Th45b

Speech intelligibility in noise for listeners with single-sided deafness with and without a cochlear implant in the contralateral ear

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Conference on Implantable Auditory Prostheses

Lake Tahoe, CA July 16-21, 2017

INTRODUCTION

- Individuals with single-sided deafness (SSD) rely only on monaural acoustic hearing and have difficulty functioning in complex acoustic environments.
- Clinical interest in providing a cochlear implant (CI) in the deaf ear of individuals with SSD (SSD-CI) both to suppress tinnitus and to aid hearing is increasing.
- There is growing evidence to suggest that having a CI combined with a normal-hearing (NH) ear leads to improved sound localization ability and speech understanding in noise[1-3], however, current measurement techniques are not able to effectively quantify the subjective benefits reported by SSD-CI patients[3].
- Pupillometry, or using an eye tracker to objectively measure pupil dilation, is one method that can be used to quantify changes in listening effort over time.

The aim of this study is to look at speech intelligibility outcomes for SSD patients by merging two approaches: 1) calculating percent correct scores while, 2) measuring change in pupil dilation, to objectively quantify changes in listening effort over time and across conditions.

METHODS

Participants

7 participants with SSD (NH thresholds in contralateral ear)
- 5 participants tested prior to receipt of CI *{and will be tested again after receiving a CI}*
- 2 participants tested ≥ 1 year post CI

Table 1: Participant Information

Subject	Sex	Deaf Ear	Etiology	Age at time of deafness	Age at time of implantation	Internal CI	CI Processor	CI Duration
MBA	F	R	Temporal bone fracture	44	ant. 47			
MBB	M	R	Sudden SNHL	40	ant. 47			
MBC	F	R	Sudden SNHL	66	ant. 68			
MBD	M	R	Sudden SNHL	46	ant. 49			
MBE	F	R	Sudden SNHL	25	ant. 26			
MAI	M	L	Sudden SNHL	33	54	Cochlear Freedom	Nucleus 5	4.0 years
MAJ	M	L	Sudden SNHL	38	40	AB HR90K	Naida Q70	1.0 years

Subjects who do not yet have a CI and plan to receive one

Stimuli

- Male Target ( ) IEEE Sentences spoken by a male talker
  Presented in lists of 15 sentences each containing 5 key words
- Interferers ( ) AzBIO Sentences, spoken by two different male talkers
- Presentation level = 65dB SPL. If time allowed, target level was adjusted and testing completed at -5 and +5 SNR

Configurations

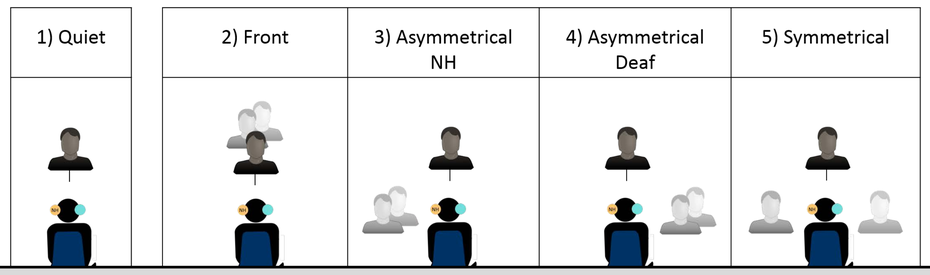


Figure 1: Diagram of subject seated in the testing room listening to the target speech in each of the 5 interferer configurations

Task

- Percent correct was measured in five configurations (see Fig. 1)
- Pupil dilation was measured during those same trials using an Eyelink 1000 eye tracker
- Participants listened with the NH ear alone (Acoustic Only)
- The 2 SSD-CI participants also listened bilaterally with the CI and NH ear (Acoustic+CI)

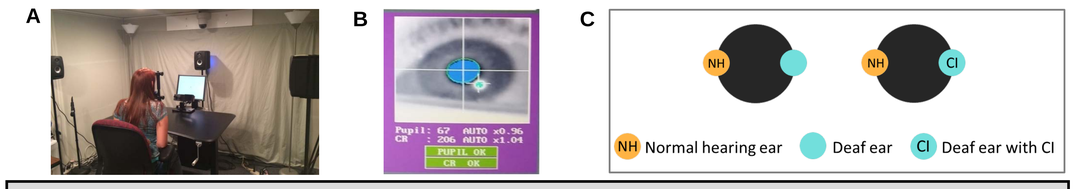
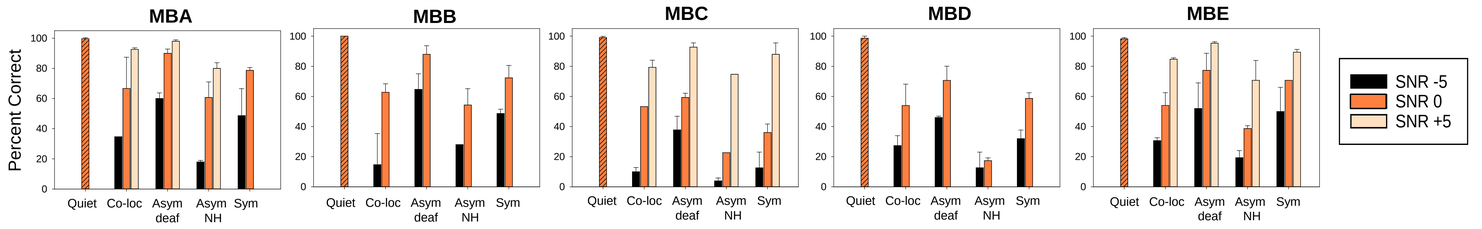


Figure 2: (A) Testing room with loudspeakers and eye tracker. (B) Tester's view of participant's pupil during testing.

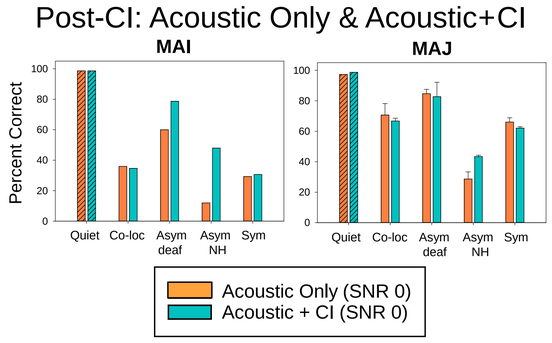
RESULTS

1. Percent Correct Results

SSD subjects prior to receiving a CI: Acoustic Only



Post-CI: Acoustic Only & Acoustic+CI



Acoustic Only (no CI)

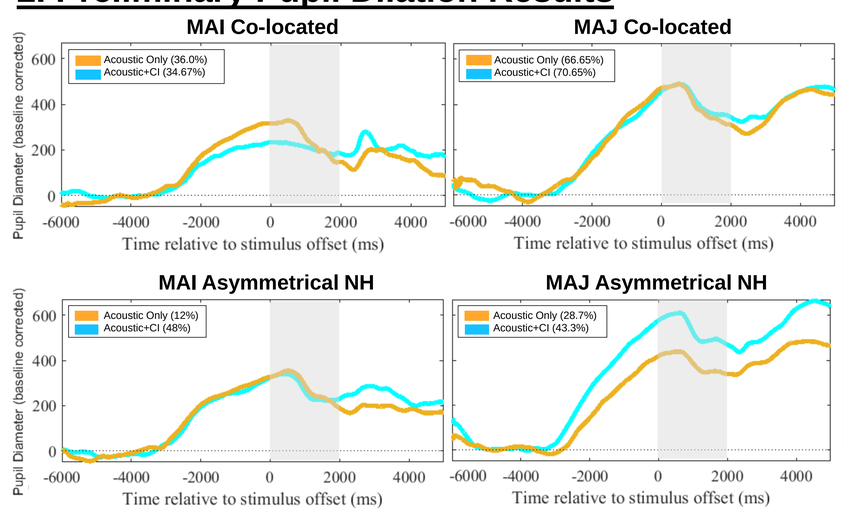
- In Quiet, speech perception was at ceiling
- In the presence of Interferers
  - Performance was worst when interferers were located on the side of the ear with NH (Asym NH)
  - Performance was best when interferers were located on the side of the deaf ear (Asym deaf)

Acoustic+CI

- There was a trend in the data toward improved performance relative to Acoustic Only, when the interferers were close to the NH ear (Asym NH)
- Acoustic Only vs Acoustic+CI were similar for all other configurations

Figure 3: Percent key words correct for each of the listening configurations. SSD subjects without a CI were tested Acoustic Only at more than one SNR. SSD-CI subjects were tested at 0 SNR Acoustic Only and Acoustic + CI.

2. Preliminary Pupil Dilation Results



Preliminary Results on effect of adding a CI to the Acoustic Ear

- Co-located:
  - MAI showed a small reduction in pupil dilation, but speech scores did not change
  - MAJ showed no change in pupil dilation, and had a small improvement in speech scores
- Separated (Asymmetric):
  - MAI showed a slight increase in pupil dilation in the later stages of processing, with improved speech scores
  - MAJ showed increased pupil dilation, along with improved speech scores

Figure 4: Pupil diameter as a function of time for the two SSD-CI subjects. Gray rectangles indicate the area of interest for listening effort . Acoustic Only condition is shown by the orange line and Acoustic+CI by the blue line. Percent correct scores are listed in parentheses.

DISCUSSION

1. Adding a CI to a NH ear, i.e. providing a unique form of bimodal hearing with one NH ear and one electric ear, could have various consequences on speech understanding and listening effort. Preliminary data are shown from 5 SSD Acoustic Only (pre-surgical), and 2 SSD-CI (post-surgical) subjects.
2. Combining a CI with a NH ear improves speech intelligibility when the interferer is located on the same side as the ear with normal hearing, suggesting the subjects were able to use the CI meaningfully to understand speech.
3. Pupil dilation as a proxy for listening effort adds to our understanding of speech intelligibility scores and reveals differences between subjects.
4. Further work is needed to better understand the relationship between localization, speech understanding, and listening effort in SSD-CI patients.

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ACKNOWLEDGEMENTS

The authors thank Matt Winn for his assistance with pupillometry for this study.
We also thank the participants for their involvement in this study, and the students of the BHSL for many hours spent assisting with data collection and analysis. This Work is supported by NIH-NIDCD (R01DC003083, R. Litovsky) and in part by a core grant to the Waisman Center from the NIH-NICHD (U54HD090256).

Printing courtesy of the Friends of the Waisman Center