



# Assessing Cognitive Load in Individuals who have Single-Sided Deafness and Receive a Cochlear Implant

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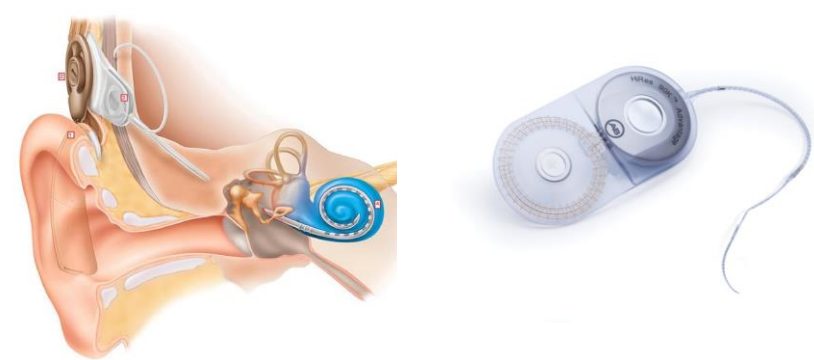


Binaural Hearing and Speech Laboratory

## INTRODUCTION

### Cochlear Implants (CIs)

- CIs are implantable auditory devices that provide sound through electrical stimulation of the auditory nerve.
- For individuals with profound bilateral sensorineural hearing loss who do not benefit from hearing aids.



### Single-Sided Deafness (SSD)

- \*SSD defined as normal hearing in one ear and deaf in the other ear.
- There is now a unique population of individuals with SSD, who are receiving a CI in their deaf ear.
- Some patients with SSD benefit from a CI, as indicated by improved speech perception in noise and better sound localization abilities, whereas others do not.<sup>3,5,8</sup>

## PURPOSE OF THIS STUDY

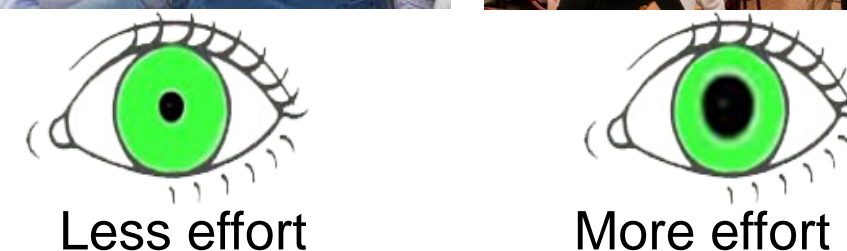
- To explore another potential benefit for patients with SSD who receive a CI: decreased listening effort.
- \*Due to the relatively small number of these patients, the present study aimed to simulate SSD in individuals with two normal-hearing (NH) ears using computer simulations of CIs.

### Listening Effort

- **Listening Effort** is a component of auditory perception involving cognitive processing or cognitive load.



Elevated effort is associated with adverse psychological outcomes.<sup>1,2,4</sup>



**Pupillometry** can be used to objectively quantify changes in listening effort during cognitively demanding tasks (e.g. listening to speech) by capturing changes in pupil dilation.

## METHODS

### Normal Hearing (NH) Participants

- TGB (23 years old), TJI (21 years old)
- \*participants passed a hearing screening

### Stimuli

- Harvard IEEE sentences<sup>6</sup> spoken by a female
- E.g., "The rice was served in a round dish."

### Procedure

- Participants sat in a soundproof booth with their head in a chin rest.
- They were instructed to fixate their gaze on a small cross in the center of the computer screen & repeat exactly what they heard.
- Stimuli were presented over headphones.



Fig. 1. Participant sitting comfortably with head placed in the chin rest.

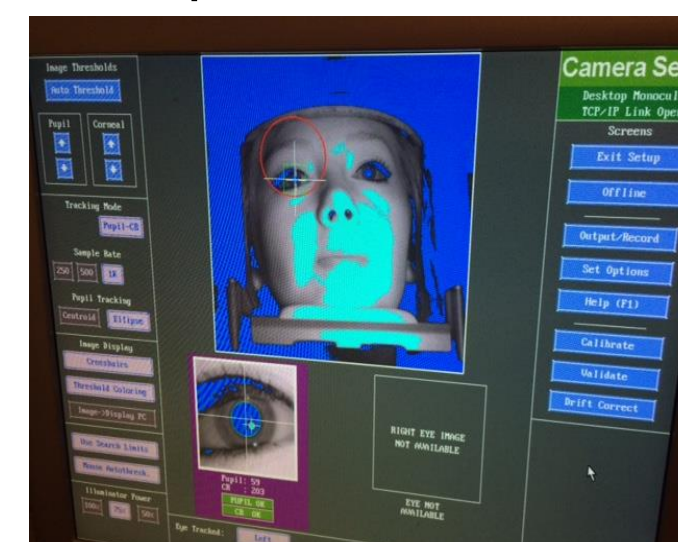
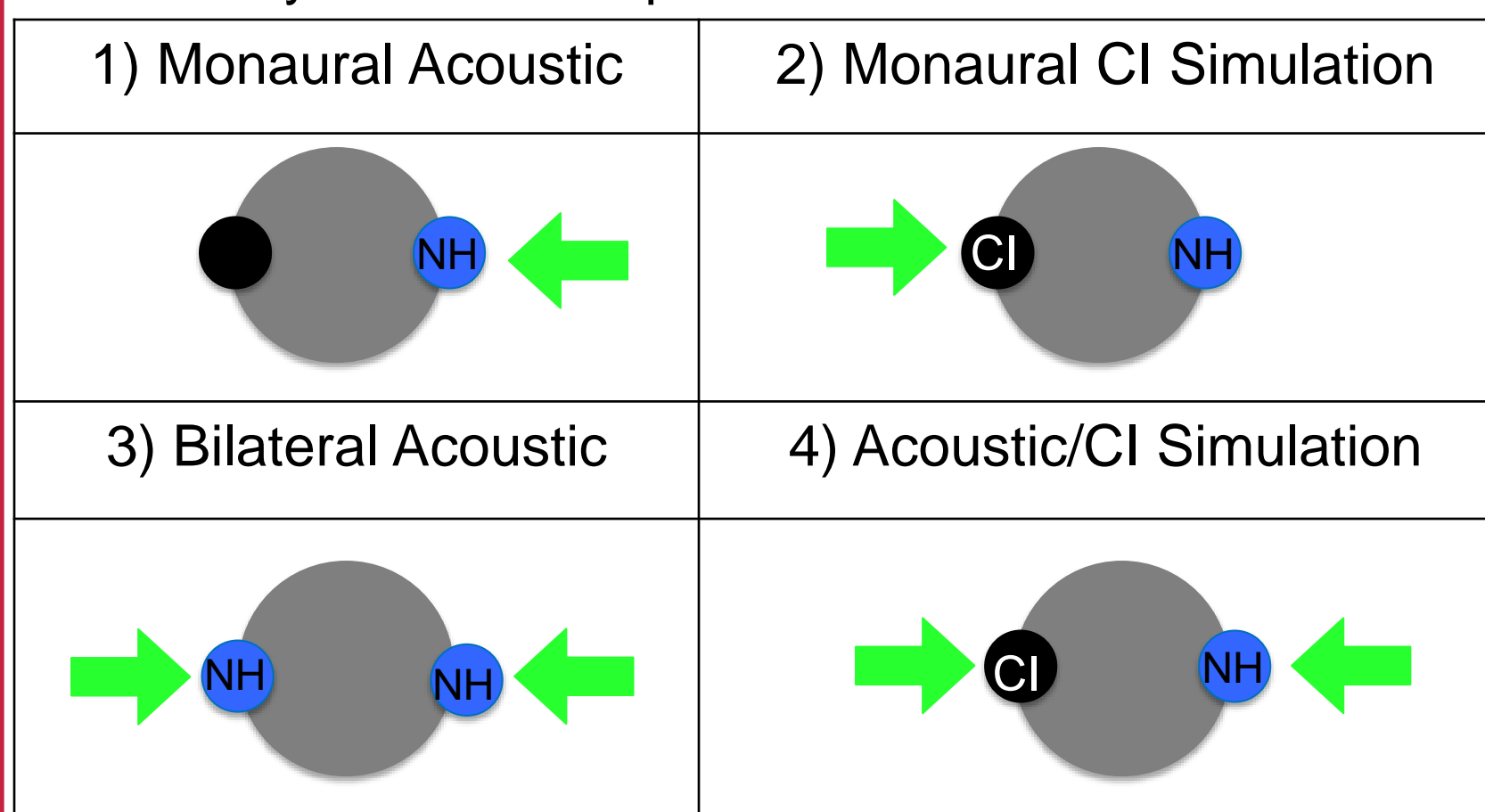


Fig. 2. Examiner's view of the participant's pupil from the EyeLink's infrared camera.

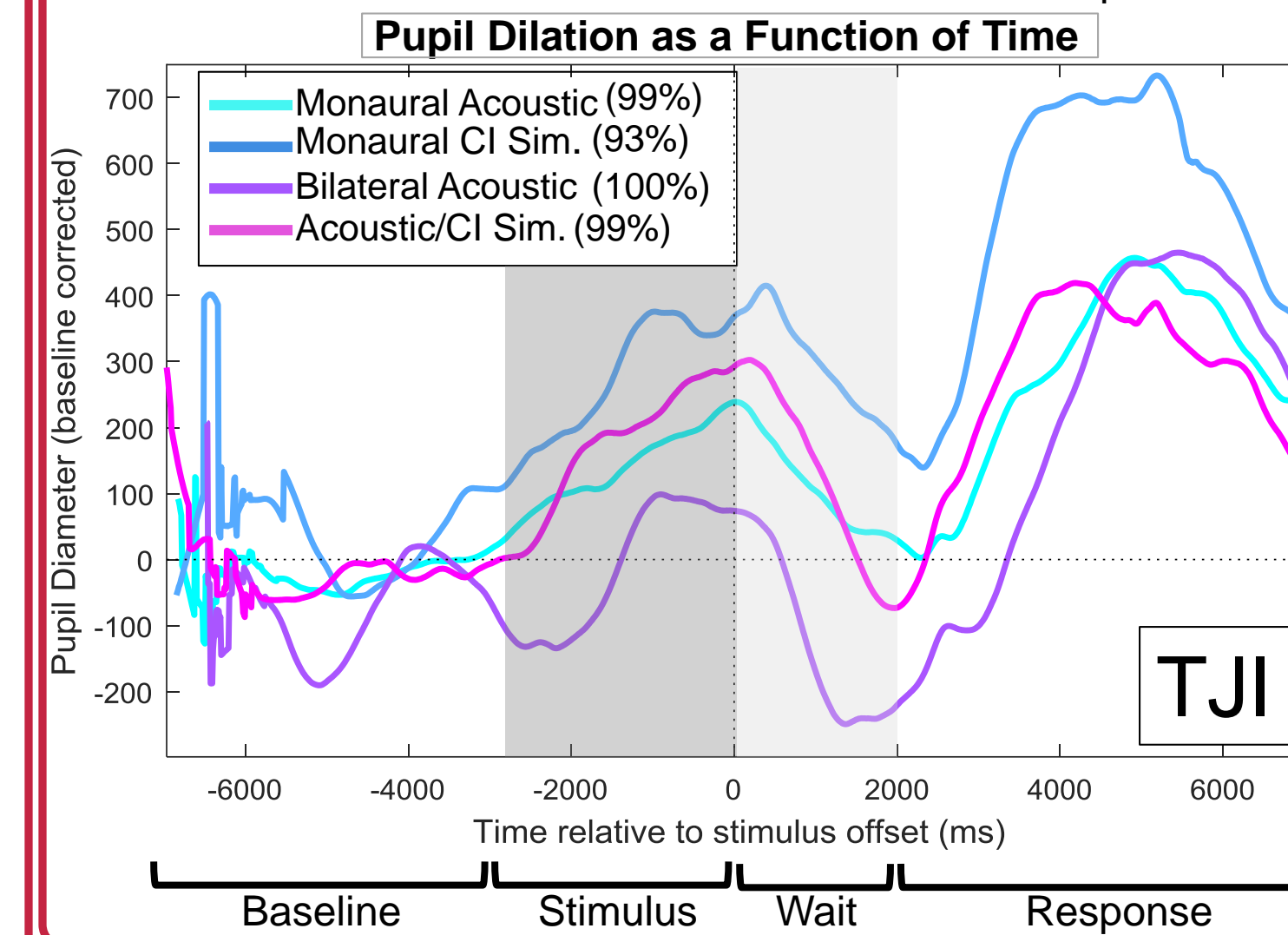
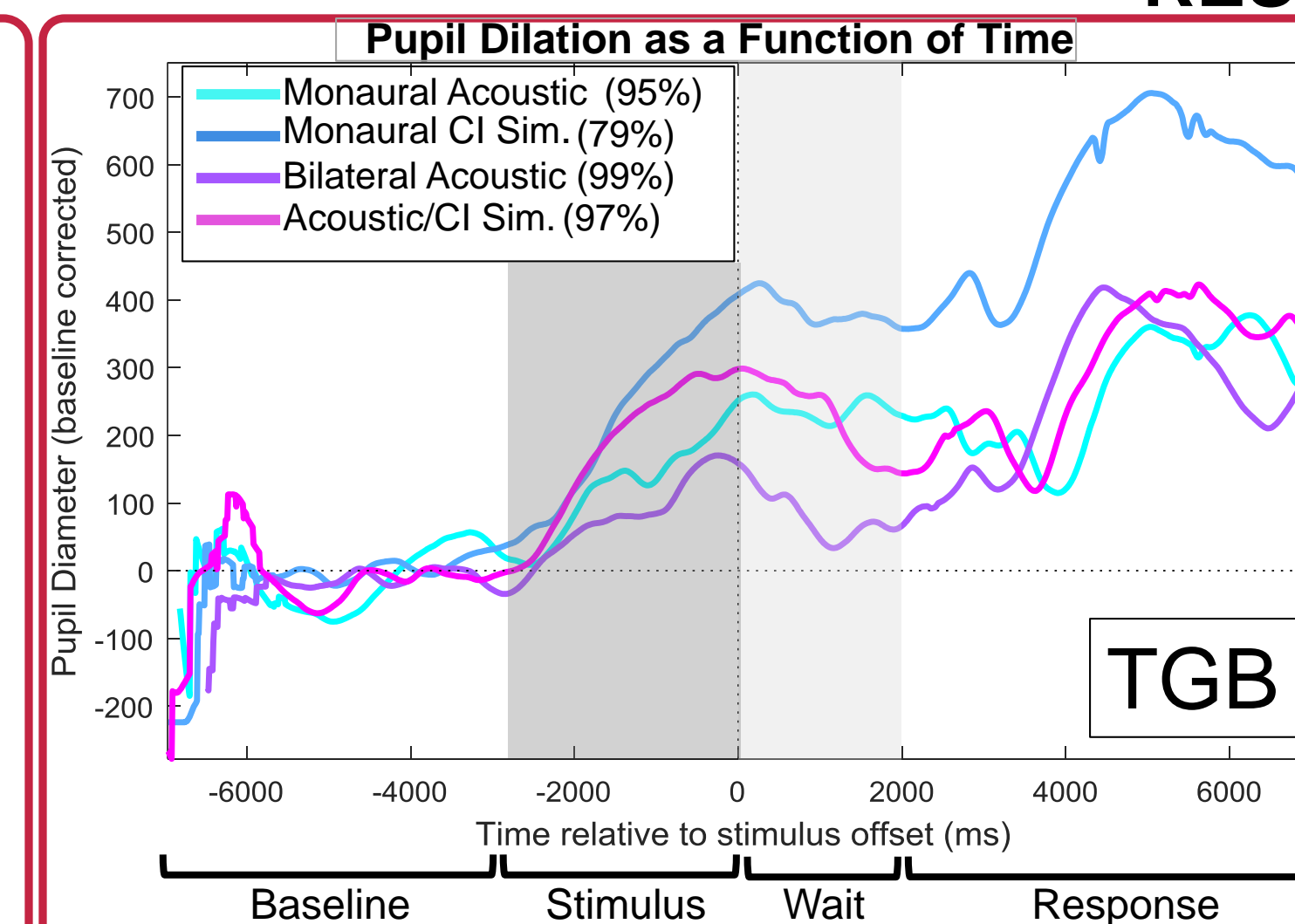
- During the presentation of auditory stimuli, the EyeLink 1000 Plus recorded pupil dilation.
- Auditory stimuli were presented in one of 4 conditions:



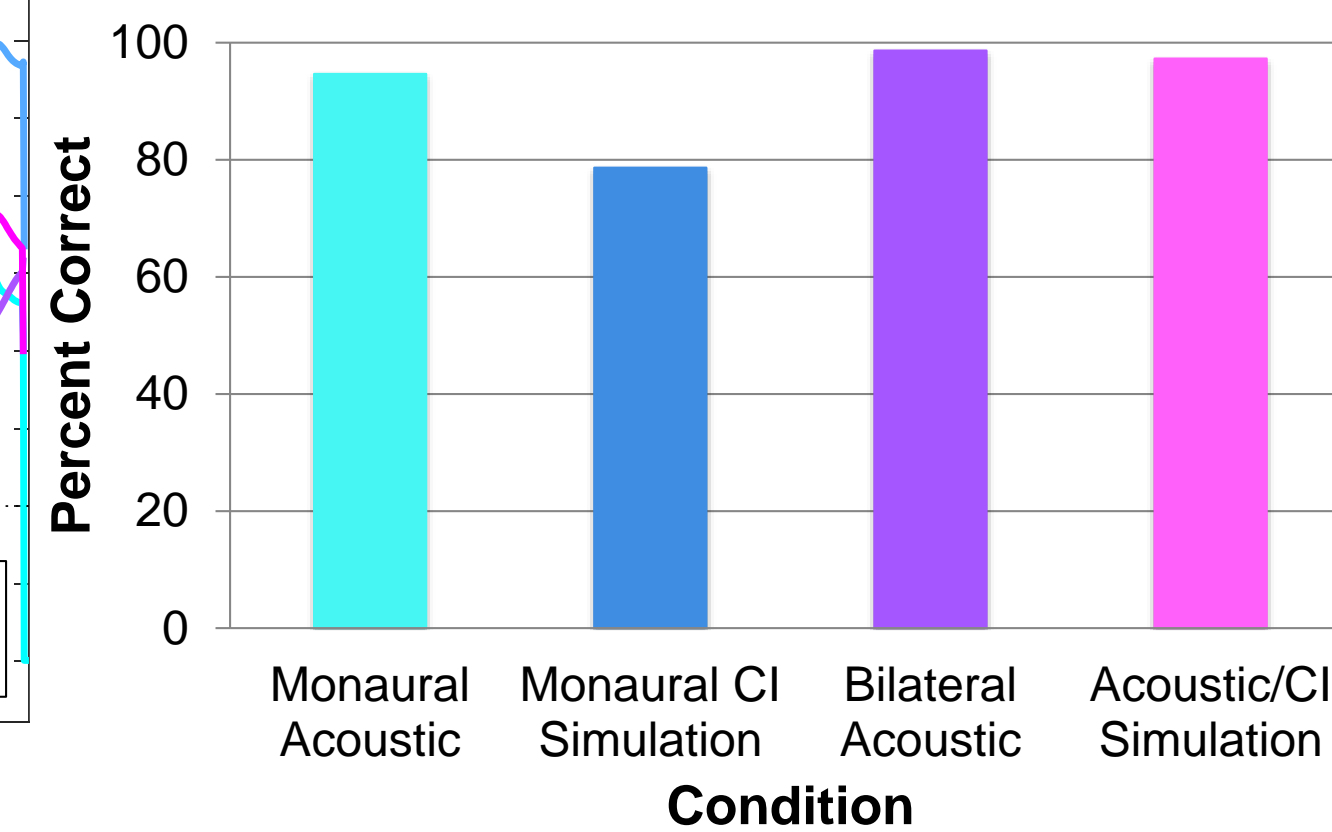
CI Simulated CI ear NH Normal hearing ear → Target Stimuli

- CI conditions were tested using a CI simulation.
- Speech intelligibility scores and pupil dilation were obtained within each condition.

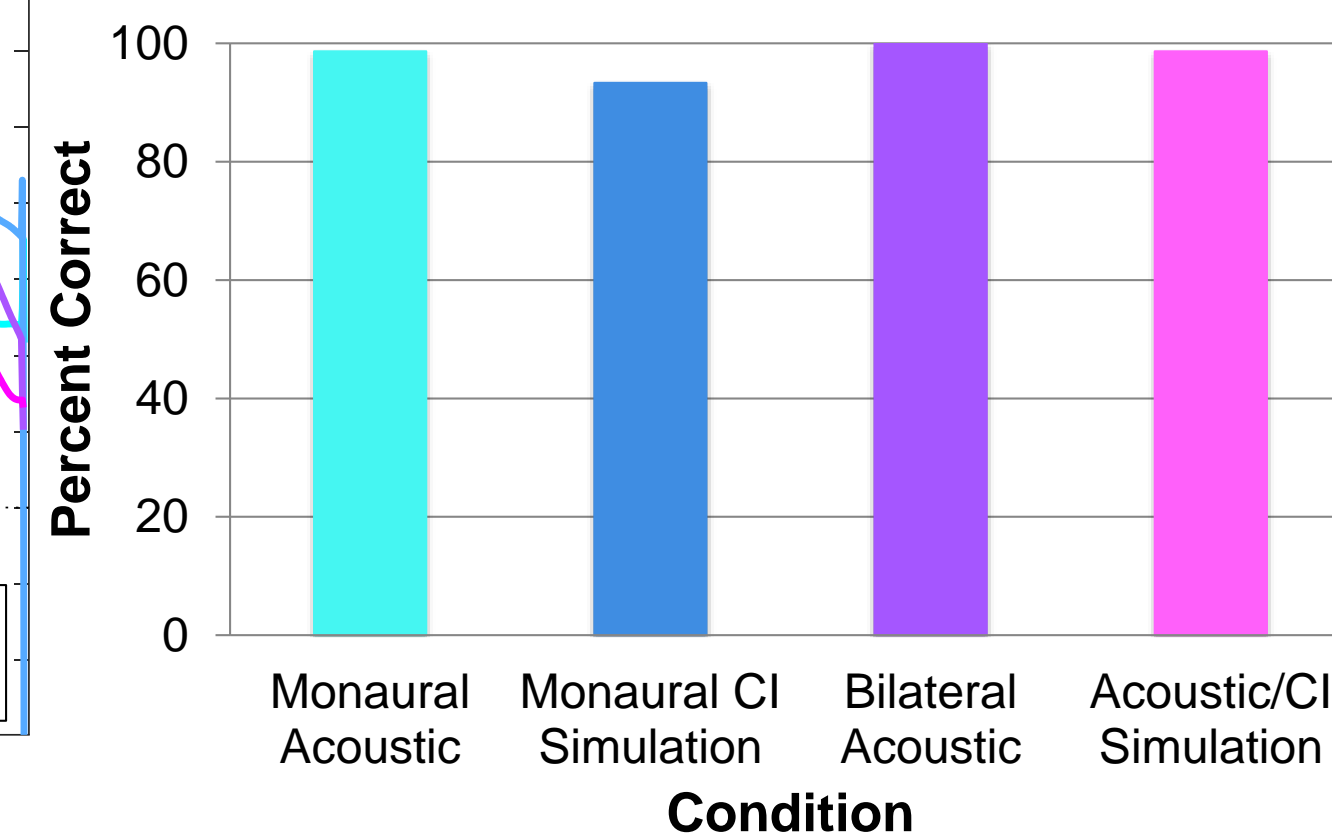
## RESULTS



### Speech Intelligibility Scores (TGB)



### Speech Intelligibility Scores (TJI)



## DISCUSSION

- Both participants demonstrated good speech intelligibility scores in the monaural acoustic and the bilateral acoustic conditions, suggesting that one NH ear is sufficient for good speech understanding *in quiet*.
  - However, listening effort was lower for the bilateral acoustic condition. This suggests that there is a benefit from adding a second NH ear that is not evident by intelligibility scores alone.
- Speech intelligibility was poorest and listening effort was highest in the monaural CI simulation condition when access to normal acoustic cues was not available. This is not surprising since the signal is degraded through the CI processing. However, many individuals with CIs show improvement over time.
- Speech intelligibility and listening effort in the monaural acoustic condition and the acoustic/CI simulation condition were nearly the same for both participants. This suggests that, in addition to providing improved speech perception in noise and better sound localization abilities, adding a CI to the deaf ear does not increase listening effort.
  - Preliminary data provides further support that CIs may be a good option for individuals with SSD. Future directions are to investigate similar questions in more noisy realistic listening environments.

## REFERENCES

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