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Taking your own path: Individual differences in executive function and language processing skills in child learners



Kristina Woodard*, Lucia Pozzan, John C. Trueswell

Department of Psychology and Institute for Research in Cognitive Science, University of Pennsylvania, Philadelphia, PA 19104, USA

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ABSTRACT

Children as old as 5 or 6 years display selective difficulties in revising initial interpretive commitments, as indicated by both online and offline measures of sentence comprehension. It is likely, however, that individual children differ in how well they can recover from misinterpretations and in the age at which they become adult-like in these abilities. To better understand the cognitive functions that support sentence processing and revision, the current work investigated how individual differences in children's ability to interpret temporarily ambiguous sentences relate to individual differences in other linguistic and domain-general cognitive abilities. Children were tested over 2 days on a battery of executive function, working memory, and language comprehension tasks. Performance on these tasks was then used to predict online and offline measures of children's ability to revise initial misinterpretations of temporarily ambiguous sentences. We found two measures of children's cognitive flexibility to be related to their ambiguity resolution abilities. These results provide converging evidence for the hypothesis that the ability to revise initial interpretive commitments is supported by domain-general executive function abilities, which are highly variable and not fully developed in children.

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* Corresponding author. Fax: +1 215 573 9247.

E-mail address: woodardk@sas.upenn.edu (K. Woodard).

Introduction

Real-time sentence parsing and revision

To interpret spoken language, listeners must rapidly categorize the linguistic input into candidate phonemes, syllables, words, and phrases and assign it a provisional structural analysis and interpretation based on the currently available linguistic and nonlinguistic evidence (e.g., Tanenhaus, Spivey-Knowlton, Eberhard, & Sedivy, 1995). However, because listeners accomplish much of their interpretation in real time as sentences unfold, they are forced to deal with temporary ambiguity that frequently arises in the input. They must rapidly resolve ambiguities associated with words that have multiple possible meanings and phrases that have multiple possible parses. A natural consequence of real-time interpretation is that initial interpretive commitments can turn out to be incorrect, resulting in the need for processing revision when late-arriving evidence supports a different interpretation. For example, listeners typically experience a “garden path” when hearing a sentence like (1) below. Even though the prepositional phrase (PP) “on the napkin” could serve as a modifier for the preceding noun phrase “the frog,” listeners tend to initially interpret it as a goal of the action (i.e., where to put the frog). Upon hearing the actual goal phrase (“onto the book”), listeners are forced to revise their initial interpretation of “on the napkin,” reanalyzing it as a noun phrase modifier.

(1) Put the frog on the napkin onto the book

Evidence for this processing pattern comes from studies within the visual world paradigm, in which participants’ eye movements and actions are recorded while they hear speech about a visually co-present referent world (e.g., Spivey, Tanenhaus, Eberhard, & Sedivy, 2002). When listeners hear “the frog” in sentence (1) within the context shown in Fig. 1, they typically first shift their gaze to the target referent (the frog sitting on a napkin). After hearing the PP “on the napkin,” they shift their gaze toward the so-called “incorrect goal” (a second “empty” napkin); this suggests that this phrase is being interpreted as the goal of the action. Finally, when hearing “onto the book,” listeners tend to look around the scene, showing some signs of confusion, before carrying out the correct action of moving the frog onto the book. This pattern of looks toward the incorrect goal, and the resulting delay integrating the “correct goal” within listeners’ current interpretation of the sentence, do not occur when listeners instead hear sentence (2), an analogous sentence that contains the same lexical items but does not present a temporary ambiguity. This difference suggests that the processing difficulty associated with sentence (1) is due to an initial mis-parse of “on the napkin” and the resulting revision needed when hearing “onto the book”.

(2) Put the frog that’s on the napkin onto the book

Strikingly, children as old as 5 or 6 years display selective difficulties in revising initial interpretive commitments during sentence comprehension (see Trueswell, Sekerina, Hill, & Logrip, 1999, for the first report of the so-called *kindergarten-path* effect, subsequently replicated in a number of studies, e.g., Anderson, Farmer, Goldstein, Schwade, & Spivey, 2011; Choi & Trueswell, 2010; Hurewitz, Brown-Schmidt, Thorpe, Gleitman, & Trueswell, 2000; Weighall, 2008). In response to temporarily ambiguous sentences like (1) above, children perform an incorrect action on approximately 50% of the trials. These errors almost exclusively involve moving the frog onto the empty napkin, suggesting a failure to revise an initial goal interpretation for the PP “on the napkin” even after hearing unambiguous evidence against this interpretation (i.e., once the second PP has been heard). Children’s virtually error-free performance in response to the corresponding unambiguous sentence (2) indicates that act-out errors associated with ambiguous sentences like (1) do not stem from generalized difficulties with complex sentences, but from selective difficulties in revising initial misinterpretations. Importantly, children’s difficulties in recovering from garden path sentences have also been documented in other languages and other structures (Choi & Trueswell, 2010; Omaki, Davidson White, Goro, Lidz, & Phillips, 2014), suggesting that it is a fundamental characteristic of the developing parser.

It is important to note, however, that individual children likely differ from each other in how well they can recover from initial misinterpretations and might also differ regarding when their sentence

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