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The role of incremental parsing in syntactically conditioned word learning

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ABSTRACT

In a series of three experiments, we use children's noun learning as a probe into their syntactic knowledge as well as their ability to deploy this knowledge, investigating how the predictions children make about upcoming syntactic structure change as their knowledge changes. In the first two experiments, we show that children display a developmental change in their ability to use a noun's syntactic environment as a cue to its meaning. We argue that this pattern arises from children's reliance on their knowledge of verbs' subcategorization frame frequencies to guide parsing, coupled with an inability to revise incremental parsing decisions. We show that this analysis is consistent with the syntactic distributions in child-directed speech. In the third experiment, we show that the change arises from predictions based on verbs' subcategorization frame frequencies.

1. Introduction

In language acquisition, and indeed in many areas of child development, researchers often find themselves struggling with questions of competence and performance. Do children fail at some task because they lack the relevant knowledge or because that knowledge is masked behind the performance systems used to deploy that knowledge (Hamburger & Crain, 1984; Spelke & Newport, 1998)? Rarely, however, do we face the question of how children's developing performance systems constrain the generalizations that they ultimately make and how errors of interpretation feed forward for subsequent learning (Elman, 1990; Newport, 1990). In this paper, we take up this issue in the domain of syntactic development and word learning. In particular we ask how children's immature parsers lead to the assignment of erroneous grammatical structures and how such errors contribute to the acquisition of unknown words in those structures. This paper thus contributes to discussions of syntactic development, the role of syntax in word learning, and the role of parsing in syntactic development.

In understanding the interaction between parsing and learning, it is important to consider ways that parsing impacts understanding. We can consider two situations. First, the child may have acquired the grammatical rules for some construction without being able to deploy this knowledge consistently and robustly in real time (Hamburger & Crain, 1984; Huang, Zheng, Meng, & Snedeker, 2013; Omaki, Davidson White, Goro, Lidz, & Phillips, 2014; Trueswell, Sekerina, Hill, & Logrip, 1999). Second, the child may not have acquired a given grammatical construction but nonetheless succeeds in interpreting

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sentences exhibiting it due to heuristics that promote understanding without relying on precise grammatical knowledge (Gagliardi, Mease, & Lidz, 2016; Gertner & Fisher, 2012; Yuan, Fisher, & Snedeker, 2012).

The case of successful acquisition of the grammatical rules in the absence of a robust deployment system can lead children to fail at accurately interpreting sentences for which they have appropriate grammatical knowledge. This could happen because the construction places high demands on component processes of understanding, such as lexical access, structure building, temporary ambiguity resolution, or retrieval from working memory, making the child's success with the construction dependent on the ease with which these subprocesses can be completed. For example, if a sentence uses low frequency words that are difficult to access from the lexicon, or if it contains a temporary ambiguity, then demands on the parser could be amplified in a way that hinders understanding, despite the child having an appropriate grammar for that construction.

In older children, there is mounting evidence that parsing dynamics shape understanding in a way that gives rise to children behaving in non-adult-like ways (Snedeker & Trueswell, 2004; Trueswell et al., 1999). For example, Trueswell et al. (1999) show that in certain discourse contexts, both adults and 5-year-old children initially interpret the first PP (*on the napkin*) in (1) as if it were the locative argument of the verb. Whereas adults can recover from this initial misinterpretation upon encountering the second PP (*in the box*), children have difficulty doing so.

(1) Put the frog on the napkin in the box.

Similar behavior has been found in at least four other domains: pronoun resolution, WH question interpretation, argument structure construction, and quantifier scope computation.

In the domain of pronoun resolution, Leddon and Lidz (2006) find that 4-year-old children only resolve reflexive pronouns to the closest syntactically licit antecedent, even in the presence of other licit antecedents. For instance, 4-year-olds resolve *herself* in (2) to Janie but not to Miss Cruella.

(2) Janie knew which picture of herself Miss Cruella put on the wall.

They argue that this bias derives from the ballistic nature of the parser, which links the reflexive pronoun to an antecedent as quickly as possible (Sturt, 2003), coupled with children's inability to revise their initial interpretive commitments (Trueswell et al., 1999). Indeed, recent eye-tracking work (Omaki, 2010) shows that adults also initially resolve *herself* in (2) to Janie, but unlike children, are able to revise that initial commitment when necessary.

In the domain of WH question interpretation, Omaki et al. (2014) find that adults and 5-year-old children prefer to associate adjunct WH words like *where* in (3) to the closest verb in terms of linear order (*say*).

(3) Where did Lizzie say that she was going to catch butterflies?

This finding is cross-linguistically robust. In Japanese, which is a head-final language, the order of *say* and *catch* is reversed. Omaki et al. found that the biases displayed by Japanese-speaking adults and 5-year-old Japanese-learning children were concomitantly flipped: both adults and children prefer to associate *where* with *catch* in Japanese.

In the domain of argument structure construction, Huang et al. (2013) find that, upon hearing a subject that is a plausible agent, 5-year-old Mandarin-learning children begin to construct an active interpretation for the sentence, and if they receive information that the sentence is actually passive, they have trouble recovering from this initial misparse. Huang and Arnold (2016) find a similar pattern in a word-learning task with 5-year-old English-learning children.

Finally, in the domain of quantifier scope computation, Musolino, Crain, and Thornton (2000), Musolino and Lidz (2003, 2006) find that 5-year-old children are heavily biased towards interpreting sentences like (4) as meaning (4-a) but not (4-b).

(4) Every horse didn't jump over the fence.
  a. All of the horses failed to jump over the fence.
  b. Not every horse jumped over the fence.

Conroy (2008) and Viau, Lidz, and Musolino (2010) argue that children's bias results from the interpretation in (4-a) being the first interpretation constructed, paired with children's difficulty to revise their initial parsing commitments. Support for this view comes from several adult on-line parsing studies demonstrating that children's only interpretation corresponds to adults' initial interpretation (Conroy, Fults, Musolino, & Lidz, 2008; Lidz & Conroy, 2007).

Given these and other findings showing that preschool aged children's parsers are more brittle than adults' and less able to integrate across multiple information sources (Choi & Trueswell, 2010; Omaki, 2010; Snedeker & Trueswell, 2004), it stands to reason that younger children will be at least as susceptible to failures of understanding due to parsing difficulty as older children are. Moreover, to the degree that parsing derails understanding, we expect that any process of language