Real-Time Lexical and Semantic Processing in Children with Hearing Loss

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Background

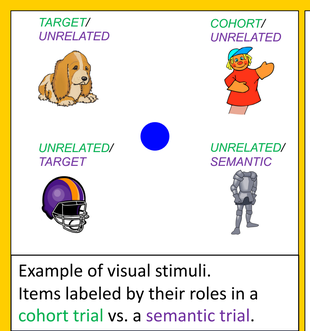
- Children with any degree of hearing loss are at risk for language deficits (e.g., discourse comprehension[1])
- To comprehend speech, listeners must quickly and efficiently employ two processes[2]:
  1) Activate lexical candidates consistent with the speech signal
  2) Activate semantic features of these candidates
- Differences in how children with hearing loss activate lexical candidates and/or activate semantic information may explain some of the deficits in how these children comprehend running speech
- For efficient language processing, normal hearing (NH) listeners immediately activate many lexical candidates that match early portions of the input. These candidates compete over time until only one remains[3].
- Prelingually deaf adolescents with cochlear implants (CIs) show a distinct approach to speech processing: They process speech less incrementally than NH listeners, leading to delayed lexical access and reduced phonological competition[4]
- It is currently unknown…
  1) If developing language via hearing aids (HAs) results in the same delays in lexical access as developing language via CIs
  2) How differences in lexical access cascade to affect semantic activation in children with HAs or CIs, or if deficits exist in semantic activation that are distinct from differences in lexical access

Study Goals

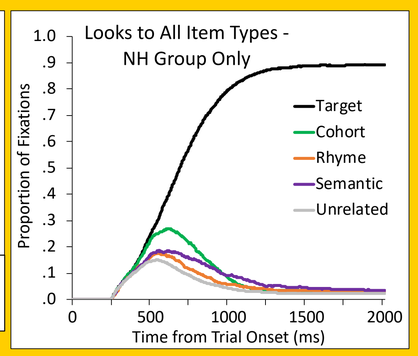
1. Characterize the dynamics of lexical access during spoken word recognition in children with HAs and children with CIs, relative to NH peers.
2. Characterize the dynamics of semantic activation during spoken word recognition in children with HAs and children with CIs, relative to NH peers.

Visual World Paradigm

- Isolated target words presented in quiet via loudspeaker
- Screens contain four pictures: one target, two unrelated items, and either a cohort, rhyme, or semantically related item
- Listeners click on picture corresponding to target word
- Eye movements monitored at 250 Hz
- Eye fixations index the extent to which child is considering each item
- Each child completes 120 each of cohort, rhyme, and semantic trials
- Analyses include only correct trials

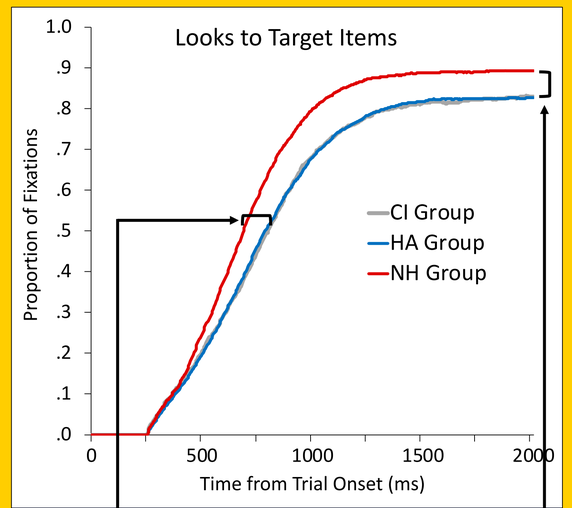


Example of visual stimuli.
Items labeled by their roles in a cohort trial vs. a semantic trial.



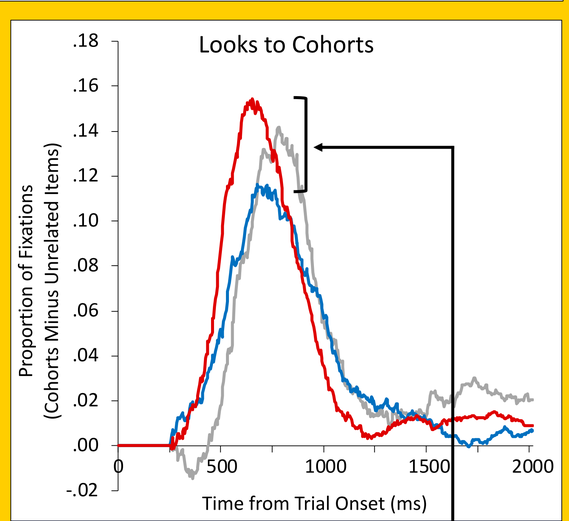
Results

- Statistical analyses compare NH group and HA group (data for CI group are preliminary and therefore have not been analyzed)
- Proportion of fixations compared every 4 sec using Bootstrapped Differences of Time Series[5] to determine statistical significance

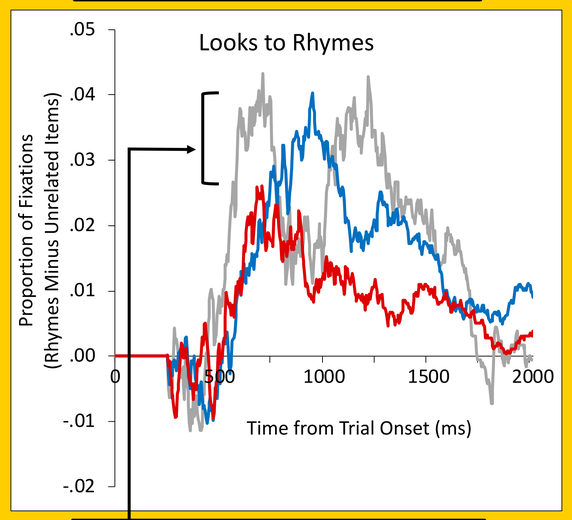


Children with HAs are slower to look to the target than children with NH.

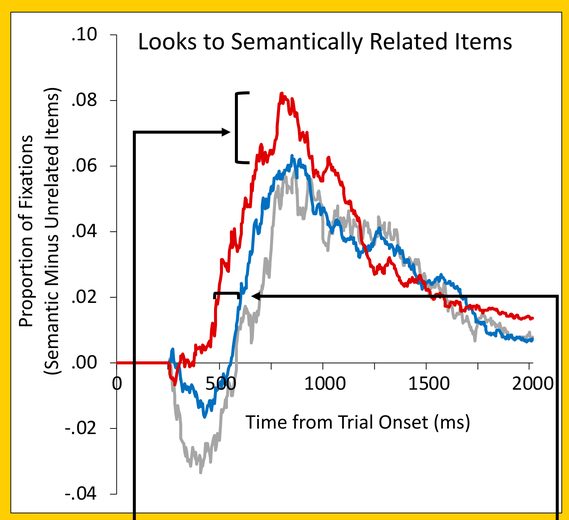
Children with HAs have lower peak fixations to the target than children with NH.



Children with HAs have lower peak fixations to the cohort than children with NH.



Children with HAs have higher peak fixations to the rhyme than children with NH.



Children with HAs have lower peak fixations to the semantically related item than children with NH.

Children with HAs are slower to look to the semantically related item than children with NH.

Participants

Group	n	Age *Mean (SD)*	Receptive Vocabulary: PPVT-4 Standard Score *Mean (SD)*	Accuracy on Visual World Paradigm *Mean (SD)*	Better-Ear PTA *Mean (SD)*
NH	17	10.7 yr (.90)	110.1 (12.6)	99.0% (.008)	≤ 20 dB HL
HA	19	11.2 yr (.95)	105.5 (12.7)	98.1% (.014)	50.7 dB HL (8.5)
CI	8	11.2 yr (.67)	99.3 (10.8)	98.0% (.014)	--

PTA = pure-tone average, PPVT-4 = Peabody Picture Vocabulary Test, NH = normal hearing, HA = hearing aid, CI = cochlear implant

Conclusions

- Even when listening to single words presented in quiet, children with HAs show slower lexical access (less incremental processing) than children with NH.
- Children with HAs show slower and reduced semantic activation than children with NH. Future analysis will determine the extent to which this difference is due to overall slower lexical access vs processing differences that are specific to semantic activation.
- Preliminary data from the CI group suggest a strong similarity between children with HAs and children with CIs regarding the dynamics of lexical access and semantic activation.
- Developing language via any degree of signal degradation appears to alter the dynamics of real-time spoken language processing, even when standardized language scores are within the normal range.
- Children with hearing loss may benefit from intervention targeting language processing efficiency through at least late elementary school.

References

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