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Spatial attention (contralateral unmasking) in children with bilateral cochlear implants and in normal hearing children

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INTRODUCTION

Auditory Scene Analysis

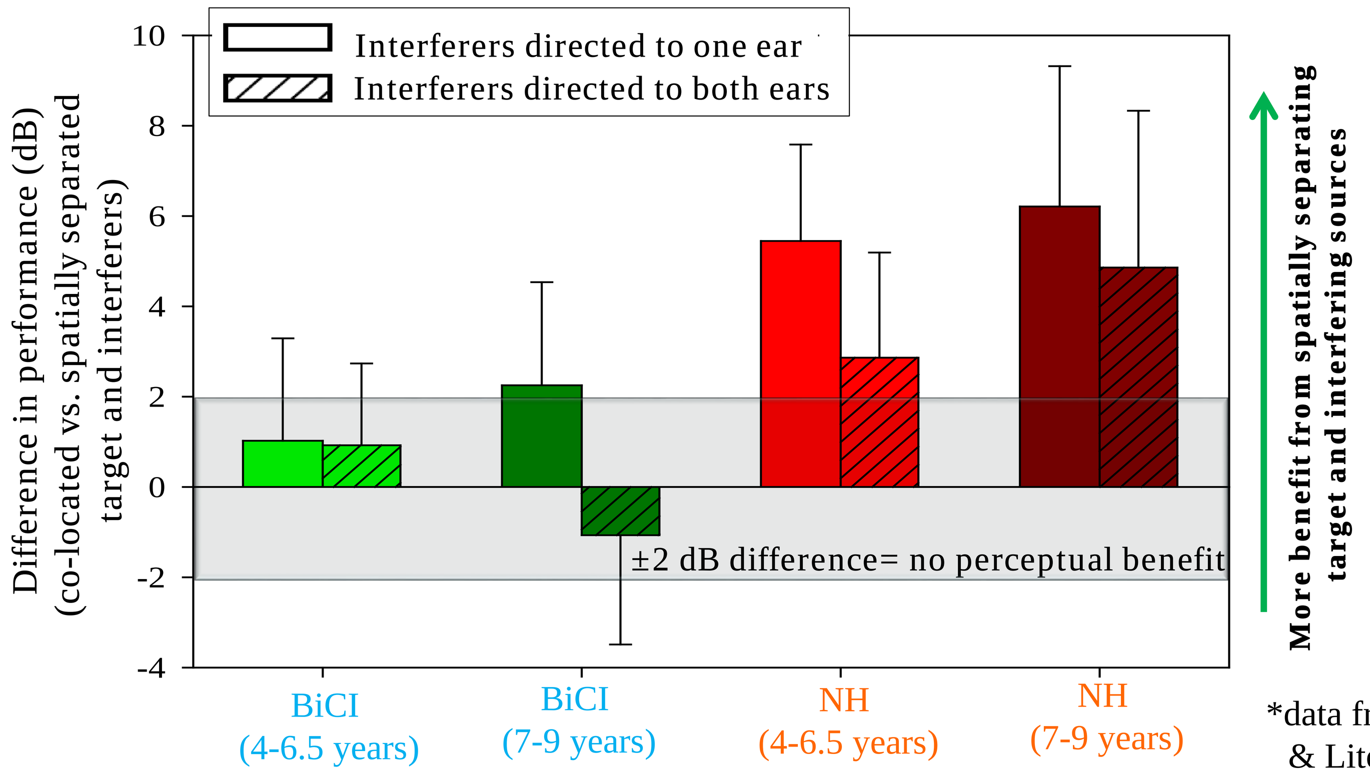
- The process by which the auditory system segregates information into various streams[1].
  - This is related to the ability to selectively attend to a target while simultaneously ignoring distracting information.
- The ability to perform "spatial attention" (contralateral unmasking) tasks is complex, challenging, and **essential for successful communication** in noisy environments.
  - It is especially important for *children*, who spend much of their day in noisy environments where learning is facilitated by a target talker (i.e. teacher in classroom).

Quiet= Ideal

Noisy= Realistic!

- For this study, we are particularly interested in how *children* who are deaf and fitted with bilateral cochlear implants (BiCIs) function in noisy environments and, more specifically, perform on contralateral unmasking tasks.
  - Previous **free-field** spatial unmasking studies show that children with BiCIs receive little to no benefit when the target and interfering speech are spatially separated vs. co-located[5]

(i.e. unlike children with NH, children with BiCIs show no spatial unmasking).



*data from Misurelli & Litovsky, 2012

Question

- What factors contribute to the lack of spatial unmasking for children with BiCIs (i.e. central processing, peripheral coding)?

METHODS

Participants:

Normal Hearing (NH) (n=4)

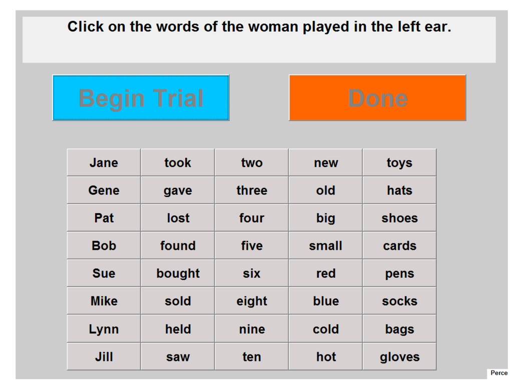
Participant	Chronological Age (yrs)
CVP (M)	15
CLC (M)	12
CUN (F)	10
CVF (M) *Could not perform task	7

Bilateral Cochlear Implants (BiCI) (n=5)

Participant	Chronological Age	CI use (yr;mo) Right	CI use (yr;mo) Left
CIAY (M)	15	*10;9	9;11
CIAW (M)	15	*14	9;9
CIAG (M)	14	*13;2	11;9
CIDJ (F)	14	*12;5	9
CIEH (M)	10	9	9
		*First CI	

Stimuli:

- 5-word closed-set sentences (name, verb, number adjective, and object) *(Kidd et al., 2008)*
  - Target: female talker; Interferer: male talker
  - Reference level= 70 dB SPL
    - Signal-to-noise ratio (SNR)
      - **Positive SNR:** *Interferer* level *decreased*; **Negative SNR:** *Target* level *decreased*
- NH: presented with speech via headphones
- BiCI: presented stimuli via direct audio input to their clinical processors

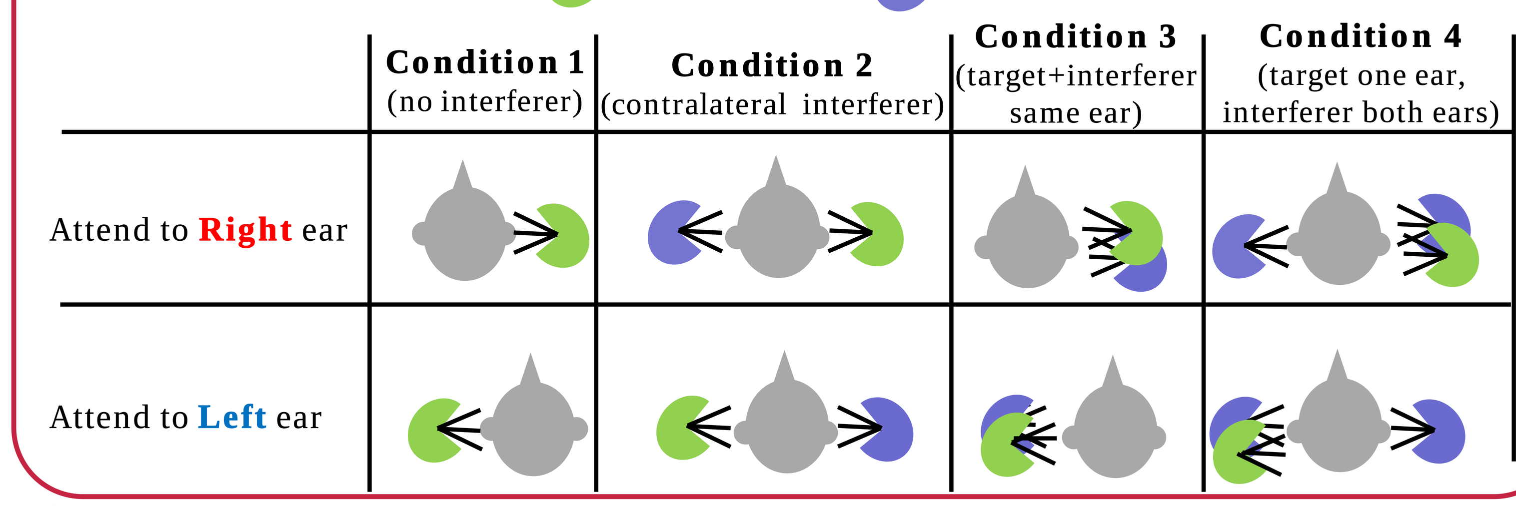


Procedure:

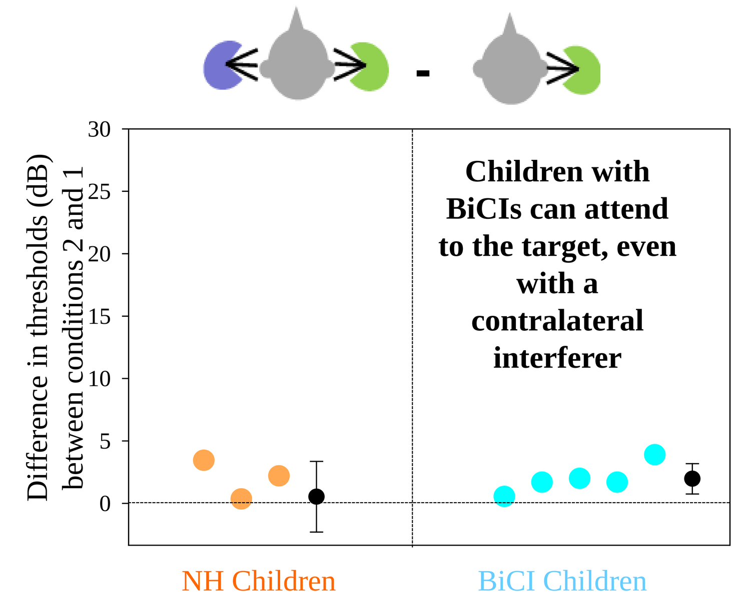
- Order of conditions, ear to attend to, and SNRs randomized
  - Trials/condition:
    5 words/sentence x 10 sentences/block x 2 blocks/SNR = 100
- Percent correct (PC) for each condition calculated by creating a psychometric function
  - **Speech Reception Threshold (SRT) defined as PC=50%**

Conditions:

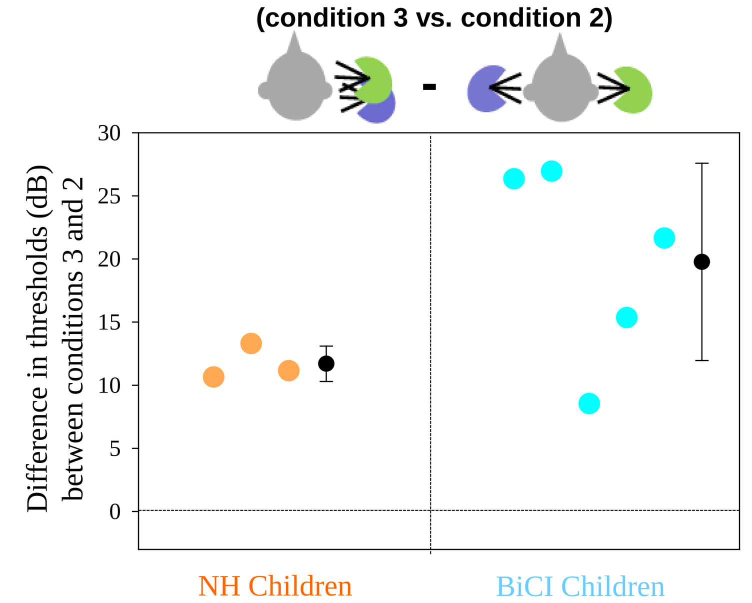
Target= Interferer=



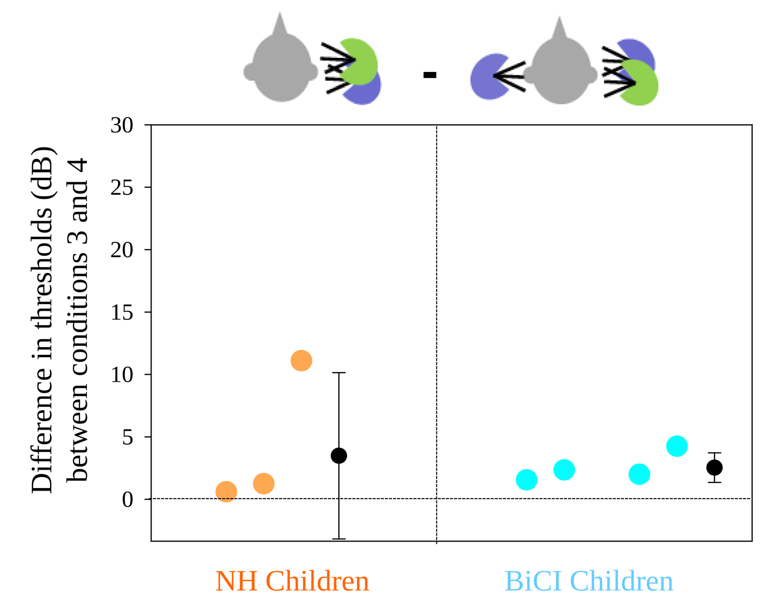
RESULTS



Both children with NH and with BiCIs show little to no difference in thresholds with or without an interferer in the contralateral ear, suggesting no difficulty attending to the target with a contralateral interferer.

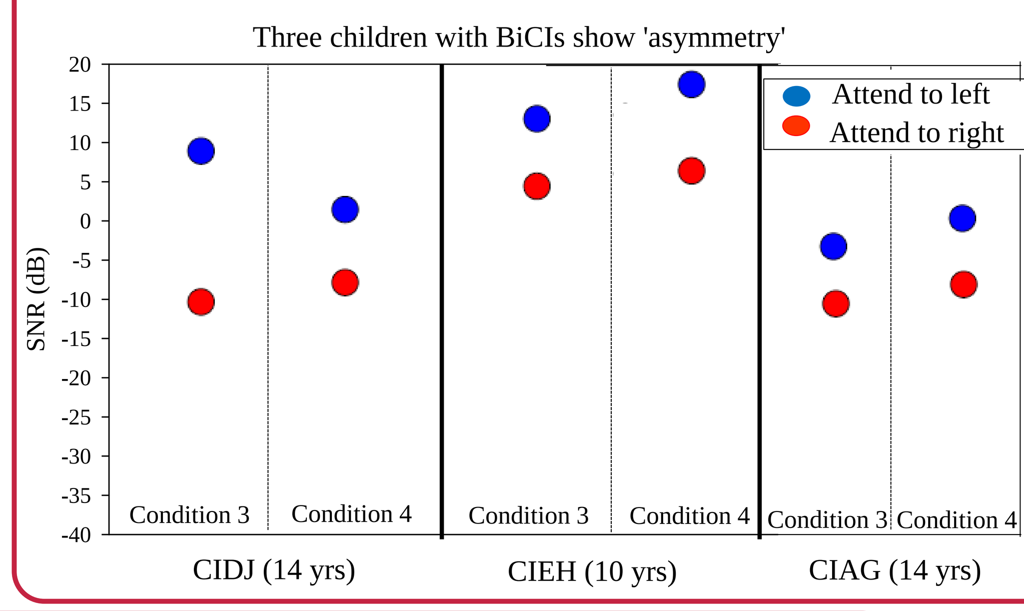


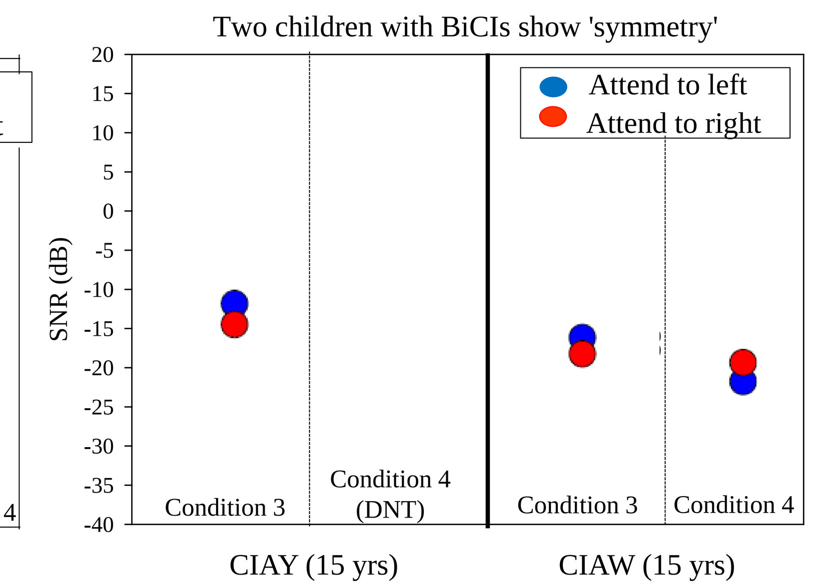
Both the children with NH and BiCIs show improvement in condition 2 vs. 3. That is, performance is better when the target and interferer are directed to separate ears vs. when they are co-located. As a whole, the children with NH do not show as much improvement as the children with BiCIs when the target and interferer are separated.



On average, the children with BiCIs show little to no contralateral unmasking. That is, adding an interferer in the opposite ear did not benefit the BiCI group. More data is needed to draw a conclusion from the NH data.

BiCI children: RE/LE (a)symmetry in the ability to attend to the target



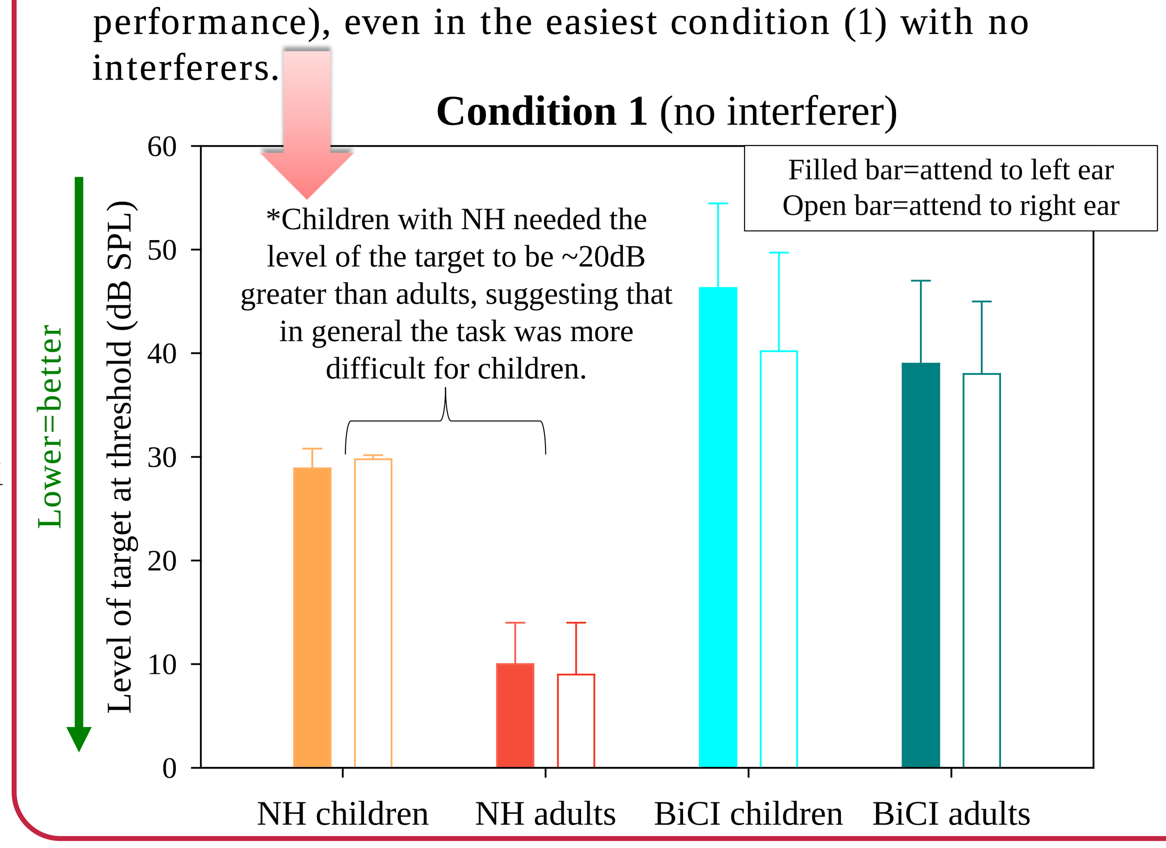


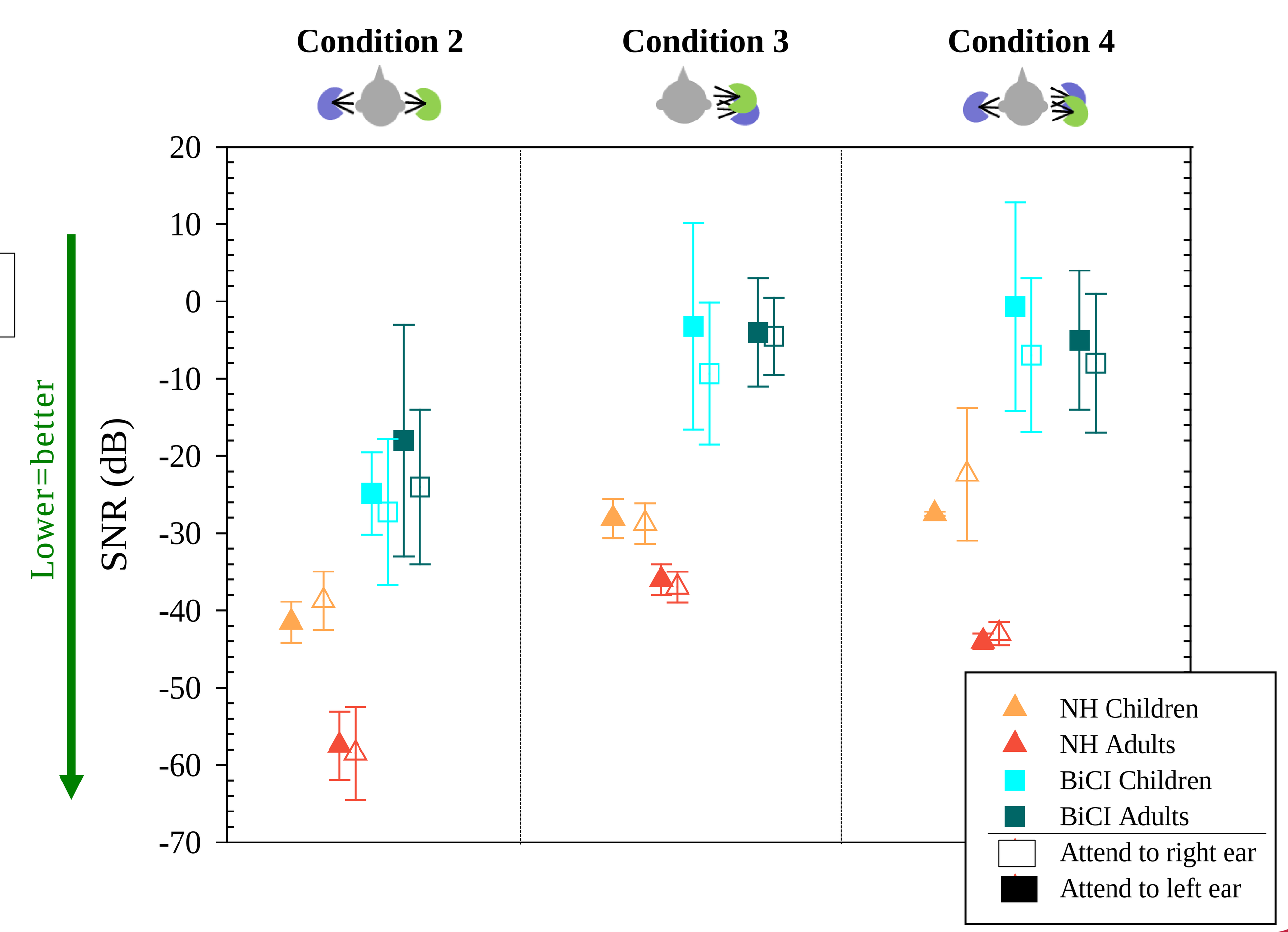
- BiCI performance is variable when comparing right vs. left ear for each participant within each condition.
- It is noteworthy that the two children who show symmetry between ears on conditions 3 and 4 (when the target and interferer are played in the same ear) are also children who show sensitivity to interaural timing differences (see poster W16 Ehlers *et al.*).

Overall comparison to previous adult data[3]

(adult data from Goupell, Kan & Litovsky, CIAP 2013)

- NH adults show the lowest SNRs (i.e. best performance), even in the easiest condition (1) with no interferers.





Discussion

- With more data, these findings may help to elucidate limitations in spatial unmasking for children with BiCIs.
- Specifically, in this study we are interested in investigating if exposure to BiCIs early in life facilitates emergence of *contralateral unmasking.*
- Results thus far suggest that the lack of spatial unmasking in children with BiCIs is not due to the inability to attend to a target in the presence of an interferer (see above condition 2 vs. 1).
- This may suggest that the problem is due to the reduced cues provided by the coding of the incoming signal.

References

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