The influence of visual cues, case marking, and prosody on thematic role assignment in 5-year-olds and young adults

In six eye tracking studies, we investigated the influence of prosody, case marking (Exps 1 and 2), and visual cues (Exp 3) on real time thematic role assignment and directly compared five-year-old children with young adults (Exps 1 and 3, Exp 2 adults only). In addition to eye movements, we measured comprehension via post-sentence comprehension questions in active and passive voice.

Materials: Speech stimuli contained unambiguously case-marked SVO and OVS sentences (Exp1, Exp2a), unambiguously and ambiguously case-marked OVS sentences (Exp 2b), or ambiguously case-marked OVS sentences only (Exp 3). We emulated the SVO and OVS biasing prosodic contours presented by Weber et al. (2006) - SVO: L*+H accent on the subject, H* accent on the verb; OVS: L+H* accent on the subject. In Exp 1, we added a neutral prosodic contour as a baseline; in Exp 2, we manipulated prosodic contour (biasing towards SVO vs. OVS); and in Exp 3, we kept the OVS biasing prosodic contour constant across conditions. In the scene, two of the three clipart animals were depicted as performing identical actions in Exps 1 and 2, meaning that visual cues did not disambiguate thematic role relations early during the sentence. By contrast, in Exp 3, one animal (the target role filler) was depicted as either performing an action, or wiggling, or both, resulting from a manipulation of visual cues to the target role filler (no-cue baseline, depicted action, wiggling target character, action plus wiggle). The visual cues were time-locked to the verb and, different from previous research, their presentation was time-limited to the lifetime of the verb (i.e., a few hundred milliseconds). At issue was to which extent different cues (case marking, prosody, and actions/ wiggling) permit the children versus adults to derive expectations about the sentence-final object (in SVO) or subject (in OVS) sentences as they listened to such sentences and inspected related scenes.

To the extent that existing results on prosody and case marking in adults are robust (Weber et al., 2006; Knoeferle et al., 2008), and that visual context effects generalize to situations in which action presentation is short-lived (see Knoeferle & Crocker, 2007 for first evidence), adult participants should visually anticipate the target (NP2 referent) in NP1-V-NP2 utterances. Prior research on child language processing suggests that children were also able to use prosody for thematic role assignment (Grünloh et al., 2011) but struggled with case marking in non-supportive visual contexts (Dittmar et al., 2008). Children rapidly recruited depicted actions (Münster, 2016; Zhang & Knoeferle, 2012) but struggled to exploit visual referential context (Trueswell et al., 1999). Since our scenes in Exp 1 depicted actions ambiguously, we expected no rapid case marking effects on target agent anticipation. Prosodic and visual cues could, however, influence target anticipation, corroborating prior effects of prosody and depicted actions on thematic role assignment in children.

Results (adults): The results of Exp 1 and 2 revealed no clear effects of prosody in the adults. By contrast, the adults used case marking to anticipate the target role filler as early as the verb, even though actions were ambiguous (distractor -actionA-> NP1 referent <-actionA- target). When case marking was ambiguous in OVS sentences, we observed a slight preference of target inspections but this gaze pattern emerged when prosody biased towards SVO (instead of OVS). Overall, effects of prosody were, however, non-significant. Perhaps case marking is a stronger cue for thematic role assignment than prosody. In Exp 3 effects of action and wiggle cueing the target were significant, as was the interaction of action and wiggle (all *ps* < .001) during verb and

adverb. Post-hoc tests revealed more target inspections in all three visual conditions compared to the no-cue baseline. Response accuracy to the questions was highest for both cues (vs. one or none).

Results (children): For children, the results of Exp 1 revealed no clear effects of prosody or case marking. Children interpreted both SVO and OVS sentences as agent-first (SVO) sentences. Perhaps children need additional visual information in order to use case marking for thematic role assignment (which we did not provide since the actions events did not disambiguate the target role filler in Exp 1 and 2). Similar to the adults, the results for the children in Exp 3 revealed main effects of action and wiggle and a reliable interaction (all *ps* < .001) during verb and adverb with more looks to the target character in the visual-cue conditions compared to the no-cue baseline during the verb. Additionally, children made more target inspections in the action plus wiggle conditions compared to the wiggle-only condition during the adverb. These results in the children corroborate the rapid visual context effects in 5-year-olds reported by Zhang & Knoeferle (2012) and Münster (2016). We observed reliable target role filler anticipation at the same time in children as in adults (but peaking in adults during the verb and in children during the adverb region). It is possible that the sudden onset of the visual cues in our study boosted children's attentional responses, eliminating the delay (by one word region) that had been observed in children's anticipatory target gaze when the actions were available throughout sentence comprehension. Children's response accuracy for the post-sentence comprehension questions in the present study was lower, however, than that of the adults and than previous accuracy results to such questions in children. When questions were in active (vs. passive) voice, the children's responses were more often correct when the wiggle was presented (vs. action, action plus wiggle, or no cue). Although the visual cues facilitated immediate attentional responses, their temporal limitations may have had negative effects on the depth of processing depicted actions.

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