

On-line sentence processing in children: Evidence from eye movements during listening

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We report the preliminary results of a new method for studying the language processing strategies of children, in which a free-head eyetracking system was used to monitor eyemovements as children responded to spoken instructions. Prior experiments have used this methodology to successfully examine referential and linguistic processing in adults [1]. To our knowledge, this is the first time that the methodology has been used to study children's development of sentence processing mechanisms.

Subjects as young as 4 years old were eyetracked using a lightweight eyetracking visor specifically designed for children. The present study examined the development of referential constraints on resolving temporary syntactic ambiguities. Children ages 4 and 5 moved stuffed animals ("beanie babies") based on spoken instructions. We compared instructions containing temporarily ambiguous prepositional attachments (i.e., "Put the cow on the plate in the box") with unambiguous versions ("Put the cow that's on the..."). Visual contexts were either "referentially supportive" of treating the first preposition as a modifier of the preceding noun (e.g., two cows--one of which was on a plate; an empty plate; and an empty box) or "referentially unsupportive" of the modifier interpretation (e.g., one cow on a plate; a pig; an empty plate; and an empty box). Tanenhaus et al. reported that adults were sensitive to referential constraints, in that ambiguous sentences resulted in increased eyemovements to the incorrect destination (the empty plate) only for the referentially unsupportive contexts.

First, an inspection of the children's eyemovements showed clear signs of rapid incremental interpretation (e.g., definite noun phrases with unique referents resulted in eyemovements to the correct referent on average 500 ms after the onset of the head noun). However, with respect to resolving temporary syntactic ambiguities, task performance and eyemovements revealed that subjects had an initial preference for verb phrase attachment, independent of referential context. Although subjects performed the task nearly perfectly with unambiguous constructions (putting the correct animal in the correct destination 96% of the time for both contexts), subjects showed significantly more errors with ambiguous instructions (52% and 54% correct on supportive and unsupportive contexts respectively). Near 50% performance is well above chance (errors tended to involve movements to the incorrect destination, but sometimes included secondary movements to the correct destination). Even when subjects performed the task correctly, eyemovement patterns revealed consideration of the false destination (subjects looked at the incorrect destination about 45% of the time independent of context). Suggestive evidence was found that four and five year olds were on the edge of developing sensitivity to referential constraints. First, means for the oldest children showed better overall performance, and decreased eyemovements to the false destination in the referentially supportive condition. Moreover, preliminary data from an 8-year old indicates performance and eyemovements nearly equivalent to adults. (A study involving children between 5 and 8 is currently underway.)

Thus, in addition to demonstrating a new method for studying children's sentence processing as it occurs in real time, the current results reveal that children who otherwise have strong command of the language have yet to fully develop contextually dependent processing mechanisms for resolving temporary ambiguities. The presence of consistent structural preferences suggests partial independence of encoding grammatical and referential regularities. However, prior data from adults suggest that independent encoding is coupled with processing mechanisms that can rapidly integrate multiple sources of information.

References:

[1] Tanenhaus, M.K., Spivey-Knowlton, M.J., Eberhard, K.M., Sedivy, J.C. (1995). Integration of visual and linguistic information in spoken language comprehension. *Science*, 268, 1632-1634.