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Evaluating the Variational Model of Language Acquisition*

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In this study, we evaluate the Variational Model of Language Acquisition proposed by Yang (2002), which claims that all UG-defined grammars are accessible to the learner at the start, and that language acquisition is a process of competition among these grammars. We show that the acquisition of preposition-stranding in English poses a serious challenge to this proposal, and favors the traditional model of parameter-setting. A broader implication is that the time course of language acquisition is a rich source of evidence concerning the mechanisms of parameter-setting.

1. Introduction

Modern linguistic theory attempts to explain why language acquisition is possible despite the fact that relevant experience available to children is severely limited ("Plato's problem," e.g. Chomsky (1986:xxv)). The proposed answer postulates that a human child is genetically equipped with Universal Grammar (UG), which narrowly constrains the space of hypotheses to entertain. Under the Principles-and-Parameters approach to UG (Chomsky 1981), UG consists of (i) a number of principles that specify the properties to be satisfied by any language, and (ii) a small number of parameters that sharply restrict the range of possible cross-linguistic variation. The major task for modern linguistic theory, then, is to reveal the exact nature of such principles and parameters.

In contrast, the theory of language acquisition aims to answer a broader question of how language is acquired. The answer should contain (at least) the specifications of (1), in addition to the specification of the initial state (UG).

(1) The learning algorithm *L*, which maps the initial state S_0 to the terminal state S_T on the basis of linguistic experience E.
L: $(S_0, E) \rightarrow S_T$

There is no doubt that language acquisition studies so far have made significant contributions to (1). The major proposals include the Subset Principle (e.g. Wexler and Manzini 1987), Indirect Negative Evidence (Chomsky 1981:8-9, Rizzi 1982), and the Triggering Learning Algorithm (Gibson and Wexler 1994).

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However, we have to admit that, compared with an enormous amount of investigation on the nature of principles and parameters, the research on (1) has been quite scarce, which indicates that more has to be done to make progress toward constructing a general theory of language acquisition.

Recently, Yang (2002) has made an influential proposal concerning the learning algorithm, which he calls the Variational Model of Language Acquisition. Granting its importance, this study attempts to evaluate its empirical validity by looking at the acquisition of preposition-stranding (P-stranding) in English. We argue that the process of setting the P-stranding parameter poses a serious challenge to this model and favors a more traditional model of parameter-setting.

2. The Variational Approach to Language Acquisition

2.1 Language Acquisition as Grammar Competition

It has been demonstrated at least since Otsu (1981) that properties of UG constrain the course of language acquisition from virtually the very beginning of life (see also Crain & Thornton 1998). Such findings constitute the empirical basis of the Continuity Assumption (Pinker 1984:7), whose strongest form suggests that child language is subject to the same principles and constraints as adult language, and that every utterance in child language is potentially an utterance in adult language. Under this assumption, the difference between child and adult languages is attributed to differences in the *organization* of a continuous grammatical system. Yang (2002:12) points out that there are two different realizations of this position:

(2) a. Child language reflects a *unique* potential adult language.
b. Child language consists of a *collection* of potential adult languages.

The traditional and dominant view in language acquisition studies has been (2a). For example, under the Triggering Learning Algorithm of Gibson and Wexler (1994), the learner changes the value of a parameter in the current grammar if the current grammar cannot analyze the input sentence and the grammar with the changed parameter-value can. Yet, Yang (2002:14-24) argues that such an algorithm faces many theoretical and empirical problems. Perhaps the most serious empirical problem is that it necessarily makes the following prediction, for which little developmental evidence has been provided:[1]

(3) As the learner moves from grammar to grammar, abrupt changes in linguistic expressions should be observed (Yang 2002:20).

The null-subject phenomenon in the acquisition of English runs counter to this prediction. According to Bloom (1993:731), in the speech of Adam and Eve

[1] Despite Yang's claim to this effect, the recent literature does provide some support for (3). For example, see Snyder and Stromswold (1997), Snyder (2001) and Sugisaki (2003) for evidence from children's acquisition of English and Japanese.

(Brown 1973), the transition in the proportion of overt subjects is gradual, and there is no point where the children suddenly stop omitting subjects. Yang (2002:107) argues that the same holds for the acquisition of the verb-second (V2) phenomenon in Dutch: The percentage of V2 use in matrix sentences rises not radically but gradually, from about 50% at 2;4 (years;months) to 85% at 3;0.

As these findings appear to falsify the prediction in (2a), Yang (2002) proposes that (2b) is the correct perspective, and develops the *Variational Model of Language Acquisition* (VMLA), which has its conceptual foundation in the Darwinian view of biological evolution. In this model, all UG-defined grammars are accessible to the learner from the start, and language acquisition is metaphorically the process of *competition* among these grammars. The proposed learning algorithm can be schematically shown as follows (Yang 2002:26-27):

(4) Under the presentation of an input datum *s*, the child
   a. selects a grammar G_i with the probability p_i,
   b. analyzes *s* with G_i
   c. • if successful, reward G_i by increasing p_i
      • otherwise, punish G_i by decreasing p_i

In simpler terms, this learning algorithm rewards grammars that succeed in analyzing a sentence and punishes those that fail to do so. Hence, learning is the adaptive change in the weights of grammars in response to the sentences successively presented to the child. As learning proceeds, grammars that are more compatible with the input data will be more prominently represented in the learner's hypothesis space. Learning stops when the weights/probabilities of all grammars stabilize and do not change any further; at this point, the target grammar has eliminated all other grammars in the population as a result of learning.

2.2 Evidence from Null Subjects in the Acquisition of English

One well-known observation about child English is that it permits subjectless sentences, which are exemplified in (5).

(5) a. See window.
   b. Want more apple. (Hyams 1986:63)

In her seminal work, Hyams (1986) proposed a parametric account in which these utterances stem from an early non-adult-like setting of the null-subject parameter. Yet, her account falls under the triggering model presented in (2a), and hence fails to explain the absence of radical change discussed in the preceding subsection. Such problems have led to a performance account (e.g. Bloom 1990, 1993; Valian 1991), which attributes the omission of subjects to children's production limitations.

Yang (2002) revives the parameter-setting account, by making use of his VMLA. He postulates three major types of grammars to compete, which have the following characteristics (Yang (2002:116) with slight modification):

(6) a. The Chinese type:

Object drop, restricted subject drop (no subject drop with argument topicalization).

b. The English type:
   No object drop, obligatory subject, use of expletive *there*.
c. The Italian type:
   No object drop, unrestricted subject drop, rich Agreement morphology.

Yang suggests that English-learning children rapidly eliminate the Italian grammar from the competition on the basis of their knowledge of agreement morphology. There is strong evidence that young children have near-perfect knowledge of agreement morphology (e.g. Phillips 1995:327). Thus, every time an Italian grammar is selected to analyze an incoming English sentence, the lack of unambiguous agreement causes the grammar to fail and be punished as a result.

The Chinese-type grammar is far harder for English-learning children to rule out, since (i) morphological information is of no help, and (ii) the relevant evidence against the Chinese grammar (sentences with expletive *there*) is quite low in frequency (1.2% of all adult sentences directed to children, based on the CHILDES database). Thus, under the VMLA, null subjects in child English are attributed to the coexistence of English grammar and Chinese grammar.

Yang argues that the claim of grammar coexistence directly explains the fact that the rate of subject drop in English-speaking 2-year-olds is slightly lower (30% of total utterances) than that of Chinese-speaking children around the same age (46.5%) (Wang et al. 1992). In addition, his VMLA account makes a highly specific prediction about the relative frequencies of null subject (NS) and null object (NO). If NS in child English is due to the presence of the Chinese grammar, then English-learning children should also use NO, and the relative ratio of NO/NS should hold fairly constant across English and Chinese children in the same age group. Yang (2002:121-122) shows that this quantitative prediction has been born out: The ratio of NO/NS was 32.1% in child English and 36.2% in child Chinese.

3. A Challenge from the Acquisition of Preposition-Stranding

Yang's (2002) VMLA indicates very promising directions to pursue with respect to the learning algorithm that maps the initial state to the steady state on the basis of linguistic experience. In addition, it provides a new and intriguing explanation of the long-standing issue of null subjects in child language. Yet, as is often the case with a novel proposal, there are findings that constitute an apparent problem for this approach and hence remain to be examined. We will point out one such acquisitional finding, drawing on recent work by Sugisaki and Snyder (2003).

An exotic property of English is that it allows preposition stranding (P-stranding): The *wh*-movement of a prepositional complement can strand the preposition, as shown in (7). In contrast a majority of languages, including Romance languages like Spanish, do not have such an option, and *wh*-movement in these languages must pied-pipe the preposition.

(7) English: Which subject did they talk <u>about</u> *t* ?

(8) Spanish:

a.	*Cuál	asunto	hablaban		sobre	*t* ?
	which	subject	were-they-talking		about	
b.	Sobre	cuál	asunto	hablaban	*t* ?	
	about	which	subject	were-they-talking		

This cross-linguistic variation would suggest that UG is equipped with a parameter of P-stranding that has two values, one leading to the availability of P-stranding and the other leading to obligatory pied-piping. See Hornstein and Weinberg (1981), Kayne (1981), Law (1998), Abels (2003), and Bošković (2004) for concrete proposals concerning the P-stranding parameter.

The parameter of P-stranding constitutes a crucial testing ground for the VMLA, since both values induce visible effects on *wh*-movement. If this basic form of the P-stranding parameter is on the right track, then the VMLA makes the following predictions: Since all UG-defined grammars are available to the learner from the start and compete with each other, (A) both P-stranding and pied-piping should be observed in child English, and (B) prepositional questions (of both types) should appear as soon as the child starts using *wh*-movement and prepositions (the prerequisites for both P-stranding and pied-piping). [2]

The data reported in Sugisaki & Snyder (2003) show that these predictions are not correct: According to their investigation of the CHILDES database (MacWhinney 2000), while English-learning children start producing direct-object *wh*-questions at 2;3 on average, and show frequent use of PPs (including PP complements of V) even before their first direct-object *wh*-questions, P-stranding does not appear until around 2;7 (see (9)). Hence, after the first clear use of *wh*-movement and PP, many children show a certain period of time in which no P-stranding is observed.

In order to evaluate the statistical significance of observed age differences between the acquisition of direct-object *wh*-questions and the acquisition of P-stranding, Sugisaki and Snyder (2003) counted the number of clear uses of the earlier construction before the first clear use of the later construction. Next the relative frequency of the two constructions in the child's own speech was determined, starting with the transcript after the first use of the later construction, and continuing for the next ten transcripts or through the end of the corpus (whichever came first). Then the binomial test was used, to obtain the probability of the child's producing at least the observed number of examples of the first construction, before starting to use the second construction, simply by chance. The null hypothesis for the test is that the second construction was grammatically available at least as early as the first construction, and had the same relative frequency observed in later transcripts (cf. Stromswold 1996,

[2] Other parameters should also provide important testing grounds for the VMLA, to the extent that (i) both of their values induce visible effects, and (ii) the process of their setting can be observed in the course of acquisition. As far as we are aware, there are few parameters that have both of these properties. One candidate would be the parameter regulating left-branch extraction. Yet, the spontaneous speech data of English-learning children available in the CHILDES database do not seem to provide enough data concerning the acquisition of this property. The apparent left-branch violations that are sometimes found in experimental studies of English-learning three-year-olds have been argued *not* to result from a misset left-branch parameter (Yamane, Pichler, & Snyder 1999).

Snyder and Stromswold 1997).

(9) Ages of First Clear Use:

child	*direct object wh-question*	*P-stranding*
Abe	2;5.0	2;7.7
Adam	2;5.0	2;5.0
Allison	2;10.0	-----
April	2;1.0	2;9.0
Eve	1;8.0	2;2.0
Naomi	1;11.30	2;8.30
Nina	2;1.12	2;9.13
Peter	2;1.18	2;5.3
Sarah	2;10.11	3;3.7
Shem	2;2.16	2;6.6
average	2;3	2;7

Of the nine children who acquired both properties, six (Abe, Eve, Naomi, Peter, Sarah, and Shem) acquired direct-object *wh*-questions significantly earlier than P-stranding (for four children, $p < .01$ by binomial test; and for two children, $p < .10$, marginally significant). Since these children did not use P-stranding as soon as they acquired *wh*-movement, they succinctly falsify Prediction (B).

(10) Results of the Statistical Analysis:

child	*relative frequency*		*p =*
	direct object wh	*P-stranding*	
Abe	.583	.417	11^.583 < .01
Adam	-----	-----	-----
Allison	-----	-----	-----
April	.842	.158	1^.842 > .10
Eve	.818	.182	48^.818 < .001
Naomi	.833	.166	42^.833 < .001
Nina	.826	.174	12^.826 > .10
Peter	.904	.096	26^.904 = .073
Sarah	.786	.214	10^.786 = .090
Shem	.714	.286	18^.714 < .01

More importantly, none of the children in (10) ever produced a *wh*-question with pied-piping anywhere in their corpora, which shows that Prediction (A) is also false. Hence, in the acquisition of English, there is no indication that P-stranding grammars and pied-piping grammars coexist to compete. If they did, we should find a certain amount of pied-piping in the child's speech, which would correspond directly to the English-learning child's use of null subjects, discussed in the previous section. The findings made by Sugisaki and Snyder (2003) are compatible with the classical triggering model of

parameter-setting, with the non-trivial assumption that the P-stranding parameter has no default setting: Neither P-stranding nor pied-piping is employed until the child determines the correct setting for her target grammar.[3]

4. Conclusion

In this study, we evaluated Yang's (2002) Variational Model of Language Acquisition, which constitutes a novel proposal about the learning algorithm that maps the initial state (UG) to the steady state on the basis of linguistic experience. We pointed out that the acquisition of P-stranding in English does not exhibit the pattern predicted by the Variational Model: There is no indication that P-stranding grammars and pied-piping grammars coexist to compete. The findings are in turn more consistent with the classical triggering model of parameter-setting. A broader implication of this study is that the time course of child language acquisition is a potentially rich source of evidence concerning the mechanisms for parameter-setting.

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[3] Thus, setting of the P-stranding parameter is a case of what Snyder (2002) calls "highly conservative acquisition": The child does not make productive use of a surface form (P-stranding or pied-piping) until she has determined that the form is in fact grammatically possible in the target language. An important question remains as to whether there exist *any* parameters that take a non-subset value as a default setting. This question is left for further research.

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