COUNTERPARTS BLOCK SOME 'DE RE' READINGS*

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Abstract

Irene Heim in unpublished work proposed a new syntax-semantics interface for propositional attitude reports based on an ontology without transworld individuals, but counterpart functions instead. We show that the approach can capture the 'de re'/'de dicto' distinction, but makes different predictions from accounts with transworld individuals. Specifically, the account uses a non-invertible counterpart functions: a single individual in an alternative world can be the counterpart of many individuals of the real world. The directionality of counterpart functions predicts that a 'de dicto' interpreted DP cannot be an argument of a 'de re' interpreted predicate. We show that the predicted restriction is corroborated by existing work on restrictions on 'de re' interpretation. The derivation of constraints on 'de re' interpretation argues empirically for the counterpart ontology and Heim's implementation thereof.

In a 2001 talk at the University of Tübingen, Irene Heim sketched an approach to intensionality without world variables (Heim 2001). Instead, Heim employed the counterpart ontology of Lewis (1968, 1986). On this view, individuals occupy only ever a single possible world, but an individual can have counterparts in other possible worlds. A direct consequence of this view is that individuals carry with them the information of the possible world they are a part of. For any individual x, we can define $\mathsf{w}(x)$ as the unique world that x is a part of.

In this paper, I explore the consequences of Heim's proposal for restrictions on *de re* readings. Percus (2000), Keshet (2008, 2011), and Romoli and Sudo (2009) describe such restrictions. They also seek to derive them, as I discuss in Section 4 below. The main point of this paper is though to show that at least some such constraints follow from an ontology and analysis of propositional attitudes that has already been proposed for independent reasons. So, in a sense the restrictions that can be derived here come for free if the independent motivations are correct. Therefore I first

*For helpful comments on the ideas developed in this paper and for her continous support over the last more than twenty year, I thank Irene Heim. Orin Percus, Hazel Pearson, one reviewer, and an audience at the University of Amsterdam in June 2014 provided me useful comments on a draft of this paper. Orin Percus (2013) independently developed very similar ideas to the ones layed out here.

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present Heim's proposal in section 1, then an account of the *de re/de dicto* distinction in section 2, and then the restrictions on *de re* interpretation the account predicts in 3.

Since the main new point of this paper is near the end in section 3, I want to conclude this introduction with a brief, non-technical preview of the main point. One of the restrictions on *de re* interpretations that I address in 3 is illustrated by (1) (from Romoli and Sudo 2009, p. 430). Romoli and Sudo argue that (1) lacks an interpretation where *the president* is interpreted *de dicto*, but *the wife* is interpreted *de re* (see also the discussion in (42) below) and explain this constraint in term of the proper binding condition, a syntactic condition on movement relations.

(1) *Irene thinks $\underbrace{\text{the wife}}_{\text{de re}}$ of $\underbrace{\text{the president}}_{\text{de dicto}}$ is nice.

The alternative explanation I propose derives the lack of the interpretation indicated in (1) from the absence of transworld individuals and Heim's implementation of counterparts using functions. On its *de dicto* reading, *the president* denotes an individual A that is the president in Irene's belief world. But since A isn't a transworld individual, applying a *de re* interpretation of *wife* isn't straightforward. A *de re* interpretation of wife requires that there be an individual B in the actual world who is married to somebody else in the actual world, but need not be married at all in Irene's belief worlds. But individual A cannot be married in the actual world since A exists only in the Irene's belief world. Intensionality though requires frequently that we talk not only about individuals in the worlds they occupy, but also about their properties in other worlds. If individuals themselves don't exist across different worlds, then this intensionality requires that Lewis's counterparts of individuals of one world exist in some other worlds. If counterparts were mathematical relations, we could seek out an individual A' in the actual world that's related to A allowing the unavailable *de re* interpretation of *wife* in (1). But if counterparts are implemented as functions as in Heim's proposal, it could be that such functions only run in one direction: from the actual world into the belief world. And if that's the case, we can't go from A back to an individual in the actual world. Then if *the president* is interpreted *de dicto* in (1), *the wife* must also be interpreted *de dicto*. In this way, an ontology without transworld individuals and with only restricted sets of counterpart functions predicts the constraint illustrated by (1). The rest of the paper spells out this approach.

1 Heim's Proposal

The proposal by Heim (2001) is a sketch that occupies little more than a page of a handout and is geared towards an analysis of the *de re/de se* distinction in pronoun interpretation. In this section, I present Heim's analysis as I understand it.

As mentioned already, Heim adopts the basic ontological assumptions of the counterpart theory of Lewis (1968, 1986). Most importantly, individuals occupy only one possible world, but can be related to individuals in other worlds by the counterpart relation, implemented though as a counterpart function. For *de re* pronoun interpretation, Heim (2001) uses the notation in (2) for mapping any suitable individual to its counterparts in the world of individual x.

(2) C_x maps individual y to $\mathsf{C}_x(y)$, the counterpart of y in world $\mathsf{w}(x)$.

Heim herself notes that (2) leaves open the question what kind of counterpart relation is relevant; an issue I also leave open for now, but return to in the next section. In general, C_x will be a partial function – not every individual has a counterpart in $\mathsf{w}(x)$. The one case where (2) is always defined is that when x and y both occupy the same world (i.e. $\mathsf{w}(x) = \mathsf{w}(y)$). In that case, $\mathsf{C}_x(y) = y$ must hold as Heim notes.

For predicates, Heim explores one way of integrating them into her proposal. Namely, she proposes that counterpart functions apply in the lexical entries of predicates (see also Percus (1998) for a similar proposal). Specifically, Heim proposes that instead of a world argument position, predicates take an additional individual argument. Furthermore she assumes that an individual cannot have a property in the world of another individual unless the two individuals occupy the same world. For this reason, she assumes that counterpart functions apply to the arguments of predicates such that they all occupy the same world. Concretely, Heim provides the lexical entry for an intransitive like *smile* in (3a). The extra individual argument is represented here as the innermost argument introduced by λx, and though it is an individual argument, I'll sometimes speak of it as the *'world' argument* in the following. A counterpart function applies to all arguments other than the 'world' argument. In example (3a), C_x applies to the subject of *smile*. I add in (3b) an entry for *it is raining*, but since this predicate only takes the one 'world' argument, no counterpart function needs to be applied.

(3) a. $[\![\text{smile}]\!] = \lambda x \in D_e\ \lambda y \in D_e\ .\ \mathsf{C}_x(y)$ smiles in world $\mathsf{w}(x)$
b. $[\![\text{it is raining}]\!] = \lambda x \in D_e\ .$ it rains in world $\mathsf{w}(x)$

For example, the unembedded intransitive clause (4a) would be interpreted as in (4b). The inner argument position of *smile*, in this case, is filled by a first person reference – I use the first person pronoun *I* for simplicity, though Heim's views the pronoun as further decomposed into presuppositional person features and a variable (also Heim 2008). The evaluation parameter c is the speaker of the utterance (at least at the utterance level), and therefore $[\![\text{I}]\!]^c = c$. For the interpretation of the proper name, I also assume here that it is relative to evaluation parameter c yielding as a result the person named *John* in the $\mathsf{w}(c)$. I use @ for the actual speaker, which is the value of the evaluation parameter. So, the truth conditions of (4a) amount to a condition that the person Ana, which is in $\mathsf{w}(@)$, smiles.

(4) a. Ana smiles.
b. $\text{smile}([\![\text{I}]\!]^{@})([\![\text{Ana}]\!]^{@}) = \mathsf{C}_{@}(\text{Ana})$ smiles in world $\mathsf{w}(@)$
$=$ Ana smiles in world $\mathsf{w}(@)$

Now consider attitude predicates. One consequence of Heim's proposal is that propositions cannot be functions of possible worlds, but must be functions from individuals to truth values, i.e. of type $\langle e,t\rangle$, or some higher type. In other words, the proposal forces us to treat all sentential complements of attitude verbs as properties.[1] Since Lewis (1979), Chierchia (1984) and others argue that complement clauses of attitude verbs are properties, this prediction of Heim's proposal is at least unproblematic, and probably even desirable since nothing needs to be said to rule

[1] Hazel Pearson (p.c.) points out that the complements of modals too would need be analyzed as properties or some higher type. This consequence seems less welcome than the one concerning attitude predicates and I don't have words of comfort to offer at this point.

out analyses of complement clauses other than the property analysis. Attitude predicates in this property analysis amount to quantifiers over individuals if the quantificational analysis of attitude predicates following Hintikka (1962) is correct. Heim specifically gives the lexical entry for *think* in (5), which is based on the notion of doxastic alternatives. The set of doxastic alternatives to an individual a are all those individuals z across all worlds such that a was put into z's place, a would not experience any difference to what a takes to be actually the case. For example, if John believes that he is Irene Heim, then any individual in **Dox(John)** is a smart woman and also has any other properties John ascribes to Irene Heim. In Heim's lexical entry (5), the subject argument of *think* is not directly the argument of **Dox**, but just as with *smile* in (3a), first the counterpart function is applied.

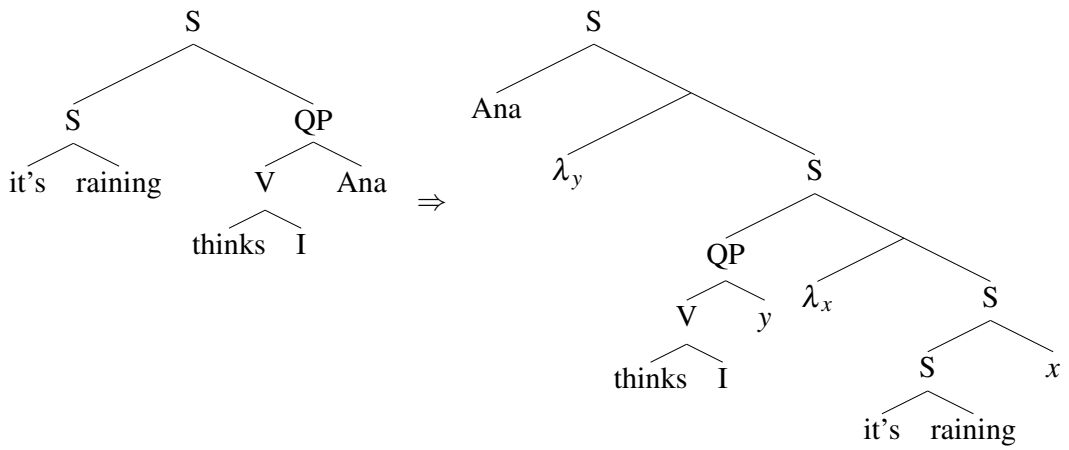
(5) $[\![\text{think}]\!] = \lambda x \in D_e\ \lambda y \in D_e\ \lambda P \in D_{et}\ .\ \forall z \in \mathbf{Dox}(\mathsf{C}_x(y))\ P(z)$

Note that the order of arguments in Heim's lexical entry (5) is somewhat unexpected: the subject argument y is closer to the verb than the complement clause P. So, Heim's proposal requires the order of predication in (6b) for sentence (6a). (6b) amounts to the condition that the counterpart of Ana in my world (i.e. that of the speaker) thinks that she is someone who occupies a world where it rains.

(6) a. Ana thinks that it's raining.
b. $[\![\text{thinks}]\!]\ ([\![\text{I}]\!]^{@})\ (\text{Ana})\ (\lambda x\ .\ \text{it's raining}(x))$

Heim proposes this order of predication because it allows a movement analysis to derive the structure in (6b). Specifically, the constituent $[\![\text{thinks}]\!](@)(\text{Ana})$ is a generalized quantifier of type $\langle\langle e,t\rangle,t\rangle$. So, Heim advances the idea that this quantifier orginated from the structure in (7) via movement as shown, and also postulates further A-movement of *Ana* to a position from where it can binds into the 'complement' clause.[2]

(7)



The syntactic part of Heim's proposal is relevant only at two points below.[3] For this reason I keep to Heim's order of predication in the following. But my primary interest in this paper are the

[2] I diverge slightly from Heim's presentation: She uses @ in the object and meta language, while I use only the pronoun *I* in the object language, and only @ in the meta language.

[3] Namely in footnote 18 and for example (38a).

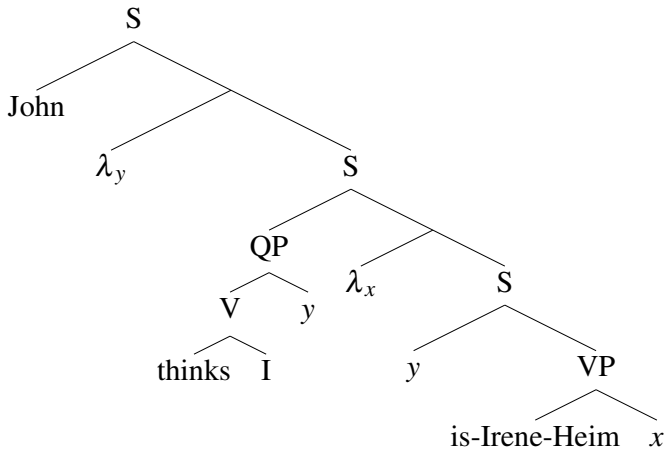
restrictions on *de re* interpretation that follow from the nature of counterpart functions. Therefore, I don't discuss movement derivations like (7) more fully in the following.

Now consider how Heim derives the *de se* and *de re* interpretations of a pronoun. Let us consider example (8). For simplicity, I analyze the identity predicate *is Irene Heim* without further composition as a simple intransitive predicate of type $\langle e, \langle e, t \rangle \rangle$ like *smiles* in (3a).

(8) John thinks that he is Irene Heim.

The *de re* interpretation arises, for example, in a scenario where John knows who he really is. But while looking at a reflection of himself, he thinks that he is looking at Irene Heim instead of recognizing himself. In this scenario, there is a unique person that John is looking at, both in the actual world (where it's John) and in the worlds of John's doxastic alternatives (where it is Irene Heim). The description *the person John is looking at* therefore establishes an acquaintance relationship *R* in the sense of Kaplan (1968) between, on the one hand, John in $\mathsf{w}(@)$ and himself and, on the other hand, John's doxastic alternatives and Irene Heim. For the time being, let's assume that the existence of this acquaintance relationship allows us to accommodate a counterpart function C_x that maps the actual John to Irene Heim for and of John's doxastic alternatives x. Then, the *de re* interpretation can be captured by the following representation:

(9)



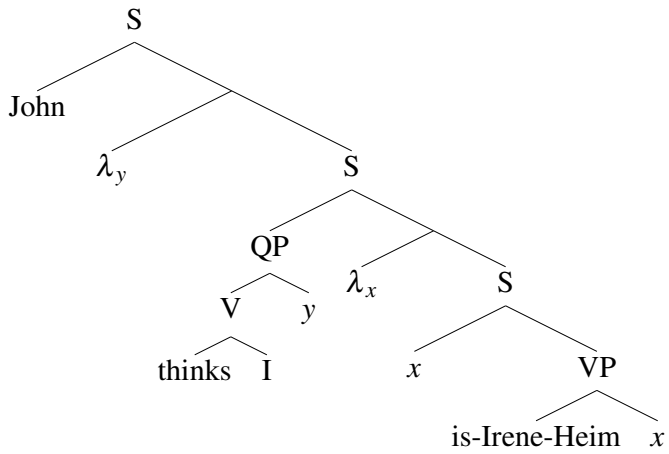
The compositional evaluation of (9) leads to the result in (10). Since the 'world' argument x of the predicate *is-Irene-Heim* occupies a different world from the individual argument y, the result of applying the counterpart function C_x to y results in an individual different from y, namely the counterpart of y's in a belief world of John's. For now, we assume for simplicity that this counterpart is the unique individual Irene Heim in $\mathsf{w}(x)$ via the acquaintance relationship *R*, but return to this issue in the following section. Thereby (10) captures the *de re* interpretation that in John's doxastic alternatives a counterpart of John's is identical to Irene Heim.

(10) $[\![\text{thinks}]\!]\,([\![\text{I}]\!]^{@})\,([\![\text{John}]\!]^{@})\,(\lambda x\,.\,\text{is-Irene-Heim}(x)(y))$

The *de se* interpretation of (9) is true in a different scenario; one where John is actually wrong about his identity. For example, John may have lost all his memories and possessions except for his collection of Irene Heim handouts, and therefore conclude that he must be Irene Heim after he

regains his senses. As Lewis (1979) shows, the *de se* representation can generally be described in two different ways: either as a special case of the *de re* interpretation, or from a separate *de se* interpretation. To derive *de se* from the *de re* representation, we need to assume a counterpart function that maps John in the real world to the person John thinks he is in any other possible worlds where there is a unique such individual. With this counterpart function, the representation in (10) is true in the given scenario. However, Chierchia (1984) and Percus and Sauerland (2003a,b) argue that there are asymmetries between *de re* and *de se* interpretations, and that therefore also a specialized *de se* representation is required.[4] Within Heim's approach, representation (11) is a natural candidate for this specialized *de se* representation. In (11), the embedded subject position is bound by the λ-operator that scopes over the argument of the verb *think*.

(11)



The interpretation predicted for (11) is shown in (12). The only difference between (10) and (12) is the content of the second, the individual argument, of the predicate *is-Irene-Heim*. Because in (12) the two arguments of *is Irene-Heim* are identical, the application of the counterpart relation C_x is always without any effect.

(12) $[\![\text{thinks}]\!]\,([\![\text{I}]\!]^{@})\,([\![\text{John}]\!]^{@})\,(\lambda x\,.\,\text{is-Irene-Heim}(x)(x))$

The discussion of (8) shows that the nature of the counterpart function plays a role in Heim's proposal. As Heim herself noted, she left open how counterpart functions are determined and how they relate to acquaintance relationships. In the following section, I show that Heim's analysis can be straightforwardly extended to the full range of cases of *de re* interpretations by exploring the counterpart functions further.

2 De re and de dicto Interpretations

Heim's focus in her 2001 presentation were *de se* interpretations of pronouns. For *de re*-interpretations and the *de re*/*de dicto* difference with full DPs, Heim's proposal needs to

[4] Anand (2006), Maier (2009), and Pearson (2013) discuss this issue further, though I think the conclusion drawn here remains. Specifically, Maier's analysis is based on the multi-layered discourse representation theory of interpretation where syntactic representations are transformed into DRS representations prior to model-theoretic interpretation. The operation 'presupposition movement' in Maier's account creates disambiguated representations.

extended. As it stands, it is restricted to a single counterpart function for each individual in $\mathsf{w}(@)$, but already Quine (1956) showed that more than one counterpart is possible. Consider example (13), a version of Quine's Ortcutt example.[5]

(13) Ana thinks that Irene teaches semantics.

Assume for now that the name *Irene* is evaluated from the perspective of the current speaker as shown in (14), so as $i_@$, the most salient person named *Irene* in the world of the current speaker.[6] Then the interpretation of the verb *teaches semantics* applies the counterpart function just like *smile* does in (3a) resulting in $\mathsf{C}_x(i_@)$, the counterpart of $i_@$ in Ana's belief worlds. Since the value of $\mathsf{C}_x(i_@)$ is not specified beyond it being a single individual in world $\mathsf{w}(x)$, Heim's proposal can capture some *de re* interpretations.

(14) $[\![\text{thinks}]\!]\,([\![\text{I}]\!]^@)\,(\text{a})\,(\lambda x\,.\,\text{teach-semantics}(x)([\![\text{Irene}]\!]^@))$

As Heim mentions herself, though, she leaves open the question of which counterpart is chosen. To extend her proposal, we need to be more specific about the choice of counterpart. Consider in particular a scenario with two counterparts as Quine (1956) introduced to the literature: (15a) is judged true simultaneously with (13) in natural scenarios like the following: Ana encountered Irene twice without realizing that it's the same person. Once, Irene was on the beach and Ana thought that she isn't a semantics teacher. The other time Irene was at MIT talking with a student and Ana thought that she is a semantics teacher. But if the counterpart of Irene in Ana's belief worlds is determined by a function, (13) and (15b) couldn't be simultaneously true since they would ascribe contradictory beliefs to Ana, i.e. that some individual is simultaneously teaching semantics and not teaching semantics.

(15) a. Ana thinks that Irene doesn't teach semantics.
b. $[\![\text{thinks}]\!]\,([\![\text{I}]\!]^@)\,(\text{a}_@)\,(\lambda x\,.\,\neg\text{teach-semantics}(x)([\![\text{Irene}]\!]^@))$

To allow *de re*-readings with different counterparts, I propose a version of a proposal from earlier work of mine (Percus and Sauerland 2003a), which was using relevant ideas to lecture notes of Heim (1993). The proposal associates different counterpart functions with different acquaintance relations in the sense of Kaplan (1968). In example (8) above, the acquaintance relation *R* actually was a function mapping John in the actual world to himself and John's doxastic alternatives to counterparts of Irene Heim. Generally, I assume that acquaintance relations are partial functions of type $\langle e, e\rangle$.[7] I thereby exclude acquaintance relations that aren't functional, but it seems to me that it always natural to describe acquaintance relations in such cases as the unions of functions and therefore have the same descriptive power as with relations by just using functions. For example, Ana may think that the church bell on Plum Island is always rung by a

[5] Quine's original example was *Ralph believes that Ortcutt is a spy.*

[6] Heim assumes essentially following Kaplan (1978) that the value of c is the current speaker (i.e. @, the origo) throughout the compositional evaluation of the sentence. This derives a compositional interpretation that might result in $[\![\text{Irene}]\!]^@$ as shown unless *Irene* was interpreted as a predicate with a 'world' argument. Both options are shown in (34) below where there is also further relevant discussion.

[7] As is standard mathematical practice, I assume that relations and functions are sets of pairs. Functions are sets F where each first member of a pair occurs only once in F as a first member.

single person with a hunchback, while in reality there could be rotating system involving many residents. All these residents can truthfully say "Ana thinks I have a hunchback". For Kaplan, Ana stands in the acquaintance relation R' that we can paraphrase as *the person ringing the church bell* to many people in the actual world which isn't a function. But the more specific acquaintance relations paraphrased as *the person ringing the church bell today*, *the person that rang the church bell yesterday*, and so on would be functions and their union would result in the relation R'. For the scenario described for (13) and (15a), two acquaintance functions are relevant: one described by the definite description *the woman I met at MIT* and the other described by the definite description *the woman I met on the beach*. The two functions are given as b and c in (16). For the partial extensions I provide in (16), $a_@$ is Ana in the real world, a_w is counterpart of Ana's in one of her belief worlds, n_w is the woman Ana as a_w sees on the beach in w and that doesn't teach semantics in w, while s_w is the one at MIT that does.

(16) $b = [a_@ \mapsto i_@, a_w \mapsto n_w, \ldots]$
$c = [a_@ \mapsto i_@, a_w \mapsto s_w, \ldots]$

Capturing acquaintance relations via functions is also part of the proposal of Percus and Sauerland (2003a). The particular way this is done here, though, is possibly more intuitive. In particular, it seems possible to give some more content to the relation between an acquaintance function and a definite description corresponding to it. Note that with a suitable semantics of definite descriptions taking an external world argument, the equalities in (17) hold for a all individuals x.

(17) $b(x) = [\![\text{the woman I met on the beach}]\!]^x(x)$
$c(x) = [\![\text{the woman I met at MIT}]\!]^x(x)$

More generally, I define acquaintance functions based on descriptions as in (18).[8] Typically the descriptions would be singular definite descriptions or pronouns.

(18) *Acquaintance Function:* f of type $\langle e, e\rangle$ is an acquainance function iff. there is a description δ such that $[\![\delta]\!]^x(x) = f(x)$ for any $x \in \text{domain}(f)$.

The more limited set is that is defined in (19) captures acquaintance relationships encoding acquaintance with belief-holder u for any individual u. These are functions that map u itself to some individual and also yield a value for any doxastic alternative of u.[9]

(19) *Belief-Related Acquaintance Function for u:* f is an belief-related acquaintance function for individual u iff. f is an acquaintance function and $u \in \text{domain}(f)$ and $\mathbf{Dox}(u) \subset \text{domain}(f)\}$

[8] I extend this slightly on the next page to allow additional parameters.

[9] Two limitations of (19) are the following: 1) Orin Percus (personal communication) points out that there could be acquaintance functions that the individual u forgot about and hence might not be defined for all doxastic alternatives of u. 2) Kaplan (1968) motivated a restriction to 'vivid' acquaintance functions. At present, I have to leave it up to future work to determine whether it is feasible to modify (19) so as to address these shortcomings. Possibly helpful is the following observation: At least some cases of non-vivid acquaintance functions, e.g. the one described by *the shortest spy*, result in functions that are 'perspective-independent' in the following sense: $[\![\text{the shortest spy}]\!]^x = [\![\text{the shortest spy}]\!]^y$ whenever $\mathsf{w}(x) = \mathsf{w}(y)$.

Below the notation (20) is useful.

(20) $A_u = \{f \mid f \text{ is a belief-related acquaintance function for } u\}$

In the above example, the set of acquaintance functions would at least have the elements given in (21), where $a_@$ is Ana in the real world and b and c are as given in (19). The 'self' function $\lambda x\,.\,[\![I]\!]^x$ is always available as an acquaintance function since the *de se* interpretation seems to be always available via a *de re* representation as well (Percus and Sauerland 2003a).

(21) $A_{a_@} = \{b,\ c,\ \lambda x\,.\,[\![I]\!]^x,\ \ldots\}$

Now we need to derive counterpart functions from acquaintance functions.[10] Given an acquaintance function f, we define the counterpart via f-acquaintance as follows:

(22) *Counterpart via Acquaintance:* x' is the counterpart of x via f-acquaintance to a' (Notation: $\mathsf{C}^a_{a'}(x) = x'$) iff. $\exists a$: $f(a) = x$ and $f(a') = x'$.

In example (16) above, the counterpart functions $C^b_{a_w}(i_@) = n_w$ and $C^c_{a_w}(i_@) = s_w$ hold. Also for the self function $s = \lambda x\,.\,[\![I]\!]^x$ the equality $C^s_{a_w}(a_@) = a_w$ holds. The notation $C_{a'}(x)$ that Heim's introduced, we can keep using in the special case if there is a unique acquaintance function f available with a' in its domain and x in its image.

Though working with transworld individuals, Percus and Sauerland (2003a) make use of similar ideas. Our system assumes concept generator functions that map individuals to individual concepts, i.e. are of type $\langle e, \langle s, e\rangle\rangle$. If we ban transworld individuals, we can use instead of a concept generator G an extended function G of type $\langle e, \langle e, e\rangle\rangle$ with $G'(x)(y) = G(x)(\mathsf{w}(y))$ to define the same system. What is then the relationship between the two statements $\mathsf{C}^f_{a'}(x) = x'$ and $G'(x)(a') = x'$? The main difference between the two implementations is that an acquaintance function f is always based on a single definite description, while a concept generator G can incorporate more than one definite description and the corresponding acquaintance functions. Specifically for a given concept generator G of type $\langle e, \langle s, e\rangle\rangle$, the set of acquaintance functions contained within G is $\{f \mid \exists x \in D_e\ G(x) = f\}$. In this way, the Percus and Sauerland (2003a) implementation of *de re*, hence, bundles several acquaintaince functions into one concept generator. But, there are also cases of *de re* where it requires multiple concept generators. In particular, the scenario involving Ana I describe above is such a case. For any concept generator G, the result of applying G to Irene can only be one of the concepts related above, either the one picking out non-semanticists or the one picking out semanticists. Hence, Ana's beliefs require two concept generators, G_1 and G_2 that yield different individual concepts when applied to Irene. In other cases, though, we have no way to decide whether the analysis should involve a single concept

[10] Ninan (2012) argues that with some propositional attitude verbs, for example *imagine*, a single acquaintance function and a corresponding counterpart function is sometimes difficult to formulate. E.g. if Ana imagines that the woman she saw at MIT was teaching syntax, we can report this as *Ana imagines that Irene teaches syntax.* I hope that such data can be captured by the composition of counterpart functions, e.g. the first mapping Irene ($i_@$) to her semantics teaching counterpart s_w in Ana's belief world, and then a second one mapping that maps s_w to a syntax teaching counterpart. In this way, closure of the set of counterpart functions under composition may address Ninan's concern without any need for the multi-centered worlds Ninan proposes. In the text, I focus on the case of *believe* where such issues don't arise.

generator with multiple individuals in its domain or multipe concept generators. In this way, the bundling of acquaintance functions into concept generators seems to impose an indeterminacy that doesn't correspond to anything in the linguistic data. For this reason, I prefer the present, unbundled approach using type $\langle e,e\rangle$ variables in this paper.

There is one case though where the bundled approach using concept generators seems to offer an advantage: Namely, Charlow and Sharvit (2014) discuss a reading of example (23) where the quantifer *every female* and the bound pronoun *her* are both interpreted *de re*, but with different acquaintance relations. E.g. John is given a set of two pictures each of every female student. In all pictures the students are dressed up; in one as a male teacher, in the other as a male student. John is fooled: he thinks he is looking a male teachers or students and also thinks that each picture shows a different person. So when asked to guess who likes whose mother, John says 'The male teacher in the picture on the left must like the mother of the male student in the picture on the right' repeatedly, but John happens to always be pointing to the two different pictures of the same female student as he says this.

(23) John believes that every female student$_{\rm i}$ likes her$_{\rm i}$ mother.

Charlow and Sharvit (2014) show that this reading can be captured using two concept generators one mapping the actual female students to male professors, and the other mapping the actual female students to male students. To capture this reading with acquaintance functions as considered so far is impossible though because the value $a(x)$ is required to be derived from a definite description δ as $[\![\delta]\!]^x$ only depending on the context variable x. But, for example, the value of the bound variable her_i in (23) is assignment dependent. Rather than going back to the bundling of descriptions with a concept generator, though, we could also allow acquaintance functions sensitive to the assignment function. For instance, the two functions in (24) are acquaintaince functions with an extra assignment argument position for an assignment g:

(24) a. $b(g)(x) = [\![\text{the person whose picture I look at time } t \text{ on my left}]\!]^{g,x}(x)$
b. $c(g)(x) = [\![\text{the person whose picture I look at time } t \text{ on my right}]\!]^{g,x}(x)$

For the following, though, the assignment dependence of acquaintance functions doesn't play any role, so I don't represent the assignment argument in the following.

Now consider the questions of whether and how the acquaintance functions must be represented in the linguistic structure. Two approaches that would avoid explicit quantification over acquaintance function variables in the syntactic representation would be to either integrate existential closure over acquaintance functions into the counterpart functions or to leave it at the discourse level. I now show that both of these aren't feasible in the present approach (building on Percus and Sauerland (2003a)). Specifically, the former approach would assume the lexical item in (25) for *teach semantics* (cf. (3a) above), where I assume that the z index of A_z is coindexed with subject of the embedding attitude verb (see the definition in (20)).

(25) lexical item with wrong predictions:
$[\![\text{teach semantics}]\!] = \lambda x \in D_e\ \lambda y \in D_e\ .\ \exists a \in A_z\ \mathsf{C}^a_x(y)$ teaches semantics in world $\mathsf{w}(x)$

But (25) would wrongly predict (26) (repeated from (15a)) to be false in the scenario considered above: the set $A_{a_@}$ as defined in (21) contains the acquaintance function c that makes *Irene teaches semantics* true in any of Ana's doxastic alternatives $\mathsf{w}(a_w)$. This renders the negation false, regardless of whether $A_{a_@}$ also contains function b or not.

(26) Ana thinks that Irene doesn't teach semantics.

At the same time, it is known that the scope of existential quantification over a must be below quantifiers in the matrix clause (Percus and Sauerland 2003a). Consider example (27), which is false in the following scenario: A group of drunken election candidates watching campaign speeches on television do not recognize themselves in the broadcast. John, the only confident one, thinks "I'll win," but does not recognize himself in the broadcast. Bill, a depressive one, thinks "I'll lose" but is impressed by the speech that happens to be his own and is sure "that candidate" will win. Peter, also depressive, happens to be impressed not by his own speech but by John's (cf. Percus and Sauerland 2003a, (18)).

(27) Only Bill thinks that he will win the election.

Consider the two expressions in (28) with different scope of the existential quantifier binding a. I assume in (28b) that the constant b in A_b refers to the actual Bill. For $x =$ Bill, a based on the definite description *the guy with the speech that impressed me* makes the subformula starting with $[\![thinks]\!]$, which occurs in both (28a) and (28b), true. For $x =$ John, the self-acquaintance function $\lambda x\,.\,[\![I]\!]^x$ makes the the same subformula true. Since *John* is a focus alternative to *Bill*, (28a) is therefore predicted to be false. (28b), however, could be true since for $x =$ John the subformula starting with $[\![thinks]\!]$ is undefined if a is an acquaintance function defined only for Bill.

(28) a. only Bill $\lambda_x\ \exists a \in A_x$: $[\![\text{thinks}]\!]([\![\text{I}]\!]^{@})(x)\ [\lambda_y\,.\,\text{win}(y)(\mathsf{C}^a_y(x))]$
b. $\exists a \in A_b$: only Bill $\lambda_x\ [\![\text{thinks}]\!]([\![\text{I}]\!]^{@})(x)\ [\lambda_y\,.\,\text{win}(y)(\mathsf{C}^a_y(x))]$

Example (27) therefore shows that existential quantifiers over acquaintance function variables must be bound below the quantifier *only*. The analysis of (28b) shows that it might not be necessary to stipulate this scopal constraint, but that it can be derived. Specifically, (28b) might necessarily lead to a presupposition failure or be an obligatory tautology since a can only ever be defined for one individual in the actual world, while *only* requires a to be defined for Bill and at least one alternative to Bill.

In sum, we have seen that acquaintance functions must be existentially bound at the level of *think*. Already Percus and Sauerland (2003a) assume that concept generators are existentially bound at this level, and build this into the lexical item of *think*. It would also be possible to do this on our approach,[11] but since I am primarily concerned with examples involving only one or two counterpart relations, I will use explicit existential quantifiers.

Now consider how to represent acquaintance functions in the syntactic structures. In example (3a) above, the counterpart relation applied in the process of function application. But the acquaintance functions can't be treated within the predicate since for a function taking more than argument, each argument might require an acquaintance function of its own: the acquaintance functions need to form a constituent with the individual denoting phrases, not the predicate.[12] Therefore, I diverge from Heim's account and propose that the acquaintance function (identifying

[11] In fact, building acquaintance function binding into *think* seems desirable since it would make it natural to require cobinding of the attitude holder argument of *think* and the subscript of A_x.

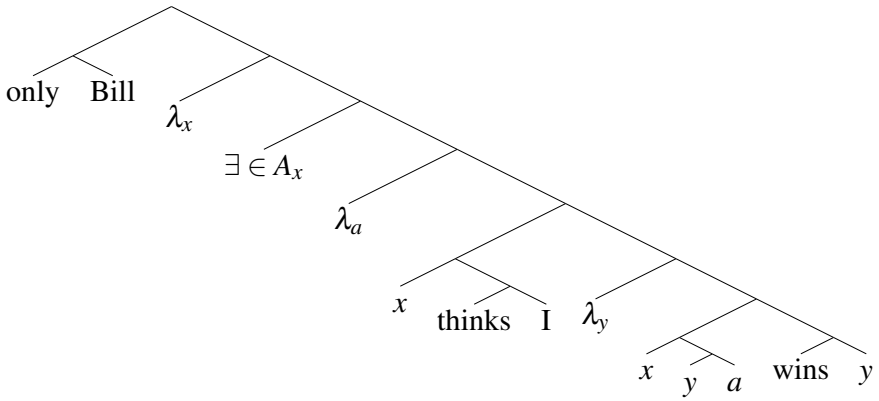
[12] Orin Percus (p.c.) correctly points out that it would be easily possible to define predicates to take more than one acquaintance function argument. But I think the point I make in the text can be defended by looking at non-argument DPs.

the counterpart function) can be compositionally represented for each DP. Specifically, I assume that the equality in (29) holds if y is an individual and a an acquaintance function – technically, this assumption amounts to interpreting acquaintance function variables such as a in (29) via new lexical interpretation principle as the function $\lambda y \lambda x \,.\, \mathsf{C}^a_y(x)$ of type $\langle e, \langle e, e\rangle\rangle$.[13]

(29) $\left[\!\!\left[\begin{array}{c} \text{DP} \\ y \quad a \end{array} \right]\!\!\right] = \mathsf{C}^a_y([\![DP]\!])$

Since for *de re* interpretations I argued that acquaintance functions must by syntactically represented, I cannot rely on Heim's assumption any longer that a counterpart function is applied automatically in the course of predication when necessary. Nevertheless I think, being in the same world is a presupposition of any predication – if it wasn't, sentences could be false too easily (and their negations true). Concretely I propose to assume the following domain restriction of predicates to the world they apply in. For unary predicates, this is the following: $\text{domain}(\lambda y \,.\, P(y)) = \{x \mid \mathsf{w}(x) = \mathsf{w}(y)\}$. This predicts that the 'world' argument of a predicate must be coindexed with the 'world' arguments of acquaintance functions applying to its arguments. This is illustrated by the structure (30) for (27): the inner arguments of *wins* and of *a* must be coindexed.[14]

(30)



The composition principles of Heim and Kratzer (1998) with the one modification for a mentioned predict that (30) receives the interpretation represented in (28a).[15]

Two pieces of the account are still missing: So far we primarily considered the interpretation of pronouns and the *de re* reading of proper names, but not the interpretation full DPs. For full DPs the *de dicto* interpretation is uncontroversially available, while this is debated for proper names especially in the context of the claim by Kripke (1980) that names are rigid designators. Consider first example (31) for an illustration of the account of the *de dicto* reading of a full DP. I then return to the issue of proper names below.

[13]Note that it is possible to reformulate the proposal such that a is of type $\langle e, \langle e, e\rangle\rangle$. Also note that this is the type of the concept generator functions of Percus and Sauerland (2003a), though the order of arguments is different here – the inner argument is the 'world' argument.

[14]Orin Percus (p.c.) reminds me to mention here that at this point of the paper, the lexical entry for *think* can no longer be Heim's, but must be $[\![\text{think}]\!] = \lambda x \lambda y \lambda P \,.\, \forall z \in \mathbf{Dox}(y)\; P(z) = 1$ with the presupposition that $\mathsf{w}(x) = \mathsf{w}(y)$.

[15]I leave open for now the question whether it is necessary to impose coindexation of the positions occupied by x in A_x and the subject of *thinks*. It seems likely that if coindexation didn't hold, interpretation would fail, but I'm not sure at this point whether this is really a necessity.

(31) Irene thinks that the unicorn is hungry.

Example (31) is true in a scenario where Irene mistakes her cat for a unicorn and believes that the the unicorn is hungry. The *de dicto* representation that accounts for this judgment yields the truth conditions in (32), where the 'world' argument of *unicorn* is bound within the argument of *think*. In the scenario, there is a unique salient unicorn within Irene's belief worlds, namely the individual Irene is looking at (a counterpart of the actual cat). And since this individual is hungry in Irene's belief worlds, (32) is true in the scenario described.

(32) $[\![\text{thinks}]\!]([\![\text{I}]\!]^{@})(\text{Irene})\ [\lambda_x\ .\ \text{hungry}(x)\ (\text{the unicorn}(x))]$

For comparison, (33) shows the truth-conditions of the *de re* representation of (31). (33) is predicted to fail the existence presupposition of the definite description since there are no unicorns in the actual world.

(33) $\exists a \in A_{\text{Irene}}\ [\![\text{thinks}]\!]([\![\text{I}]\!]^{@})(\text{Irene})\ [\lambda_x\ .\ \text{hungry}(x)\ (\mathsf{C}^a_x(\text{the unicorn}(@)))]$

Now consider again the interpretation of proper names; specifically, how we can introduce a *de re/de dicto* ambiguity for proper names within the present analysis. As I mentioned above, it is controversial whether proper names are rigid designators or display a *de re/de dicto* ambiguity. Both theoretical positions can be captured in the present framework, though some technical modifications are necessary for the position that there's no such ambiguity. Specifically, the concept of a rigid designator relies on transworld individuals, and is therefore incompatible with the counterpart ontology adopted here, where no transworld individuals exist. However, we have two options of representing names illustrated in (34) for the name *Irene*: (34a) where names always receive a *de re* interpretation resembles the rigid designator theory, while (34b) treats names more like full definites since they take a 'world' argument.

(34) a. $[\![\text{Irene}]\!]^c$ = the person named 'Irene' in $w(c)$
b. $[\![\text{Irene}]\!]^c = \lambda x \in D_e$. the person named 'Irene' in $w(x)$

Account (34a) is what I assumed above. The referent of the proper name on this theory is identified in the actual world even if *Irene* is embedded under an attitude verb. Then a counterpart function must apply when *Irene* is embedded under an attitude verb as it combines semantically with a predicate like with other cases of *de re* interpretation. If furthermore there was only one counterpart function, any occurrence of *Irene* would be unambiguous as in the rigid designator theory. However, many linguists believe that the rigid designator theory is wrong, and prefer the definite desription theory of proper names (e.g. Matushansky 2008). On this theory, proper names are interpreted as regular predicates with a 'world' variable, but independent of the context parameter of the interpretation function. Then a definite determiner must occur with proper names in argument positions. In English this definite determiner isn't pronounced except when there is an adjective or other modifier as in *the famous Sherlock Holmes*. The lexical entry for (34b) is a simplified representation of such an analysis of a proper name in argument position.[16] For example, this analysis allows an analysis of (35a) involving a *de dicto* interpretation of *Noman* as in (35b), which doesn't oblige the speaker to believe that Ulysses, who the cyclops has been misled to call Noman, is actually named Noman.

[16]Namely, it is simplified in the following way: The world argument of *Irene* in (34b) would actually have to be satisfied before the definite determiner applied if (34b) was decomposed into a definite determiner and a property.

(35) a. The cyclops Polyphemus thinks that Noman is killing him.
b. ⟦thinks⟧(⟦I⟧$^{@}$)(⟦Polyphemus(I)⟧$^{@}$) λ_x killing(x) (x) (⟦Noman⟧(x))

For concreteness, I assume analysis (34b) in the following as the account of proper names. However, everything below is as far as I can see also compatible with the account in (34a), for those who aren't convinced that names display a *de re/de dicto* ambiguity.

In sum, we saw in this section that Heim's proposal can be extended to address the *de re/de dicto* distinction with pronouns, proper names, and full DPs. The main addition I made was to represent variables ranging over acquaintance functions in the logical form representation.

3 Deriving Constraints on *De Re* Interpretation

Percus (1998, 2000) first argued that *de re* interpretation must be constrained, and Keshet (2008, 2011) and Romoli and Sudo (2009) have since described additional restrictions on *de re* interpretation. In this section, I show that several of these restrictions follow straightforwardly from the counterpart-function based system of *de re* interpretation as described above (see Percus 2013 for an account this is similar to present one). The reason lies in the assumption that counterpart relations are intuitively asymmetric because we see our actual world as privileged over other possible worlds: in the interpretation (15a), the woman on the beach in Ana's belief world is a counterpart of Irene in the real world because the the beach-woman's existence is causally related to the real Irene, but not vice-versa: the real Irene exists for me independently of whether I know of her beach-woman, non-semanticist counterpart. In the system described above this asymmetry is captured by the assumption that any counterpart-function f is a mapping from individuals of the actual world to individuals of a belief-world.[17] In this way, the asymmetry a function encodes is natural to the counterpart-based ontology. But if transworld individuals are assumed, any individual in someone's belief world could also be an individual of the actual world and therefore the asymmetry is lost. Therefore the constraints on *de re* readings that I discuss in the following corroborate the claim that transworld individuals are absent from the ontology our minds form when we interpret natural language.

Romoli and Sudo (2009) summarize and introduce terms for the constraints *de re* interpretation is known to be subject to. The five constraints that they distinguish are the following: the Main Predicate Constraint and the Adverb Constraint (Generalizations X and Y of Percus 2000), the Intersective Predicate Constraint (Generalization Z of Keshet 2008, 2011), Presuppositional DP Constraint (Keshet 2008, cf. Musan 1995), and the Nested DP Constraint (Romoli and Sudo 2009). I show in the following that three of these five constraints follow from the counterpart-based system of *de re* interpretation: the Main Predicate Constraint, the Intersective Predicate Constraint, and the Nested DP Constraint. For the remaining two constraints, I don't see at present whether they can be derived or not since it depends on the semantic account of adverbs and existential constructions. In this section, I show how to derive the three constraints mentioned, and discuss the other constraints further in the conclusion.

Consider first the Main Predicate Constraint by means of example (36). Percus (2000) notes for similar examples that (36) is judged false in the scenario preceeding given in (36).

[17] In cases of higher order belief, f could be a mapping from a belief-world of degree n to one of a higher degree.

(36) Scenario: Irene met an actual Canadian, but she mistakenly thought that he was American.
#Irene thinks that the American is Canadian. (after Percus 2000)

Percus argues that a specific syntactic representation of (36) must be ruled out; namely one that would derive an interpretation described by the formular in (37). Assume that the definite description *the American* picks out an individual in the world $w(x)$, i.e. a belief world of Irene's. The predicate *Canadian*, however, applies in the actual world.

(37) *thinks(@)(Irene) [λx . Canadian (@) (ιz . American$(x)(z)$)]

If individuals existed across worlds or counterpart functions were freely available, (37) would indeed be interpretable and therefore predict incorrectly the existence of a reading that would be true in the scenario in (36). However, the formula in (37) is uninterpretable in the present system because we would need to map an individual existing in the world of a doxastic alternative of Mary's to a counterpart of it that exists in the actual world. But such a counterpart function is not available.[18]

To further explicate this point, consider the following alternative representations of (36), that differ with respect to the indexation of the 'world' argument slots of *Canadian* and *American*.

(38) a. *thinks(@)(Irene) [λx . Canadian (@) (ιz . American$(@)(z)$)]
b. $\exists a \in A_{\text{Irene}}$. thinks(@)(Irene) [λx . Canadian (x) (a(ιz . American$(@)(z)$))]
c. thinks(@)(Irene) [λx . Canadian (x) (ιz . American$(x)(z)$)]

Representation (38a) is interpretable, however, the operator λx doesn't bind any variable. I assume that for this reason the representation is ruled out: either because there is an explicit ban against vacuous binders (Kratzer 1995) or because the property argument of *think* must not be a constant (cf. Gajewski 2008 on contradictions/tautologies) or because Heim's movement of *Irene thinks* (see Section 1) must originate from some position in the complement clause. Representation (38b) represents the *de re* interpretation as discussed in the previous section. The *de re* interpretation requires a counterpart function a mapping an individual of the actual world (the American) to individuals in Irene's doxastic alternatives' worlds, which can exist. The *de re* reading is false in the scenario given for (36) above; it requires that Irene mistake an actual American for a Canadian. Finally, representation (38c) is the well-formed *de dicto* interpretation.

The second constraint that can be derived is the Intersective Predicate Constraint. The constraint is illustrated by (39), which again is odd in the given scenario.

(39) Scenario: Irene met a confused person, who she thinks is a bachelor, though he's actually married.
#Irene thinks that the married bachelor is confused. (Keshet 2008, p. 53)

Keshet's concern is that the formula in (40) predicts (39) to be true in the given scenario: the predicate *married* is applied in the actual world to z itself, while the predicate *bachelor* is applied in a belief world of Irene's to a counterpart of z.

[18] Heim's movement proposal described at the end of section 1 constitutes an independent way of deriving the main predicate constraint. If we assume that quantifier movement, in the case of (36), the quantifier *Irene thinks* is subject to a syntactic conditions that blocks extraction from subjects, representation (37) cannot be generated. Orin Percus (personal communication) points out that Shimada 2007 makes a similar proposal to the one I hint at here.

(40) $\exists a \in A_{\text{Irene}}$. thinks(@)(Irene) [λx . confused(x) ($\mathsf{C}^a_x(\iota z$. married(@)(z)
$\wedge$ bachelor(x)($\mathsf{C}^a_x(z)$))]

In this case, formula (40) is also interpretable in the counterpart-based system assumed here. However, the actual compositional interpretation of (39) doesn't result in (40), but relies on the predicate modification rule of Heim and Kratzer (1998) which I state in (41).

(41) If both $[\![\text{A}]\!]^c$ and $[\![\text{B}]\!]^c$ are of type $\langle e,t\rangle$, then $[\![\text{A B}]\!]^c$ is defined as follows:

$$\lambda x \in \text{domain}([\![\text{A}]\!]^c) \cap \text{domain}([\![\text{B}]\!]^c) \text{ . } [\![A]\!]^c(x) = 1 \wedge [\![B]\!]^c(x) = 1$$

Predicate modification determines the derived predicate directly as the intersection of two initial predicates before they might apply to an argument in the syntax. Crucially the arguments aren't represented in the syntax, and therefore a counterpart function cannot apply to only one of them. But then, if individuals are partitioned into worlds, predicate modification can only apply if both both predicates apply in the same world. Consider for example the above case: the two predicates *married(@)* and *bachelor(x)* are combined by predicate modification. But if there are no cross-world individuals, the domains of the two predicates have no overlap: the domain of *married(@)* is a subset of $\{y \mid w(y) = w(@)\}$, the individuals in the actual world, while the domain of *bachelor(x)* is a subset of $\{y \mid w(y) = w(x)\}$, the individuals in a belief world of Irene's. Hence, the result of predicate modification would be a predicate with an empty domain.[19]

The third and final constraint I argue can be derived from the absence of transworld individuals is the Nested DP Constraint of (Romoli and Sudo 2009). Example (42) with the scenario preceeding it illustrates this constraint.

(42) Irene sees Bono Vox on TV with his wife Alison Hewson. Irene wrongly believes that he is the president, and furthermore, that the nice woman next to him is his sister.
#Irene thinks the wife of the president is nice. (Romoli and Sudo 2009, p. 430)

The problem Romoli and Sudo (2009) raise is illustrated by the representation in (43), where the 'world' argument of *wife* is the actual speaker, but the 'world' argument of *president* is bound within the argument of *think*.

(43) $^*\exists a \in A_{\text{Irene}}$. thinks(@)(Irene) [λx . nice(x) ($C^a_x(\iota y$. wife(@)(ιz . president(x)(z)) (y)))]

If transworld individuals existed, (42) is predicted to be true in the scenario given: The person Irene takes to be the president has a wife in the actual world who is nice. But if there are no transworld individuals, (43) is not interpretable: The referent of the second argument of *wife* in (43) (the term starting with ιz) is an individual within the world of a doxastic alternative of Irene's. If cross-world individuals and reverse counterparts don't exist, the predicate *wife(@)* cannot apply to this individual. So, (43) ends up being uninterpretable.

[19] This assumes that there is no overlap between what the speaker takes to be (i.e. Irene's doxastic alternatives) and the beliefs of the speaker. This is generally a plausible assumption, except when the the speaker and the belief holder are identical. In the case of embedding under *I think*, the doxastic alternatives actually include @, so there would be overlap. But in that case, there is no de dicto/de re distinction in the first place, so no testable empirical predictions arise in this case.

4 Conclusion

In this paper, I developed a syntactic and semantic approach to intensionality building on unpublished work of Heim (2001) and argued that Heim's approach predicts three established constraints on *de re* interpretation. Romoli and Sudo (2009) called the three constraints I derived the the Main Predicate Constraint, the Intersective Predicate Constraint, and the Nested DP Constraint. In all three cases, the ontological assumption that there are no transworld individuals that Heim adopts from Lewis (1986) was responsible for the derivation. In addition, Heim's implementation of counterparts as functions was important to derive the result: Because of the irreversibility of counterpart functions, predicates cannot apply in the actual world to individuals that are not located in the actual world.

To conclude I would like to discuss two limitations of this paper, if not of the approach I presented. For one, I have not been able to properly compare the approach to the restrictions on *de re* readings described here with others. Secondly, I am presently not sure whether further restrictions on *de re* interpretation follow from the approach presented here in addition to three restrictions I could derive from Heim's approach. In particular, this would be important to determine for two further constraints established in the literature, the Adverb Constraint and the Presuppositional NP Constraint.

Consider first other accounts of restrictions on *de re* interpretation, namely those of Percus (2000), Romoli and Sudo (2009), and Keshet (2011). Overall the comparison is rather difficult because of the differences in ontology assumed, but I think that the approach presented in this paper is at least worth considering further in the discussion of restrictions on *de re*. Consider the three alternative approaches in turn: the approach of Percus (2000) is based on binding restrictions on world variables. However, it seems that the approach requires us to state a different restriction for each known constraint. Until it can be shown that the different binding restriction can be in some way unified, this type of approach is less attractive than an approach deriving multiple constraints from a single restriction. Secondly consider the proposal Romoli and Sudo (2009) who claim to derive all five constraints on *de re* from a single mechanism, namely a mechanism of relating the *de re/de dicto* distinction to local vs. global presupposition accommodation (Heim 1992). However, the account of *de re* Romoli and Sudo (2009) adopt from Geurts (1998) seems not work to me. Romoli and Sudo represent *de re* interpretation as (44a) while (44b) represents *de dicto* interpretation.

(44) John thinks that the president is smart. Romoli and Sudo (2009, p. 433)

a. $\underline{\exists!x : \text{president}(x)}$ and John thinks that $\iota x[\text{president}(x)]$ is smart.
b. John thinks that $\underline{\exists!x : \text{president}(x)}$ and $\iota x[\text{president}(x)]$ is smart.

Geurts discusses a similar representation, namely the one shown in (45a).[20] But, Geurts assumes that the representation in (45a) has an interpretation where simultaneously the presupposition of the *de re* and the *de dicto* interpretation are satisfied; i.e. both the speaker and Louise believe that she has one niece and furthermore they believe this of the same person.[21]

[20] Geurts attributes the analysis of (45) to Zeevat (1992) with the qualification 'implementational details aside'.

[21] The identity requirement (i.e. that the person Louise takes to be her niece is her actual niece) is as far as I can see not a prediction of standard DRT interpretation rules for structures like (45).

(45) Louise believes that her niece lives in Leeds. Geurts (1998, p. 554)

a. [x: x is L's niece, L believes: [x: x is L's niece, x lives in Leeds]]

Geurts also reports that the copying rule involved in deriving (46a) *will make false predictions for attitude contexts created by verbs other than* believe *and its synonyms.*[22]

Both Geurts (1998) and Romoli and Sudo (2009) assume that variables ranging over possible worlds aren't represented in the representations that a model-theoretic interpretation procedure applies to, but they seem to make different assumptions about how the values of world arguments are determined. If we make the content of world argument positions explicit for (44), (46a) represents the binding relations Romoli and Sudo (2009) assume, while (46b) represents what Geurts (1998) assumes.

(46) a. $\underline{\exists!x : \text{president}(@)(x)}$ and John thinks λ_w that $\iota x[\text{president}(@)(x)]$ is smart.
b. $\underline{\exists!x : \text{president}(@)(x)}$ and John thinks λ_w that $\iota x[\text{president}(w)(x)]$ is smart.

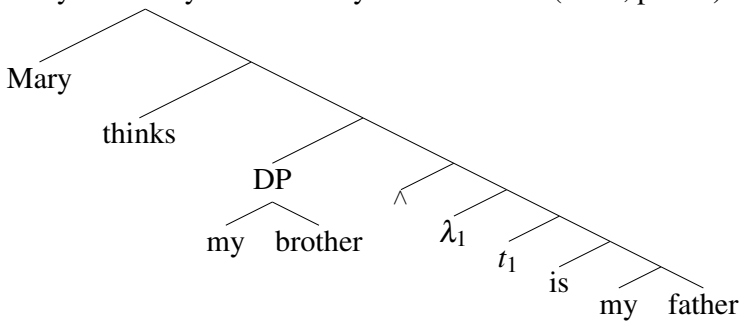
The strictly local binding of world arguments as in (46b) would be predicted from the intensional logic of Montague (1974[1970]), however, it doesn't result in the true *de re* reading. Assuming that non-local binding as in (46a) is available, raises the question what binding is available in the *de dicto* representation (44b), shown in (47) with world argument positions. If the actual world @ can occur the scope of λ_w as in (46a), why not also in either of the two positions in (47)? But if @ could occur here an interpretation like (46b) results, which isn't actually available.

(47) John thinks λ_w that $\underline{\exists!x : \text{president}(\_\_)(x)}$ and $\iota x[\text{president}(\_\_)(x)]$ is smart.

I conclude that the account offered by Romoli and Sudo (2009) is incomplete as it stands, and turn to the analysis of Keshet (2011).

Keshet (2008, 2011) assumes that there is an intensional operator ($^\wedge$) that occurs in the complement attitude verbs such as *think*. Whether a DP is interpreted *de re* or *de dicto* is determined by its scope relative to $^\wedge$. For example, the *de re* reading of *my brother* in (48) is captured by the following representation:

(48) Mary thinks my brother is my father. Keshet (2011, p. 264)



[22] As far as I can see, the reading (45a) is also not generally available with *believe*. Consider e.g. (i) in the following scenario: Mary doesn't know that X is Sue's niece. Instead she incorrectly thinks Y is Sue's niece. Louise however knows that X is Sue's niece. Both X and Y are known by both Mary and Louise to live in Leeds. Then (i) would be predicted to be true, but I at least judge (i) false in the scenario given.

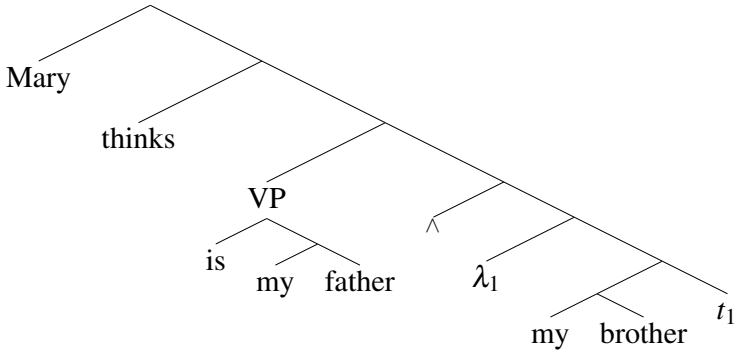
(i) Only Louise believes that Sue's niece lives in Leeds.

Keshet's analysis predicts that *de re* interpretation is constrained by the syntactic constraints on covert scopal movement. As he shows, two of the constraints discussed in section 3 can be related to established syntactic restrictions on movement. However as far as I can see, the Main Predicate Constraint doesn't follow from Keshet's proposal since predicate movement is possible in many languages including (marginally) English as (49) illustrates.[23]

(49) ?Be my father, my brother did.

Since (49) isn't blocked within syntax, the structure in (50) should also be possible. But the interpretation predicted for (50) violates the main predicate generalization, and therefore (50) should be ruled out.

(50)



Keshet's analysis, however, also makes predictions that the present account doesn't make. So, a combination of both accounts fares best empirically at this point. In particular, Keshet argues that *de re* readings are impossible for DPs that are embedded within a syntactic island within a belief report. (51) shows one of Keshet's relevant examples. If a *de re* interpretation of *three professors* were available for (51), (51) should have a coherent interpretation, but Keshet reports that this isn't the case.

(51) #Mary thinks that, if three professors were professors, the classes would be better taught. (Keshet 2011, p. 258)

Hopefully, a closer examination of the predictions of both approaches will make it possible to evaluate both in more detail.

Finally consider two remaining constraints on *de re*: Romoli and Sudo (2009) call these two constraints the Adverb constraint and Presuppositional NP constraint, and they are exemplified by (52) and (53) respectively.

(52) Secenario: Ana has met every actual semanticist, but she thought each time that the person she met was a tour guide. Based on this experience Ana forms the belief that all the tour guides she's met smile all the time.
#Ana thinks that a semanticist always smiles. (after Percus 1998)

[23] Keshet (2008, chapter 5) disagrees with this assessment of the predictions of his account, and claims that *DPs can raise, while VPs cannot* (p. 145). Possibly Keshet has LF reconstruction in mind which Heycock (1995) claims to be obligatory for predicates on the basis of binding data. But, Lebeaux (2009) offers another account of the data Heycock is concerned with that doesn't require LF reconstruction of predicates.

(53) Scenario: Charley mistakes the two horses for two donkeys.
#Charley thinks that there are two horses. (Romoli and Sudo 2009)

Formulas within the present system that might incorrectly predict both of these sentence to be true in the scenarios given are shown in (54).

(54) a. thinks(@)(Ana) [λx . always(@)[C] [λt . smile (x) ($\mathsf{C}_x(\iota$ semanticist(t)))]
b. thinks(@)(Charley) [λx . exist(x) ([two(@) $\wedge$ horses(@)] (z))]

At this point, I have no conclusive account of these restrictions to offer. But this may be due to the fact that my understanding of the semantics of existential sentences and adverbs is at present limited. Hence there is still hope that future work may show that the interpretations in (54) are actually not available in a variant of the system I described and that also the two further constraints of Percus and Keshet can be derived in a system based on the Heimian counterpart-function ontology.

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