

## INTRODUCTION

In the normal hearing binaural system, the brain uses **interaural differences** to...

map spatial cues with the location of sounds

detect a signal in noise

In the lab, sensitivity to interaural differences is often measured by...

- applying an interaural level or timing difference (**ILD; ITD**) to a stimulus and finding the smallest detectable change in direction.
- the binaural masking level difference (**BMLD**), which is the difference in signal-to-noise ratio needed to detect a tone when presented dichotically vs. diotically.

For children with bilateral cochlear implants...

Ehlers et al. (2017)<sup>1</sup> found that while all children had ILD sensitivity, **less than 50% had ITD sensitivity.**

Todd et al. (2016)<sup>2</sup> found that some of the children from the Ehlers study who **had no measurable ITD sensitivity had measurable BMLDs.**

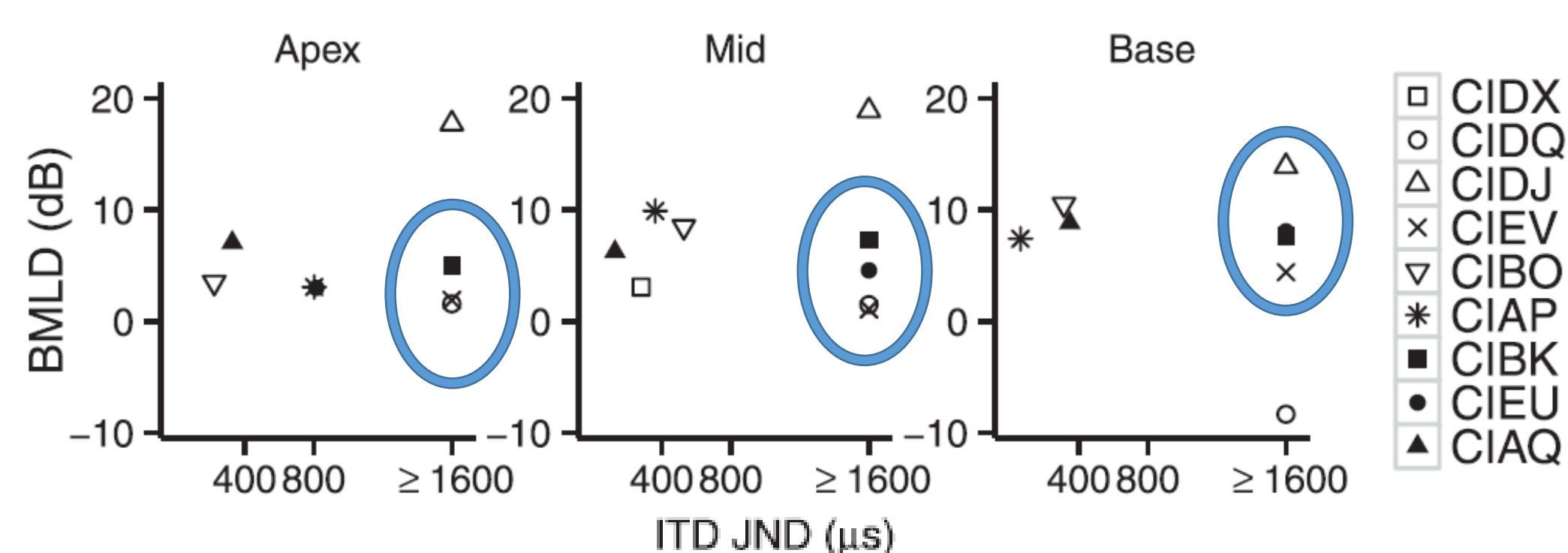


Figure 1 shows ITD just noticeable differences (JNDs) vs BMLDs measured in the same children (figure from Todd et al., 2016). It can be seen that some children with measurable BMLDs do not show sensitivity to ITDs.

**Because ITD and BMLDs both depend on binaural processing, this study aims to understanding why some children showed sensitivity to BMLDs but not ITDs.**

### Two possible hypotheses:

- Difference in task demand in the two studies - discrimination of direction vs detection of differences
- Stimuli used in the different paradigms provided access to different cues – whole waveform interaural time difference vs envelope incoherence

## METHODS

### Participants:

Five children with bilateral Cochlear Nucleus devices.

Table 1. Participant hearing history. Ages reported in years; months.

	Sex	Age at Testing	Age at 1 <sup>st</sup> Implant	Inter-device Interval	BiCI Exp.	Etiology of deafness
<b>CIAY</b>	M	17;8	5;1	0;10	11;8	Bilateral ear infections
<b>CIBW</b>	F	13;10	1;0	2;8	10;1	Connexin 26
<b>CIEV</b>	F	15;2	2;7	8;3	4;3	Genetic
<b>CIBK</b>	M	17;1	2;1	4;11	10;1	Connexin 26
<b>CICL</b>	M	11;11	1;5	1;3	9;3	Connexin 26

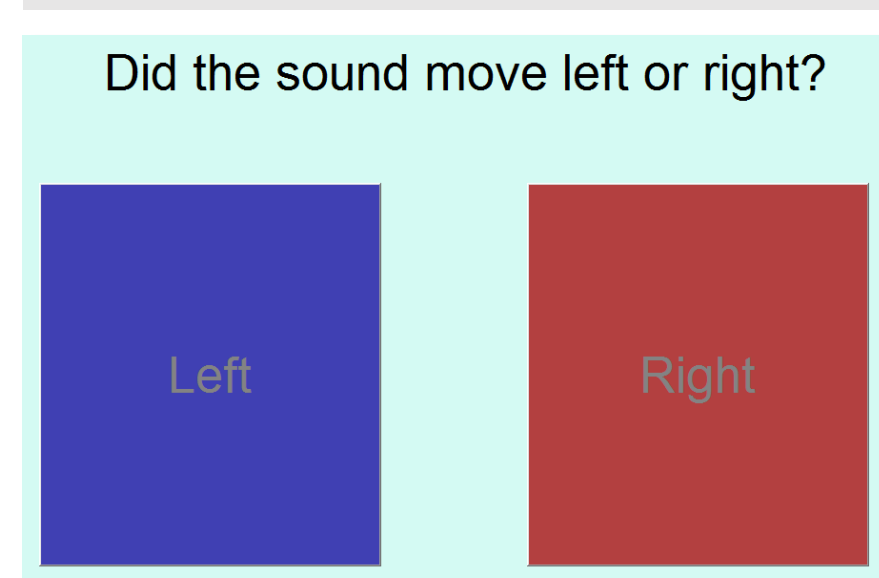
### Stimuli:

- Presented to a medial pair of interaurally pitch-matched electrodes<sup>4</sup>, with either a nonzero ILD or ITD, using a bilaterally synchronized research platform (Cochlear RF GeneratorXS).
- Stimuli were 100 pulse per second biphasic electric pulse train with 25  $\mu$ s phase width and 300 ms duration.

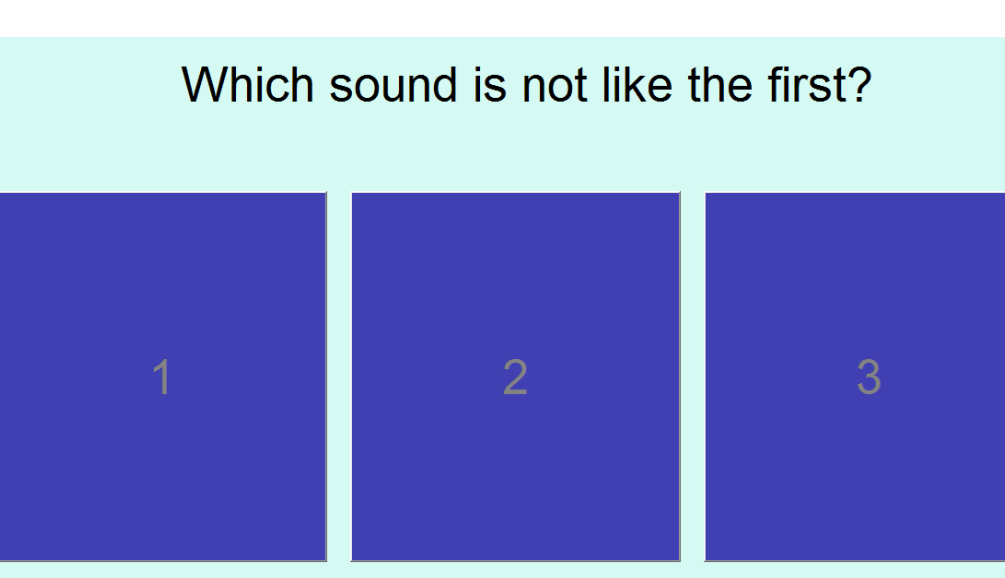
### Tasks:

- Responses were taken using a touch screen. ILD and ITD JNDs were measured using 2 tasks:

2-interval, 2-alternative forced-choice (2I-2AFC) **right vs. left discrimination task.**



3-interval, 2-alternative forced-choice (3I-2AFC) **oddball detection task.**



### Analysis:

A psychometric function was fitted to the ILD and ITD data to obtain a JND threshold at 70.7% correct<sup>5</sup>.

## RESULTS

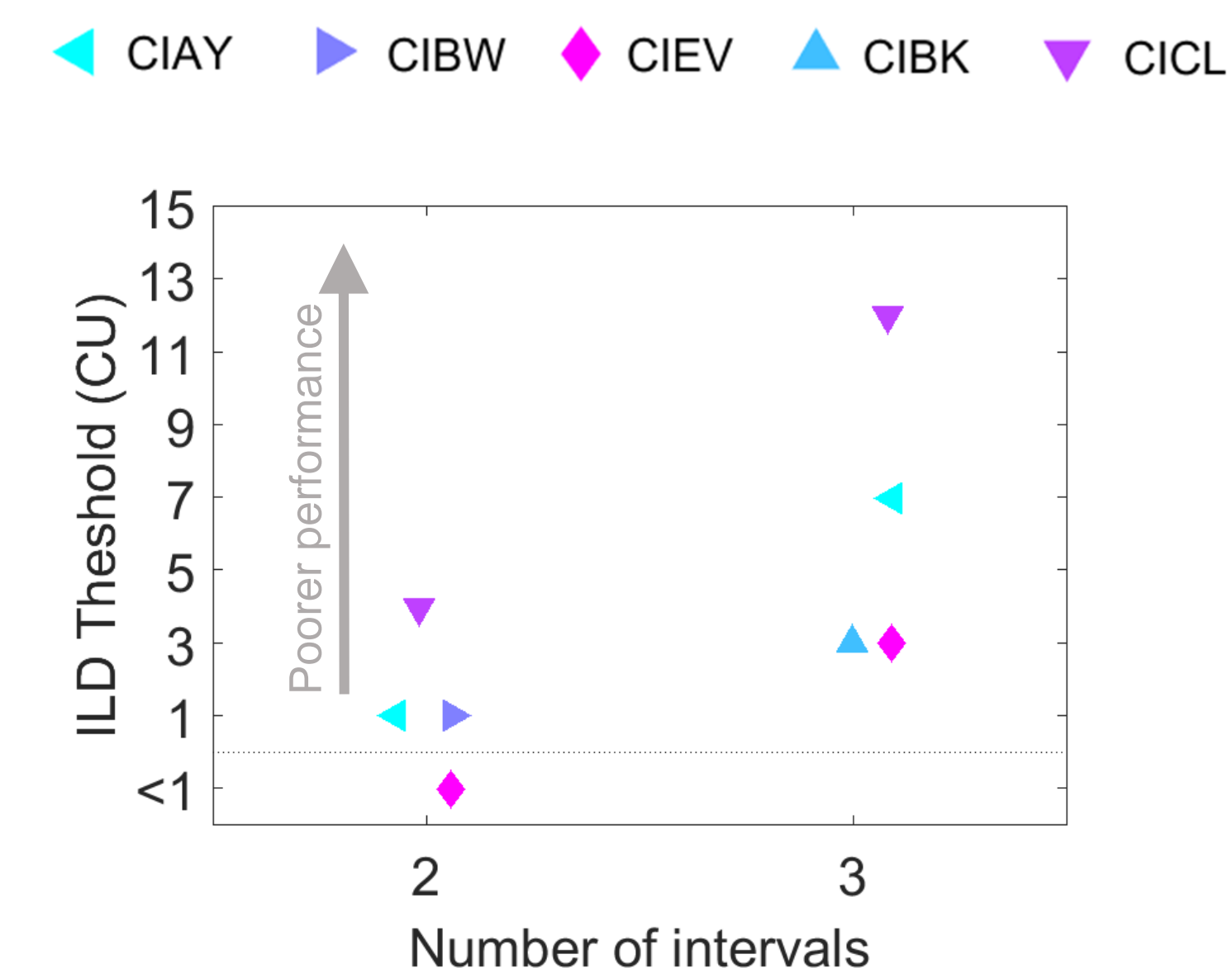


Figure 2. Individual ILD thresholds, measured in current units (CU), in the 2-interval, 2AFC and 3-interval, 2AFC tasks.

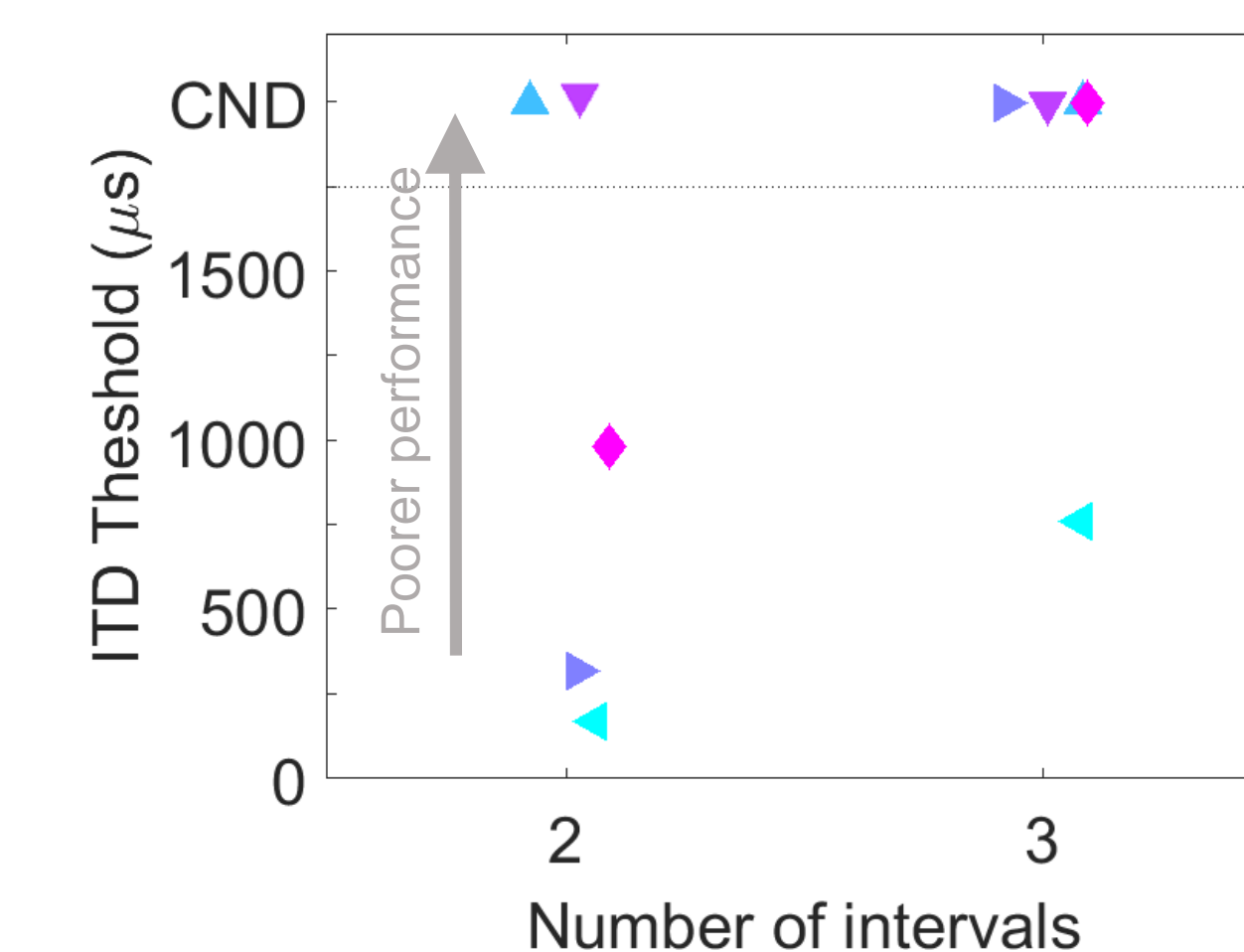


Figure 3. Individual ITD thresholds, measured in  $\mu$ s, in the 2-interval, 2AFC and 3-interval, 2AFC tasks. CND = Could not determine.

- All children demonstrated sensitivity to ILDs, regardless of task type (Fig. 2).
- All children demonstrated elevated thresholds in the 3-interval, 2AFC task compared to the 2-interval, 2AFC task (Fig. 2 & 3).**
- Three out of four children tested demonstrated ITD sensitivity. **Lack of sensitivity appears to be independent of task (Fig. 3).**
- For children with ITD sensitivity, **the 3-interval, 2AFC task resulted in the elevation or elimination of ITD thresholds (Fig 3).**

Table 2. ITD and ILD JNDs for individual participants. CND = Could not determine DNT = did not test (due to time constraints)

	2-interval ILD JND	3-interval ILD JND	2-interval ITD JND	3-interval ITD JND	Pitch-matched electrodes (Left-Right)
<b>CIAY</b>	1.3	6.2	169	759	12 – 12
<b>CIBW</b>	1.4	DNT	300	CND	12 – 14
<b>CIEV</b>	0.7	2.6	979	CND	12 – 14
<b>CIBK</b>	DNT	2.75	CND	CND	12 – 14
<b>CICL</b>	4.0	12.5	CND	CND	12 – 12

## CONCLUSIONS

- Measurement of binaural hearing thresholds can be influenced by the task.
- Contrary to initial expectation, children with ITD sensitivity had elevated thresholds in the 3I-2AFC compared to the 2I-2AFC task. This difference in performance may be due to a higher auditory memory load in the 3I-2AFC task.
- Children who had measurable BMLDs but not ITD JNDs may be using different strategies when completing the BMLD task, such as discriminating interaural decorrelation of the different intervals<sup>6</sup>.

## ACKNOWLEDGEMENTS

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