Structure and process-level lexical interactions in memory search: A case study of individuals with cochlear implants and normal hearing

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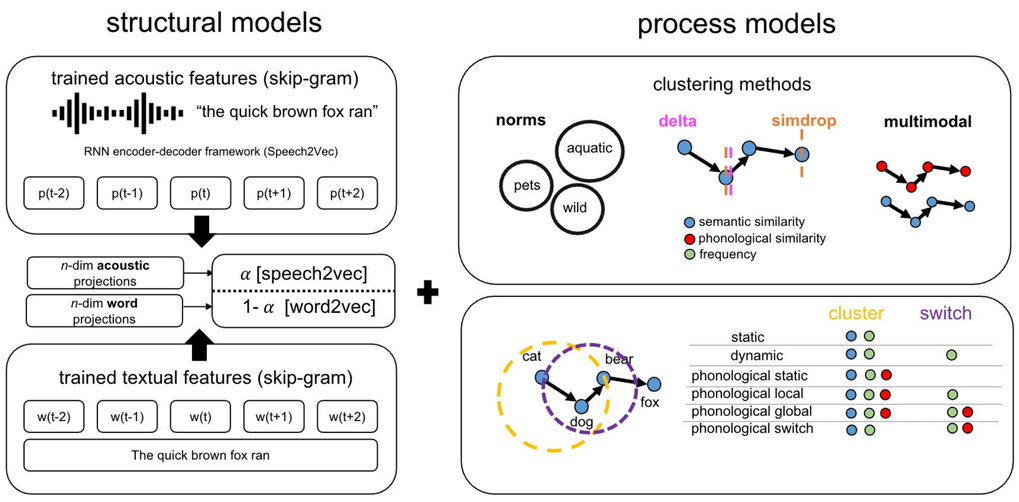
INTRODUCTION

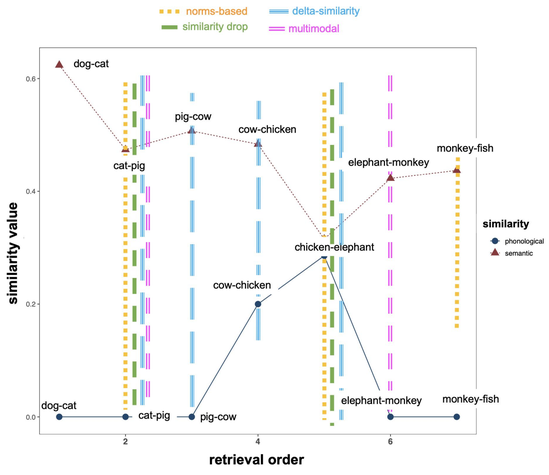
- Individuals with cochlear implants (CIs) and normal hearing (NH) engage in "clustering and switching" during memory search, similar to optimal foraging in the wild.
- Semantic and phonological cues influence memory search differently in individuals with cochlear implants (CIs) compared to normal hearing (NH).
- We investigate search in prelingually deaf individuals with CIs to explore the impact of early phonological input on semantic organization and retrieval processes.

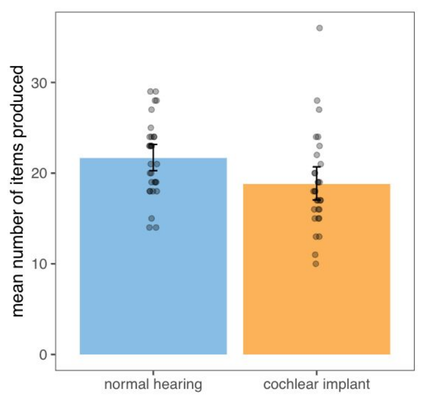
MODELING FRAMEWORK



FLUENCY MEASURES

Example: dog - cat - pig - cow - chicken - elephant - monkey - fish





PARTICIPANTS

Variable	Mean (Range) in CIs (N = 30)	Mean (Range) in NHs (N=30)
Chronological age (Years)	15.74 (9.86-26.66)	16.18 (10.2-27.07)
Age at implementation (months)	37.94 (11.07-75.76)	-
Duration of CI use (Years)	12.58 (7.79-21.19)	-
Age of onset of deafness (months)	2.41 (0-24)	-
Standardized PPVT-5*	84.69 (42-123)	108.63 (79-132)

Note: PPVT-5 stands for the Peabody Picture Vocabulary Test, a standardized test that measures receptive vocabulary knowledge

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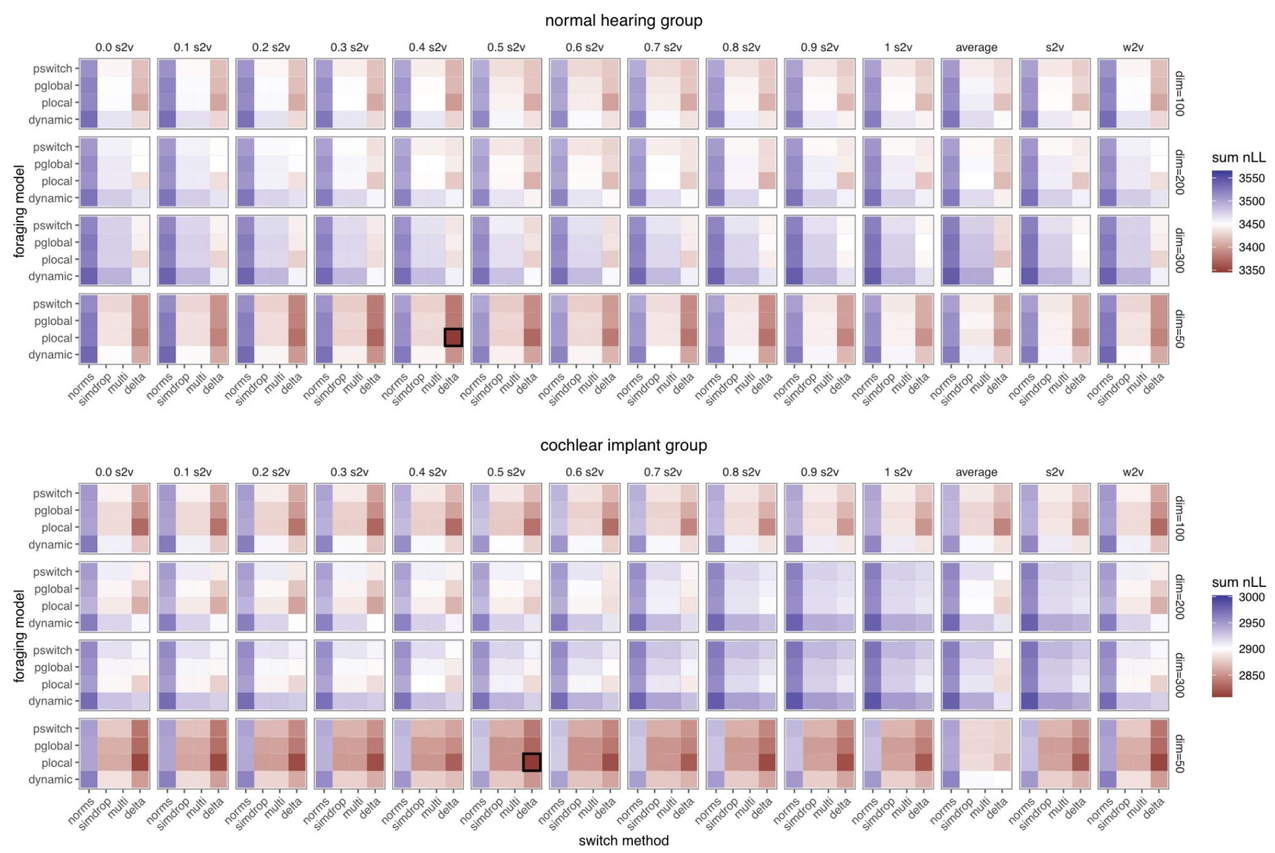
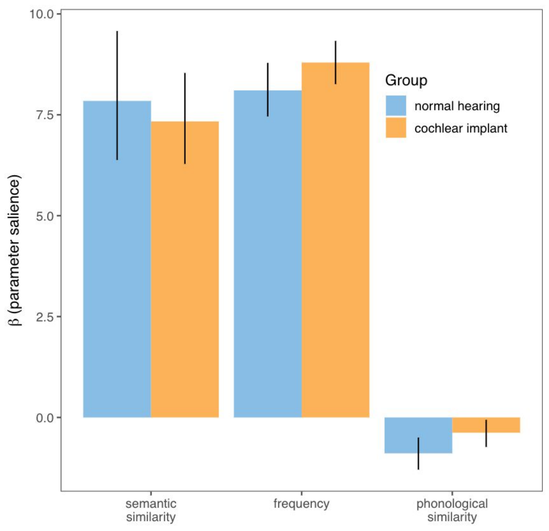
* All error bars represent 95% confidence intervals

RESULTS



- Structural models:
  - Embeddings with lower dimensions provided a better fit than models with higher dimensions.
  - The concatenated variants of *speech2vec* and *word2vec* performed better than the single-model or the "average" model.
  - For **normal hearing group**, the best-performing structural model emphasized *word2vec* over *speech2vec* (α = 0.4).
  - For **cochlear implant group**, the best-performing structural model emphasized *speech2vec* and *word2vec* equally (α = 0.5).
- Process models:
  - Best-performing process model was the dynamic foraging model that incorporated semantic similarity, phonological similarity, and frequency in local "cluster" transitions and frequency in global "switch" transitions, and used the delta similarity method to assign cluster-switch designations.

LEXICAL SOURCES / FLUENCY PERFORMANCE



- **CIs attend more to frequency than NHs, no differences in use of semantic similarity**
- **Both groups appear to use phonology for local within-cluster transitions (based on best-performing models)**

DISCUSSION

- **CIs and NHs WERE SENSITIVE TO REPRESENTATIONS DERIVED FROM TEXT AND SPEECH**
  - The lexicon is most likely represented in a multimodal format across both groups.
- **CIs EQUALLY EMPHASIZED REPRESENTATIONS DERIVED FROM SPEECH & TEXT, NHs DE-EMPHASIZED SPEECH IN FAVOR OF TEXT**
  - Among neurotypical individuals, speech-related cues may be overtaken by textual or linguistic cues over time, whereas CIs may rely on these cues a lot more than their peers.
- **CIs ATTENDED TO WORD FREQUENCY MORE THAN NHs**
  - CIs may be more likely to latch on to frequently used words and have a sparser mental lexicon

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