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On the link between complex predictive abilities and memory in language acquisition

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In their keynote paper, Phillips and Ehrenhofer (2015) (henceforth: P&E) make an interesting and courageous move towards exploring a domain that is typically underexplored (at least in a generative framework), namely that of actual learning mechanisms in the process of the acquisition of syntax and semantics. The crucial question is: “How do learners (children and adults) move from one language developmental stage to the next?”

P&E hypothesize that language processing abilities play an important role in language learning, and they identify three essential components of parsing, namely, analysis, reanalysis and prediction. They argue that adults are better at reanalysis than children. The relatively poor reanalysis skills of children is in line with P&E’s finding that, using five constraints on anaphora as a test case, adults’ first interpretation corresponds to children’s only interpretation. P&E suggest that children’s poor reanalysis skills can be attributed to independent limitations in their cognitive control abilities (Omaki & Lidz, 2014; Snedeker, 2013; Trueswell, Sekerina, Hill, & Logrip, 1999), which is likely due to the delayed maturation of their frontal lobe, the primary home of executive function abilities (Davidson, Amso, Anderson, & Diamond 2006).

However, this line of reasoning creates a paradox: If language learning depends on processing capacities, and adults are better at reanalysis, the question remains as to why children are usually more successful at language learning than adults.

According to P&E a key to the answer lies in the predictive abilities of children and adults. Starting from the idea that a predictive parser is a hypothesis testing device, P&E make several speculations regarding potential differences between children’s and adults’ predictive abilities. Proposing a ‘Less-is-eventually-more’ analysis (crucially different from Newport’s (1990) ‘Less-is-more’ Hypothesis), they suggest that children’s immature memory mechanisms may make them less

committed to what they learn initially, and hence more receptive to later insights, and/or that simple predictive abilities develop earlier in adult learners than in children such that it makes the learning process in adults different from that in children.

Interestingly, earlier on in their article (Section 2.5), P&E make a distinction between ‘fast’ and ‘slow’ predictions (in terms of processing speed), or ‘simple’ and ‘complex’ predictions. Fast, or simple predictions occur at the word level, and involve low-level, associative relations; slow, or complex predictions are formulated on the basis of more sophisticated use of semantic and pragmatic context. Prediction complexity is then defined as the parallel processing and integration of knowledge from different language domains. For example, the interpretation of pronouns requires predictions in the domains of syntax (case, gender, number), semantics (reference) and pragmatics (discourse participants), and the integration of these predictions, making the process of formulating predictions complex, and, supposedly, slow.

Relating this to language learning, P&E state that “a learner who successfully parses an input sentence could extract more or less information from that sentence, depending on his ability to predict ahead of time how the sentence will unfold. A learner who can make more sophisticated predictions about what will be said when may be able to learn more complex contingencies about the language.” (p. 417). The question then is when (child and adult) learners develop the ability to make these more sophisticated, slow, complex predictions. P&E suggest that child learners develop complex prediction abilities relatively late, which is why they acquire linguistic phenomena at the interface of grammar and semantics/pragmatics later than phenomena that are purely grammatical. Furthermore, they claim that such interface phenomena are often not attained by even the most advanced adult learners. So here the ‘less-is-eventually-more’ Hypothesis does not apply: by the age children develop complex prediction abilities, they no longer suffer from memory or other cognitive limitations, and are thus as committed to what they learn as adults.

In summary, if we want to explain the difference between (more successful) child language acquisition and (less successful) adult language acquisition by means of processing abilities, the only feasible candidate seems the ability to formulate simple predictions: adults have this from the beginning of their acquisition process, but children do not, because of cognitive limitations. This may lead adults to sticking to incorrect initial hypotheses too long.

But is it really true that linguistic phenomena that require the integration of grammatical and semantic/pragmatic processing, and thus the formulation of complex predictions, are always acquired late, by both children and adults? Consider the phenomenon of direct object scrambling in Dutch, i.e. the placement

of a direct object preceding or following an adverb (or negation), depending on its semantics (referentiality) and information structure (topic, focus, ...). This is illustrated in (1) and 2:

- (1) Kim heeft het boek goed/niet gelezen (scrambling → referential, topic)
Kim has the book well/not read
'Kim read the book well' / 'Kim didn't read the book'
- (2) Kim heeft goed/niet een boek/geen boek gelezen (no scrambling → non-referential, focus)
Kim has well/not a book / no book read (any book)
'Kim read a book well' / 'Kim read no book'

Loosely speaking, the scrambled direct object in (1), preceding the adverb or negation, refers to a unique, referential book, known to both speaker and hearer, and fulfills a topic function. In contrast, the non-scrambled direct object in (2), following the adverb or negation, refers to a non-unique, non-referential book, known to neither speaker nor hearer, and is the focus of the sentence. Direct object scrambling thus requires the integration of semantic knowledge (specificity, reference), pragmatic knowledge (speaker/hearer knowledge, information structure), and syntactic knowledge (object placement, case and theta-role restrictions) and can therefore be considered a complex phenomenon. Casting this in a processing framework along the lines of P&E, direct object scrambling requires the formulation and integration of predictions following from both the grammatical and the semantic/pragmatic properties of the object, i.e., complex predictions. P&E would therefore predict that direct object scrambling is acquired relatively late in children, presumably at the earliest at an age when their memories and other cognitive abilities potentially limiting their predictive abilities no longer differ from those of adults. Moreover, P&E would also predict that adult L2 learners of Dutch would have great difficulty attaining direct object scrambling.

Schaeffer (1997; 2000) shows that young Dutch children aged 2 often fail to scramble in obligatory contexts, but that at age 3 they make an enormous leap towards adultlike scrambling behavior. Furthermore, testing the same phenomenon in L2, Unsworth (2005) reports that L1 English adult learners of Dutch proceed through the same developmental stages regarding the position of the direct object as the Dutch-speaking children, and are ultimately able to acquire direct object scrambling. So, despite its complexity as a phenomenon at the interface of semantics, pragmatics and syntax, direct object scrambling is not a particularly late or hard phenomenon to acquire. This must mean that both young Dutch L1 learners and adult L2 learners of Dutch are able to rapidly generate (complex) predictions regarding the direct object based on semantic, pragmatic and syntactic

considerations. However, this is at odds with P&E's suggestion that young children's memory and other cognitive limitations cause weak predictive abilities, and thus it conflicts with their 'Less-is-eventually-more' Hypothesis. It means that young children can formulate complex predictions, even at an age at which they are still cognitively immature, suggesting that predictive abilities and memory are separate functions, developing independently of each other.

In contrast to young typically developing Dutch-acquiring children, Dutch children with SLI or with Autism Spectrum Disorder (ASD) fail to scramble direct objects in obligatory contexts until at least the age of 12 (Schaeffer & Van Witteloostuijn, 2014; Schaeffer, under review). The question is why they do this, and whether children with SLI fail to scramble for the same reason as children with ASD. An analysis of the same children's scores on a non-verbal working memory task ("Odd-one-out task"; Henry, 2001) reveals an interesting pattern: the children with ASD do not differ from their typically developing (TD) age-mates, but the children with SLI have significantly lower non-verbal working memory scores than their TD age controls.

The SLI results are compatible with PE's hypothesis that immature (or, perhaps, in this case, deficient) memory skills prevent the learner from formulating predictions required for direct object scrambling, and one could choose this processing account to explain the weak scrambling behavior of the children with SLI. However, such an analysis does not fare well with the ASD results: despite their good memory skills, the children with ASD still fail to scramble, and would thus seem unable to formulate the complex predictions required for this complex contingency (the integration of different types of information is a well-known weakness in ASD, see, e.g., Minshew & Williams, 2007; Just, Keller, Malave, Kana, & Varma, 2012; Geutjes, 2014). However, it cannot be the result of immature or deficient memory skills in this group.

Concluding then, besides complex interface phenomena that are acquired late in both children and adults, such as the correct use of null and overt subjects in *pro*-drop languages (Sorace, 2011), there are complex linguistic phenomena, such as direct object scrambling, that are not acquired all that late in TD children and can be acquired by L2 learners. In addition, the failure to scramble in children with Autism Spectrum Disorder cannot be related to immature or deficient memory skills. This seems to provide evidence against the hypothesis that children's immature memory causes limitations in (simple and complex) predictive abilities. Finally, the early acquisition of interface phenomena, such as scrambling, which require complex predictions in processing by TD children does not support the 'Less-is-eventually-more' Hypothesis, because there does not seem to be anything 'less' to begin with.

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