}([\![Msx_1]\!]^{+}(\{h : g \subset_{\{x_1\}} h\}))\ \& \\
&h'(x_1) = a\}\}
\end{aligned}$$

Considering the first line, the elements of G get extended by x_1 and subsequently restricted to those assignments that assign a fat man to x_1. Afterwards, all those men are collected in the set. The same happens in the second to third line. But after extending by x_1 and restriction to fat men, the resulting set is fed to the definite description. Thus, basically, one again finds oneself in a situation representable by (205) and following—hence updating with the definite description proceeds in the same way it did above. Now, if there is a fat man in the domain for whom no (single) donkey that he doesn't like can be found, all of his occurrences are eliminated from the file, like it happens above. But this means that this man doesn't make it into the set derived at the end, and thus, since the universal quantification requires subsethood to hold between the first and the second set derived to let an assignment g pass, all those $g \in G$ that happen to assign such a situational core to their situation variable that necessitates introducing such a fat man as possible value for x_1 don't make it in the end. Note once again that this general assessment stays true in case the initial file G is more elaborate in the sense that it has more variables in its domain. If nothing in the restrictor or the nuclear scope of the determiner depends on these additional variables, all that this extra information really does is necessitating the calculation of one and the same quantification for the same situational core over and over again—namely as often as there are different assignments with one and the same situational core. But the result always is the same, since the extra information can't make a difference.

Summing up, even though the definite seems to "auto-accommodate" in the Lewisian sense when it is used under indefinites or not embedded at all, it doesn't "accommodate" in the more technical sense (van der Sandt, 1992) if used in the nuclear scope of a quantifier. This is due to the quantifier introducing a requirement on the *values* a dedicated variable is assigned, in the form of set formation, that indefinites lack.

To conclude the discussion, consider the following variation of the example that is closer to the original example that constitutes Heim's problem:

(222) Every fat man pushes his bicycle.

Given what was said in section 3.1.2, *his* needs to be the locally bound one and not the one which is allowed to refer freely in order to derive the bound reading. Thus, the following, repeated from above (p. 90), have to be adapted:

(22) $[\![\text{his}_{Det}]\!] = \lambda S_{\mathbf{e(et)}}.\lambda R_{\mathbf{e(et)}}.\lambda x_{\mathbf{e}}.(\mathbf{THE}y)[S(y)(x)](R(y)(x))$

(29) $[\![\text{he}_n\text{'s}]\!] = \lambda S_{\mathbf{e(et)}}.\lambda R_{\mathbf{e(et)}}.\lambda x_{\mathbf{e}}.(\mathbf{THE}y)[S(y)(x_n)](R(y)(x))$

In the light of the present discussion, the uniqueness condition (embodied by the square brackets) needs to be reformulated with the help of above's formulation. But note that this can't simply be done by substituting the definite quantifier, since this would allow both forms to reuse a variable from the preceding discourse. This would make (29) doubly anaphoric in the sense that both relata of the Of relation could be given by the preceding discourse. But this doesn't seem to be correct. The solution is to use the (dynamic) existential quantifier instead, since the variable quantified over has to be "fresh". But then, the uniqueness condition (210) does its job as it is supposed to do. In employing the quantifier that enforces the use of a "fresh" variable, the assumed determiner form once again connects to reflexives, which likewise need to introduce a new variable to be compatible with the ban on coindexation argued for in section 3.5. As soon as FCS gains the means to λ-abstract (cf. section 4.2.4), (22) and (29) can be represented as (223a) and (223b), respectively:

(223) a. $\lambda S.\lambda R.\lambda y.(\text{ᗡ}^* x_2)[Ssyx_2] \wedge Rsyx_2$
b. $\lambda S.\lambda R.\lambda y.(\text{ᗡ}^* x_2)[Ssx_nx_2] \wedge Rsyx_2$

The only thing that is a bit unfortunate as this point is that the uniqueness condition is part of the denotation of ᗡ, and not available as a constant of FCS in its own right. This is relevant because the variable introduced the possessive-internal definite description has to be "fresh". If the uniqueness condition was available, one could formulate both versions in (223) with the help of $\exists$. But this condition is a property of sets of assignments that isn't easily mapped into a predicate about the *content* of the assignments, i.e. the values assigned to the variables in their domain. So this predicate shouldn't be introduced as a predicate of the language, if this is possible at all. Thus, it seems, a third quantifier is called for to express possessive pronouns directly, with is assumed to happen with ᗡ^* above: it is like ᗡ, except that its extension relation is strenghened from $\subseteq_V$ to $\subset_V$.

One might object that uniqueness shouldn't figure in the description of the truth-conditions but the definedness-requirements instead, since the uniqueness of the referent doesn't seem to be asserted, but presupposed (cf. Elbourne, 2013, among others for an argumentation along these lines). This is the Fregean way of looking at definites opposed to the Russellian treatment basically adopted by (218). This alternative comes down to something along the following lines:

(224)
$$\begin{array}{lcl} \llbracket \text{℩}\upsilon[\varphi]\rrbracket^{d}(G) & = & \textsc{Unique}_{\{\upsilon\}}(G)(\llbracket\varphi\rrbracket^{+}(\{h : \exists g \in G : g \subseteq_{\{\upsilon\}} h\})) \\ \llbracket \text{℩}\upsilon[\varphi]\rrbracket^{+}(G) & = & \llbracket\varphi\rrbracket^{+}(\llbracket(\text{℩}\upsilon)[\varphi]\rrbracket^{d}(G)) \end{array}$$

This variant is pretty strict in terms of definedness. It only lets those assignments pass in which only a single individual with the property expressed in the restrictor can be added if the definite doesn't reuse a variable already in the domain. While the first variant contents itself with the possibility to add some individual with the respective property to the sequence. But in the asserted part of (218) uniqueness is required. It also is in the positive value of the second variant (since it is identical with the definedness condition), but there it is trivialized, given that the first condition is fulfilled, in the sense that no remaining assignment is eliminated on its basis. In (218) uniqueness does exactly that, simply because there are more assignments that survive the definedness condition compared to (224).

But ultimately, the variant in (224) shouldn't be used here. This is mainly for two reasons. First, the kind of partiality represented by the definedness conditions isn't meant to deal with presuppositions. It is there to prevent mishandling the "bookkeeping device", by not allowing it to have any influence on truth conditions. Secondly, as will become apparent in the final chapter, it is desirable not to allow the existence of assignments that come up with values for all the variables employed but the expression is still undefined for this set. Endowing the definedness condition with the uniqueness requirement would allow exactly that. This is not to say that a Fregean way of accounting for definite descriptions is incompatible with the present approach. But it shouldn't be implemented via the $\llbracket\bullet\rrbracket^{d}$ values. Keeping these values restricted to account for bookkeeping is compatible with adding another notion of undefinedness reserved for dealing with presuppositions. This is the strategy in van den Berg (1996) as well. Since this thesis is not about presuppositions, this approach is not worked out here, so the interested reader is referred to consult the thesis just mentioned (and the brief remarks in section 5.2). The only reflection of the presuppositional nature of the quantifier will be found in the clause defining its negative value. The quantifier together with its restrictor will not be allowed to be false, i.e. to have a non-empty negative value. The effects of this choice are discussed in the next section in connection with negation. Thus, whole clause for definites is this:

(225)
$$\begin{array}{lcl} \llbracket \text{℩}\upsilon[\varphi]\rrbracket^{d}(G) & = & \llbracket\varphi\rrbracket^{d}(\{h : \exists g \in G : g \subseteq_{\{\upsilon\}} h\}) \\ \llbracket \text{℩}\upsilon[\varphi]\rrbracket^{+}(G) & = & \textsc{Unique}_{\{\upsilon\}}(G)(\llbracket\varphi\rrbracket^{+}(\{h : \exists g \in G : g \subseteq_{\{\upsilon\}} h\})) \\ \llbracket \text{℩}\upsilon[\varphi]\rrbracket^{-}(G) & = & \emptyset \text{ (never)} \end{array}$$

This introduces the possibility that the positive and the negative value are empty for some sets of assignments. This is as in Russell (1905).

To sum up, three assumptions connect discourse-new and anaphoric uses of definites:[126]

[126] One might add, *pace* Schwarz (2009) and Schwarz (2012), there is no need to distinguish two lexical entries for definite descriptions. This doesn't mean that the correlation of forms and uses he discusses

1. Definites make use of a weaker extension relation than indefinites, namely one that allows their variable names to occur in the domain of a file they are evaluated against, but doesn't fail to work if they don't;[127]

2. Definites make use of a uniqueness condition that checks for uniqueness relative to a file distributively; and only after the input file has been reduced to those assignments that have an output with respect to the definites' restrictor;

3. Files, even discourse initially, are not blank, but contain at least variables for the situational core, either situation variables, or variables for every situational aspect different from individuals.

The first assumption does most of the work in that it allows definite descriptions to act as pronouns. Given the second assumption, the third one explains their behavior when used non-anaphorically, simply because it gives the uniqueness condition some input to work with in terms of comparing input and output assignments. This assumption in fact is more specific than it needs to be in that it assumes that there need to be variables having to do with what is called the 'situational core'. But for the uniqueness condition to work, any kind of variable would do as long as it can be argued that lexical material inside of the restrictor is dependent on its value. That situations are used here only stems from the general perspective on Context Theory adopted and justified in Chapter 1. But the uniqueness condition (210) and the lexical entry for the definite (218) can be put to work in different frameworks as well. But, to turn things around, whatever is proposed as fulfilling the rôle situation variables are assumed to fulfill here, it is necessary to relativize the contributions of definite descriptions to the right granularity. Otherwise, they would demand that there exists a single individual in every situation such that the restrictor holds; which is way beyond reasonable.

What remains to be seen is how the connection to deictically used definites can be made.

3.4.3 Negation revisited

As was pointed out above, the logic of sentential connectives is a weak Kleenean one:

(197) a.

&	1	0	#
1	1	0	#
0	0	0	#
#	#	#	#

b.

¬	
1	0
0	1
#	#

In fact, there are several ways to flesh this out for negation. This connects to the fact that the orthodox definition of negation in (195), repeated below, doesn't make use of the negative values denoted by $[\![\bullet]\!]^-$. They usually are utilized in a definition like the one below. This second kind of negation may be identified with *denial* (cf. van den Berg,

isn't real. It just objects to the correlation of forms with two different lexical entries.

[127]Whether this embodies "weak familiarity" (Roberts, 2003; Roberts, 2004) or not can be left open.

1996), which in turn is associated with sentence initial phrases like *it is not the case that* or similar.

(195) e. $$\begin{aligned}[\![\neg\varphi]\!]^d(G) &= \{g \in G : [\![\varphi]\!]^d(\{g\}) \neq \emptyset\} \\ [\![\neg\varphi]\!]^+(G) &= \{g \in [\![\neg\varphi]\!]^d(G) : [\![\varphi]\!]^+(\{g\}) = \emptyset\} \\ [\![\neg\varphi]\!]^-(G) &= \{g \in [\![\neg\varphi]\!]^d(G) : [\![\varphi]\!]^+(\{g\}) \neq \emptyset\}\end{aligned}$$ preliminary

(195) e′. $$\begin{aligned}[\![\sim\varphi]\!]^d(G) &= [\![\varphi]\!]^d(G) \\ [\![\sim\varphi]\!]^+(G) &= [\![\varphi]\!]^-(G) \\ [\![\sim\varphi]\!]^-(G) &= [\![\varphi]\!]^+(G)\end{aligned}$$ first alternative

As can be seen, the definedness condition doesn't hinge on negation and every discourse referent introduced within φ projects further. This is not adequate, as pointed out in 3.3.4. Instead of singulars (especially indefinite singulars) pluralized discourse referents should make it, if any. Also, if this notion is adapted, all kinds of entities are projected, especially when it comes to negated existential sentences, as the following sample calculation shows. Let the sentence under consideration be a rough translation of *It is not the case that she owns a Porsche*:

(226) $$\begin{aligned}& [\![\sim(\exists x_1)[Psx_1 \wedge Osx_2x_1]]\!]^+(G) \\ = \;& [\![(\exists x_1)[Psx_1 \wedge Osx_2x_1]]\!]^-(G) \\ = \;& [\![Psx_1 \wedge Osx_2x_1]\!]^-(\{h : \exists g \in G : h \subset_{\{x_1\}} h\}) \\ = \;& [\![Osx_2x_1]\!]^-([\![Psx_1]\!]^+(\{h : \exists g \in G : h \subset_{\{x_1\}} h\})) \cup \\ & [\![Osx_2x_1]\!]^+([\![Psx_1]\!]^-(\{h : \exists g \in G : h \subset_{\{x_1\}} h\})) \cup \\ & [\![Osx_2x_1]\!]^-([\![Psx_1]\!]^-(\{h : \exists g \in G : h \subset_{\{x_1\}} h\}))\end{aligned}$$

The final formula denotes sets of assignments which store, say, Porsches under x_1 that are not owned by the value of x_2, entities that she owns but are no Porsche, and finally entities neither Porsche nor owned by x_2. This is not correct in terms of the anaphoric potential. But there is also a problem with the truth conditions. Take a situation in which three Porsches exist, one of them is owned by Anna, the value of x_2 according to all assignments in G that map the situation variable to the situation in question. If these assignments are lengthened by x_1 and restricted to Porsches, two out of three possibilities make it through according to (226), since there are Porsches not owned by Anna. This isn't correct. Intuitively, all assignments in G that assign the situation in question to the situation variable s should be eliminated. More generally, the result of (226) should contain only those assignments that cannot be extended in such a way that they make the embedded sentence true (i.e. non-empty). This is exactly what is demanded in the original DPL-like definition of $\neg$ in (195). Thus, the positive value of the negated sentence needs to be restricted to those assignments in the initial file that contain no way to make the sentence true—contrary to its negative value. There the classical duality between truth values holds: a negated sentence is false iff its unnegated counterpart is true.[128]

[128] The result corresponds to the *strong dynamic negation* of van den Berg (1996).

(195) e″. $[\![\sim\varphi]\!]^d(G) = [\![\varphi]\!]^d(G)$ second alternative
$[\![\sim\varphi]\!]^+(G) = [\![\varphi]\!]^-(\{g \in G : [\![\varphi]\!]^+(\{g\}) = \emptyset\})$
$[\![\sim\varphi]\!]^-(G) = [\![\varphi]\!]^+(G)$

This first adaptation repairs the issues with truth conditions and partially also the chaotic projection behavior. But it doesn't make the step to pluralized discourse referents. Fortunately, it is possible to sum up all assignments making a sentence false. To this end, a DRT-like abstraction operator is defined first, similar to the one mentioned in 3.3.4. It targets two sets of assignments, which are left unspecified for the moment.[129]

(227) *Summation*: For any two sets of assignments G and H and a set of variables $V = D(H)\backslash D(G)$:
$\boxed{\oplus}(G)(H) := \{f : \exists g \in G : f = g \cup \{\langle x_n, \bigoplus_{h \in H^{\succeq_V g}} h(x_n)\rangle : x_n \in V\}\}$
with $H^{\succeq_V g} = \{h \in H : g \subseteq_V h\}$

Informally, the operation looks through its second argument H to find all extensions of each element of its first argument G. The values of all V-continuations of an element of g in H are added up and paired with the respective "address" in the difference between the domains of the files. All the elements of G are then extended by all variables in V in such a way that each of them gets assigned the set of values the respective variable gets assigned in the respective parcel of the partition of H induced by g and V.[130]

To see an example, if (228a) plays the rôle of G and (228b) that of H then the result of applying $\boxed{\oplus}$ is (228c):

(228) a.

s	s_1	s_1
x_1	a	b

b.

s	s_1	s_1	s_1	s_1
x_1	a	a	b	b
x_2	c	d	e	f

c.

s	s_1	s_1
x_1	a	b
x_2	$c \oplus c$	$e \oplus f$

If negation in the style of (195e″) is endowed with a summation operator like (227), the result is something like the following. The pluralization does not affect all variables *tout court*, but only those that are newly introduced in the embedded sentence. Hence, all variables in $\mathcal{R}[\varphi]$ that are not in $D(G)$:

(229) $[\![-\varphi]\!]^d(G) = [\![\varphi]\!]^d(G)$ third alternative
$[\![-\varphi]\!]^+(G) = \boxed{\oplus}(G)([\![\varphi]\!]^-(\{g \in G : [\![\varphi]\!]^+(\{g\}) = \emptyset\}))$
$[\![-\varphi]\!]^-(G) = \boxed{\oplus}(G)([\![\varphi]\!]^+(G))$

Consider the little example from above once more:

(226) $[\![-(\exists x_1)[Psx_1 \wedge Osx_2x_1]]\!]^+(G)$

[129] Obviously, more has to be said and done before this becomes a well-defined operation. But this enterprise lies beyond the scope of this thesis. The following is just to get an idea.

[130] In the special case $D(H) \subseteq D(G)$, $\boxed{\oplus}(G)(H)$ returns H, as the inclined reader is invited to verify. This is because $\subseteq_\emptyset$ boils down to identity.

Furthermore let G be a file with s and x_2 in its domain, and just a relatively small range of values for them, namely just three situations s_1–s_3, and only one individual Anna a. In all three of the situations three Porsche, p_1–p_3 exists. Anna owns exactly one Porsche, p_1, in s_1, whereas in s_2, she owns even more, namely p_2 and p_3, while she doesn't own a Porsche in the third situation.

(230)

s	s_1	s_2	s_3
x_2	a	a	a

$(= G)$

Hence, (226) should turn out to be false with respect to s_1 and s_2, and that means that the following should return a singleton file containing only an extension of the assignment assigning s_3 to s. This is mostly due to the restriction of the initial file to those assignments that have no true continuation at all. That is, the embedded sentence isn't interpreted against G, but against $\{g \in G : [\![(\exists x_1)[Psx_1 \wedge Osx_1]]\!]^+(\{g\}) = \emptyset\}$ instead.

(231) $\boxed{\oplus}(G)([[\![(\exists x_1)[Psx_1 \wedge Osx_1]]\!]^-(\{g \in G : [\![(\exists x_1)[Psx_1 \wedge Osx_1]]\!]^+(\{g\}) = \emptyset\}))$

Calculating the file just mentioned first, each assignment in the original file G is extended to cover x_1 separately. That is, the first column of (230) is extended to (232a), the second to (232b), and the third to (232c); displaying just the part where Porsche are the values of x_1:

(232) a.

s	s_1	s_1	s_1
x_2	a	a	a
x_1	p_1	p_2	p_3
...	...	...	...

b.

s	s_2	s_2	s_2
x_2	a	a	a
x_1	p_1	p_2	p_3
...	...	...	...

c.

s	s_3	s_3	s_3
x_2	a	a	a
x_1	p_1	p_2	p_3
...	...	...	...

Restricting each sub-file to the assignments that value their variables in such a way that the embedded sentence is true one yields these:

(233) a.

s	s_1
x_2	a
x_1	p_1

b.

s	s_2	s_2
x_2	a	a
x_1	p_2	p_3

c. $\emptyset$

Thus, only those assignments assigning s_3 to s give rise to the correct sub-file; therefore restricting evaluation in (231) to one out of three initial assignments, g_3, to give it a name:

(234) $\boxed{\oplus}(G)([\![(\exists x_1)[Psx_1 \wedge Osx_1]]\!]^-(\{g_3\}))$

Dealing with the negative value of the embedded conjunction after computing g_3's extension by x_1 leads to the following disjunction:

(235) $\boxed{\oplus}(G)([\![Osfx_1]\!]^-([\![Psx_1]\!]^+(\{h : \exists g \in \{g_3\} : g \subset_1 h\})$
$\cup\ [\![Osfx_1]\!]^+([\![Psx_1]\!]^-(\{h : \exists g \in \{g_3\} : g \subset_1 h\})$
$\cup\ [\![Osfx_1]\!]^-([\![Psx_1]\!]^-(\{h : \exists g \in \{g_3\} : g \subset_1 h\})\ )$

Disregarding the second and the third case for the moment, the first line boils down to the following (with P' and O' being constants representing the intension of *Porsche* and *own*, respectively):

(236) $\{h : g_3 \subset_{\{1\}} h \ \& \ \langle h(s), h(x_1)\rangle \in P' \ \& \ \langle h(s), h(x_2), h(x_1)\rangle \notin O'\}$

If the remaining assignment is again extended by x_1 and only Porsche are considered further, it looks like this:

(237)

s	s_3	s_3	s_3
x_2	a	a	a
x_1	p_1	p_2	p_3

If this were the complete file, i.e. the whole input to the pluralizing operator, the following would be the resulting file:

(238)

s	s_3
x_2	a
x_1	$p_1 \oplus p_2 \oplus p_3$

This is because H in (227) is (237), which stems from extending $g_3 \in G$ alone. Therefore, the final set (238) is the set of x_1-extensions of the single assignment g_3 that assign the sum of all values of x_1 according to (237) to x_1, i.e. (238).

But there are all the other cases in (235) that make a conjunction false. The second one collects all things not Porsche in s_3 that Anna owns, while the third collects all entities not Porsche she doesn't own. If these cases are computed further, they give rise to further assignments similar to the one depicted in (238) in which either the sum of everything except Porsches in Anna's possession or the sum of everything not in Anna's possession (except Porsches) is assigned to x_1. These assignments are unreasonable. One strategy to get rid of them is to make the indefinite article as "presuppositional" as the definite. I.e. the lexical entry for existential quantifiers in (195), repeated as (239a), has to be changed to (239b):

(239) a.
$$\begin{aligned} [\![(\exists v_n)[\varphi]]\!]^d(G) &= [\![\varphi]\!]^d(\{h : \exists g \in G : g \subset_{\{v_n\}} h\}) \\ [\![(\exists v_n)[\varphi]]\!]^+(G) &= [\![\varphi]\!]^+(\{h : \exists g \in G : g \subset_{\{v_n\}} h\}) \\ [\![(\exists v_n)[\varphi]]\!]^-(G) &= [\![\varphi]\!]^-(\{h : \exists g \in G : g \subset_{\{v_n\}} h\}) \end{aligned}$$

b.
$$\begin{aligned} [\![(\exists v_n)[\varphi]]\!]^d(G) &= [\![\varphi]\!]^d(\{h : \exists g \in G : g \subset_{\{v_n\}} h\}) \\ [\![(\exists v_n)[\varphi]]\!]^+(G) &= [\![\varphi]\!]^+(\{h : \exists g \in G : g \subset_{\{v_n\}} h\}) \\ [\![(\exists v_n)[\varphi]]\!]^-(G) &= \emptyset \text{ (never)} \end{aligned}$$

One immediate consequence is that the leeway in translating indefinite descriptions mentioned above vanishes. With (239b) in force, it isn't adequate to use (240a) anymore. Instead, (240b) does the trick.

(240) a. $(\exists x_n)[Px_1 \wedge Qx_1]$
b. $(\exists x_n)[Px_1] \wedge Qx_1$

Using this, the structure of the example sentence changes. It now has to be the following:

(241) $-((\exists x_n)[Psx_1] \wedge Osx_2x_1)$

Running the calculation once again, the set of assignments $[\![(241)]\!]^-$ has to be evaluated against before the pluralization operator can do its job is the same as before:

(242) $\{g \in G : [\![(\exists x_1)[Psx_1] \wedge Osx_2x_1)]\!]^+(\{g\}) = \emptyset\}$
$= \{g \in G : [\![Osx_2x_1]\!]^+([\![(\exists x_1)[Psx_1]]\!]^+(\{g\})) = \emptyset\}$
$= \{g \in G : [\![Osx_2x_1]\!]^+(\{h : \exists g' \in \{g\} : g' \subset_{\{1\}} h \;\&\; \langle h(s), h(x_1)\rangle \in P'\}) = \emptyset\}$
$= \{g \in G : \{h : \exists g' \in \{g\} : g' \subset_{\{1\}} h \;\&\; \langle h(s), h(x_1)\rangle \in P' \;\&\; \langle h(s, h(x_2), h(x_1)\rangle \in O'\} = \emptyset\}$
$= \{g_3\}$

The only difference to (235) above is the scope of the inner conjunction with respect to the existential quantifier:

(243) $\boxed{\oplus}(G)([\![Osfx_1]\!]^-([\![(\exists x_1)[Psx_1]]\!]^+(\{g_3\}))$
$\cup [\![Osfx_1]\!]^+([\![(\exists x_1)[Psx_1]]\!]^-(\{g_3\}))$
$\cup [\![Osfx_1]\!]^-([\![(\exists x_1)[Psx_1]]\!]^-(\{g_3\})))$

This time, the second and third line are ignored "officially" since they both contain the clause $[\![(\exists x_1)[Psx_1]]\!]^-(\{g_3\})$ that can never be non-empty by definition. The first line returns the same file as above, i.e. (236). Hence, the argument of the summation operator is just the desired file, which is shown to yield the intuitively correct output above.

Now consider a further situation s_4 in which Porsches do not exist. If the example at hand is evaluated against a file containing $g_4 = \{\langle s, s_4\rangle, \langle x_2, a\rangle\}$, this assignment also makes it into the set of assignments the negative value of the formula is evaluated against. If this assignment is the only element of the initial file, the intermediate result is the following:

(244) $\boxed{\oplus}(G)([\![Osx_2x_1]\!]^-([\![(\exists x_1)[Psx_1]]\!]^+(\{g_4\}))$
$\cup [\![Osx_2x_1]\!]^+([\![(\exists x_1)[Psx_1]]\!]^-(\{g_4\}))$
$\cup [\![Osx_2x_1]\!]^-([\![(\exists x_1)[Psx_1]]\!]^-(\{g_4\})))$

Since it is impossible to extend g_4 in such a way that the value of the variable x_1 is a Porsche, not even the first line in (244) gives any output other than $\emptyset$, and hence, the whole formula boils down to

(245) $\boxed{\oplus}(G)(\emptyset) = \emptyset$

This might be felt to be wrong since s_4 seems to be a viable possibility in a discourse where $-((\exists x_1)[Psx_1] \wedge Osx_2x_1)$ is accepted as true. But this is a consequence of the adaptation of the existential quantifier in (239b) that isn't avoidable even if negation is not endowed with a pluralization operator. Speaking more generally, negated existential sentences give rise to all kinds of problems once this presuppositional variant of the existential quantifier is adopted. On the other hand, assumptions along these lines are frequently made in order to explain the projection behavior of quantifiers in dynamic settings. All that is done here is to demonstrate how far one can get with the assumptions made.[131]

To conclude the discussion of simply negated sentences, consider (246), the negative value of the initial example:

(246) $[\![-((\exists x_1)[Psx_1] \wedge Osx_2x_1)]\!]^-(G) = \boxed{\oplus}(G)([\![(\exists x_1)[Psx_1] \wedge Osx_2x_1]\!]^+(G))$

As can be seen, all that is asked is to calculate the standard output of unembedded indefinites, namely $[\![(\exists x_1)[Psx_1] \wedge Osx_2x_1]\!]^+(G)$, and sum the values of x_1 afterwards. The result is the unsurprising (247). What this shows apart from being an example of the negative value is that the output of the pluralization operator can be a singular in the sense that the variable in question is assigned an atomic individual. Thus, with respect to *semantic number*, variables might turn out to be heterogeneous.

(247)

s	s_1	s_2
x_2	a	a
x_1	p_1	$p_2 \oplus p_3$

Now its time to turn attention to an example with double negation. The following can be understood as a translation of *it is not the case that she doesn't own a Porsche*:

(248) $[\![-(-((\exists x_1)[Psx_1] \wedge Osx_2x_1))]\!]^+(G)$

Let the initial file G consist of all assignments considered in the last section and let the assumptions about the situations be the same as above:

(249)

s	s_1	s_2	s_3	s_4
x_2	a	a	a	a

The formula to calculate thus is:

(250) $\boxed{\oplus}(G)([\![-((\exists x_1)[Psx_1] \wedge Osx_2x_1)]\!]^-$
$(\{g \in G : [\![-((\exists x_1)[Psx_1] \wedge Osx_2x_1)]\!]^+(\{g\}) = \emptyset\})\ )$

The file in the second line, the second argument of the pluralization operator boils down to this:

(251) $\{g \in G : \boxed{\oplus}(\{g\})([\![(\exists x_1)[Psx_1] \wedge Osx_2x_1]\!]^-$
$(\{g' \in \{g\} : [\![(\exists x_1)[Psx_1] \wedge Osx_2x_1]\!]^+(\{g'\}) = \emptyset\})) = \emptyset\}$

[131] A second option allows a dedicated individual named *zilch* (cf. Oliver and Smiley, 2013) of which every natural language predicate is true to count as value of a discourse referent as well. Potentially, this allows the machinery to collect even those cases in which no individual that fulfills the restrictor exists. Hence, the step towards presuppositional quantifiers would no longer be necessary. This issue is too complex to go into here and therefore left open.

The elements of G for which the positive value of the existentially quantified formula (second line of (251)) returns the empty set are g_3 and g_4, as above. The question is, thus, if any of these two make the pluralization yield the empty set. As seen above, g_4 leads to the empty file, but g_3 doesn't. Thus, g_4 makes it. But for g_1 and g_2 the whole set starting with "$\{g'$" is empty, hence the second argument of the pluralization operator, hence its result. Thus, g_1 and g_2 make it as well. The result of (251) thus is $\{g_1, g_2, g_4\}$, and (250) becomes:

(252) $\boxed{\oplus}(G)(\llbracket -((\exists x_1)[Psx_1] \wedge Osx_2x_1)\rrbracket^{-}(\{g_1, g_2, g_4\})\ )$
$= \boxed{\oplus}(G)(\boxed{\oplus}(\{g_1, g_2, g_4\})(\llbracket(\exists x_1)[Psx_1] \wedge Osx_2x_1)\rrbracket^{+}(\{g_1, g_2, g_4\}))$

The result of the inner pluralization is the same as above, (247), since g_4 doesn't come up with any Porsche, it disappears quietly. The arguments of the outer pluralization operator thus are G and (247), repeated here as (253a) and (253b), respectively, whereas the latter one also is its final value:

(253) a.

s	s_1	s_2	s_3	s_4
x_2	a	a	a	a

b.

s	s_1	s_2
x_2	a	a
x_1	p_1	$p_2 \oplus p_3$

Note again that the values stored under x_1 in (253b) differ from one situation to the other in terms of what might be called *semantic number*. x_1 is sort of singular with respect to the first assignment, but plural with respect to the other. Thus, the summation operator allows for the projection of referential expressions. The most natural follow up would be to endow singular pronouns with a condition that they only are felicitously used if related to a semantically singular discourse referent (an *atom*-condition). In such a setup, using a singular pronoun to relate to x_1 as in (253b) eliminates all assignments that assign a plural individual to x_1 solely on the basis of said *atom*-condition. That is, continuing *it is not the case that she doesn't own a Porsche* with *it is in the garage* eliminates the second assignment in (253b). This is without counterpart in scenarios where the file assigns singular values to a discourse referent homogeneously. The very fact that a singular pronoun in a later sentence relates back to this discourse referent doesn't eliminate any assignment whatsoever. This happens because of the interpretation of lexical material making up its syntactic environment. Thus, using a singular pronoun to relate back to x_1 in (253b) may have the effect of coming as a surprise in a concrete conversation, because the respective speaker talks as if the use of a singular pronoun was not a big deal.

Plural pronouns are usually said to be less restrictive. That is, they do not come with a non-*atom*-condition analogous to singular pronouns (cf. van den Berg, 1996; Brasoveanu, 2008; Kamp and Reyle, 1993, a.o.). This directly encodes that it is "easier" to use the plural pronoun. Not just that they manage to relate to the plural individuals introduced by the summation operator, but they do not necessarily eliminate the other alternatives.

Note that the decision to make the existential quantifier presuppositional (239b) doesn't make it impossible to define, say, universal quantification in terms of existential quantification and negation. Furthermore, the following kind of reasoning carries over to all kinds of quantifiers that are first-order definable (hence *most* is not accounted for). The formula that does the trick for universals is the following:

(254) $-((\exists x)[\varphi] \wedge -\psi)$

If this formula is evaluated against a file G, this is the first step in the calculation:

(255) $\boxed{\oplus}(G)(\llbracket((\exists x)[\varphi] \wedge -\psi)\rrbracket^{-}(\{g \in G : \llbracket(\exists x)[\varphi] \wedge -\psi\rrbracket^{+}(\{g\}) = \emptyset\}))$

This formula evaluates the negative value of the embedded conjunction against the set of those assignments in the initial file G that have no continuation that assigns a value to x that makes φ true but ψ false. This reduces G to those assignments that value x in such a way that both φ and ψ are true. Out of those the ones that lie in the negative value are filtered. These are the ones that have a way to make φ true but $-\psi$ false. Due to the presuppositional nature of the existential quantifier, this is the only way to figure in this set. Thus, the file that is the second argument of the summation operator is the one in which all possible values for x are such that if they make φ true, they falsify ψ. And since φ is not allowed to be false, this boils down to the set of all assignments that make φ and $-\psi$ true. The summation operator then just collects all values for x in one set per assignment (and possibly values of further variables introduced within φ or ψ). As the inclined reader is invited to verify, (254) gives rise to the so-called strong reading of donkey sentences of the following variety:

(256) Every farmer who owns a donkey beats it.

In principle, it shouldn't be flat out ungrammatical to use singular pronouns in a subsequent sentence to pick either contribution made by (256). As in case with simply or doubly negated sentences, there might be situations in which only one farmer (and donkey) is present that don't get pluralized in the course of the calculating. A continuation by (257) would then concentrate on these situations only:

(257) He doesn't like it very much.

On the other hand, if an interlocutor wanted to focus on these special situations, (256) is a strange sentence to begin with, as it seems to reckon with there being more than one of each of them. Thus, the degradedness of (257) as a continuation of (256) may be due to some sort of clash of implicatures.

Above (p. 182, ex. (219)) is is demonstrated that the universal quantifier-formula taken from DRT doesn't let presuppositional material accommodate in its restrictor, i.e. *intermediately*, but only in its nuclear scope, i.e. *locally* (cf., e.g., Beaver and Zeevat, 2006, for the terminology). This is different when the considerations of this section are taken into account. To the contrary, the assumptions about negation and the presuppositional nature of the quantifiers $\exists$ and $\Game$ interact in a way that makes *intermediate accommodation* the default. Consider a variant of (203), namely the following (somewhat stiled):

s_1: $\begin{array}{lcl} M' & \approx & \{a,b,c\} \\ B' & \approx & \{d_1,d_2\} \\ O' & \approx & \{\langle a,d_1\rangle,\langle b,d_2\rangle\} \\ P' & \approx & \{\langle a,d_1\rangle,\langle b,d_2\rangle\} \end{array}$	s_2: $\begin{array}{lcl} M' & \approx & \{a,b,c\} \\ B' & \approx & \{d_1,d_2,d_3\} \\ O' & \approx & \{\langle a,d_1\rangle,\langle b,d_2\rangle,\langle c,d_3\rangle\} \\ P' & \approx & \{\langle a,d_1\rangle,\langle b,d_2\rangle,\langle c,d_3\rangle\} \end{array}$
s_3: $\begin{array}{lcl} M' & \approx & \{a,b,c\} \\ B' & \approx & \{d_1,d_2\} \\ O' & \approx & \{\langle a,d_1\rangle,\langle b,d_2\rangle\} \\ P' & \approx & \{\langle a,d_1\rangle\} \end{array}$	s_4: $\begin{array}{lcl} M' & \approx & \{a,b,c\} \\ B' & \approx & \{d_1,d_2,d_3\} \\ O' & \approx & \{\langle a,d_1\rangle,\langle b,d_2\rangle,\langle c,d_3\rangle\} \\ P' & \approx & \{\langle a,d_1\rangle\} \end{array}$

Figure 3.1: Four possibilities

(258) a. Every man pushes the bicycle he owns.

b. $\sim((\exists x_1)[Msx_1] \wedge \sim((\text{Ɑ}x_2)[Bsx_2 \wedge Osx_1x_2] \wedge Psx_1x_2))$

As can be seen, (258b) is the translation of (258a) making use of a formula similar to the one in (254). It features $\sim$ instead of $-$, because the point to make doesn't concern the projection of pluralized variables. Also for convenience, the following set of assignments is assumed to be the input:

(259)

G	f_1	f_2	f_3	f_4
s	s_1	s_2	s_3	s_4

The situations in (259) make the relevant predicates characterize the sets of (pairs of) individuals depicted in Figure 3.1. Thus, s_1 is a situation in which every man who owns a (single) bike also pushes it, while not every man owns a bike. This is the most crucial situation for the issue at hand. According to the DRT-interpretation, (258a) is false in s_1, simply because there is a man that doesn't push a bike, because he doesn't own one. According to a van der Sandtian account of (258a), s_1 makes it true. This is argued to happen because the presupposition that every man owns a (single) bicycle is accommodated in the restrictor of the universal quantifier. This basically restricts the quantificational domain to men who satisfy this presupposition. s_1 then is a situation for which the universal statement over the so restricted domain comes out true. With respect to s_2, both accounts should render the sentence true, because the every man in the domain indeed owns a single bike and pushes it. For the other two situations the sentence should be false, because there are men satisfying the presupposition but not engaged in pushing. This shouldn't even be ignored by accommodation in van der Sandt's sense, and it isn't, as the outcome with respect to s_3 will show.[132]

To make the following calculation easier, these are the sets of assignment derivable from the members of G by adding the variable x_1 and restricting it to men:

[132] The situations are construed in such a way that uniqueness won't be an issue. This is for convenience, only.

(260)

H_1	h_1^1	h_1^2	h_1^3
s	s_1	s_1	s_1
x_1	a	b	c

H_2	h_2^1	h_2^2	h_2^3
s	s_2	s_2	s_2
x_1	a	b	c

H_3	h_3^1	h_3^2	h_3^3
s	s_3	s_3	s_3
x_1	a	b	c

H_4	h_4^1	h_4^2	h_4^3
s	s_4	s_4	s_4
x_1	a	b	c

The first steps just recapitulate the structure:

(261) $[\![\sim((\exists x_1)[Msx_1] \wedge \sim((\text{℩}x_2)[Bsx_2 \wedge Osx_1x_2] \wedge Psx_1x_2))]\!]^+(G)$

$= [\![(\exists x_1)[Msx_1] \wedge \sim((\text{℩}x_2)[Bsx_2 \wedge Osx_2x_1] \wedge Psx_2x_1)]\!]^-$
$(\{g \in G : [\![(\exists x_1)[Msx_1] \wedge \sim((\text{℩}x_2)[Bsx_2 \wedge Osx_2x_1] \wedge Psx_2x_1)]\!]^+(\{g\}) = \emptyset\})$

The argument (second line) reduces as follows:

(262) $\{g \in G : [\![(\exists x_1)[Msx_1] \wedge \sim((\text{℩}x_2)[Bsx_2 \wedge Osx_2x_1] \wedge Psx_2x_1)]\!]^+(\{g\}) = \emptyset\}$

$= \{g \in G : [\![\sim((\text{℩}x_2)[Bsx_2 \wedge Osx_2x_1] \wedge Psx_2x_1)]\!]^+([\![(\exists x_1)[Msx_1]]\!]^+(\{g\})) = \emptyset\}$

$= \{g \in G : [\![(\text{℩}x_2)[Bsx_2 \wedge Osx_2x_1] \wedge Psx_2x_1]\!]^-$
$(\{h \in [\![(\exists x_1)[Msx_1]]\!]^+(\{g\}) : [\![(\text{℩}x_2)[Bsx_2 \wedge Osx_2x_1] \wedge Psx_2x_1]\!]^+(\{h\}) = \emptyset\})$
$= \emptyset\}$

Its the easiest to solve this for each member of G separately. Thus, the first question to ask is whether f_1 is collected in the set or not. This depends on whether the set of elements of H_1, i.e. the set of assignments resulting from $[\![(\exists x_1)[Msx_1]]\!]^+(\{f_1\})$, that, given as arguments to $[\![(\text{℩}x_2)[Bsx_2 \wedge Osx_2x_1] \wedge Psx_2x_1]\!]^+$ yield the empty set, results in the empty set for the formula in the first line of (262). In H_1, only h_1^3 qualifies, since it is the only element for which $[\![(\text{℩}x_2)[Bsx_2 \wedge Osx_2x_1] \wedge Psx_2x_1]\!]^+$ returns the empty set. This is due to c neither owning nor pushing a bike. Thus, the last question to ask is what the output of the following is:

(263) $[\![(\text{℩}x_2)[Bsx_2 \wedge Osx_2x_1] \wedge Psx_2x_1]\!]^-(\{h_1^3\})$

Due to the assumption that $[\![(\text{℩}v)[\varphi]]\!]^-$ returns the empty set for every argument, out of the three cases that come into play when calculating the negative value of a conjunction, only one is possibly non-empty, namely:

(264) $[\![Psx_2x_1]\!]^-([\![(\text{℩}x_2)[Bsx_2 \wedge Osx_2x_1]]\!]^+(\{h_1^3\}))$

But this is empty as well, since h_1^3, the assignment that assigns c to x_1 doesn't make the definite true because c doesn't own any bike at all. Thus, to conclude, f_1 makes it. Reasoning similarly for the other assignments in G, (262) turns out to be just $\{f_1, f_2\}$. That is, those assignments that feature one of the two situations in which (258) should be false are eliminated already. This is because the surviving candidates are those that don't make the last formula (263) return the empty set.[133] Thus, the calculation simplifies to:

[133] For completeness' sake, the candidates that survive the second to last step are $\emptyset$, from H_2, $\{h_3^2, h_3^3\}$ from H_3, and $\{h_4^3\}$ from H_4. h_3^2 and h_4^3 survive the procedure analogous to (264) because the man in question doesn't push the single bicycle he owns, thus, both f_3 and f_4 fail in producing the empty set as output.

(265) $[\![(\exists x_1)[Msx_1] \wedge \sim((\text{℩}x_2)[Bsx_2 \wedge Osx_2x_1] \wedge Psx_2x_1)]\!]^-(\{f_1, f_2\})$

Once again, due to the assumption that the negative value of the indefinite cannot be non-empty, the only potentially interesting, i.e. non-empty case is this:

$$
\begin{array}{ll}
(266) & [\![\sim((\text{℩}x_2)[Bsx_2 \wedge Osx_2x_1] \wedge Psx_2x_1)]\!]^-([\![(\exists x_1)[Msx_1]]\!]^+(\{f_1, f_2\})) \\
= & [\![\sim((\text{℩}x_2)[Bsx_2 \wedge Osx_2x_1] \wedge Psx_2x_1)]\!]^-(H_1 \cup H_2) \\
= & [\![(\text{℩}x_2)[Bsx_2 \wedge Osx_2x_1] \wedge Psx_2x_1]\!]^+(H_1 \cup H_2) \\
= & [\![Psx_2x_1]\!]^+([\![(\text{℩}x_2)[Bsx_2 \wedge Osx_2x_1]]\!]^+(H_1 \cup H_2))
\end{array}
$$

The sets of assignments that result from calculating the argument are these:

(267)

I_1	i_1^1	i_1^2
s	s_1	s_1
x_1	a	b
x_2	d_1	d_2

I_2	i_2^1	i_2^2	i_2^3
s	s_2	s_2	s_2
x_1	a	b	c
x_2	d_1	d_2	d_3

Hence, (266) continues:

(268) $[\![Psx_2x_1]\!]^+(I_1 \cup I_2) = I_1 \cup I_2$

As can be seen, not only do all assignments stemming from f_2 find a continuation in (268), namely the ones in I_2, but also some of the assignments that originated from f_1. Thus, (258) counts as true with respect to s_1. This is because the definite accommodates in the restrictor of the universal quantifier (254).

Apart from the fact that this is a result that is expected from sentences like (258) in van der Sandt's perspective, it isn't so clear whether this outcome is desirable. Sure, it seems to come for free, given that all the assumptions that led to this point are justified on other grounds. But the more natural outcome would so-called *local accommodation*, i.e., the reading that just allows the elements of I_2 in the output, as DRT's standard interpretation of duplex conditions has it. On the other hand, there are quite some principles around (Heim, 1983; van der Sandt, 1992, a.o.) trying to make the intuitive preference for higher accommodation more precise. The rule of thumb seems to be, the higher the better. And since the definite description contains a variable bound by the universal quantifier, it cannot accommodate *globally*, i.e., above the universal (this is called the *Trapping Principle* in Beaver and Zeevat, 2006; van der Sandt, 1992). In other words, the restrictor is as high as it can get.[134]

Everything just said carries over to the determiner *no*. It can be defined using:

(269) $-((\exists x)[\varphi] \wedge \psi)$

[134]Note further that the same holds for the weak universal quantifier as defined in Dekker (1996). This definition cannot be implemented without further ado, because for the case at hand it turns out be equivalent, since here, the restrictor isn't allowed to be false from the begin with.

Similar to the universal quantifier, this projects the set of things φ but not ψ as value of the variable x. This makes it possible to use a plural pronoun to refer back to its restrictor as in (270a). It even accounts for (270b) if the connective *either ... or* is defined as in (271) (see Krahmer and Muskens (1995)):

(270) a. No man left. They stayed another hour.
b. There either is no bathroom in this house or it is in a funny place.

(271) $-(-\varphi \wedge -\psi)$

The use of the singular pronoun in (270b) is justified along the same lines as above.[135] That is, if (269) makes its appearance within φ, the first conjunct is a doubly negated sentence. Thus, the discourse referent *no* introduces is as mixed as the one introduced by (186). The singular pronoun in ψ then forces concentration on the semantically singular output.[136]

Anyway, the price for this is that a reply like B's in (272b) is unaccounted for:

(272) A: I met the president of New York City at the main station.
B: This can't be true. There is no president of New York City.

This basically is the problem of negated presuppositional existentials mentioned above. Since they presuppose the truth of their restrictor, a variant like (272) contradicts itself. As indicated in fn. 131, this might be repaired somehow. But this enterprise has to await another occasion.

3.5 Digression I: Remarks on Binding Theory

It is necessary to go into Binding Theory at least briefly because the Extended Novelty-Familiarity Condition cannot rule out all kinds of coindexations not allowed. But Binding Theory comes with such a vast amount of different phenomena, subtle observations, and general questions that it is impossible to cover it to a satisfactory degree here. In the following it is briefly reviewed how classical binding theory, condensed in the famous three conditions in (273) (after Chomsky, 1981, 188, repeated from above), is implemented (if at all) in dynamic theories.

(15) Binding Principles
(A) A reflexive is bound in its binding domain.

[135] This is how this account captures van Rooij's (2001) intuition that uniqueness plays a crucial rôle licensing this kind of projection behavior.

[136] The present account predicts that (i) is better than the original sentence because no "silent" throwing out of viable options has to happen. This does not seem to be the case though:

(i) There either is no bathroom in this house or they are hidden pretty well.

Hence, something needs to be said about the availability of plural anaphors within the same sentence as their (dynamic) singular antecedent. Presumably, a syntatic reason can be given why (i) is worse that (271).

(B) A pronoun is free in its binding domain.
(C) An R-expression is free.

Binding is, as usual, understood as coindexation under c-command. Thus, Principle A demands that reflexives are coindexed with c-commanding expressions, while B excludes exactly this for personal pronouns, etc.

One point connected to this was touched upon in the discussion of Novelty of variables in FCS. There, what was needed to get the argument going was a guarantee that Novelty cannot be violated in forming a basic sentence (that is, a formula of the form $\beta\tau_1 \dots \tau_n$, with β being a predicate of arity n and $\tau_1, \dots, \tau_n$ being variables). If this isn't assumed from the get-go, there isn't any hope for providing a formulation Novelty on the basis of files alone, which in turn is needed if one allows variable names to enter the domain through the context.

To be precise, what needs to be excluded independently of the Extended Novelty-Familiarity-Condition (176) is the possibility to translate a sentence like (273a) as (273b), where the second definite reuses the same variable as the first:

(273) a. The woman hits the manager.
b. $(\text{Ꞁ}x_1)[Wsx_1] \wedge (\text{Ꞁ}x_1)[Msx_1] \wedge Hsx_1x_1$

This can be seen (and is) as one instance of a more general principle that excludes other possible coindexings[137] of arguments. To illustrate, neither of the sentences in (274) is allowed to be translated by a basic formula in which only one variable name is used for both arguments (as sketched). On the other hand, (275) seems to demand exactly this.

(274) a. A woman hits her. $(\exists x_1)[Wsx_1] \wedge Hsx_1x_1$
b. A woman hits a manager. $(\exists x_1)[Wsx_1] \wedge (\exists x_1)[Msx_1] \wedge Hsx_1x_1$
c. A woman hits the manager. $(\exists x_1)[Wsx_1] \wedge (\text{Ꞁ}x_1)[Msx_1] \wedge Hsx_1x_1$

(275) A woman hits herself. $(\exists x_1)[Wsx_1] \wedge Hsx_1x_1$

Under the formalization worked with here, it seems enough to exclude formulæ composed out of predicates with the arity n and only m distinct variables, where $m < n$; that is, e.g. $Rsxx$; $Ssxyx$, $Tsxyzy$, etc. That is, Hsx_1x_1 in (274) is made the culprit for ungrammaticality. As long as reflexives and reciprocals are set aside, this *Ban on Coindexation* suffices to describe the net-effect of Binding Theory. If they are taken into account, they need not necessarily violate this constraint. That is, even though reflexives identify argument slots of a verb, this identification does not need to be expressed by sameness of variables occupying different slots: As already demonstrated in section 3.4.2, if one uses something in the spirit of (276b) opposed to (276a) to model reflexives, one captures the

[137]Here and in the following, no difference is made between coindexing and translating by a variable/discourse referent of the same name. To the contrary, it is assumed that coindexing means nothing but translation by the same variable, and vice versa, although the first notion may belong to natural language syntax while the other finds its suitable home in the meta-language used to describe semantic dynamics. But since those levels of representation are not firmly distinguished here, the equivocation of coindexing and translation by the same variable is only consequential.

their reading without violating the constraint under consideration, since the identity in (276b) does not claim sameness of variable names, but identity of referents.[138,139]

(276) a. Rsx_1x_1
b. $(\exists x_2)[Rsx_1x_2 \wedge x_1 = x_2]$

Of course, this can only be the beginning of a full story.[140] One needs to be clear about how this formula comes about compositionally (i.e. whether it is built up from a pronoun and *self* or not[141]), what x_2's projection behaviors is, and so on.

In what follows, it is stipulated that something like the *Ban on Coindexation* is available and thus, that excluding basic formulæ that make use of one variable more than once seals the deal.

Since individual variables share the domain of interpretation, distinct variable names do not guarantee different values. E.g., there are assignment functions that assign the

[138]The informed reader will recognize the standard translation of a pronoun in 'official' DRT in (ib). In Kamp and Reyle's (1993) version of DRT, pronouns are translated in such a way that they always introduce a new discourse referent, which needs to be identified with an already introduced and accessible discourse referent. Thus, predicates are always fed different variable names in DRT, too. But since DRT systematically employs a system of identity-statements between variables, this does not have the same effect as proposed here, that is, the non-identity of variable names seldom means that the variables do not covary in DRT, contrary to FCS. See below for DRT's implementation of Binding Theory.

[139] If one λ-abstracts over x_1 and R, one basically yields the account of reflexives of section 3.1.2. That is, the reflexive pronoun might be rendered as (ia) and the result of applying (ia) to the translation of a transitive verb V as (ib). (ib) is obviously equivalent to the syntactically "forbidden" (ic):

(i) a. $\lambda R.\lambda x.(\exists x_i)[Rxx_i \ \&\ x = x_i]$
b. $\lambda x.(\exists x_i)[Vxx_i \ \&\ x = x_i]$
c. $\lambda x.Vxx$

[140]One piece of evidence that should be mentioned is the following observation made in Percus and Sauerland (2003b). They observe that the following sentence has a reading according to which John's *dream-self* kissed *John* as opposed to John's dream self. This alleged divergence of antecedents might be due to the presence of the existential quantifier in (276). If it is assumed that variables in attitudes are interpreted in a different way than in matrix-clauses, due to the shift introduced by the attitude verb, it is at least possible that the existential quantifier contributes to such a story.

(i) John dreamed that he kissed himself.

[141]This idea morphologically fits English best. In other languages, it does not make that much sense, viz. the following brief overview:

English				German				French			
Possessives		Reflexives		Possessives		Reflexives		Possessives		Reflexives	
his	he+s	himself	him+self	sein	er+?	sich	er+?	son	le+?	se	le+?
her	she+s	herself	her+self	ihre	sie+?	sich	sie+?	sa	la+?	se	la+?

Furthermore, if one wants to propose a rule for the combination of *her+self* then one must acknowledge that this rule violates everything binding theory has to say about binding domains, because *self* needs to "absorb" the free variable contributed by *her* by introducing some antecedent strictly locally.

same values to the arguments in (274), possibly even whole files. But distinct variables as such never receive the same value. That is, the following holds trivially, even though the value of a variable does not depend on the file (at least not immediately; in the long run, e.g., when it is employed and interpreted within a basic sentence, it surely does), since, e.g., the functions return $\#_e$ for different assignment functions:

(277) For any file G, if $n \neq m$, then $[\![x_n]\!]^d(G) = \lambda f.f(n) \neq \lambda f.f(m) = [\![x_m]\!]^d(G)$

But since files are manipulated by expressions continuously, they could be reduced to a set of assignments that necessarily assigns distinct variables the same value. This is illustrated by the following examples taken from Kamp and Reyle (1993) and Büring (2005a) (italics added, J.K.):[142]

(278) Oscar is a popular guy. Fred likes him. Mary likes him. Elaine likes him. *And Oscar likes him (, too).* (cf. Kamp and Reyle, 1993, p. 236)

(279) (I think they gave my paper to Zelda Jones for review.) *The reviewer / She praises Zelda to high heavens* (and ignores my stuff). (Büring, 2005a, p. 151)

Presumably, neither the second occurrence of *Oscar* and *him* in (278) nor *the reviewer/she* and *Zelda* in (279) are coindexed. Even though proper names weren't discussed yet, it is a safe assumption that they are translated by variables as well (their variation needs to be restricted differently than the variation of variables used to translate definites or indefinites, though). An even stronger assumption is needed to explain the well-formedness of (278), namely, that two occurrences of the same name have to be contraindexed.[143] If so, then both examples exhibit (necessary) covariance without coindexation. This is due to the relevant pronoun in (278) being anaphorically related to the same proper name in different position. Of course, all of the three relevant expressions would be coindexed if proper names introduced the same index over and over again. The file, speaking in FCS's terms, is thereby altered in such a way that before the pronouns or definite description are interpreted, the amount of possibilities is reduced with respect to the variable names in play. Whatever variable name is introduced to translate the proper names in question, the respective anaphoric expression is translated in the same way and thus inherits its valuation. Since the antecedents are proper names in both cases, the variables are assigned the referents constantly, for every assignment function remaining in the file. If it comes to the interpretation of the relevant basic

[142] The observation itself is older. Similar examples could have been taken from Heim (1993), Reinhart (1983a) and Reinhart (1983b) or Evans (1980), just to name a few. It should be noted that the example given in the text only is a variant of Kamp and Reyle's example. They provide:

(i) Oscar is a popular guy. Fred likes him. Mary likes him. Elaine likes him. Even Oscar likes him.

This may be taken to illustrate the same point but it is doubtful whether *Oscar* and *him* really are corarguments of *like* in the last sentence. If the structure of the example is assumed to be [[*even Oscar*] [*likes him*]] (cf. Heim, 1993, p. 213), then (i) doesn't exemplify covariation of contraindexed arguments, since then, the coargument of *him* is *even Oscar*. (278) avoids this problem altogether.

[143] This can be taken lie behind Principle C of Binding Theory.

sentences the respective other argument (despite the anaphoric) expression introduces another variable, which, since it is the same proper name, varies across the file in the same way. Therefore, different variables covary harmoniously, leaving the impression of coindexation; contrary to fact. To sum up, even though at least two argument slots of the respective predicates receive the same interpretation, the sentences are fine, as long as the arguments are syntactically distinguished (contraindexed), which suggests that sameness of semantic value alone isn't a problem at all.

However, the assumption that every occurrence of the same proper name carries a "new" index poses an additional problem if one assumes that Binding Theory also is responsible for ruling out examples like the following. Under this assumption, both occurrences of the proper name come with their own unique index, and therefore, should be fine, contrary to fact.

(280) Oscar likes Oscar.

But since constructions like these were judged "deviant but not horrible" (Schlenker, 2005, p. 64), this might not be an issue. A possible line of thought that does not appeal to Binding Theory may resort to something like an implicature-based reasoning.[144] According to a story like this, (280) is deviant because of a simpler alternative which expresses the same proposition, namely:

(281) Oscar likes himself.

Since this formulation makes use of a reflexive pronoun whose sole job consists in (semantically) multiplying the subject, the very fact that it is avoided carries the implicature that something different has to be the point of (280). But since, by assumption, the proper names refer unequivocally to the same individual, (280) can't have a different point. Thus, it is degraded or semantically anomalous because it clashes which an implicature evoked by comparing it to (281). But there is a hole in this explanation. It is by no means clear by which measure (281) should be simpler as (280). One can't simply speculate that it has to do with processing more variable names, since according to (276b), reflexives also introduce variables. This needs further investigation.

Roughly the same solution is available for the version of DRT used here. Since its syntax is similar to FCS's, the ban on coindexing coarguments is in principle also applicable. But it should be mentioned that the formalism in Kamp and Reyle (1993) is slightly different. Instead of translating pronouns using only accessible variables already in play, pronouns themselves introduce new variables which need to be linked to accessible ones. Thus, instead of rendering (282a) as (282b), as above, Kamp and Reyle use (282c) (leaving situation variables out of the picture):

(282) a. Bill supports Hillary. He admires her.

[144] Something along these lines is found, e.g., in Roberts (2003). On p. 326, she suggests that the use of a full definite descriptions is marked if a personal pronoun would do as well. She adduces brevity, but doesn't flesh this out in more detail. Sure, if brevity of expression would be the whole point, *Jo likes Jo* should be even better than *Jo likes herself.*

b.

x_1 x_2
Bill(x_1)
Hillary(x_2)
Support(x_1)(x_2)
Admire(x_1)(x_2)

c.

x_1 x_2 x_3 x_4
Bill(x_1)
Hillary(x_2)
Support(x_1)(x_2)
$x_3 = x_1$
$x_4 = x_2$
Admire(x_3)(x_4)

As can be seen, both pronouns are linked to the appropriate antecedents by identity statements connecting variable names. Roughly put, the resolution algorithm introduces a system of identity statements between distinct variables. Thereby, DRT manually forces covariation between pronouns and their antecedents while both are translated using distinct variables. An unconnected variable, that is, a variable that isn't explicitly linked to others, still varies freely over the domain of individuals, like it does in FCS. Viewed globally, across all assignments, these variables exhibit relative freedom with respect to other variables in play, but locally, at certain assignments, the values of distinct variables may coincide. Fortunately, the remark on FCS from above applies to 'official' DRT as well. That is, the semantic value of a whole sentence consists in a (characteristic function of a) set of assignments, and, like in FCS, distinct variables usually are assigned distinct functions from assignments into individuals. So, two expression only then get assigned the same meaning (in context) systematically, if they are (i) translated by the same variable, which is forbidden in Kamp and Reyle's (1993) DRT, or (ii) explicitly linked by an identity statement, which comes into play only if the resolution process demands it.

What is also built into the "official" resolution mechanism but not represented here, is a checking mechanism which makes sure that pronouns are only linked to antecedents matching in gender (and mostly in number, too). For this very example, this leaves only one option to resolve the pronouns, namely in the way depicted. For a slightly different example, this mechanism isn't of much help.

(283) a. Bill supports Donald. He admires him.

b.

x_1 x_2	
Bill(x_1)	Donald(x_2)
Support(x_1)(x_2)	
He admires him	

For this example, more possibilities for the pronouns to resolve to exist, at least when it comes to antecedents matching in φ-features. But only some of them represent actual readings of the sentences.[145] For the sake of argument, it is supposed that the pronoun

[145] One issue with (283) won't be addressed, namely that it equally possibly for *he* in subject position to resolve to *Bill* or *Donald*. Both solutions are fine from the perspective of the resolution algorithm and Binding Theory as long as the pronoun in object position takes the respective other expression as antecedent. But the reading *Donald admires Bill* should somehow be harder to get if judged possible at all.

in subject position resolves, as above, to the subject of the preceding sentence; meaning that it introduced a new variable, namely x_3, and inserts the identity statement $x_3 = x_1$ into the box. For the second pronoun then three variables are accessible, namely x_1, x_2, and x_3. As should be clear, the only variable that should count as accessible is x_2, but without any addition to the mechanism sketched, this isn't guaranteed at all. One way to install something to this end is to manually remove those variables used for translating expressions that c-command the pronoun in the surface structure of the sentence under scrutiny. That is, applied to the present example, to disallow linking the pronoun to the newly introduced x_3.[146] But this doesn't settle the issue, yet, since nothing prevents resolution to x_1, yielding a structure, which shouldn't be possible at all, namely (283c), making *Bill supports him* meaning *Bill supports himself*:

(283) c.

x_1 x_2 x_3 x_4	
Bill(x_1)	Donald(x_2)
Support(x_1)(x_2)	
$x_3 = x_1$	$x_4 = x_1$
Admire(x_3)(x_4)	

It therefore isn't enough just to disallow picking up the variable introduced by the expression in subject position. What is needed is a prohibition on picking *any* variable that is linked to variables stemming from c-commanding expression; namely x_1 in the example above. To provide something to this end, the following auxiliary notion is defined (cf. Kamp and Reyle, 1993, 235f.):

(284) The class of discourse referents identified with a given discourse referent x_i, relative to a DRS K—$[x_i]_K$—is the smallest set Y such that

a. $x_i \in Y$, and
b. If $x_j \in Y$ and there is a k such that either $x_j = x_k$ or $x_k = x_j$ occurs somewhere in K (as element of Con_K or as element of $\mathrm{Con}_{K'}$, where K' is a subDRS of K), then $x_k \in Y$.

Applied to above's example, x_4 cannot resolve to x_3 or x_1 anymore, since both belong to $[x_1]$, the class of discourse referents identified with x_1. This leaves only one option for the pronoun in object position, namely x_2, the discourse referent introduced by the proper name in object position of the first sentence. Thus, armed with a resolution rule for non-reflexive pronouns utilizing $[x_1]$, the correct structure obtains, rightly assigning an interpretation to the second sentence which can be paraphrased as *Bill admires Donald.*

This amendment does not rule out examples like the following which show that mere sameness of semantic value isn't an issue:

(285) a. Oscar is a popular guy. Fred likes him. Mary likes him. Elaine likes him. Oscar likes *him* (, too). (= (278))
b. Oscar is a popular guy. Fred likes him. Mary likes him. Elaine likes him.

[146] Cf. Berman and Hestvik, 1994, p. 22 for this intermediate step.

Even Oscar likes *him*.

c. The man in the mirror was on the point of being attacked from behind. When Bill saw *him*, he cried out in order to warn him. Had he realized he himself was that man, he would have turned around instead and would have tried to defend himself. (Kamp and Reyle, 1993, p. 236)

In all examples, the italicized pronouns are resolved in such a way that they end up referring to the individual that is denoted by the term in subject position as well.[147] The italicized pronoun in (285a) (x_3 below) is linked to the discourse referent that is introduced by discourse-initial *Oscar* (o_1 below, in order to make the DRS easier to read), like every other pronoun in the discourse (x_1 and x_2) is. But, under the assumption that the second occurrence of *Oscar* (i) introduces a new variable (o_2) which (ii) is not linked to any of these discourse referents already in play, $[o_2]$ for the whole DRS in (286) solely consists of o_2, allowing the pronoun to resolve to the first occurrence of *Oscar*, namely o_1. Very similar stories can be told for the other examples in (285).

(286)

$o_1\ o_2\ m\ e\ x_1\ x_2\ x_3$		
Oscar(o_1)		Popular(o_1)
Mary(m)	$x_1 = o_1$	Like(m)(x_1)
Elaine(e)	$x_2 = o_1$	Like(e)(x_2)
Oscar(o_2)	$x_3 = o_1$	Like(o_2)(x_3)

In Kamp and Reyle (1993), there is no need to make use of $[x_n]_K$ for reflexives, since they need to be identified with a coargument of the predicate they are located in.[148] Thus, if something like the following is considered, the only discourse referent the reflexive may resolve to is z, the one introduced by *Zelda*:

(287) a. Meryl admires Hillary. Zelda praises herself to high heavens.

b.

$h\ m\ z\ x_1$		
Meryl(m)	Hillary(h)	Admire(m)(h)
Zelda(z)	$x_1 = z$	Praises_to_high_heavens(z)(x_1)

Thus, the reflexive doesn't have a broad range to choose antecedents from. Despite the similarities to non-reflexive pronouns in terms of introducing its own discourse referent which needs to be linked to a preexisting one, it has no choice but to cling onto whatever serves as translation of the expression in subject position (restricting talk to transitive predicates); that is, the translation of the closest c-commanding expression. Thus, if z is the discourse referent translating the subject, x_1, the variable introduced by the reflexive, has to be linked to z. This gives a very close relative of above's (276b) (but with different variable names):

(288) $(\exists x_1)[Rzx_1\ \&\ z = x_1]$

[147] If *Oscar* really is the coargument of *him* in (285b). See fn. 142

[148] Excluding *exempt anaphora* from the discussion for the moment. See below.

Thus, the techniques developed by FCS and DRT to accommodate Binding Theory can roughly be characterized along the following lines: if predicates are translated by λ-terms, such that the number of λs is the same as the ariy of the predicate (viz. (289a)), reflexives in object position reduce this number, but replicate the argument of the subject position (see (289b)), while a non-reflexive avoids precisely that, that is, neither are directly identified nor coindexed with the argument in subject position. Or, simply put, reflexives are *bound* within the predicate they are an argument of (their *coargument domain*[149]), while non-reflexives are *free*:

(289) a. $[\![\text{like}]\!] = (\lambda y.\lambda x.x \text{ likes } y)$
b. $[\![\text{like herself}]\!] = (\lambda x.x \text{ likes } x)$
c. $[\![\text{like her}_i]\!] = (\lambda x.x \text{ likes } [\![x_i]\!])$
with i not being the index of the argument in subject position

What both theories (and DPL), viewed from the perspective of (289), lack is a clear distinction between saturation (indicated by λ-prefixes above) and resolution processes. As claimed above (section 3.1.2), reflexives do not (necessarily) need to engage in the business of antecedent seeking, since their job is to multiply a coargument. It is thereby not mandatory to model their behavior akin to that of non-reflexives with "reduced search space", so to speak. Instead, one can try to make use of the difference between coindexation and argument multiplication, as sketched above. In the emerging picture, (co-)indexing (and conditions thereon), as a matter of modeling, e.g. anaphoricity, seems to be only needed for non-reflexives.

In Büring (2005a), (289) is presented in a slightly different way, more in the spirit of Heim and Kratzer (1998) where what is done by λ-terms in the denotation of predicates in (289) is achieved by syntactically represented binder prefixes—indexed βs in the following—stemming from moving the argument in subject position to a higher position:

(290) a. Lisa likes her$_{*1}$/herself$_1$.
b. Lisa β_1 [t_1 likes like her$_{*1}$/herself$_1$]

The way in which this is put to use is pretty straightforward. Reflexives need to be coindexed with the trace in subject position, while non-reflexives need to avoid exactly that. But since the system sketched in (290) models argument multiplication via coindexation, in contrast to the one sketched in (289), where the bound variable doesn't carry an index, this has to be ensured on external grounds. Hence, the Ban on Coindexation has to reckon with two cases: coindexation of the non-reflexive pronoun and the trace in subject position in (290), as well as coindexation of the non-reflexive pronoun and the moved constituent. What is not depicted in (290b) is the fact that the moved proper name *Lisa* needs to bear an additional index in order to be available as antecedent for anaphoric pronouns. The index this expression has to carry may or may not be the same as the index of the (β-bound) trace. Since β-binding translates into λ-abstraction,

[149] For a definition of *coargument domain*, cf., e.g., Büring, 2005a, p. 59.

interpreting *Lisa* as the subject of *like* is not a matter of coindexation, but of functional application. But if the sentence is continued with *She owns seven mirrors*, identification of *Lisa* and *she* proceeds via coindexation, hence *Lisa* needs to have an index as well. And since the index on the trace and β gets "interpreted away" in (290b), a new index is needed. Thus, (290b) should better be depicted as (290c):

(290) c. Lisa$_2$ β_1 [t_1 likes like her$_{*1/*2}$/herself$_{1/2}$]

And this makes clear that Binding Theory should rule out two possible indexations once the variant with the non-reflexive pronoun is considered, namely that the pronoun carries either 1 or 2:

(290) d. #Lisa$_2$ β_1 [t_1 likes her$_1$]
e. #Lisa$_2$ β_1 [t_1 likes her$_2$]

(290d) treats the non-reflexive as a reflexive, which is ruled out by Principle B of Binding Theory. But (290e) circumvents Binding Theory and therefore must be ruled out on different grounds. And this is achieved in Büring (2005a) and Büring (2005b) (following Grodzinsky and Reinhart (1993), Reinhart (1983a), and Reinhart (1983b), cf. Heim (1993) as well) by appealing to the so-called *Have Local Binding*-Rule.[150] It consists of an explanation of the (im)possibility of coreference which makes use of alternative constructions in which coindexed but free variables are substituted for (semantically) bound ones. The idea is that the existence of an alternative syntactic representation with bound variables in place of coindexed ones that has the same reading is favored over the one with free variables. It thereby blocks coindexation. That is, by this rule, it is not possible to coindex subject and pronoun like in (290e), because this indexation would generate the same reading that (290d) has. But since (290) cannot be represented as (290d) because the pronoun is non-reflexive (Principle B), this reading cannot be generated on the basis of (290) at all.

The technique sketched in (289) has to have *Have Local Binding* as well. But the other part comes out without further ado. Since reflexives are conceived of as argument repeater, they automatically obey Principle B. And that the variable the non-reflexive pronoun contributes and the variable that is a placeholder for the subject are not allowed to be coindexed is implicitly captured if one thinks of (289c) being derived from (289d), that is, via functional application, which isn't allowed to mix up bound and free variables, anyway. That is, (289d) with coindexed argument-placeholder and pronoun has the structure of (291a) which is not allowed to be reduced like in (291b) where the formerly free x stemming from the pronoun suddenly ends up in the scope of the inner λ-prefix of the transitive verb. This would change the meaning of the whole construction and therefore cannot justify the identity. Instead, one has to rename this bound variable before the function is applied to the argument. After this, one gets (291c), which is what one wants.

[150] Its predecessor, the *Coreference Rule* comes from Reinhart (1983a). Note that for this very example, the Ban on Coindexation still does the job since after functional application, *Lisa$_i$* again is a coargurment of *her$_i$*.

(289) d. $[\![\text{like}]\!]([\![\text{her}_x]\!])$

(291) a. $[\lambda y.\lambda x.Rxy](x)$
b. $*[\lambda y.\lambda x.Rxy](x) = [\lambda x.Rxx]$
c. $[\lambda y.\lambda x.Rxy](x) = [\lambda y.\lambda z.Rzy](x) = [\lambda z.Rzx]$

The only thing that really needs to be prohibited is that the result of (291c) is applied to x once again. Hence the need for *Have Local Binding*. The respective accounts of FCS and DRT start their work right at this problem, but they are not modeling Binding Theory, so conceived, but Büring's *Have Local Binding*, or Reinhart's *Coreference Rule* or the simply Ban on Coindexation suggested above. The whole argument comes full circle.

Note that one might try simply *not* distinguishing indices carried by DPs for later anaphoric relations from indices they leave when moved. That is, one might claim that there shouldn't be a configuration like (290d) or (290e), where the trace and *Lisa* are contraindexed. Instead, the following would need to be the only case:

(290) f. #Lisa$_1$ β_1 [t_1 likes her$_1$]

And this in turn can excluded because two variables of the same name occupy different argument slots of the same predicate; i.e. by the Ban on Coindexation.

Furthermore, since the binder β cannot be contraindexed with its to-be nominal argument anymore, one might as well make DPs the expressions that saturate the predicate's argument slots (instead of coindexed traces) again; as they are traditionally conceived to be. That means, taking the translation of indefinites as an example, one could go back to the traditional translation already mentioned in 3.1.1, namely (292), but give the embedded existential quantifier the "dynamic" interpretation:

(292) $\lambda Q.\lambda P.(\exists x_1)[Qx_1] \wedge Px_1$

This has the advantage that the argument slot of predicates would be guaranteed to be occupied by a variable with the "right" index. Thus, it is incompatible with a VP containing a coindexed personal pronoun in any other argument position for the same reason as (291b) is not true. Usually, this problem can be solved by renaming the bound variable, which is justified in classical systems because their names don't matter. That is, in non-dynamic languages, (292) is equivalent to (293), thus this step is warranted. But this isn't possible once bound variables become more meaningful, as shown in 3.3.2.

(293) $\lambda Q.\lambda P.(\exists x_2)[Qx_2] \wedge Px_2$

This is turn would be compatible with an argument containing x_2 in another position, like, say, $\lambda x.Rxx_2$ either as substitute for Q or P. The dynamically understood existential quantifier cannot distinguish between x_2 within and outside of its scope, anyway, simply because "scope" in the traditional sense isn't applicable anymore. Thus, what isn't possible with λ-terms—namely applying them in such a way that a variable formerly outside of their scope finds itself within it, cf. (291)—becomes possible with dynamic existential quantifiers, because even the remotest variable *is* in their scope in some sense. Hence, something like the Ban on Coindexation is necessary.

Be this as it may, what is presented here is only a brief sketch of what has to be done. There remain a lot of issues to be solved, especially the nasty question under which circumstances combinations of lexical material count as *one* predicate instead of many. As already mentioned in section 3.1.4 there are configurations in which the complementary distribution of non-reflexives and reflexives seems to break down (examples taken from Büring (2005a, p. 223)):

(294) a. Lucie saw a picture of herself/her.
 b. Max keeps a gun near himself/him.
 c. Max boasted that the queen invited Lucie and himself/him for a drink.

The point of the examples in (294) is that both pronouns seem to be allowed in these environments. Mostly, this is taken to mean that there is something wrong with a very strict implementation of non-reflexive and reflexive pronouns that predicts their distribution to be complementary. E.g., what is said to be the only possible antecedent of reflexives at the same time is the only potential antecedent not allowed for non-reflexive pronouns. In the light of (294), one may conclude that the precise definition of *coargument domain* in which a (non-)reflexive has to be bound (free) is not as easily provided as by alluding to basic sentences or lexical predicates as is suggested by the Ban on Coindexation. Instead, one might challenge the somewhat implicit assumption that the domain within which reflexives need to find their antecedent is the same as the domain within which non-reflexives are not allowed to pick their antecedents from (cf. Chomsky, 1981, among others). On the other hand, the Ban on Coindexation only then would prevent *him* being coindexed from *Max* in (294b) if *keeping ... near ...* was an atomic predicate; roughly (and still abstracting from the correct implementation of proper names):

(295) $(\exists x_1)[Gx_1] \wedge KNm_1x_1m_1$

Since this is quite unnatural, one might conclude that everthing is fine with (294). But, of course, it still remains a mystery how the reflexive finds its antecedent.

3.6 Digression II: A brief comparison to Plural Dynamic Predicate Logic

Apart from the situational ingredient, sets of assignments collecting all possible contributions of indefinites and other expressions have already been put to use in different frameworks, but in a different way and to different ends. Especially van den Berg (1996) and, as a follow-up, Brasoveanu (2007) and Brasoveanu (2008) use sets of assignments to model what they call *plural information states*. Roughly put, the basic idea is that the distinguishing feature between singulars and plurals is that the former refers (if it refers) to one (atomic) entity at a time while the latter simultaneous refers to more than one (atomic) entity. This is modeled by trading assignment functions that related through evaluation of lexical material form sets of such functions that are structured and interpreted differently depending on whether, say, a singular or plural indefinite is interpreted. Thus, where standard DRT or DPL relate a single (input) assignment function to another one (output), PCDRT, as Brasoveanu develops it, relates sets of them.

Why should this lift be needed? They claim that these structures help to explain the elaboration on quantificational dependencies as well as maximality effects found with singular and plural pronouns that DRT is otherwise unable to capture. To see this, recall the interpretation of so-called *duplex conditions* in Kamp and Reyle (1993). They come in the following form:

(296)
$$\begin{array}{|c|}\hline \\ \hline \begin{array}{|c|}\hline U(\varphi)\\ \hline C(\varphi)\\ \hline\end{array} \; \Diamond\!\begin{smallmatrix}Q\\x\end{smallmatrix} \; \begin{array}{|c|}\hline U(\psi)\\ \hline C(\psi)\\ \hline\end{array} \\ \hline \end{array}$$

(297) $\mathcal{M} \vDash_f [\varphi]\ \langle Qx\rangle\ [\psi]$ iff $\langle R, S_{w/s}\rangle \in [\![Q]\!]$, with

a. $R = \{r : (\exists g)(f \cup \{\langle x, r\rangle\} \subseteq_{U(\varphi)-\{x\}} g \ \&\ \mathcal{M} \vDash_g \varphi\}$

b. $S_w = \{s : (\exists g)(f \cup \{\langle x, s\rangle\} \subseteq_{U(\varphi)-\{x\}} g \ \&\ \mathcal{M} \vDash_g \varphi\ \&$
$(\exists h)(g \subseteq_{U(\psi)} h \ \&\ \mathcal{M} \vDash_h \psi))\}$

c. $S_s = \{s : (\exists g)(f \cup \{\langle x, s\rangle\} \subseteq_{U(\varphi)-\{x\}} g \ \&\ \mathcal{M} \vDash_g \varphi)\ \&$
$(\forall g)(f \cup \{\langle x, s\rangle\} \subseteq_{U(\varphi)-\{x\}} g \rightarrow (\exists h)(g \subseteq_{U(\psi)} h \ \&\ \mathcal{M} \vDash_h \psi))\}$

These rules can be applied to the infamous donkey sentence that is represented as follows:

(298) Every farmer who owns a donkey beats it.
$$\begin{array}{|c|}\hline \\ \hline \begin{array}{|l|}\hline x\ y\\ \hline F(x)\\ D(y)\\ O(y)(x)\\ \hline\end{array} \; \Diamond\!\begin{smallmatrix}\forall\\x\end{smallmatrix} \; \begin{array}{|l|}\hline z\\ \hline z = y\\ B(z)(x)\\ \hline\end{array} \\ \hline \end{array}$$

According to the interpretation rules for duplex conditions, one arrives at the following sets:

a. $\{r : (\exists g)(f \cup \{\langle x, r\rangle\} \subseteq_{\{y\}} g \ \&\ \mathcal{M} \vDash_g F(x)\ \&\ D(y)\ \&\ O(y)(x)\}$

b. $\{s : (\exists g)(f \cup \{\langle x, s\rangle\} \subseteq_{\{y\}} g \ \&\ \mathcal{M} \vDash_g F(x)\ \&\ D(y)\ \&\ O(y)(x)\ \&$
$(\exists h)(g \subseteq_{\{z\}} h \ \&\ \mathcal{M} \vDash_h z = y\ \&\ B(y)(x)))\}$

c. $\{s : (\exists g)(f \cup \{\langle x, s\rangle\} \subseteq_{\{y\}} g \ \&\ \mathcal{M} \vDash_g F(x)\ \&\ D(y)\ \&\ O(y)(x))\ \&$
$(\forall g)(f \cup \{\langle x, s\rangle\} \subseteq_{\{y\}} g \rightarrow (\exists h)(g \subseteq_{\{z\}} h \ \&\ \mathcal{M} \vDash_h z = y\ \&\ B(z)(x)))\}$

Interpreting (298) using (298a) as restrictor and (298b) as nuclear scope set yields the weak reading which in predicate logic is expressed by (299a). If (298c) is used as the nuclear scope instead, one arrives at (299b).

(299) a. $(\forall x)[(\exists y)[F(x) \wedge D(y) \wedge O(y)(x)] \rightarrow (\exists y)[D(y) \wedge O(y)(x) \wedge B(y)(x)]]$
b. $(\forall x)[(\exists y)[F(x) \wedge D(y) \wedge O(y)(x)] \rightarrow (\forall y)[D(y) \wedge O(y)(x) \rightarrow B(y)(x)]]$
$\equiv$ $(\forall x)(\forall y)[F(x) \wedge D(y) \wedge O(y)(x) \rightarrow B(y)(x)]$

As can be seen, the orthodox DRT-account predicts *homogeneity* of quantificational force for the nuclear scope. Either, all variables introduced are existentially quantified, as in (299a), or universally, as in (299b). But for an example like the following, this kind of analysis makes the wrong predictions:

(300) Every person who buys a book on amazon.com and has a credit card uses it to pay for it.

The readings predicted by the analysis are:

(301) Every person who buys a book on amazon.com and has a credit card uses . . .
a. . . . *every* credit card she has to pay for *every* book she bought.
b. . . . *some* credit card she has to pay for *some* book she bought.

Hence, if a person owning three credit cards bought three books, (301a) demands that each book is paid by using every credit card; which is quite absurd. Furthermore, the reading in (301b) is compatible with the person only paying for some of the books she bought, which intuitively isn't a correct reading, either. The most natural reading is that every person pays for *every* book she buys by using *some* credit card she has. Hence, there is no homogeneity among the quantifiers on the right hand side.

In a nutshell, Brasoveanu attempts to capture this reading by making indefinites ambiguous between a weak and a strong reading. Basically, this ambiguity makes them differ with respect to the number of witnesses they introduce into the mix. Strong indefinites, as indefinites are conceived of here, introduce the whole set of witnesses, spread across all assignments in the file they apply to. The contribution of weak indefinites doesn't need to be maximal in this sense. They are satisfied with contributing proper subsets. This allows for using the interpretation mechanism generating the strong reading while not necessarily obtaining the strongest reading possible. If *a credit card* makes a weaker conribution, e.g. providing just one out of three credit cards the person in question owns, then the pronoun can be heard as being existentially quantified even though it is covered by the universal quantifier in the logical form. The universal simply doesn't vary over all credit cards the person owns, but only over those provided by the weaker indefinite. This coupled with a strong construal of *a book* leaves the impression of mixed or heterogeneous quantification.

To see that this approach to *discourse plurality* still is compatible with the present setup, recall the treatment of an example like *a man owns a dog*. The truth conditions of such sentences are arrived at by forming the set of assignment functions that make this sentence true. This is depicted as follows:[151]

[151] The file is oriented differently compared to section 3.4 just for reasons of space.

(302)

G	s	x_1	x_2
	s_1	Hidesaburō Ueno	Hachikō
	s_1	Richard Nixon	Checkers
	s_1	Richard Nixon	King Timahoe
	s_1	Richard Nixon	Vicki
	s_1	Richard Nixon	Pascha
	...	...	...

As can be seen, Nixon owns more that one dog in s_1 (he actually owned even more than listed here). But this means that, in principle, the structure that Brasoveanu (2008) claims to be needed to account for discourse plurality still is available. The only thing that needs to be done in order to extract the dogs owned by Nixon out of (302) is to add a situational referent. That is, all one has to do is to collect all values for the variable x_2 while fixing x_1 *and* s to one of their values, e.g. Richard Nixon and s_1:

(303) $\{d : \exists g \in G : g(x_1) = \text{Richard Nixon} \ \& \ g(s) = s_1 \ \& \ g(x_2) = d\}$
$= \{\text{Checkers, King Timahoe, Vicki, Pascha}\}$

So far, so good. What isn't readily available is evidence for freely occurring weak indefinites, i.e. weak indefinites not embedded under a quantifier. One might try to connect so called *specific indefinites* to the weak reading stipulated by van den Berg and Brasoveanu. If they really can be understood as contributing less than "normal" indefinites, they exemplify what is needed. This, however, lies beyond the scope of the present work. This brief remark is only intended to demonstrate the general compatibility to the framework just sketched.

4 Two Dimensional Dynamic Semantics

4.1 Bookkeeper's pitfalls

4.1.1 Dimensions vs. sets of variables

Having discussed Kaplanian Context Theory and Dynamic Semantics, it now comes to marrying these two strands in such a way that the resulting theory has the following properties:

1. Double indexing

2. Dynamics in terms of adding variable names to the index

What seems to be the next step is to relate the notion of dimension to the sets of variables. That is, according to Context Theory, two dimensions of dependency need to be provided, namely contexts and indices. According to Dynamic Semantics, up to three sets of variables have to be reckoned with, namely free, active, and bound variables. Since the third is a superset of the second one, they cannot be treated as different dimensions, though, because dimensions normally do not overlap. That is, they of course are made up of the same kind of entities, which is captured in some systems in chapter 1 by deriving both contexts and indices from situations. But their overlap in content doesn't confuse their rôles in a derivation. In other words, even though contexts can be conceived of as special kind of indices, they play a different rôle when it comes to the calculation of an extension. According to a famous hypothesis ('(L)' in T. E. Zimmermann 1991), (lexical) expressions are either context- or index-dependent relative to their use, but not both at the same time. This is consistent with an expression having both uses as long as for each use it doesn't overlap with the respective other. This means that, speaking of variables, they normally are not "overloaded" in the sense that they have antecedents both in the context and in the index. So, there seems to be no choice but to identify context-dependent pronouns with free variables and anaphoric pronouns with active/bound ones. Furthermore, these sets have to be distinct. To illustrate what this means, a variant of the FCS-model of the previous chapter is used as an example. Double indexing in such a system might be implemented by demanding of the elements of the file G to be bipartite, namely consisting of one "anchored" part for context variables (that is the same for all elements of G) and another part for index variables (which is allowed to change from one element of G to another). Both parts might as well be abstracted over, giving a two-dimensional system similarly to the latest version of DRT in the previous chapter (where truth is defined relative to an anchor). Let this be denoted by $[\![\bullet]\!]^c(I)$, where c is a context assignment, and I is a set of index assignments. This is just to establish a *façon de parler*. Contrary to FCS in the previous chapter,[1]. any expression φ thus is not just interpreted against a file, but against a file and another assignment; or a singleton set thereof. As suggested above, c takes care of free variables, while the assignments in I cover bound (and active) ones. $[\![\varphi]\!]^c(I)$ denotes the intension of φ, and $[\![\varphi]\!]$ is its character.[2]

Certain assumptions underlying the free/bound dichotomy have to be given up in order to be compatible with the interpretation of Context Theory given in chapter 1. The most crucial one concerns recategorization. The way $\exists x_n$ and $\reflectbox{D} x_n$ are introduced above suggests that they operate on the free variables of the expressions they are attached to. If, e.g., $(\exists x_n)[\varphi]$ is considered, it is said that x_n has to have an occurrence in φ that projects into its set of free variables $F(\varphi)$ (covered by c) in order for the quantification not to be vacuous. By adjoining $(\exists x_n)$, x_n gets recategorized in the sense that it doesn't make its appearance in $F((\exists x_n)[\varphi])$ anymore, but in $A((\exists x_n)[\varphi])$ as well as in $B((\exists x_n)[\varphi])$ instead, and thus gets handed over from c to I. Conceived this way, $\exists x_n$ makes a formerly context-dependent expression (φ) an index-dependent one. To show this in more detail, a lot of notational decisions have to be made, since at the moment, there is no semantic value assigned to $\exists x_n$ in isolation.[3] But from the description it should be clear that $\exists x_n$ acts as if it incorporated a partial[4] variant of diagonal-operator $\rhd$ from chapter 1 ((29) on p. 35). Thus, as pointed out by T. E. Zimmermann (1991, p. 204) and more recently by Rabern (2012) and Rabern (2013), treating variable binding in such a way, is a *monstrous* construction, since $\rhd$ operates on characters. *Monster* is the term Kaplan (1989b) uses to describe constructions that necessarily make use of the character of an expression. Thus, another way of putting it is:

(1) *Ban on Monsters* (T. E. Zimmermann, 2012b, p. 2395)
All syntactic constructions are (at most) intensional.

The interpretation of bound personal pronouns in section 3.1.3 is compatible with an *a priori*-interpretation of this ban (T. E. Zimmermann, 2012b), as opposed to an empirical interpretation (cf. Schlenker, 2003, most notably). The former basically is adopted by following Lewis (1980) in making shiftability a *criterion* for index-dependency. That means that context-dependent expressions cannot be bound by definition, and no ex-

[1]Heim isn't fully clear about the way in which the contextually determined part of assignments making up a file can be identified. One cannot simply take the "stable" part, that is, the part that is the same in every assignment. This doesn't work because it may be possible that the number of alternatives somehow is reduced to only one, e.g. by collecting a lot of information about a variable, initially possibly introduced by an indefinite. By making the "stable" part of the assignments the context, said indefinite's contribution would suddenly belong to the context as well. This of course shouldn't happen. Thus, there seems to be no choice: contexts and indices have to be distinguished from the get-go.

[2]Note that the intension needs a "common ground" in addition to a context. This is different from Context Theory in chapter 1.

[3]Principally, it could be, and this is often done. In a lot of languages influenced by DPL, $\exists x_n$ is a meaningful sentential expression in its own right and $(\exists x_n)[\varphi]$ can be defined as $\exists x_n \wedge \varphi$.

[4]It is partial in the same sense as the operators in (48) in chapter 1 (p. 43) are in that they do not shift all context parameters, but only one of them.

ample can show otherwise, since every example used with such an intention simply demonstrates that the expression needs to be conceived of as index-dependent from the get-go, *because* the example demonstrates shiftability. Thus, Schlenker (2003) has to assume otherwise if he wants his argument to show that it indeed is contexts that get bound. And anybody who models *de se* readings of attitude reports by shifting contexts needs to do so, too.

This severely complicates the identification of lexical expressions as embodying a certain kind of dependency. That is, if it is found that an alleged indexical is bound in other constructions, it needs to be ambiguous. This is mostly acknowledged for definite descriptions or third person pronouns which happen to exhibit both uses, but not universally taken to be the story for expressions like *two days ago* (cf. Schlenker, 2003). Jeffrey King argued through a series of publications (King, 1999; King, 2001; King, 2008) that the alleged demonstrative-only *that* (simplex as well as complex) has uses comparable to discourse-new definite descriptions as well as anaphoric uses. One of his examples features a complex "demonstrative" that needs to covary with a quantifier while being discourse new. This is what definite descriptions usually do, but it is clear that no pointing gesture needs to be involved for the interpretation of the *that*-headed expression:

(2) Every university professor cherishes that first publication of his/hers.

Thus, it seems, even a paradigm indexical expression like *that* sometimes is just index-dependent.

If the ban on monsters under its *a priori* interpretation is taken for granted, it ultimately makes it impossible to identify context-dependent pronouns with free variables and index-dependent with bound ones, if it is assumed that recategorization shifts variables from the set of free variables to the others. $\exists$ and $\complement$ so conceived operate on characters. Therefore, either it is not possible to proceed as desired, or something has to be done about recategorization. Without variables of the appropriate kind in the index, this dilemma is inescapable, and thus, variable binding highlights the inconsistency of the identification of free variables with context dependency with an *a priori* interpretation of Kaplan's ban on monsters. That is, the current issue stems from the hidden claim that variables which are recategorized when bound and variables that are interpreted as context-dependent are the same. But it is claimed above that there is evidence for bound individual variables in the index as well. According to Lewis' criterion, *de se*/*de re* readings of embedded personal pronouns are evidence for them being index-dependent. Furthermore, it is assumed that this index-dependency lies behind *anaphoricity*. Hence, there are two kinds of free variables, namely anaphorically and deictically interpreted ones. Thus, to avoid the issues surrounding recategorization, it only needs to be assumed that potential anaphoric pronouns are the variables that can be bound, while potentially context dependent ones can't. To put it differently, if pronouns could be bound in an environment, but aren't, then they either are anaphorically related to something in the file or the whole construction is simply undefined. If they are interpreted deictically, they couldn't have been bound.[5]

If recategorization cannot be a matter of removing one variable from the set of those variables that are interpreted deictically, because that would be monstrous, what else is it? As suggested by Heim's typology of (in-)definites, recategorization means (possibly) adding a (possibly yet unused) variable to the domain of the file. To see this, consider the existential quantifier as it would have to be implemented in original FCS, where the assignments don't map any variable to the 'dummy individual' $\#_e$, but are fully specified. Because of the novelty condition, adjoining $(\exists x_n)$ to a formula φ (in which x_n occurs) only then is licensed if n isn't part of the file's domain already. That is, if the file under consideration is G, then $[\![\varphi]\!](G)$ needs to be undefined so that $[\![(\exists x_n)[\varphi]]\!](G)$ is felicitous. If G is understood as suggested by Heim (before she builds in context dependency), it doesn't prove a specific value for x_n, but hosts all possible values instead, since x_n did not play a rôle in the determination of truth values, yet. In other words, a variable not in the domain of a file isn't without a value (with respect to the file). That it isn't in the domain just indicates that it wasn't used in any part of the discourse already evaluated. That being said, $[\![\varphi]\!](G)$ technically isn't without a value, even if it hosts x_n. It counts as undefined, but this is solely because of the bookkeeping device, operating on the context-independent notion of the domain of a file, worked in to cope with the "meaningfulness" of bound variables. If domain related constraints are ignored, G certainly assigns some value to x_n and therefore is able to cope with φ; hence $[\![\varphi]\!](G)$ then is as computable as any other formula. Since the result of such a computation again is a set of assignments G', namely the set of those assignments that make φ true, one can describe the effect of adjoining $(\exists x_n)$ to φ by defining what $\exists x_n$ should do when given G' as argument. If G' is empty, it is wrong, while it is true if G' isn't. Since any other of the "dynamic" properties related to this quantifier depend on the domain, this is all there is.[6]

What this shows is that "official" FCS endowed with $(\exists x_n)$ already behaves different than standard PL, since it doesn't make use of just one assignment as source for the values of variables, but sets thereof.[7] Thus, as long as context dependency is left out of the picture, binding is as compositional as it can be;[8] because the impact $(\exists x_n)[\varphi]$ has on a file G can be described by reduction (as the impact of φ alone). In traditional PL, free x_n are assigned one and only one value, because truth conditions are relativized to one assignment only. This value is "thrown away", so to speak, when $(\exists x_n)[\varphi]$ is

[5] It should be mentioned that this claim is impossible to verify empirically since it involves demonstrating that a pronoun *could not* be bound in a given environment when it turns out to be interpreted deictically after all. But in most cases it is easy to provide a variant of such an example where the pronoun *is* bound. The claim that has to be made then is that it wasn't the *same* pronoun. But how should this be demonstrated when the pronouns do not differ in form?

[6] This already is reflected in DRT_{FAB} above, where the clause dealing with the semantics of $\exists$ is basically vacuous. Its main effect lies in recategorization, which is handled syntactically, and its impact on truth conditions is handed over to the definition of truth.

[7] In the terminology of T. E. Zimmermann and Sternefeld (2013, ch. 10), FCS operates with *global* as opposed to *local* values. Textbook introductions to PL traditionally only mention local ones.

[8] Modulo the fact that assignment functions necessarily "contain" syntactic material because variables make up their domains. A strict interpretation of compositionality can't allow any bit of syntax to enter meanings and with respect to such a notion, neither FCS nor PL nor any other system modeling semantic values as or with the help of (sets of) assignment function is compositional.

constructed, because it is necessary to consider all n-variants of the "input" assignment to capture the impact of $(\exists x_n)$. This traditional picture tacitly makes its reappearance in the assumption that bound variables are former globally free ones that are interpreted deictically if no binder is employed. If a set of assignments G already values x_n as part of the anchored variables, then x_n likewise receives only one value (thus correctly accounting for *direct* referentiality of truly context dependent expressions), which is "thrown away" if x_n is (re-)quantified. Under these premises, variable binding definitely is non-compositional, because the one individual that x_n refers to according to the anchored part of G isn't enough to describe the truth conditions of $[\![(\exists x_n)[\varphi]]\!](G)$.

Thus, to maintain that binding doesn't abstract from specific individuals, as in the traditional picture, one only needs to assume that the variable quantified over wouldn't have been interpreted deictically when not bound.[9] Bind*able* variables are interpreted by the non-anchored part of the file from the get-go; regardless whether bound or not. That is, returning to the picture from above, where G is divided into an anchored part c and a non-anchored part I, if x_n is bindable, it should be covered by I. If x_n is covered by c, then it can't be bound and thus, the use of $(\exists x_n)$ would be infelicitous.

Returning to assignments as defined above, i.e. assignments that are "unspecified" for all variables not in the domain, a formula φ containing x_n is not defined with respect to I if x_n isn't in the domain of I. But this is one prerequisite for the felicitous usage of $(\exists x_n)$ in front of φ. Thus, if x_n isn't quantified over, it doesn't have a value, while if it has a value, it cannot be quantified (by $(\exists x_n)$, at least). If I already hosts x_n, then x_n was introduced by $(\exists x_n)$ (or $(\reflectbox{$\complement$}x_n)$) in an earlier sentence. In this case adjoining $(\exists x_n)$ is infelicitous. This means that already valued variables are not requantified.[10,11]

If $(\reflectbox{$\complement$}x_n)$ is taken into consideration as well, then this picture only marginally changes. True, as pointed out in section 3.4.2, $(\reflectbox{$\complement$}x_n)$ is allowed to pick up variables already in use—that is, $[\![\varphi]\!](G)$ need not be undefined for $[\![(\reflectbox{$\complement$}x_n)[\varphi]]\!](G)$ to be felicitous –, but it doesn't abstract from the values already assigned, but simply puts more demands on these very values. It checks for uniqueness (which is trivialized when x_n already is in play) after it possibly reduces the file by those assignments that assign a value to the variable in question that doesn't fulfill whatever the descriptive material in $\reflectbox{$\complement$}$'s restrictor demands. Thus, $(\reflectbox{$\complement$}x_n)[\varphi]$ looses its "quantificational" force if x_n already is part of the

[9] Cf. T. E. Zimmermann (1991, 204f.) for this strategy, objections and alternatives.

[10] This assumption relates to the *Frege-Style Predicate Logic* recently developed by Kai Wehmeier (Wehmeier, 2018). He proposes an alternative syntax for Predicate Logic to the effect that free variables are distinguished from bound ones, and only the latter are interpreted. This is the same in FCS, since bindable variables cannot be in the domain. The difference is that FCS allows free occurrences of variables, but these aren't bindable (by $\exists$). Thus, in both accounts there aren't any values "thrown away".

[11] Note further the repercussion on the so-called *antinomy of the variable* as discussed in Fine (2003) and Fine (2007). This is too deep a topic to go into here. But note that this antinomy cannot be formulated in the present setup because (i) if two distinct variable names both are in the domain of one file, they always vary differently, and hence, are distinct, and (ii) if sets of assignments only accounting for one of them are considered, these files have different domains, hence different definedness conditions, and thus are different. Thus, it is not possible to formulate one horn of Fine's dilemma, namely that (yet unused) variables "are the same", even though their possible course of values coincide.

domain of G, regardless whether c or I. In this case, it only elaborates on whatever the file assigns to x_n, and thereby possibly eliminates some candidates. And if $(\sqsupset x_n)[\varphi]$ is used in an environment $(\exists x_n)[\varphi]$ would be felicitous according to the bookkeeping device, it "quantifies" in the same sense.

To put a long story short: if recategorization isn't understood as moving a variable from the set of free variables to the set of bound ones, but as extension of the file's domain, then all the features responsible for variable binding being monstrous by design disappear. This doesn't necessarily lead to a fully compositional treatment of variable binding, since part of the felicity conditions of the true quantifier $(\exists x_n)$ is that the variable x_n needs to be "fresh". Thus, $[\![(\exists x_n)[\varphi]]\!](I)$ isn't calculated on the basis of $[\![\varphi]\!](I)$, since I isn't allowed to provide any value for x_n.

This view on recategorization might as well be established by simply leaving context dependency out of the picture completely. That is, what might equally well be the culprit is the identification of the set of free variables with the context dimension. If free variables are conceived of as being index dependent as well, there is no way variable binding can turn out to be monstrous, simply because the contextual dimension isn't involved at all. Variable binding by $\exists$ and $\sqsupset$ then rightly is characterized as shifting a variable from the set of free variables to the set of bound variables, but the overall interpretation of freedom changes. Under such a view, there is no way for a variable to be in the domain of a file except being used earlier in the discourse. That is, there cannot be such a thing as a "globally free" variable, and thus, singling out an anchored part is hopeless. Context dependency then is a different animal altogether.

But this easy way out isn't tenable, if one wants to keep the Heimian typology ((177) on page 162), because the novelty condition cuts across both dimensions. To ensure the correct interpretation of $[\![(\exists x_n)[\varphi]]\!](G)$, x_n has to be new with respect to G. This does not only hold for the index related part I of G but for the anchored part c as well. If one simply leaves anchored variables out of the picture, then there is no (non-syntactic) way to make sure that x_n isn't used deictically somewhere earlier in the discourse currently evaluated. Thus, the domain-extension by $\exists$ (and sometimes $\sqsupset$) cannot be described on the basis of I alone. Even though it is not a contextual variable that gets quantified, but a yet unvalued index-variable, x_n has to be new with respect to both dimensions.

This can be circumvented. Sentences like (3) indicate that there needs to be some sort of *contextual import*:

(3) a. He [pointing] is the guy Peter told me about.
    b. He is in danger.

Intuitively, *he* in (3b) isn't interpreted deictically, but is anaphorically related to the demonstratively used *he* in (3a).[12] If this is indeed the case, this can only be explained

[12] "When we wish to refer to the referent of an earlier demonstrative, we do not repeat the demonstrative, we use an anaphoric pronoun, *He* [pointing] *won't pass unless he* [anaphoric pronoun] *studies.* The fact that demonstrative and anaphoric pronouns are homonyms may have led to confusion on this point. The case is clearer when the demonstrative is not homonymous with the anaphoric pronoun. Contrast, *This student* [pointing] *won't pass unless he* [anaphoric pronoun] *studies* with *This student*

if it is assumed that a suitable antecedent is available in the index, although *he* in (3a) intuitively is best understood as being deictically used. Thus, even if interpreted solely against c, *he* in (3a) seems to extend the domain of I as well. If the variable it picks from c and the one introduced into the domain of I are the same, it seems that variables may be part of the index because they are part of the context. Context and index assignments thus possibly overlap.

This conclusion is far from inescapable. Alternatively, one may claim that the variable introduced into the domain of I is different, yet assigned the same value as the variable picked from the context (similarly to reflexives). For instance, one might use the indefinite quantifier to introduce a "fresh" individual variable and restrict its interpretation to the contextual parameter. If x_1 is the contextually determined variable, something along the following lines would do the trick (assuming that it is somehow ensured that x_1 and x_2 are interpreted against c and I respectively):

(4) $(\exists x_2)[x_2 = x_1 \wedge \dots]$

Then context and index assignments do overlap in terms of content, but the variables used to describe this content are different (and so are the (sets of) assignments covering them). But the novelty condition isn't restricted just to variables made use of, but needs to hold for all variables, no matter what. Hence, if (5) is evaluated against the same context (the first sentence of) (3) is evaluated against, the indefinite's variable better not be part of the context. And this must be the case, even if (5) is the first sentence in a conversation:

(5) A man is in danger.

Whichever variable is used to translate *a man*, it must be new with respect to the domain of c as well as I; regardless whether preceding sentences make use of context variables or not.

There are two principal routes here: either, (i) potential context variables are syntactically distinguished from potential index variables. Thus, context assignments and index assignments never overlap, and constructions like (4) establish cross-dimensional correspondences in terms of content. Deictically used expressions thus have to be described using two variables: one to account for further anaphoric relations and one to account for them picking their antecedents from the context; once again as (4) has it. This can be achieved by introducing a distinction among variables by restricting x_n with odd n to context-dependent uses and x_n with even n to index-dependent ones. $\exists x_n$ then also needs to be restricted to even n as well, and hence, x_n with an odd n are unbindable by definition. Alternatively, (ii) the distinction between context and index variables is not preestablished syntactically. The concrete context (with a concrete domain) as well as particular *parses* of sentences decide upon whether a given x_n belongs to the context or the index. Then, deictically used expression can be described using only one variable,

[pointing] *won't pass unless this student* [pointing a second time at what is believed to be the same person] *studies.* The awkwardness of the second shows that the way to secure a second reference to the referent of a demonstrative is to use an anaphor." Kaplan (1989a, p. 589) but this variable needs to occur in both dimensions (after their semantic contribution is calculated, at least). Thus, the dimensions are allowed to overlap in variables *de facto* used.

Taking the first route seems to give up on providing a unified semantics for deictically and anaphorically used expressions. This is not because pronouns are suddenly ambiguous between translations using an odd numerical index on the variable and translations using an even index, since under the present view, pronouns are ambiguous in this sense anyway. Just disallowing any overlap between the two dimensions doesn't add any further ambiguity *per se*. Furthermore, at first glance it isn't clear where the much needed ingredient (x_2 in (4)) has its origins if not as a contribution of a deictically used expression. Hence, it seems, there is a difference between anaphorically and deictically used pronouns. On the other hand, this could be a reason so resort to the common DRT-rendering of pronouns, i.e. to generally translate pronouns by formulæ like (4). The difference between deictic vs. anaphoric interpretations would be solely due to the variable used on the right hand side of the identity sign. But the neat Heimian picture of definite descriptions doesn't survive this move: what seems to allow deictical as well as anaphoric uses of definite articles is the less restrictive extension relation. Thus, if $\text{℩}x_n$ is considered, and x_n is in the domain of c, the expression is referential, while if x_n is in the domain of I, it is anaphorical. This means that one needs to allow n to be odd or even. But in case x_n isn't in either domain, then x_n is discourse new and should be introduced into I's domain. But this is the case as soon as one uses $\text{℩}x_n$ with n being odd in a non-demonstrative context. Hence, x_n is introduced into I's domain and the whole distinction breaks down. If one tries to avoid this by using the following variant of (4) with the additional restriction of n to even numbers and the assumption that x_m is valued by the context (and P is the description's restrictor), discourse-new uses become an issue, since such an antecedentless usage isn't possible once x_m is incorporated:

(6) $(\text{℩}x_n)[x_n = x_m \wedge Px_n]$

One would then have to posit an ambiguity of definite descriptions between (6) and (7), the former standard-translation, admitting that the lax extension relation cannot do the work:[13]

(7) $(\text{℩}x_n)[Px_n]$

For this reason, it appears to be more attractive to pursue the second alternative first and see whether it is tenable or not. As will turn out in the next section, it is only partially. It is possible to leave variables translating third person pronouns and definite descriptions underspecified with respect to the question which dimension they belong to. But generally, this cannot be said for all variables that are needed to translate indexical expressions. Furthermore, (representations of) contextual situational cores have to be distinguished from the situational core of indices for technical reasons—thus,

[13]This of course is a viable alternative, especially since this very ambiguity is associated with different morphological realizations of the definite article in Schwarz (2009) and Schwarz (2012). The ambiguity thesis also avoids some problems the present account has, cf. the discussion in 4.2.3.

the possible distinction between odd and even number on individual variables can be avoided by distinguishing two kinds of situation variables. Double indexing thus needs to have a (quasi[14]) syntactic correlate.

4.1.2 The nature of indexing

Apart from variable binding, there are a lot of further issues to be tackled. One of the more urgent ones is the relation between tuples as defined in chapter 1 and (sets of) assignments utilized in chapter 2, assuming they are extended to contain situation variables as well. These two kinds of entities are not identical, but they can be brought into correspondence in multiple ways. Connected to this issue is the nature of indexing. The usual way to relate assignments to contexts is by the use of appropriate natural language predicates, as *speaker* or *addressee*. All one needs to do is let their argument slot be occupied by a (fresh) variable and the relation is established automatically. These predicates can't be anything but close relatives of the functions Sp, Ad, and Dem used in section 2.2.1 to derive contexts from situations. But, as argued there, the very availability of these predicates is called into question when the data is inspected somewhat closer. Thus, this is the conclusion of the first chapter, there isn't anything special about the contextual rôles expressed by associated indexicals. They just have to be kept separate in order to avoid confusions. If this is taken as a starting point, one cannot resort to a version of the usual approach. A different approach must be developed.

Heim (1982), for example, uses tuples instead of assignments from the get-go and hence makes indices on variables refer to positions in sequences. That is, x_n is assigned the n-th individual in a sequence. In contrast, in next to all other dynamic systems, x_n is not related to any tuple whatsoever,[15] but just assigned the value an assignment happens to come up with for this variable name. Just as a reminder, sequences of values individuating contexts in chapter 1 reserve the first positions for the situational core. Depending on the granularity of analysis—whether the situational core is 'unpacked' or not—this takes up between 1 and 3 positions in the sequence. Afterwards, the sequences just contain individuals, indented for the interpretation of individual-related context dependent expressions. The first entry of this second part of the sequence stores the values for *I*, the second the values for (non-demonstrative) *you* and the positions to follow are reserved for deictically used third person personal pronouns and similar expressions. For the sake of argument, consider sequences that host just a situation variable in core-position, i.e. sequences of the following kind (elements of $d\Gamma$ as defined in section 2.2.2):

(8) $\langle s, d_1, d_2, d_3, \dots \rangle$

One might count as follows: s in (8) occupies the 0th position in the sequence, d_1 the first, etc. That is, one might represent (8) as the following set of pairs:

[14] "Quasi" because the syntax of, say, FCS either merely translates or simply *is* a piece of natural language syntax. See fn. 54 on page 108

[15] Dekker's (2012) PLA is an exception.

(9) $\{\langle 0, s\rangle, \langle 1, d_1\rangle, \langle 2, d_2\rangle, \langle 3, d_3\rangle, \ldots\}$

(9) could as well be represented by an assignment with the domain $\{0, 1, 2, 3, \ldots\}$ and the respective value assignments. This kind of function is available in the other frameworks as well, although they're not ready to interpret one numerical index ('0') as variable for situations. But this is easily done. The more crucial thing that follows from an account like this is that numerical indices on variables in a DRT/DPL/FCS-like framework are associated with a special interpretation. If, say, x_1 is associated with the first position of the individual part of the sequence, it always is assigned the value that is reserved for *I*. That is, x_1 is turned into a *designated* (agent) *variable*.

It is questionable whether this kind of direct association of contexts/indices and assignment functions is desirable at all. This is because the values may need to be stored across several contexts, e.g., in an ongoing conversation with varying speakers and addressees but one (manipulable) "common ground". Thus, since all agents need to make their way into the first position, one would need to 'overload' the designated variable x_1, etc. pp. One may question this the other way round and ask what exactly the use of associating a specific rôle like AGENT with a fixed position in a sequence is, as chapter 1 has it. Of course, this is just a convention. There is no inherent reason for the referent of, e.g. *you* to sit in the second position of the index, etc. So why does Context Theory use sequences at all, to begin with? Because they are a neat way to carry around independently varying parameters that, taken together, make up a dimension. Apart from that, there is nothing to account for, if the first chapter is in the right track. That is, in a concrete *situation*, the interpreter, faced with a concrete utterance, has to select one out of many possible sequences to assign all indexicals their referents. As it was argued, there are as many tuples as there are combinations of individuals per situation. Thus, any individual can make its appearance in the first position, any individual can make its appearance in the second position, etc. pp. This is just a more technical slang for the statement that any individual in a given situation can "count" as the agent (this is how Kratzer (1978) has it), and so on. This is not to say that it is equally reasonable for all individuals to be conceived of as an agent (or addressee, ...). Viewed this way, there seems to be no need for sequences at all, because the order of possible semantic values does not matter. But there is another relevant consideration, coming from the grammatical side of the coin. The distinguished positions in a sequence may correspond to person features. That is, the first individual in a given sequence stores the referent for *first* person pronouns, the second position for *second* person pronouns, and all other positions for *third* person pronouns (and other third person expressions that can be used demonstratively).[16] Conventionalizing the sequences in this way makes it hard to confuse the contributions of the indexical expressions. That is, it allows one to formulate constraints to the end that the sameness of referents of, say, first and second person pronouns within one and the same sentence are merely coincidental; i.e. cases of *acci-*

[16]Manfred Sailer rightly pointed out to me (p.c.) that this association isn't as strict as I make it look here. For example, *Sie*, the German polite form of the second person pronoun *you* is grammatically of the 3rd person (plural), but needs to be interpreted as second person singular. Thus, the following formulations have to be taking *cum grano salis*.

dental coreference. Two different positions in a sequence may host the same individual, but the positions themselves are always distinct. This makes a sentence employing two different demonstratively used expressions potentially informative, since two positions in a sequence aren't necessarily occupied by the same individual, but still allows both to refer to the same entity, if exactly this happens to be the case. Of course, all of this surely can be captured by using distinct variable names for the translation of pronouns with different person features. But the crucial problem once again is how to state a meta-rule like this. If all (indexical) personal pronouns are to be translated by variables, then there seem to be two demands that have to be fulfilled simultaneously: (i) the variables have to be in the domain of the contextual assignment for the utterance to be interpretable, but (ii) they have to be distinct if the pronouns they translate differ in their person features. Even though this looks like a special version of the novelty condition, this cannot be formulated with respect to the file alone, since (i) demands that all indexicals are translated by variables already present in the file, and hence, no variable is "new". One way out consists in assuming that there are different *sets* of variables for the translation of first, second, and third person expressions. As will turn out, this is the way to go. But instead of straightforwardly doing so, it is instructive to see what happens without such an assumption.

Since the straightforward identification is off the table, sequences and assignments are related by means of *representations*. The gist is that a (set of) assignments might be understood as (set of) contexts/indices if its values can be given an order so they yield an index. To this end, the notion of an *ordering* is defined first:

(10) A (finite) sequence $\vec{v}$ is called an *ordering* of a (finite) set of variables V iff

a. $\vec{v} \in V^{|V|}$ and — with $|V|$ being the number of variables in V

b. $\forall i, j \leq |V| : i \neq j \rightarrow \vec{v}_i \neq \vec{v}_j$, — where $\vec{v}_i$ denotes the element in ith position in $\vec{v}$.

In prose, $\vec{v}$ is one way to linearize a set of variables V. If the set of variables $\{x_1, x_2, x_3\}$ is considered, all of the following and only those are possible orderings of it:

(11) $\langle x_1, x_2, x_3\rangle$, $\langle x_1, x_3, x_2\rangle$, $\langle x_2, x_1, x_3\rangle$, $\langle x_2, x_3, x_1\rangle$, $\langle x_3, x_1, x_2\rangle$, $\langle x_3, x_2, x_1\rangle$

With the help of this notion, assignment functions can be mapped to contexts:

(12) An assignment f *represents* a context $c \in \Gamma \cup d\Gamma$ under the ordering $\vec{v}$—symbolically: $f \cong_{\vec{v}} c$—iff

a. $\vec{v}$ is an ordering of $D(f)$ and

b. $f(\vec{v}) = c$, — where $f(\langle v_1, \ldots v_n\rangle) = \langle f(v_1), \ldots, f(v_n)\rangle$.

The definition makes use of the domain of variables every assignment carries around. (12a) (with the help of (11)) makes clear that $\vec{v}$ stands for a sequence of (distinct) variables entirely built out of the domain of the assignment function in question such that no variable is lost and that every variable has only one occurrence within the tuple. (12b) formulates the crucial criterion, namely that the sequence of values induced by the order of variables has to match the context in question. Thus, an assignment represents a context iff the context can be understood as sequence of values of the assignment. Note that the definition requires the domain to provide enough variables for all possible positions in a tuple, i.e. for all rôles associated with contexts (demonstrative and non-demonstrative) regardless whether these variables are used in a sentence or not.[17] This relation makes it possibly to single out the set of *contextual* assignments C:

(13) The set of *contextual* assignments C is the set of all assignments that are able to represent an element of the set of contexts $\Gamma \cup d\Gamma$:
$C = \{f : \exists\vec{v}\ \exists c \in \Gamma \cup d\Gamma : f \cong_{\vec{v}} c\}$.

One and the same context is represented by a multitude of assignment functions. These may have disjoint or overlapping domains, since the representation relation only looks at ways to arrange variables of a given domain, not at (the names of) the variables themselves. One thereby gains the exact opposite of a *designated variables* approach, namely one where any variable can stand in for anything.

This is way too liberal when it comes to stating the semantics of indexicals in terms of assignments. On the one hand, translating, e.g., *you* doesn't require making use of a designated variable, but, on the other hand, without any further conditions, it cannot be guaranteed that its value ends up in the second individual position of a sequence. This doesn't mean that assignments reflect the uncertainty of the interpreter which of the possible contexts induced by a certain *situation* to use. As pointed out in chapter 1, there are as many contexts per situation as there are permutations of individuals in a tuple. If, to give an example, the context to be represented consists of two slots for individuals (a non-demonstrative context), and there exist 23 in the situation, there are $23 \cdot 23 = 529$ possible contexts, that is, sequences starting with the situational core followed by two individuals. *One* assignment with a domain of the right size but without the right ordering does not represent this set of possible contexts. Assuming it assigns its situation variable the situation in question, it at most represents two of the 529 sequences, depending on which individuals are assigned to the individual variables in question. This is because without the ordering being fixed, it can't be determined which of the two individual variables represents the AGENT and which the ADDRESSEE; so the assignment in question represents both possibilities simultaneously according to (12). But this kind of indeterminacy is neither useful nor intuitively adequate. If I is used in contrast to *you*, the *rôle* of whichever individual referred to should be fixed. What is claimed in the first chapter not to be fixed (necessarily) is which *individual* plays which rôle in a given situation. But it is clear that the translation of I is interpreted as referring to the agent (whoever that may be). In other words, it may not be clear who the (intended) referent of I is, but its clear that I doesn't mean *you*; the rôles of expressions need to be fixed, the rôles of individuals need not. Thus, if indexicals are translated by individual variables as well, the realm of possible orderings needs to be constrained such that only the appropriate mappings remain possible. That is, if *you* is

[17] Note that it is impossible to define this using the *values* of f instead of its domain, because distinct variables might corefer according to f. Thus, any definition that makes use of the values of variables instead of variables fails to discriminate positions in a tuple.

translated using a variable, it isn't enough for an assignment to count as contextual when it *possibly* maps this very value onto the second position in a tuple (as (12) might be paraphrased). It needs to map it *exactly* to this position. This needs to hold whichever numerical index is used with the variable translating *you*. If, e.g. x_m is used, only those assignments count as contexts that map m to the correct position, while if x_n is used, n has to be mapped to this position. Hence, if *you* is used, it has to find a variable in the context which is mapped onto the second position reserved for individuals in a sequence. One might also say that *you* forces the ordering to map its variable to this position. More generally, all indexicals thus need to fix the ordering. The content of an indexical then still depends on the assignment function alone. Thus, the indeterminacy which tuple to use in a given situation recurs as indeterminacy which assignment to use, given a fixed ordering.

This kind of solution requires relativizing semantic values to orderings of variables. This notion is syntactic in the sense that it refers to sequences of variables instead of sequences of their values. This might be harmless as long as they are quantified over in the meta-language only. That is, if the truth conditions are stated in a language over and above the formal language the truth conditions are formulated in. This would be a rather innocent conception of ordering. Unfortunately, it's not tenable: indexicals need to constrain these orderings and therefore need to contain clauses that mention the variable instead of its value. Hence orderings making their way into the truth conditions cannot be considered innocent.

A mixture of both extremes consists in making use of multiple special variable*s* per rôle, that is, one set of first and one set of second person variables, as already indicated above:

(14) a. $Z := \{z_i : i \in \mathbb{N}\}$
b. $Y := \{y_i : i \in \mathbb{N}\}$
c. $X := \{x_i : i \in \mathbb{N}\}$

X is the old set of individual variables, Y and Z are added and given a special interpretation. Note that the sets aren't overlapping. This allows one to define a stricter notion of ordering, namely one that is *rôle sensitive*:

(15) A sequence $\vec{u}$ is called a *rôle sensitive ordering* of a set of variables V iff
a. $\vec{u}$ is an ordering of V, and
b. $V \cap Z = \{\vec{u}_1\}$, and $V \cap Y = \{\vec{u}_2\}$. (preliminary)

This simply nails down in which respect the variables in Z and Y are special. Their sole job consist in representing the second or third position of tuples, i.e. the agent and addressee of a context, since the first (0th) position is occupied by the situational core.[18] Note further that this restricts the job of the "old" variables in X as well. According to (15), they cannot stand in for any of these rôles, but are restricted to individuals farther to the right, if they play a rôle in a contextual assignment at all. Furthermore, if the

[18]If not decomposed in the sense of section 2.2.3.

initial set of variables V doesn't contain exactly one element of Y and Z each, $\vec{u}$ cannot be rôle sensitive, because the second and the third clause cannot be true.

With this in mind, the definition of the set of contextual assignments changes to the following (where the use of $\vec{u}$ as opposed to $\vec{v}$ is short for demanding the ordering to be rôle sensitive):

(16) $C := \{f : \exists \vec{u} : \exists c \in \Gamma \cup d\Gamma : f \cong_{\vec{u}} c\}$

This effectively constrains the set of admissible assignments to those that come with a suitable domain. Apart from a variable for the situational core, they at least have to contain a first and a second person variable. If so, and if no further variable is in the domain, the context represented is an element of Γ simpliciter. If further variables are in play, the respective assignment represents an element of $d\Gamma$. As above, the assignments in C aren't homogeneous in the sense that they don't necessarily share a domain. But the suitable domains share some structure. Basically, the notion of a rôle sensitive ordering (presupposing distinguished sets of variables) introduces the distinction of first, second, and all following positions for individuals within a tuple into the realm of variables and henceforth assignment functions.

A single context thus is represented by a set of assignments with different (yet structurally similar) domains:

(17) For any context c in $\Gamma \cup d\Gamma$ there is a set of assignments F_c such that
$F_c = \{f \in C : \exists \vec{u} : f \cong_{\vec{u}} c\}$

If c is in Γ simpliciter, then there is a single assignment per possible domain. Since the first and the second coordinate of c are represented by a special stock of variables each, there can't be two assignments with the same domain differing in values. Hence, given an admissible domain, there is a one to one correspondence between elements of Γ and elements of C. To put it differently, non-demonstrative contexts are represented by singleton sets of assignments, *modulo* a particular domain. This is as desired. This proposition still is true for elements of $d\Gamma$ that have just one more coordinate. Since the rôle of every variable in a domain of a representing assignment still is fixed. Apart from the situational core, there still is no choice but to map elements of Z to the first individual coordinate, elements of Y to the second, and elements of X to the third. This neat correspondence breaks down for even longer contexts. If two individuals apart from the agent and the addressee are to be represented, the respective domain needs to feature two elements of X. But since their respective order isn't fixed by (15), there isn't just a single assignment per domain that represents the respective context but two. This must be excluded, somehow. If a sentence like (18) is evaluated against such a non-singleton set of contextual assignments, where the first *that* is translated by one element of X, say x_n, and the second one by the other, e.g. x_m, then there are two representations (for this particular domain) of the context in (18a), namely the ones in (18b). To count as representations of (18a), both need to be ordered, but there are two such orderings compatible with (15) available, namely (assuming that z_1 and y_1 are the first and second person variables, and $\mathfrak{c}$ is the variable for the situational core) the ones listed in (18c):

(18) That is lighter than that.

a. $c = \langle s_1, a, b, d_1, d_2 \rangle$

b. $F_c = \{f_1, f_2\}$, with $f_1(x_n) = f_2(x_m) = d_1$ and $f_1(x_m) = f_2(x_n) = d_2$

c. $\langle c, z_1, y_1, x_n, x_m \rangle$ and $\langle c, z_1, y_1, x_m, x_n \rangle$

The devastating effect of F_c not being a singleton is the following: (18) can either express the proposition that d_1 is lighter than d_2 or that d_2 is lighter than d_1, depending on the assignment chosen. This means that (18) would expression *both* proposition simultaneously with respect to F_c, while F_c is the set of assignments representing *one* context only, namely c. This is disastrous.

On the other hand, based on the conclusion reached in section 2.3.5 of the first chapter, one might question that there is a difference between the context in (18a) and the one in (18d), since the relative ordering of third person parameters isn't associated with anything substantial happening within the situation at hand. If it doesn't reflect, say, the order of demonstrations (e.g. pointing gestures) anyway, since it is denied in said section that their existence is a necessary condition, and every expression possibly associated with either position might as well be associated with the respective other, why make a distinction between them?

(18) d. $\langle s_1, a, b, d_2, d_1 \rangle$

The problem that is dealt with introducing dedicated variables for first and second person recurs as a problem about positions farther to the right. This is of course a problem of fixing the mapping between assignments and tuples. But, furthermore, if contexts like (18a) aren't distinguished from contexts like (18d), this task is unsolvable. By declaring both tuples to *be* the same context, one rules out any one to one correspondence between contexts and assignments. There then is no ground for excluding, say, f_2 from F_c, since it surely does represent c in one of its guises (18a,d). Finally, this approach attributes the disastrous effect described above to the context itself if (18a) and (18d) *are* thought to be *the* context in question.

Thus, one needs a way to do away with one of the assignments in F_c. This of course needs to be solved generally, because the same problem occurs for sentences / contexts featuring three demonstratives / demonstrations, etc. The strategy applied to first and second person pronouns of course is applicable as well, but it is less favorable in this case, because it ultimately stipulates an ambiguity of all third person expressions. A set of expressions would be translated by elements of a set of dedicated variables (say, X_1) which is constantly mapped onto the third position in tuples, another one would use elements of another set of variables (X_2) for the fourth position, etc. Expressions thus would be ambiguous between an X_1 and an X_2 usage, and so forth for further sets of variables, if they can express both rôles. Intuitively, the distinction between Z, Y, and X above introduces the distinction between first, second, and third person expressions into the realm of variables; that is, the syntax of the dynamically interpreted language. It is less clear what the distinction between X_1 and X_2 means. Technically, if used in the same way as the distinction between Z and Y, it draws a distinction within third person expressions. But that doesn't mean that, e.g., elements of X_1 refer to the first or only demonstrated object in a situation, and elements of X_2 refer to the second demonstrated object in a situation. Phrased this way, this distinction presupposes (i) a definite order of demonstrated objects (contrary to what chapter 1 claims) and (ii) that this order is grammatically realized in the same way as the difference between *I* (elements of Z) and *you* (elements of Y). This second presupposition makes this distinction less intuitive than the one between X, Y, and Z, to say the least. But it isn't completely out of the ordinary, as the existence of third person expressions with subtle differences in usage indicates. English *this* and *that* spring to mind as well as German *dies-* and *jen-*, or Latin *hic* and *ille*. To the extent that these expressions can be used demonstratively,[19] they seem to articulate some kind of difference that could be thought to be reflected by a distinction among the variables in X, and therefore be manifested in the set of admissible rôle sensitive orderings. Usually, these differences are said to be connected to spatial proximity or sometimes just temporal succession—hence, they are sensitive to some sort of preestablished ordering of referents (cf. Diessel, 2012, for an overview). Furthermore, to the extent that these expressions also have anaphoric uses, they share some characteristics with *the former* and *the latter*, respectively, in that one of them has to refer back to an antecedent introduced earlier than the other. This distinction might be reduced to temporal succession as well. A comment is in order: to be compatible with the results of chapter 1, these distinctions need to be thought of as being less about the usage of the expressions, but more about the rôles that are grammatically encoded in a language. Since the first chapter argues in favor of a less utterance-based but more abstract notion of contexts, a distinction between, e.g. Z and Y cannot be tied to the use of expressions, since no use of any expression has anything to do with the individuation of contexts. Talking about rôles is a tad better, since the individual sitting in first position and the individual in second position are just discriminated on the basis of their rôle in a context. And this distinction seems to be reflected in the difference between *I* and *you* directly.

But, even though there are expressions that seem to be sensitive to what represents a way out of the issues connected with even longer contexts, they aren't the only ones. In other words, arguments for distinguishing subsets of X don't generalize to all expressions that make use of elements of X. Definite descriptions are a case in point. They can, when used demonstratively, fulfill the same jobs as *this* and *that* while not being restricted to either of them. That is, speaking with Kaplan (1989b), in a context in which (19a) is accompanied with appropriate pointing gestures that conform to whatever constraints the uses of *this* and *that* put, using (19b) while keeping the pointing gestures as they are is somewhat degraded. This holds completely irrespective of what is demonstrated. This is different for (20). While (20a) of course cannot be used in the very same context as (20b), this impossibility is solely due to the lexical material in the descriptions' restrictors, and not due to definites in general being restricted to express a specific contextual rôle (within the realm of third person expressions). If one imagines a context that preserves

[19] Which doesn't seem to be the case for German *jen-*. But these expressions are pretty formal if not atavistic, anyway.

the pointing gestures but swaps the objects demonstrated, this doesn't change anything in the acceptability of (19a) (and the comparative degradedness of (19b)), but renders one of the sentences in (20) flat-out inappropriate while the respective other one improves dramatically.

(19) a. I want to try this and that.
b. ?I want to try that and this.

(20) a. I want to try the cheese and the wine.
b. I want to try the wine and the cheese.

This first and foremost means that there are expressions that seem to make use of X as a whole, even though it is divided into subsets that are associated with particular uses. Hence, these expressions are ambiguous (or underspecified) with respect to whatever rôle X_1 and X_2 articulate. But, on the other hand, it is questionable whether this account of the difference between *this* and *that* is on the right track, anyway. This is mostly due to the rather vague connection to the comparatively clear distinction between Z and Y and the expressions that make use of the respective elements. Furthermore, reiterating the point of section 2.3.5, the abstract nature of contexts makes it impossible to encode anything substantial with the help of X_1 and X_2, like the (temporal) order of pointing gestures or the relative proximity of agent and object demonstrated. If one wants to proceed this way, something needs to be done to accommodate Kratzerian examples featuring demonstratives. Finally, this subdivision of X doesn't even solve all the issues. Supposing that *this* has to be translated using variables from X_1 and *that* by elements of X_2, sentences like the following pose the same problems once again:

(21) I want to try this and this and that and that.

The elements of X_1 and X_2 have to be ordered somehow to avoid that (21) expresses up to 4 different propositions in a context c, because there are at least 4 assignment functions in F_c. Hence, the solution isn't as general as it needs to be.

This makes a distinction among the elements of X less attractive; at least as answer to the general question how to let only singleton sets of assignments (with a given domain) represent contexts. To this end, elements of the single X are from now on simply ordered by their numerical index. Assuming that $n > m$ in the example (18) above, repeated as (22), it would mean that second ordering in (22c) would be ill-formed. This in turn excludes f_2 from F_c and hence, F_c would be a singleton set, too.

(22) a. $c = \langle s_1, a, b, d_1, d_2 \rangle$ ≈ (18)
b. $F_c = \{f_1, f_2\}$, with $f_1(x_n) = f_2(x_m) = d_1$ and $f_1(x_m) = f_2(x_n) = d_2$
c. $\langle c, z_1, y_1, x_n, x_m \rangle$ and $\langle c, z_1, y_1, x_m, x_n \rangle$

Note that this doesn't turn x_n (or x_m) into a dedicated variable in the sense that it is thereby tied to a particular position. It simply isn't necessary to use it at all. Everything expressible with the help of x_n might as well be expressed by using a different variable x_o with $o > n$. What isn't possible, however, is to use x_1 to translate a demonstratively used expression that refers to the fifth individual position in a context (or any other position farther to the right), since there need to be other variables for the positions in between. In principle, this convention could be extended to first and second person pronouns in place of the *dedicated variables* approach made work by *rôle sensitive orderings* above. But this reintroduces the problem of formulating a constrain to the end that, say, *m has* to be lowest index of a variable in a formula if it translates *I*, etc. That is, if m happens to be the lowest index, I gets interpreted in the desired way, but if it isn't, then the whole translation should be uninterpretable. The problem consists in formulating a general mechanism that applies whenever a first person pronoun is translated. And, *mutatis mutandis*, the same holds for second person pronouns. This problem doesn't arise for third person expressions if it is assumed that the relative order of their referents in a context doesn't need to correspond to anything substantial in particular; as is argued in chapter 1. It thus seems best to stick to the final version of (15) extended by a general clause to enforce an ordering upon elements of X:

(23) A sequence $\vec{u}$ is called a *rôle sensitive ordering* of a set of variables V iff

a. $\vec{u}$ is an ordering of V, and
b. $V \cap Z = \{\vec{u}_1\}$, and $V \cap Y = \{\vec{u}_2\}$, and
c. $\forall i, j, n, m \in \mathbb{N} : x_n \in V \cap X \;\&\; x_m \in V \cap X \;\&\; \vec{u}_i = x_n \;\&\; \vec{u}_j = x_m \;\&\; n > m \rightarrow i > j$ (still preliminary)

The question remains how to determine the correct domain. This can be thought to depend on the formula that needs to be interpreted against a context. For example, if a sentence makes use of the whole arsenal of personal pronouns, the subset of the domain reserved for individual variables is fully determined. So there is not much choice. But if a sentence, e.g., doesn't make use of first and second person pronouns, the respective formula doesn't allow to single out a complete domain V. Whatever the context is, the corresponding set of assignments cannot be a singleton set. But the variables actually used fix enough. Since the sentence in question doesn't make use of first and second person pronouns, neither their potential referents nor their potential translations are relevant for determining the proposition expressed. It thus doesn't matter that the set of assignments varies in parts not relevant for the determination of the intension. It certainly doesn't lead to a dilemma like above, where a sentence suddenly expressed two propositions at one context.

There is one further problem that is easier to discuss on the background of the concrete interpretation procedure proposed below (see section 4.2.3). But this problem ultimately necessitates to single out a further set of "special" variables, namely the set of contextual situation variables $\mathcal{C}$. This is needed, roughly, because the contextual interpretation has somehow to be marked in order to receive the special interpretation it requires. And because of this, (23) is still preliminary. The final notion is the following:

(24) A sequence $\vec{u}$ is called a *rôle sensitive ordering* of a set of variables V iff (final)

a. $\vec{u}$ is an ordering of V, and
b. $V \cap \mathcal{C} = \{\vec{u}_0\}$, and $V \cap Z = \{\vec{u}_1\}$, and $V \cap Y = \{\vec{u}_2\}$, and

c. $\forall i, j, n, m \in \mathbb{N} : x_n, x_m \in V \cap X \;\&\; \vec{u}_i = x_n \;\&\; \vec{u}_j = x_m \;\&\; n > m \rightarrow i > j$

Turning back to the representation relation, there are reasons to think that one needs to be more liberal. In case a definite description comes with a fresh variable, the files' domain is extended and so are the (minimal) tuples its elements represent. This is more than just checking material marked as context dependent: taken literally, the context isn't the same after evaluation as it was before—it is longer. One way to sidestep this consists in relaxing the definition of representation in the following sense: The present definition assumes that assignments represent indices only if the number of coordinates of an index matches the number of variables in the domain. Instead, an assignment with a domain containing three variables might be taken to represent indices of *at least* length 3, but possibly more. That is, two contexts as in (25a) and (25b) share some representations, namely the ones in (25) (concentrating on one domain and its supersets only, and just depicting the part of the assignment function for which it is defined):

(25) a. $\langle s_1, a, b, d_1 \rangle$
b. $\langle s_1, a, b, d_1, d_2 \rangle$

(26) a. $\{\langle c, s_1 \rangle, \dots\}$
b. $\{\langle c, s_1 \rangle, \langle z_1, a \rangle, \dots\}$
c. $\{\langle c, s_1 \rangle, \langle z_1, a \rangle, \langle y_1, b \rangle, \dots\}$
d. $\{\langle c, s_1 \rangle, \langle z_1, a \rangle, \langle y_1, b \rangle, \langle x_1, d_1 \rangle, \dots\}$
e. $\dots$

This more liberal picture probably is more appropriate when it comes to the representation of indices. Especially when modeling attitude ascriptions through the notion of an attitude holder's perspective (à la Hintikka) which in turn is understood as a set of indices. It shouldn't be the case that the indices one individual believes to be candidates of the actual world are restricted in length by a discourse s/he doesn't necessarily participate in. Thus, in a given discourse, it should be possible that the belief of an attitude holder talked about is even more articulate. More on this below, section 4.3. But for contexts, this doesn't seem to be correct. Intuitively, the special status of a definite description introducing a fresh variable into the contextual assignment's domain should be reflected somehow. If an interpreter is asked to *accommodate* a further parameter of contexts, this shouldn't go as smoothly as the introduction of a new discourse referent into the index-assignment, which happens without further ado. Simply because the producer of the utterance makes use of such a parameter of context it doesn't mean that the existence is equally obvious to any interpreter as well. Thus, if a "new" variable is encountered while interpreting a sentence against a suitable representation of what the interpreter deems to be the actual context, the interpreter learns that the context represented in fact is more articulate than she thought it was (at least the producer of the sentence strongly suggests this). Thus, the interpretation needs to be repeated with a longer context and therefore with a different set of assignments, different at least insofar as there needs another element of X in the domain of the file formerly not included. If this is the right description of accommodation—following Lewis (1979b) in this respect—the notion of representation should stay as is.

Turning to (the representation of) indices, there are two cases that need to be distinguished, namely self-standing and embedded (declarative) sentences. The reason for this lies in the availability of at least one expression for embedded sentences that suggest that something about the order or individuals in a sequence is relevant for its semantic value. This expression is PRO. The consensus on PRO is that it needs to be interpreted as expressing *de se* attitudes univocally (with the exception mentioned on p. 102), which in turn is usually modeled as attitude towards centered worlds. This can be captured by assuming that the first position in a sequence receives a somewhat special interpretation in comparison to any other position. Attitude holders presumably “store” beliefs about themselves (*as* themselves) under this “address”. This of course is just a convention. There is no inherent property of this position in a sequence that makes it fulfill this duty that any other position in a sequence doesn't have. But, since the agent-parameter in contexts also targets this position, it adds some additional plausibility to assume that any agent localizes him-/herself in the very position s/he occupies *as* agent, anyway. Assuming this to be on the right track for the moment, the important point is that there seem to be no comparable expressions that do the very same in non-embedded sentences. At least in English and German, there seem to be no PRO-like expressions for which the most natural interpretation can be said to consist in tying their variables to a distinguished position in indices. This observation (among others) led many researchers to the assumption that the Ban on Monsters is violated in every attitude ascription. One cornerstone of this view, apart from the parallelism between *I* and PRO, is that indices are usually not thought to contain any (further) position for individuals whatsoever. That is, centered worlds/situations are closer to contexts than indices on virtually any account found in the literature. Anyway, for matrix sentences, there is no reason to assume that differences in position really play a rôle. Contrary to contexts, the following indices univocally either make a non-embedded sentence true or false:

(27) $\langle s_1, a, b, c\rangle, \langle s_1, a, c, b\rangle, \langle s_1, b, a, c\rangle, \langle s_1, b, c, a\rangle, \langle s_1, c, a, b\rangle, \langle s_1, c, b, a\rangle$

This is due to them being representable by one and the same assignment under different orders. Taking the semantics given in (195)—FCS with partial transitions—in section 3.4.1 as in indication of what seems to be needed for (non-embedded) sentences, there is no need to specify an order for domains of variables at all. That is, the interpretation of, e.g., a 3rd person pronoun doesn't change with the position its value is located in. Thus, it isn't necessary to individuate assignments representing indices as fine-grained as contexts.[20] As long as every variable employed in a formula is covered, the sentence receives the interpretation it needs to receive.

Furthermore, the restrictions on the elements of the domains of contextual assignments can't be put on index assignments if contextual import exists. If a variable used to translate *you* in a sentence needs to be introduced into the set of assignments representing

[20] One may even give up on modeling indices via sequences of values, since all that seems to be relevant is captured by so-called *multisets* as well. This possibility is not pursued any further here.

indices to allow for further anaphoric reference (within the same sentence), then the output of the whole procedure is carried over to the interpretation of the next sentence in a discourse and thus, the very variable is part of the domain of the "common ground" from that point onwards. Nevertheless, a following sentence might feature another *you*, which then has to be translated using a different element of Y which again has to enter the domain and so on and so forth. Variables enter the domain to stay.[21] This means that in order for the "common ground" to represent indices at all, index assignments have to stay free from constraints that restrict the number of variables of any type. The domain of index assignments therefore possibly features any number of elements of Z, Y, and X. This basically means that the earlier notion of representation, not the rôle sensitive variant, is adequate for the representation of indices. The set of index assignments then is defined as follows ($\vec{v}$, as opposed to $\vec{u}$, is mnemonic for non-rôle sensitive orderings, the rest of the notation is as in chapter 1):

(28) $I := \{f : \exists \vec{v} : \exists \sigma \in \Sigma : f \cong_{\vec{v}} \sigma\}$

Summing up, order matters a great deal when contexts are concerned, arguably matters to a smaller degree when intensional environments are considered, and doesn't matter at all when matrix clauses are evaluated. This is reflected in the definition of C and I in that the former, but not the latter, utilizes the notion of rôle sensitive orderings which imposes a lot of constraints on the domains of assignments. Embedded clauses are discussed more generally in section 4.3.

Like the assignments in C, the assignments in I aren't homogeneous with respect to their domains. One restriction needs to be mentioned, even though it is implemented later. The contextual situation variables $\mathcal{C}$ mentioned above need to be excluded from the domain of indices. This is due to the special rôle assigned to situation variables in general, which becomes clear at the end of section 4.2.2. This single exception amounts to stipulating a second set of situation variables, exclusively for the representation of indices. This set, $\mathcal{S}$ to give it a name, thus contains variables that represent the situational cores of indices and therefore must be part of every domain of any assignment in I. The conventions are summarized in figure 4.1.

More generally, the final conclusion of this section is that double indexing, one cornerstone of two dimensional semantics, needs to be given a quasi-syntactic representation. That is, the peculiarities of contexts, i.e. their structure, are translated into special variables in order to enable assignment functions—the basic building blocks of "meanings" in dynamic systems—to play the rôle of contexts in the semantic machinery. In other words, contexts and indices as discussed in chapter 1 do not enter the derivation of semantic values (or their very definition) directly, but only mediated by representing assignment functions. This allows to bridge the gap between the family of theories dealing with context dependency and the family of theories dealing with anaphoricity.

[21] One consequence of this view might be that it should be possible to pick these contributions up anaphorically in subsequent sentences, i.e., that the existence of an anaphoric I is predicted. This is excluded by not introducing an index-based element of Z as expression. See below, 4.2.4.

Variables	Domain	Restriction(s)
$\mathcal{C}$	C only	only one occurrence
$\mathcal{S}$	I only	only one occurrence
Z	C and I	mapped to AGENT when in C; none when in I
Y	C and I	mapped to ADDRESSEE when in C; none when in I
X	C and I	ordered by numerical index when in C; none when in I

Figure 4.1: Overview of variable conventions

4.1.3 Context-Index interactions

Complex demonstratives are phrases headed by *this* or *that* that also contain a possibly complex noun. That is, unlike *pure demonstratives* as in (29), where *that* forms the subject of the sentence on its own, a complex demonstrative is more determiner-like, as (3), repeated from above corroborates:

(29) That is a cute dog.

(3) Peter told me about this man [pointing]. He is in danger.

This example is used to argue that *contextual import* exists, i.e. that overtly used context-dependent expressions need to introduce their variables (with their values) into the index. This relies on the intuition that in order to interpret *he* in the second sentence "repointing" isn't required, meaning that this personal pronoun isn't interpreted deictically. One of the questions that need to be tackled is that of timing, i.e., the question when the variable with its value is introduced into the index.

This can be narrowed down by looking at intra-sentential anaphora as opposed to cross-sentential anaphora in (29). For example, (30) shows that the variable with its value possibly have to be imported as soon as possible:

(30) This [pointing] man, who (by the way) owns a horse that he can't tame, wants to sell it on the market.

(30) show that pronouns anaphoric to complex demonstratives can be part of the same sentence. Generally, there are two possible readings of the relative clause that are relevant to the argument:

- Either the demonstrative imports its variable immediately, that is, before the relative clause is evaluated. Then the non-deictic interpretation of personal pronouns within it is unproblematic;
- or the demonstrative cannot introduce a variable (and value) into the index right away. Then the anaphoric interpretation of personal pronouns has to be accounted for by assuming that the whole relative clause is evaluated with respect to the context as well. This option of course is available because the pronoun in question

comes with the same index as the demonstrative, if any.[22]

But the second option is not available for (30). Firstly, *he* in the relative clause would also be a context dependent pronoun, even though it seems to be used in the same way as the pronoun in (3). Secondly and more importantly, if the whole relative clause is evaluated against the context, then it is far from clear how the indefinite located inside this matrix manages to introduce its variable into the index. If what is claimed for contexts above is correct, then its values cannot be introduced into the context first (and then end up in the index due to contextual import), since this kind of *accommodation* isn't possible in the way contexts are set up above, mainly for two reasons: The first is that "paths split" when an indefinite is interpreted. Thus, if the situational core is valued in such a way that it supports more than one horse (that is owned by the man pointed at, etc.) then the one to one correspondence between contexts and assignments necessarily breaks down. The second reason simply is that the indefinite's variable has to be new. It thus simply isn't possible to accommodate and start over, as suggested above, since then, the Novelty Condition built into the extension relation contributed by the indefinite article renders the second round of evaluation undefined.

It thus seems that one needs to conclude from (30) that the demonstrative introduces its variable directly into the index, e.g. after interpreting *this* [pointing]. But a problem is, then, that this argument might carry over to *man* as well. Since the index so modified (also) comprises the very individual variable needed to interpret the relative clause with respect to the index only, it could possibly also interpret *man*. This introduces the possibility of interpreting the whole sentence apart from *this* homogeneously at the index, while the demonstrative just picks up the contextually supplied variable and introduces it into the index right away (together with its value). But this needs to be ruled out for different reasons. For example, a sentence like (31) is predicted to be ambiguous in a context c where Fred is the demonstratum (cf. Braun, 2008, for an argument like this):

(31) That spy is clever.

a. Fred (who actually is a spy) is clever. — noun evaluated against c

b. Fred is a spy and clever. — noun evaluated against i

Thus it seems that both options are unsatisfactory. The relative clause cannot be evaluated with respect to the context, and thus the (complex) demonstrative must provide its variable as early as it can. But, on the other hand, the noun that comes with the complex demonstrative must not be interpreted against the index. That is, if the demonstrative is clearly used deictically/referentially. The contributions of Jeffrey King (King, 1999; King, 2001; King, 2008) are full of attempts to provide scenarios in which index-based readings of complex demonstratives as a whole are more natural. Recall (2), repeated from above, where the alleged context-dependent expression varies with a quantifier:

(2) Every university professor cherishes that first publication of his/hers.

[22] As suggested in section 3.1.3, the relative pronoun might bind *he*. If this is the case, then the pronoun isn't dynamically bound but syntactically.

The correct generalization, it seems, is to allow only for *homogeneous* interpretations of complex demonstratives: the interpretation of the determiner and the (possibly complex) noun has to be relative to the same set of assignments. If this rule is obeyed, a relative clause (adjoined to the phrase) can be evaluated against an *index* that is extended by the variable introduced by the complex demonstrative.[23]

That complex demonstratives must be interpreted homogeneously is also argued for with examples like (32):

(32) Peter believes that this professor is in danger. But she isn't.

In (32), a complex demonstrative is embedded under an attitude verb. It is assumed that its individual variable is new to both the set of assignments in charge of the matrix sentence as well as the embedded sentence. Furthermore, it is also assumed that a new file needs to be created to interpret the embedded sentence. The assignments of the matrix sentence cannot be extended to cover the embedded sentence as well, because this leaves the set of assignments characterizing indices. The assignments so extended would have to have two (or more) situation variables denoting (possibly) different situational cores. That is not to say that there is no connection between the file responsible for the evaluation of the matrix sentence and the file for the embedded sentence. But it is clear that they generally do not coincide. E.g., if the complex demonstrative is evaluated with respect to the context, the ascribed belief has to be *de re*, that is, it can be true even though Peter doesn't believe the person pointed at to be a professor. In fact, as will be argued below (section 4.3), the referent doesn't even need to figure in the sequences the individual's *doxastic perspective* consists in—the only connection made to the person pointed at is the reuse of the same variable within the parse of the embedded sentence and whatever follows from that. The problem with (32) then is that the discourse new variable needs to be introduced into the domain of the assignments in charge for the *matrix* sentence, even though it is so deeply embedded. That this needs to happen is corroborated by the ease with which the variable is picked up by an anaphoric pronoun in the second sentence of (32)—the complex demonstrative thus provides an antecedent. Furthermore, the variable's value with respect to the contextual assignment shouldn't be imported into the assignments evaluating the embedded sentence, even though the

[23] There is yet another twist, discussed in the literature on non-restrictive relative clauses (cf. AnderBois et al., 2010; Dever, 2001; Koev, 2014; Potts, 2005, just to name a few): *non-restrictive* relative clauses (like the one in (30)) update the common ground somewhat differently than "normal", *at-issue* content. This can be seen in examples for which there is no reason to assume that the contextual dimension is involved at all:

(i) Mary, who by the way owns a horse that she can't tame, wants to sell it on the market.

Since (i) doesn't feature a (complex) demonstrative, but a proper name, the relative clause also is non-restrictive. Here, the relative clause also contributes to the index, but in a different way than a restrictive relative clause would. Thus, the problem with the relative clause in (30) can be tackled with the same techniques.

variable could be reused there.[24]

4.1.4 Index-Index interactions

Even if context dependency is left aside, (in-)definite descriptions and other DPs are the source of ambiguities if they are embedded in propositional attitude reports. That is, they can either be interpreted as being (referentially) dependent on either the matrix clause or the embedded clause. This ambiguity is known under the label *de dicto* vs. *de re*, where the DPs in question are interpreted as referentially opaque in the former and transparent in the latter case. (33) is a case in point.

(33) John thinks that the president of the US is smart.

One can put this ambiguity as follows: Under the *de re* reading, where *the president of the US* is interpreted transparently, John (possibly unbeknownst to him; see below) has a belief about the value of *the president* according to the author of the main clause, i.e. whoever the producer of the utterance of (33) thinks is the president of the US. The *de dicto* reading has it that the subject of the belief, John in this case, can be held responsible for the value of the DP. Thus, whoever John thinks to be the president, he also thinks of him that he is smart. The following rough paraphrases should capture these readings, where (34a) still is ambiguous between the two *de re* readings.

(34) a. There is a (unique) president such that John thinks that he is smart.
b. John thinks that who he believes to be the (unique) president is smart.

In the present setup, *the president of the US* may be evaluated against the (set of assignments representing the) context and thus receive its referential *de re* interpretation, or against the (set of assignments representing the) index the matrix sentence is evaluated against, which yields the attributive *de re* reading, or the (set of assignments representing the) index the embedded sentence is interpreted against, leading to the *de dicto* interpretation. A rough depiction of what is meant by this is found in (35), where situation variables are utilized to indicate the choice. (Situation variables followed by a colon indicate the point where the variable is introduced or bound, the enclosing square brackets represent their scope, and situation variables following a dash following an expression indicate that the expression in question is evaluated against the variable in question. If an expression doesn't come with a variable, it is interpreted against the closest one that takes scope.) This way of representing the ambiguities is quite common in the literature (Büring, 2004; Elbourne, 2005; Keshet, 2008; Percus, 2000; Schwarz, 2009, to name only some, but there is a twist, see below). The referential reading can be presented by letting the DP be evaluated against the context situation $\mathfrak{c}$ (cf. (35a). The other ambiguity correspondingly follows from the evaluation of the DP against one of

[24] As in the following variant of both (30) and (32), with pointing gesture after *professor*:

(i) Peter believes that this professor, who owns a horse that she can't tame, wants to sell it on the marked.

the two situation variables that are needed to account for the intensional construction, that is, either the matrix clause's situation variable s (which leads to the transparent interpretation (35b)), on which the attitude verb is dependent as well, or the embedded clause's situation variable s' (leading to the opaque reading in (35b)), on which the embedded predicate depends:

(35) a. [s : John thinks [s' : [the president]$-c$ is smart]] de re/referential
b. [s : John thinks [s' : [the president]$-s$ is smart]] de re/attributive
c. [s : John thinks [s' : [the president]$-s'$ is smart]] de dicto

The readings in (35b) and (35c) can be understood as embodying *attributive uses* of definite descriptions, relating the evaluation of definites against either the situation of the matrix sentence or the one of the embedded sentence to Donnellan's (1966) famous distinction. Their *referential* reading is linked to context dependent uses (cf. Maier, 2006; Recanati, 1993, among many others).[25]

In principle, attributive readings can be iterated by adding further intensional layers. Thus, in a sentence like the following, the DP *the president* can be evaluated against the matrix clause's situation variable, or against one of the two embedded ones:

(36) Mary suspects that John thinks that the president is smart.
a. [s : Mary suspects [s' : John thinks [s'' : [the president]$-s$ is smart]]]
b. [s : Mary suspects [s' : John thinks [s'' : [the president]$-s'$ is smart]]]
c. [s : Mary suspects [s' : John thinks [s'' : [the president]$-s''$ is smart]]]

There are different ways to achieve this. What needs explanation are the *de re* readings, since the *de dicto* interpretation (35c) follows from the standard interpretation mechanism when the DPs in question are taken to occupy their surface position in Logical Form. One standard account of (35a) resorts to the insertion of *dthat*-like operators. That is, the referential reading may be obtained by making DPs in their surface positions arguments of covert *dthat* simpliciter, or of *actually*, *present*, and something like *local*. Given the correctness of the argumentation in chapter 1, this doesn't (necessarily) lead to an interpretation according to which somebody has to point at the actual president in the context.

The other *de re* reading in (35b) usually receives a different treatment, although there are ways to generalize an operator-based approach, too.[26] But at first glance, it seems to be enough to raise DPs from their in situ position into the matrix clause. The result of this movement operation basically takes the paraphrases in (34) as Logical Forms in terms of placement of the DP. Accounts like these make use of a movement operation—QR—that is questionable from a syntactic point of view, since tensed embedded clauses

[25] Note how this association clashes with a strict conception of contexts which ties the existence of third person parameters to pointing gestures.

[26] Accounts along these lines introduce so-called *backwards-looking* operators that allow to substitute the local point of evaluation for a structurally higher one. See Saarinen (1979) for the origin of these operators and Köpping and T. E. Zimmermann (2018) for remarks on the good they can serve in languages like Montague's (1970) *IL*.

are islands. But even more problematic, Bäuerle (1983) shows that it is untenable.[27] One prediction this simple movement-based explanation makes is that the DP outscopes the attitude verb in the *de re* case and is outscoped by it in the *de dicto* case. Bäuerle shows that contradictory demands arise as soon as examples like (37) are taken into consideration:

(37) George glaubt, dass alle Nationalspieler in einem 5-Sterne-Hotel wohnen.
George believes that all internationals in a 5-star-hotel live.
John believes that all internationals live in a 5-star hotel.

This sentence seems to be true in a scenario where George forms a belief about a group of people who are all, unbeknownst to him, internationals. Thus, the phrase is read *de re*. Furthermore, he believes that there is a 5-star hotel they all live in, that is, the indefinite scopes over the subject. For the dramatic effect, this is a mistake on his part, that is, there is no real hotel satisfying this requirement. Nevertheless, (37) seems to report his belief truthfully. Summing up, to be true in such a scenario, *all internationals* has to be read referentially transparent and *a 5-star hotel* referentially opaque. Thus, it is impossible to get this reading under the simple QR-based approach, since (i) *all internationals* is interpreted *de re*, this DP has to scope over the attitude verb *believe*, while (ii) *a hotel*, interpreted *de dicto*, has to take scope below *believe*. But, (iii) *a hotel* has to take scope over *all internationals*, in order to get the reading right. Hence, a paradox results.

One lesson drawn from cases like these is that the "quantificational force" of the DP in question (*all internationals*) has to be exerted *in-situ*, since it has to scope below the indefinite, which has to stay within the intensional context. Bäuerle thus concludes that this reading requires leaving the DP *all internationals* below *believe* (and the indefinite) and evaluating its restrictor against the situation variable of the matrix clause.[28] This effect can be achieved in multiple ways. One popular approach put forth in many variations in, e.g., Percus (2000), Elbourne (2005) and Elbourne (2013), Keshet (2008), Schwarz (2009) and Schwarz (2012), and many others, consists in making use situation variables in a slightly different way. That is, it is also assumed that situation variables are syntactically represented and associated with some DPs. But these variables regulate the evaluation of the DP's restrictors only. One very explicit account along these lines, elaborating on Schwarz (2009), is found in Schwarz (2012), where it is argued that situation variables are the syntactic complements of (some) D heads. The semantic value of these heads apply to situation pronouns and to their restrictors afterwards, yielding the effect of interpreting the restrictor against the situation denoted by the syntactically realized variable. The sister of the resulting DP may either be interpreted against a different situation, or both of them are either integrated by an overt binding operator (Büring, 2004; Elbourne, 2013) or simply translated in such a way that they

[27] See also von Fintel and Heim (2011) and the references therein. Fodor (1970) is credited for the crucial observation.

[28] Which corresponds to just raising the bare NP out of the embedded clause into the matrix clause. This doesn't run into Bäuerle's paradox, but is as questionable a movement operation as raising the complete DP is. Thus, tackling this problem this way is rather unfashionable nowadays.

utilize the situation needed. This, in a nutshell, are the proposals within Kratzer's (2007) Situation Theory. To see the difference to what was said above, instead of using (38a) to represent the attributive *de re* reading, the accounts just mentioned use (38b):

(38) a. [s : John thinks [s' : [the president]$-s$ is smart]]
b. [s : John thinks [s' : the [president$-s$] is smart]]

Note that these accounts do not take the projection behavior of definites into consideration. As noted above, a discourse new individual variable of a definite isn't necessarily introduced locally. Instead, it is introduced into that set of assignments its restrictor needs to be evaluated against. Thus, the projection of individual variables is more akin to the behavior of the restrictor in the accounts under discussion than that of the determiner, if it is its job to host its "quantificational force". That is, the set of assignments into which the individual variable has to be introduced is exactly that set of assignments that host a value for the situation variable the restrictor needs to be evaluated against. Thus, viewed with projection in mind, the definite description as a whole cannot be interpreted *in situ*. Hence, if (38b) was the structure to work with, and the set of assignments the definite article was evaluated at was the one that hosts a value for s', its individual variable would be introduced into this set and not the one that hosts a value for s, and hence, anaphoric relationships would be impossible. Thus, (38a) seems to be exactly what is needed. On the other hand, Bäuerle's solution to his example requires the DP *all internationals* to be evaluated *inhomogeneously*, i.e. with respect to two sets of assignments instead of one. This is because the determiner *all* would take scope over the indefinite if interpreted higher.

However, recent research uncovered several restrictions and generalizations to keep in mind. The *de re/de dicto* ambiguity does not arise in connection with just any kind of expression but is restricted to a certain class of DPs only. E.g., neither predicates nor adverbs seem to be able to freely choose their situation variable. Thus, the readings represented in (39c)[29] and (40c) don't seem to exist.

(39) a. Mary thinks that the president is Canadian.
b. [s : Mary thinks$-s$ [s' : [the president]$-s/s'$ is Canadian]]
c. #[s : Mary thinks$-s$ [s' : [the president]$-s/s'$ is Canadian$-s$]]

(40) a. Mary thinks that the president always won the game.
b. [s : Mary thinks$-s$ [s' : [the president]$-s/s'$ always won the game]]
c. #[s : Mary thinks$-s$ [s' : [the president]$-s/s'$ always$-s$ won the game]]

Observations like these motivate the following generalizations:

(41) *Generalization X* (Percus, 2000, p. 201)
The situation pronoun that a verb selects for must be coindexed with the nearest λ above it.

[29] At least the first statement doesn't seem to be quite right. See the example by Sudo (2014) (discussed in Baron (2015)) below.

(42) *Generalization Y*[30] (Percus, 2000, p. 204)
The situation pronoun that an adverbial quantifier selects for must be coindexed with the nearest λ above it.

More generally put, neither verbs nor adverbs are predicted to receive transparent interpretations. This subsumes VPs in which DPs are used predicatively. In the following sentences, a transparent interpretation for the embedded definite description is said to be impossible:[31]

(43) Mary believes that Napoleon is the greatest French soldier.

Another constraint, motivated by examples like (44) gives rise to another generalization:

(44) Mary thinks that the married bachelor is confused. (Keshet, 2008, p. 53)

The idea behind (44) is that the threatening inconsistency stemming from the complex noun phrase *married bachelor* could be avoided if it were possible in evaluate the predicate and the noun against different situations. That is, if both parts of this complex noun phrase are evaluated against the matrix clause's situation variable, the speaker, normally held responsible for the formulation, has uttered a logical falsehood; and if the believe situations of Mary are used to interpret the complex noun phrase, the utterance roughly states that she believes a logical falsehood, that is, utter nonsense. But if the noun phrase could be evaluated against a different situation than the predicate, then these conflicting properties could be attributed to different subjects and no contradiction could arise. But this kind of 'repair strategy' does not seem to be available here, thus the contradictory impression.

(45) a. [s : Mary thinks [s' : the married$-s$ bachelor$-s$ is confused]]
b. [s : Mary thinks [s' : the married$-s'$ bachelor$-s'$ is confused]]
c. #[s : Mary thinks [s' : the married$-s$ bachelor$-s'$ is confused]]
d. #[s : Mary thinks [s' : the married$-s'$ bachelor$-s$ is confused]]

Thus, the following generalization has been proposed:

(46) *Intersective Predicate Generalization* (Keshet, 2008, p. 44)
Two predicates combined via Predicate Modification may not be evaluated at different times or worlds from one another.

Predicate modification (PM) is a rule to combine two semantic values of the predicative type—that is, depending on the overall type assignment, e.g. **(et)**, **s(et)**, or **e(st)**—by intersecting the sets characterized by these values (cf. Heim and Kratzer, 1998). Since there is no formalization in play, yet, a formulation of this rule is postponed.

[30]In a two-dimensional system as presented in Chapter 1 this also holds for modifiers like *now*. But the situational λ-abstract (42) talks about binds vacuously, since *now* retrieves the value it feeds to its complement directly from the context.
[31]There are counterexamples to this view, to be reviewed in section 4.3.3.

Based on (46), Keshet (2008) goes on to argue that PM is used in existential *there* constructions as well as in *have* constructions. Thus, he claims that this combinatory rule is in play in both of the following examples:

(47) a. Mary thinks there is an infant in college.
b. Mary thinks I have an infant daughter in college.

Again, the only readings available enforce the ascription of a highly implausible if not necessarily false belief to Mary or the speaker. This is again attributed to the Intersective Predicate Generalization by claiming that the DPs *an infant* or *an infant daughter* and the PPs *in college* are combined by PM. This is only possible if the DPs in question are of the predicative type, contrary to what they are in examples like, say, (40). This may be reduced to predicative uses, like it was pointed out in connection with (43) and Percus's *Generalization X*. If this is correct, the following generalization can be viewed as a special case of this more general constraint. Keshet bases it on a generalization on the temporal interpretation of DPs by Musan (1995, p. 81). She also traces the availability of temporally transparent/opaque interpretations back to the distinction of weak vs. strong noun phrases in the terminology introduced by Milsark (1974).[32] So-called strong DPs are not allowed in existential *there* constructions, while weak nouns are. But weak nouns seem to lack the ability of strong definites to let their restrictors be interpreted transparently. Cardinals are a case in point (example adapted from Romoli and Sudo (2009)):

(48) [Scenario: There are two horses behind the barn, but Charley thinks that they are donkeys.]
a. #Charley thinks that two horses are behind the barn.
b. #[s : Charley thinks [s' : [two horses]$-s$ are behind the barn]]

Thus, regardless of whether PM is at work in the constructions in (47) or not, the following seems to hold as well:

(49) *Generalization Z* (Keshet, 2008, p. 126)
The situation pronoun selected for by a noun in a weak [DP] must be coindexed with the nearest λ above it.

Returning to the questions dealing with the timing of the introduction of variables (and their values), it isn't clear whether (32), repeated here as (50a) has a *de dicto* reading, but (50b) definitely has.

(50) a. Peter believes that this female professor in our department is in danger. But she isn't.

[32] Her generalization reads as follows:

(i) Distribution of temporally (in)dependent noun phrases:
A noun phrase can be temporally independent if and only if it is presuppositional.

b. Peter believes that the female professor in our department is in danger. But she isn't.

If the example is understood in this way, the anaphoric relationship to the pronoun in the following sentence should be blocked, so this reading should be impossible to get after reading the second sentence of (50b). If the anaphoric link is established, it must be due to the two other readings. I.e., the definite description could be interpreted with respect to the context (thus referentially/deictically), or with respect to the matrix sentence (thus *attributively* with respect to the matrix sentence but *de re* with respect to the embedded one). In all three readings, the variable introduced by *the female professor in our department* could be discourse-new. But again, as things stand, it isn't clear how the variable is introduced into the right set of assignments, since it isn't necessarily the local one. Furthermore, as already said with respect to (32), the contextually or "co-textually" determined *value* of the variable isn't (necessarily) introduced together with the variable. Thus, there is a dilemma: on the one hand, a separate file needs to be opened up in order to account for possibly deviating values of individual variables in case of *de re* belief, as well as blocking effects when a definite is interpreted merely *de dicto*. On the other hand, the initial file used to evaluate the matrix sentence not only needs to be available to retrieve values already fixed, but must be able to "grow" further, when the variables introduced by definites are (globally) "new".

Furthermore, there are cases in which the rule to interpret definite descriptions (and complex demonstratives) homogeneously seem to be circumvented. Consider the following example:

(51) A crop duster crashed into Peter's farm. Fortunately, it caused only little damage. But he claims that the UFO destroyed half of his accommodation wing.

(51) has a weird ring to it. To get the interpretation intended here, *the UFO* would need to reuse the (individual) variable introduced by *a crop duster*, but evaluate its descriptive content (*UFO*) against the claim-situations. Thus, *the UFO* would need to collect its variables from different sources—which possibly brings about the weirdness. To the extend that this is possible, this means that the variable *a crop duster* introduced is available for anaphoric reference in the embedded clause, but its value can change. Thus, (51) then might be understood as meaning that Peter claims that what crashed into his farm was a UFO. This interpretation is clearly not available if the following is considered:

(52) A crop duster crashed into Peters farm. Fortunately, it caused only little damage. But he claims that it destroyed half of his accommodation wing.

(51) thus might exploit the potential of definite descriptions that pronouns lack due to their lack of descriptive material.

However, here is a final observation on the distribution of situation variables due to Romoli and Sudo (2009). It shows that the restrictor of a (strong) DP doesn't need to be interpreted homogeneously with respect to one situational parameter when it is complex enough to host further strong elements. But not all conceivable combinations are equally well-formed. This gives rise to what they call the

(53) *Nested DP Constraint* (Romoli and Sudo, 2009, p. 432)
a. When a *DP* is embedded inside a *DP*, the embedding *DP* must be opaque if the embedded *DP* is opaque;
b. When an indefinite is embedded inside a *DP*, the indefinite must be wide scope transparent, if the embedding *DP* is transparent.

What this seeks to describe is the following distribution of situation variables:

(54) Mary thinks the wife of the president is nice.
a. [s : Mary thinks [s' : [the wife of [the president]] is nice]]
b. [s : Mary thinks [s' : [the wife of [the president]$-s$]$-s$ is nice]]
c. [s : Mary thinks [s' : [the wife of [the president]$-s$] is nice]] mixed!
d. #[s : Mary thinks [s' : [the wife of [the president]$-s'$]$-s$ is nice]] mixed!

Thus, out of two possible mixed cases, only one is well-formed, namely the one where the surface-higher DP is interpreted with respect to the lower situation variable and the surface lower one to the higher. It is not possible to use (54) to express Mary's belief about the actual wife of who she thinks is the president—which is a weird thing to say in the first place –, while it is possible to report her believe about who she thinks to be the wife of the actual president.

Roughly the same is true for the following, where the second DP is situated inside a restrictive relative clause:

(55) a. Mary thinks that the man who likes the unicorn is a woman.
b. #[s : Mary thinks [s' : [the man who likes [the unicorn]$-s'$]$-s$ is a woman]]

The only mixed reading that (55a) possibly could have is the following one, which can't be true according to the state of the art in the research on unicorns:[33]

(55) c. #[s : Mary thinks [s' : [the man who likes [the unicorn]$-s$]$-s'$ is a woman]]

Intuitively, it is pretty clear what happens in cases like these. The complex restrictor is responsible for fixing the denotation of the whole DP. Those cases in which this doesn't work are cases in which some referent in the actual situation (or the ones the speaker thinks to be candidates thereof) is to be established with material only evaluated against believe-situations; hence, possibly non-actual situations.

Substituting the lower definites for indefinites, the observation firstly seems to be the same:

(56) [s : Mary thinks [s' : that [the unicorn that [a famous linguist]$-s$ hides from her] is beautiful]]

[33]Furthermore, it ascribes a contradictory belief.

(56) once again shows that the embedded indefinite can be read transparently, even though the embedding definite is interpreted referentially opaque. But, furthermore, Romoli and Sudo (2009) claim that even under this disambiguation, there is yet another ambiguity to be found. This second ambiguity can be described in terms of scope, i.e. the embedded indefinite in (56) can have wide or narrow scope with respect to the definite. This possibility is lost if the embedding definite is read transparently. Not only has the indefinite to be interpreted transparently as well—as embedded definites in (54) and (55) need to be, too –, it also cannot take narrow scope anymore. That is, according to Romoli and Sudo, only the wide-scope reading of the indefinite is possible in the following configuration:

(57) [s : Mary thinks [s' : that [the semantics paper about [a tone language]$-s$]$-s$ is a phonology paper]]

Here is the scenario they give (Romoli and Sudo, 2009, p. 432):

> [T]here is a semantics paper about Vietnamese. Mary knows that it is about either Vietnamese, Cantonese or Thai, but she is unaware of the fact that these languages are tone languages, and she thinks that the paper is a phonology paper. In this context, the sentence is again judged false, but it would not if the indefinite could be read [...][34] narrow transparent.

This last observation might be tied to Higginbotham's (2006) "hardest problem". He claims that indefinites are generally bad if embedded within definite DPs:

(58) The woman in a car is furious.

More generally, this whole complex of judgments may provide some insight into *Haddock's Puzzle*, namely the fact that sentences like (59) do not give rise to a presupposition failure in contexts where neither hats nor rabbits are unique, thus, the presuppositions especially of the embedded DP are weakened[35]:

(59) The rabbit in the hat is white.

Albeit pretty interesting, these lines are not pursued further.

(Romoli and Sudo, 2009) suggest that presuppositionality is the key for explaining the distribution. They thus take something like the mirror image of Percus's *Generalization Z*, namely their following contraint as a starting point (cf. the generalization of Musan (1995) given in footnote 32):

(60) *Presuppositional DP Constraint*
Only presuppositional *DP*s can receive transparent readings.

Furthermore, they make the following assumptions:

[34] An obviously erroneous "opaque" is omitted from this sentence.
[35] Named after Haddock (1987), cf. Bumford, 2017; Champollion and Sauerland, 2011; Meier, 2003; Sailer, 2015, for accounts.

1. Strong D heads presuppose what is contained in their sister NP. This holds for definites as well as quantifiers, which thereby are modeled as partitives. Presuppositions project, while the DP remains syntactically where it belongs, hence, the quantificational force is exerted within the embedded sentence, as in Bäuerle's original example.

2. The projection of presuppositions fails if the restrictor contains variables bound in their surface position, but "freed" when projected. This essentially is the *Trapping Principle* of Beaver and Zeevat (2006) and van der Sandt (1992).

3. Their accounts of the *Main Predicate* and the *Adverb Constraint* are not easily paraphrasable.[36]

So far for the empirical generalizations. The technicalities of all the different accounts mentioned in this section are not so relevant at the moment. There are just a few things to mention here. First, both ways to make sure that the DPs in question get the "right" situation to work with—the operator-based approach as well as the situation-pronoun approach—can be seen as making a connection between context dependency and Bäuerle readings. Either, *dthat* is generalized to a family of operators that manipulate the slot of their arguments in which the situation variable has to be placed, or situation variables are freed from the λ-based machinery completely and more or less treated as free variables. Approaches in this vicinity differ with respect to how they attempt to deal with these free variables, e.g. how they establish that they are bound at some point in the semantic derivation. Operator-based approaches usually need to find a way to guarantee that the right (bound) situation variable is picked. This isn't as easily done as for the original *dthat* operator. The ease of its formulation is due to the whole semantics being two-dimensional. It just has to target *the* context parameter. This can't be just generalized without making the semantic values of sentences multi-dimensional. Below, basically the syntactic side of the approach of Schwarz (2012) is adopted, where situation variables are free, and are freely chosen by (in-)definite articles. As already mentioned, it is possible to make use of situations without buying into the defining claims of Situation Theory, especially the Kratzerian variant Schwarz uses. But the syntactically free situation variables are closest in spirit to what is done here. If the notion of meaningful variable names is endorsed anyway, why not wholeheartedly?

[36]The full passage runs as follows

> The Main Predicate and Adverb Constraints follow from the fact that the nature of presuppositions associated with presuppositional predicates and adverbs is different from the nature of presuppositions of presuppositional DPs [...]. Simply put, while presuppositional DPs mention the same individuals or sets thereof in the presupposition and the assertion, the presuppositions of main predicates and adverbs are always about different sets of individuals, properties, events, situations etc. This lack of direct anaphoric dependency between the presupposition and the assertion straightforwardly explains why transparency ambiguity does not arise with main predicates and adverbs. (Romoli and Sudo, 2009, 433f.)

4.2 Dealing with heterogeneous formulæ

4.2.1 Heterogeneity

Whichever account is adopted, the connection established between context dependency and *de re* readings can be phrased as follows: the formal machinery is enabled to deal with *heterogeneous formulæ*. Up until now, formulæ where *homogeneous* in the sense that they only contained one situation variable and thus could be evaluated with respect to sets of assignments with a domain that allowed them to represent indices (in the technical sense (12) defined above). This is convenient, but ultimately cannot be maintained if the diagnosis of the literature on *de re* readings as well as the Kaplanian account of context dependency are on the right track. One hallmark of Context Theory, as presented in Chapter 1, is double indexing, i.e. the use of a second situational source of evaluation. This basically is argued to be the case for sentential embedding as well, if one follows the aforementioned accounts. To deal with *de re* readings of any kind thus means dealing with multiple situation variables (or multiple situations simpliciter) at once. The difference is that the contextual dimension has to be assumed regardless of the construction, while further *de re* readings are only possible if the grammatical construction allows more situation variables to enter the picture.[37]

This is not to say that the realm of index-representing assignment functions is left at any point. On the contrary, the whole machinery below depends on the assumption that a file values one situation variable only. Thus, *multi-dimensional* formulæ have to be interpreted several times, and variables that play a rôle in more than one dimension have to be copied from one set of assignments to the other. It may be possible to work with assignments covering more than one situation variable (which then necessarily do not represent indices), but it is extremely difficult to cut assignment functions covering multiple situation variables into index-representing assignments on general grounds. Especially, if one wants to stay true to the spirit of compositional semantics which demands this to happen 'blindly', so to speak, i.e. without taking into account non-local information.[38] So, one better does not abandon index-representing assignments but should rather come up with a way to deal with heterogeneous formulæ utilizing only those assignments that cover exactly one situational core. As will be shown in section 4.2.3, this is possible based on the $[\![\bullet]\!]^d$-values defined in (195) for homogeneous formulæ. But the system is hardly comprehensible if one isn't familiar with its basic idea that finds a predecessor in *Layered DRT*.

[37]See T. E. Zimmermann (2018) and Köpping and T. E. Zimmermann (2018), for accounts that attempt to deal with Bäuerle readings within languages comparable to *IL*. There "backwards-looking" operators are made dependent upon *depth of embedding*. This directly reflects the dependence on appropriate grammatical constructions.

[38]Of course, due to the very nature of assignment functions, namely being a mapping from *variables* to values, every system outlined here cannot be compositional in the traditional sense, since they take in *syntactic information*. This is the most general downside of the "meaningful variables"-approach taken here.

4.2.2 Layered Discourse Representation Theory

Layered Discourse Representation Theory (LDRT) is a framework developed to deal with DRSs that contain content from different areas. The idea is, roughly speaking, that several "dimensions" of meaning, that is, in its original formulation in Geurts and Maier (2003), indexical, presuppositional, and asserted content and the like, are composed in a single LDRS. These *layers* need to interact somehow, but also be kept apart. Both is made possible by *labeling* conditions. So, for example, indexical content is put on one layer of meaning (or content), meaning that it is indexed with one designated label, while other material, e.g. not context- but index-dependent material, is put on another layer, indexed by a different label. The standard DRT rules of composition and interpretation have to be made sensitive to labels in order for this to amount to something.

In Geurts and Maier (2003) (cf. Geurts and Maier, 2013) LDRT was initially developed without any upper limit of different layers in mind, and they distinguished contextual, asserted, presupposed and implicated content by using the labels k, a, p and i. So at least four different layers of meaning were involved. In later installments (esp. Maier, 2006; Maier, 2009b), only two layers (and labels) remained, namely the so-called *K*ripke-*K*aplan layer (labeled *kk*) and the so-called *Fr*egean layer (labeled *fr*). They are thought of as representing, roughly speaking, context- and index-dependent material, respectively. The reasons for this shift are touched upon below.

In the following, the earlier account of LDRT is briefly laid out, just to get the idea. But the later version of LDRT is reviewed and applied to the relevant data in more detail, because this seems to be the more worked-out framework of the two.

Geurts and Maier illustrate their framework with the following example, where p, a and i stand for layers representing presupposed, asserted, and implicated material, respectively.

(61) a. The porridge is warm. b.

$$\begin{array}{|l|}\hline x_p \\ \hline \text{porrigde}_p(x) \\ \text{warm}_a(x) \\ \neg_i \begin{array}{|c|}\hline \\ \hline \text{hot}_i(x) \\ \hline\end{array} \\ \\ \hline\end{array}$$

The built-up proceeds roughly along the following lines: the definite description *the porridge* presupposes the existence of porridge, so it introduces a discourse referent and a condition labeled p. The property *warm* is predicated of this presupposed porridge, so it is applied to x, although it doesn't belong to the presupposed material. Instead, it is labeled a, standing in for the asserted part of the sentence. Hence, the presupposed and the asserted material are forced to interact somehow (this solves some "management problems"; see also Dekker, 2008, on this point). Last but not least, the usage of *warm* implicates (by the maxim of quantity) that the porridge in question is not hot, since otherwise, the speaker wouldn't be cooperative; thus, the condition $\neg_i$[: $\text{hot}_i(x)$] is added to the LDRS, posing yet another condition on the presupposed discourse referent, sitting on another layer.

Formally, the basic rules for DRS formation need to be endowed with layers (with slight and tacit amendments taken from Geurts and Maier, 2003, p. 12):

(62) *Syntax of* LDRT:
Let L be a set of layer labels. Then:

a. An LDRS φ is a pair $\langle U(\varphi), C(\varphi)\rangle$, where $U(\varphi)$ is a set of labeled discourse referents and $C(\varphi)$ is a set of labeled DRS-conditions.
b. If u is a discourse referent, then u_L is a labeled discourse referent.
c. If P is an n-place predicate and $u_1, \ldots, u_n$ are discourse referents, then $P_L(u_1, \ldots, u_n)$ is a labeled condition.
d. If u and v are discourse referents, then $u =_L v$ is a labeled condition.
e. If φ and ψ are LDRSs, then $\neg_L\varphi$, $\varphi\vee_L\psi$, and $\varphi \Rightarrow_L \psi$ are labeled conditions.

The resulting Layered DRSs (LDRSs, e.g. (61b)) can be interpreted using any number of layers as parameters. To make this more concrete, the following clauses from Geurts and Maier (2003, 13f.) are adapted. Basically, every interpretative clause is relativized to labels as well. If the label it is evaluated against occurs in the clause to be interpreted syntactically, it receives the standard DRT-interpretation. Labels in the syntax that aren't also parameters of interpretation render the so-labeled material invisible for interpretation. E.g. the extension-relation only then gets something to work with if the set of labels L it is relativized to and the set of syntactically occurring labels share some elements:

(63) $f[^{\varphi}_{L}]g := f \subseteq g \ \&\ D(g) = D(f) \cup \{u : \exists K : K \cap L \neq \emptyset \ \&\ u_K \in U(\varphi)\}$

Likewise complete LDRSs. As mentioned in the first chapter, possible worlds can be added as interpretation functions for predicate symbols (and this is what Geurts and Maier do). That is, w's are for the sake of this discussion understood as functions from predicates into sets of tuples of individuals. The length of the tuples match the arity of the predicate in question:[39]

(64) *Definedness and interpretation of* LDRSs:
Let φ be an LDRS. Then:

a. $[\![\varphi]\!]^d_{L,w}(f) = 1$ iff $\exists g : f[^{\varphi}_{L}]g$ and $\forall\psi \in C(\varphi) : [\![\psi]\!]^d_{L,w}(g) = 1$. $[\![\varphi]\!]^d_{L,w}(f) = 0$, otherwise.
b. $[\![\varphi]\!]^+_{L,w}(f) = \{g : f[^{\varphi}_{L}]g$ and $\forall\psi \in C(\varphi) : [\![\psi]\!]^+_{L,w}(g) = 1\}$, if $[\![\varphi]\!]^d_{L,w}(f) = 1$.

Hence, if φ is an LDRS, $[\![\varphi]\!]^+_{L,w}(f)$ is the set of embedding assignments that (possibly) extend f and make the L-part of φ true in w. From this, other values may be obtained as well.

[39]The following clauses feature some larger notational changes. Noteworthy are especially the reformulations of Geurts and Maier's definedness-conditions in terms of a function $[\![\bullet]\!]^d$. This is just to present LDRT in the same manner as FCS above.

(65) Notation: $[\![\varphi]\!]^{+}_{L}(f) = \{w : [\![\varphi]\!]^{+}_{L,w}(f) \neq \emptyset\}$, if $\exists w : [\![\varphi]\!]^{d}_{L,w}(f) = 1$, undefined otherwise.

In order to let this trickle down, the following definedness and interpretation-clauses for conditions have to be assumed:

(66) *Definedness of* LDRT-*conditions*:

a. $[\![P_K(u_1, \ldots, u_n)]\!]^{d}_{L,w}(f) = 1$ iff $\{u_1, \ldots, u_n\} \subseteq D(f)$
b. $[\![u =_K v]\!]^{d}_{L,w}(f) = 1$ iff $\{u, v\} \subseteq D(f)$
c. $[\![\neg_K \varphi]\!]^{d}_{L,w}(f) = 1$ iff $[\![\varphi]\!]^{d}_{L,w}(f) = 1$
d. $[\![\varphi \vee_K \psi]\!]^{d}_{L,w}(f) = 1$ iff $[\![\varphi]\!]^{d}_{L,w}(f) = [\![\psi]\!]^{d}_{L,w}(f) = 1$
e. $[\![\varphi \Rightarrow_K \psi]\!]^{d}_{L,w}(f) = 1$ iff $[\![\varphi]\!]^{d}_{L,w}(f) = [\![\varphi \oplus \psi]\!]^{d}_{L,w}(f) = 1$
where $\varphi \oplus \psi = \langle U(\varphi) \cup U(\psi), C(\varphi) \cup C(\psi)\rangle$

(67) *Interpretation of* LDRT-*conditions*:
If K is a set of labels, φ_K is an LDRS-condition, $[\![\varphi_K]\!]^{+}_{L,w}(f) = 1$ iff $[\![\varphi_K]\!]^{d}_{L,w}(f) = 1$ and either $K \cap L = \emptyset$ or one of the following holds:

a. If φ_K is of the form $P_K(u_1, \ldots, u_n)$ and $\langle f(u_1), \ldots, f(u_n)\rangle \in w(P)$.
b. If φ_K is of the form $u =_K v$ and $f(u) = f(v)$.
c. If φ_K is of the form $\neg_K \psi$ and $[\![\psi]\!]^{+}_{L,w}(f) = \emptyset$.
d. If φ_K is of the form $\psi \vee_K \chi$ and $[\![\psi]\!]^{+}_{L,w}(f) \cup [\![\chi]\!]^{+}_{L,w}(f) \neq \emptyset$.
e. If φ_K is of the form $\psi \Rightarrow_K \chi$ and $\forall g \in [\![\psi]\!]^{+}_{L,w}(f) : [\![\chi]\!]^{+}_{L,w}(g) \neq \emptyset$.
$[\![\varphi_K]\!]^{+}_{L,w}(f) = 0$ iff $[\![\varphi_K]\!]^{d}_{L,w}(f) = 1$ and $[\![\varphi_K]\!]^{+}_{L,w}(f) \neq 1$.

For the example at hand, the values for singleton sets of labels are the following, if applied to the empty assignment $f^{\emptyset}$, as the inclined reader is invited to verify:

(68) a. $[\![(61a)]\!]^{+}_{\{p\}}(f^{\emptyset})$ = the set of possible worlds containing porridge
b. $[\![(61a)]\!]^{+}_{\{a\}}(f^{\emptyset})$ = undefined
c. $[\![(61a)]\!]^{+}_{\{i\}}(f^{\emptyset})$ = undefined

(68a) stands for the semantic value of the presuppositional layer. The semantic values of single layers other than p are not defined because the discourse referent x is labeled p as well. Hence, it isn't available to bind its occurrences in the conditions if p is absent from L. Intuitively, what the interpretation function 'sees' instead of the full (61a), repeated here for convenience, is just (69), respectively:

(61a)
$$\begin{array}{|l|}\hline x_p \\ \hline \begin{array}{ll} \text{porrigde}_p(x) & \\ \text{warm}_a(x) & \neg_i \begin{array}{|l|}\hline \\ \hline \text{hot}_i(x) \\ \hline \end{array} \end{array} \\ \hline \end{array}$$

(69) a. $\begin{array}{|l|}\hline x_p \\ \hline \text{porridge}_p(x) \\ \hline\end{array}$ b. $\begin{array}{|l|}\hline \\ \hline \text{warm}_a(x) \\ \hline\end{array}$ c. $\begin{array}{|l|}\hline \\ \hline \neg_i \begin{array}{|l|}\hline \\ \hline \text{hot}_i(x) \\ \hline\end{array} \\ \hline\end{array}$

So, if the p-layer is not invoked, all other conditions lack a binder. Technically speaking, according to (63), the assignment function doesn't get extended to cover the variable x, because the discourse referents in the universe are labeled as well and, in the case at hand, there is no K such that $K \cap L$ isn't the empty set, if $p \notin L$; so neither x nor any condition x is a part of is assigned a value. This represents the asserted and implicated material's dependence on the presupposed discourse referent. Thus, if the layer p is not in L, the assertion fails. Of course, single layer values are not the only values one can get out of LDRSs. The more interesting values are the following:

(68) d. $[\![(61\text{a})]\!]^{+}_{\{a,i\}}(f^{\emptyset})$ = undefined

e. $[\![(61\text{a})]\!]^{+}_{\{p,i\}}(f^{\emptyset})$ = the set of possible worlds containing porridge that is not hot

f. $[\![(61\text{a})]\!]^{+}_{\{p,a\}}(f^{\emptyset})$ = the set of possible worlds containing warm porridge

g. $[\![(61\text{a})]\!]^{\emptyset}_{\{p,a,i\}}(f^{\emptyset})$ = the set of possible worlds containing warm but not hot porridge

Only the last set of possible worlds gives the full contextual meaning of the sentence; the impact it may have on a concrete discourse. The second to last value may be called the 'minimal' proposition, that is, the proposition expressed without taking implicatures into consideration. Thus, this proposition is comparable to the one that serves as input for Gricean reasoning in standard accounts of implicatures. (69e) is the implicature; adding p is necessary to yield a definite value. There is no common term for (69g), but it can be seen as the non literal meaning of (61a).

There is not need to go through the respective takes on presuppositions, implicatures and the problems they run into.[40] Instead, it is time to turn an eye on LDRT's account of indexicality.

A straightforward but misguided extension of LDRT to deal with indexicality would be the addition of another layer, k, and proceeding as above:

(70) a. I am tired. b. $\begin{array}{|ll|}\hline x_k & \\ \hline \text{speaker}_k(x) & \text{tired}_a(x) \\ \hline\end{array}$

As Geurts and Maier rightly point out, this isn't enough:

> However, it is not enough to just put indexical content in a layer of its own: $[[\![(70\text{b})]\!]^{\emptyset}_{\{k,a\}}]$ merely says that there is a speaker, whereas it should say of the individual who *in fact* is doing the talking that he is the speaker. In order

[40]See Maier (2006) for a thorough criticism of this earlier account.

> to account for this, we follow Kaplan by making the content of an LDRS dependent on the context in which it occurs. (Geurts and Maier, 2003, p. 16)

As said above, k-marked material shouldn't merely impose existential presuppositions. Instead, it should *anchor* the LDRS in the sense of Kamp and Reyle (1993). Thus, technically, k-marked conditions are taken to determine an assignment that maps variables to individuals that count as the unique speaker, addressee, etc. of a given context c. For the example at hand, assume that ι is such an anchor, mapping the variable x to the (unique) speaker in (the present context) c, that is $\iota(x) = c(\text{speaker})$. Then, the LDRS in (70a) is only defined if the k-marked material is true at ι (and c). The proposition (70a) expressed is the set of possible worlds making true the remaining layers at ι. Relative to a given context c, the indexical content of the L-part of an LDRS φ is defined as follows:

(71) $\mathbb{I}_{L,c}(\varphi) := [\![\varphi]\!]^+_L(\iota)$, if $[\![\varphi]\!]^+_{\{k\},c}(f^{\emptyset}) = \{\iota\}$; otherwise undefined.

As can be seen in (71), k-marked material is checked against contextually given material and then abandoned. This is to avoid that the k-layer is evaluated twice: first as to provide an anchor for the LDRS, ι above, which is ok, and then again as part of the content, which would be false.

(72) $\mathbb{I}_{L,c}((70\text{a})) = [\![(70\text{a})]\!]^+_L(\iota)$, if $[\![(70\text{a})]\!]^+_{\{k\},c}(f^{\emptyset}) = \{\iota\}$; otherwise undefined.

To see how this works suppose the actual context c is one in which Carl utters the sentence under consideration. The indexical content defined in (72) makes sure that the whole LDRS is evaluated against (not an empty assignment but) ι, the assignment which maps the variable x onto the speaker in c, Carl. This has to be the case, otherwise the value is not defined. The outcome is:

(73) $\{w \mid c(\text{speaker}) \in w(\text{tired})\}$,

which corresponds to the proposition one can obtain from a Kaplanian character. Thus, the special treatment of k-marked material results in the same values a two-dimensional theory assigns—as desired.

There is a downside to this otherwise pretty nicely working system: It clashes somewhat with standard DRT-notions like projection. E.g., consider the following sentence:

(74) a. Every woman hates this man

b. $$\begin{array}{|c|}\hline \\ \hline \begin{array}{|l|}\hline x_a \\ \hline \mathrm{W}_a(x) \\ \hline \end{array} \Rightarrow_a \begin{array}{|l|}\hline y_k \\ \hline \mathrm{M}_k(y) \\ \mathrm{H}_a(y)(x) \\ \hline \end{array} \\ \hline \end{array}$$

c. $$\begin{array}{|l|}\hline y_k \\ \hline \mathrm{M}_k(y) \\ \begin{array}{|l|}\hline x_a \\ \hline \mathrm{W}_a(x) \\ \hline \end{array} \Rightarrow_a \begin{array}{|l|}\hline \\ \hline \mathrm{H}_a(y)(x) \\ \hline \end{array} \\ \hline \end{array}$$

If (74b) were a representation of (74a), then (71) runs idle. Since the universe of the principal LDRS is empty, and the set of conditions boils down to a single a-labeled statement, there is no set of labels K such that $K \cap \{k\}$ isn't empty, and hence the contextually determined assignment function cannot differ from $f^{\emptyset}$. (74a) comes out as context-independent, contrary to fact. (71) yields the intuitively correct result only for a structure like (74c), where the context-dependent material is lifted so that its discourse referent projects into the principal DRS.

This of course reminds one of orthodox DRT, where it is merely stipulated that directly referential discourse referents project into the universe of the main DRS. This stipulation is necessary because otherwise, the wrong truth-conditions result, but it is quite difficult to give it a compositional justification. In LDRT, this is even more difficult. The definitions provided fail to put k-marked discourse referents in the domain of the external anchor if they are interpreted in situ. But Geurts and Maier cannot simply assume that k-marked material projects into the principal LDRS because this (special) interpretation should follow simply from the material being k-marked. If such an assumption is made anyway, why should labeling be needed in the first place? Not that everything falls out immediately if one assumes that directly referential discourse referents project in this way. But in this version of LDRS, k-marked material receives this interpretation *qua* being used to determine the anchor. Thus, k-marked material would have to project higher *because* it *then* receives an interpretation that renders it directly referential; an interpretation it wouldn't receive if it stayed lower.

To be fair, Geurts and Maier don't even attempt to argue in this direction. Instead, they propose a second method for indexical interpretation. Basically, their solution consists in going two-dimensional by treating contexts as another parameter of the interpretation function $[\![\bullet]\!]$ different from w. The whole system changes somewhat, but the crucial part is the condition for basic sentences:

(75) Revised interpretation of atomic conditions:
$[\![P(u_1,\ldots,u_n)_K]\!]^{+}_{L,w}(f,c) = 1$ iff $[\![P(u_1,\ldots,u_n)_K]\!]^{d}_{L,w}(f,c)$ is defined and either $K \cap L = \emptyset$ or one of the following holds:
a. $k \notin K$ and $\langle f(u_1),\ldots,f(u_n)\rangle \in w(P)$;
b. $k \in K$ and $\langle f(u_1),\ldots,f(u_n)\rangle \in c(P)$.

As can be seen, this is a disjunctive definition: if lexical material is k-marked, it has to be interpreted against the context, if not, the index is used. The whole machinery has to be relativized to the new parameter c. Once this is done, the problem presented by (74) doesn't occur, since k-marked material can be interpreted locally, as the inclined reader is invited to verify. The technical details are not so important. More important is the following observation concerning (75). This rule basically establishes a connection between being k-marked and being interpreted against the context. Thus, one might wonder whether a labeling algorithm is really needed. One might also go for overt situation variables in the syntax, as suggested in the last section, and let the situations play the rôle of labels.

This idea becomes even more appealing when the further development of LDRT in Maier

(2006) and Maier (2009b) is taken into consideration. Instead of having a multitude of layers (with more or less anecdotal content), he shrinks the number of labels to two. As already mentioned (on p. 248), indexical content is labeled *kk* (for *K*ripke and *K*aplan), while other contents are labeled *fr* (mnemonic for *Fr*ege). The interpretation procedure too, is simplified, and the ties between *kk*-labeled material and contexts are made even stronger. Formally, it spells out as in (64)–(67), but its application is different. The only combinations of layers and parameters allowed are *kk* and a context-situation c and *fr* and a index-situation w, respectively. The idea is that discourse referents and conditions just bear one label only and thus are interpreted against only one of the two Kaplanian dimensions. This is a reflection of a hypothesis know under the somewhat cryptic name “Hypothesis L” stated in T. E. Zimmermann (1991, 164, “L” is short for “Lexikon”), suspecting that every basic lexical element either is context- or index-dependent, but never both[41] (proper names may be neither). Material labeled *kk* still is taken to determine an anchor, while *fr*-marked material determines propositional content. This version of LDRT doesn't interpret its contents against more than one layer. There are thus two cycles, so to speak: the *kk*-labeled content is calculated first (cf. (76a)); if this content determines one and only one contextual assignment ι, this assignment serves as input for the calculation of *Fr*egean content (cf. (76b)). Thus, one and the same LDRS gets interpreted twice:

(76) a. $[\![\varphi]\!]^{+}_{kk,c}(f^{\emptyset}) = \iota$ b. $[\![\varphi]\!]^{+}_{fr,w}(\iota)$

Potentially, the problem of the first account still arises, despite of the strict association between labels and dimensions. But this is circumvented in Maier (2006) and Maier (2009b) by adopting a two-step interpretation procedure (following van der Sandt (1992); cf. also Kamp, van Genabith, et al. (2011)) that assumes a representation of the ‘context’ with which the (L)DRS representing the semantic value of a discourse is merged in a first step. Crucially, anaphoric material gets resolved only after merger, which in turn means that embedded *kk*-labeled material ends up in the principal (L)DRS, since ‘contextual’ material is assumed to reside there generally.[42]

To see an example, the standard routine (after van der Sandt (1992)) consists of building a so-called *preliminary LDRS*, consisting of a *kk*-presupposition standing for the contribution of the first-person pronoun that needs to be resolved (the dashed box in (78b)). Before this can be done, the preliminary box has to be merged with the context (78a), in which a representation of the actual speaker is found. The result of this process is found in (78c). After merger, it is time to run the resolution process. It is guided by person features and variable names, as in Kamp and Reyle (1993) (sketched in section 3.5). This gets rid of the dashed box. Since matching material thereby becomes redundant and can safely be omitted, the LDRS to interpret looks like (78d) (capital S representing *speaking*, while lower-case s stands in for *speaker*).

[41] See Bierwisch (2004), T. E. Zimmermann (2004a), and T. E. Zimmermann (2004b) for a discussion.

[42] *Context* is put into quotation marks here because it isn't exactly the same notion as in Context Theory. This becomes quite obvious if Maier's take on *de re* and *de se* readings (Maier, 2006; Maier, 2009a) is considered. To discuss the relation between these two notions leads too far astray at the moment.

(77) I am speaking

(78) a. Input b. PrelLDRS c. Merger d. Output

$$\begin{array}{|l|}\hline x_{kk} \\ \hline \mathrm{s}_{kk}(x) \\ \hline \end{array} \quad \begin{array}{|l|}\hline \\ \hline \mathrm{S}_{fr}(y) \\ \begin{array}{|l|}\hline y_{kk} \\ \hline \mathrm{s}_{kk}(y) \\ \hline \end{array} \\ \hline \end{array} \quad \begin{array}{|l|}\hline x_{kk} \\ \hline \mathrm{s}_{kk}(x) \\ \mathrm{S}_{fr}(y) \\ \begin{array}{|l|}\hline y_{kk} \\ \hline \mathrm{s}_{kk}(y) \\ \hline \end{array} \\ \hline \end{array} \quad \begin{array}{|l|}\hline x_{kk} \\ \hline \mathrm{s}_{kk}(x) \\ \mathrm{S}_{fr}(x) \\ \hline \end{array}$$

Hence, *kk*-marked material either projects into the principal LDRS or simply is not bound at all, when the variable name is 'new' even to the context.[43]

Or so it seems.[44] For reasons having to do with his account of *de se* readings (cf. Maier, 2009a), embedded sentences contribute their *diagonal* propositions. That allows, among other things, for binding even *kk*-marked material under attitude verbs and verbs of saying and thus to account for shifted indexicals in languages like Amharic. For the bound reading of the famous (79), the following LDRSs are proposed (simplified somewhat; the intermediate step after merger is omitted for readability[45]):

(79) John jiəgna n-ññ yɨl-all
John hero COP.PRES-1sO say.3M
Lit. 'John says I am a hero.'
John says he is a hero. (Schlenker, 2003, p. 68)

[43] Maier (2006) and Maier (2009b) endorses an accommodation procedure (in the van der Sandtian, non-Lewsian sense) that allows the unbound variable to project into the universe on its own. This possibility needs to be ruled out, so that the general account isn't undermined. Maier (2009a) therefore poses several restrictions on the resolution process, one of them being **kk*-ACCOMMODATE, which has the sole job of preventing exactly that.

[44] The following lays out Maier's theory of indexical shift. This is just done to make a certain point about the projection behavior in LDRT. For comments on the phenomenon of indexical shift see section 5.1.

[45] Note that proper names are presuppositional as well. This facet is not discussed here. The inclined reader is referred to Maier (2009b) for further details. Furthermore, the internal semantics of *say* do not matter for the point to be made.

(80) a. Input b. PrelLDRS c. Output

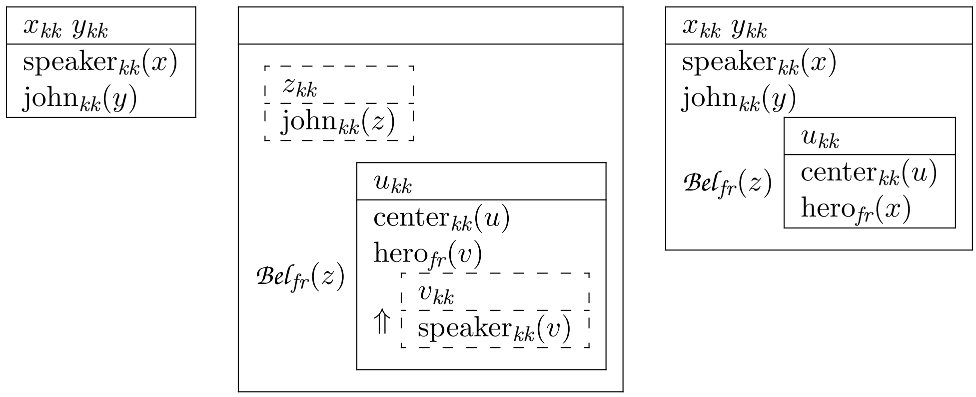
$$
\begin{array}{|l|}\hline x_{kk}\ y_{kk}\\\hline \text{speaker}_{kk}(x)\\ \text{john}_{kk}(y)\\\hline\end{array}
\qquad
\begin{array}{|l|}\hline \\\hline
\begin{array}{:l:}\hdashline z_{kk}\\\hdashline \text{john}_{kk}(z)\\\hdashline\end{array}\\
\mathcal{S}\!ay_{fr}(z)\ \begin{array}{|l|}\hline u_{kk}\\\hline \text{center}_{kk}(u)\\ \text{hero}_{fr}(v)\\ \begin{array}{:l:}\hdashline v_{kk}\\\hdashline \text{center}_{kk}(\text{v})\\\hdashline\end{array}\\\hline\end{array}\\\hline\end{array}
\qquad
\begin{array}{|l|}\hline x_{kk}\ y_{kk}\\\hline \text{speaker}_{kk}(x)\\ \text{john}_{kk}(y)\\
\mathcal{S}\!ay_{fr}(z)\ \begin{array}{|l|}\hline u_{kk}\\\hline \text{center}_{kk}(u)\\ \text{hero}_{fr}(x)\\\hline\end{array}\\\hline\end{array}
$$

The embedded indexical contributes what is represented by the lower dashed LDRS in (80b). Here, a more abstract *center*-predicate ("representing John's internal self, so to speak", Maier 2009b, p. 303) instead of the *speaker* condition found in LDRSs representing unembedded *I* is used, but this difference is not the point. This presupposition is resolved to the internal center of the belief, u_{kk},[46] yielding the output LDRS as depicted in (80c). This center gets bound when the diagonal proposition is formed (which in turn is assumed to be mandated by the semantics of $\mathcal{S}ay$), thereby generating the bound reading.

But there is a downside to this solution (apart from being monstrous). First, for reasons not relevant at the moment, Maier assumes a language like English also to make use of the diagonals of embedded sentences. Thus, one predicts English to have bound indexicals as well, contrary to fact. Secondly, (79) also has a true indexical reading, i.e. a reading where the embedded indexical refers to the author of the sentence. To derive this reading as well as the only possible reading in languages like English, Maier stipulates a 'super-rigidity-feature', represented by $\Uparrow$, that forces resolution to the principal context. English indexicals, assumed to be always endowed with such a feature, thus never get bound to an intermediate *kk*-layer. This feature comes into play in the resolution algorithm. For an English counterpart of (79) the following PrelLDRS is derived that, because of 'super-rigidity', guarantees the desired output, given an appropriate input context like above:

[46] Respecting one of van der Sandt's (1992) restrictions on the resolution process that forces resolution to the closest antecedent in terms of projection paths. Compare the No intervening Binder-constraint proposed in Anand (2006) and Anand and Nevins (2004).

(81) a. Input b. PrelLDRS c. Output



Even though there happens to exist an appropriate binder for the embedded *I*, namely center$_{kk}(u)$,[47] the indexical chooses to bind to the contextually given speaker; as desired. So, once again, for languages like English, the resolution algorithm as such doesn't predict the correct projection behavior—this time, because there exists an additional point in the structure where $_{kk}$-marked material gets evaluated, namely below verbs of saying (and attitude verbs). Thus, the need for something like a 'super-rigidity-feature' $\Uparrow$ to guarantee that embedded *kk*-marked material helps determining an (external) anchor. Although the diagonal proposition is assumed to be embedded under attitude verbs even in English, *kk*-marked conditions need to be interpreted higher; hence, the 'super-rigidity feature' has to be assigned to all (proper) indexicals to guarantee that. Amharic and similar languages on the other hand seem ambiguous between a structure with and without $\Uparrow$, since both readings are possible.

This introduces an interesting asymmetry between lexical material labeled *kk* and *fr*. The only possible 'binder', so to speak, for *kk*-marked material is the context (global or embedded), while *fr*-marked material is 'caught' whenever a proposition is formed, that is, whenever a situation variable gets bound.

To see this, consider the following sentence and its (simplified) representation below:

(82) The man thinks that Peter owns a horse.

[47] Assuming that these rather abstract predicates indeed match in content.

(83) a. Input b. PrelLDRS c. Output

$$\begin{array}{|l|}\hline x_{kk} \\ \hline \text{peter}_{kk}(x) \\ \hline \end{array}
\qquad
\begin{array}{|ll|}\hline \\ \hline
\begin{array}{:l:}\hdashline y_{fr} \\ \hdashline \text{man}_{fr}(y) \\ \hdashline \end{array} & \\
\mathcal{B}el_{fr}(y) & \begin{array}{|l|}\hline z_{fr} \\ \hline \begin{array}{:l:}\hdashline x_{kk} \\ \hdashline \text{peter}_{kk}(x) \\ \hdashline \end{array} \\ \text{horse}_{fr}(z) \\ \text{own}_{fr}(y)(z) \\ \hline \end{array} \\ \hline
\end{array}
\qquad
\begin{array}{|ll|}\hline x_{kk}\ y_{fr} & \\ \hline
\text{peter}_{kk}(x) & \\
\text{man}_{fr}(y) & \\
\mathcal{B}el_{fr}(y) & \begin{array}{|l|}\hline z_{fr} \\ \hline \text{horse}_{fr}(z) \\ \text{own}_{fr}(y)(z) \\ \hline \end{array} \\ \hline
\end{array}$$

In these LDRSs, both the matrix definite and the embedded indefinite are labeled *fr*, but they get interpreted at different world variables. *The man* is interpreted at the matrix-level's world variable and the embedded *a horse* at the shifted world variable, introduced by the construction rule for embedded sentences. This is so since *fr* doesn't relate to a special interpretation rule like *kk* does, but serves as marker for conditions that have to be interpreted once determining the LDRSs anchor by *kk*-marked material is finished.

If there was a configuration like (83b) with a transparent reading of the indefinite (or any other expression in its place), this reading could be derived in one of the following ways. First, one could use another 'rigidity-feature' (without 'super'powers) that allows the condition to skip the closest candidate for resolution (or accommodation) and take the next one. Second, one could argue that the condition in question is moved syntactically, yielding a PrelLDRS where the material sits outside the LDRS representing the content of the belief.

The following version of FCS implements the basic idea of LDRT in the way indicated: Instead of labels, it uses situation variables to collect all contributions into one set of assignments. The interpretation then has to run in cycles, each time with a different file as argument, and each time ignoring all parts not relevant for the 'layer' at hand. For this to work out, some major changes have to be made to the general interpretation mechanism. For example, as one may already guess from the discussion of *contextual import* in section 4.1.3, some kind of "communication" between layers, understood as sets of assignments, has to be assumed. These changes are discussed after the formal system is introduced.

4.2.3 Non-eliminative FCS

The following interpretation rules (using $\|\ldots\|^{\bullet}_{\omega}$, with ω being a run-of-the-mill assignment function not to be confused with the ones collected in files) are designed in such a way that they still only contribute something meaningful if the formula is defined for the file, but contrary to the rules above (using $[\![\ldots]\!]^\bullet$), in case the formulæ aren't, the file is left intact. Remember that definedness is just a matter of the bookkeeping device and doesn't imply anything substantial like a presupposition failure or the like. Whenever it has to be checked whether an expression α (where α is not a term) yields a proper output if applied to a set of assignments G, $\|\alpha\|^d_\omega(G)$ is calculated. If this returns a non-empty set H, α is defined for G, but when it yields the empty set, α is undefined for G. In case α is a *test*, H is G (or a subset of G, see below). In case α is not a test, H's domain contains more variables than G's. But this means that H cannot be used as a restriction in the formulation of the positive and negative value of α. Thus, what is needed in this second case is the set of assignments in G that have a non-empty outcome. This is usually captured by a *closure operator*.[48] Its effect can be stated as in (84a) for all α except terms, which need (84b). (84b) will be abbreviated as indicated in the following:

(84) a. $\{g \in G : \|\alpha\|^d_\omega(\{g\}) \neq \emptyset\}$ as long as α is no term
b. $\{g \in G : \|\upsilon\|^d_\omega(G)(g) \neq \#\}$ $=: [\upsilon]^d_\omega(G)$

Needless to say, the closed value in (84a) cannot be taken to be the d-value of α because this makes a recursive definition impossible in case α contains one of the quantifiers that introduce variables needed in other parts of a formula α is a part of.

As above, the closure of $\|\alpha\|^d_\omega(G)$, (84a), only has two possible outputs, namely G or $\emptyset$, when G is homogeneous with respect to the domain, which is the case for index-assignments, but not necessarily for context-assignments. If α isn't defined for G, the positive as well as the negative value was assigned $\emptyset$ in the old system. In the new one, this is circumvented by adding α's *anti-domain* with respect to G, namely (85)—which in the following will be abbreviated as indicated—, in the calculation of its meaningful values.

(85) $G \backslash \{g \in G : \|\alpha\|^d_\omega(\{g\}) \neq \emptyset\}$ $=: \overline{\|\alpha\|^d_\omega(G)}$

Roughly, one can think of this along the following lines:

(86) $\|\alpha\|^+_\omega(G) \cup \overline{\|\alpha\|^d_\omega(G)}$
$= \|\alpha\|^+_\omega(G) \cup \big(G \backslash \{g \in G : \|\alpha\|^d_\omega(\{g\}) \neq \emptyset\}\big)$

In case $\|\alpha\|^d_\omega(G) = G$, $\overline{\|\alpha\|^d_\omega(G)}$ simply adds the empty set, and the result of (86) is $\|\alpha\|^+_\omega(G)$. But in case $\|\alpha\|^d_\omega(G) = \emptyset$, the result of (86) then is G again, instead of $\emptyset$, since $\|\alpha\|^+_\omega(G)$ boils down to the empty set, but $\overline{\|\alpha\|^d_\omega(G)}$ contributes G again. Undefined formulæ are thus simply ignored—and no update of the file is carried out. This allows one to deal with heterogeneous formulæ by evaluating different parts separately, in different "cycles", as in LDRT. α may be part of a larger formula that employs different situation variables in its other parts. If the domain of the file G only contains a situation variable not used in φ, the calculation doesn't abruptly come to a halt, but continues as if the

[48] $\{g \in G : \|\alpha\|^d_\omega(\{g\}) \neq \emptyset\}$ is $\|\alpha\|^d_\omega$'s satisfaction set in the sense of Groenendijk and Stokhof ((125a), on page 135). It is denoted by '$!\alpha$' in van den Berg (1996).

part didn't exist.

These changes on the level of the d-values allow the calculation to continue even though the relevant criteria aren't met. Mostly, these amendments just consist in adding the demand to evaluate a specific situation variable to the definedness conditions already established. But situation variables now are assumed to have a wider distribution: they are also used as parts of most operators, i.e. quantifiers and negation. These occurrences affect their interpretation. For example, if a negated sentence is evaluated against a file which doesn't evaluate the situation variable that the negation sign now comes with, the "quantificational force" of negation isn't exerted. In other words, the negation simply is ignored and the embedded sentence is interpreted as if it wasn't embedded. This allows material embedded under negation that comes with the right kind of situation variable for the file to be interpreted transparently. In case the situation variable in question is $c \in \mathcal{C}$, the material in question is marked as context-dependent and (because the negation sign comes with a different situation variable) it projects to the right universe.

(87) Non-eliminative FCS
υ stands for a variable of any type, β for predicates of any arity.

a. For a term υ of any type:

$$\begin{aligned}
\|\upsilon\|^d_\omega(G) &= \lambda g.g(\upsilon)\\
\|\upsilon\|^+_\omega(G) &= \lambda g.g(\upsilon)\\
\|\upsilon\|^-_\omega(G) &= \|\upsilon\|^+_\omega(G)
\end{aligned}$$

b. For any predicate with arity n, with $\upsilon_0, \ldots, \upsilon_n \in T$:

$$\begin{aligned}
\|\beta\upsilon_0\ldots\upsilon_n\|^d_\omega(G) &= [\upsilon_0]^d_\omega(G) \cap \ldots \cap [\upsilon_n]^d_\omega(G)\\
\|\beta\upsilon_0\ldots\upsilon_n\|^+_\omega(G) &= \{g \in G : \langle\|\upsilon_0\|^+_\omega(G)(g), \ldots, \|\upsilon_n\|^+_\omega(G)(g)\rangle \in \beta'\}\\
&\cup\ \overline{\|\beta\upsilon_0\ldots\upsilon_n\|^d_\omega(G)}\\
\|\beta\upsilon_0\ldots\upsilon_n\|^-_\omega(G) &= \{g \in G : \langle\|\upsilon_0\|^-_\omega(G)(g), \ldots, \|\upsilon_n\|^-_\omega(G)(g)\rangle \notin \beta'\}\\
&\cup\ \overline{\|\beta\upsilon_0\ldots\upsilon_n\|^d_\omega(G)}
\end{aligned}$$

c.

$$\begin{aligned}
\|\varphi\wedge\psi\|^d_\omega(G) &= \|\psi\|^d_\omega(\|\varphi\|^d_\omega(G)) \cup \|\varphi\|^d_\omega(G) \cup \|\psi\|^d_\omega(G)\\
\|\varphi\wedge\psi\|^+_\omega(G) &= \|\psi\|^+_\omega(\|\varphi\|^+_\omega(G)) \cup \overline{\|\varphi\wedge\psi\|^d_\omega(G)}\\
\|\varphi\wedge\psi\|^-_\omega(G) &= \|\psi\|^-_\omega(\|\varphi\|^+_\omega(G)) \cup \|\psi\|^+_\omega(\|\varphi\|^-_\omega(G)) \cup \|\psi\|^-_\omega(\|\varphi\|^-_\omega(G))\\
&\cup\ \overline{\|\varphi\wedge\psi\|^d_\omega(G)}
\end{aligned}$$

d.

$$\begin{aligned}
\|-^\upsilon\varphi\|^d_\omega(G) &= \|\varphi\|^d_\omega(G)\\
\|-^\upsilon\varphi\|^+_\omega(G) &= \boxed{\oplus}([\upsilon]^d_\omega(G))(\|\varphi\|^-_\omega(\{g \in [\upsilon]^d_\omega(G) : \|\varphi\|^+_\omega(\{g\}) = \emptyset\}))\\
&\cup\ \|\varphi\|^+_\omega(\overline{[\upsilon]^d_\omega(G)}) \cup \overline{\|-^\upsilon\varphi\|^d_\omega(G)}\\
\|-^\upsilon\varphi\|^-_\omega(G) &= \boxed{\oplus}([\upsilon]^d_\omega(G))(\|\varphi\|^+_\omega([\upsilon]^d_\omega(G))) \cup \|\varphi\|^+_\omega(\overline{[\upsilon]^d_\omega(G)})\\
&\cup\ \overline{\|-^\upsilon\varphi\|^d_\omega(G)}
\end{aligned}$$

e.

$$\begin{aligned}
\|(\exists^{\upsilon_1}_{\upsilon_2})[\varphi]\|^d_\omega(G) &= \|\varphi\|^d_\omega(\{h : \exists g \in [\upsilon_1]^d_\omega(G) : g \subset_{\{\upsilon_2\}} h\} \cup \overline{[\upsilon_1]^d_\omega(G)})\\
\|(\exists^{\upsilon_1}_{\upsilon_2})[\varphi]\|^+_\omega(G) &= \|\varphi\|^+_\omega(\{h : \exists g \in [\upsilon_1]^d_\omega(G) : g \subset_{\{\upsilon_2\}} h\})\\
&\cup\ \|\varphi\|^+_\omega([\upsilon_1]^d_\omega(G) \cap \overline{[\upsilon_2]^d_\omega(G)}) \cup \overline{\|(\exists^{\upsilon_1}_{\upsilon_2})[\varphi]\|^d_\omega(G)}\\
\|(\exists^{\upsilon_1}_{\upsilon_2})[\varphi]\|^-_\omega(G) &= \|\varphi\|^+_\omega(\overline{[\upsilon_1]^d_\omega(G)}) \cup \overline{\|(\exists^{\upsilon_1}_{\upsilon_2})[\varphi]\|^d_\omega(G)})
\end{aligned}$$

$$
\begin{array}{lrcl}
\text{f.} & \|(\text{℩}^{\upsilon_1}_{\upsilon_2})[\varphi]\|^d_\omega(G) & = & \|\varphi\|^d_\omega(\{h : \exists g \in [\upsilon_1]^d_\omega(G) : g \subseteq_{\{\upsilon_2\}} h\} \cup \overline{[\upsilon_1]^d_\omega(G)}) \\
& \|(\text{℩}^{\upsilon_1}_{\upsilon_2})[\varphi]\|^+_\omega(G) & = & \textsc{Unique}_{\{\upsilon_2\}}([\upsilon_1]^d_\omega(G))(\\
& & & \|\varphi\|^+_\omega(\{h : \exists g \in [\upsilon_1]^d_\omega(G) : g \subseteq_{\{\upsilon_2\}} h\})) \cup \|\varphi\|^+_\omega(\overline{[\upsilon_1]^d_\omega(G)}) \\
& & \cup & \overline{\|(\text{℩}^{\upsilon_1}_{\upsilon_2})[\varphi]\|^d_\omega(G)} \\
& \|(\text{℩}^{\upsilon_1}_{\upsilon_2})[\varphi]\|^-_\omega(G) & = & \|\varphi\|^+_\omega(\overline{[\upsilon_1]^d_\omega(G)}) \cup \overline{\|(\text{℩}^{\upsilon_1}_{\upsilon_2})[\varphi]\|^d_\omega(G)}
\end{array}
$$

As can be seen in (87a), nothing has changed for the interpretation of variables. The new rules show their effect in (87b) first, where the interpretation for basic sentences is given. There, the addition of the *anti-domain* is needed. The idea is that basic sentences come with one situation variable only, because their value is only dependent on one situational parameter; either context or index, as "hypothesis (L)" has it. Taking this for granted, as does, e.g. Maier (2006), basic sentences either are defined for a file or not, since files are restricted to those sets of assignments valuing only one situational core. There are no parts that need to be taken care of. This is different in conjunctions, treated in (87c). They are defined for some file G as soon as one of their parts is. If one of them comes with a situation variable G doesn't account for, only the part that contains the right one is interpreted. As is easily seen, all other parts of the definedness condition for conjunctions contribute the empty set. Conjunctions are thus the smallest formulæ that can be heterogeneous. The can be because the interpretation rules for other formulæ deal with the addition of the *anti-domain.* (87d-f) take a special form compared to the simpler system because they need to deal with distinguished variables added to the formulæ in question, e.g. υ_1 in (87e,f). These are there to make sure that the operators exert their special forces only on one "layer" of meaning, similarly to negations and conditionals in LDRT. E.g., the existential quantifier doesn't introduce its discourse referent no matter what, but only if the file comes with the "right" situation variable. This is of invaluable help when it comes to describing intensional constructions as well as context dependent (complex) expressions.

To see how this works, the following example is considered in some detail. It is assumed that there is a demonstrative context $c \in d\Gamma$ in which a particular man is somehow brought into focus such that he figures as a coordinate within the respective tuple. This tuple is represented by the (heterogeneous) set of assignments F_c in the sense of section 4.1.2. The variables $\mathcal{c} \in \mathcal{C}$ and $\mathcal{s} \in \mathcal{S}$ mark context- and index-dependent material respectively. Thus, there is no assignment in F_c that takes care of $\mathcal{s}$. Furthermore, there is a set of assignments I that could come with a rather elaborate domain if it was the output of the evaluation of earlier discourse. But to keep things easy, it is assumed that its domain just comprises $\mathcal{s}$. The example is the following:

(88) a. The man [pointing] is bald.
b. $(\text{℩}^{\mathcal{c}}_{x_1})[M\mathcal{c}x_1] \wedge B\mathcal{s}x_1$

This setup makes (88a) in the translation (88b) contain a demonstratively used definite description. Armed with these assumptions, it is time to tackle the calculation of (88b)'s d-value with respect to F_c. The first step simply applies the rule for conjunction:

$$
\begin{array}{ll}
(89) & \|(\sqsupset^{c}_{x_1})[M\boldsymbol{c}x_1] \wedge B\boldsymbol{s}x_1\|^{d}_{\omega}(F_c) \\
= & \|B\boldsymbol{s}x_1\|^{d}_{\omega}(\|(\sqsupset^{c}_{x_1})[M\boldsymbol{c}x_1]\|^{d}_{\omega}(F_c)) \\
\cup & \|(\sqsupset^{c}_{x_1})[M\boldsymbol{c}x_1]\|^{d}_{\omega}(F_c) \\
\cup & \|B\boldsymbol{s}x_1\|^{d}_{\omega}(F_c)
\end{array}
$$

Since, by design, F_c doesn't cover $\boldsymbol{s}$, it doesn't help that it contains assignments that assign a value to x_1; the last line of (89) inevitably boils down to the empty set. Because the second disjunct also makes its appearance in the previous line, it is calculated first:

$$
(90) \qquad \|(\sqsupset^{c}_{x_1})[M\boldsymbol{c}x_1]\|^{d}_{\omega}(F_c) = \|M\boldsymbol{c}x_1\|^{d}_{\omega}(\{h : \exists g \in [\boldsymbol{c}]^{d}_{\omega}(F_c) : g \subseteq_{\{x_1\}} h\} \cup \overline{[\boldsymbol{c}]^{d}_{\omega}(F_c)})
$$

Since F_c is heterogeneous, it contains assignments that come up with values for $\boldsymbol{c}$ and x_1, but also ones that evaluate neither or only one of them. The assignments with $\boldsymbol{c}$ and x_1 in their domain are of course the relevant representations of c, but the machinery doesn't know this. Thus, the first disjunct in (90) preserves those assignments, while it eliminates those that don't cover $\boldsymbol{c}$ and extends those that don't feature x_1 (but $\boldsymbol{c}$). These latter assignments don't represent c, because of the addition of x_1. The contexts these assignments represent thus have more individual coordinates than c. Furthermore, there might be more than one man in c. This is no issue for the assignments in F_c that feature x_1 from the start, but for those assignments in which x_1 isn't in the domain, this would lead to the insertion of more than one output assignment in the calculation of the positive value. The other part, $\overline{[\boldsymbol{c}]^{d}_{\omega}(F_c)}$ reintroduces the assignments excluded because they don't assign a value to $\boldsymbol{c}$. They don't get extended, even if they also don't cover x_1. Ultimately, all of these get excluded in the next step, because the atomic sentence $M\boldsymbol{c}x_1$ requires both x_1 and $\boldsymbol{c}$ to be in the domain. Note that the definedness-condition for atomic sentences doesn't add the *anti-domain* to the intended value. Thus, the contribution of $\overline{[\boldsymbol{c}]^{d}_{\omega}(F_c)}$ is eliminated altogether. This doesn't hold for the assignments in F_c that are extended by x_1 in $\{h : \exists g \in [\boldsymbol{c}]^{d}_{\omega}(F_c) : g \subseteq_{\{x_1\}} h\}$. To conclude the discussion of (89), the second line once again returns the empty set, simply because the assignments that are the output of the calculation still don't have $\boldsymbol{s}$ in their domains. Thus, in the end, the result isn't empty, but there are two kinds of assignments that "survive" the procedure: those that had a value for $\boldsymbol{c}$ and x_1 already from the start, and those that just had one for $\boldsymbol{c}$ and got extended by x_1. The calculation of the positive value should be restricted to the first kind of assignments. Thus, albeit defined for all kind of elements of F_c, the intended value must be among those that use x_1 to represent the demonstrative coordinate. But for the question whether the formula is defined of F_c or not, these unintended assignments don't matter that much. If the process returns a non-empty file, as it does in this case, the formula is defined for the set of assignments given. This shouldn't be confused with felicity: the whole procedure just checks whether it is possible to represent the context at hand in such a way that its representations can be used to interpret the translation of the sentence. But what wasn't checked yet is whether the individual coordinate that is represented by x_1 is a man or not. Thus, the question whether (88) is felicitous in the context c cannot be answered by just looking at the d-value of its translation. That the sentence is interpretable is no surprise either, because F_c collects all possible ways of representing the context. As long as the formulæ are designed in a certain way, there is no chance for this procedure to fail. For example, formulæ that make use of more variables in $\mathcal{C}$ cannot be defined for any context-representing set of assignments, since these are restricted to assignments containing only one situation variable in their domain. One thus might restrict the set $\mathcal{C}$ to one variable only, because there can't be any "multi-contextual" formulæ, anyway.

For the calculation of the positive value of (88) it is thus not enough to restrict the evaluation to those elements of F_c that yield a non-empty output. What needs to be required is that only those elements make it that were already present. That is, instead of using (91a), one has to take (91b):[49]

(91) a. $\{f \in F_c : \|(\text{℩}^{c}_{x_1})[Mcx_1] \wedge Bsx_1\|^d_\omega(\{f\}) \neq \emptyset\}$
b. $\{f \in F_c : \|(\text{℩}^{c}_{x_1})[Mcx_1] \wedge Bsx_1\|^d_\omega(\{f\}) = \{f\}\}$

This excludes the lengthened assignments. Let (91b) be denoted by G_c. G_c still is no singleton set, because the representation of speaker and addressee aren't fixed. This is due to (88) and its translation: except from the definite description, the example doesn't feature indexicals and hence, there is no way to fix the domain completely. But this doesn't matter, because its semantic value doesn't depend on either coordinate. The calculation of the positive value now proceeds as follows:

(92) $\|(\text{℩}^{c}_{x_1})[Mcx_1] \wedge Bsx_1\|^+_\omega(G_c)$

$= \quad \|Bsx_1\|^+_\omega(\|(\text{℩}^{c}_{x_1})[Mcx_1]\|^+_\omega(G_c)) \cup \overline{\|(\text{℩}^{c}_{x_1})[Mcx_1] \wedge Bsx_1\|^d_\omega(G_c)}$

Since G_c is restricted to those assignments that figured in F_c and in the output of the d-value, the overlined part in (92) just contributes the empty set. This also holds for the overlined formula that comes into play when the inner part of (92), $(\text{℩}^{c}_{x_1})[Mcx_1](G_c)$, is calculated. That is, the second line of the following doesn't contribute anything:

(93) $\|(\text{℩}^{c}_{x_1})[Mcx_1]\|^+_\omega(G_c)$

$= \quad \text{Unique}_{\{x_1\}}([c]^d_\omega(G_c))(\|Mcx_1\|^+_\omega(\{h : \exists g \in [c]^d_\omega(G_c) : g \subseteq_{\{x_2\}} h\}))$

$\cup \quad \|Mcx_1\|^+_\omega(\overline{[c]^d_\omega(G_c)}) \cup \overline{\|(\text{℩}^{c}_{x_1})[Mcx_1]\|^d_\omega(G_c)}$

Since all assignments in G_c come up with the same value for c and x_1 each, and since x_1 represents a man in the context c, the output of the uniqueness function is G_c. That is, the formula doesn't eliminate any of the assignments in G_c. Substituting this result in (92), the calculation continues:

(94) $\|Bsx_1\|^+_\omega(G_c)$

$= \quad \{g \in G_c : \langle \|s\|^+_\omega(G_c)(g), \|x_1\|^+_\omega(G)(g)\rangle \in B'\} \cup \overline{\|Bsx_1\|^d_\omega(G_c)}$

The first disjunct boils down to the empty set because no assignment in G_c covers s, but

[49](91b) can be understood as a version of $^*kk$-Accommodate as mentioned in footnote 43.

the second disjunct contributes G_c again, for the same reason. The predicate is basically ignored because it comes with a different situation variable than the one that is part of the file's domain. It will be interpreted in the second cycle, when all the parts that were of relevance in this cycle will be ignored. Thus G_c as a whole is the positive value of the formula in question with respect to the context.

In sum, if the representation of the actual context is such that it maps the variables used in the restrictor of the definite description to appropriate values from the get-go, then the whole calculation returns said representation. Otherwise, it is the empty set of assignments. This outcome signals the use of an expression either not licensed, or simply wrong. This should be taken as the semantic answer to Donnellan's (1966) question whether an expression like the definite in (89) can be used to refer successfully in a context where its restrictor is wrong: Not semantically. It might be true that it is possible to refer to some non-man by using *the man* and a pointing gesture in some sense of "refer", but this sense is not encoded in the semantics of the expression. This seems to be the common answer nowadays. This picture doesn't change when F_c's domain is assumed to consist only in a situation variable, a speaker variable z_n and an addressee variable y_m. In this case, x_1 must be *accommodated*. This can't be done by just letting the definite description add x_1 and restricting its values to men by the restrictor. The resulting set of assignments would only then make it past the uniqueness condition if there just is a single man in c. If there isn't, the uniqueness condition returns the empty set. Instead, a new context c' must be used, one that is longer than the original one, and the set of all of its representations $F_{c'}$ has to be used in a new calculation. But this means that the decision which man to make the value of x_1 already has been made: It happens in the selection of c', or more precisely in the calculation of $F_{c'}$ from c', not in the calculation of the formula's semantic value with respect to $F_{c'}$. This corresponds to "accommodation" in the sense of Lewis and Heim. This more or less "silent" adaptation of the (representation of the) context of course is easier if uniqueness is guaranteed in the context. That is, if there is indeed only one man, there is nothing to decide. By failing to calculate a non-empty output on the first try, one may become aware of the fact that the original context wasn't articulate enough; whether this happens with pointing gestures or not doesn't matter that much, though it does of course help. The first context then is abandoned in favor of a slightly more specific one, namely one in which the obviously missing coordinate is represented. That is, if the "old" context supports the introduction of another parameter with a single value, the switch to the new one is rather straightforward. This feature is what Heim (1982) tried to capture by an entailment requirement in definites, which was argued to be too strong in the previous chapter. But if the context doesn't support the quick introduction of the single man as a parameter, simply because there are more men, one has to make a decision. However this is done exactly is beyond the scope of this thesis. The point to take away from this section is that it has to happen before the semantic value is calculated. Accommodation thus is an extralinguistic operation, not a byproduct of the dynamic algorithm. But, on the other hand, this is simply because of the stipulation made in (91b), which cuts the assignments to the right length. That this is justified despite for the reason that it leads to the right result can be seen by looking at non-demonstrative contexts. If (88) is used in such a context, there is no way to make it past (91b). That is, there are no assignments the initial representation of the context that render the formula defined—but there are updated assignments that do. If (91b) were not in force, the use of definite descriptions would never be infelicitous. Furthermore, choosing (91b) over (91a) also prevents the demonstrative (or referential) use of indefinites in non-demonstrative contexts. Thus, the stipulation isn't made just to prevent "auto"-accommodation, but has other benefits as well. It therefore can be defended on more general grounds.

Before proceeding to calculate the intension of (88), it is shown that there is no way to make the restrictor of a demonstratively used definite description contribute to the intension. If one attempts this by translating the restrictor using the variable s in place of c, as shown in (95), the whole formula is undefined with respect to F_c.

(95) $(\text{℩}^c x_1)[Msx_1] \wedge Bsx_1$

(96) $\|(\text{℩}^c_{x_1})[Msx_1] \wedge Bsx_1\|^d_\omega(F_c)$

$=$ $\|Bsx_1\|^d_\omega(\|(\text{℩}^c_{x_1})[Msx_1]\|^d_\omega(F_c))$

$\cup$ $\|Msx_1\|^d_\omega(\{h : \exists g \in [c]^d_w(F_c) : g \subseteq_{\{x_1\}} h\} \cup \overline{[c]^d_\omega(F_c)})$ $\quad (= \|(\text{℩}^c_{x_1})[Msx_1]\|^d_\omega(F_c))$

$\cup$ $\|Bsx_1\|^d_\omega(F_c)$

Since s isn't in the domain of any assignment in F_c and can't be when F_c represents a context, all three components of (96) boil down to the empty set. This is easily seen for the last line, and not much more complicated for the second one. Neither extending by x_1 nor taking the relative complement of F_c (with respect to c) adds s to the assignments and hence, the restrictor can't be assigned a value. This then also carries over for the condition in the first line and because the d-value of the predicate thus is applied to the empty set, it contributes $\emptyset$ as well. This is because the situation variable the quantifier prefix comes with differs from the sole situation variable the restrictor comes with. The interpretation rules require at least parts of the restrictor of a quantifier to depend on the values of the quantifier's situation variable. This intuitively needs to be the case in order to prevent the introduction of fresh variables that vary unrestrained.

What remains to be shown is that the very same mechanism is at work when the intension of the example (with respect to a "common ground") has to be calculated. To this end, the sentence has to be applied to a suitable set of assignments G. Its domain has to feature x_1 along with s, whereas x_1 is assumed to be mapped to one and the same individual by all elements of G, namely the individual that is x_1's value according to G_c. That is, the intension of the formula in question has to make use of the variable and the value only after the contextual assignment has been checked in a procedure like above. More generally, whatever (then) contextual variable is made use of in those parts of the formula that feature just the non-contextual situation variable, its value has to agree with what the contextual assignment determines it to be. How this comes about is defined later. First, the calculation is carried out.

The first steps remain the same, with G in place of G_c, of course. The first point to stop is this:

$$
\begin{array}{ll}
(97) & \|(\text{ᗡ}^{c}_{x_1})[Mcx_1] \wedge Bsx_1\|^{d}_{\omega}(G) \\
= & \|Bsx_1\|^{d}_{\omega}(\|(\text{ᗡ}^{c}_{x_1})[Mcx_1]\|^{d}_{\omega}(G)) \\
\cup & \|(\text{ᗡ}^{c}_{x_1})[Mcx_1]\|^{d}_{\omega}(G) \\
\cup & \|Bsx_1\|^{d}_{\omega}(G)
\end{array}
$$

This time, the value in the last line doesn't boil down to the empty set, but yields the set of assignments it is applied to. This is of course is because G is assumed to come with a domain that contains at least s and x_1. But the other two applications yield the empty set, due to the situation variable that accompanies the definite description being c. Since c isn't in the domain of G, this requirement cannot be fulfilled no matter what the rest of its domain or the formula is. That is, $\{h : \exists g \in [c]^{d}_{\omega}(G) : g \subseteq_{\{x_1\}} h\}$ is the empty set, because the extension is restricted to those assignments that take care of c, and $\|Mcx_1\|^{d}_{\omega}(G)$ is empty for the same reason. G is contributed by $\overline{[c]^{d}_{\omega}(G)}$. Thus, the third line of (97) is the empty set and so is the second, since $\|Bsx_1\|^{d}_{\omega}(\emptyset)$ is beyond repair. Hence, the whole procedure boils down to

$$
\begin{array}{ll}
(97) & \cdots = \|Bsx_1\|^{d}_{\omega}(G) = G,
\end{array}
$$

which is as desired. Thus, the positive value of the whole formula must be calculated with respect to G:

$$
\begin{array}{ll}
(98) & \|(\text{ᗡ}^{c}_{x_1})[Mcx_1] \wedge Bsx_1\|^{+}_{\omega}(G) \\
= & \|Bsx_1\|^{+}_{\omega}(\|(\text{ᗡ}^{c}_{x_1})[Mcx_1]\|^{+}_{\omega}(G)) \cup \overline{\|(\text{ᗡ}^{c}_{x_1})[Mcx_1] \wedge Bsx_1\|^{d}_{\omega}(G)}
\end{array}
$$

The overlined condition contributes the empty set because, as just calculated, the whole conjunction is defined for G. The argument of the other part unfolds as follows:

$$
\begin{array}{ll}
(99) & \|(\text{ᗡ}^{c}_{x_1})[Mcx_1]\|^{+}_{\omega}(G) \\
= & \textsc{Unique}_{\{x_1\}}([c]^{d}_{\omega}(G))(\|Mcx_1\|^{+}_{\omega}(\{h : \exists g \in [c]^{d}_{\omega}(G) : g \subseteq_{\{x_2\}} h\})) \\
\cup & \|Mcx_1\|^{+}_{\omega}(\overline{[c]^{d}_{\omega}(G)}) \cup \overline{\|(\text{ᗡ}^{c}_{x_1})[Mcx_1]\|^{d}_{\omega}(G)}
\end{array}
$$

The first disjunct inevitably leads to the empty set because $[c]^{d}_{\omega}(G)$ is empty and the uniqueness function doesn't add assignments. The second disjunct also contributes the empty set because $\overline{[c]^{d}_{\omega}(G)}$ is G again, which doesn't come up with a value for c and thus is emptied out. But the last part contributes G again, since $\|(\text{ᗡ}^{c}_{x_1})[Mcx_1]\|^{d}_{\omega}(G) = \emptyset$. This means that (98) simply is

$$
\begin{array}{ll}
(98) & \cdots = \|Bsx_1\|^{+}_{\omega}(G)
\end{array}
$$

This leads to a subset of G, depending on the values for s and the fixed individual assigned to x_1. Thus, the calculation featuring the set of assignments G with the domain $\{s, x_1\}$ simply ignores all parts of the initial formula that aren't defined for G, as the former calculation (89) with the sets F_c and G_c ignored the respective other parts. This is as it should be.

That a quantifier and at least some part of its restrictor needs to come with the same situation variable partly explains the *Nested DP Constraint*, repeated from above:

(53) *Nested DP Constraint* (Romoli and Sudo, 2009, p. 432)

a. When a *DP* is embedded inside a *DP*, the embedding *DP* must be opaque if the embedded *DP* is opaque;

b. When an indefinite is embedded inside a *DP*, the indefinite must be wide scope transparent, if the embedding *DP* is transparent.

Concentrating on the first part and making this a statement about context dependency, the configuration in (100a) is the only possibly configuration with a heterogeneous restrictor:

(100) The wife of the president

a. $[c : [s : [\text{the wife of [the president]}-c]-s]]$

b. $\#[c : [s : [\text{the wife of [the president]}-s]-c]]$

If the following formulæ are taken to be the correct translations, the first part of this constraint falls out immediately:

(101) a. $(\text{ᗡ}^{s}_{x_1})[(\text{ᗡ}^{c}_{x_2})[Pcx_2] \wedge Wsx_2x_1]$

b. $\#(\text{ᗡ}^{c}_{x_1})[(\text{ᗡ}^{s}_{x_2})[Psx_2] \wedge Wcx_2x_1]$

The relational constant W stands for *wife of ...*, P translates *president*. As can be seen, the lower *DP* doesn't occupy its surface position but sits right below the contribution of the surface higher definite article. This may be due to a (type-driven) movement step.[50] How the formulæ come about is touched upon in the next section. Taking them without syntactic derivation for the time being, it is easily seen that (101b) cannot work for a similar reason (96) above didn't. This time, x_2 is the problem. (101b) can be evaluated against a set of context-assignments F_c that represent c, a non-demonstrative context which nevertheless represents the actual president under the variable x_1. This set can be thought of as stemming from the accommodation of the actual president after an earlier attempt to calculate the *d*-value, which initially failed because x_1 wasn't present yet. However, if this set F_c is the argument, the complete left conjunct of in the restrictor of the surface-higher *DP* in (101b) is ignored due to its situation variable being s instead of c. This holds for the outer quantifier as well. Thus, the only part of the formula that could contribute a non-empty file is the relational noun. But its translation features x_2, a variable that by assumption is not part of any domain in F_c. Thus, the whole formula is undefined for F_c. One might try again to accommodate a further parameter of the context, that this time might end up being represented by the problematic variable x_2. But because the variable doesn't come with any restriction apart from the relational noun, it isn't clear what to accommodate exactly. The only possible candidate that doesn't lead to a disastrous outcome is the actual president. But if he was made a

[50] Alternatively, one can raise the lower *DP* even higher, on top of the whole *DP*. This doesn't affect the point to be made.

further coordinate that then could be represented by x_2, it is kind of pointless to parse the surface-lower *DP* as belonging to a different layer than the other *DP*. If x_2 could be added in this fashion, the other *DP* would then become redundant.[51] This doesn't mean that this is ruled out altogether, but it is kind of unlikely. Especially if compared to the ease of the calculation of (101a) once x_2 is thought to be part of the domain of one of the assignments in F_c: once again, the outermost determiner can safely be left aside, as can be the right conjunct (both due to using s instead of c). The left conjunct, on the other hand, can be interpreted straightforwardly. Then, x_2 needs to be added to whatever file represents the "common ground". If this file values s as well, (101a) can be interpreted smoothly again. Intuitively, (101a) thus is easier in some sense than (101b).

This still doesn't rule out (101b) altogether. But if one imagines some similar formula with s in the rôle of c and some other situation variable s' in the rôle of s, namely the formulæ in (102) x_2 becomes a huge problem.

(102) a. $(\text{℩}^{s'}_{x_1})[(\text{℩}^{s}_{x_2})[Psx_2] \wedge Ws'x_2x_1]$
b. $\#(\text{℩}^{s}_{x_1})[(\text{℩}^{s'}_{x_2})[Ps'x_2] \wedge Wsx_2x_1]$

s might then be the situation variable of some matrix clause that features the embedding of another clause that makes use of s', and of which this *DP* is a part. Arguably, given the capability to introduce "fresh" variables whenever needed by employing an appropriate quantifier, the accommodation of a further coordinate comparable to accommodation in the contextual domain is strictly forbidden. If this is the case then (102b) is doomed to be undefined for any set of index-assignments that don't have x_2 in their domain, since there is no way to make it a part if the definite article is interpreted against a deeper layer. This is the case Romoli and Sudo have in mind when they formulate the first part of the *Nested DP constraint*, and this case is accounted for by this version of FCS per design. Nevertheless, there also exists a way to rescue this construction. If the file that evaluates s also has x_2 in its domain, this is enough to ensure the interpretation of the predicate. x_2 then is introduced into the domain of the file responsible for s' later on. The *DP* thus is interpreted anaphorically, as might be intended since its individual variable was already in play, but its descriptive content is evaluated against s'. This configuration was already mentioned above, repeated here for convenience:

(51) A crop duster crashed into Peter's farm. Fortunately, it caused only little damage. But he claims that the UFO destroyed half of his accommodation wing.

If this indeed is possible, then it this shows the possibility to violate the *Nested DP Constraint*. But even worse, the *DP*'s restrictor might not be integrated at all: if it reuses an individual variable already in play but contributes a "fresh" situation variable. That is, (102b) could also be the translation of a full matrix-sentence, and if the file's domain contains s and x_2, it just fails to interpret the restrictor, but this doesn't lead

[51] At least nearly redundant: The "common ground" would not only be restricted to those indices that feature the actual president in one of their coordinates, but it would further be restricted to those situations in which the actual president also is the president. This isn't guaranteed on the basis of the imported individual as such.

to undefinedness, because the formerly missing individual variable now is already there. The whole part in which the uniqueness condition comes into play is left out of the interpretation, but the sentence receives an interpretation, roughly paraphrasable as *the wife of him*.

This is hard to avoid. Ultimately, this is one consequence of the more liberal extension relation employed by the definite article. One could try to rule out using (102b) as a matrix sentence syntactically, by counting free situation variables (of the s-type) and demand that a root clause shouldn't contain more than two. It should be noted that theories working with ambiguous definite articles (see 220, especially footnote 13) don't run into these problems.

On a different note, it is of course possible to strengthen the definedness conditions (and the other values) in such a way that the restrictor is ignored together with the quantifier prefix if the file doesn't cover the prefix's situation variable. But this would mean that lexical material that is situated in a restrictor but dependent on a higher situation variable needs to be "evacuated", i.e. raised above the embedding *DP* in order to contribute to the higher layer. Such an approach must rely on movement steps that are not possible according to syntactic theory. For example, it would be impossible to interpret a *DP* inside a relative clause that is part of a restrictor of another *DP* against a higher situation variable. (56) above is a case in point:

(56) [s : Mary thinks [s' : [the unicorn that [a famous linguist]$-s$ hides from her] is beautiful]]

To derive the relevant reading in question, the whole phrase starting with *the unicorn* needs to be interpreted against the situation variable s' introduced by the attitude verb. On the strengthened account under discussion this would render *a famous linguist* inaccessible for the interpretation against the file that accounts for the matrix sentence's situation variable s if the indefinite description stays *in situ*. In order to contribute to the main layer, the structure needed would then be the following:

(103) [s : Mary thinks [s' : [a famous linguist]$_1 - s$ [the unicorn that t_1 hides from her] is beautiful]]

It is still not necessary to move the phrase into the matrix sentence and thereby cross the attitude verb to interpret it transparently, but it must be able to escape the relative clause, which also is in island. In the account represented by the interpretation rules in (87), (56) can be interpreted as is, i.e. *a famous linguist* can stay *in situ*.

Sticking to the system as defined, the implementation of *contextual import* will now be discussed. As pointed out in the discussion of (88), repeated from above, the contextually interpreted individual variable x_1 needs to find its way into the set of assignments that take care of the situation variable s in order for the formula to be defined.

(88)
a. The man [pointing] is bald.
b. $(\sqcap^{c}_{x_1})[Mcx_1] \wedge Bsx_1$

Furthermore, and also crucially, x_1 shouldn't be part of the index-representing assignment's domain before it is imported. Thus, not all possible domains to represent the context are admissible. Only those that don't make use of variables already in play are allowed to be used this way. This makes use of the fact that the "common ground", i.e. the set of index-representing assignments that also represent the state of the discourse, is carried from one evaluation of a sentence to the next, while the set of context-representing assignments is generated "on demand" so to say, for every sentence (and context) to be evaluated. Thus, F_c varies with c, the context represented, which varies constantly in the course of a conversation, for example: different participants speak, and thus, different contexts need to be invoked. But the set G transcends contextual change. It is assumed to store the course of discourse referents introduced (in its homogeneous domain) and the values that are compatible with what was contributed so far. Thus, the set of *admissible context-representing assignments* needs to respect the domain of G in the sense that it doesn't reuse variables already in play:

(104) G_c is an *admissible* representation of a context c with respect to a "common ground" G iff
$G_c = \{f \in F_c : D(f) \cap D(G) = \emptyset\}$

This just concerns individual variables, since situation variables are assumed to be distinct anyway. But, e.g., if G stores the contribution of a first person pronoun under the variable z_n, this variable isn't allowed to figure in the representation of c's speaker-coordinate in G_c.

The need for *contextual import* means that the domains of all context-representing assignments and index-representing assignments cannot stay disjoint. After checking whether the formula in question conforms to the context it is evaluated against, variables that are made use of need to be imported into G and thus, G's domain cannot be disjoint from G_c's. But this does no harm since G_c then doesn't play a rôle anymore. When its variables and values are copied, its job is done. With respect to the example (88) this means two things: (i) in order to be felicitous, x_1 cannot be part of the domain of G, because otherwise, it couldn't figure in G_c and the formula isn't interpretable. After the positive value of (88) is evaluated against G_c, x_1 together with its value has to be introduced into G in order for the predicate Bsx_1 to be defined (assuming that G indeed takes care of s). Furthermore, all other variables in the domain of any assignment in G_c should not be copied. The speaker-coordinate of c isn't relevant for the semantic value of (88), so its representation shouldn't be either; and the same holds for the addressee parameter of c as well. Fortunately, the domains of the assignments in G_c after evaluating (88) converge on the variables in fact made use of. This holds for $\mathfrak{c}$ as well as x_1, while the elements of Y and Z vary from one assignment in G_c to the other. Generally, since F_c usually is heterogeneous and thus no suitable argument for the domain function $D(\bullet)$, an auxiliary notion $D^*(F_c)$ has to be defined that gives the set of variables all assignments in F_c make use of. Since G's that represent the common ground are homogeneous, $D(G)$ can safely be replaced by $D^*(G)$ if desired to, i.e. $D^*(\bullet)$ is applicable if $D(\bullet)$ is:

(105) $D^*(G) := \bigcap_{f \in G} D(f)$

Initially, even if F_c is restricted to admissible representations, $D^*(F_c)$ is the empty set if multiple contextual cores are allowed, i.e. if the set of context variables $\mathcal{C}$ is not just a singleton. But after calculating $\|\bullet\|^+_\omega$ with respect to F_c, there possibly are variables made use of in all of the assignments in the resulting file. If not, the formula doesn't depend on the context. If there is a variable in $D^*(F_c)$ all assignments also agree on its value. This is because all assignments in F_c represent one context only and the mapping from variables to values is so rigid that there isn't any leeway.

The "common ground" G thus has to be extended by variables that are in $D^*(\|\alpha\|^+_\omega(G_c))$ before α is evaluated against G. Since G_c has to be admissible, this means that the variables G is extended by are "fresh" with respect to G. Conversely, if all variables in $D^*(\|\alpha\|^+_\omega(G_c))$ are "fresh", the set is admissible. Furthermore, the extension isn't allowed to leave the set of index-representing indices; thus the contextual core cannot be imported.

(106) $H = \text{Ci}(F_c)(G)$ is the result of importing the contextually used variables in F_c into G iff there is an $X \subseteq D^*(F_c)$ such that $X = D^*(F_c)\backslash\mathcal{C}$ and the following holds:

a. $\forall h \in H\ \exists g \in G : g \subset_X h$ and
b. $\forall v \in X\ \forall h \in H\ \forall f \in F_c : f(v) = h(v)$ and
c. $H \subseteq I$
d. H is the largest set for which all conditions hold.

Since contextual and index assignments have one situation variable in their domain each, it is clear that the whole context cannot be imported. Thus, (106) is restricted to the largest subset of "stable" variables in the set of contextual assignments, which is the set $D^*(F_c)$ without the situation variables in $\mathcal{C}$ that are reserved to represent contexts. Variables in the remaining set have to be imported. (106a) demands that the result of the import must be a strict extension of the "common ground". This by itself leads to a restriction to *admissible* contextual assignments, i.e. if one of the variables in the remaining set is already used in G, the import fails. But this condition doesn't exclude that there aren't any variables to be imported, since $g \subset_V h$ is defined as $g \subseteq_V h$ provided that $D(g) \cap V = \emptyset$, which is guaranteed if V is empty. (106b) makes sure that the imported variables have the same value in the new "common ground" as they have in the set of contextual assignments. (106c) makes sure that the result still is a set of index assignments. (106d) is necessary in order to preserve as much descendants of elements of G as possible. This condition makes sure that only those assignments in G don't find a continuation in H that don't represent an index if the contextually used variables together with their values are imported.

Putting everything together, the set of indices a sentence φ expresses in a context c, represented by a set of assignments F_c, with respect to a "common ground" G is represented by the set of assignments that is the result of the following calculation:

(107) $\|\varphi\|^+_\omega(\text{Ci}(\|\varphi\|^+_\omega(\{f \in F_c : \|\varphi\|^d_\omega(\{f\}) = f\}))(G)),$

provided that the d-value of φ for this argument isn't empty for the argument of its positive value in (107). The individual parts of (107) are collected from the present section:

1. $\{f \in F_c : \|\varphi\|^d_\omega(\{f\}) = f\}$ is the set of context assignments that survive the check for definedness without accommodating any variable.
2. $\|\varphi\|^+_\omega(\{f \in F_c : \|\varphi\|^d_\omega(\{f\}) = f\})$ either is the same set as in 1., if the context-dependent part of φ is indeed true at the context, otherwise, it is the empty set, which renders all further calculations pointless. Thus, if the sentence is used infelicituously, it is felt at this point.
3. $\textsc{Ci}(\|\varphi\|^+_\omega(\{f \in F_c : \|\varphi\|^d_\omega(\{f\}) = f\}))(G)$ is the result of importing the variables in the stable part into the common ground.
4. $\{g \in \textsc{Ci}(\|\varphi\|^+_\omega(\{f \in F_c : \|\varphi\|^d_\omega(\{f\}) = f\}))(G) : \|\varphi\|^d_\omega(\{g\}) \neq \emptyset\}$ is the check for successful assignments in this set left out in the formulation in (107).
5. $\|\varphi\|^+_\omega(\{g \in \textsc{Ci}(\|\varphi\|^+_\omega(\{f \in F_c : \|\varphi\|^d_\omega(\{f\}) = f\}))(G) : \|\varphi\|^d_\omega(\{g\}) \neq \emptyset\})$ is the application of the positive value of the sentence to the set of assignments that pass the definedness-test in 4., if there are any.

But all of this is not enough to account for the following difference:

(108) a. She is in tears.
b. SHE is in tears.

Intuitively, under this intonation (capital letters mark stress), (108b) should feature a demonstratively used pronoun, while (108a) contains an anaphorically used one. (108a) is correctly derived if the pronoun is translated by a variable that is in the domain of the "common ground". But (108b) still isn't accounted for. This is due to the fact that single variables are not marked for context-dependency, or more generally, they aren't relativized to any situation variable. Thus, a translation of (108b) that is in line with the way natural language sentences were rendered in FCS up to this point is something like the following:

(109) Tsx_{23}

But a translation of (108a) would look the same (or be very similar up to the variables used). Thus, (108a) and (108b) aren't distinguishable in the present version of FCS. Furthermore, evaluating (109) against a set of assignments representing a demonstrative context doesn't help either, since the only situation variable that is present is not covered by this set per definition. There are in fact two problems with (109): The first is that the pronoun cannot receive a contextual interpretation and the second is that a formula like this comes out as undefined for any set of contextual assignments because it doesn't come with a situation variable. Thus, if (109) is understood as a translation of (108a), the "common ground" should be enough to interpret it, but it isn't because the calculation doesn't make it past step 2. This second problem can be circumvented by making an element of $\mathcal{C}$ appear in every formula, even if it doesn't contribute anything or doesn't restrict a predicate. This is done below. To be clear, it is not correct to simply translate (108b) by just using $\mathcal{c}$ in place of $\mathcal{s}$ in (109). This translation would also create the need to check the predicate against the context, which shouldn't be required, and, furthermore, the formula wouldn't be defined for any index-representing file, since it then wouldn't contain any element of $\mathcal{S}$ anymore. The moral to be drawn thus is that both kinds of situation variables need to be present in any translation to yield the intuitively correct results. Furthermore, ultimately a difference between (109a) and (109b) is acknowledged in the sense that they will be differences in their translations. This is also implemented in the next section.

4.2.4 Translations

To describe the distribution of terms in the formulæ of FCS, one can avail oneself of the machinery of true variables, abstraction and application. This is why the formulæ in (87) were relativized to an assignment function ω that didn't have anything to do up to now. To avoid confusions, these true variables are denoted by boldface variables, e.g. $\mathbf{x}$, $\mathbf{y}$, etc. ω takes care of these and not of the variables x_i, $\mathcal{s}$, $\mathcal{c}$, etc. that are already part of FCS. The values of the latter variables depend on the files, while boldface variables depend on ω alone. Thus, all formuæ introduced so far are, in a sense, *constants*, since they don't depend on ω. But soon it will be possible to abstract away from certain parts. The interpretation rules for the additional material are parallel for all three kinds of values. They are thus given in schematic form:

(87) g. $\|\mathbf{x}\|^{\bullet}_{\omega}(G) \;=\; \omega(\mathbf{x})(G)$

h. $\|\alpha(\beta)\|^{\bullet}_{\omega}(G) \;=\; \|\alpha\|^{\bullet}_{\omega}(\|\beta\|^{\bullet}_{\omega})(G)$

i. $\|(\lambda\mathbf{x}.\alpha)\|^{\bullet}_{\omega}(u)(G) \;=\; \|\alpha\|^{\bullet}_{\omega[\mathbf{x}/u]}(G)$

The only rule that needs to be changed is the rule for atomic sentences, repeated below, which is abandoned in favor of a new interpretation rule for predicate constants (where β', as before, is a set of tuples of $LS \times D^n$, or a set of indices in which the individuals stand in the relation expressed in the situation in 0th position. Note further that the reformulation also doesn't make active use of ω at any point):

(87)

b. For any predicate with arity n, with $\upsilon_0, \ldots, \upsilon_n \in T$:

$$\begin{aligned}
\|\beta\upsilon_0 \ldots \upsilon_n\|^{d}_{\omega}(G) &= [\upsilon_0]^{d}_{\omega}(G) \cap \ldots \cap [\upsilon_n]^{d}_{\omega}(G) \\
\|\beta\upsilon_0 \ldots \upsilon_n\|^{+}_{\omega}(G) &= \underline{\{g \in G : \langle \|\upsilon_0\|^{+}_{\omega}(G)(g), \ldots, \|\upsilon_n\|^{+}_{\omega}(G)(g)\rangle \in \beta'\}} \\
&\cup\ \|\beta\upsilon_0 \ldots \upsilon_n\|^{d}_{\omega}(G) \\
\|\beta\upsilon_0 \ldots \upsilon_n\|^{-}_{\omega}(G) &= \underline{\{g \in G : \langle \|\upsilon_0\|^{-}_{\omega}(G)(g), \ldots, \|\upsilon_n\|^{-}_{\omega}(G)(g)\rangle \notin \beta'\}} \\
&\cup\ \|\beta\upsilon_0 \ldots \upsilon_n\|^{d}_{\omega}(G)
\end{aligned}$$

b′. For any predicate with arity n, with $\tau_0 \in D_{\mathbf{s}}$ and $\tau_1, \ldots, \tau_n \in D_{\mathbf{e}}$:

$$\begin{array}{rcl}
\|\beta\|^d_\omega(\tau_0)\dots(\tau_n)(G) & = & \{g \in G : \tau_0(G)(g) \neq \#\} \cap \dots \cap \\
 & & \{g \in G : \tau_n(G)(g) \neq \#\} \\
\|\beta\|^+_\omega(\tau_0)\dots(\tau_n)(G) & = & \{g \in G : \langle \tau_0(G)(g), \dots, \tau_n(G)(g)\rangle \in \beta'\} \\
 & \cup & \overline{\|\beta\|^d_\omega(\tau_0)\dots(\tau_n)(G)} \\
\|\beta\|^-_\omega(\tau_0)\dots(\tau_n)(G) & = & \{g \in G : \langle \tau_0(G)(g), \dots, \tau_n(G)(g)\rangle \notin \beta'\} \\
 & \cup & \overline{\|\beta\|^d_\omega(\tau_0)\dots(\tau_n)(G)}
\end{array}$$

$D_{\mathbf{e}}$ is understood as the domain the non-boldface variables are mapped onto by $\|\varphi\|^\bullet_\omega$. That is, $D_{\mathbf{e}}$ is the set of functions from files into the set of functions from assignments into individuals. The type $\mathbf{e}$ is understood as hiding all references to assignment functions in the way of, e.g. the types Muskens (1996) assigns to formulæ are hidden in Brasoveanu (2008) or Kobele (2010), to name just some examples. To be more concrete, if π is the type assigned to those assignments that are collected in files (not ω), then the type of (non-boldface) variables would be $\langle\langle\pi, t\rangle, \langle\pi, e\rangle\rangle$.[52] Of course, $\mathbf{e} \neq e$, since $\mathbf{e}$ is supposed to abbreviate the complex type in which e occurs. Thus, $D_{\mathbf{e}}$ hosts no individuals simpliciter, even though it is the domain individual constants are mapped to. One "reaches" the individuals of type e only when the terms of type $D_{\mathbf{e}}$ are properly embedded; e.g. as arguments of a predicate.[53] Similar remarks hold for situation variables, which are mapped onto $D_{\mathbf{s}}$, and the newly introduced predicates, which in this system are functions of types $\langle\mathbf{s}, \langle\mathbf{e}^n, \mathbf{t}\rangle\rangle$ (for $n > 0$), where n depends on the arity of the predicate in question.

In this sense, the newly introduced boldface variables can be typed in the usual way: boldface individual variables ($\mathbf{x}$, $\mathbf{y}$, ...) are of type $\mathbf{e}$, boldface situation variables ($\mathbf{s}$, $\mathbf{s}'$, ...) are of type $\mathbf{s}$, boldface predicate variables ($\mathbf{P}$, $\mathbf{Q}$, ...) of type $\langle\mathbf{s}, \langle\mathbf{e}, \mathbf{t}\rangle\rangle$, etc.

For this to work, the syntax of FCS of course has to be extended by the newly introduced variables, the application structure and λ-terms. For the following, this is tacitly assumed to have happened. The inductive definition of the set of free boldface variables in a formula α is straightforward:[54]

[52]Muskens (1996) uses the type s for $\langle\pi, t\rangle$, so his type for discourse referents is $\langle s, \langle\pi, e\rangle\rangle$, which looks more like an individual concept.

[53]Thus, in a sense, the final version of FCS is very Russellian in nature, compare his remarks on denoting expressions:

> "This is the principle of the theory of denoting I wish to advocate: that denoting phrases never have any meaning in themselves, but that every proposition in whose verbal expression they occur has a meaning." (Russell, 1905, p. 480)

[54]One caveat concerns negation. Below, it is argued that the negation sign shouldn't "choose" the layer it is interpreted at as freely as the definite and the indefinite article. Thus, for it to necessarily being bound by the most local antecedent, it must be possible to abstract from the position occupied by v as well.

(110)

α	$F(\alpha)$
x_n	$\emptyset$
β	$\emptyset$
$\varphi \wedge \psi$	$F(\varphi) \cup F(\psi)$
$-^{\upsilon}\varphi$	$F(\varphi)$
$(\exists^{\upsilon_1}_{\upsilon_2})[\varphi]$	$F(\varphi)$
$(\text{Ↄ}^{\upsilon_1}_{\upsilon_2})[\varphi]$	$F(\varphi)$
$\mathbf{x}$	$\{\mathbf{x}\}$
$\beta(\chi)$	$F(\beta) \cup F(\chi)$
$(\lambda\mathbf{x}.\beta)$	$F(\beta)\backslash\{\mathbf{x}\}$

What is also shown straightforwardly by induction over the complexity of formulæ is that if two assignment functions ω and ω' agree on all elements of $F(\alpha)$ of some formula α then all of α's values with respect to ω and ω' coincide, i.e.:

(111) *Coincidence Lemma*:
For all assignments ω and ω'. If $\omega(\mathbf{x}) = \omega'(\mathbf{x})$ for all $\mathbf{x} \in F(\alpha)$, then $\|\alpha\|^{\bullet}_{\omega} = \|\alpha\|^{\bullet}_{\omega'}$.

In order to formulate the *Substitution Lemma* as well, one needs the notion of *freedom for substitution*. Intuitively, a term β may be substituted for free variable $\mathbf{x}$ in a formula α (of the same boldface type), if no free variable in β gets bound when it lands in α. For example, if β is a variable itself, e.g. $\mathbf{y}$, it shouldn't land in the scope of a $\lambda\mathbf{y}$-prefix. *Mutatis mutandis*, the same holds for all free variables inside of β, if β is more complex.

(112) A variable term β is free for substitution for a $\mathbf{x}$ of the same type in an expression α iff α hosts no term of the form $(\lambda\mathbf{z}.\gamma)$ with $\mathbf{x} \in F(\gamma)$, for all $\mathbf{z} \in F(\alpha)$.

With the help of this notion, substitutivity can be defined:

(113) *Substitution Lemma*:
If β is a term that is free for the substitution for a variable $\mathbf{x}$ in a formula α, then for all assignments ω, if $\|\mathbf{x}\|^{\bullet}_{\omega} = \|\beta\|^{\bullet}_{\omega}$, then $\|\alpha\|^{\bullet}_{\omega} = \|\alpha[{}^{\mathbf{x}}/_{\beta}]\|^{\bullet}_{\omega}$.

As is well known, these ingredients are enough to show that α- and β-conversion are available. E.g., if $\mathbf{x}$ is free for substitution by $\mathbf{y}$ in α, (114a) holds generally; and if $\mathbf{x}$ is free for substitution by β in α, (114b) holds as well:

(114) a. $\|(\lambda\mathbf{x}.\alpha)\|^{\bullet}_{\omega} = \|(\lambda\mathbf{y}.\alpha[{}^{\mathbf{x}}/_{\mathbf{y}}])\|^{\bullet}_{\omega}$ α-conversion
b. $\|(\lambda\mathbf{x}.\alpha)(\beta)\|^{\bullet}_{\omega} = \|\alpha[{}^{\mathbf{x}}/_{\beta}]\|^{\bullet}_{\omega}$ β-conversion

The proofs are all omitted here, because they are fairly straightforward and pretty standard. This is so because the extra machinery that allows for modeling context-dependency and anaphoric relationships does in no way interfere with boldface variables and the notions connected to them. This is because the way the interpretation of boldface variables, boldface abstraction, and application are put, they apply to formulæ before their denotation is evaluated against a file. The formulæ are thus "dynamically closed", if one wishes to put it like this.

The availability of β-reduction or λ-conversion opens up the possibility to state a fairly standard translation procedure from natural language expressions into FCS. E.g., intransitive and transitive verbs as well as nouns can be translated as follows. Of course, S, H, and D have to be assumed to receive the intended interpretation.

(115) a. $|\text{sleep}|^{c} = \lambda\mathbf{s}.\lambda\mathbf{x}.S(\mathbf{s})(\mathbf{x})$
b. $|\text{hit}|^{c} = \lambda\mathbf{s}.\lambda\mathbf{y}.\lambda\mathbf{x}.H(\mathbf{s})(\mathbf{x})(\mathbf{y})$
c. $|\text{dog}|^{c} = \lambda\mathbf{s}.\lambda\mathbf{x}.D(\mathbf{s})(\mathbf{x})$

The translations are all relativized to a contextual-core variable $\mathfrak{c}$. This is because otherwise, one would describe the composition of formulæ on the level of character. This wouldn't be monstrous *per se*. Only if it could be shown that the invocation of characters is necessary, i.e., if characterial composition wouldn't be a pointwise generalization of intensional (or even extensional) composition (cf. T. E. Zimmermann, 2012b, especially p. 2383).

Extensional compositionality is not easy to represent in this system. This is because the files now host situation variables as well. What would correspond to the composition of extensions is not the evaluation against every single assignment in a file separately. This is more fine-grained than extensional composition, because different indices still feature the same situational core and should thus count as representing the same situation. One would have to partition files into sets of assignments that value the situational core alike. Thus, going extensional wouldn't change that much in the sense that one would still have to work with sets of assignments. So it is easier to work with intensions from the get-go, which under this perspective amounts to the joint calculation of all extensions. Thus, extensional composition is sacrificed for the greater good, so to speak.

The indefinite and the definite article can be given the following translations, which are pretty close to the (static) orthodoxy:

(116) a. $|\text{a(n)}^{n}_{m}|^{c} = \lambda\mathbf{s}.\lambda\mathbf{Q}.\lambda\mathbf{P}.(\exists^{\upsilon_n}_{x_m})[\mathbf{Q}(\upsilon_n)(x_m)] \wedge \mathbf{P}(\mathbf{s})(x_m)$
b. $|\text{the}^{n}_{m}|^{c} = \lambda\mathbf{s}.\lambda\mathbf{Q}.\lambda\mathbf{P}.(\text{ᗡ}^{\upsilon_n}_{x_m})[\mathbf{Q}(\upsilon_n)(x_m)] \wedge \mathbf{P}(\mathbf{s})(x_m)$

As can be seen, there is an asymmetry between restrictor and nuclear scope: whereas both are calculated from the intension of the noun and predicate respectively, the intension of the noun is applied to the situation variables the article brings into the derivation. This is comparable to the accounts in Büring (2004) and Schwarz (2009) and Schwarz (2012), where situation variables (or "situation pronouns") are syntactically realized sisters of determiners. Here, there simply is another index on the article,[55] a superscript to be precise, that is translated into a situation variable υ that either stands for a contextual situation variable (for odd n) or an index situation variable (for even n; if only one

[55] Since indices are thus understood to be part of the expressions that are translated, Binding Theory as discussed in section 3.5 doesn't need to apply to formulæ of FCS, but can deal with the expressions directly. This frees the formal language from the burden of accounting for the Ban on Conindexation.

contextual situation variable is admitted, the coding could be different: υ_0 could then translate as c and all other numerical indices as s with $n-1$ '′' attached to them). This difference is only cosmetic in nature. But note that there is no need to introduce binders for situational pronouns to derive attributive, or generally, integrated readings, as it is necessary in the accounts mentioned. This is because the matrix clause has to be interpreted against a free situation variable as well, and the attributive reading necessarily results if it is the same as the one introduced by a determiner. Thus, if a determiner introduces a different situation variable, then it is either understood as context dependent, or the whole clause must be embedded in order for the determiner to contribute anything at all. As can be imagined, the composition of an article and a noun as well as the composition of the resulting quantifier with a verb phrase has to deal with the $\lambda\mathbf{s}$-prefix the translations start with. This can be done by the pointwise generalization of extensional composition, i.e. (using D as the category of articles, Q for quantifiers, N for nouns, and P for intransitive predicates), expressing more clearly that it is just the "extension" that matters:

(117) a. $|D\ N|^c = \lambda\mathbf{s}.|D|^c(\mathbf{s})(|N|^c)$
b. $|Q\ P|^c = \lambda\mathbf{s}.|Q|^c(\mathbf{s})(|P|^c)$

With the help of these translations, one can describe the composition of a sentence like (118) (disregarding tense, of course):

(118) The^1_2 dog slept.

The result of this little exercise is the following λ-term:

(119) $\lambda\mathbf{s}.(\sqsupset^{s_1}_{x_2})[D(s_1)(x_2)] \wedge S(\mathbf{s})(x_2)$

(119) is not a self-standing sentence, yet. There is one further argument position to take care of, signaled by the λ-abstract. If (118) was embedded under an attitude verb or a comparable expression, this would be the slot this operator uses to insert its situation variable. Thus, the system of translations and rules of composition capture the spirit behind Percus's *Generalization X*, repeated from above:

(41) *Generalization X* (Percus, 2000, p. 201)
The situation pronoun that a verb selects for must be coindexed with the nearest λ above it.

Percus's other generalizations can be accounted for in the same fashion. This also holds for Keshet's *Intersective Predicate Generalization.* All one needs to do is describe the composition of the expressions involved in terms of their translations, utilizing $\lambda\mathbf{s}$-prefixes to ensure the correct distribution. This an advantage of having situation variables available that is shared with accounts likes Schwarz's. This is not done here. The upshot of the present account is that only some expressions are allowed to freely introduce situation variables that are fed to their respective restrictors. All other expressions behave "static" in the sense that the composition unambiguously makes sure which free (non-boldface) situation variable they are relativized against. This lack of flexibility should be extended to the negation sign in (87) as well. Negation doesn't seem to be able to choose the layer on which it exerts its forces; it is grammatically determined to do it on the most local layer possible. Thus, as in the reformulation of the interpretation of atomic sentences into an interpretation rule for predicates, the negation sign in (87) needs to be a function from some term τ_0 into the very same clauses given there, whereas τ_0 plays the rôle υ plays in the actual interpretation. Then, τ_0 is available for abstraction, and the whole relativization to τ_0 is turned into a relativization to whatever variable is fed to the respective $\lambda\mathbf{s}$-term that binds into the relevant position. If adapted along these lines, negation behaves as any other modifier built and thus, is subject to *Generalization Y* as well.[56]

Proceeding in the way indicated captures all generalizations in spirit, not in letter, because the $\lambda\mathbf{s}$-prefixes involved need to be done away with in order to let the file-based interpretation process work out (118)'s intension. Thus, there needs to be some further operator that contributes a variable the λ-term can be applied to. On this occasion, one of the problems discussed at the very end of section 4.2.3 can be solved as well. As it turned out, all formulæ not containing a contextual situation variable are undefined for any set of context-representing assignments F_c. But the definedness criterion demands a non-empty subset of F_c to "survive" this procedure for the sentence to be felicitous. Thus, all relevant formulæ have to contain at least one context-dependent element. This can be attributed to the same operator that needs to provide a situation variable to turn (119) into a self-standing sentence. All that is takes is a 'dummy' predicate of situation variables that is fulfilled by any situation whatsoever. If this predicate is written $\top$ the closure operator needed can be understood as the contribution of the *root*-property of the matrix clause:

(120) $|\textsc{Root}^n|^c = \lambda\mathbf{p}.\top(c) \wedge \mathbf{p}(\upsilon_n)$ with $\mathbf{p}$ of type $\langle\mathbf{s},\mathbf{t}\rangle$, for even n only

As can be seen, (120) is designed to take (119) as argument which leads to υ_n being

[56] This is especially important for definitions like (254), (269), and (271) (on pages 193 and 196) in section 3.4.3, repeated here for convenience:

(254) $-((\exists x)[\varphi] \wedge -\psi)$

(269) $-((\exists x)[\varphi] \wedge \psi)$

(271) $-(-\varphi \wedge -\psi)$

To preserve these definitions, one has to make sure that all non-lexical material is situated on the same layer, namely on the most local one. Thus, all three negation signs in (271) have to come with the same situation variable, which is guaranteed by the adaptions just mentioned. But the same needs to hold for the existential quantifier in (254) and (269) as well. Thus, in order to make these formulations work as well, one has to assume that their situation variable can also be determined locally. But even this doesn't mean that the present account has to acknowledge an ambiguity of at least the existential quantifier, because these clauses can be introduced as abbreviations. That is, (254) contributes a formula in which the situation variables are distributed exactly as one wants them to be.

inserted in all positions occupied by **s**. Furthermore, (120) contains a conjunct that makes use of the contextual situation variable c, giving F_c something to bite on, as desired. ROOT can be understood as the syntactic embodiment of the presumption that the sentence it is a part of has something to say about the actual context and the "common ground" in use. But this only then is the case if the s-variable chosen indeed is taken care of. If not, but other s-variables introduced by articles are, the "common ground" is updated by random *DP* interpretations without verbal contributions. Some "pre-established harmony" is required. Since the distribution of ROOT is predictable—it occurs only once per sentence, always on top of it—it can be made another constant in (87) that doesn't allow files that come with different situation variables than the ones it contributes to look into its complement. This operator only allows two kinds of files to continue and doesn't add the *anti-domain* if confronted with a different kind:

$$(121)\qquad \begin{array}{rcl} \|(Я^{\upsilon_n,\upsilon_m})[\varphi]\|^d_\omega & = & \|\varphi\|^d_\omega([\upsilon_n]^d_\omega(G) \cup [\upsilon_m]^d_\omega(G)) \\ \|(Я^{\upsilon_n,\upsilon_m})[\varphi]\|^+_\omega & = & \|\varphi\|^+_\omega([\upsilon_n]^d_\omega(G) \cup [\upsilon_m]^d_\omega(G)) \\ \|(Я^{\upsilon_n,\upsilon_m}[\varphi])\|^-_\omega & = & \|\varphi\|^-_\omega([\upsilon_n]^d_\omega(G) \cup [\upsilon_m]^d_\omega(G)) \end{array}$$

The translation (120) then has to be changed accordingly:

$$(122)\qquad |\text{ROOT}^n|^c = \lambda\mathbf{p}.\top(c) \wedge (Я^{c,\upsilon_n})[\mathbf{p}(\upsilon_n)]$$

Thus, if a Я-headed formula is evaluated against a file that doesn't take care of either of the variables, both $[\upsilon_n]^d_\omega(G)$ and $[\upsilon_m]^d_\omega(G)$ are empty and the formula isn't defined for said file. This doesn't guarantee definedness of a formula for every "common ground", but it doesn't allow parts of its constituent sentences to modify the file on their own if undefinedness should arise. Another possibility, not pursued any further here, consists in a modification of the "common ground" so that it fits the situational requirement. If G is such a file that has s in its domain but a sentence headed by ROOT asks to be interpreted against s', one could generate another file G' that is exactly as G in terms of indices represented, but has s' in its domain. This operation is kind of the reverse of an x-variant in predicate logic in that it preserves all values but substitutes a variable name. A solution like this might even be more adequate, because there don't seem to be any cases where communication breaks down because some or all participants aren't able to parse a sentence in such a way that it is interpretable against their common ground. But technically, these two solutions come down to the same.

The conjunct with the "dummy" predicate in (122) is only there to ensure that there is at least one atomic sentence that depends on c. It has no influence on the truth conditions expressed, but on the definedness conditions. This very same trick can be used to formulate the translations of first and second person pronoun. In section 4.1.2 it was established that *I* and *you* have to be translated by different variables, and that both need to differ from the x_i-variables used by 3rd person expressions. But, because of contextual import, it isn't possible to restrict these variables to contextual uses only. They inevitably are introduced into the domain of the "common ground" if the procedure established at the end of section 4.2.3 is in force. Thus, z_n (as translation of *I*) or y_n

(as the translation of *you*) aren't "recognized" as context-dependent when embedded in formulæ like the following:

(123) a. Tsz_1
b. Tsy_{231}

This is exactly the same problem as discussed for demonstratively used 3rd person pronouns, cf. (109), repeated from above:

(109) Tsx_{23}

Thus, context-dependent pronouns have to be marked as such. This can be done in the same fashion as in the ROOT-clause. One needs another "dummy-predicate" $\top$ that holds of all situations and individuals, but then one can use the following translations:

(124) a. $|\mathrm{I}_m|^c = \lambda\mathbf{s}.\lambda\mathbf{P}.\top(\mathfrak{c})(z_m) \wedge \mathbf{P}(\mathbf{s})(z_m)$
b. $|\mathrm{you}_m|^c = \lambda\mathbf{s}.\lambda\mathbf{P}.\top(\mathfrak{c})(y_m) \wedge \mathbf{P}(\mathbf{s})(y_m)$
c. $|\mathrm{SHE}_m|^c = \lambda\mathbf{s}.\lambda\mathbf{P}.\top(\mathfrak{c})(x_m) \wedge \mathbf{P}(\mathbf{s})(x_m)$

The latter translation can be decomposed into the "normal" contribution of a 3rd person pronoun and a tailor-made *dthat* operator, that combines with the pronoun to form a quantifier like the ones in (124):

(125) a. $|\mathit{dthat}|^c = \lambda\mathbf{x}.\lambda\mathbf{s}.\lambda\mathbf{P}.\top(\mathfrak{c})(\mathbf{x}) \wedge \mathbf{P}(\mathbf{s})(\mathbf{x})$
b. $|\mathrm{he/she/it}_m|^c = x_m$

Thus, demonstratively used personal pronouns aren't exactly translated as their anaphoric cousins, but they are derived from them.

The *dthat*-operator in (125a) is not able to combine with definite descriptions to derive their demonstrative uses in the same way. But this is not necessarily a bad thing, since there are other means to achieve this. One consists in using modifiers like *present* or *actual* on the noun. These shift the situation the noun depends on from the index to the context, which translates into the present account schematically in the following way:

(126) $|\mathrm{actual}|^c = \lambda\mathbf{P}.\lambda\mathbf{s}.\lambda\mathbf{x}.\ldots \wedge \mathbf{P}(\mathfrak{c})(\mathbf{x})$

If one abstracts away from the fact that *actual* should only shift the world-component of the index even in its situation-based form,[57] this is what happens: the predicate gets fed the contextual situation variable, while (126)'s own index-situational λ-term binds vacuously. This makes an *actual*-modified noun compatible with an article, but the article's freely chosen situation variable doesn't trickle down anymore, because the slot it is supposed to land in is already occupied by $\mathfrak{c}$. If a translation of the definite article takes such a complex noun as argument, its restrictor has to be evaluated against a set of context-representing assignments. But this doesn't necessarily mean that the

[57]What has to go on is supposed to be hidden behind '...'. Stating what *actual* does of course is way more transparent when the index and thus the assignments are decomposed. This is too much to ask for at the moment. Cf. the brief remarks in section 5.3.

definite itself is translated as making use of the same variable as its restrictor. Thus, a configuration like the following could arise (where AP abbreviates *actual president*):

(127) $(\text{℩}^{\mathscr{s}}_{x_1})[APcx_1]$

Unfortunately, (127) again makes it through when its d-value is evaluated at F_c, the set of assignments representing a context c. Even though the article comes with an $\mathscr{s}$ variable, the d-value of its restrictor is evaluated against F_c again, as the clause in (87) demands. This makes x_1 a parameter of the context, that then gets introduced into the "common ground's" (G) domain by contextual import. If this domain already hosts x_1, undefinedness arises. But even if it doesn't, G cannot deal with (127) appropriately: it has to have $\mathscr{s}$ in its domain (given ROOT), so the d-value of the restrictor is evaluated against G. This doesn't work because G doesn't take care of $\mathscr{c}$; thus, the procedure returns the empty set. But the interpretation procedure knows an alternative route, namely evaluating the restrictors d-value against $\overline{[\mathscr{s}]^d_\omega(G)}$. But this set again is empty, because G has to cover $\mathscr{s}$. In other words, with respect to any pair of sets of context- and index-assignments, (127) cannot be defined. The only actual parse that makes it through is the desired one, namely:

(128) $(\text{℩}^{\mathscr{c}}_{x_1})[APcx_1]$

To put this long story short, modification of the noun forces the article to choose its situation variable accordingly. Thus, a *dthat*-operator for definites isn't required.

Finally, note that it is now possible to implement reflexive and possessive pronouns as envisioned in sections 3.1.2, 3.4.2, and 3.5. Possessives have to come in two varieties, as was stated in (223) in the latter section, repeated here as (129), while reflexives need identity between discourse referents (see footnote 139 on page 199, section 3.5):

(129) a. $\lambda S.\lambda R.\lambda y.(\text{℩}^*x_2)[Ssyx_2] \wedge Rsyx_2$
b. $\lambda S.\lambda R.\lambda y.(\text{℩}^*x_2)[Ssx_nx_2] \wedge Rsyx_2$

(130) $\lambda R.\lambda x.(\exists x_i)[Rxx_i \ \& \ x = x_i]$

It should be kept in mind that this is mostly pseudo-notation. ℩^* is like ℩, except that its extension relation wasn't $\subseteq_V$, but $\subset_V$. If such a quantifier is added to (87), and the rather vague OF-relation is introduced too, (129) becomes (131). Furthermore, once at least identity between objects of type $\mathbf{e}$ is available, (130) can easily be expressed as well.

(131) a. $\lambda\mathbf{s}.\lambda\mathbf{S}.\lambda\mathbf{R}.\lambda\mathbf{x}.(\text{℩}^{*,\upsilon_n}_{x_2})[\mathbf{S}(\upsilon_n)(\mathbf{x})(x_2)] \wedge \mathbf{R}(\mathbf{s})(\upsilon_n)(\mathbf{x})(x_2)$
b. $\lambda\mathbf{s}.\lambda\mathbf{S}.\lambda\mathbf{R}.\lambda\mathbf{x}.(\text{℩}^{*,\upsilon_n}_{x_2})[\mathbf{S}(\upsilon_n)(x_n)(x_2)] \wedge \mathbf{R}(\mathbf{s})(\upsilon_n)(\mathbf{x})(x_2)$

(132) $\lambda\mathbf{R}.\lambda\mathbf{x}.(\exists^{\upsilon_n}_{x_n})[\mathbf{x} =_{\upsilon_n} x_n] \wedge \mathbf{R}(\mathbf{s})(\mathbf{x})(x_n)$

Once again (cf. footnote 56) it may be better to suppress the ability of the quantifiers to introduce situation variables on their own and force them to pass down whatever they receive through the $\lambda\mathbf{s}$-canal. This may be justified on the grounds that ℩^* is not intended to translate a particular expression, but serves as a means to describe the truth conditions correctly. Note further that the identity relation in (132) has to come with a situational argument as well. This is not because its meaning is claimed to depend on a situation, but for a similar reason the 'dummy'-predicate $\top$ was introduced: without situational core $x_m = x_n$ would come out as employing context-dependent variables, since any F_c makes use of all possible domains. The details of implementation are spared out. This is because there are quite some issues connected especially with possessives. A more comprehensive discussion of possessives in FCS has to await another occasion.

This basically concludes the discussion of context-dependency. Apart from some brief remarks in section 5.1, the contextual dimension doesn't play a rôle anymore. What the following section attempts to do is to find a way to implement attitude verbs in the present system. This basically is in order to show that the basic system outlined in this section is also able to deal with the *index-index* interactions reviewed in section 4.1.4 apart from the distribution of the situation variable. Furthermore, the following section in the end illustrates in which sense pronouns are generally bound when embedded under attitude verbs, and thus behave as index-parameters in the sense of Lewis.

4.3 Attitudes towards indices

4.3.1 Representation vs. Content

In a sense, the meaningfulness of variables is an unwanted feature of the general system. That is, they are just meant to provide addresses under which the information expressed by certain expressions is stored. This bookkeeping device definitely isn't immaterial in the sense that it can be suspended with, since simpler systems cannot account for anaphoricity, especially across sentences. But the addresses an interpreter *in fact* uses when engaged in conversation may differ from those used by a different participant. As long as the sentences are alphabetic variants of each other (i.e. the same expressions *modulo* the variables used) such that one can be obtained via a process of substitutions from the other, they come down to the same indices. That is, how they are represented doesn't matter that much and ultimately shouldn't, simply because variables aren't overt expressions. Thus, given a next to empty common ground to start with, it doesn't matter whether one interpreter *parses* a sentence like (133) as in (133a) or (133b), as long as she sticks to her use of variables throughout the conversation:

(133) A girl is laughing.
  a. $(\exists x_{23})[Gsx_{23}] \wedge Lsx_{23}$
  b. $(\exists x_{123})[Gsx_{23}] \wedge Lsx_{123}$

This means that once an interpreter decides to parse (133) as (133b), she should parse (134) as (134a):

(134) She is in tears.
  a. Tsx_{23}

b. Tsx_{123}

Participants in a conversation are usually conceived of as being committed to a certain *content*, e.g. when they assert something like (133) and follow up with (134), they are held responsible for the truth conditions of the proposition expressed. But they can't be held responsible for a particular *representation* of said content. Thus, they are committed to sets of indices and not sets of assignments.

This is important when it comes to the interpretation of attitude ascriptions, especially if they are interpreted *de re*. Likewise, an individual is said to entertain a certain attitude towards the *content* of the embedded sentence, not towards a *representation* of its content. And the attitude itself needs to be defined in terms of contents (indices) and not representations (assignments), even though accounting for anaphoricity necessitates working with the latter instead of the former.[58] For the sake of argument, assume that a participant in a conversation in which (133) and (134) (in either variant) were used ascribes the following belief to Fred, who in turn is not present in the conversation:

(135) Fred thinks she is in love with him.

Certainly, it is way to strong to ascribe a belief about the variable name x_{23} (or x_{123} for that matter) to Fred, since this variable name only is restricted by its use in the conversation he doesn't participate in. What needs to be ascribed is a belief about the value of the variable, or, more precisely, who Fred thinks is in love with him needs to be successfully connected to the value of the variable for the ascription to be true. And this means that whatever is needed in order to implement a current theory of *de re* belief, it has to be implemented on the level of content, and not on the level of representation.[59]

That being said, it is by no means easy to work with full indices in a satisfactory manner. It is, for example, quite difficult to state the criterion that collects an index σ in the doxastic perspective of an attitude holder. Assume for the sake of argument that for some reason, it is clear that the subject of an attitude α in a situation s counts σ in.

[58] The claim that discourse referents bear no "cognitive significance" that is put forth in T. E. Zimmermann (1999) means that switching from sets of situations to sets of indices to model the content of beliefs is unjustified. Roughly, one does not need to work with indices simply because the corresponding set of situations in the sense of section 3.2.3 does the same job. See Spohn (2008) for a discussion.

[59] Somewhat relatedly, Geurts in talking about a DRS φ that represents an attitude ascription points out the following:

"In its entirety, [φ] represents the commitment slate of a given speaker [...], while its embedded DRSs represent the doxastic context of somebody else, viz. *A*. So we shouldn't even require that the information in these DRSs be consistent with the information contained in the main DRS." (Geurts, 1998, p. 573)

He later adds that in

"an important sense, *everything* that is contained in a DRS φ represents information that the speaker is responsible for. [...] It is the speaker who selects the linguistic means for characterizing a subject's beliefs, and in particular it is the speaker who chooses between presuppositional and non-presuppositional devices." (Geurts, 1998, p. 581)

The point made above is roughly the same, but with respect to variables instead of presuppositional devices.

Does this mean that α also counts in σ^-, which is like σ except that the last coordinate is absent? The same question also arises for some other index σ^+, which is like σ except it comes with a further coordinate. Even worse, this coordinate could be occupied by an individual that already figures in σ, but it could also be new. But does this mean that σ is the same index as σ^+? Or is it a different one? Are the indices compatible in any sense?

All of these questions are tough to answer. This is because neither the length nor the order of the coordinates is in any way restricted. Some criterion needs to be found such that the number of indices (and possibly their order) in an individual's perspective is in some way reduced. This issue is briefly discussed once again in section 4.3.4, but ultimately, no index-based account of attitudes is developed.

Having this out of the way, it is now possible to start reviewing the ideas found in the literature. The next section starts with a brief discussion of the accounts of Hintikka, Kaplan and Lewis in terms of structure. What is meant by this is that if these accounts are translated into a theory that works with sets of indices to model an attitude holder's perspective, these sets seem to be required to have a certain structural property in order to qualify as basis of an attitude *de re*.

4.3.2 De re belief

Up until now, basically three different types of variation were discovered. A variable could stem from an indefinite and thus possibly assign more than one individual to a situational core. A variable could stem from a discourse-new definite description and either assign one individual per situation (if its restrictor doesn't depend on anything else), or one individual to all situations, if its restrictor is dependent on contextual material only. Hence, tables of the following kind came up:

(136) a.

s_i	s_1	s_1	s_1	s_2	s_2	s_2	s_3	s_3	s_3	$\ldots$
x_j	d_1	d_2	d_3	d_1	d_2	d_3	d_1	d_2	d_3	$\ldots$
$\ldots$	$\ldots$	$\ldots$	$\ldots$	$\ldots$	$\ldots$	$\ldots$	$\ldots$	$\ldots$	$\ldots$	$\ldots$

b.

s_i	s_1	s_2	s_3	$\ldots$
x_j	d_1	d_2	d_3	$\ldots$
$\ldots$	$\ldots$	$\ldots$	$\ldots$	$\ldots$

c.

s_i	s_1	s_2	s_3	$\ldots$
x_j	d_2	d_2	d_2	$\ldots$
$\ldots$	$\ldots$	$\ldots$	$\ldots$	$\ldots$

Of course, indefinites possibly only add one individual per situation if the lexical material is so restrictive that no other fits the descriptive content at the situational core in question; and likewise, definites of the second kind do not necessarily introduce different individuals to different situational cores. Furthermore, not all situational cores are necessarily preserved in the process. Furthermore, when the operations are iterated, the variation can be more restricted in case of definite descriptions dependent on not just the situational core, but other variables in the mix. Finally, the variation can simply be distorted, i.e. not immediately recognizable, because of the sheer complexity of the indices represented. But by and large, the tables depicted exhaust all possibilities.

When it comes to attitude reports, their value must be described on the basis of the contribution of the attitude verb and the embedded sentence (plus the subject in the matrix sentence). Hence, when attitude verbs are combined with the embedded sentences, they possibly encounter all three kinds of variation. Possibly, the outcome of this combination even differs due to the kind of variation. This doesn't just hold for *de dicto* readings of the expressions involved. At least the most common theories of *de re* readings roughly define *de re* interpretations as consisting of *de dicto* beliefs plus some further ingredient. This might seem to be unexpected given that typical *de re* constructions are such that some expression outside of the intensional environment quantifies into it. It therefore isn't clear whether the quantifying expression should leave a trace in the tuples contributed by the embedded sentence or not. On the other hand, even *de re* attitudes need to have something to do with attitude holders' states of mind. That is, in case of, e.g., a true *de re* belief about a single individual in the actual world, there must be something *within* the attitude holders' states of mind corresponding to this individual, if not the individual itself. Otherwise the belief doesn't depend in its value on said individual at all; and thus cannot be said to be about it. Thus, there is some intuitive justification for the view that *de re* belief needs to be understood as *de dicto* belief of a special kind.

If quantification into intensional environments were transparent like quantification into extensional ones, the following would be the case: A sentence like (137) would be true in a situation s_k if and only if (138) (or something similar) was the set of assignments representing the subject's belief in s_k, and each assignment made the embedded statement true (whereas s_2 is the situation variable used in the translation of the embedded sentence and x_2 is the contribution of *Bruce Wayne*):[60]

(137) James Gordon thinks that Bruce Wayne is a coward.

(138)

s_i	s_1	s_2	s_3	s_4	$\dots$
$\dots$	$\dots$	$\dots$	$\dots$	$\dots$	$\dots$
x_j	bw	bw	bw	bw	$\dots$
$\dots$	$\dots$	$\dots$	$\dots$	$\dots$	$\dots$

As can be guessed, the contribution of the embedded proper name, *bw* in (138), is paired with every situation accessible according to James Gordon's doxastic perspective in s_k. These assignments therefore characterize a set of indices that need to contain the set of indices held possible by James Gordon if (137) is true. And since Bruce Wayne figures in the table, he also needs to be part of these sets and hence, James Gordon knows who Bruce Wayne is (to borrow from Hintikka (1962)). But, by this reasoning, the following sentence should receive the same truth value:

[60] Assume for the sake of argument that all the characters are real and not just fictional individuals.

(139) James Gordon believes that Batman is a coward.

Since Batman, the one and only Dark Knight, is Bruce Wayne, *Batman* contributes the same referent to all assignments as *Bruce Wayne* and thus, no difference in value should arise. It is easily seen that this is not the case. If James Gordon doesn't happen to know (or believe) that Batman's secret identity is Bruce Wayne, but happens to believe that Batman is the bravest man in Gotham City, then the inference from (137) to (139) obviously breaks down. Thus, even though the referents of both expressions are the same, substituting one for the other isn't *salva veritate*. This failure of substitutivity among other things led Quine (1953) to reject quantification into *opaque environments* like the complement of *believe*.[61]

Nevertheless, there is the quite nasty intuition that sentences like (137), if true, do formulate statements meaning that an attitude holder has a belief about somebody existing in the real world. To account for this intuition, Quine (1956) discusses the distinction between what he calls *notional* believe-predicate and a *relational* one; or $belief_n$ and $belief_r$ for quick reference. The first one is associated with attitudes *de dicto*, while the second one is intended to provide a position for material to be understood *de re* that allows for substitution as well as quantification. $Belief_r$ is at work when (137) and (139) are translated. Quine thus accepts that both are true. But he claims that this doesn't amount to ascribe contradictory believes to James Gordon. His paraphrases would be something like the following:

(140) a. James Gordon believes$_r$ $\lambda s.\lambda z.$ (z is a coward in s) of Bruce Wayne.
b. James Gordon believes$_r$ $\lambda s.\lambda z.$ (z is not a coward in s) of Batman.

He simply states that it is "undesirable to look upon [(140a)] and [(140b)] as implying" (Quine, 1956, p. 182) what he paraphrases as

(141) James Gordon believes$_r$ $\lambda s.\lambda z.$ (z is a coward in s and z is not a coward in s) of Bruce Wayne,

which would indeed be a contradictory belief.

It is just fair to remark that this distinction of Quine's is not intended to be the basis of a full-fledged theory of attitudes *de re*, even though it was quite influential as a way to describe the problem. Furthermore, this solution avoids the question set up with the tables above: there is no obvious *de dicto* belief that somehow forms the basis of the truthful *de re* ascription in the sense that there must be a set of assignments interpreting a variable in some specific way such that James Gordon believes of the values that they each are cowards or not. *De dicto* belief is modeled via $belief_n$ which still takes propositions as arguments. But whatever term occurs within an embedded sentence, it then is in a referentially opaque position and therefore inaccessible for substitution and quan-

[61] That sentences like (137) and (139) count as constructions that utilize quantifying into opaque environments isn't obvious in the first place. But because they are able to differ in truth value, it cannot be that the proper names are interpreted *in situ*. Only if they are interpreted as sitting outside the intensional environment they can contribute the same referent while the constructions differ in truth value.

tification. This changes when *belief*$_r$ is used, which comes with at least one referentially transparent position that can be occupied by the expression denoting the individual the belief is about. But, crucially, *belief*$_r$ is a relation between two individuals—the attitude holder and the individual the belief is about—and a property. Hence, it doesn't lead to the aforementioned table, since the referential expression doesn't occupy any position within the expression denoting the (*de dicto*) belief.

The general view underlying this solution thus is that *de re*- and *de dicto*-belief are two irreducible kinds of attitudes, since the former is an attitude towards properties while the latter relates to full propositions. This, together with the assumed lexical ambiguity of *belief*, or, to be more general, of every attitude verb that allows *de re* and *de dicto* readings, is very unsatisfactory. It is thus no surprise that several attempts to define one notion in terms of the other while still accounting for the failure of substitutivity emerged. Two of them, namely that of Hintikka (1962) and Kaplan (1969), make use of the fact that *Batman* and *Bruce Wayne* are different names, even though they denote the same individual.

For Hintikka, the extension of names seems to covary with possible worlds (or situations). Hence, they aren't rigid in the sense of Kripke (1972). Kripkean arguments therefore undermine Hintikka's solution to the problem, but it is nevertheless instructive to review it briefly. Hintikka criticizes Quine for being overcautious. Just because substitutivity fails, this doesn't mean that it is impossible to quantify into intensional contexts (Hintikka, 1962, p. 112). In his view, when such a construction is interpreted, one needs to restrict quantification to individuals known to the attitude holder, to use a formulation of Hintikka (1967).[62] That is, according to him, it must be the case that the attitude holder assigns one and the same individual to a proper name, namely that individual that actually is denoted by the term. So, for example, Hintikka holds that James Gordon knows who Bruce Wayne is, if Bruce Wayne is assigned to *Bruce Wayne* in all those indices that make up James Gordon's doxastic perspective. Hence, if the perspective is structured as the table in (138), repeated below:

(138)

s_i	s_1	s_2	s_3	s_4	$\ldots$
$\ldots$	$\ldots$	$\ldots$	$\ldots$	$\ldots$	$\ldots$
x_j	bw	bw	bw	bw	$\ldots$
$\ldots$	$\ldots$	$\ldots$	$\ldots$	$\ldots$	$\ldots$

If an attitude holder's perspective is structured in such a way, then it holds that there is somebody in the actual situation that serves as the value for the proper name in all of the alternatives held possible. Or, for short, the attitude holder in question knows *who* the individual bearing that name is:

[62] In fact, the domain of potential values of variables is sensitive to their occurrences. If variables occurring within an intensional context alone, the domain of quantification are those individuals known to the attitude holder; similarly for other attitudes. If variables only have occurrences outside of intensional environments, their possible values stem from the set of actual individuals. And in mixed cases, the values need to be in the intersection of both domains. This characterization is found in Kaplan (1969, 213, fn. 27).

(142) There is an x_j such that James Gordon knows $\lambda s.x_j = [\![\text{Bruce Wayne}]\!]^s$.

This of course doesn't need to hold for all proper names that are *in fact* coreferential. In the example at hand, it doesn't hold for *Batman*; i.e. there is no (single) individual that is assigned to *Batman* in all of James Gordon's doxastic alternatives. Thus his belief isn't structured like (138), but rather either like (143a) or (143b) (cf. (136a) and (136b)), if there is any structure at all:

(143) a.

...	...	...	...	...	...	...	...
s_i	s_1	s_1	s_1	s_2	s_2	s_2	...
x_j	d_1	d_2	d_3	d_1	d_2	d_3	...
...	...	...	...	...	...	...	...

b.

...	...	...	...	...
s_i	s_1	s_2	s_3	...
x_j	d_1	d_2	d_3	...
...	...	...	...	...

Thus, as is easily seen, in Hintikka's view, it makes a difference whether the respective row is filled by one and the same individual or not. Hence, only one of the three possible variations in (136) serves as basis for *de re* belief, namely (136c). In this sense, Hintikka's account is a reduction of *de re*-belief to *de dicto*-belief. The former is a special kind of the latter in the sense that (i) the *de dicto*-belief has to have a certain kind of structure, namely something akin to (138) or (136c), and (ii) the individuals involved in the *de dicto*-belief actually exists. Hence, a *de dicto*-belief of the right form but about Santa Claus or Pegasus won't do.

But this account reaches its limits when it comes to one of the most famous of Quine's examples, namely the story of Ortcutt:

> There is a certain man in a brown hat whom Ralph has glimpsed several times under questionable circumstances on which we need not enter here; suffice to say that Ralph suspects he is a spy. Also there is a gray-haired man, vaguely known to Ralph as rather a pillar of the community, whom Ralph is not aware of having seen except once at the beach. Now Ralph does not know it but the men are one and the same. Can we say of this *man*, (Bernard J. Ortcutt, to give him a name) that Ralph believes him to be a spy? (Quine, 1956, p. 179)

That is, the question is whether (144a) or (144b) or both or neither are true:

(144) a. Ralph believes that Ortcutt is a spy.
b. Ralph believes that Ortcutt isn't a spy.

Intuitively, both can be heard as true, at least, in a sense. But to pinpoint exactly in which sense is not so easy. Firstly, also intuitively, ascribing both beliefs to Ralph doesn't amout to accuse him of holding a contradictory belief like (145):

(145) Ralph believes that Ortcutt is and is not a spy.

But this is unavoidable if Hintikka's criterion for the truth of sentences like (144) is applied. To be true means that Ralph needs to have a constant belief structured like (138), meaning that the name *Ortcutt* denotes the same individual (probably, but not necessarily, Ortcutt) in all of his doxastic alternatives. But if this is the case, and if it is assumed that his doxastic perspective also makes (144a) true, (144b) must be false. Likewise the other way round. Thus, the sentences in (144) cannot both be true without making (145) true as well.

What Hintikka could claim is that both alternatives in (144) are false, that is, that Ralph simply doesn't have a stable belief in the sense of (138) with respect to *Ortcutt*. On the other hand, there are some variants of (144) that are less controversial, namely:

(146) a. Ralph believes that the man in a brown hat is a spy.
b. Ralph believes that the man he saw at the beach isn't a spy.

Once again, if one of these is assumed to be true under its *de re* reading, as seems to be intuitively correct, the respective other one can't be, simply because the truth (146a) requires that Ralph knows (or believes[63]) who the man in a brown hat is, while the truth of (146b) requires that Ralph knows who the man he saw at the beach is. Since the referents of both definite descriptions have to coincide at the actual situation (or every situation included in the common ground), the individual making up one entire row in a table representing Ralph's beliefs has to be Ortcutt. While it might be tenable to argue that Ralph doesn't believe any of the sentences in which the proper name *Ortcutt* makes its appearance, this strategy can hardly be applied to the sentences in (146), since they intuitively seem to express exactly what Ralph believes. Thus, as Quine's examples show, thinking of the denotations of proper names and descriptions as varying with possible worlds making up a perspective doesn't help. Thus, it isn't of any help to assume that Kripke was wrong.

In Kaplan's (1969) take on quantification into intensional contexts, ascriptions of *de re*-attitudes are mediated through *(vivid) names* the attitude holder is assumed to entertain to keep track of the *ensemble* of all the situations s/he deems possible candidates for being real. That is, Kaplan roughly assumes that attitude holders have some means to represent to themselves all the individuals they made some sort of contact with. More precisely, he assumes that subjects come up with an inventory of names that they tack on individuals they think exist. These names may or may not in fact denote individuals in the real world. If they do, they allow *exportation* from an attitude-internal position if the attitude holder in question takes them as denoting the same individual throughout all her doxastic alternatives. Hence, his position is like Hintikka's in that the belief must be stable or constant. The difference lies in the way he makes use of vivid names one the one hand, and how he handles the contribution of proper names (and the like) in attitude reports on the other. Firstly, a definition of *representation* in the Kaplanian sense:

(147) α represents x to y—symbolically: $\mathcal{R}(\alpha, x, y)$—iff
a. α denotes x,

[63]Unfortunately, the correct way to say what Hintikka requires would be *Ralph believes who the man in a brown hat is*, which is plainly ungrammatical. The paraphrase that comes closest to what is needed here is *there is someone who Ralph believes to be the man in a brown hat.*

b. α is a name of x for y, and
c. α is (sufficiently) vivid. (Kaplan, 1969, p. 203)

Next to all aspects of this are rather complicated. Firstly, vivid names do not need to be proper names, but can be rather description-like, in that they refer to an object by means of properties. In other words, vivid names have descriptive content. This feature distinguishes them from proper names in a Kripkean sense.[64] It also makes vivid names denote one individual rather than another with respect to the actual situation. Thus, the criterion in (147a) is connected to the descriptive content of a vivid name. But there is a second layer Kaplan distinguishes, namely a vidid name's origin or "genetic factors". These are associated with (147b). For example, if James Gordon is introduced to Bruce Wayne under the "name" *the billionaire whose parents got shot in a robbery*, this definite description (together with visual and other information available at the moment of the introduction) can be though of as the (vivid) name *of* Bruce Wayne *for* James Gordon. The adequacy of the description's descriptive content doesn't matter for this relation to hold. That is, it also possible to introduce Dick Grayson to James Gordon in an otherwise identical situation under this description, even though it in fact doesn't apply to him. Nevertheless, this description would become James Gordon's vivid name of Dick Grayson. The crucial ingredient is the shared history of the individual and the name. It features in a (causal) connection between James Gordon and Bruce Wayne, and this is what makes this vivid name a *name of* Bruce Wayne *for* James Gordon. The latter can thus use this description to formulate his believes about Bruce Wayne internally. The last part of (147) is there to ensure that not any kind of description can count as providing a vivid name. Its descriptive content needs to be quite rich in order to count as one of an attitude holder's *inner characters*. I.e., using the analogy to pictures drawn by Kaplan, there are rather rich, detailed pictures and rather poor ones. But these features are independent of the question whether a picture is a picture *of* somebody real. There can be poor, blurred pictures *of* real people as well as crystal clear pictures of fictional characters. In short, objective descriptive adequacy, (causal) connection and "richness" are separate aspects. But they need to come together in vivid names in order to let them represent an actual individual to an attitude holder. And this requires a rather detailed "inner picture". A fuzzy and distorted picture, or a rather general predicate doesn't provide a good basis for someone to group his beliefs around. Likewise, intuitively, an individual isn't acquainted with some other if the only thing the former believes is that the latter is of Asian origin, or something vague like this. In Kaplan's words, such a sparse characterization doesn't suffice to being given a "major role" in the "inner story" (Kaplan, 1969, p. 201) of the attitude holder. This feature can be tied to the structure of beliefs discussed above. If a characterization is rather sparse, the variation under the respective "address" is pretty high, while if the descriptive content is rather detailed, the number of candidates is rather low. Thus, there is a tight connection between the *vividness* of the name and the variation encountered. For example, slightly varying a point Kaplan himself makes, as soon as an individual takes the existence of spies for

[64]It should be mentioned that *Descriptivists* do not share this assessment.

granted, the existence of a youngest one among them probably also is assumed—mostly on independent grounds like background beliefs as "one person of a group always has to be the youngest". But the sparse descriptive content of *the youngest spy* shouldn't all by itself be able to somehow connect the subject's beliefs to the individual which in fact is the youngest spy. This doesn't hold for several reasons. Firstly, it is quite unlikely that this potential vivid name suffices to fill an entire row with one individual only. Since the initial belief simply means that the attitude holder deems situations in which spies exist to be possible, but doesn't restrict them somehow to be constant across all doxastic alternatives, it is pretty unlikely that the youngest one among them happens to be the same in every alternative. The descriptive content just isn't restrictive, the potential vivid name not vivid enough. Secondly, the fairly general descriptive content doesn't suggest that a "major role" is played in the attitude holder's perspective by whichever individual falls under it. And thirdly, there is no hint at a (causal) connection between the attitude holder and the actually youngest spy. Thus, none of the above's criteria for *representation* in (147) is fulfilled. It therefore is justified to conclude that *the youngest spy* isn't and couldn't possibly be a vivid name for an attitude holder.

Returning to James Gordon and Ralph, it is not difficult to see that the Kaplanian approach fares better than Hintikka's. If it is true that James Gordon (*de re*-) believes that Bruce Wayne is a coward, then he entertains a vivid name that represents Bruce Wayne to him in the sense of (147), that is, the vivid name is a name *of* Bruce Wayne *for* Ralph, it denotes Bruce Wayne in the actual situation, and is sufficiently vivid. Hence,

(148) $\exists\alpha\mathcal{R}(\alpha, [\![\textit{Bruce Wayne}]\!], \text{James Gordon})$ & James Gordon believes that α is a coward

But this doesn't entail that James Gordon also believes of Batman that he is a coward, even though Bruce Wayne in fact is Batman. This is because the name that represents Bruce Wayne to James Gordon does not need to represent Batman to him as well. From (148) it isn't even clear whether James Gordon has a vivid name for Batman at all. Thus, substituting $[\![\textit{Batman}]\!]$ for $[\![\textit{Bruce Wayne}]\!]$ doesn't preserve (148)'s truth value. This also means that (149) is can be true as well, assuming James Gordon indeed has a name for Batman as well:

(149) $\exists\alpha\mathcal{R}(\alpha, [\![\textit{Batman}]\!], \text{James Gordon})$ & James Gordon believes that α is not a coward

Hence, (148) and (149) are consistent since it doesn't follow that the James Gordon's name *of* Bruce Wayne and his name *of* Batman are the same. But this is a prerequisite for a truly inconsistent *de re*-belief:

(150) $\exists\alpha\mathcal{R}(\alpha, [\![\textit{Bruce Wayne}]\!], \text{James Gordon})$ & James Gordon believes that α is a coward and that α is not a coward.

Similarly for Ralph and Ortcutt: There is a vivid name *of* Ortcutt *for* Ralph under which Ralph ascribes spyhood, and there is another vivid name, under which he doesn't. Thus, both of the following are true without contradicting one another:

(151) a. $\exists\alpha\mathcal{R}(\alpha, \text{Ortcutt}, \text{Ralph})$ & Ralph believes that α is a spy.
b. $\exists\alpha\mathcal{R}(\alpha, \text{Ortcutt}, \text{Ralph})$ & Ralph believes that α is not a spy.

Another famous account of *de re* readings is found in Lewis (1979a). His solution is pretty similar to Kaplan's. He also makes the truth of a *de re*-attitude dependent on the truth of a *de dicto* attitude, and he also relativizes the presence of individuals in a *de dicto* belief of an attitude holder to the satisfaction of a description. But instead of vivid names, his descriptions are relational. That is, the general condition on beliefs of the form *a believes that y is X* is described using the following:

(152) a ascribes property X to individual y under description Z iff
a. a bears the relation Z uniquely to y, and
b. a self-ascribes the property of bearing relation Z uniquely to something which has property X. (Lewis, 1979a, 153, with slight notational changes)

This is not intended to work for belief *de re* just yet. The point is, once again, that the descriptions in play need to be more intimately tied to the individual (y) in question in order to 'connect' the *de dicto* belief with the right individual. So, not all descriptions are *suitable*. What counts as suitable description for Lewis is found in the clauses (153a) and (153b):

(153) a ascribes property X to individual y if and only if the subject ascribes X to y under some description Z such that either
a. Z captures the essence of y, or
b. Z is a relation of acquaintance that the subject bears to y.
(Lewis, 1979a, p. 155)

His *suitable descriptions* play roughly the same rôle as Kaplan's relation *is a name of ... for*, i.e., they contribute some sort of (causal) relation of the subject to the individual the belief is about. (153a) is intended to deal with modal statements like the famous (154b) (slightly updated), while (153b) deals with attitude ascriptions—or, more generally, *epistemic modalities*—and accounts for examples like Quine's.

(154) a. 8 is necessarily greater than 7.
b. The number of planets is 8.
c. The number of planets is necessarily greater than 7.

The exportation step that derives (154c) from (154b) should (under one reading) be blocked. This is done by (154a). The phrase *the number of planets* doesn't capture the essence of the number 8, since it is a contingent fact that the number of planets equals 8. Thus, the definite description is no *suitable* description in the sense of (153a) and hence, exportation isn't possible.[65]

[65] This doesn't mean that Lewis' account of the invalidity of (154) is adopted here as well. The consensus seems to be that it is possible to transparently quantify into this kind of intensional context if the adverb has no epistemic component to it. Thus, if *the number of planets* is construed *de re* with

But there is a difference to Kaplan's account as construed above. When (152) and (153) are put together, one can see that the relation varies with the belief-situation.[66] That is, if a bears the relation Z uniquely to y is abbreviated by $Z!(a, y)$, and Ralph and Ortcutt by r and o respectively, (151) becomes:[67]

(155) a. $(\exists Z)Z!(r, o)$ and Ralph believes $(\exists z)Z!(r, z)$ and z is a spy.
b. $(\exists Z)Z!(r, o)$ and Ralph believes $(\exists z)Z!(r, z)$ and z is not a spy.

As can be seen, although Kaplan's solution (151) and Lewis' solution (155) are pretty similar, there is one ingredient in (155) absent from (151), namely the existential quantifier in the scope of the attitude verb. For this to have any effect at all, one must assume that $Z!$ is relativized to situations. But this allows more than Kaplan's solution in terms of structures of beliefs underlying *de re* ascriptions. That is, contrary to Kaplan and Hintikka, Lewis allows structures like (136b), repeated from above, to underlie true ascriptions of *de re* beliefs as well:

(136) a.

s_i	s_1	s_1	s_1	s_2	s_2	s_2	s_3	s_3	s_3	...
x_j	d_1	d_2	d_3	d_1	d_2	d_3	d_1	d_2	d_3	...
...	...	...	...	...	...	...	...	...	...	...

b.

s_i	s_1	s_2	s_3	...
x_j	d_1	d_2	d_3	...
...	...	...	...	...

c.

s_i	s_1	s_2	s_3	...
x_j	d_2	d_2	d_2	...
...	...	...	...	...

Or so it seems. Viewing this trough the lens of counterpart theory, this conclusion is far from warranted, mainly for two reasons: (i) (136c) is not possible in counterpart theory, because one individual cannot exist in two different worlds. If one assumes that this carries over to situations as well, and $s_1 \neq s_2 \neq s_3$, then (136c) is out. But this means that (136b) is the only structure Lewis has to offer anyway, but it somehow needs to count as the same case as the one Hintikka and Kaplan make use of. If the individuals assigned to x_j are all connected by the counterpart relation (by virtue of being *the* individual the subject of the attitude believes to be acquainted with), they describe just one (actual) individual. Thus, (ii) the difference that is at stake here is between a structure like (136b) where all individuals in one line stand in the counterpart relation and the very same structure where they don't. But it is far from clear whether this second option is even available for Lewis. Thus, given counterpart theory, the difference cannot be expressed without further ado.[68]

respect to the intensional environment created by *necessarily*, then (154c) is indeed entailed. The distinction between epistemic and non-epistemic intensional environments is also found in Aloni (2001) among others.

[66] "My account of belief *de re* is broadly similar to Kaplan's. The most important difference is that Kaplan takes the subject's causal *rapport* with the described individual under the description as an extra condition; whereas I take it as part of the content of a suitable description, at least in most cases." (Lewis, 1979a, 153, fn. 14)

[67] There is a further complication, namely that the occurrence of r below *believes* should be substituted for the *center* of the belief-situations. This complication is ignored for the moment.

[68] If the counterpart relation is reconstructed as in Kupffer (2010), the very fact that the individuals show

Structures like (136b) are of special interest, because definite descriptions are dependent on situations. As said above, their semantic contributions are sensitive to their placement with respect to the attitude verb—or, to put it differently, it usually makes a difference, whether they are interpreted against one situation variable or the other. (156) is a case in point. That is, the first two representations (156a) and (156b) should capture the *de re* readings—referential vs. attributive –, while (156c) represents the *de dicto* reading:

(156) James Gordon believes that the dark knight is a coward.

a. [c : [s : James Gordon believes [s' : [the dark knight]$-c$ is a coward]]]
b. [c : [s : James Gordon believes [s' : [the dark knight]$-s$ is a coward]]]
c. [c : [s : James Gordon believes [s' : [the dark knight] is a coward]]]

To ensure that this really amounts to a difference, the kind of variation that (156c) induces usually isn't conceived of being a proper basis of *de re* ascriptions. This is different in (156a) and (156b), since the individual contributed by the definite description is fixed independently of the situations considered possible by the subject of the attitude.

(157)

s_2	s_1	s_2	s_3	...
x_2	bw	jg	dg	...

with $bw \neq jg \neq dg$

But Kaplan's (1969) *shortest spy problem* can be taken to show that the structural demands are less important than Hintikka thought they were. Suppose that Ralph has the *de dicto* belief that spies exist. In the present framework, this ascription comes about by the following distribution of situation variables, and it induces a structure like (159) (cf. (136a)):

(158) [c : [s : Ralph believes [s' : $(\exists^{s'}_{x_1})[Ss'x_1]$]]]]

(159)

s'	s_1	s_1	s_1	s_2	s_2	s_2	s_3	s_3	s_3	...
x_1	d_1	d_2	d_3	d_4	d_5	d_6	d_7	d_8	d_9	...
...	...	...	...	...	...	...	...	...	...	...

On top of this, Ralph also entertains the belief that there must exist a shortest spy. He doesn't have particular person in mind—his belief is rather unspecific. But he is convinced that the shortest spy must have the ability to jump pretty high, because otherwise, he would have flunked the aptitude test in spy academy. Thus, there is a further *de dicto* belief that can be expressed by the following:

(160) [s : Ralph believes [s' : the shortest spy can jump pretty high]]

For the sake of argument, it is assumed that the definite description introduces a new individual variable x_2 whose values (per situation) have to be among the spies stored under x_1. Then this second *de dicto* belief transforms (159) into the following:

up in such a table that represents the (true) belief on an attitude holder *makes* them counterparts of each other *for* the attitude holder, because they *represent* the same thing in all belief-situations.

(161)

s'	s_1	s_1	s_1	s_2	s_2	s_2	s_3	s_3	s_3	$\dots$
x_1	d_1	d_2	d_3	d_4	d_5	d_6	d_7	d_8	d_9	$\dots$
x_2	d_2	d_2	d_2	d_5	d_5	d_5	d_8	d_8	d_8	$\dots$
$\dots$	$\dots$	$\dots$	$\dots$	$\dots$	$\dots$	$\dots$	$\dots$	$\dots$	$\dots$	$\dots$

As can be seen, with respect to x_2, (161) has the crucial structure (136b): there is one spy per situation (guaranteed by the uniqueness condition within the definite description *the shortest spy*), but not one spy for all situations. If (161) was a proper basis for *de re* belief, then two rather unspecific *de dicto* beliefs were enough to have one. But it is not enough to conclude from this that structures like (161) aren't sufficient. *De dicto* beliefs shouldn't generally suddenly turn into *de re* beliefs without further ado. E.g., if the outcome of the procedure just sketched wasn't (161) but a table that was structurally similar to (136c), i.e. one in which the same individual is the value of x_2 with respect to all situations, this result still shouldn't count as the proper basis of a *de re* belief all by itself.[69] Structures like these of course can arise by pure coincidence. But this still doesn't mean that Ralph suddenly knows who the shortest spy is, to phrase it like Hintikka. Thus, Kaplan's argument concludes, there is more to belief *de re* than just structure. His account does this justice by the *is a name of ... for ...*-relation, built into the definition of a vivid name. Something similar can be said about the acquaintance relations built into the definition of *suitable* descriptions in Lewis' account. These two features add the quality that distinguish *de re* attitudes from mere *de dicto* ones.

If this is correct, one expects this to work the other way around as well. That is, it should be possible for a potential vivid name to denote the "right" individual in the actual situation while also fulfilling the *is a name of ... for*-relation, but still not licensing *exportation*, because of a lack of vividness. If Kaplan's view is presented correctly, this would amount to an attempt to justify the ascription of *de re*-belief that fails because of the structure of the attitude holder's perspective.

Suppose James Gordon saw Alfred Pennyworth for the first time, when the butler walked past him and Bruce Wayne while they were engaged in a conversation about polo. The circumstances are rather unfortunate, *Wayne Manor* wasn't well-lit to begin with, and Alfred approached them quietly from behind, walked past James Gordon quickly, without saying a word and disappeared behind a curtain. James Gordon only saw Alfred's back, the parts of his uniform, etc., but he didn't see his face or heard his voice. Then, Bruce Wayne explains, because he saw the irritation on James Gordon's face: "that was my butler".

The phrase *Bruce Wayne's butler* definitely denotes Alfred Pennyworth, and it also seems to qualify as *name of* Alfred Pennyworth *for* James Gordon, since it is a part of the little bit of history they share in the same sense *the billionaire whose parents got shot in a robbery* above. The question is whether this is enough to determine a single individual relative to all the situations James Gordon cannot exclude to exist in

[69]From Hintikka's perspective, if construed correctly, this might be exactly what one wants to do. At least, as long as one does not insist on this individual being the actual shortest spy, this is as close as one can get to *de re* beliefs "from within", so to speak.

(after updating them with the information that Bruce Wayne has a butler).[70] The main question of course is whether this scenario suffices to ascribe a *de re* belief about Alfred Pennyworth to James Gordon. A case in point could be:

(162) James Gordon believes that Bruce Wayne's butler disappeared behind a curtain.

Intuitively, (162) is correct under its *de re* interpretation. But, arguably, it doesn't exhibit the structure Hintikka thought to be neccessary. If *Bruce Wayne's butler* is paired with this predicate to form the embedded clause, it most likely induces a structure like (136b):

(136b)

s_i	s_1	s_2	s_3	$\ldots$
x_j	d_1	d_2	d_3	$\ldots$
$\ldots$	$\ldots$	$\ldots$	$\ldots$	$\ldots$

That is, there is *one* individual per situation and not *one* individual for all situations. Thus it seems safe to conclude that the Kaplanian account must be able to make structures like (136b) the basis of true *de re*-beliefs as well.

Note that this could also be argued to be the case for one of Ralph's beliefs about Ortcutt, namely that he isn't a spy: Since Ralph saw Ortcutt only once at the beach and didn't recognize him, the description *the man I saw at the beach* cannot reasonably be taken to be stable with respect to Ralph's perspective. This doesn't necessarily have to be the case for the (vivid) name *the man with the brown hat*, because Ralph "glimpsed" him several times. However, for Kaplan's *representation*-relation it seems to be necessary (not sufficient) that the name is *vivid* enough to induce that kind of variation that is also induced by attributively used definite descriptions. This basically means that the vividness-criterion is fulfilled if it can be argued that the attitude holder's inner character can be circumscribed by a definite description with respect to the set of alternatives the individual entertains. More generally, in terms of structure, the following two kinds of variations seem to be able to serve as a basis stable enough to justify exportation (given that the other constraints are fulfilled). The variation thus doesn't need to be *rigid*, *pace* Hintikka, but only *definite*, as Aloni (2001) calls it:[71]

(136) b.

s_i	s_1	s_2	s_3	$\ldots$
x_j	d_1	d_2	d_3	$\ldots$
$\ldots$	$\ldots$	$\ldots$	$\ldots$	$\ldots$

c.

s_i	s_1	s_2	s_3	$\ldots$
x_j	d_2	d_2	d_2	$\ldots$
$\ldots$	$\ldots$	$\ldots$	$\ldots$	$\ldots$

This conclusion justifies the talk about *the* "Kaplan/Lewis" account of *de re* belief found in the modern literature. On the technical side, modern accounts of (*de re*) attitudes

[70] Or something similarly strong but compatible with Counterpart Theory. For the rest of this discussion, questions concerning trans-world (and trans-situation) identity are disregarded.

[71] Thus, the difference Lewis observes doesn't amount to much, at least in terms of structure. Note that this conclusion also renders the need to connect the world-bound individuals in Lewis' account by a counterpart relation obsolete.

mostly make use of *individual concepts* (e.g. Aloni, 2001), acquaintance relations (e.g. Maier (2006) and Maier (2009a), following Lewis (1979a)), or mixtures of both (e.g. Baron, 2015; Percus and Sauerland, 2003a), to model this kind of approach.

Percus and Sauerland (2003a) implement it by means of the following (cf. also the generalization of this approach in Baron (2015)):

(163) C is an acquaintance-based y-concept for x in s if:

a. C is an individual concept (of type $\langle s, e\rangle$);

b. $\exists Z : y = (\iota z)[Z(x, z, s)]$ & $\forall \langle s', x'\rangle \in \mathcal{Bel}_{x,s} : (\iota z)[Z(x', z, s')] = C(s')$

Z is an acquaintance relation in Lewis' sense. The first clause demands y to be the only individual the subject of the attitude x is acquainted with in s, while the second clause defines the individual concept that stands in for Z as its course of values with respect to all centered worlds the individual holds possible (Percus and Sauerland don't work with indices in the sense used here). Thus, these have to be given by other means. With the help of (163), ascriptions of *de re*-attitudes are captured by means of existential quantification over acquaintance-based conceptual covers. For example, the truth-conditions of Quine's Ortcutt-examples (144), repeated from above, come out as in (164) (with s as the matrix sentence's situation variable):

(144) a. Ralph believes that Ortcutt is a spy.

b. Ralph believes that Ortcutt isn't a spy.

(164) a. $\exists C : C(s) = o$ & $\forall \langle s', x'\rangle \in \mathcal{Bel}_{r,s} : Spy_{s'}(C(s'))$

b. $\exists C : C(s) = o$ & $\forall \langle s', x'\rangle \in \mathcal{Bel}_{r,s} : \neg Spy_{s'}(C(s'))$

Note that the value of the individual concept (i) doesn't have to be the individual the *de re* belief is about, and (ii) possibly varies with the concept's world argument. Thus, Percus and Sauerland allow for erroneous beliefs to count as *de re* as well (as do Kaplan and Lewis), i.e. the individual the subject believes to be acquainted with isn't the one she in fact is acquainted with. The way out of the shortest spy-problem is the same as Kaplan's, i.e. in order to avoid two (or more) *de dicto* beliefs to suddenly license a *de re* reading, they have to assume that there aren't any covers available due to the lack of an appropriate acquaintance relation.

The solution presented in Aloni (2001) also makes use of individual concepts, but her concepts are not acquaintance-based. She doubts that acquaintance relations or vivid names can play the rôles Kaplan and Lewis envisaged. This is due to some examples that will be mentioned in section 4.3.3. To compensate for this, she makes use of sets of individual concepts compatible with one rôle of an "inner character" in order to form several quantificational domains. Thus, in contrast to the formulation of Percus and Sauerland, the domain of the existential quantifier might not be the same for two distinct individual variables. This allows for a quite elegant picture of quantification: In her system, individual variables bear a numerical index. But in contrast to the way in which these indices are used here, they have an interpretation of their own. A numerical index on a variable denotes the domain the variable is interpreted against. Thus, different variables range over different sets of concepts. And since the domains are sets of individual concepts, variables range over individual concepts instead of individuals. In order for this not to cause any damage, Aloni argues for the following assumption:

(165) A conceptual cover based on a non-empty set of worlds W and a non-empty domain of individuals D is a set of functions CC from W to D such that: $\forall w \in W\ \forall d \in D\ \exists! C \in CC : c(w) = d$

This guarantees that there are exactly as many individual concepts as there are individuals in the domain—hence, quantifying over concepts is exactly as fine-grained as quantification over individuals. Thus, as long as the existence and uniqueness-condition encapsulated in (165) are met, quantification over individual concepts behaves as quantification over individuals.

Aloni puts conceptual covers to use in the way indicated above: each numerical variable index introduces its own set of covers in the sense of (165). Thus, two variables differing in their index may have non-overlapping domains. This is used to account for Quine's original Ortcutt examples. If the relevant sentences are translated as in (166) (where $\Box$ stands for Ralph's doxastic perspective), then the two formulæ do not contradict each other:

(166) a. Ralph believes Ortcutt to be a spy. $\exists x_1(x_1 = o \wedge \Box S(x_1))$
b. Ralph believes Ortcutt not to be a spy. $\exists x_2(x_2 = o \wedge \Box \neg S(x_2))$

This is because they are roughly interpreted as follows:

(167) a. $(\exists c)[c \in C_1\ \&\ c(w) = o\ \&\ (\forall w')[Dox_r(w)(w') \rightarrow S_{w'}(c(w'))]]$
b. $(\exists c)[c \in C_2\ \&\ c(w) = o\ \&\ (\forall w')[Dox_r(w)(w') \rightarrow \neg S_{w'}(c(w'))]]$

Aloni comments as follows:

> The compatibility of the two sentences [(167a)] and [(167b)] is captured by letting the variables [x_1] and [x_2] range over different sets of concepts [namely C_1 and C_2]. The availability of different sets of non-overlapping concepts as possible domains of quantification on different occasions enables us to account for the dependence of belief reports on the ways of referring to objects (and so for double vision cases) [...]. (Aloni, 2001, p. 64.)

Thus, the individual concept corresponding to *the man with the brown hat* may be in the set assigned to the numerical variable-index 2, C_2, but then, this set cannot also contain the concept *the man on the beach*, because the concepts inside one and the same cover aren't allowed to overlap at any world—viz. (165)—and these concepts do assign the same individual to the matrix world. But the second concept might be assigned to 1, namely C_1, then barring the first concept from being contained in the very same domain. Hence, only one of the intuitively relevant concepts is available per numerical index, allowing only one interpretation per sentence.

But since neither acquaintance relations nor vivid names are at the core of Aloni's individual concepts, and because a variation like (136b) counts as "stable enough" to be the basis of a *de re* ascription—since covers inducing this variation are allowed according to (165) –, she needs an additional story to deal with the shortest spy problem. In her analysis, it isn't obvious why the two *de dicto* beliefs shouldn't be enough to allow for *exportation*. Thus, she has to assume that the relevant concept that would justify a *de re* construal, namely the individual concept *the shortest spy*, simply isn't part of the cover.

If Aloni's approach is correct, *de re* ascriptions don't need to be justified by acquaintance relations or *name of ... for ...*-relations as Lewis and Kaplan thought. The next section discusses examples that were put forth to demonstrate exactly that. As will be seen, as soon as other attitudes, especially constructions involving *want* are considered, *de re* ascriptions are encountered that (arguably) aren't licensed by either vivid names or acquaintance.

4.3.3 De re without acquaintance

Aloni (2001) collects many examples that are *de re* ascriptions which don't conform to the criteria put forth by Kaplan and Lewis. One of those examples is the story of *Odette's lover*:

> Thanks to some clues, Swann has come to the conclusion that his wife Odette has a lover, but he has no idea who his rival is, although some positive proof has convinced him that this person is going to leave Paris with Odette. So he decides to kill his wife's lover, and he confides his plan to his best friend, Theo. In particular, he tells Theo that the killing will take place the following day, since he knows that Odette has a rendezvous with her lover. [...] Unknown to Swann, Odette's lover is Forcheville, the chief of the army, and Theo is a member of the security staff which must protect Forcheville. During a meeting of this staff to draw up a list of all the persons to keep under surveillance, Theo (who, unlike Swann, knows all the relevant details of the story) says [(168)] meaning by this that Swann is to be included in the list. The head of the security staff accepts Theo's advice. [...] Swann is kept under surveillance. A murder is avoided.
>
> (after Bonomi (1995, 167f.), through Aloni (2001, p. 55))

(168) Swann wants to kill the chief of the army.

The crucial point in the description of the scenario of course is that Swann "has no idea who his rival is". Thus, the background belief he entertains is rather sparse: he seems to entertain the belief that his wife has *one* lover, but he isn't able to sort out which of all the individuals that come into consideration it is. The most that one can hope for is one candidate per situation, i.e. a structure like (136b). But more crucially, it is questionable whether *my wife's lover* or *Odette's lover* is a vivid name for any of the potential individuals Swann counts in. Note that there also is no plausible account on Lewis' terms, since there is no relation of acquaintance that Swann bears uniquely to any person that could be Odette's lover according to his beliefs. There may be a relation of acquaintance he bears to Forcheville. But Swann does not necessarily believe him to be Odette's lover, i.e. he doesn't necessarily make that connection. Furthermore, *Odette's lover* is the only description that seems to be relevant in the given scenario. That is, there is no other suitable description or vivid name of Forcheville for Swann that somehow overcomes all these difficulties. Finally, even if it is somehow established that *Odette's lover* has to play that rôle and somehow fulfills it, the following sentence becomes a problem (Aloni (2001, p. 56)), since it is false on any reading (*de re* and *de dicto*), which it then shouldn't:

(169) Swann believes of the chief of the army that he is Odette's lover.

Thus, it seems, there is no acquaintance relation or vivid name that established the needed (causal) connection to add the extra quality needed (according to Kaplan and Lewis) for the ascription of *de re* attitudes over and above mere *de dicto* ones. Nevertheless, (168) seems to be true. Needless to say, on Aloni's account, this ingredient isn't needed. Her individual concepts aren't acquaintance-based to begin with (as opposed to Percus and Sauerland's (2003)), so their unavailability doesn't do any harm.

But there are other accounts on the market that have something to say about (168) as well. One crucial observation that provides a key to parts of this problem is that Theo in the scenarios presumably avoids uttering a sentence like (170) because he can't be sure that his audience gets its meaning and thus sees the relevance for their task at hand:

(170) Swann wants to kill Odette's lover.

This doesn't sidestep all the problems that Kaplanian/Lewisian accounts have with respect to the scenario given, but at least some, since (170) makes use of the crucial description which could, if anything, provide the link between Forcheville to the belief Swann entertains. Note that, firstly, (170) is true under its *de dicto* reading, contrary to (168). Thus, one suspects that *this* is what Theo reports with his utterances. Secondly, *Odette's lover* and *the chief of the army* refer to the same individual when evaluated against the context. This equivalence and the resulting indistinguishability of the respective contextual import seem to make this substitution of phrases possible in the first place. That something along this lines is part of the explanation of some cases of *de re* is the driving force in Schwager (2011) and Sudo (2014). Schwager (2011) proposes the following principle:

(171) *Replacement principle* (Schwager, 2011, p. 409)
For the sake of reporting an attitude, a property that is involved in the content of the attitude that is to be reported (the *reported property*) can be replaced by a different property (the *reporting property*) as long as the reported property is a subset of the reporting property at all relevant worlds.

Similarly, Sudo (2014) suggests to analyze true *de re* readings of predicates as true *de dicto* readings of *contextually equivalent predicates*. Two predicates are contextually equivalent iff for all situations in the common ground it holds that their extensions coincide. If the actual world is among the “relevant worlds” (as Schwager assumes), then (168) reports the (true) *de dicto* reading of (170). Sure, apart from us readers only Theo knows that *Odette's lover* and *the chief of the army* refer to the same individual in the context. That is, it doesn't seem necessary for the example to work that every other attendee of the meeting knows this. If it were, Theo could have used (170) as well (in its *de re* reading), but this doesn't seem to be correct. Thus, *pace* Sudo, the equivalence isn't necessarily part of the *common ground*, at least, if “common ground” isn't meant to be the common ground between us, the readers, and Theo. *Odette's lover* and *the chief of the army* refer to the same individual if they are equivalent with respect to the context. This of course renders the respective updates of the set of assignments that store the course of the previous discourse equivalent as well. But, to reiterate, it is possibly only because Theo is aware of this. Thus, the communicative impact of the three phrases could still differ. But this shouldn't be taken as an attempt to explain the problem away. That the scenario at hand features an utterance of one of the characters isn't necessary. There are other examples that differ in this respect, e.g.:

(172) [Context:] A murder has occurred on campus, people with offices in the left wing of the building might have seen it. Detective CS Foyle decides, ‘I want to talk to someone who has his office in the left wing of the building.’ Unbeknownst to him, all offices in the left wing belong to the English department, and only professors have offices. (Schwager, 2011, p. 407)

   a. Foyle wants to interrogate an English professor.

(173) [Context:] Mary is looking at the Burj Dubai, which has 191 floors and is currently the highest building in the world. Also, no other building has more floors. Mary doesn't know this. She also doesn't know how many floors Burj Dubai has. She thinks, ‘Wow, I want to buy a building that's even one floor higher!’ (Schwager, 2011, p. 399)

   a. Mary wants to buy a building with (at least) 192 floors.

It seems that both (172a) and (173a) correctly describe what the respective subjects desire, even though they themselves aren't aware of it. (173) adds the further complication that the phrase used to formulate Mary's desire fails to denote anything in the actual world or the worlds of the matrix sentence. This is because the description of the scenario makes it clear that no *building with (at least) 192 floors* exists. Schwager deals with this by collecting worlds maximally similar to the matrix world(s) except that the property isn't empty among the “relevant worlds”. This move is adopted by Sudo as well.

Note that Schwager's examples all use *want*, as does Aloni's (168). This may be another crucial feature that has to be taken into consideration. For example, it has been assumed (Geurts, 1998; Heim, 1992; Maier, 2015; Yanovich, 2011, among others) that desires are parasitic on beliefs. This is partly due to presupposition projection. As Karttunen (1974) already observes, presuppositions triggered in the complement of *want* (and other non-factive attitudes) don't (necessarily) project to the matrix layer, but are (or can be) caught in a belief-layer as well. That is, the presupposition that (174) seems to project is not (174a), but (174b) (the example is Heim's (1992)):

(174) Patrick wants to sell his cello.
  a. Patrick owns a cello.
  b. Patrick believes that he owns a cello.

For sake of illustration, one way this can be worked into a semantic account is by relativizing desire worlds to belief-worlds:

(175) α *wants* φ is true iff for every $w' \in Dox_\alpha(w)$: every φ-world maximally similar to w' is more desirable to α in w than any non-φ-world maximally similar to w'. (Heim, 1992, p. 193)

If something like (175) is available, it opens up the possibility of having *de re* desires about something that is (just) *de dicto* believed to exist. This of course doesn't solve the issues at hand, since the connection between the expressions chosen and the background-belief described still isn't straightforward.[72] Furthermore, except for maybe (173), the additional layer of worlds doesn't seem to help with Schwager's examples. That is, one may conclude from the description of the scenario that Mary believes *de dicto* that a building with (at least) 192 floors exists, but such an inference doesn't seem to be available for (172) or in Aloni's example (168).

Furthermore, the phenomenon isn't restricted to desires. Sudo puts forth further examples with the same features, one of them even constitutes a true counterexample to Percus's *Generalization X*:

(176) [Context:] John knows that his friend Bob is dating Mary. Furthermore, John has the belief that Bob would never date anyone outside his religion. Despite this, he does not know what religion Bob belongs to. We know that Bob is Catholic. (Sudo, 2014, p. 448)
  a. John thinks that Mary is Catholic.

Sudo's point is that the predicate *is Catholic* has to be understood *de re* simply because otherwise, (176b) wouldn't express the belief John has according to the scenario, namely that Bob dates somebody of the same denomination. He furthermore points out that the substitution of contextually equivalent predicates might explain Bäuerle's original observation as well, repeated from above:

(37) John believes that all internationals live in a 5-star hotel.

This would also explain why here, in contrast to the cases with definites discussed above,

[72] For a more general picture cf. Blumberg (2018), where it is argued that cases like these can be captured systematically by assuming that the attidude verb does not embed propositions, but sets of pairs of situations. The first component of these pairs then is interpreted as stemming from the doxastic perspective and possibly serves as a parameter of evaluation for DPs like *a cello*. I refrain from implementing this here in order to keep the discussion manageable.

the "quantificational force" of *all* stays *in situ* while its restrictor is interpreted transparently.

Aloni also provides examples without *want*:

(177) [Context:] Susan's mother is a successful artist. Susan goes to college, where she discusses with the registrar the impact of the raise in tuition on her personal finances. She reports to her mother 'He said that I should ask for a larger allowance from home'. Susan's mother exclaims: [(178)] Susan, looking puzzled, says 'I don't think he has any idea who you are'. (after van Fraassen (1979, p. 372), through Aloni (2001, p. 56))

(178) He must think I am rich!

Aloni further points out that Kaplan and Lewis cannot both explain the reading which Susan must have gotten (to explain her weird reply) by assuming that there is a suitable vivid name or acquaintance relation, and at the same time exclude the following, which is intuitively unacceptable, but turns out to be (trivially) true with the help of the same name or relation:

(179) He must think I am your mother. (Aloni, 2001, p. 57)

On the other hand, *I* can be interpreted under a cover containing the individual concept *Susan's mother* in both cases as well. Thus, if Aloni doesn't assume that the two first person pronouns are translated by different variables as in her take on Ralph's beliefs about Ortcutt, she doesn't have an explanation either. She points out (Aloni, 2001, p. 74) that the cover would make the belief ascribed in (179) trivial and suggests that this is what restricts its application to (178) only. This, *mutatis mutandis*, also holds for (169).

What is the moral that should be drawn from this discussion? It seems as if there are two modes of *de re*. One rather demanding one that is described as requiring causal relationships and/or acquaintance, and one rather lax one, which hasn't anything to do with the subject of the attitude but seems more to be about the way in which people report about the attitudes (especially desires) of others. The Bäuerle-example seems to sit in the middle of both extremes. All accounts mentioned in section 4.1.4 are born out of the desire to account for it in terms of the distribution of situation variables. The present account doesn't do this, because it is more interested in getting the projection of variables right. The hope is that Sudo (2014) is correct in claiming that his and Schwager's (2011) accounts are able to deal with this adequately. If this is on the right track, it seems best to concentrate on implementing the other notion of *de re*. But it should be kept in mind that aspects of Aloni's (2001) critical examples may also be explained away by the other account.

4.3.4 A strategy to implement attitude reports

Classical accounts of attitude reports à la Hintikka (1969) derive their truth conditions with the help of a subject's *perspective*. Perspectives, differing in flavor depending on whether knowledge, belief, or any other state of the subject's mind is at stake, are modeled as set of possible situations. As the background reasoning has it, Logical Space as a whole is presented to an attitude holder x in a particular situation s and she sorts the element of LS according to whether they conform to her attitude or not. This of course shouldn't be taken literally. Usually, this is understood as a behavioral disposition—the attitude holder would act this way if LS could be presented to her this fashion. Nevertheless, taking belief as an example, the perspective is the following subset of LS:

(180) $\{s' \in LS : x \text{ cannot exclude to be in } s' \text{ on the basis of its beliefs in } s\}$

Since this subset of LS normally stands in set-theoretical relations to any (other) proposition, especially those expressed by sentences, this helps in establishing a route from the attitude holder's state to the truth (or falsity) of an attitude report. The point is that the perspective (180) needs to be a subset of the embedded sentence's intension (understood as set of possible situations as well) for an attitude report to be true. That is, all of the situations not excluded on the basis of the individual's beliefs have to make the embedded sentence true as well. If this isn't the case then the subject cannot be said to believe whatever the embedded sentence means.

This procedure is sufficient only for a subset of the relevant cases. As famously noted in Perry (1977), examples like the following cannot be captured by the approach underlying (180):

> An amnesiac, Rudolf Lingens, is lost in the Stanford library. He reads a number of things in the library, including a biography of himself, and a detailed account of the library in which he is lost. He believes any Fregean thought you think might help him. He still won't know who he is, and where he is, no matter how much knowledge he piles up, until that moment when he is ready to say, *This place is aisle five, floor six, of Main Library, Stanford. I am Rudolf Lingens.* (Perry, 1977, p. 492)

Examples like these motivate a well know move from propositions to properties (Chierchia, 1989; Lewis, 1979a, a.o., cf. section 3.1.3). Instead of entertaining an attitude towards a set of worlds (or situations), the attitude holder needs to *self-ascribe* a certain property, namely being a particular individual in a particular situation. What Lingens in the example lacks is precisely this kind of *self-locating* knowledge. Even if he is assumed to have an overview over the complete *ensemble* of a situation together with all propositional information available, since he can't identify himself with one of them, he doesn't know who he is, and vice versa. To make this identification possible so-called *centered situations* are introduced:

(181) $\{\langle s', y\rangle : x \text{ cannot exclude to be } y \text{ in } s' \text{ on the basis of its beliefs in } s\}$

For this move to be of any help, the contributions of embedded sentences need also be understood as being built out of centered situations: i.e. functions from individuals into propositions, functions from situations to (Schönfinkelized) sets of individuals, or sets of pairs of situations and individuals, as (181) is. This is especially needed in case an infinitive is embedded. Under this modeling, every element of (181) also has to be an element of the intension of the embedded infinitive. Thus, the set theoretical relation utilized in the basic Hintikka-style account carries over to the Lewisian one. Lewis in particular argues that "when propositional objects of attitudes will do, property objects also will do" (Lewis, 1979a, p. 516), i.e. that it isn't necessary to use both. This option was briefly touched in section 3.1.3 as well.

So far the literature. The following problem is unprecedented so far. Since it is argued that the entities playing the rôle of situations are indices, possibly and mostly coming with even more individuals than just a center, one needs to find a way to generalize this step.[73] That is, one needs to clarify what its means for indices to figure in the perspective of an attitude holder. There basically are two options: One can try to stay rather agnostic about other coordinates and basically stick to a variation of (181), namely a set of indices of arbitrary length *starting* with the appropriate coordinates.[74] or one can try to add more meat to the notion of attitudes towards indices of an individual α in a situation $s \in LS$:

(182) $\{\langle s', y, d_1, \ldots, d_n \rangle : \alpha$ cannot exclude to be y coexisting with $d_1 \ldots d_n$ in s' on the basis of its beliefs in $s\}$

First and foremost, given the use of sets of assignments above, it is clear that whichever sentence is embedded, it indeed expresses a set of indices in the end. Furthermore, it is reasonable to assume that the newly defined perspective still needs to be a subset of this set of indices for an attitude report to be true. But there are two varieties to consider. First, sentences may express sets of indices that are unordered. That is, one allows for permutations within the part of the tuples after the situational core and the center (assuming that it is 'stable'). Just to give an example, if an attitude holder α cannot exclude to be u in s' coexisting with v_1, v_2, v_3 on the basis of its beliefs in s, (182) not only hosts (183a), but all the indices in (183b) and even more:

(183) a. $\langle s', u, v_1, v_2, v_3 \rangle$
b. $\langle s', u, v_3, v_1, v_2 \rangle$, $\langle s', u, v_2, v_3, v_1 \rangle$, $\langle s', u, v_3, v_2, v_1 \rangle$, ...

That this first coordinate is not as flexible as the others is of course due to the Lewisian move to centered situations. This means, roughly speaking, that one and the same situational core followed by the very same individuals in next to any order possible makes it into the set (182). If the indices in the perspective are so liberal, the contributions

[73] Assuming that indices are indeed needed to model perspectives, despite the arguments to the contrary presented in T. E. Zimmermann (1999).

[74] This yields a larger set than (182) because the attitude holder doesn't need to be aware of the existence of the other coordinates.

of embedded sentences need to be as well. Up until now, when a sentence's intension was derived, it was in the form of a set of assignments. Even if it is assumed that the evaluation is restricted to assignments representing indices (the relevant set of assignments is I as defined in (28), p. 233 above), the indices represented are unordered. Even more than the indices in (183) since there is no need to assume that the first position is relatively stable. If this format is chosen for an attitude holder's perspective and the semantic contribution of embedded sentences is the same as that of matrix sentences, one may simply stick to assignments simpliciter, and not bother with the exact way of mapping them onto indices, since the machinery is designed to handle assignments and thus, everything is easier to manage, as already suggested in section 4.3.1.

For non-embedded sentences, there doesn't seem to be any evidence for the need of ordered tuples, contrary to embedded ones. As suggested, PRO seems to claim a certain position in the tuple that receives a special interpretation compared to the others. This doesn't need to be the first position of the part of the index where the individuals are, but this is kind of convenient given the structure of contexts. Since I is associated with the first position in contexts, it makes sense to associate PRO with the first position of indices, since this is the 'address' where the attitude holder stores information about him/herself. This is related to the idea found in Kaplan (1989b, sec. XX), namely to capture the content of beliefs with the help of characters of sentences and their diagonals.[75] Intuitively, an individual potentially expresses beliefs about herself by using clauses like (184). So it is quite natural to assume that the beliefs are built out of contexts c such that (184)'s character applied to c not only results in the intended proposition, but this proposition is also true at c.

(184) I think my pants are on fire.

However, all other individual positions in indices don't receive a special interpretation in this sense. But this allows them to vary as unrestrictedly as they can.

One could try to say something more substantial. That is, instead of just constraining the situational core and the center (181), one may use (182), paired with some further ingredient in order to express an attitude holder's *conceptualization* of the domain of individuals in a situation. If, e.g., a Kaplanian account of *de re* readings is adopted, the existence of conceptualizations might as well be stipulated to impose some structure on the indices figuring in a perspective. In a sense, Kaplan's talk of "inner characters" is taken seriously only if it is used in this way: indices are taken to be possible candidates of the attitude holder for the actual situation. Thus, they shouldn't feature any "characters" that the subject of the attitude doesn't expect to exist, anyway. Conversely, they also shouldn't just figure in an index if it is already established that they serve as the basis of an attitude *de re*. "Inner characters" are made use of no matter what,[76] and if

[75] This is shown to be too weak in von Stechow and T. E. Zimmermann (2005). The characters believed are underdetermined and hence are the truth conditions of attitude reports. The details don't matter here that much, since the proposal is not adopted. It is only mentioned to motivate the choice of the first position as the 'store' for individuals the attitude holder believes to be.

[76] "Ralph may enjoy an inner story totally out of contact with reality, but this is not to deny it a cast

it turns out that the means of "conceptualizing" them employed by the subject of the attitude indeed extends to the actual individual in the actual situation (or all situations in the "common ground"), the attitude indeed is *about* the (actual) individual—and if it turns out that this doesn't work out, the conceptualization only manages to represent a *de dicto* belief. Thus, it seems only consequential to use (182) instead of (181) and impose some restriction on each coordinate that fixes the rôle of this "inner character" in the indices. But, as already mentioned in section 4.3.1, there are multiple issues to solve first. The most urgent one might be the following: it isn't clear how the set of inner characters should be described without making use of embedded sentences. Note that all the accounts reviewed in the previous section don't describe a full set of conceptual covers (acquaintance-based or not) in advance. Perspectives are individuated either by worlds/situations alone or by their centered alternatives. One can assume that the so individuated perspective of an attitude holder is compatible with the existence of individuals under a certain cover or conceptualization when it can be successfully applied in the calculation of the truth conditions of a particular attitude ascription. But without the material of the embedded sentence it is not so clear how to state that an attitude holder like Ralph entertains a certain conceptual cover. He can be said to believe that a certain man in a brown hat exists and he can also be said to believe that he saw a certain man at the beach. But it can't be determined how many of these existence claims can be made, possibly only finitely many, but it could also turn out that this can be continued indefinitely (Ralph believes that a certain brown hat exists, Ralph believes that another brown hat exists, Ralph believes that brown hats exists, Ralph believes that brown hats existed in 1966, etc.). Furthermore, the set of indices (182) isn't a good starting point either. No conceptual cover can be "read off" by abstracting a set of relations between the situational core in σ_0 and the individuals occupying a particular position σ_i, since the indices vary unconstrained. Thus, a procedure like this would yield the set of all relations compatible with the situations and individuals making up the indices for each and every position of the indices in (182). This is way too unspecific to work with. Thus, without a way of preestablishing a particular order among the indices in (182), no conceptualization can be derived. But without preestablished conceptualization, there are only arbitrary ways to enforce an order among the tuples, and this approach cannot be guaranteed to come without negative consequences.

But there is a way to give an independent characterization of conceptualizations that allows singling out a less chaotic set of indices. The basic idea is that something similar to the domains Aloni (2001) works with can be generated from the embedded sentence by interpreting it against a fresh set of assignments. The ingredients that need to be incorporated are the following:

- With respect to what was said in section 4.1.4, the situation variable of an embedded sentence needs to be distinguished from that of the matrix sentence. Thus, the attitude verb has to introduce a new one.

- In order to diminish the influence of the discourse for the evaluation of an embedded

of robust and clearly delineated characters." (Kaplan, 1969, 201f.)

sentence, a file has to be created "from scratch". Its domain need to consist of the situation variable the attitude verbs feeds to the embedded sentence and every other variable that is needed to render the embedded sentence defined.

- A certain overlap between the domains of the matrix assignments and that of the—yet to be determined—embedded assignments is not only allowed but necessary: firstly, to allow for *de re* readings in the first place, and secondly, in order for the embedded sentence's $\|\bullet\|_{\omega}^{+}$-value to be defined for the second set of assignments in the sense of section 4.2.3 in case variables from the matrix sentence indeed occur within the embedded sentence and the embedded assignments have to provide a value for them.

On the first point: the novelty of the situation variable the attitude verb introduces cannot be guaranteed by the use of $\subset_V$ at some point. This is because the assignments collected in files are restricted to index-representing assignments, which means that there can't be two situational cores. Thus, the attitude verb doesn't extend a preexisting file, but creates a new one. Of course, the attitude verb's contribution itself is dependent on the value of a situation variable. But this fact cannot be used to make sure that no confusions arise. That is, if it is just required that the situation variable introduced by the attitude verb is different from the one it depends on (by way of its value), iteration becomes a problem. Suppose an attitude ascription introduces a situation variable s' because it couldn't use the matrix sentences' situation variable s. Another attitude ascription embedded under the first one would just need to introduce a variable different from s' and thus could opt for s again. But if material inside of the most deeply embedded sentence is supposed to be interpreted on the layer of the matrix sentence, this choice creates confusion. In a standard system, this problem can't arise, because quantification is described on the level of boldface variables. There, the variables stay bound and are not confused because the introduction of a variable of the same name forces renaming. This is different in FCS because situation variables are free.

But since this only concerns sentence-internal configurations, the right choice can be determined syntactically, e.g., by making use of a projection mechanism like (156) discussed in section 3.3.3 (p. 151).

Concerning the second point, it is assumed that the situation variable introduced by the attitude verb is s'. The domain a file at least needs to cover to render the embedded sentence defined derived by the following:

(185) A set of variables V_α is the smallest set of variables built around s' that guarantees a truth-conditionally relevant outcome for an expression α iff:

a. $s' \in V_\alpha$, and
b. $Ass^{V_\alpha} \cap I \neq \emptyset$, and
c. $\|\alpha\|_{\omega}^{d}(Ass^{V_\alpha}) \neq \emptyset$, and
d. $\|\alpha\|_{\omega}^{d}(Ass^{V}) = \emptyset$, for all proper subsets V of V_α.

(185a) ensures that the variable contributed by the attitude verb is part of the domain, (185b) demands that the domain allows for index-representing assignments (I is defined in (28) on page 233). Hence, s' must represent the situational core. (185c) checks whether this domain comes up with all the variables needed, while (185d) checks whether there are any superfluous ones. Generally speaking, this can be understood as a (multi-layered) variant of the notion of *minimal domain* ($\mathcal{D}[\alpha]$) defined in (199) in section: 3.4.1.

Given V_φ for an embedded sentence φ, $\|\varphi\|^+_\omega(Ass^{V_\varphi})$ has a relevant output.[77] This output is not necessarily a subset of Ass^{V_φ}, since φ could contain existential or definite quantifiers introducing "fresh" variables. Thus, only the assignments in $\|\varphi\|^+_\omega(Ass^{V_\varphi})$ are relevant for further use. Since the novelty or familiarity of variables shouldn't matter (as argued in section 4.3.1), the "complete" assignments in $\|\varphi\|^+_\omega(Ass^{V_\varphi})$ must be relevant for the truth-conditions of the attitude ascription. Since the file Ass^V_φ is the full set of assignments with the domain V_φ, the interpretation step corresponds to evaluating a sentence against LS—the difference consists just in the presence of further coordinates, which after evaluation represent all possible witnesses for the variables in question.

From this set of assignments, sets of relations between situations and individuals can be derived in the following way: all witnesses that make the sentence true are stored under each variable in the domain with the exception of the situation variable s'. Thus, the variables partially characterize relations over $LS \times D$. More specifically, for any individual variable υ_i in the domain of the file $\|\varphi\|^+_\omega(Ass^{V_\varphi})$ there is a set of pairs of situations and individuals:

(186) $\quad R_{\upsilon_i} := \{\langle f(s'), f(\upsilon_i)\rangle : f \in \|\varphi\|^+_\omega(Ass^{V_\varphi})\}$

R_{υ_i} is a relation over $LS \times D$, but it most likely only covers a subset of LS and a subset of D. The variables would only then characterize a full relation with respect to LS if φ was a tautology. Otherwise, R_{υ_i} is compatible with several relations that differ for the situations that aren't values of s' (contradictions characterize the empty relation).

All relations can be collected into one set, dubbed $\Phi_{de\ dicto}$:

(187) $\quad \Phi_{de\ dicto} := \{R_{\upsilon_i} : \upsilon_i \in D(\|\varphi\|^+_\omega(Ass^{V_\varphi}))\}$

If a set of situations $Dox_{a,s}$ is the doxastic perspective of an individual in a situation s, this set entails the sentence φ iff all relations in the set in (187) cover $Dox_{a,s}$ as a whole. That is, the conceptualizations preserve the doxastic perspective of the attitude holder.

(188) $\quad \forall R \in \Phi_{de\ dicto} \forall s' \in Dox_{a,s} : \exists d : R(s')(d)$

For this to hold it suffices to use relations. This is because the domain $\|\varphi\|^+_\omega(Ass^{V_\varphi})$ contains all variables of φ's s'-layer, regardless whether they already played a rôle in the matrix sentence or not. Thus, for a mere *de dicto* belief, this is already enough.

This leads to the third bullet point. For *de re* belief, more is needed: Firstly, the assignments that take care of the matrix sentence possibly assign situations to their situation variable that are already excluded in $Dox_{a,s}$, and secondly, the connection between the individuals that are the values of the variables in the matrix sentence that

[77] In the same way Ass^{V_α} relates to $\mathcal{D}[\alpha]$, $\|\varphi\|^d_\omega(Ass^{V_\alpha})$ relates to $\mathcal{R}[\alpha]$ defined in (200) also on page 173

are also relevant for the embedded sentence has to be established. Following Aloni, it is not enough to take the elements of $\Phi_{de\ dicto}$ into account. One needs to take the set of compatible relations. The set of compatible relations is the set of all relations over $LS \times D$ R_{υ_1} is a subset of, and that has the structure Aloni requires:

(189) $\mathcal{R}_{\upsilon_i} := \{R \in LS \times D : R_{\upsilon_i} \subseteq R \;\&\; \forall s \in LS\, \forall d \in D\; \exists! c \in R : c(w) = d\}$

As can be seen, this switches from relations to functions of the required format. Since all R in the set correspond on the R_{υ_i}-part that is the basis of $\Phi_{de\ dicto}$ this operation singles out those covers that guarantee definite variation. These relations are again collected in a set, this time $\Phi_{de\ re}$:

(190) $\Phi_{de\ re} := \{\mathcal{R}_{\upsilon_i} : \upsilon_i \in D(\|\varphi\|^{+}_{\omega}(Ass^{V_\varphi}))\}$

This set contains all possible conceptual covers in the sense of Aloni compatible with the embedded sentence φ. For the interpretation of a concrete *de re* ascription, this is too much. She argues at length for a particular selection operation, modeled in Optimality Theory. Instead of going into this, it is just assumed that there is a particular selection $\Phi^{*}_{de\ re}$ that contains one element of each $\mathcal{R}_{\upsilon_i}$.

If the set of assignments that takes care of the matrix sentence is G (and the situation variable is s), the constraint on this set can be put as follows:

(191) $\{g \in \|\varphi\|^{+}_{\omega}(G) : \forall \upsilon_i \in D(g) \cap D(\|\varphi\|^{+}_{\omega}(Ass^{V_\varphi})) : \exists \mathcal{R}_{\upsilon_i} \in \Phi^{*}_{de\ re} : \exists c \in \mathcal{R}_{\upsilon_i} : c(g(s)) = g(\upsilon_1)\}$

This final operation corresponds to the introduction of the existential quantifier over conceptual covers in Aloni's system. Apart from that, as can be seen in the prefix of the set formation, the embedded sentence is also evaluated against the set of matrix-assignments. This allows the procedure described in section 4.2.3 to collect the material inside of φ that is dependent on s.

This is quite far away from an implementation of attitude reports in FCS. Hopefully, some points can be taken home:

1. It is possible to implement *de re* quantification in a more local fashion than Aloni does. Conceptual covers are only called forth when needed, i.e. when an attitude ascription has to be evaluated. In general, FCS's quantifiers don't quantify over concepts, but over individuals. But they always do this within a set of assignments, so to speak, so that individual concepts, and therefore conceptual covers can be extracted.

2. The semantic value of the embedded sentence is derived with respect to a newly built set of assignments. This set could in principle have nothing in common with the set of matrix assignments. What it can share with this set is a part of its domain. This can happen when there indeed are variables in the domain of the matrix assignment that get reused in the embedded sentence. Especially, this happens automatically if a(n) (in-)definite in the embedded clause introduces the

situation variable the matrix sentence also uses (because of ROOT). The article together with its restrictor are then evaluated against the set of matrix assignments and thus introduce their variables into its domain. But the nuclear scope is always interpreted *in situ* while it also has to contain the individual variable of the quantifier. Thus, the domain of the matrix assignments and the domain of the embedded assignments overlap. In this case, the *de re* procedure just sketched takes over.

3. Because of the last point, all variables in the embedded sentence are (dynamically) bound in the same sense as anaphoric variables in the matrix sentence are: they are contained in a domain of a file. But since the matrix and the embedded clause are evaluated separately, there can't be any direct connection between these two variables. The only connection that holds is the one established by the *de re* procedure in that it guarantees that the set of matrix assignments is reduced according to the demands of the conceptual cover that is introduced on the basis of the evaluation of the embedded sentence. In a sense, this is according to Lewis' criterion.

5 Problems and Prospects

5.1 Indexical Shift

According to Lewis' criterion for index-parameters discussed in Chapter 1 is the existence of expressions that are best analyzed as shifting such a parameter when they modify a full sentence. As argued in section 3.1.3, part of the data on bound personal pronouns conforms to everything an index-parameter must conform to. And, as demonstrated in section 4.3, embedded personal pronouns are "bound" in the same sense as are anaphoric pronouns: they all find a value in a freshly created set of assignments that must be interpretable as representing (parts of) an attitude holder's *perspective*. Thus, pronouns are not bound from outside the intensional environment, even though their translation as variables that were already present in the "common ground" suggests that they are.

If this thesis is on the right track so far, all of this seems to hold for English (and German). But there are languages that behave differently. As famously argued in Schlenker (2003), in a language like Amharic, it can be demonstrated that *indexicals* are shifted – which is a concept that should be self-defeating, if Lewis is right. One of the examples that Schlenker uses to demonstrate Amharic's capacities is the following (already mentioned on page 255, ex. (79)):

(1) John jiəgna n-ññ yɨl-all
John hero COP.PRES-1sO say.3M
Lit. 'John says I am a hero.'
John says he is a hero. (Schlenker, 2003, p. 68)

The point is found in the literal translation when compared to its paraphrase: Amharic uses 1st person agreement markers on the embedded verb to express what John said about himself as opposed to the actual utterer of (1). This surprising property was subject of further investigation, most notably in Anand and Nevins (2004) and Anand (2006). "Indexical Shift" turned out to be a highly constrained phenomenon. Mostly, it is restricted to sentences embedded under verbs of saying, even though it also occurs under doxastic operators like *believe*. It is furthermore not restricted to 1st person expressions, but extends to other indexical expressions as well (cf. Deal, 2017, for an excellent survey). One of the hallmarks of this research is the so-called SHIFT TOGETHER CONSTRAINT, first demonstrated to be at work in Zazaki and Slave in Anand and Nevins (2004), later shown to hold in Amharic as well (Anand, 2006). It roughly states that all indexicals (belonging to the same class, cf. Deal, 2018, p. 11) have to shift if one of them is shifted. Just to illustrate, if c^* is the utterance context and c is the embedded, shifted one, the lack of variety predicted by SHIFT TOGETHER can be represented as follows (Zazaki, Anand and Nevins, 2004, p. 23):

(2) Vɨzeri Rojda Bill-ra va kɛ ɛz to-ra miradiša
Yesterday Rojda Bill-to said that I you-to angry.be-pres

(2) only has two out of four possible readings (representing the contribution of *I* and *you* as Auth and Addr, respectively):

(3) a. Yesterday Rojda said to Bill, "Auth(c) am angry at Addr(c)."
b. Yesterday Rojda said to Bill, "Auth(c^*) is angry at Addr(c^*)."
c. #Yesterday Rojda said to Bill, "Auth(c^*) am angry at Addr(c)."
d. #Yesterday Rojda said to Bill, "Auth(c) am angry at Addr(c^*)"

In a sense that is expected from a formal point of view, since indexicals, as expressions that are index-dependent, address themselves to one and the same parameter of contexts/indices, and if this parameter is manipulated by an appropriate expressions, all expressions depending on the parameter shift accordingly. Thus, even if the Kaplan/Lewis-perspective on monsters is wrong, the general architecture provides the ground for the right explanation.

But the data are not as clear-cut as one might expect. At first glance, it looks as if the Shift Together Constraint – which is well established for the languages mentioned above – is easily violated in Amharic:

(4) John al-ɨttazzəzə-ññ al-ə
J. NEG.1s-obey.mkimperf-1sO sayPerf.3sm
'John said I will not obey me.' Amharic, Leslau (1995, p. 779); through Anand (2006)

Anand observes two things. Firstly, there is a mixed reading available that shouldn't be possible given his Shift Together Constraint, namely (5a). On the other hand, secondly, only one of the two possible mixed readings is available. That is (5b) should be possible as well, if Amharic didn't obey Shift Together at all:

(5) a. John said he will not obey me.
b. #John said I will not obey him.

But, if the two 1st person expressions aren't in a c-command relationship, the reading (4) misses is available again. That is, (6) has all four readings listed in (7):

(6) John lɨj-e ay-ɨttazzəzə-ññ alə
John son-1s NEG.3s-obey.mkimperf-1sO say.PERF.3sm
'John said my son will not obey me' (Anand, 2006, 101, (299))

(7) a. John said his son will not obey him.
b. John said my son will not obey me.
c. John said his son will not obey me.
d. John said my son will not obey him.

Anand's solution to the problem—as reaffirmed by Amy Rose Deal (Deal, 2018)—is as follows: he claims (4) doesn't involve true indexicals in all positions. The best way to analyze the alleged shifted indexical is to make it a logophoric element, similar to *PRO* in English and German. This move does explain why (4) seems to disobey Shift Together. Since logophoric elements—like *PRO*—need to be bound locally, the other, non-shifted element has no choice but to 'refer back' to the matrix subject if contraindexed—the center of the embedded clause is already occupied. This is confirmed by constructions that do not select for *PRO*-headed complements, e.g. the following variation of (1):

(8) John jiəgna n-ññ yɨSəllɨg-all
John hero Cop.Pres-1sO think.3m
Lit. 'John thinks I am a hero.' (Anand, 2006, p. 76, cf. Schlenker, 2003; Deal, 2018)

(8) doesn't have a 'shifted' reading. That is, it can only be interpreted like its English counterpart *John thinks (that) I am a hero.* This is readily explained if it is assumed that Amharic *think*, contrary to *say*, doesn't select for sentences headed by logophoric elements.

Furthermore, this assessment also helps explaining the absence of several analytically possible readings in constructions like the following, where a sentence like (8) is embedded under *say*:

(9) Mary John lɨj-e ay-ɨttazzəzə-ññ yɨSəllɨg-all aləCC
Mary John son-1s NEG.3s-obey.Imperf-1sO think.Imperf-3sm say.Perf.3sf
Lit. 'Mary said John thinks my son will not obey me.' (Anand, 2006, 102, (303))

As one expects from (8), (9) has no reading under which the most deeply embedded sentence is about John's son. Furthermore, there are in fact only two readings available, namely an 'unshifted' one, and one where all the crucial expressions 'refer back' to *Mary*:

(10) a. Mary said John thinks my son will not obey me.
b. Mary said John thinks her son will not obey her.

All conceivable mixed readings are impossible. This shows that the allegedly shifted indexicals that disobey Shift Together indeed are best analyzed as logophors. The argument goes as follows (cf. Deal, 2018, emphasizing that this is Anand's true argument): If Shift Together could be violated easily, (9) should have way more readings, contrary to fact. But if it is assumed that the cases in which Shift Together apparently is violated do in fact not involve indexicals at all, but logophors, (9) is predicted to have less readings because (i) logophoric elements aren't compatible with *think*, and (ii) cannot be licensed over some distance. Hence, (9) cannot involve logophors at all. And hence, it only has the readings in (10), not only compatible with, but predicted by Shift Together.[1]

[1] "I then turned to Amharic, which seems to disobey Shift Together, and demonstrated that such 'shift separate' cases are highly constrained: one of the indexicals must be in the immediate scope

Given this very brief overview, one may not be convinced that Lewis was wrong. Especially given the framework developed in this thesis one may ask why all of this shouldn't be possible on the basis of an index-parameter. There are even dedicated variables that denote the agent in a context if (and only if) evaluated against the context. So it seems to be reasonable to assume that these variables may play a more important rôle in some other language's embedded sentences. One can try to tackle this in the following way. The asymmetry between 1st and 2nd person pronouns on the one hand and third person pronouns on the other that was proposed in section 4.2.4 manifested itself in the following formulæ:

(11) a. $|\mathrm{I}_m|^c = \lambda\mathbf{s}.\lambda\mathbf{P}.\top(c)(z_m) \wedge \mathbf{P}(\mathbf{s})(z_m)$
b. $|\mathrm{you}_m|^c = \lambda\mathbf{s}.\lambda\mathbf{P}.\top(c)(y_m) \wedge \mathbf{P}(\mathbf{s})(y_m)$

(12) a. $|\mathit{dthat}|^c = \lambda\mathbf{x}.\lambda\mathbf{s}.\lambda\mathbf{P}.\top(c)(\mathbf{x}) \wedge \mathbf{P}(\mathbf{s})(\mathbf{x})$
b. $|\mathrm{he/she/it}_m|^c = x_m$

The former class of pronouns is necessarily tied to the context, while 3rd person pronouns must be helped to receive a context-dependent interpretation. One could thus try to make use of the z_i and y_m variables in the index as well by assuming that all pronouns form a homogeneous class in the sense that all of them must be manipulated by *dthat* to receive a context-dependent reading:

(13) a. $|\mathit{dthat}|^c = \lambda\mathbf{x}.\lambda\mathbf{s}.\lambda\mathbf{P}.\top(c)(\mathbf{x}) \wedge \mathbf{P}(\mathbf{s})(\mathbf{x})$
b. $|\mathrm{I}_m|^c = z_m$
c. $|\mathrm{you}_m|^c = y_m$
d. $|\mathrm{he/she/it}_m|^c = x_m$

But the puzzle is the following: all of this might be true. But still, one doesn't have the choice between a context-dependent and bound reading for each individual "indexical" element in an embedded clause: either all of them are bound (and shifted) or all of them are free and are interpreted against the context. This cannot be explained under the translations in (13), because *dthat* is understood to be available at any stage. That is, it is far from clear what should exclude applying *dthat* to only one out of several embedded *I*'s, for example.

What might come into play is an assumption that was made in section 4.1.2. There it was argued that the domains of context-representing assignments must be highly restricted. This was necessary because the more abstract conception of contexts defended in section 2.3 made it impossible to use some kind of predicate that denotes the descriptive content of an indexical. To compensate for this, it was assumed that assignments are able to represent contexts only if their domain could be arranged in the following way (cf. (24) in section 4.1.2:

of *say* and refer to that author. I suggested that this indicates that what I have been calling the Amharic 1st person indexical is actually morphologically homophonous between a real 1st person indexical and a local logophor. And, indeed, when we control for the logophor, Shift Together reappears. Thus, to conclude: Amharic also obeys Shift Together." (Anand, 2006, p. 103)

(14) A tuple $\vec{u}$ is called a *rôle sensitive ordering* of a set of variables V iff

a. $\vec{u}$ is an ordering of V, and

b. $V \cap \mathcal{C} = \{\vec{u}_0\}$, and $V \cap Z = \{\vec{u}_1\}$, and $V \cap Y = \{\vec{u}_2\}$, and

c. $\forall i, j, n, m \in \mathbb{N} : x_n \in V \cap X \;\&\; x_m \in V \cap X \;\&\; \vec{u}_i = x_n \;\&\; \vec{u}_j = x_m \;\&\; n > m \rightarrow i > j$

As can be seen by inspecting (14b), contextual assignments are only allowed to have one element of Z and Y each in their domain. In fact they need to have exactly one of each of them in their domain to represent a context.

Thus, one way to restrict the unrestricted applicability of *dthat* is to assume that some clause embedding verbs put some restrictions on their complements in terms of the number of elements allowed. That is, one can assume that Amharic *say* demands there to be at most one element of Z, etc. And since *dthat*-modified pronouns leave the same traces in their environments as non-modified pronouns, this means that all examples violating *Shift Together* are also examples that feature more than one of those elements.

If this is on the right track, then it serves as a further argument for the approach developed here. This very possibility is unique to this account, since others work with lexical material (however abstractly interpreted) to individuate context-dependent pronouns. However, it remains to be seen whether such a try is tenable in the end. This problem is left for further research.

5.2 The current version of FCS is ill-defined

The following gives the final form of partial FCS that starts out with (87) on page 260, but is developed further in this very section.

(15) Non-eliminative FCS

υ stands for a variable of any type, β for predicates of any arity.

a. For a term υ of any type:

$$\|\upsilon\|^{\bullet}_{\omega}(G) \;=\; \lambda g.g(\upsilon)$$

b. For any predicate with arity n, with $\tau_0, \ldots, \tau_n \in D_{\mathbf{e}}$:

$$\begin{aligned}
\|\beta\|^{d}_{\omega}(\tau_0)\ldots(\tau_n)(G) &= \{g \in G : \tau_0(G)(g) \neq \#\} \cap \ldots \cap \\
& \quad\; \{g \in G : \tau_n(G)(g) \neq \#\} \\
\|\beta\|^{+}_{\omega}(\tau_0)\ldots(\tau_n)(G) &= \{g \in G : \langle \tau_0(G)(g), \ldots, \tau_n(G)(g)\rangle \in \beta'\} \\
& \cup \;\; \overline{\|\beta\|^{d}_{\omega}(\tau_0)\ldots(\tau_n)(G)} \\
\|\beta\|^{-}_{\omega}(\tau_0)\ldots(\tau_n)(G) &= \{g \in G : \langle \tau_0(G)(g), \ldots, \tau_n(G)(g)\rangle \notin \beta'\} \\
& \cup \;\; \overline{\|\beta\|^{d}_{\omega}(\tau_0)\ldots(\tau_n)(G)}
\end{aligned}$$

c.

$$\begin{aligned}
\|\varphi \wedge \psi\|^{d}_{\omega}(G) &= \|\psi\|^{d}_{\omega}(\|\varphi\|^{d}_{\omega}(G)) \cup \overline{\|\varphi\|^{d}_{\omega}(G) \cup \|\psi\|^{d}_{\omega}}(G) \\
\|\varphi \wedge \psi\|^{+}_{\omega}(G) &= \|\psi\|^{+}_{\omega}(\|\varphi\|^{+}_{\omega}(G)) \cup \overline{\|\varphi \wedge \psi\|^{d}_{\omega}(G)} \\
\|\varphi \wedge \psi\|^{-}_{\omega}(G) &= \|\psi\|^{-}_{\omega}(\|\varphi\|^{+}_{\omega}(G)) \cup \|\psi\|^{+}_{\omega}(\|\varphi\|^{-}_{\omega}(G)) \cup \|\psi\|^{-}_{\omega}(\|\varphi\|^{-}_{\omega}(G)) \\
& \cup \;\; \overline{\|\varphi \wedge \psi\|^{d}_{\omega}(G)}
\end{aligned}$$

$$
\begin{array}{llcl}
\text{d.} & \|-^{\upsilon}\varphi\|^d_\omega(G) & = & \|\varphi\|^d_\omega(G) \\
& \|-^{\upsilon}\varphi\|^+_\omega(G) & = & \boxed{\oplus}([\upsilon]^d_\omega(G))(\|\varphi\|^-_\omega(\{g \in [\upsilon]^d_\omega(G) : \|\varphi\|^+_\omega(\{g\}) = \emptyset\})) \\
& & \cup & \|\varphi\|^+_\omega(\overline{[\upsilon]^d_\omega(G)}) \cup \overline{\|-^{\upsilon}\varphi\|^d_\omega(G)} \\
& \|-^{\upsilon}\varphi\|^-_\omega(G) & = & \boxed{\oplus}([\upsilon]^d_\omega(G))(\|\varphi\|^+_\omega([\upsilon]^d_\omega(G))) \cup \|\varphi\|^+_\omega(\overline{[\upsilon]^d_\omega(G)}) \\
& & \cup & \overline{\|-^{\upsilon}\varphi\|^d_\omega(G)} \\
\text{e.} & \|(\exists^{\upsilon_1}_{\upsilon_2})[\varphi]\|^d_\omega(G) & = & \|\varphi\|^d_\omega(\{h : \exists g \in [\upsilon_1]^d_\omega(G) : g \subset_{\{\upsilon_2\}} h\} \cup \overline{[\upsilon_1]^d_\omega(G)}) \\
& \|(\exists^{\upsilon_1}_{\upsilon_2})[\varphi]\|^+_\omega(G) & = & \|\varphi\|^+_\omega(\{h : \exists g \in [\upsilon_1]^d_\omega(G) : g \subset_{\{\upsilon_2\}} h\}) \\
& & \cup & \|\varphi\|^+_\omega([\upsilon_1]^d_\omega(G) \cap \overline{[\upsilon_2]^d_\omega(G)}) \cup \overline{\|(\exists^{\upsilon_1}_{\upsilon_2})[\varphi]\|^d_\omega(G)} \\
& \|(\exists^{\upsilon_1}_{\upsilon_2})[\varphi]\|^-_\omega(G) & = & \|\varphi\|^+_\omega(\overline{[\upsilon_1]^d_\omega(G)}) \cup \overline{\|(\exists^{\upsilon_1}_{\upsilon_2})[\varphi]\|^d_\omega(G)} \\
\text{f.} & \|(\text{Ɑ}^{\upsilon_1}_{\upsilon_2})[\varphi]\|^d_\omega(G) & = & \|\varphi\|^d_\omega(\{h : \exists g \in [\upsilon_1]^d_\omega(G) : g \subseteq_{\{\upsilon_2\}} h\} \cup \overline{[\upsilon_1]^d_\omega(G)}) \\
& \|(\text{Ɑ}^{\upsilon_1}_{\upsilon_2})[\varphi]\|^+_\omega(G) & = & \textsc{Unique}_{\{\upsilon_2\}}([\upsilon_1]^d_\omega(G))(\\
& & & \|\varphi\|^+_\omega(\{h : \exists g \in [\upsilon_1]^d_\omega(G) : g \subseteq_{\{\upsilon_2\}} h\})) \cup \|\varphi\|^+_\omega(\overline{[\upsilon_1]^d_\omega(G)}) \\
& & \cup & \overline{\|(\text{Ɑ}^{\upsilon_2}\upsilon_1)[\varphi]\|^d_\omega(G)} \\
& \|(\text{Ɑ}^{\upsilon_1}_{\upsilon_2})[\varphi]\|^-_\omega(G) & = & \|\varphi\|^+_\omega(\overline{[\upsilon_1]^d_\omega(G)}) \cup \overline{\|(\text{Ɑ}^{\upsilon_2}\upsilon_1)[\varphi]\|^d_\omega(G)} \\
\text{g.} & \|\mathbf{x}\|^\bullet_\omega(G) & = & \omega(\mathbf{x})(G) \\
\text{h.} & \|\alpha(\beta)\|^\bullet_\omega(G) & = & \|\alpha\|^\bullet_\omega(\|\beta\|^\bullet_\omega)(G) \\
\text{i.} & \|(\lambda\mathbf{x}.\alpha)\|^\bullet_\omega(u)(G) & = & \|\alpha\|^\bullet_{\omega[\mathbf{x}/u]}(G)
\end{array}
$$

As mentioned in the main text, the expressions in (15a.–f.) are constants from the perspective of the assignment function ω. Their values don't vary with different choices of ω, but are determined entirely by the concrete choice of terms (non-boldface variables) and the argument G. The assignment ω only comes into play when boldface variables are involved; be it free occurrences or λ-bound ones.

In order to make sure that the language is well-behaved, it needs to be shown that the positive and negative values for any expression α (i) don't overlap, and (ii) exhaust $\|\alpha\|^d_\omega$. Only under these conditions is the notion of *definedness* justified.

But due to the presuppositionality of $\exists$ and Ɑ, this cannot be true. Because both operators demand their restrictor to be true, both their positive and negative values are empty, if they aren't, but their d-value isn't. That means that at this point, a second sense of partiality intervenes, namely the one which arises from presupposition failures in contrast to undefinedness because something is wrong in the "bookkeeping device". The d-values aren't intended to be sensitive to these violations of the law of contradiction, because all they care about is the proper distribution of variables. Instead of allowing this violation to happen, a second kind of partiality can be described in the way. Instead of going the Russellian way by accepting the violation of the law of contradiction, one takes the Fregean route and introduces a further, more substantial sense of (un-)definedness:

(16)
a. $\|\upsilon\|^p_\omega(G) = \lambda g.(\upsilon)$
b. $\|\beta\|^p_\omega(\tau_0)\ldots(\tau_n)(G) = G$
c. $\|\varphi \wedge \psi\|^p_\omega(G) = \|\psi\|^p_\omega(\|\varphi\|^p_\omega(G))$
d. $\|-^{\upsilon}\varphi\|^p_\omega(G) = \|\varphi\|^p_\omega(G)$

e. $\|(\exists^{\upsilon_1}_{\upsilon_2})[\varphi]\|^p_\omega(G) = \|\varphi\|^+_\omega(\{h : \exists g \in G : g \subset_{\{\upsilon_2\}} h\})$
f. $\|(\text{Ↄ}^{\upsilon_1}_{\upsilon_2})[\varphi]\|^p_\omega(G) = \textsc{Unique}_{\{\upsilon_2\}}(G)(\|\varphi\|^+_\omega(\{h : \exists g \in G : g \subseteq_{\{\upsilon_2\}} h\}))$
g. $\|\mathbf{x}\|^p_\omega(G) = \omega(\mathbf{x})(G)$
h. $\|\alpha(\beta)\|^p_\omega(G) = \|\alpha\|^p_\omega(\|\beta\|^p_\omega)(G)$
i. $\|(\lambda\mathbf{x}.\alpha)\|^p_\omega(u)(G) = \|\alpha\|^p_{\omega[\mathbf{x}/u]}(G)$

Together with the general rule that a sentence φ is p-defined for a file G iff $\|\varphi\|^p_\omega(G) \neq \emptyset$ these rules are able to filter out those cases which cause problems for the d-values. But note that the p-values presuppose the d-values: the restrictor of a(n) (in-)definite cannot be true if it is not d-defined for the file it is applied to. Thus, the p-values only then correctly filter out presupposition failures if the corresponding d-values are not empty.

The two senses of partiality can be combined into one (taking '$\natural$' to be the combination of 'p' and 'd'):

(17) a. $\|\upsilon\|^\natural_\omega(G) = \lambda g.(\upsilon)$
b. $\|\beta\|^\natural_\omega(\tau_0)\ldots(\tau_n)(G) = \{g \in G : \tau_0(G)(g) \neq \#\} \cap \ldots \cap$
$\{g \in G : \tau_n(G)(g) \neq \#\}$
c. $\|\varphi \wedge \psi\|^\natural_\omega(G) = \|\psi\|^\natural_\omega(\|\varphi\|^\natural_\omega(G)) \cup \|\varphi\|^d_\omega(G) \cup \|\psi\|^d_\omega(G)$
d. $\|-^\upsilon\varphi\|^\natural_\omega(G) = \|\varphi\|^\natural_\omega(G)$
e. $\|(\exists^{\upsilon_1}_{\upsilon_2})[\varphi]\|^\natural_\omega(G) = \|\varphi\|^+_\omega(\{h : \exists g \in [\upsilon_1]^d_\omega(G) : g \subset_{\{\upsilon_2\}} h\}) \cup \|\varphi\|^d_\omega(\overline{[\upsilon_1]^d_\omega(G)})$
f. $\|(\text{Ↄ}^{\upsilon_1}_{\upsilon_2})[\varphi]\|^\natural_\omega(G) = \textsc{Unique}_{\{\upsilon_2\}}([\upsilon_1]^d_\omega(G))($
$\|\varphi\|^+_\omega(\{h : \exists g \in [\upsilon_1]^d_\omega(G) : g \subseteq_{\{\upsilon_2\}} h\})) \cup \|\varphi\|^d_\omega(\overline{[\upsilon_1]^d_\omega(G)})$
g. $\|\mathbf{x}\|^\natural_\omega(G) = \omega(\mathbf{x})(G)$
h. $\|\alpha(\beta)\|^\natural_\omega(G) = \|\alpha\|^\natural_\omega(\|\beta\|^\natural_\omega)(G)$
i. $\|(\lambda\mathbf{x}.\alpha)\|^\natural_\omega(u)(G) = \|\alpha\|^\natural_{\omega[\mathbf{x}/u]}(G)$

This combined value rather straightforwardly removes the problems the d-values alone have: according to the $\natural$-values, the restrictor of a(n) (in-)definite has to be true (and the individual introduced unique) if it comes with the situation variable the set of assignments G can deal with (and the conditions connected to the use of extension relations are fulfilled as well), and just d-defined for G in case the situation variable isn't taken care of. Thus, the lack of non-empty negative values now is compensated by reducing the $\natural$-values to positive values (given the right situation variable). But the multi-dimensionality of (15) reintroduces this problem: in case the situation variable of the quantifier-prefix isn't accounted for by the argument file, the second clause in the description of the definedness-conditions comes into play. The whole expression also counts as defined if (a part of) the restrictor contains whatever situation variable the argument file accounts for. It could, for example, be an occurrence of $\mathfrak{c}$ which allows an indexical to be part of the restrictor of a definite description (*No man I know is bald.*). By inspection of the respective clauses in (15) one can easily see that in this case the positive and the negative value coincide again, but need not be empty. Thus, the multi-dimensionality of the language makes it misbehaved in the sense that these two values do not mutually exclude one another. Furthermore, even if the situation variable is the right one, the positive and the negative value taken together don't exhaust the whole $\natural$-value, simply because it also contains assignments with completely different domains. They just exhaust the part of the $\natural$-value that takes care of the same situation variable. Note that if the earlier version in Chapter 3 ((195) on page 170; but this statement holds even after the changes made in sections 3.4.2 and 3.4.3 are incorporated) is endowed with $\natural$-values like (17), the proof is rather straightforward. By induction over the complexity of formulæ it can then be shown that the positive and negative values exhaust the *d*-values and are disjoint. But for the form (15), this obviously doesn't hold. This is a serious defect that should either be repaired somehow or shown to be harmless after all. It is not so clear what a different set of interpretation rules that avoids this problem but still allows for the interpretation of material dependent on a higher layer should look like. Maybe this shows that the van der Sandtian approach paired with layers in Maier (2006, a.o.) is on the right track after all. Since it isn't necessary to claim that the deletion of material from one box and its inclusion into a higher one is an instance of a movement operation that should respect syntactic islands, the approach pursued here, namely to make all phrases interpretable *in situ*, isn't needed after all.

5.3 Conclusions and further prospects

The ultimate goal of this thesis was to "marry" Context Theory and Dynamic Semantics in such a way that both families of theories benefit. Desiderata of this operation were to stipulate as few (lexical) ambiguities as possible, especially when dealing with 3rd person pronouns and definite descriptions. This turned out to be untenable due to peculiarities of the multi-dimensional interpretation procedure, and because of the general distinction that had to be made between local and non-local binding. This manifests itself most clearly in the ambiguity that was proposed for possessive pronouns. On the other hand, this later led to the difference between boldface and non-boldface variables. The former were used to model local binding configurations, the latter for anaphoric dependencies. This distinction intuitively plays a major rôle when it comes to the differences between overt 3rd person pronouns in embedded sentences and PRO. But this discussion has to await another occasion.

Huge parts of this only where possibly due to the move from sets of situations to sets of indices, because indices seem to allow for the right kind of granularity and flexibility when it comes to the notorious uniqueness condition of definite descriptions. Furthermore, sets of assignments receive a way more natural interpretation when they can be mapped onto indices. Whereas this part of the "bookkeeping device" is separated from possible world semantics-related notions in most former installments, it is integrated on the basis of intuitions that are found in Lewis' and Kaplan's reflections on the rôle of indices as opposed to contexts. The latter don't match sets of assignments as naturally as indices do. This is mostly due to the rather abstract interpretation that departs from the more common utterance-centric accounts and is probably more Kaplanian than Kaplan ever was. But it seems to work out in the end, especially considering the potential for the further analysis of indexical shift just mentioned.

Apart from fixing the problems with definedness and delving into the depths of indexical shift, there is at least one other future projects that suggests itself immediately: The whole system as it is defined is centered on situation variables in the sense that they guide the interpretation process. They are used to mark layers and they are ultimately responsible for the *de re* interpretation of some expressions. But, given the discussion in section 2.2.3 it is of course tempting to "unpack" situations and thereby assignment functions. The hope of course is that the present system proves to be flexible enough to deal with quantification over times and locations as well. In a decomposed framework, the job done by situation variables then would have to be overtaken by world variables. Which seems to be reasonable. But the more variables into play the more complicated things get. Thus, it wasn't possible to even touch on the peculiarities of these other modes of quantification. Needless to say, the account of attitudes *de dicto* and *de re* that was merely sketched here needs to be implemented properly.

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