

The acquisition of tense-aspect morphology and the regular-irregular debate¹

Yasuhiro Shirai
Cornell University
ys54@cornell.edu

Abstract

This paper reviews research on English past-tense acquisition to test the validity of the single mechanism model and the dual mechanism model, focusing on regular-irregular dissociation and semantic bias. Based on the review, it is suggested that in L1 acquisition, both regular and irregular verbs are governed by semantics; that is, early use of past tense forms are restricted to achievement verbs—regular or irregular. In contrast, some L2 acquisition studies show stronger semantic bias for regular past tense forms (e.g., Housen, 2002, Rohde, 1996). It is argued that L1 acquisition of the past-tense morphology can be accounted for more adequately by the single-mechanism model.

1 Introduction

The acquisition of past tense morphology has been extensively investigated in language acquisition research. There are two aspects of past tense acquisition that have received particular attention: semantic bias in early past tense marking, and the regular/irregular asymmetry in the acquisition of past tense morphology. Both areas have been areas of controversy, in particular concerning the question of innateness. The former has been used as the evidence for Bickerton's (1981) Language Bioprogram Hypothesis, and the latter has been the center of attention in cognitive science in the past fifteen years in relation to the debate between the connectionist and the symbolic paradigms (Rumelhart & McClelland, 1986; Pinker & Prince, 1988).

Although so much research has been done concerning both these issues, the two lines of research have practically ignored each other. However, for children acquiring the past tense morphology, these are one and the same phenomenon that needs to be tackled in their first years of life, and thereafter. This paper is the first systematic attempt to relate these two. In particular, it addresses the question of how the semantics of verbs interacts with regular and irregular past tense morphology, and tests the claims made by Pinker (1984) and Bickerton (1981).

2 Semantic bias in early tense-aspect morphology

The semantic bias of early past tense morphology has been attested in various languages at least since the early 1970s. In a longitudinal study of three children, Brown (1973) noted that early past tense forms are primarily restricted to punctual change-of-state verbs such as *fall*,

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break. Bronckart and Sinclair (1973), in an experimental study of the acquisition of French verb forms, showed that children tend to use perfective past tense forms (*passé composé*) for actions with clear end results, and to use present tense forms for actions without such change of states. Antinucci and Miller (1976) also showed that in the conversational data of seven Italian children, early past tense forms (*passato prossimo*) are limited to verbs that denote observable change of state.

Bickerton (1981) reinterpreted the findings of these studies and claimed that they constitute support for his Language Bioprogram Hypothesis. According to his theory, children are endowed with innate ability to make some linguistic distinctions, such as specific vs. non-specific, realis vs. irrealis. The punctual-nonpunctual distinction is one such distinction children can make based on an innate bioprogram, and he claimed that children at the early stages of acquisition in fact are marking punctuality rather than pastness by the past tense morphology.

Although there is no consensus regarding the explanation for such semantic bias, this phenomenon has been attested in various languages: English (Bloom, Lifter & Hafiz, 1980; Shirai & Andersen, 1995), Chinese (Erbauh, 1978; Li & Bowerman, 1998), Greek (Stephany, 1981), Turkish (Aksu-Koç, 1988, 1998) Japanese (Shirai, 1993), and even in second language acquisition (see Andersen & Shirai, 1996 and Bardovi-Harlig, 2000 for review). Although Weist et al. (1984) presented Polish data that go against this semantic bias, Bloom and Harner (1989) and Andersen (1989) reanalyzed Weist et al.'s results and showed that such semantic bias is present in the Polish data.

Concerning the acquisition of progressive marking, it has been observed that children do not make errors of attaching progressive marking onto stative verbs (Brown, 1973; Kuczaj, 1978). Bickerton claimed that this is also because of the bioprogram, although this question is beyond the scope of this paper (see Shirai, 1994, which focuses on this issue).

These results have been reinterpreted using inherent aspect categories proposed by Vendler (1957)², which can be summarized as follows:

1. Children first use past marking on achievement/accomplishment verbs, eventually extend use to activity and stative verbs. This roughly corresponds to Bickerton's (1981) punctual/non-punctual hypothesis.
2. In languages that encode the perfective/imperfective distinction, imperfective past appears later than perfective past, and imperfect past marking begins with stative verbs, extending next to activity verbs, then to accomplishment verbs, and finally to achievement verbs.
3. In languages that have progressive aspect, progressive marking begins with activity verbs, then extends to accomplishment/achievement verbs.
4. Progressive markings are not incorrectly overextended to stative verbs. This corresponds to Bickerton's state-process hypothesis. (Shirai, 1991, pp. 9-10)

² Briefly, Vendler's semantic categories of verbs are state, activity, accomplishment, and achievement. State terms (e.g., *love*) describe a situation that is viewed as continuing to exist unless some outside situation makes it change. Activity terms (e.g., *run*) describe a dynamic and durative situation that has an arbitrary endpoint, i.e., it can be terminated at any time. In contrast, accomplishment terms (e.g., *make a chair*) describe a situation that is dynamic and durative, but has a natural endpoint after which the particular action cannot continue (i.e., they are telic). Finally, achievement terms describe an instantaneous and punctual situation, i.e., one that can be reduced to a point on a time axis. States are [-dynamic], [-telic], [-punctual]; Activities are [+dynamic], [telic], [punctual]; Accomplishments are [+dynamic], [+telic], [-punctual]; Achievements are [+dynamic], [+telic], [+punctual]. Bickerton's punctuality roughly corresponds to telicity as far as the discussion in this paper is concerned. In this paper, I use the term punctuality when discussing his theory, but in reality it refers to telicity in aspectology.

This is known in the literature as the Defective Tense Hypothesis, the Aspect Hypothesis, the Primacy of Aspect Hypothesis, and so on. Although there may be disagreements regarding the details, this generalization appears to be universal, and needs explanation. Bickerton (1981), in particular, attributed this to an innate bioprogram within the broader context of his Language Bioprogram Hypothesis, which originally came from his research on creole genesis. The argument is that a pidgin language, a simplified contact variety that does not have complexity equal to that of a natural language, acquires various complex linguistic structures once children in the community acquire it as a native language, and the pidgin becomes a creole language. The structures that are invented by the new generation of the speakers are bioprogrammed, according to Bickerton. In the domain of tense-aspect, the punctual-nonpunctual distinction and the state-process distinction are argued to be among them. Bickerton reviewed the child language literature and argued that children's acquisition pattern suggests that they have these distinctions pre-wired. This bioprogram scenario has received a lot of attention and now is even discussed in some books written for the general public (Jackendoff, 1993; Pinker, 1994) as support for the innate basis of linguistic knowledge.

3 Regular-irregular dissociation in past tense morphology

The relationship between regular and irregular past tense acquisition has been important in language acquisition research, in particular because of the intriguing phenomenon of overregularization and recovery (e.g., Ervin, 1964; Karmiloff-Smith, 1986). Children are known to make past tense forms of irregular verbs by adding the past tense suffix *-ed* (e.g., *goed*, *eated*), and later recover from such overregularization errors. The overregularization is treated as the paradigm case of rule learning; unless children internalize a rule, such forms as *comed*, *goed* would not appear.

Interest in this phenomenon has become more intense since the advent of connectionism, or Parallel Distributed Processing—a radically different model of human cognitive processes proposed as an alternative to the predominant symbolic model, which is based on symbols and their manipulations by rules. Connectionists propose a model of human information processing which relies on representation consisting of neuron-like units and connections between them, in which processing of information is achieved by massively parallel activation of these units, the pattern of which determines the information that emerges. Learning in this model is change of representation via change in connection weights between processing units (see, for example, Plunkett, 1995).

Rumelhart and McClelland (1986) presented one such model that simulated past tense acquisition in English. This model, without representing any overt rules, exhibited a similar behavior to that of human children. The model has a single-mechanism that takes care of both regular and irregular past tenses, and Rumelhart and McClelland suggested that their model shows that it is not necessary to represent symbolic rules to deal with acquisition of regular and irregular morphological systems separately. Furthermore, they suggested that the rule-like behavior is just an emergent phenomenon that results from the pattern of activation in the network.

Pinker and Prince (1988) presented a comprehensive critique of the R & M model, but revised models such as MacWhinney and Leinbach (1991), Plunkett and Marchman (1993) responded to Pinker and Prince's criticisms. This debate between the symbolic camp and the connectionists is far from over, and it is still one of the most contentious issues in cognitive science (e.g., Pinker & Ullman, 2002, McClelland & Patterson, 2002, Marslen-Wilson &

Tyler, 2003). The regular-irregular issue in relation to single- vs. dual-mechanism models encompasses various domains, such as the denominal problem (Kim, Pinker, Prasada & Snyder, 1991; Harris, 1993; Harris & Shirai, 1997; Shirai, 1997a; Ramscar, 2002), frequency effects for irregulars (Prasada, Pinker & Snyder, 1990; Sereno & Jongman, 1997), double dissociation in specific populations (Marchman, 1993), phonological similarity and overregularization (Marchman, 1997). Almost all these studies, however, totally ignore the temporal semantics of the verbs, which has been shown to be very important in the acquisition of past tense morphology.

4 Semantic bias and the regular-irregular issue

As noted earlier, the two lines of research have mostly been pursued independently of each other, and the studies on semantic bias do not pay much attention to how they interact with the variable of regular vs. irregular, whereas the studies that focus on the regular-irregular issue ignore the semantic bias in the early acquisition of past tense morphology. There are, however, studies that are relevant to this problem. Notably, two nativist researchers I mentioned earlier, namely Bickerton (1981) and Pinker (1984), presented specific hypotheses concerning the acquisition of regular and irregular past tense forms in relation to semantic bias in tense-aspect acquisition.

4.1 Bickerton (1981)

Bickerton (1981, pp. 177-180) presented a speculative account of regular/irregular past tense acquisition and semantic bias. His bioprogram theory predicts that children use tense-aspect markers to mark distinctions which he assumes to be part of the bioprogram. In tense-aspect acquisition, what children mark first are the state-process distinction and the punctual-nonpunctual distinction, of which only the latter is discussed in this paper since the state-process distinction is not relevant to the regular-irregular issue.

Bickerton proposed a three-stage scenario: (1) Children acquiring English first start out with base forms for all verbs, but then they first mark nonpunctuality using the progressive inflection *-ing*. (2) The next step is for them to mark the punctual side of the semantic space, and they use irregular past to mark punctuality. (3) Later when they encounter the regular past, they realize that the regular past is the punctual marker, not the irregular past, and start to use *-ed* to irregular verbs as well.

His account appears to be based on the observation that irregular past is generally acquired earlier than regular past and that children, after the initial stage of correct use of irregular past forms, start to apply the regular past inflections (*-ed*) to irregular verbs. In hindsight, this is an oversimplification. As Marcus, Ullman, Pinker, Hollander, Rosen and Xu (1992) have shown, children's overregularization rates are quite low (median 2.5% of irregular past tense forms), and it is not the case that at the stage of overregularization children apply regular past marking systematically to all irregular verbs (Kuczaj, 1981). However, if the type of learning process Bickerton proposed is at work, we can predict the following association between semantics and regular-irregular morphology.

- Initially, only irregular past tense forms are associated with punctuality, whereas the regular past is not.

4.2 Pinker (1984)

Pinker (1984) proposed a comprehensive model of language acquisition, in which he briefly referred to the studies that reported semantic bias, and to the paradigm building for past tense acquisition. In proposing his acquisition model of inflectional morphology, he suggested that children at early stages acquire lexical items together with the inflectional morphology, which he calls a word-specific paradigm. Later they extract general rules of inflection, and they exhibit overregularization errors. To support this claim, he stated:

Children initially use inflections such as *-ing*, *-s*, and *-ed* only on a tiny subset of the words that allow those inflections, and then gradually expand their usage to more and more verbs (Bloom, Lifter, and Hafitz, 1978 [sic]; Brown, 1973; Cazden, 1968; Kuczaj 1977, 1981). They learn inflected irregular forms just as easily as regular ones at first; overregularization of irregular forms tends to occur at a later stage (Brown, 1973), Kuczaj, 1977). (Pinker, 1984, p. 180)

Therefore, on Pinker's account the early semantic bias is due to the word-specific paradigm, when children produce inflected forms as unanalyzed units by rote learning. Only later, when they start creating a general inflectional paradigm, do children start to produce overregularization errors. Note that Pinker avoided any reference to semantic bias. For him, it is not important that early inflections are semantically biased, because children just rely on rote learning, and therefore, in principle, can produce past tense forms regardless of the semantics of the verb.

This proposal is in line with Marcus et al.'s (1992) claim that overregularization first appears when a child starts marking past tense reliably. Marcus et al. (1992), in response to the connectionist challenge, did a quantitative analysis of the CHILDES database (MacWhinney & Snow, 1985; MacWhinney, 1995) and showed that the proportion of overregularization is relatively small, and that there are no such clear-cut stages as had been supposed previously.

Marcus et al., along with Pinker (1991) and Pinker and Prince (1991), advocate a dual-mechanism model of regular/irregular morphology, in which irregular morphology is dealt with by associative memory, and regular morphology by rule. Thus, the early word-specific paradigm is based on learning by memorization, and the general paradigm that comes later is based on a rule-learning mechanism. Thus, the dual-mechanism model makes the following prediction:

- Early past tense forms are frozen forms, and at this stage overregularization is not observed. The onset of overregularizations coincides with the obligatory marking of past tense.

These two hypotheses proposed by Bickerton (1981) and Pinker (1984) are only a small part of their global pictures. Nonetheless, they constitute an important part of their proposals, and need to be tested, because both Bickerton's bioprogram hypothesis and Pinker's semantic bootstrapping hypothesis have received so much attention from language acquisition researchers.

To my knowledge, there is only one empirical study that specifically addressed the interaction of regular vs. irregular inflections and semantic bias in the acquisition of past tense (to be discussed below). This is unfortunate in view of the considerable attention both issues have received, and their theoretical importance.

In the remainder of this paper, I will review relevant studies to address the following questions; in so doing, both Bickerton's and Pinker's hypotheses will be tested:

- What is the relationship between verb semantics and overregularization?

- Is there regular-irregular dissociation in the acquisition of past tense in relation to verb semantics?
- How do L1 and L2 acquisition differ in this regard?

5 Overregularization and semantic bias

The one exception mentioned above is Barr and Regier (1998). This is the only study available that specifically investigated the relationship between verb semantics and regular vs. irregular morphology. Given the observation that telic verbs inflected for the past tense often denote result state rather than true deictic past, they hypothesized that activity verbs are more likely to be associated with pastness than telic verbs, and hence, overregularization rate of activity verbs would be higher than that of telic verbs. The prediction was borne out in the analysis of four children's data from CHILDES, activity verbs showing a significantly higher rate of overregularization (0.67) than telic verbs (0.39) ($p < 0.01$).

Although this is an important study, it was only published as a one-page summary in a Cognitive Science Society Proceedings, and due to space limitations, some aspects of the study are not clear. In particular, it appears that Barr and Regier only looked at activity verbs and telic verbs, and nothing is mentioned about stative verbs. Stative verbs, when combined with past tense form, refer to deictic past in many cases (e.g., *I loved Mary*). Neither is it clear how the verb tokens were classified. However, their study does propose an important account of how regular past inflection is associated with temporal semantics, and why.

Shirai (1991, also Shirai & Andersen, 1995) is a study of the acquisition of English tense-aspect morphology by three children. Although this study focused on semantic bias, it also looked at the issues pertaining to the regular-irregular debate. Also, this study reported the results for regular and irregular past forms separately in its Appendix, and so reanalysis is possible.

The gist of Shirai's findings is summarized succinctly by a recent paper by McClelland and Patterson, which I quote here:

Shirai and Anderson [sic] examined the use of the past tense as a function of semantic properties of the situation referred to in children's speech. When it first appears, the use of the past tense (including over-regularization) is largely restricted to descriptions of punctuate events that have endpoints and produce results (such as *'I dropped it'*); it then gradually spreads to cases in which one of the typical properties (is punctuate, has endpoint, produces results) is violated. (McClelland & Patterson, 2002, p. 469)

What is important in this context is that the acquisition of the past tense is restricted to prototypical cases, and even the overregularized forms of past tense are restricted to those. Shirai 1991 (also Shirai & Andersen 1995) reported that the first three past tense forms used by Naomi (Sachs, 1983), one of the children studied, were *fell* (4 tokens) *found* (one token) and *throwed* (5 tokens), an overregularized form. That is, even at this emergent stage of past tense, when all past marked verb tokens were restricted to achievement verbs, overregularization is observed. In fact, Naomi produced *throwed* even before producing any correct regular past tense form. Note that generally it takes over a year from the emergence of the past tense morpheme to the attainment of 90% marking in obligatory contexts (see McClelland & Patterson, 2002, pp. 467-468). Therefore, the claim by Marcus et al. that onset of overregularization coincides with obligatory marking appears to be incorrect.

Marcus et al. (1992) claimed that "Overregularization first appears when children begin to mark regular verbs for tense reliably (i.e., when they stop saying *Yesterday I walk*)" (p. v),

based on the data from four children: Abe (Kuczaj, 1977), Adam, Eve, and Sarah (Brown, 1977). However, their claim is only supported by correlation. McClelland and Patterson (2002) clearly show that their evidence is based on a shaky ground of weak correlation, which in fact is a function of age and gradual development.

It should be also noted that the same trend is seen for the progressive marking. Shirai (1991) reported that Naomi used *sittinging down*, which is a reduplication of *-ing* produced when her progressive was mostly limited to activity verbs, suggesting that the morphological process starts when the progressive is still limited to activity verbs. This indicates that semantic bias is not necessarily caused by lexical, rote learning, even though Pinker (1984) suggests otherwise. It appears that initial representation of the progressive category is also limited to activity verbs (at least as it is inferred from the production of *-ing*). The prototype scenario of acquisition can explain the acquisition of not only irregular and regular past marking, but also of progressive marking (to be discussed in section 8).

6 Semantic bias and regular-irregular dissociation

As discussed earlier, Bickerton (1981) predicted that the irregular past develops first with punctual verbs, and that later, when the regular past appears, it will be overregularized to irregular verbs. Although Pinker (1984) does not make any specific prediction concerning the relation between semantics and regular vs. irregular past forms, if different patterns are found between regular and irregular past tense forms, that would be more consistent with the dual-mechanism model, and the single-mechanism model would have to come up with an explanation for the dissociation. Table 1, extracted here from Appendix A in Shirai (1991), shows the relationship between inherent aspect (states, activities, accomplishments, achievements) and the past tense forms at the earliest stage of past tense acquisition. The stages of development in this and subsequent tables are based on children's MLUs.

Table 1. Emergence of past tense marking at stage 1 (token count)

Adam	State	Act	Acc	Ach	total	State	Act	Acc	Ach
irreg	0	1	0	16	17	0.0%	5.9%	0.0%	94.1%
-ed	0	0	0	0	0	0.0%	0.0%	0.0%	0.0%
Eve									
irreg	0	0	0	2	2	0.0%	0.0%	0.0%	100.0%
-ed	0	0	0	2	2	0.0%	0.0%	0.0%	100.0%
Naomi									
irreg	0	0	0	5	5	0.0%	0.0%	0.0%	100.0%
-ed	0	0	0	5	5	0.0%	0.0%	0.0%	100.0%

Adam's data appear to support Bickerton's argument in that at stage 1, only irregular past forms are produced, and they mark punctuality (i.e., 94% of the past tense forms are on achievements verbs.) However, Eve and Naomi both produce the same number of regular and irregular past forms, all of which are attached to achievement verbs. This individual difference cannot be explained by a bioprogram account, which presupposes innate constraints on acquisition. Furthermore, two out of three children go against Bickerton's prediction. Note also that Naomi's 5 regular past forms are all overregularized form *throwed*, which, according to Bickerton, should come after the period when irregular past tense forms are used to mark punctuality.

Next, let us examine whether regular-irregular dissociation can be found in the course of development. Table 2 shows the percentages of past tense forms applied to achievement verbs, the semantic prototype.

Table 2. The percentages of achievement verbs among past tense marking (token count in parenthesis)

Adam	Stage 1	Stage 2	Stage 3	Stage 4
irreg	94.1% (16/17)	86.4% (57/66)	80.0% (32/40)	67.5% (27/40)
-ed	NA	88.9% (8/9)	78.3% (18/23)	70.8% (17/24)

Eve	Stage 1	Stage 2	Stage 3
irreg	100% (2/2)	70.0% (21/30)	63.3% (19/30)
-ed	100% (2/2)	62.5% (10/16)	55.6% (5/9)

Naomi	Stage 1	Stage 2	Stage 3	Stage 4
irreg	100% (5/5)	92.5% (37/40)	43.1% (22/51)	66.2% (104/157)
-ed	100% (5/5)	73.1% (19/26)	63.0% (17/27)	37.6% (35/93)

Adam's case is the most straightforward—there is virtually no difference between regular and irregular past marking except at the first stage as we discussed earlier. Both types of the past tense inflection gradually relax their restriction to achievements. Eve's case is also similar, except that the regular past shows slightly faster relaxation compared to the irregular past. Naomi's case is the most problematic, showing a zig-zag pattern of development. At stage 2, the irregular past is more strongly associated with achievements, but this pattern reverses at stage 3, and then at stage 4, the irregular past tense again has stronger association with achievements.

This is somewhat puzzling, but it appears that there is no regular-irregular dissociation. If there is, the trend seems to be that irregulars are slightly more constrained by semantics than regulars. This is congruent with Barr and Reiger's prediction that activity verbs show stronger association with the regular past than telic verbs.

In sum, a reanalysis of Shirai's (1991) study suggests that Bickerton's prediction is not supported because regular past can appear at the same time as irregular past, and that regular-irregular dissociation is not clearly observed.

7 L1-L2 difference in regular-irregular past tense acquisition

There are some studies in L2 acquisition that reported the differences between regular and irregular past in the acquisition of past tense. First, Rohde (1996) reported that the regular past was almost exclusively attached to achievement verbs, whereas the irregular past involved more variety of verb types, in particular stative verbs, which is predicted to be most unlikely to be inflected for the past tense. The study analyzed 6-month longitudinal data of 6- and 9-year-old German boys acquiring English in California. The following table is calculated based on Rohde's Figures 5 to 8, and clearly shows that the regular past is much more strictly confined to its semantic prototype (i.e., the past tense marking on achievement verbs) than the irregular past.

Table 3. Percentages of achievement verbs among past tense marked verbs (based on type count, in parenthesis)

Lars	May	June	July	August	September
irreg	0% (0/1)	66.7% (4/6)	42.9% (3/7)	63.6% (7/11)	50% (7/14)
-ed	100% (1/1)	100% (3/3)	100% (4/4)	100% (6/6)	77.8% (7/9)

Heiko	May	June	July	August	September
irreg	50% (1/2)	85.7% (6/7)	55.6% (5/9)	68.8% (11/16)	72.7% (8/11)
-ed	100% (5/5)	75% (9/12)	62.5% (5/8)	77.8% (14/18)	50% (2/4)

Housen (2002) specifically discussed the dual-mechanism model in the context of second language acquisition. In his study of a Dutch child studying English in Belgium, he found that progressive *-ing* and regular past *-ed* were more strongly associated with inherent aspect than was the irregular past, irregular state verbs showing an unexpectedly high ratio of past marking, which goes against the predicted semantic bias. Based on this observation, Housen suggests that the dissociation between regular morphology (*-ing* and *-ed*) and irregular morphology can be accounted for by the dual-mechanism model. He stated:

...one could speculate that conceptual-semantic notions (prototypes) such as stativity, durativity and telicity play a steering role in the process of morphological rule-learning, which mainly affects regular morphology like *-ing*, but not or less so in associative learning, which mainly affects irregular forms such as *went*, *go*. These irregular forms would be directly mapped onto a given conceptual scene and then stored as a one specific form-meaning unit in lexical memory. (Housen, 2002, p. 188)

However, it is premature to jump to this conclusion. Rocca (2002) reported that there was no regular-irregular dissociation in her longitudinal study of three Italian children acquiring English in the UK. She found that both irregular and regular past tense forms are strongly associated with telic verbs. In any event, it appears that it is in L2 acquisition, not in L1 acquisition, that regular-irregular dissociation is observed, and even in L2 studies it is not always the case that the dissociation is observed. If the dual-mechanism model is to apply to first language acquisition and native speakers of a language, it is hard to see why it applies better to L2 acquisition than to L1 acquisition.

8 Distributional learning and prototype-based initial representations

To summarize the discussion so far regarding the regular-irregular issue and semantic bias, we can offer the following observations:

- Overregularization is observed even at the stage when the morphology is restricted to its semantic prototype.
- In L1 acquisition, there is no clear pattern of regular-irregular dissociation in past tense acquisition.
- In L2 acquisition, there is some evidence for regular-irregular dissociation in relation to semantic bias, regular morphology being more strongly tied to semantics.

Clearly, these observations are not consistent with the dual-mechanism model (or the Words-and-Rules theory of Pinker, 1999), or the Language Bioprogram Hypothesis of Bickerton (1981).

How, then, do we account for such observations? In earlier work, I have proposed prototype formation based on distributional learning as an explanation for the semantic bias in early tense-aspect morphology, and in other aspects of grammatical development (Shirai, 1991; Shirai & Andersen, 1995; Shirai, 1997b; Shirai, 2000). In short, the semantic bias comes from biased frequency distribution in the input and learners' prototype formation based on such biased input. To illustrate, let us look at Table 4. What we see here is that if 60% of past tense forms in the input are on achievement verbs, children will create almost 100% restriction, creating a semantic prototype for the broader category 'past tense'. The same trend holds for progressive marking, with its prototype as activity verbs denoting action in progress. This input-based learning has been successfully simulated by a self-organizing neural network in Li and Shirai (2000).

Table 4. Distribution of the past tense morphology and inherent aspect in three children's and their mothers' speech at the earliest stage (Shirai, 1991) (average percentage based on token count)

	<u>State</u>	<u>Activity</u>	<u>Accomplishment</u>	<u>Achievement</u>
Children	0%	2%	0%	98%
Mothers	17%	10%	13%	60%

There are some objections to this model, and I would like to address them. One common objection to this type of prototype model is that the observed pattern of acquisition may not reflect children's competence, but rather may just be due to the discourse context in which children's spontaneous conversation is taped.³ Weist (1989) makes such an argument to account for skewed distribution in the use of tense-aspect morphology in Polish.

This is a valid criticism, and the real test of whether the skewed distribution was purely based on discourse factors must come from experimental studies. Regarding the semantic bias in tense-aspect acquisition, at least two comprehension studies (Li & Bowerman, 1998 for Chinese, and Stoll, 1998 for Russian) show that children's competence is in fact limited, and that they have higher comprehension scores for prototypical combinations (e.g., perfective and telic predicates) rather than non-prototypical combinations (e.g., perfective and atelic predicates). These studies suggest that children's restricted production patterns also reflect their restricted semantic representation.

Another, related, objection concerns the nature of semantic bias. Tomasello's usage based approach to language acquisition (e.g., Tomasello, 2003) is generally compatible with my proposal since the emphasis is on environmental factors, in particular, the role of input. However, Tomasello's (1992, 2000) Verb Island Hypothesis, like Pinker's verb-specific paradigm, presupposes that early restriction of grammatical forms is based on item-based learning, and not on productive semantic representation. My proposal is different in that I argue that the early restriction results from restricted semantic representation. The evidence, as discussed above, comes from overregularization of the past tense forms that we discussed earlier. At least for one child (Naomi), the onset of overregularization was the emergence of the regular past tense; that is, this child, at least in the transcripts, produced an overregularized form *throwed* even before a correct regular past form, and this comes around the same time as the first use of the irregular past tense. This means that rule-learning must have started even before Naomi produced any past tense forms.

³ When I presented my prototype hypothesis of tense-aspect acquisition at a workshop in 1992 in Tokyo, Steven Pinker, who was on the panel, made such a comment.

What is the mechanism behind such precocious rule-learning? It appears that comprehension is the key. Recent studies of very young children, using a variety of experimental paradigms, have shown that children, even before speaking a word, are engaged in linguistic information processing and are sensitive to linguistic distinctions that are encoded in the language. For example, Choi, McDonough, Bowerman and Mandler (1999), using preferential looking experiments, showed that Korean children are more sensitive than English children to linguistic distinctions made in Korean but not in English, even though the majority of the children, who were aged between 19 to 23 months, had not yet produced the target word. In the same vein, while children comprehend adult utterances containing tense-aspect markers, they process the input and create initial form-meaning associations, in this case the *-ed* form and punctuality, telicity, dynamicity, etc. Thus, it would be reasonable to assume that children, on the basis of the comprehension of verb forms prior to active production, have already created a restricted semantic representation of these morphological forms. Some children, like Naomi, are more attuned to rule-learning, while others, like Adam, are more likely to rely on lexical, rote learning at the early stages, and thus the irregular past may precede the production of the regular past. Eve, perhaps, is in between. Such individual differences are reported in the child language literature (Peters, 1977, 1983; Bates, Bretherton & Snyder, 1988).

How can we make sense of the L1-L2 difference in the acquisition of regular and irregular morphology? Since the number of relevant studies is very small, we should be cautious in making premature generalizations. But if indeed this trend—more regular-irregular dissociation in L2 than in L1—is confirmed in future studies, we can propose the following account. The discrepancy appears to be based on the degree of rote learning used by L1 and L2 learners. In the L2 acquisition literature, it has been suggested that L2 learners, due to their higher rote-memory capacity, can produce long formulaic forms even when their creative language is very limited. For example, Huang and Hatch's (1978) 5-year-old Chinese learner of English says things like *It's time to eat and drink*, when his productive ability of copula was still limited, (saying things like *this...kite*, instead of *This is a kite*.) Irregular verbs are frequent (only frequent words can survive as irregulars, Pinker, 1999), and therefore both L1 and L2 learners can produce them frequently relying on rote memory. But if rote memory is more readily available for L2 learners, then this explains the observation that irregulars are less constrained by semantics in L2 acquisition, since L2 learners can produce rote-learned forms even before they acquire their semantic representation. They even produce past tense forms for future contexts (Robison, 1995). This is not the case for L1 children. Brown (1973) suggests that most of children's uses of past tense are appropriate, i.e., overuse of past tense forms is very rare. Thus this type of haphazard production of rote-learned forms in L2 learners probably contributed to the weaker semantic bias in irregulars than in regulars in L2 acquisition (for further discussion of this issue, see Shirai, in press.)⁴

Now, does this mean we need to posit two separate mechanisms? Certainly not. The default is that both forms are acquired by the same principle—form-meaning mapping and generalization. The dissociation is observed only if other external and internal factors come into play. Note that rote learning can occur for regulars as well. It is just that irregulars are more prone to rote learning, but this is a matter of degree (Bybee, 1995). Some children may prefer rote strategy more than others, and that explains individual differences. And L2 learners may prefer rote-learning since they are capable of such a strategy and also since they

⁴ The difference between Rohde's and Housen's studies and Rocca's study still needs to be explained. It perhaps resulted from the differences in learners L1s and in the tasks used in these studies. But this is beyond the scope of this paper.

are often in situations where they have to produce some linguistic expressions beyond their control, in which case they have to rely on rote-learned forms.

9 Conclusion

In this paper, I have tried to integrate the two lines of research in tense-aspect acquisition—the regular-irregular debate and the semantic bias hypothesis, by reviewing and reanalyzing previous research. The observations concerning the relationship between inflection type and semantic bias presented here are still preliminary, and need further empirical investigations. In particular, not just post-hoc analysis of published research, but new studies that focus on the relationship between the two are necessary. Still, we can tentatively conclude that the empirical evidence appears to be more consistent with the single-mechanism model than the dual-mechanism model, and with the prototype hypothesis than Bickerton's bioprogram hypothesis. The onset of overregularization does not coincide with obligatory past marking, contrary to the prediction of the dual-mechanism model. Irregular past is not necessarily acquired first to denote the non-punctual side of the semantic space, contra the bioprogram hypothesis. There seems to be much individual variation in terms of regular-irregular dissociation, and L2 learners seem to be more consistent with the dual-mechanism model than L1 children, which is certainly puzzling for the dual-mechanism model that presupposes two distinct mechanisms in human language faculty. These observations are all consistent with input-based prototype formation as a model of form-function mapping, which does not distinguish regular and irregular in any fundamental sense. Although the issue of nature vs. nurture in language acquisition cannot be settled easily, we need a more integrated view of language acquisition. I hope this paper has made a modest contribution to this goal.

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