

The Dimensions of Real-Time Spoken Word Recognition in Cochlear Implant Users



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Background

Cochlear Implants (CIs) restore a sense of sound to individuals with profound hearing loss through electric stimulation of the auditory nerve

CI users must learn to adapt to the novel input from their CI, which is spectrally degraded compared to acoustic hearing

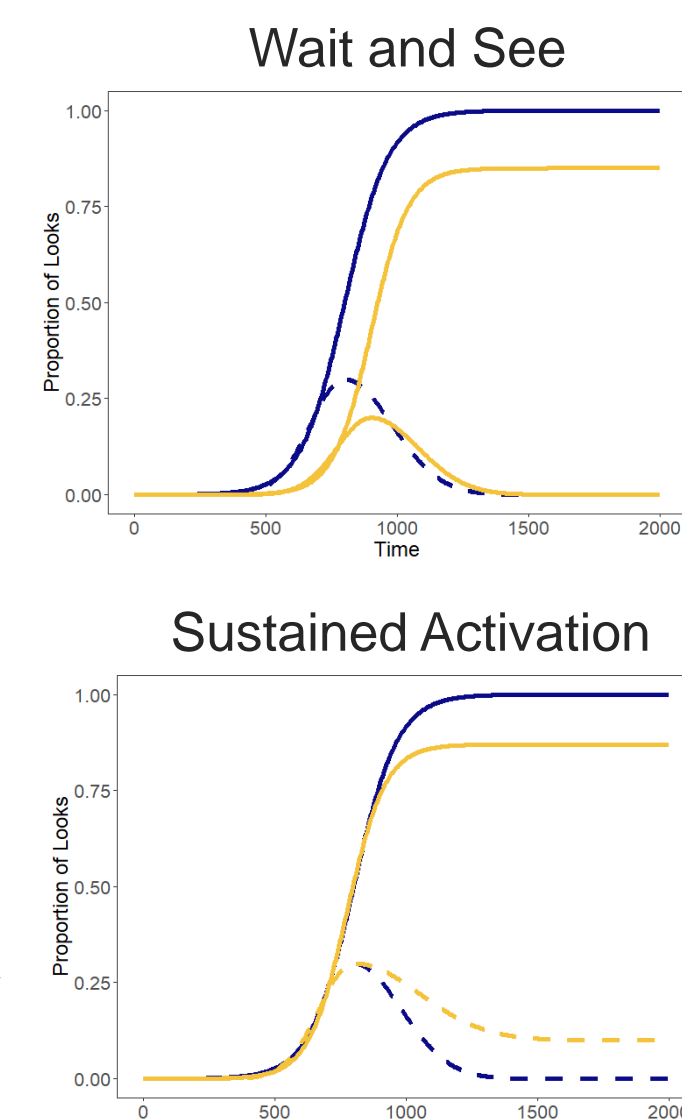
- Poorer input quality impacts how words are recognized

In normal hearing adults, word recognition begins immediately and proceeds incrementally (Alloppenna et al., 1998; Marslen-Wilson, 1987)

In CI users, lexical access is delayed, leading to differences in how competition is resolved between competitors (Farris-Trimble et al., 2014; McMurray et al., 2017)

- Wait-and-See:** characterized by slower activation of candidates, reduced competition
- Sustained Activation:** characterized by increased activation of cohort competitors for longer than typical

These processing strategies have so far only been identified with small clinical samples and it is unclear if they are distinct strategies or two ends of a continuum



Research Questions

RQ1: What are the underlying dimensions of real-time word recognition among CI users?

RQ2: What are the factors that influence where listeners fall along these dimensions?

RQ3: Do these dimensions relate to clinical/real-world outcomes?

Methods

Participants (N=101)

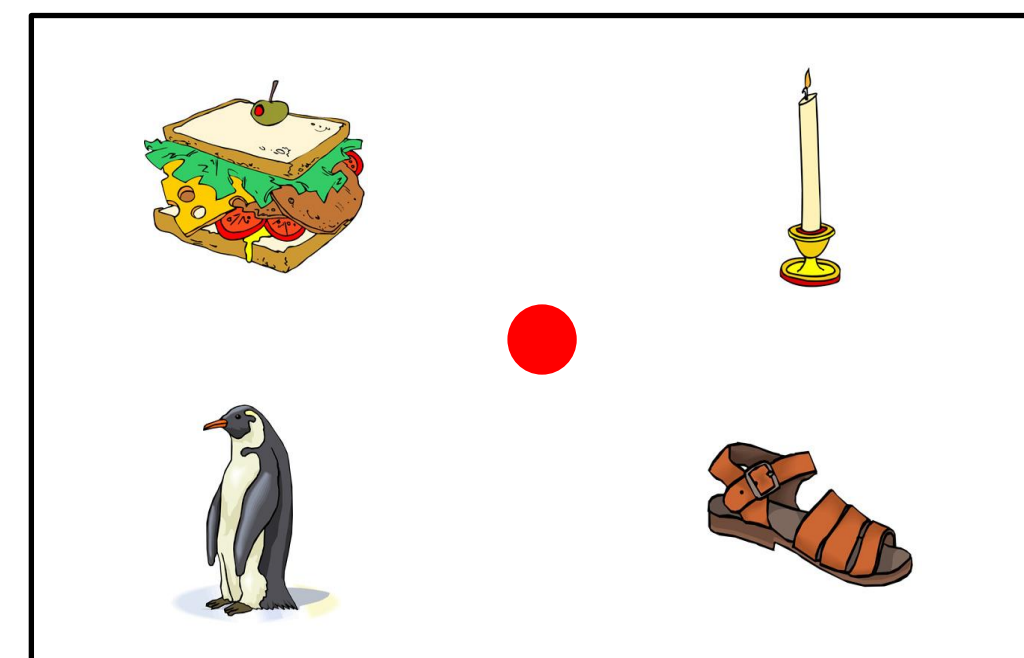
	Device Configuration	N	Mean Age (SD)	Mean Device Experience (SD)
Acoustic + Electric	Bimodal	25	58.2 (17.7)	4.9 (4.2)
	Hybrid	38	61.1 (12.0)	5.9 (3.8)
Electric	Bilateral	18	51.4 (16.6)	6.8 (5.7)
	Unilateral	20	54.3 (15.3)	12.6 (9.3)

Tasks

Auditory fidelity:	Outcomes:
Pure-tone thresholds	CNC Word recognition
Spectral Ripple	AzBio Sentence repetition
Temporal Modulation Discrimination	Speech, Spatial, Qualities (SSQ)

Visual World Paradigm

Participants click on the picture that best matches the word they heard



Visual display presents target, cohort, rhyme, and unrelated item

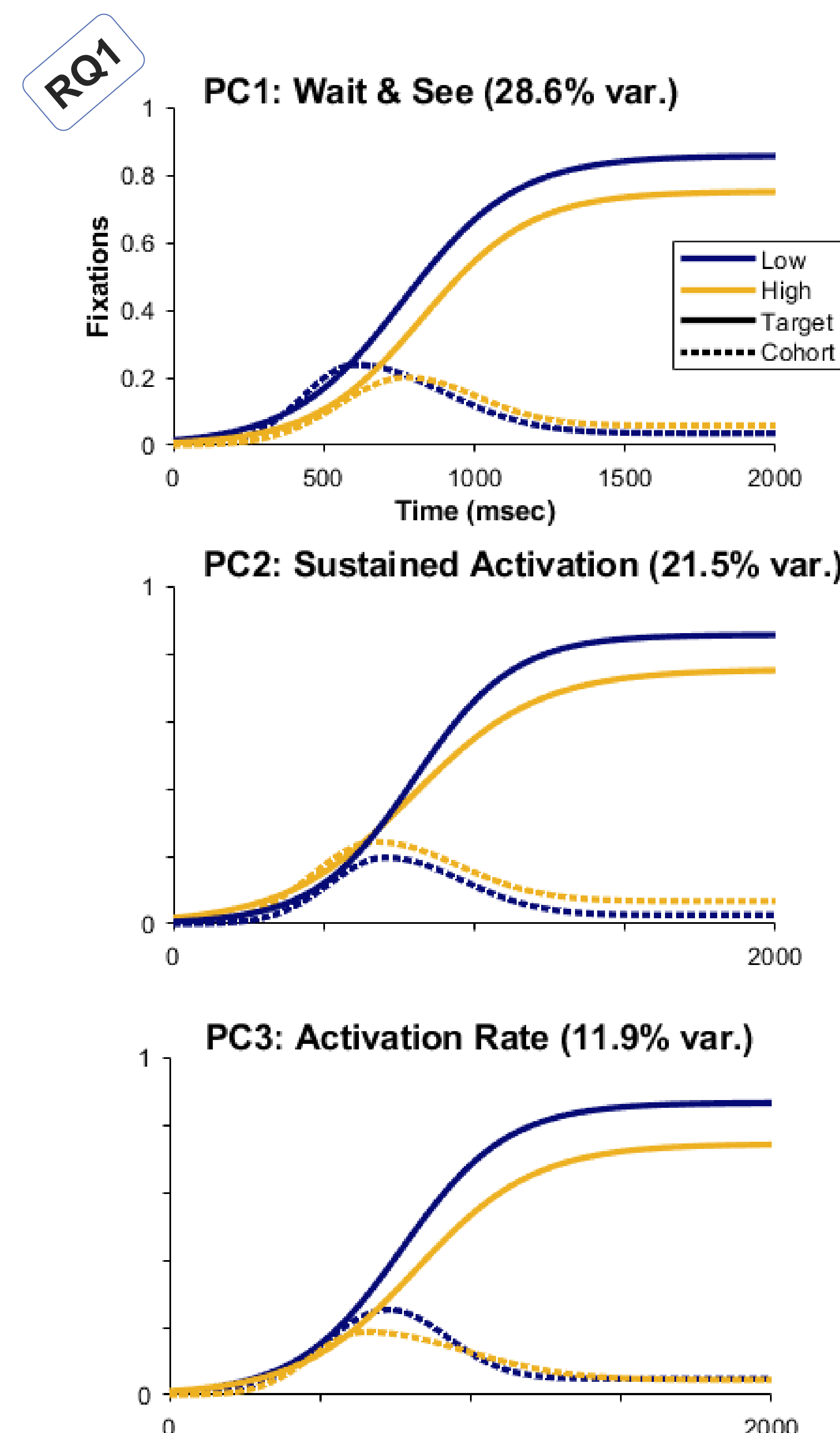
(e.g., sandal, sandwich, candle, penguin)

60 item sets x 4 items/set x 1.25 repetitions/set = 300 trials (Each item from a set is the target word once + one randomly repeated)

Principal Component Analysis (PCA)

Used to identify orthogonal dimensions from parameters of non-linear curves fit to Visual World Paradigm data

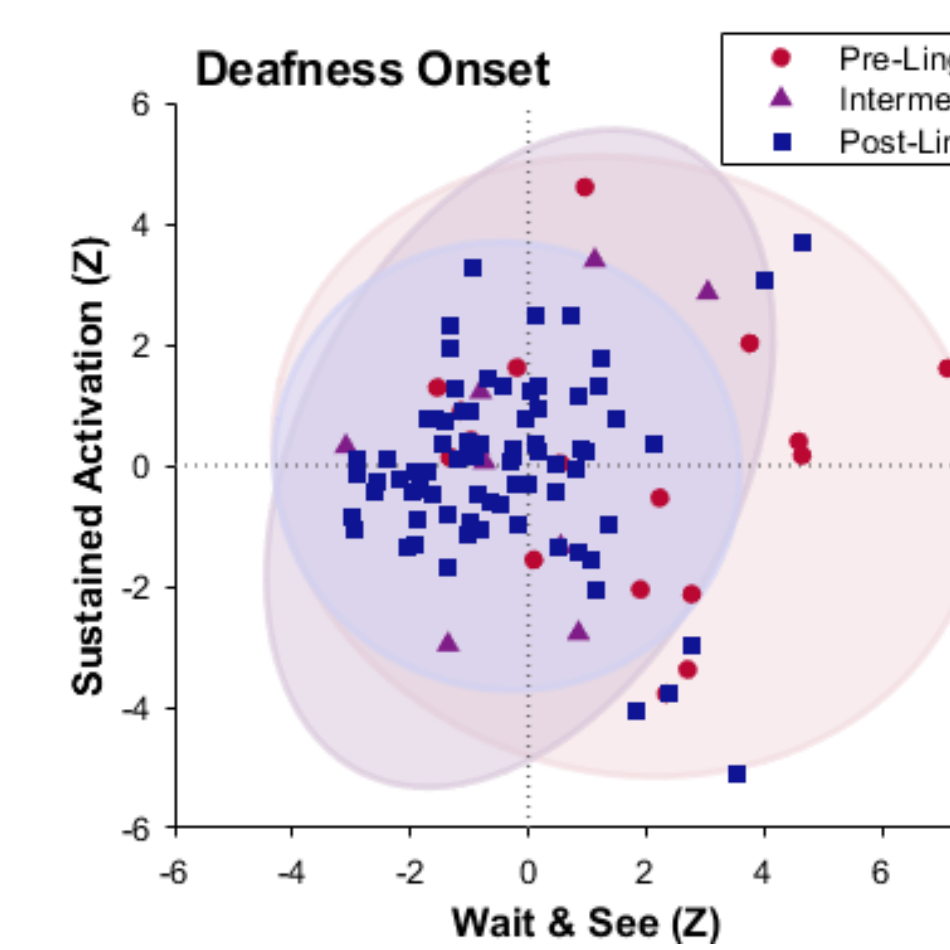
+/- 1.5 SDs of first three principal components (PCs)



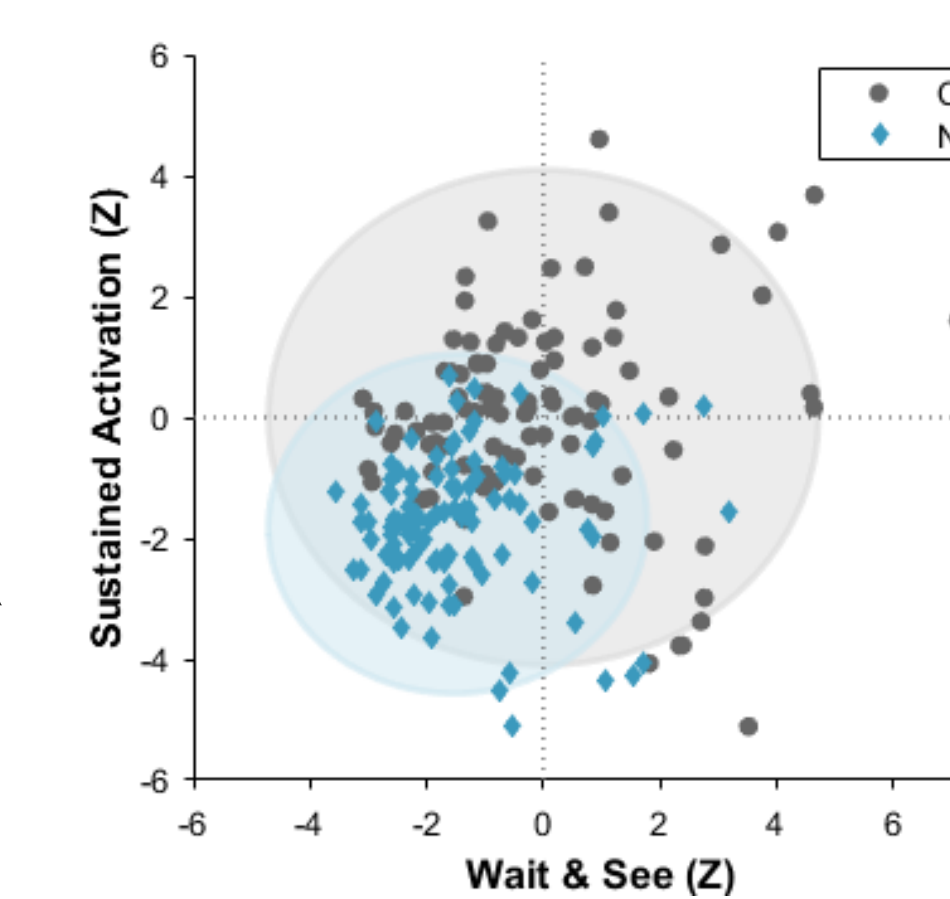
Additional PCs do not relate to word recognition

Results

Distribution of participants across *Wait & See* and *Sustained Activation* dimensions based on onset of deafness (Shaded area represents 95% confidence interval)

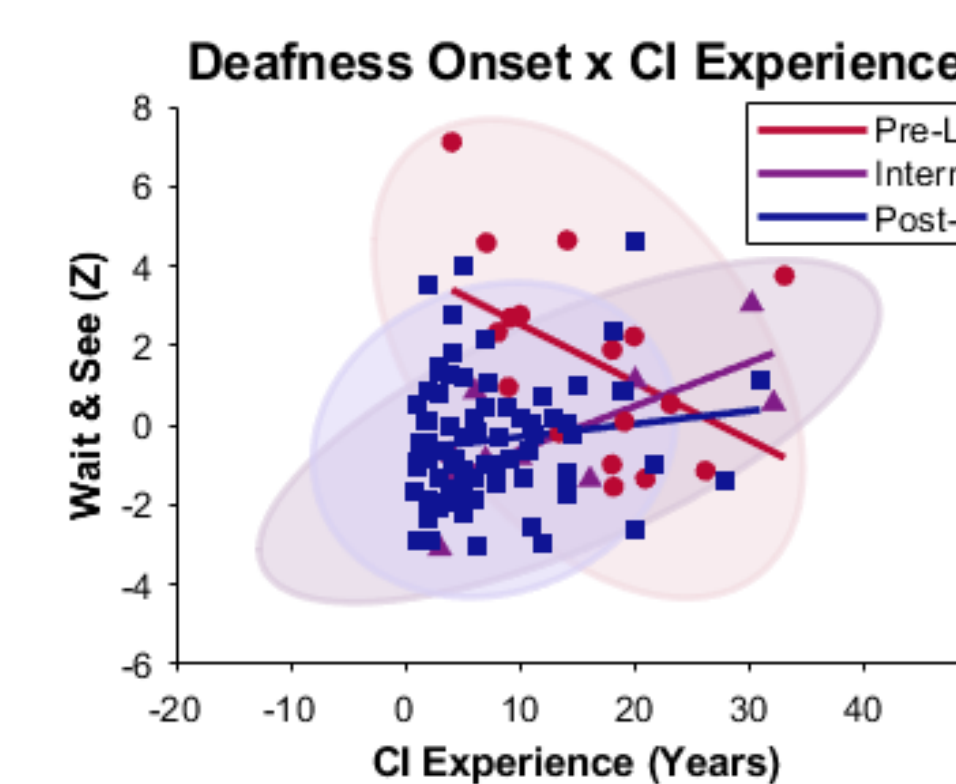


Listeners fall along similar processing dimensions

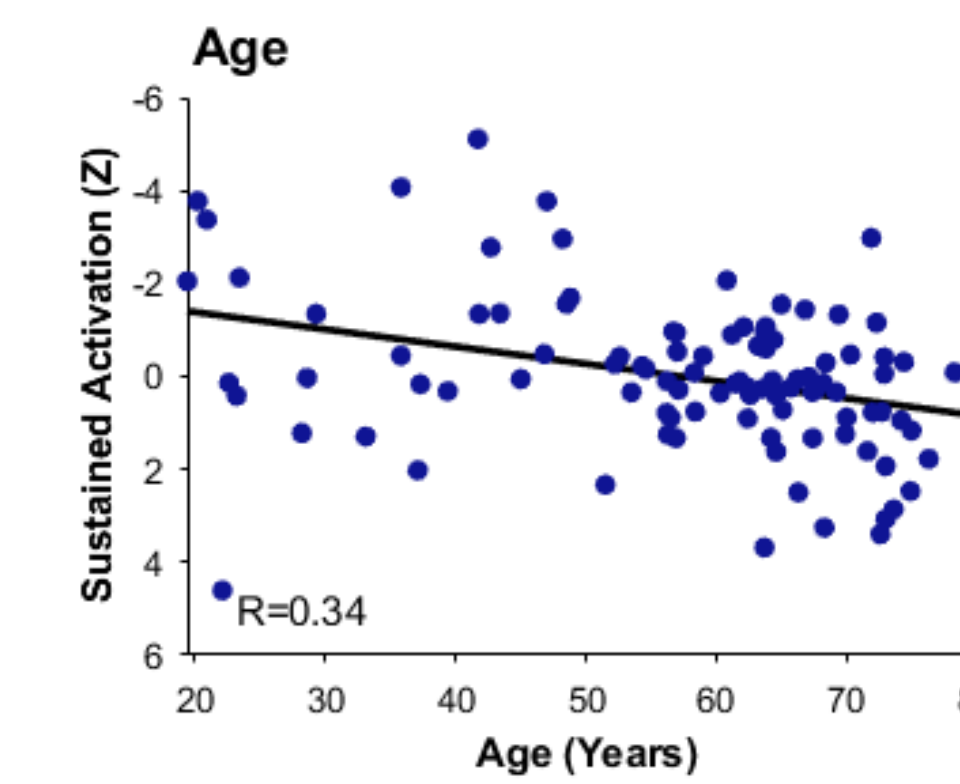


Normal hearing listeners (from Colby & McMurray, 2023) project onto smaller area of CI users' processing space

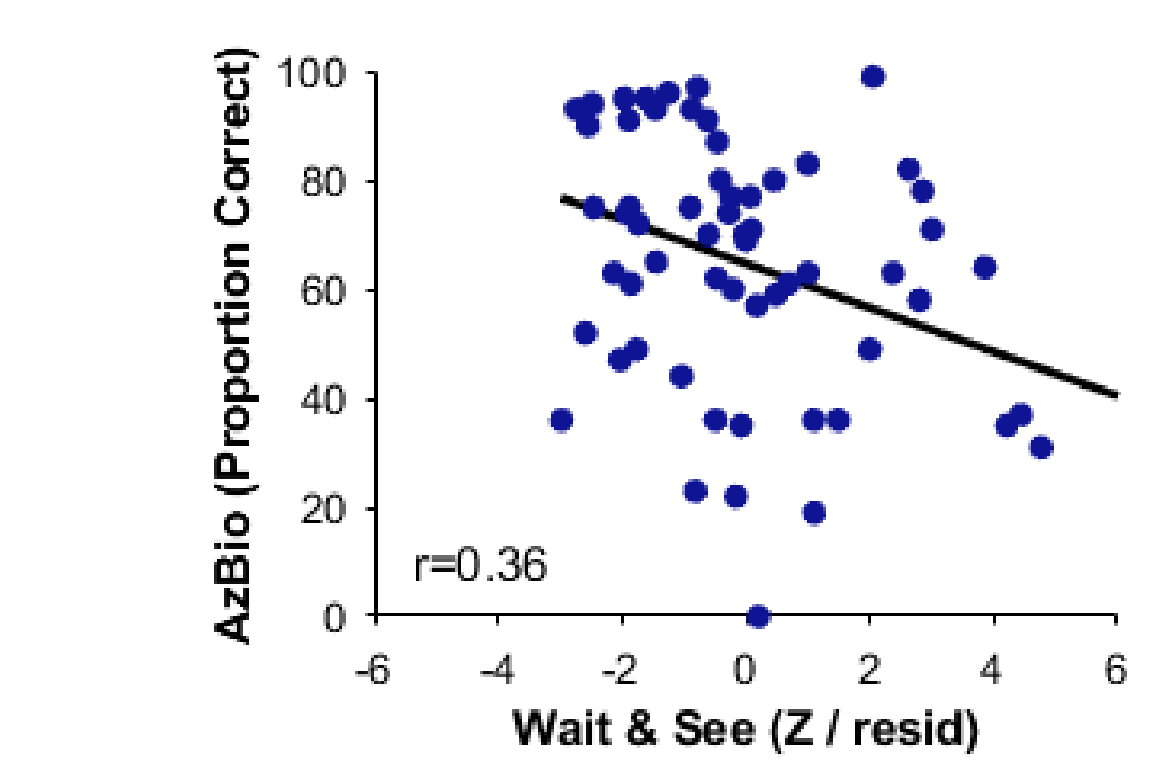
Prelingual CI users with longer device experience show less *Wait & See*



Age predicts *Sustained Activation* and *Activation Rate* (similar to normal hearing listeners; Colby & McMurray, 2023)



Wait & See predicts word and sentence recognition (CNC, AzBio)



Summary & Conclusion

Previously identified processing profiles emerged as independent dimensions

- Wait & See* predicted by onset of deafness, device experience, and functional acoustic hearing
- Sustained Activation* predicted by age and onset of deafness

Clinical outcomes of word and sentence recognition predicted by processing dimensions identified by PCA

- Wait & See* predicts word and sentence recognition
- Sustained Activation* predicts word, sentence recognition and real-world satisfaction (SSQ)
- Activation Rate* predicts sentence recognition

These processing profiles are not adaptive, but may be overcompensation to hearing loss

- Listeners who have high PC values have worse outcomes

Acknowledgements

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