

Negation Processing and Executive Functions in Preschool Children: Evidence from Eye-Tracking

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Research on negation processing has shown that negation is harder to process than affirmation [1]. According to the two-step model, two opposing representations are activated during negation processing, namely a representation of the state of affairs that is negated (non-factual state of affairs) and the representation of the state of affairs that is actually the case (factual state of affairs) [2]. Considering the utterance *The shirt is not dirty*, comprehenders may first activate the representation of a dirty shirt (non-factual state of affairs) before arriving at the representation of a clean shirt (factual state of affairs). Recent studies further suggest that successful negation processing requires the inhibition of the non-factual representation [3]. Since inhibition is a core component of executive functions (EFs), together with working memory and cognitive flexibility, and because EFs continue to develop until approximately nine years of age [4], the present study investigates whether EFs predict inter-individual differences in children's negation comprehension and processing. We tested 58 German-speaking adults as a control group (mean age: 22;9) and 60 German-speaking preschool children (age range: 4;0-6;8 and mean age: 5;2). Participants completed four EF tasks: a forward digit-span task [5] measuring short-term memory, a missing-scan task [6] assessing working memory, a flanker task [7] measuring inhibition, and a task-switching paradigm [8, 9] assessing cognitive flexibility. Negation processing was examined using a visual-world eye-tracking paradigm. Participants heard 12 affirmative (e.g., *Emilia schaukelt jetzt* – “Emilia is swinging now”) and 12 negative sentences (e.g., *Emilia schaukelt nicht* – “Emilia is not swinging”) while viewing two pictures: one matching the spoken sentence and another depicting a different action performed by the same character (e.g., Emilia riding a bike). Participants were asked to name the color of the frame surrounding the target picture (blue or yellow). Behavioral results showed ceiling performance in adults (99.7%, both conditions). Children performed near ceiling for affirmative sentences (98.7%) but showed lower accuracy for negative sentences (78.8%, mainly due to difficulties among four-year-olds), [Figure 1]. Eye-tracking data revealed that adults processed negation faster than children; however, both groups displayed similar gaze patterns [Figure 2]. Linear mixed-effect models showed that working memory predicted negation comprehension effort negation (calculated as the difference between affirmative and negative sentences), and faster sentence processing. Overall, the findings suggest that working memory plays a central role in children's sentence processing and that children, with enough time, can integrate the negator into the process of simple German sentences.

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Figure 1

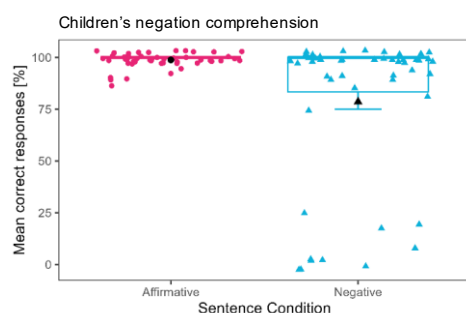


Figure 2

