

# Relating Individual Binaural Cues to Localization with the CCI-MOBILE Research Platform Using a Real-Time Mixed Rate Coding Strategy

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## Introduction

- Bilateral cochlear implant (BCI)** users have reduced access to the binaural cues for sound localization; in particular **interaural time differences (ITDs)**, and possibly also **interaural level differences (ILDs)** [1]:

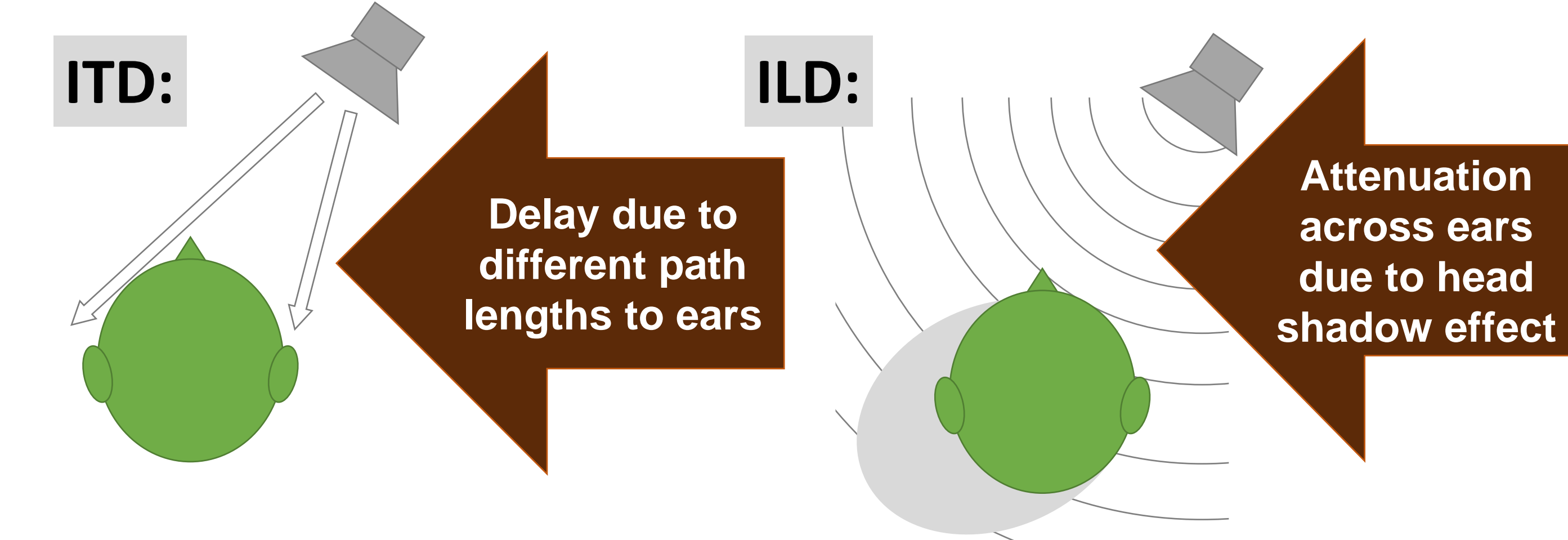


Figure 1: Schematic depictions of interaural time differences (ITDs) and interaural level differences (ILDs).

- The relatively inaccurate sound localization abilities of BCI users are due in part to sound coding algorithms that do not explicitly encode ITDs in the timing of pulses [2].
- Synchronized research processors like the **CCI-MOBILE** enable the development and investigation of sound coding strategies with bilateral synchronization, ensuring precise delivery of ITD cues at low stimulation rates [3].
- We used a localization task to test a mixed-rate sound coding strategy that provides envelope information on high-rate channels and explicitly encodes ITDs on low-rate channels [4].
- The CCI-MOBILE research platform allowed us to record the binaural cues present in the stimulus for each participant.
- HYPOTHESIS:** We hypothesized that ITDs in the stimulus would only contribute to localization with the mixed rate strategy that explicitly encoded low-rate cues. If so, we expected to see improved accuracy of sound localization in the conditions where ITDs in the timing of pulses closely matched the ITDs in the acoustic stimulus.

## Methods

- Fourteen BCI users (mean ITD JND = 347  $\mu$ s, range = 52 to 1249  $\mu$ s) completed a broadband sound localization task using four sound coding strategies as described in [4]:

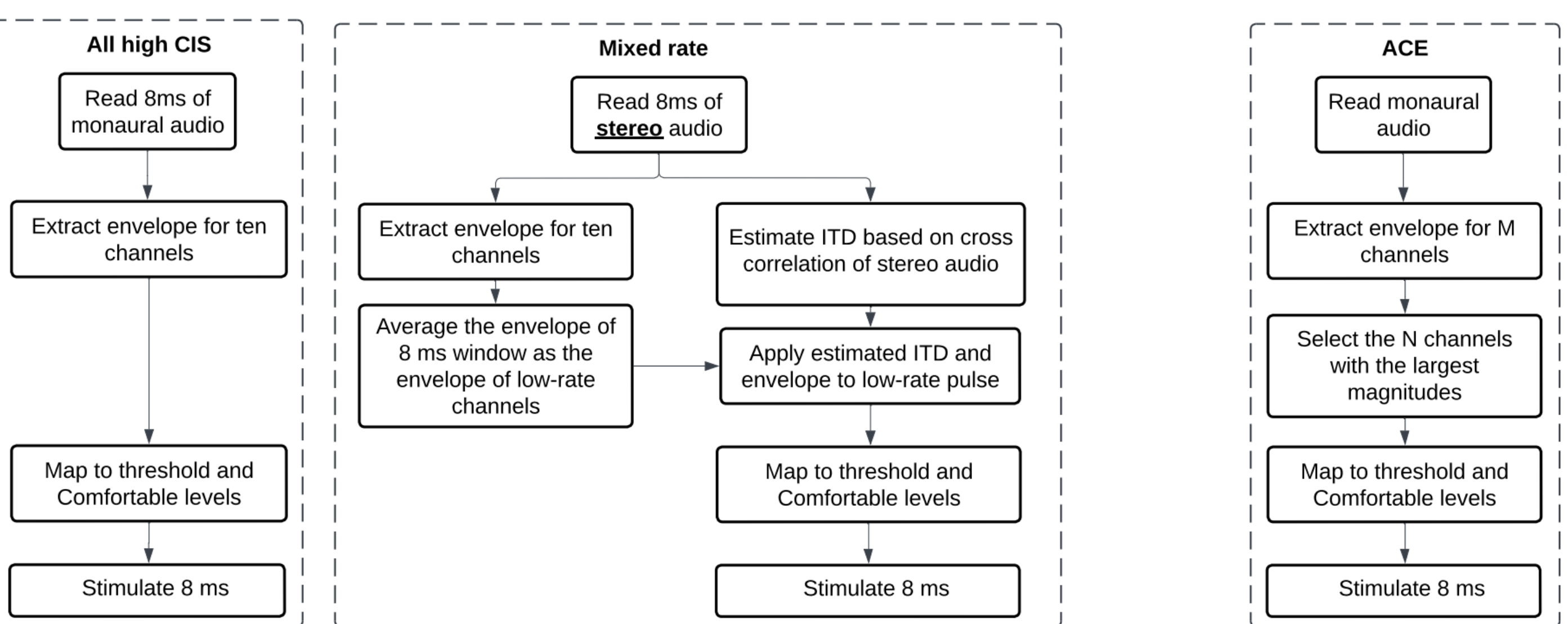
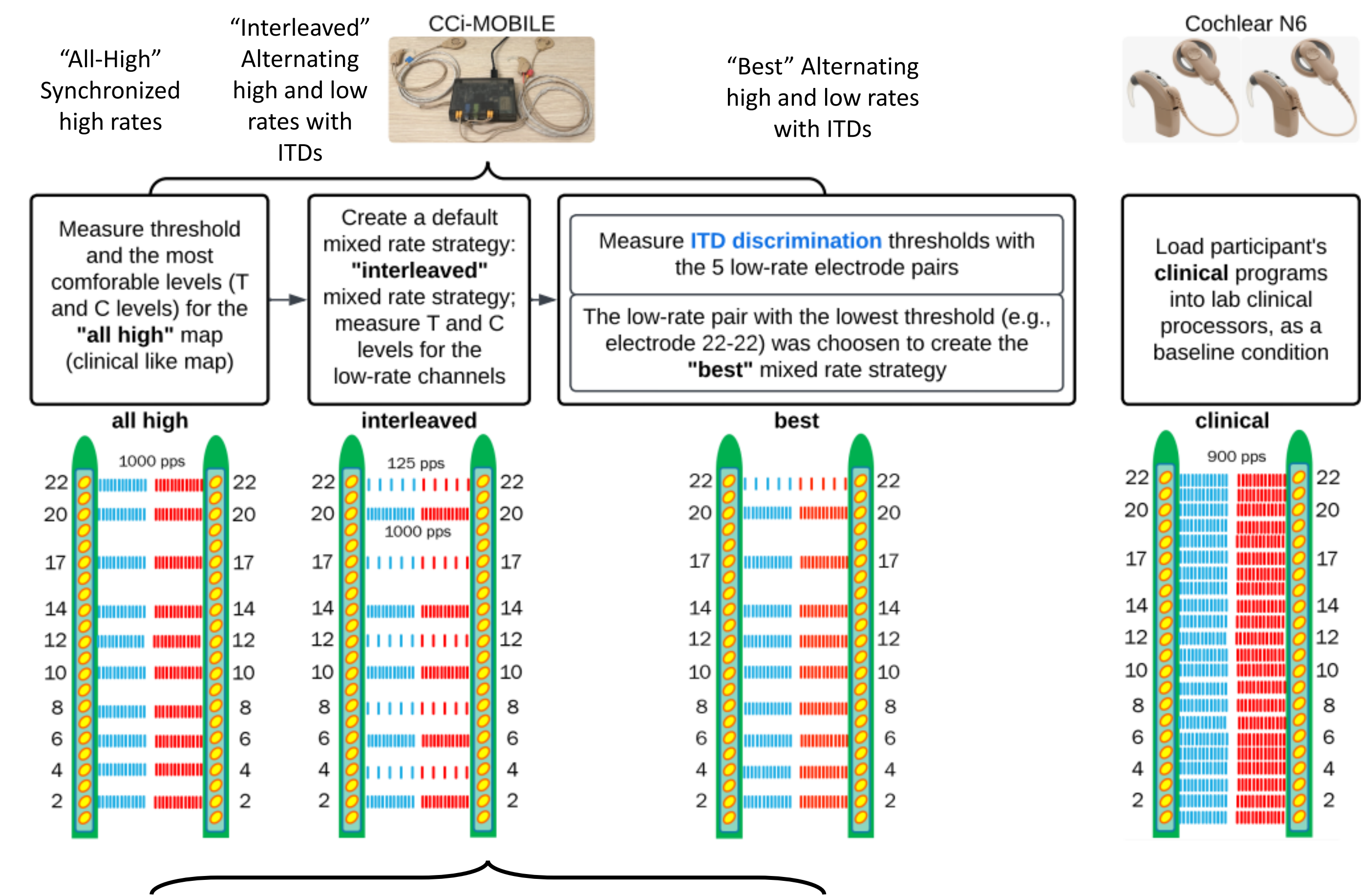


Figure 2: Schematic representation of the coding strategies used in the study.

## Results

- For each participant, binaural recordings of the experimental stimuli were collected using the CCI-MOBILE microphones
- Electrograms were reconstructed with the same set of strategies tested for localization in the study
- ITDs were calculated as the mean of the delay that maximizes the cross-correlation between wav recordings or electrograms
- ILDs were calculated as the mean log-difference in RMS energy between left and right signals in each channel

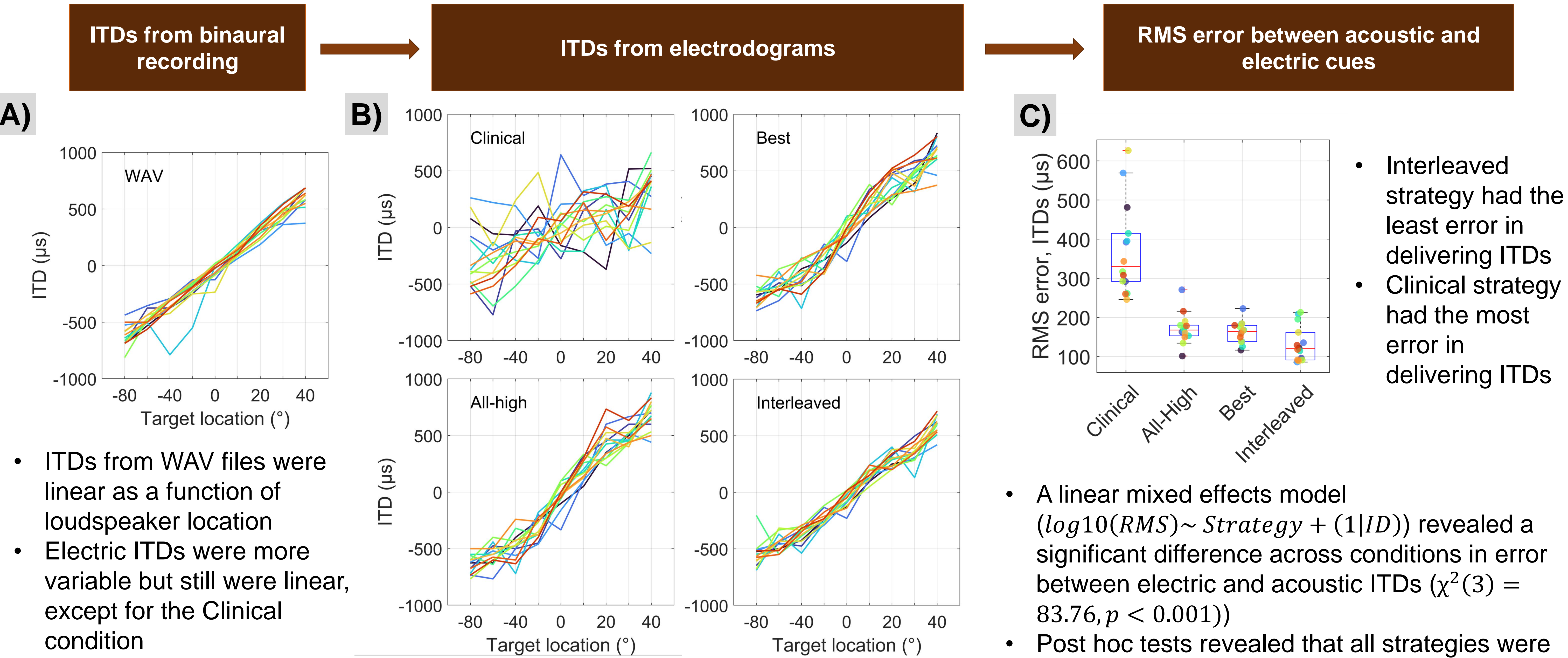


Figure 3: A) Acoustic ITDs calculated from binaural recordings, B) Electric ITDs calculated from electrograms, C) RMS error between electric and acoustic ITDs. Each color represents a participant.

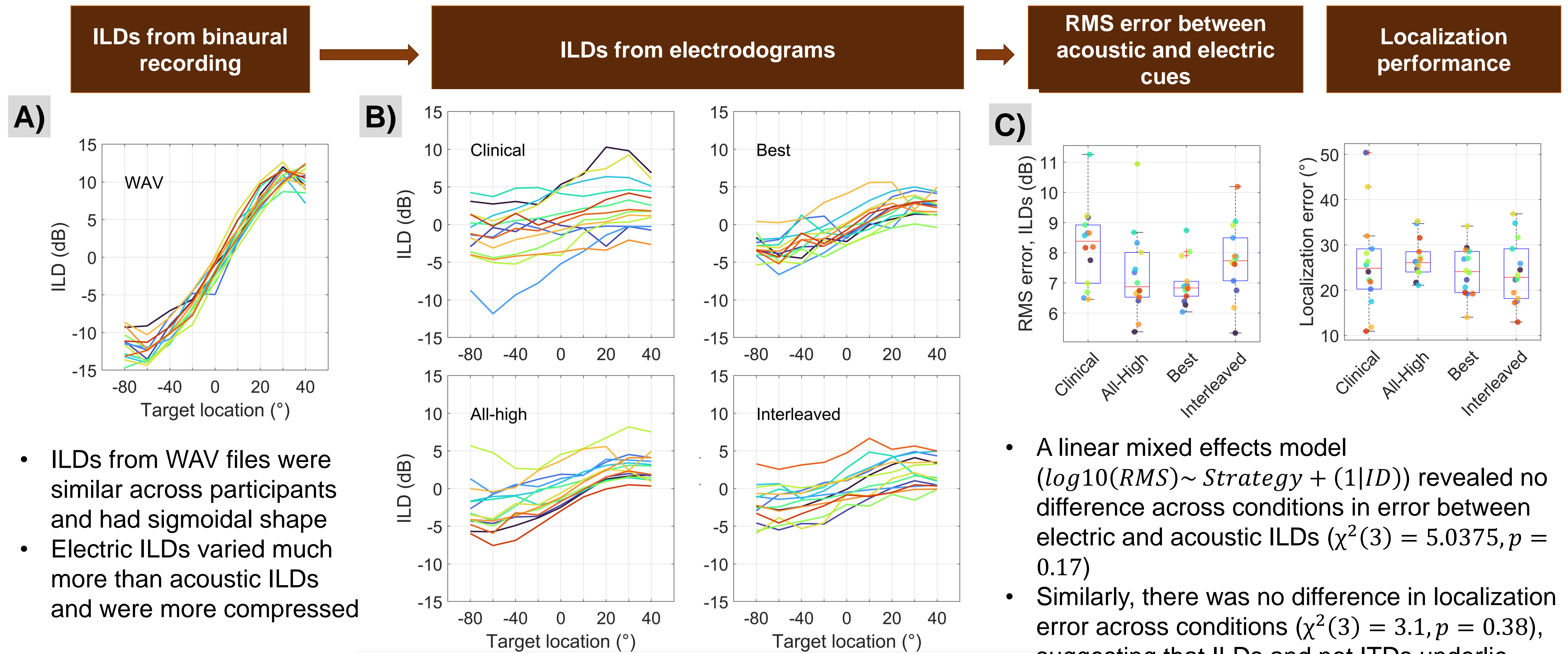


Figure 4: A) Acoustic ILDs calculated from binaural recordings, B) Electric ILDs calculated from electrograms, C) RMS error between electric and acoustic ILDs. Each color represents a participant.

## Discussion

- Estimates of binaural cues suggest that CCI-MOBILE delivers more accurate cues with synchronization than unsynchronized processors [5] and that ITDs are most accurate with the interleaved mixed rate strategy.
- Across all strategies, ILDs were not as accurate as expected and did not vary much in performance across conditions.
- Behavioral data shows no difference in localization performance across conditions, suggesting that ILDs are weighted more heavily than ITDs [1], or that BCI listeners may not have the ITD sensitivity that would be needed for them to utilize ITD cues when available.
- Even when provided with synchronized stimulation through the CCI-MOBILE, longer exposure to mixed rate strategies may be needed for fuller utilization of ITDs embedded in these strategies.

## References and Acknowledgements

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