

Effects of clause order and connective type on children's and adults' processing of complex sentences

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In order to construct a coherent mental representation of the events described in complex sentences, listeners must be able to interpret connectives to establish the semantic relationship (e.g., temporality, causality, concession) between the main- and the subordinate clause. An additional challenge for listeners is that the two clauses can occur in two clause orders, e.g., (1) *She had a coffee before she submitted the paper.* vs. (2) *Before she submitted the paper, she had a coffee.* In (1), the clause order reflects the order of events in the real world (it is iconic); in (2), the clause order is reversed. Children have difficulty in comprehending complex sentences. They misinterpret the temporal order (Clark, 1971; Blything, Davies & Crain, 2015), or reverse cause and effect (Emerson, 1979). Semantic accounts assume that iconicity is the main factor affecting comprehension (Clark, 1971). But other hypotheses have also been put forward: Syntactically oriented approaches claim that main-subordinate clause orders should generally be easier to process (Diessel, 2005). Capacity-constrained approaches assume working memory (WM) to be a major influence on processing (Blything, Davies, & Cain, 2015). Finally, frequency-based approaches predict that children's comprehension should be related to the frequency of grammatical constructions in the language that they are exposed to (see Ambridge et al., 2015).

However, individual studies have typically looked at only one type of adverbial clause, making it difficult to determine possible differences and commonalities in the precise influences of different factors on children's performance across sentence types. Our study tests the predictions of the four approaches by comparing children's comprehension of complex sentences containing the connectives *after*, *before*, *because*, and *if*, taking into account the distributions of these connectives in a dense corpus of child-directed speech (CDS; De Ruiter et al., in prep.).

We tested 71 children's (37 four-year-olds, 34 five-year-olds) and ten adult controls' comprehension with a forced-choice picture sequence task, systematically manipulating clause order (subordinate-main, main-subordinate; see Table 1 for conditions and examples). We measured both accuracy and response times (RT), and collected measures of the children's general language ability (CELF-subtests), WM, and executive function (EF).

In terms of accuracy, four-year-olds performed above chance, but showed only a fragile understanding of the complex sentences. Five-year-olds performed significantly better than the younger age group with iconic clause orders, and with *before*-sentences overall (Fig. 1). Children's score on the CELF-subtests predicted performance over and above the experimental manipulations, but WM and EF did not. Adults' accuracy was at ceiling in all conditions. Four-year-olds' RTs were significantly longer than five-year-olds'. Both child age groups took significantly longer to respond to *because*- and *if*-sentences compared to *after*- and *before*-sentences, but clause order did not have an effect. Language and cognitive task scores were negatively correlated with RTs, but did not predict performance above and beyond the experimental manipulations. Adults were significantly faster with *before*-sentences.

Our results support a semantic account: Children did not perform better with one clause order (contra syntactic account), but did so with sentences that map chronologically onto events in the real world, even when the corresponding clause order is less frequent in CDS (contra frequency account), and independent of WM (contra capacity-constrained). Moreover, longer RTs for causal and conditional sentences suggest that processing inferences slows down children's comprehension. We will discuss the full set of results and their theoretical implications for an account of children's developing sentence-processing skills.

Connective	after		before		because		if	
Clause order	main-sub	sub-main	main-sub	sub-main	main-sub	sub-main	main-sub	sub-main
Example	<i>She hoo- vers the house after she paints the old fence.</i>	<i>After she paints the old fence, she hoo- vers the house.</i>	<i>He plays his big drum, before he reads his new book.</i>	<i>Before he reads his new book, he plays his big drum.</i>	<i>He opens the door, because he sees the snowman.</i>	<i>Because he sees the snowman, he opens the door.</i>	<i>She hears the door- bell, if she presses the but- ton.</i>	<i>If she presses the but- ton, she hears the doorbell.</i>

Table 1: Eight conditions of the experiment, 4 connectives x 2 clause orders (main = main clause, sub = subordinate clause).

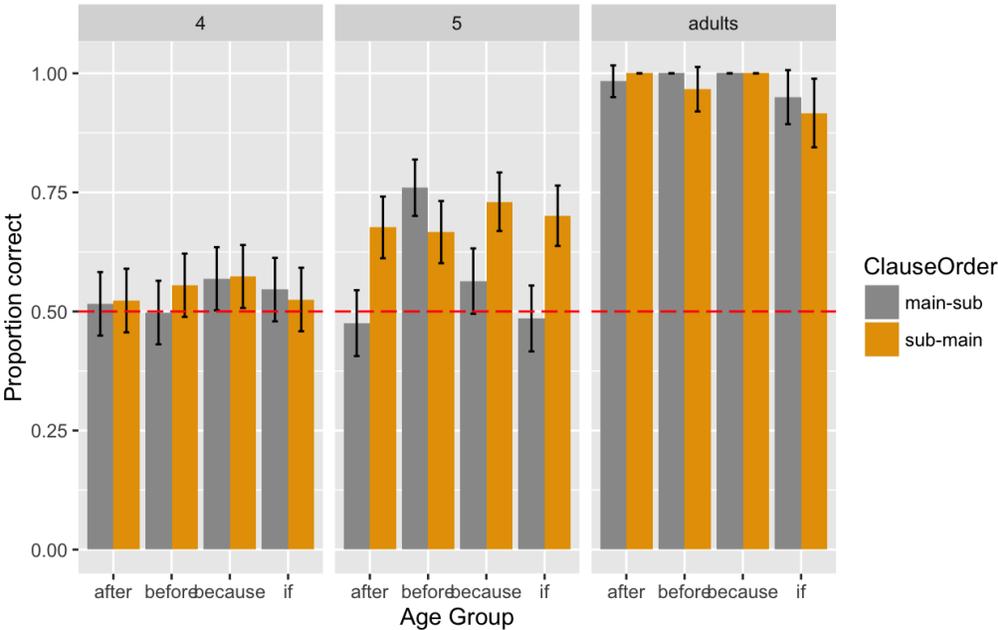


Figure 1: Four-year-olds', five-year-olds' and adults' mean proportion of correct responses for *after*-, *before*-, *because*- and *if*-clauses in subordinate-main and main-subordinate clause order. The dashed red line indicates chance level. Error bars indicate standard errors.

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