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Sensitivity to Interaural Timing Differences using the Advanced Combinational Encoder Strategy

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INTRODUCTION

- When listening through clinical processors, freefield sound localization performance is highly variable in bilateral cochlear implant (**BiCI**) users, and some patients perform rather poorly[1,2].
- Many factors may contribute to this variability[3], but one factor that has not been considered is interaural time difference (**ITD**) sensitivity when listening with clinical processors. With clinical processors, fine structure ITDs are lost due to signal processing, but envelope ITDs should still be available.
- Because some BiCI users have demonstrated ITD sensitivity when listening with clinical processors running the Advanced Combinational Encoder (**ACE**) strategy[4], we hypothesized that the variability in sound localization performance might be explained by sensitivity to ITDs when listening with ACE.

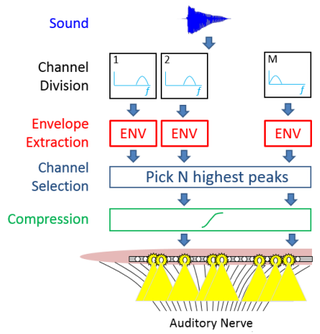

Figure 1. Conceptual block diagram of the ACE strategy

This study examines whether there is a relationship between ITD sensitivity and sound localization performance when listening with ACE.

METHODS

- **LISTENERS:** Nine bilateral Cochlear users

Table 1. Listener profiles and etiology

ID	Age	Years BiCI	Etiology
IAJ	68	10	Unknown; Progressive loss from birth
IBF	62	6	Hereditary
IBK	74	5	Hereditary or noise-induced
IBO	49	3	Otosclerosis
IBR	59	6	Progressive loss during adulthood
ICD	56	5	Enlarged vestibular aqueduct
ICI	57	6	Unknown; loss during adulthood
ICJ	66	5	Illness in childhood
ICM	61	2	Progressive loss during adulthood; nerve damage

- **TASKS:**

1. ITD Discrimination

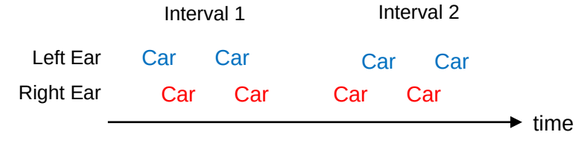

Figure 2. ITD sensitivity was measured using a two-interval, two alternative forced choice task. The stimulus was a mono-syllabic word repeated once per interval, and the ITD was applied as a delay in one ear. Stimuli were presented through the auxiliary ports of Cochlear N5 processors. Listeners responded by indicating whether the second interval was towards the left or right direction. ITD values were adaptively updated to find a discrimination threshold.

2. Sound Localization

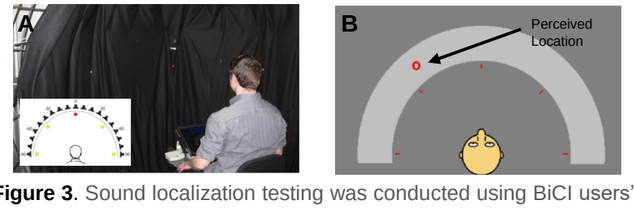

Figure 3. Sound localization testing was conducted using BiCI users' own sound processors. Nineteen loudspeakers were hidden behind a curtain at 10° intervals from left to right (A). The listener's task was to identify on a graphical user interface the direction of the loudspeaker that played a train of four pink noise bursts at each trial (B).

RESULTS

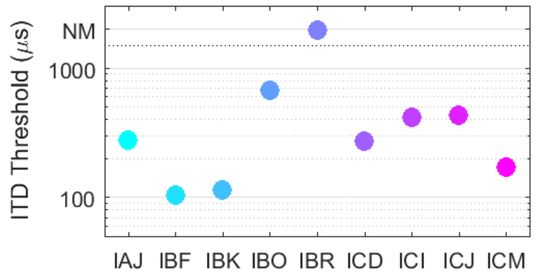

Figure 4. ITD thresholds for each listener. NM stands for not measureable.

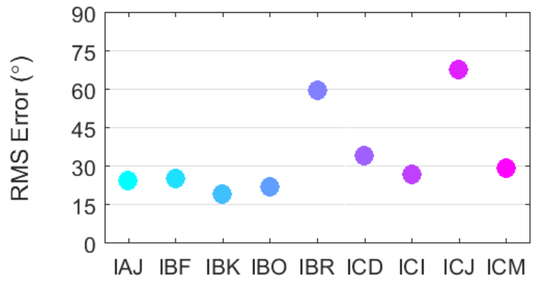

Figure 5. RMS localization error for each listener.

- ITD thresholds ranged from 105 μs to >1000 μs (not measureable) (**Fig. 4**). Mean ITD threshold is 310±69 μs.
- Listeners also showed variable localization performance from 19 to 68° root-mean-squared (RMS) error (**Fig. 5**). Mean RMS error is 34±6°.
- Linear regression found no significant relationship between the two variables [$p = 0.61$] (**Fig. 6**).

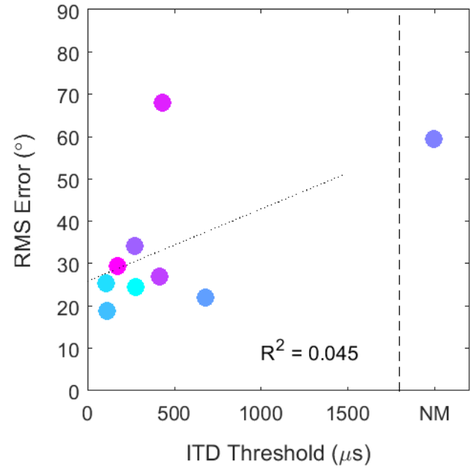

Figure 6. ITD threshold vs RMS localization error. Listener IBR was not included in the regression analysis.

CONCLUSION

- Many BiCI users appear to be sensitive to ITDs when listening with clinical processors.
- Variability in sound localization performance does not appear to be correlated with ITD sensitivity.

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