

## Children with Hearing Loss Use Semantic and Syntactic Cues for Prediction in Sentence Comprehension

Rebecca Holt (Macquarie University), Benjamin Davies (Macquarie University), Laurence Bruggeman (Western Sydney University), Katherine Demuth (Macquarie University)

Prediction of upcoming words benefits listeners' spoken language processing. Predictable words can be identified with less acoustic information [1], can be accessed earlier [2], and require less effort to process [3]. Prediction may thus be particularly advantageous to those for whom speech input is degraded and for whom language processing is slow and effortful, such as children with pre-lingual hearing loss (HL) [e.g., 4]. Prediction has not yet been examined among children with HL, though they may struggle to employ contextual information [e.g., 1]. This suggests that their ability to predict based on context may be less efficient than their normal-hearing (NH) peers.

Children with NH as young as 2 years can predict based on a range of linguistic cues, including semantic context [5] and subject-verb syntactic agreement [6]. These different types of prediction may pose different challenges for children with HL. While semantic prediction is predominantly based on content words, which are highly salient in speech, agreement-based syntactic prediction depends on function words and affixes, which are often less salient and less accessible to those with HL. Syntactic prediction can also be inconsistent; NH children demonstrate better prediction using plural subject-verb agreement than singular [6, 7]. We therefore hypothesised that children with HL would predict less than their NH peers, if at all. However, if children with HL did predict, we expected this in the more perceptually-salient semantic context, rather than in the syntactic.

In Experiment 1, 25 English-speaking children with HL (hearing aid and/or cochlear implant users;  $M_{age} = 10;2$ ) and 25 with NH ( $M_{age} = 9;6$ ) participated in a visual world paradigm eye-tracking task [8]. They heard sentences in which the object noun was semantically related (predictable) or unrelated (unpredictable) to the subject noun and verb while viewing four images on screen: the object noun and three distractors. Experiment 2 included two additional children with HL ( $N = 27$ ;  $M_{age} = 10;2$ ), and six additional children with NH ( $N = 31$ ;  $M_{age} = 9;9$ ). Children heard sentences (Table 1) with (predictable) or without (unpredictable) copula number agreement with the target noun while viewing two images: a single animal and a group of animals. Logistic curves were fit to the proportion of looks to the target for each participant and condition in both experiments. The crossover points of each curve, reflecting the timing of looks to the target, were analysed using linear mixed-effects models. Fixed factors were Predictability and Group, plus Number (i.e., singular/plural target; for Experiment 2 only). Models had maximal random effects.

In Experiment 1, participants looked to the target earlier in the predictable than the unpredictable condition ( $\beta = 23.28$ ,  $SE = 3.40$ ,  $p < .001$ ), demonstrating semantic prediction. In Experiment 2, there was a significant interaction between Predictability and Number ( $\beta = -32.48$ ,  $SE = 7.76$ ,  $p < .001$ ). Participants looked to the target earlier in the predictable than the unpredictable condition, but only for plural targets. Agreement was thus used for prediction, but only for *are*, not *is*, similar to [6, 7]. No significant differences between groups were found in either experiment. Thus, in contrast to our hypotheses, and previous findings of limited use of context among children with HL [e.g., 1], children with HL were able to predict on par with their NH peers based on both more- and less-salient auditory information. Note that our participants typically received earlier and more comprehensive intervention than those in these earlier studies. Our findings suggest that these relatively recent advances in HL intervention may have been successful in allowing children with HL to achieve more NH-like spoken sentence processing, and that interventions relying on prediction may be beneficial for children with HL.

## References

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**Table 1 – Sample stimulus sentences.** The novel adjective ‘wallawallamoony’ occurred in all sentences in Exp. 2 to delay the onset of the target noun, allowing time for anticipatory looks.

Experiment	Predictable sentence	Unpredictable sentence
Exp. 1: Semantic context	The cyclist rides the bike.	The nephew buys the bike.
Exp. 2: Subject-verb agreement	Hey look! Are the wallawallamoony ducks quacking?	Hey look! See the wallawallamoony ducks quacking.

**Figure 1 – Mean proportion of looks to the target image.** Exp. 1 on left, Exp. 2 on right. Horizontal dashed line shows chance.

