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Language Development: Emergentist Theories

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Special symbols

¬ Negation.
∀ Universal quantification.

Abstract

The course of linguistic development is shaped by processing pressures that reflect the interaction of internal factors such as burden on working memory with external factors relating to experience. Two case studies help reveal the central role of internal pressures in determining both the properties of language and the manner in which those properties emerge over time, opening the door to a new perspective on development.

Introduction

Much of the research program of contemporary linguistics focuses on two fundamental questions.

- Why do languages have the particular properties that they do?
- How do those properties emerge in the course of language acquisition?

Emergentism holds that the answer to both questions lies in the interaction of forces that exist independently of language. One such force, on which I will concentrate here, is processing cost.

The central thesis of this article is that processing pressures are largely responsible for the course of development – the series of changes that bring a learner's language in alignment with the language of his or her community. This idea can be stated informally as follows.

1. Processing determinism
   Processing pressures shape the course of development.

This thesis rules out the possibility that development is the product of maturational factors and/or environmental pressures unrelated to processing, but is neutral with respect to the nature of the mechanisms that emerge in the course of language acquisition. Although I take those mechanisms to be processing routines rather than conventional grammatical rules (e.g., O'Grady, 2005), nothing turns on that point here, and I will explore the consequences of processing determinism in theory-neutral terms to the extent possible.

Processing-related pressures come from two very different sources. On the one hand, there are external factors that arise from the environment, including the composition and quantity of the input to which learners are exposed. On the other hand, there are internal pressures that stem from the burden that particular linguistic phenomena place on working memory. I will consider each type of pressure in turn, before examining the question of whether development follows a uniform course despite apparent differences among individual learners.

External Pressures: The Role of Input

Most emergentist work on development maintains a strong input orientation. An early and very influential example of this comes from the classic Competition Model. Explicitly presented as a processing-based approach to development (MacWhinney, 1987: 301), the Competition Model focuses on the relative weighting of the input cues that help identify sound-meaning mappings. It makes a simple but daring prediction: by the virtue of its facilitatory effect on processing, cue validity should determine the order in which particular aspects of language are acquired (Bates and MacWhinney, 1987: 171).

In the classic model, cue validity reflects the interaction of two factors – availability (how often a cue is present in the input when a particular mapping is being computed) and reliability (how often the cue leads to the correct result). In English, for instance, the cue of noun–verb order, exemplified in (2), scores high in validity when it comes to identifying a sentence's subject.

2. Rob likes Lucy

Not only is noun–verb order almost always available in English (the vast majority of sentences have a noun to the left of the verb), it is also highly reliable (a preverbal noun almost always corresponds to the subject). In contrast, cues such as case (*he* vs *him*, *she* vs *her*) or verbal agreement are less frequently available, and are hence less valid. These facts are reflected in development in the predicted way: children learning English initially rely primarily on word order to distinguish subjects from direct objects. In other languages, of course, other cues have a higher validity (e.g., animacy in Italian, and case in Turkish), shaping development in those languages accordingly (Slobin and Bever, 1982; Bates et al., 1984).

The Competition Model is just one of several streams of emergentist thought that focus on the role of input in shaping development. Usage-based and constructivist approaches to language acquisition (e.g., Tomasello, 2003; Goldberg, 2006;

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MacWhinney, 2010; Ambridge and Lieven, in press) place special emphasis on children's pattern-finding skills. Research on statistical learning (Saffran et al., 1996, 2008; Thompson and Newport, 2007) focuses on learners' ability to track transitional probabilities (the likelihood that the occurrence of X will result in the appearance of Y), a phenomenon that is also the object of connectionist modeling (Elman, 2002; Chater and Manning, 2006; Chang et al., 2006). Dynamic Systems Theory (van Geert and Verspoor, in press) investigates linguistic development by considering how proficiency changes over time in response to the interaction of experience, maturation, and previous learning.

It makes sense to expect input to have a major role in shaping development. All other things being equal, frequent sound-meaning mappings should emerge and become entrenched before their less frequent counterparts. And this is in fact more or less what happens (Menn, 2000; Jurafsky, 2003; Ferreira, 2003); for a general review, see Jaeger and Tily (2011).

However, processing pressures that come from the input tell only part of the story. There is also a network of internal efficiency-related processing considerations that help to shape development in significant ways, alone and in conjunction with input. Unfortunately, the effect of these factors is often difficult to discern because of the presence of parallel external pressures. The development of relative clauses is a case in point.

A frequent finding in the acquisition literature is that children learning English find subject relative clauses easier to produce and understand than direct object relative clauses (Diessel and Tomasello, 2005; Friedmann et al., 2009; O'Grady, 2011).

3a. Subject relative clause:
the boy [that _ hugged the girl]

3b. Direct object relative clause:
the boy [that the girl hugged _]

There are a number of promising processing accounts for this asymmetry. For example, Grodner and Gibson (2005) propose that processing cost is determined, at least in part, by the amount and type of material intervening between the gap inside the relative clause and the associated 'filler' (*the boy* in our examples). The sole intervening element in the subject relative clause in (3a) is the complementizer *that*. In the direct object relative clause in (3b), in contrast, two major constituents (the NP *the girl* and the verb *hug*) intervene between the filler and the gap – increasing the burden on working memory and contributing to later mastery.

Unfortunately, however, the force of this explanation is somewhat compromised by a possible frequency-related input effect. At least some corpus research reports that subject relative clauses are in general more frequent than direct object relative clauses, and the asymmetry is overwhelming when one takes into account animacy: relative clauses that modify an animate noun, such as those in (3), are far more likely to be of the subject type than the object type (e.g., Kidd et al., 2007). Thus input factors too could be responsible for the early mastery of subject relative clauses.

Confounds between internal processing cost and frequency of occurrence in the input are to be expected: all other things being equal, language use should favor patterns that incur less processing cost. How then can we ensure that processing determinism in development is not simply input determinism?

The Case for Internal Factors

The key to establishing an independent role for internal processing factors lies in showing they have effects distinct from those predicted by external factors. Various phenomena offer the opportunity to pursue this line of inquiry, and I will consider two such cases here, both involving comprehension. In this regard, I depart from the practice, common in much of the literature on development, of focusing just on production. This departure is justified for two reasons.

First, advances in comprehension drive language acquisition. Without the input that comes from understanding the linguistic patterns that are exemplified in the speech of others, there would be no development. Moreover, development is possible in the absence of production, as the investigation of mutism has documented (Lenneberg, 1962; Hickok, 2009).

Second, as I will try to demonstrate in what follows, key insights into the nature of development come from the study of patterns for which there are few opportunities for use, especially in the speech of children. An exclusive focus on production in such cases would exclude them from consideration, an obviously undesirable result.

Scope Preferences in First Language Learners of English and Korean

A signature feature of natural language is its capacity for the expression of negation and quantification. The sentence in (4) offers a simple example.

4. Kim didn't buy all the pencils.

The dominant interpretation of this sentence is that Kim bought only some of the pencils (the so-called '*not* > *all* reading'), not that no pencils were purchased by Kim (the '*all* > *not* reading'). Interestingly, the reverse is true in Korean (Subj = subject marker; DO = direct object marker; Pst = past tense; Decl = declarative).

5. Kim-i motun yenphil-ul an sa-ss-ta.
Kim-Subj all pencil-DO not buy-Pst-Decl
'Kim bought none of the pencils.' (All the pencils went unpurchased.)

Very few sentences containing a negated verb and a universally quantified direct object occur in parental speech in either Korean or English (O'Grady, 2013). Yet scopal interpretations appear to develop in a systematic way, following a particular (but different) course in each language. Whereas Korean-speaking children manifest a strong preference for the *all* > *not* interpretation from the outset (Han et al., 2007), English-speaking children initially permit both the *all* > *not* and the *not* > *all* interpretations (Musolino et al., 2000; Musolino and Lidz, 2006).

As I have argued elsewhere (e.g., O'Grady, 2013), processing pressures offer an explanation for both why Korean and English differ in their scopal preferences and why the emergence of those preferences follows a different path in each language. Let us first consider the case of Korean.

The two key steps in processing the Korean scopal pattern can be schematically depicted as follows. (The symbol ∀ stands for universal quantification, and the symbol ¬ for negation.)

6a. Step 1: The processor encounters the quantified NP.
Kim all the pencils ….
∀x (pencils)

6b. Step 2: The processor encounters the negative.
Kim all the pencils not buy
∀x (pencils) ¬ → *all* > *not*

As illustrated here, the quantified NP is encountered and interpreted early in the sentence (step 1). This leaves just one option at the point at which the processor comes upon the negative: the *all* > *not* interpretation, as shown in (6b). Derivation of the alternative *not* > *all* option can be achieved only through revision of that initial interpretation, as depicted below.

7. Kim all the pencils not buy
∀x (pencil) ¬→ *all* > *not* (first interpr.) → *not* > *all* (revised interpr.)

It seems reasonable to suppose that revisions to a previously derived interpretation are costly (O'Grady 2013 and the references cited there) – hence children's avoidance of this option in Korean.

Matters are very different in English. Because the negative precedes the quantifier, the processor comes upon it first and registers its presence in the sentence.

8. Step 1: The processor encounters the negative.
Kim didn't buy
¬

Upon subsequently encountering the quantified NP, the processor has two options: allow the negative to scope over the quantifier (the *not* > *all* interpretation) or avoid any such interaction (the *all* > *not* interpretation).

9. Step 2: The processor encounters the quantified NP and computes scope.
Kim didn't buy all the pencils
¬ ∀x (pencils) → *not* > *all*
→ *all* > *not*

Because there are no grounds for believing that either option is inherently more costly, neither should be favored in the absence of relevant input. As summarized in **Table 1**, this aligns exactly with the initial state of development for English, which is characterized by acceptance of both interpretations.

In sum, processing pressures offer a straightforward explanation both for the difference in scopal preferences exhibited by Korean and English and for the developmental profile seen in each language. The reason that Korean strongly favors the *all* > *not* interpretation and the reason that children initially seize on that option is that it has a lower processing cost than its *not* > *all* counterpart. And the reason that English is not constrained in this way and that children initially allow both the *not* > *all* and the *all* > *not* interpretations is that the two options are comparable in processing cost.

Table 1 The developmental sequences for scope in English and Korean

English	*Korean*
1. Both *not* > *all* & *all* > *not* accepted	1. Strong preference for *all* > *not*
2. Strong preference for *not* > *all*	2. No change

Table 2 Developmental sequences for reflexive and plain pronouns

Reflexive pronouns	*Plain pronouns*
1. Correct interpretation	1. Possible misinterpretation as a reflexive 2. Correct interpretation

Of course, this does not mean that there is no role for input. Somehow, English speakers later come to favor the *not* > *all* interpretation, presumably on the basis of experience, however sparse, that is accumulated over a period of many years. (Recall that the preference is not manifested in the judgments of school-age children.) This fits well with the idea that the course of development is shaped by a combination of internal and external processing factors.

Reflexive Pronouns

Children learning English manifest a curious asymmetry in their interpretation of pronouns, with higher early success on reflexive pronouns (*himself*, *herself*, etc.) than on their plain counterparts (*him*, *her*, etc.). Of particular interest is the type of error most commonly made: plain pronouns are misinterpreted as reflexive pronouns, but not vice versa (Conroy et al., 2009; O'Grady, in press; **Table 2**).

Frequency of occurrence offers no explanation for this asymmetry, as plain pronouns occur far more commonly than their reflexive counterparts in caregiver input. In a search of the Child Language Data Exchange System (CHILDES) database, I uncovered 1836 instances of *him*, *her*, and *them* in maternal speech to Adam, Eve, and Sarah, compared with just 17 instances of *himself*, *herself*, and *themselves*.

In contrast, processing pressures offer a compelling explanation for the developmental facts, as the two types of pronoun differ in terms of the resources needed to locate the appropriate antecedent. As is standardly observed, reflexive pronouns typically require a 'local' antecedent – almost always an argument in the same clause, as illustrated in (10).

10. [**Mickey** tickled **himself**].
↑_____|

In contrast, the search for an antecedent in the case of plain pronouns focuses on referents that are prominent in the discourse, without regard for locality (Song and Fisher, 2007; Foraker and McElree, 2007; among many others).

11. Mickey tickled **him**
↖_____|

As frequently noted (e.g., Reinhart, 2006: 181ff; Reuland, 2011: 127), a search through discourse often involves greater processing cost than is required for the interpretation of a reflexive pronoun, whose antecedent is predictably located in the same clause.

Internal processing pressures thus provide a straightforward explanation for children's difficulty with plain pronouns, even after exposure to ample input. Of course, this does not mean that there is no role for experience – after all, the right forms have to be learned (*himself* rather *hisself*, *myself* rather than *meself*). In the important matter of interpretation, however, internal processing pressures do the heavy lifting.

Summary

The two case studies that we have been considering are instructive for two reasons. First, from the point of view of typology, they illustrate how processing pressure can shed light on why languages have the particular properties that they do. Korean favors the *all* > *not* interpretation of scopal patterns because that reading is easier to process than the alternative. English, like countless other languages, requires local antecedents for reflexive pronouns because that interpretation minimizes the processing cost associated with resolving referential dependencies and so on.

Second, the same processing forces that favor patterns of a particular type shape the emergence of language in children, establishing the course of early development. In some cases (perhaps relative clauses), internal processing pressures act in conjunction with the input, but there are also telling cases in which they act on their own, neutralizing the potential influence of input (as in the case of pronoun interpretation) and even making up for the absence of relevant experience (as in the case of scopal patterns).

How Uniform Is Development?

Although it is sometimes suggested that development is highly uniform (e.g., Brown, 1973; Pienemann, 2005), much recent work points in the opposite direction. Dynamic Systems Theory, in particular, has emphasized both intralearner variability and interlearner variation, raising the possibility that no two learners proceed at the same rate, make the same errors, or attain proficiency in the same manner (de Bot et al., 2007; van Dijk et al., 2011; Verspoor and van Dijk, 2011). What is the reality?

There is some reason to think that developmental diversity, however widespread, is circumscribed by the influence of processing pressures.

12. The Uniformity Thesis
    Development is uniform, where processing cost is relevant.

Three points call for immediate clarification.

First, the Uniformity Thesis has nothing to say about differences in *rate* of development – a well established and well documented parameter of ontogenetic variation. The cost of maintaining and accessing a vocabulary of, say, 150 words is the same, regardless of whether those words are acquired by age 18 months or by age 24 months. The cost of computing the agreement relationship between a verb and subject (*A boy is/*are outside*) is the same when acquired at 30 months as it is when learned at 36 months. These and other differences unrelated to processing cost fall outside the scope of processing determinism (and, by extension, the Uniformity Thesis).

Second, a large portion of the variation across learners that is reported in the literature arguably reflects differences in language use that are present independent of development. This is especially so in the case of spontaneous speech – a very common source of data in studies of developmental order (Brown, 1973; Pienemann, 2005; Bassano and van Geert, 2007). Even mature monolingual speakers of a language differ in their ability to express themselves in extemporaneous speech, and there can be fluctuations in performance literally from moment to moment. Variation and instability are no doubt magnified in learners, whose processing routines are less entrenched than those of mature speakers and hence even more susceptible to the factors that make speech difficult in the first place. Conclusions based on production data therefore need to be interpreted cautiously, and tempered by the insights afforded by controlled experiments, including those involving comprehension.

Third, the Uniformity Thesis does not predict that learners will follow identical paths of development regardless of input; rather, it predicts uniformity in the effect of input. An obvious case in point involves lexical development, whose precise course varies considerably from child to child, but nonetheless appears to reflect experience quite faithfully (Huttenlocher et al., 1991; Hoff and Naigles, 2002). That is why, to take a trivial example, children growing up in America learn the words *truck*, *elevator*, *cookie*, and *apartment* before *lorry*, *lift*, *biscuit*, and *flat*, whereas the reverse is true for children growing up in the United Kingdom.

The study of morphosyntax offers comparable examples. It would not be surprising to find earlier emergence of *shall* in the United Kingdom than in the United States, or a preference for *I don't have any milk* over *I haven't any milk* in American children but not in their British counterparts. In these and other cases, development is presumably as uniform as the input that drives it.

If all of this is right, then the case for Uniformity depends crucially on the effect of internal processing factors, especially those that operate without the confounding influence of input. Do such factors shape development in a uniform way across children and even across languages? If the phenomena considered in this article are typical, the answer may well be yes.

- Children learning Korean uniformly show an early preference for *all* > *not* scope. In contrast, English-speaking children initially permit either interpretation.
- English-speaking children sometimes interpret plain pronouns as if they were reflexives (e.g., Conroy et al., 2009), but errors in the reverse direction are uniformly avoided.

Findings of this sort point toward a fundamental similarity in those aspects of development that are shaped by internal processing pressures, consistent with the Uniformity Thesis.

Conclusion

Development is a signature phenomenon of language, and its study offers the promise of insights into the mechanisms that make language possible in the first place. The emergentist approach to this challenge takes as its starting point the idea that processing cost shapes both the properties of language and the manner in which those properties are acquired. A key component of the particular proposal that I have put forward is a distinction between two quite different determinants of processing cost, one rooted in internal pressures relating to burden on working memory and the other reflecting the composition and quantity of learners' experience. The two case studies considered here point to the crucial role of internal factors in shaping the emergence of language, at times in the absence of relevant input. Moreover, these studies raise the possibility that development may unfold in a more uniform manner than is usually assumed. For now, though, these conclusions remain tentative, awaiting the further work that is needed to fully assess their viability.

See also: Anaphora; Child-Directed Speech: Influence on Language Development; Emergent Properties; First Language Acquisition, Linguistic Theory of; Language Acquisition; Language Development, Theories of; Negation, Linguistics of; Vocabulary Acquisition.

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