



# Associations between Hearing and Cognition in Individuals with Down Syndrome

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Sigan Hartley, Andy Alexander

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  - Anshu Kumar
  - Shelly Godar
  - Stephanie Sellner
  - Kayla Kristensen

**Down Syndrome:  
High proportion (70-90%) of hearing loss  
Conductive? Sensori-Neural? How severe?**



Diagnosis

Outcomes

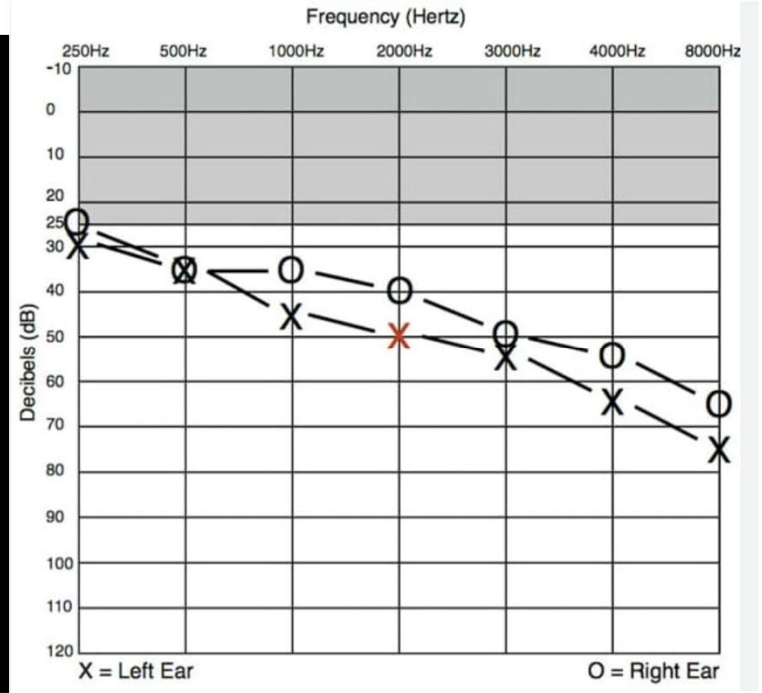
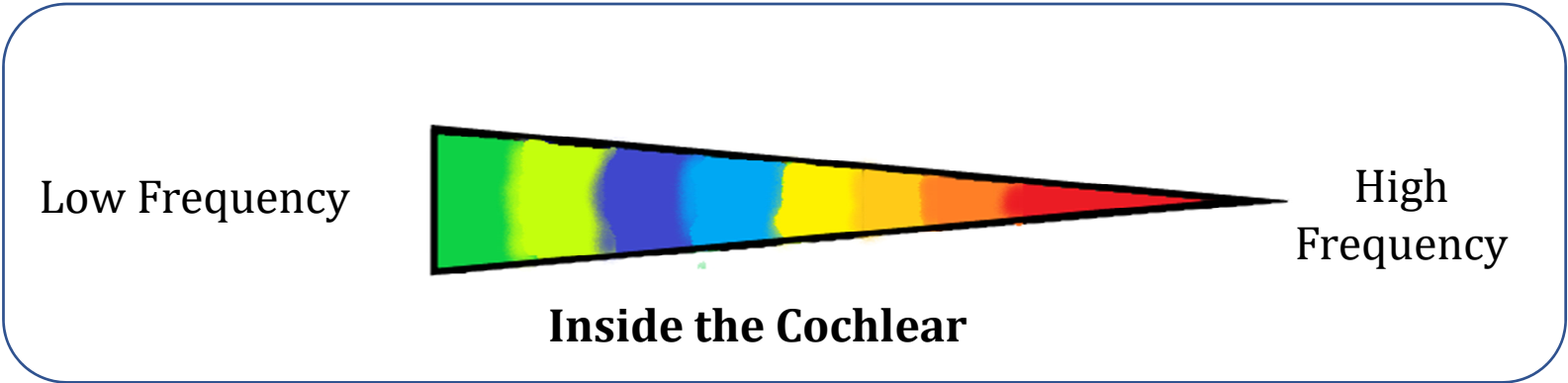
Treatment



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**Tremendous progress in treating medical conditions.  
Hearing status (degree and type) not well understood**

# How does hearing work?





# Plasticity of the auditory system and the brain

“use it or lose it”

If we don't treat hearing loss early in life, the brain is not able to develop the pathways and connections needed for good hearing.

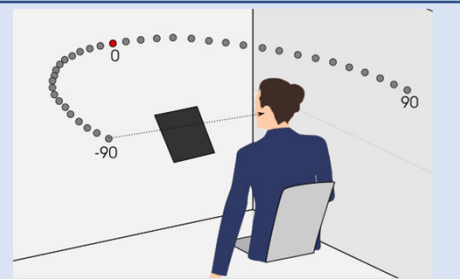


Need to assess hearing early  
***Need to treat hearing and stay on top of changes  
throughout lifetime***

# Why do we have 2 ears? Binaural Hearing

**WHERE ARE  
SOUNDS?**

*Sound Localization*



**WHAT IS THE  
SOUNDS?**

*Separating Speech  
from Noise;  
“Cocktail Party” effect*

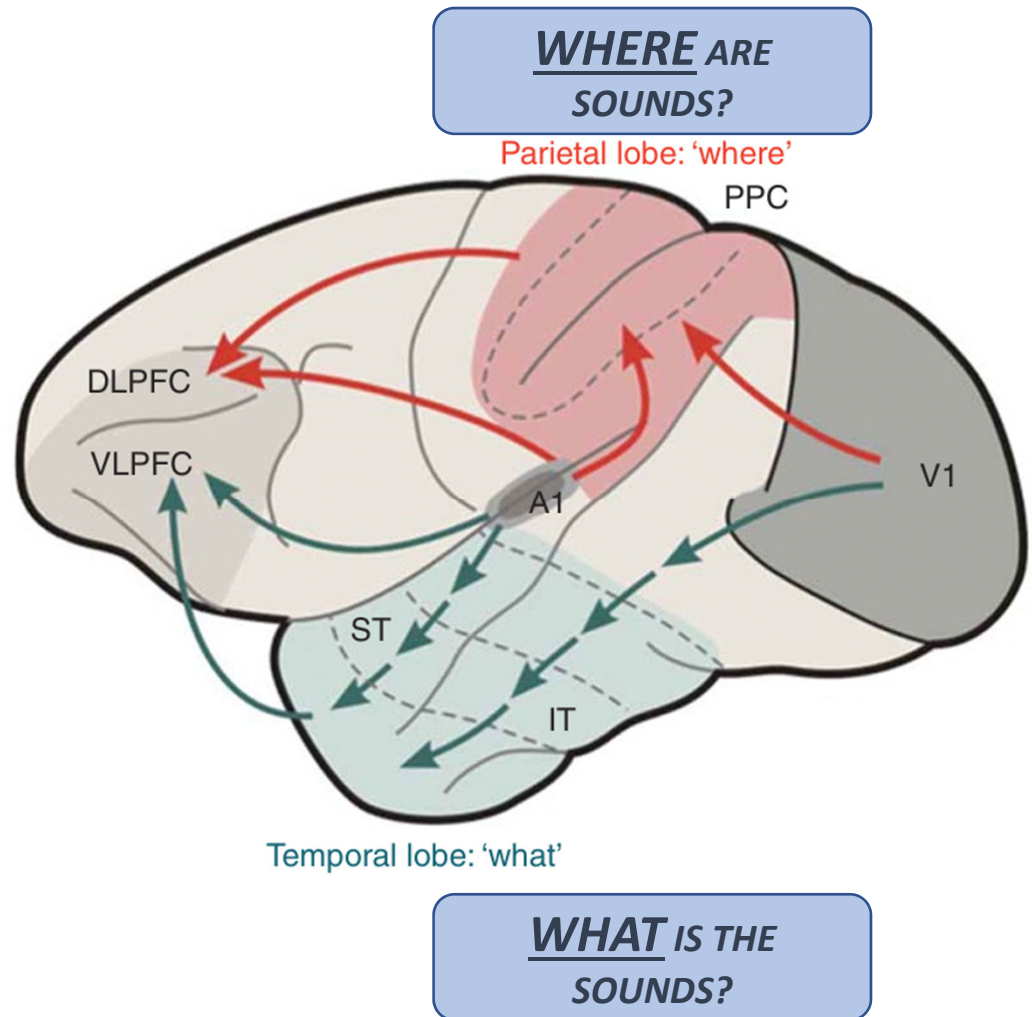


*Reduced Cognitive Load  
(engagement, fatigue)*



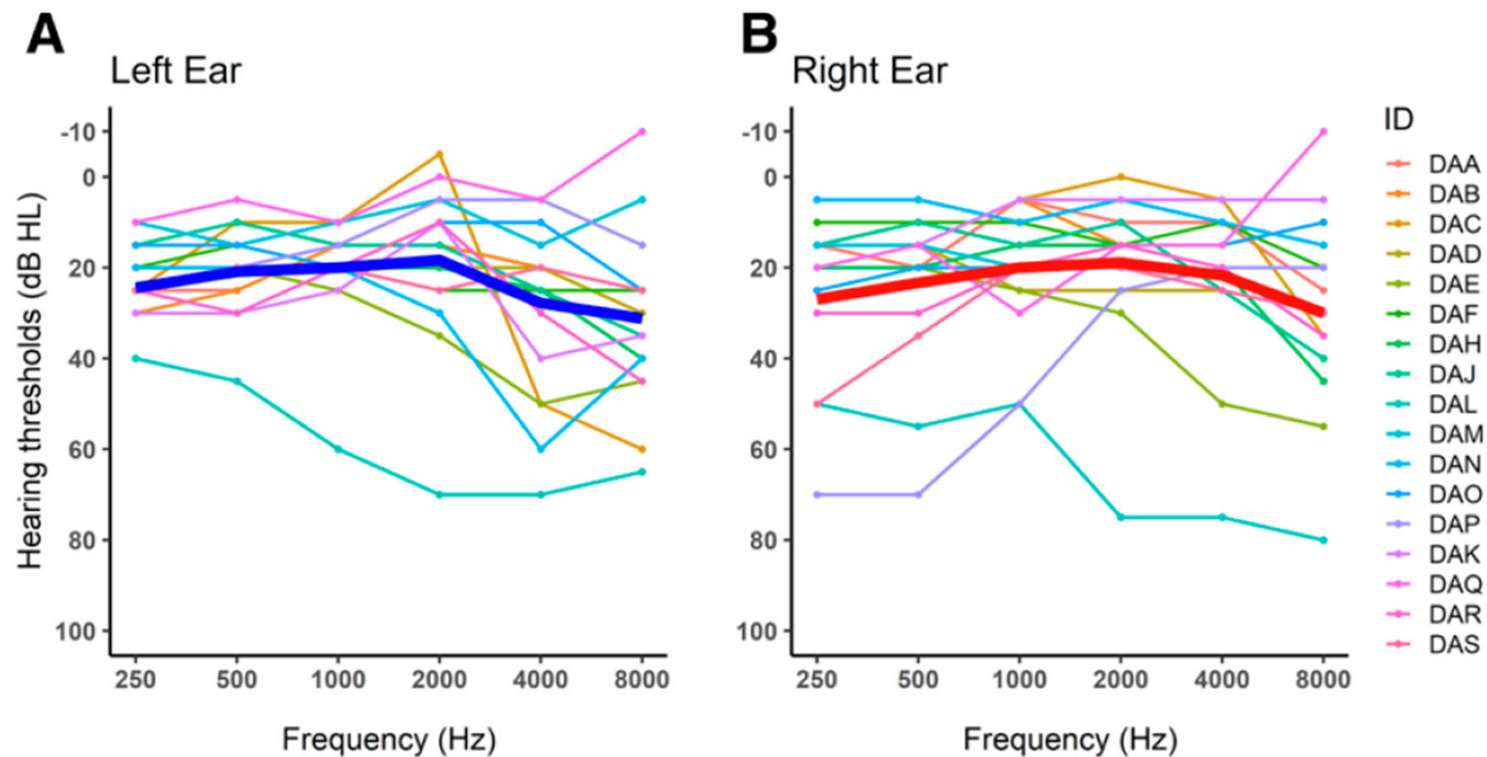
# Associations Between Perception and Brain Structure?

In the auditory pathway (visual pathway as well) there is a hypothesis that the brain has 2 streams. These streams work in parallel in the brain for processing information?

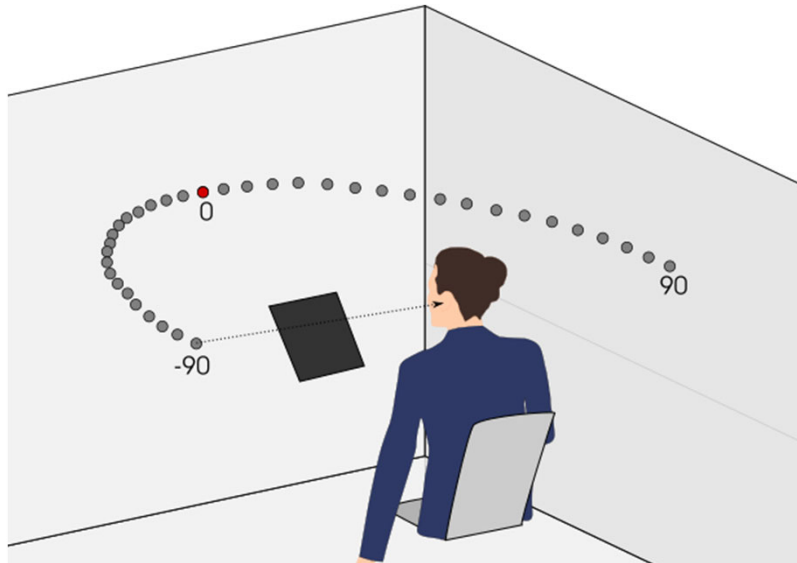


# Speech Recognition and Spatial Hearing in Young Adults With Down Syndrome: Relationships With Hearing Thresholds and Auditory Working Memory

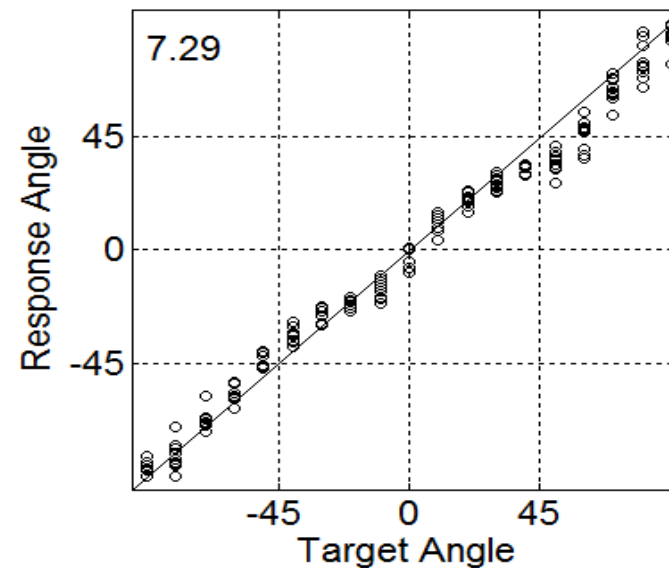
Kumari Anshu,<sup>1</sup> Kayla Kristensen,<sup>1</sup> Shelly P. Godar,<sup>1</sup> Xin Zhou,<sup>1</sup> Sigan L. Hartley,<sup>1,2</sup> and Ruth Y. Litovsky<sup>1,3</sup>

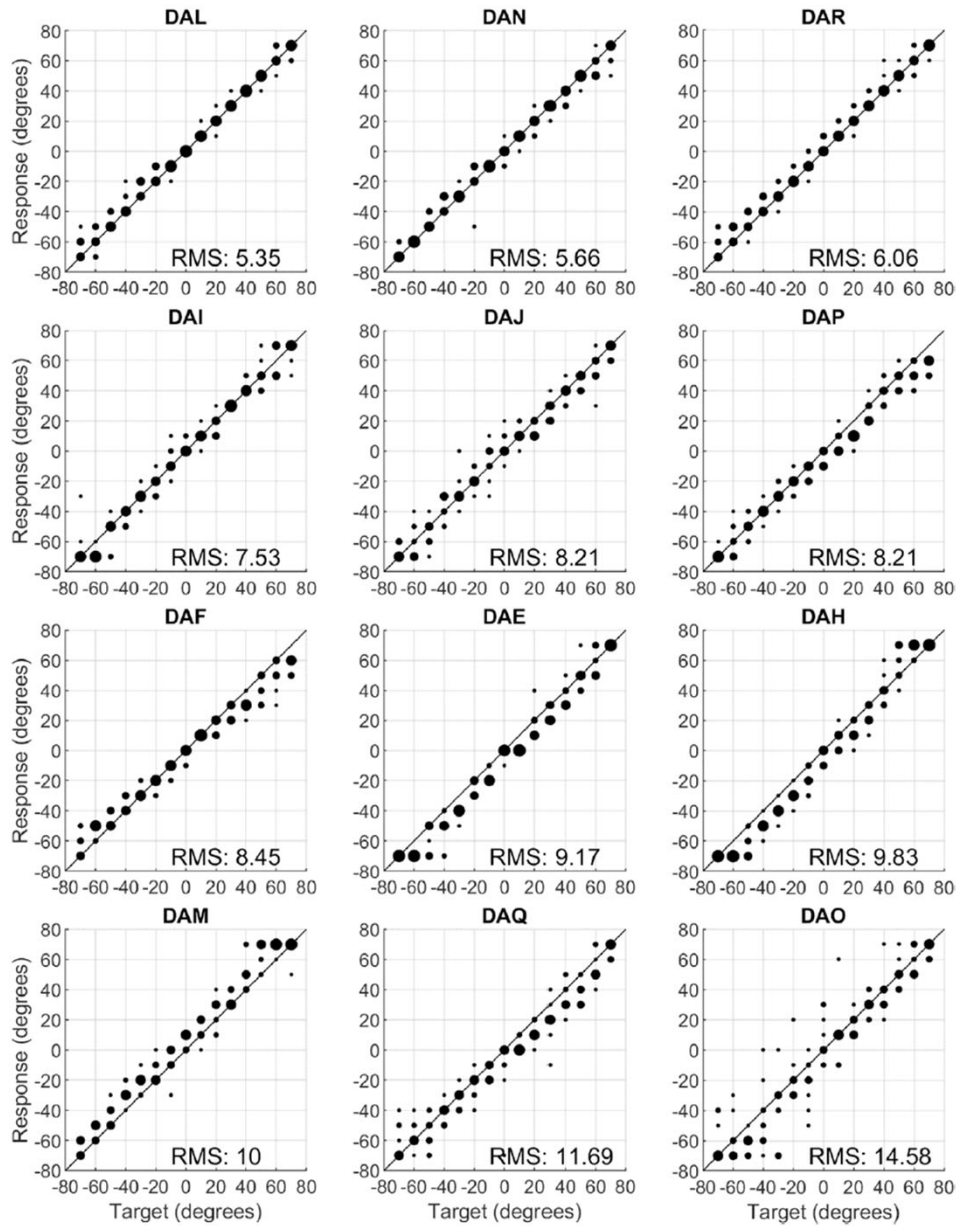


# Sound Localization (19 young adults)

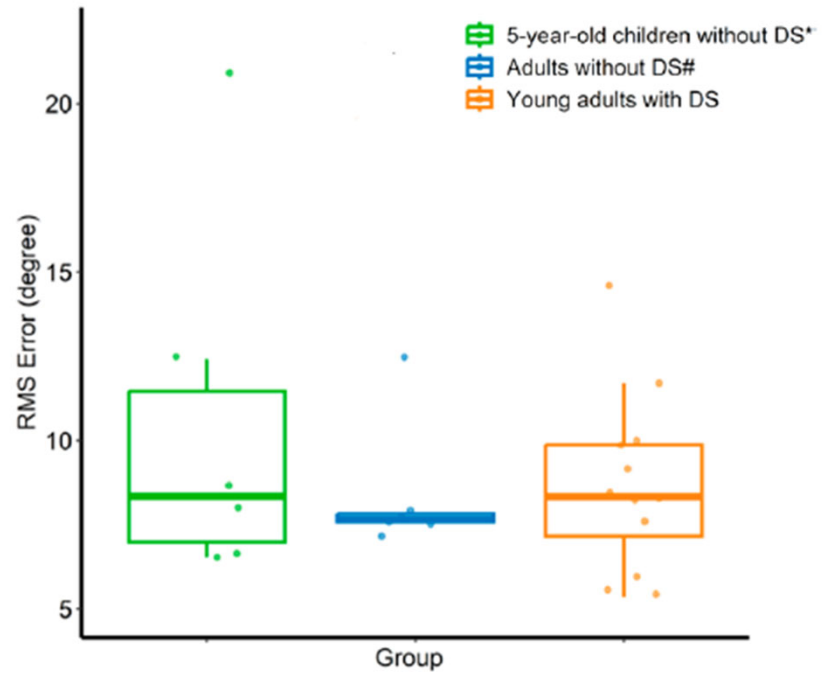


1. Young adults with DS, ages 18-24
2. Localization was excellent, and similar to that of young adults with typical hearing





**WHERE ARE  
SOUNDS?**



# How well can we hear speech in noise? Do we understand speech better when the "noise" is not right next to the speech?

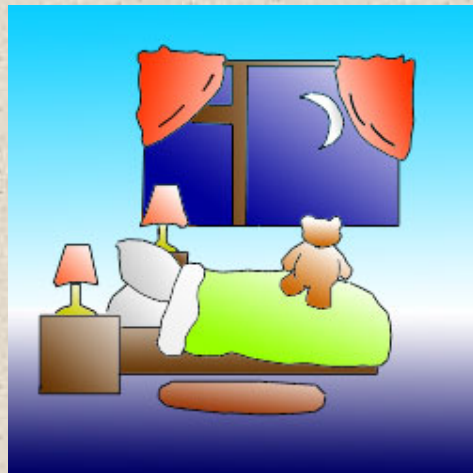
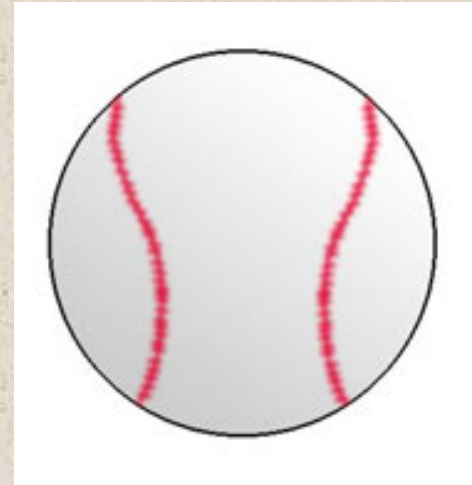
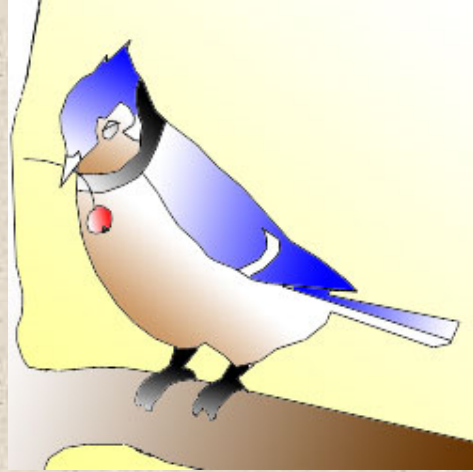
The "cocktail party" and classroom environments

*WHAT IS THE SOUNDS?*

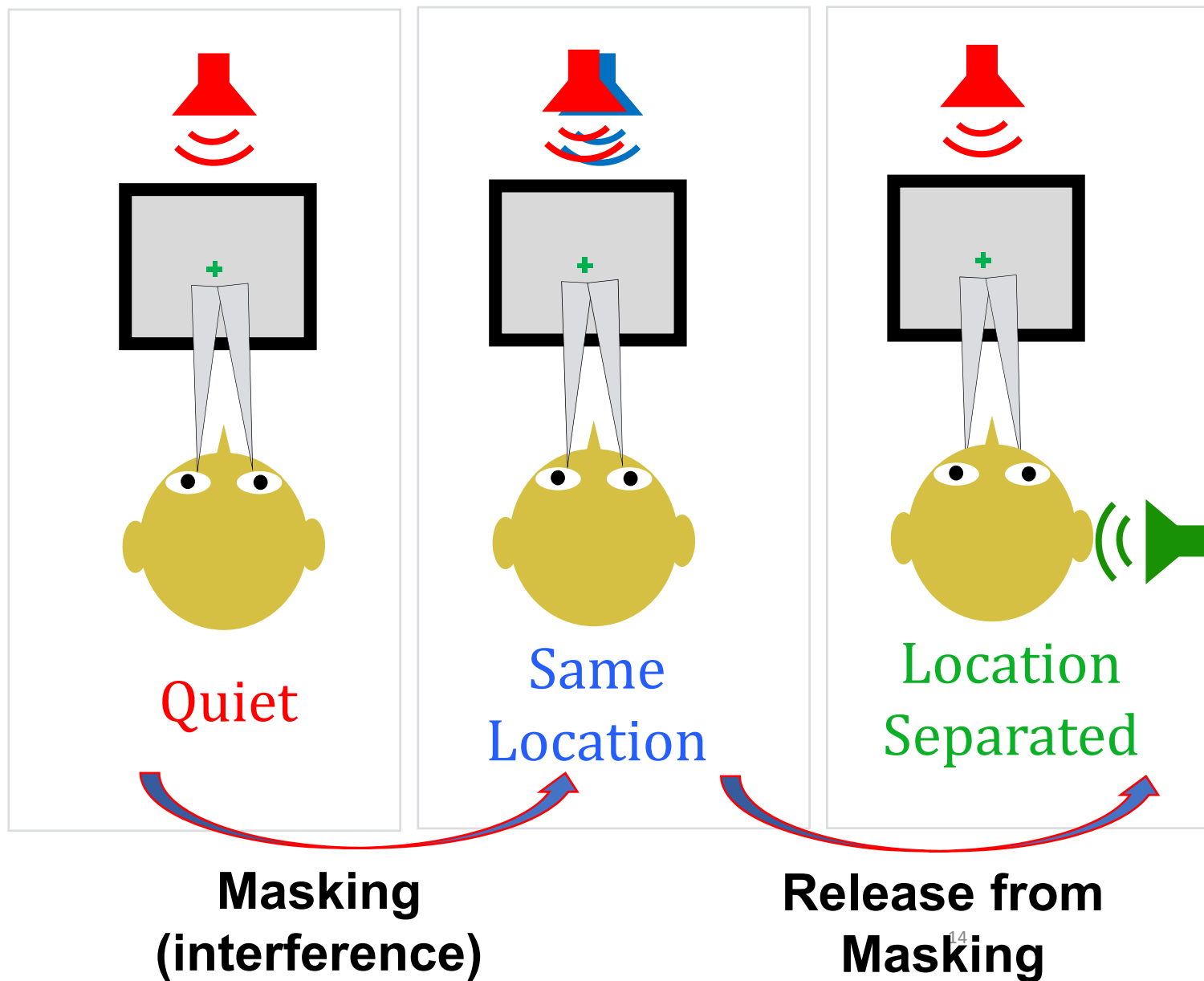
- Involvement of:**
- Bottom-up processing at monaural and brainstem levels
  - Top-down attentional and cognitive networks



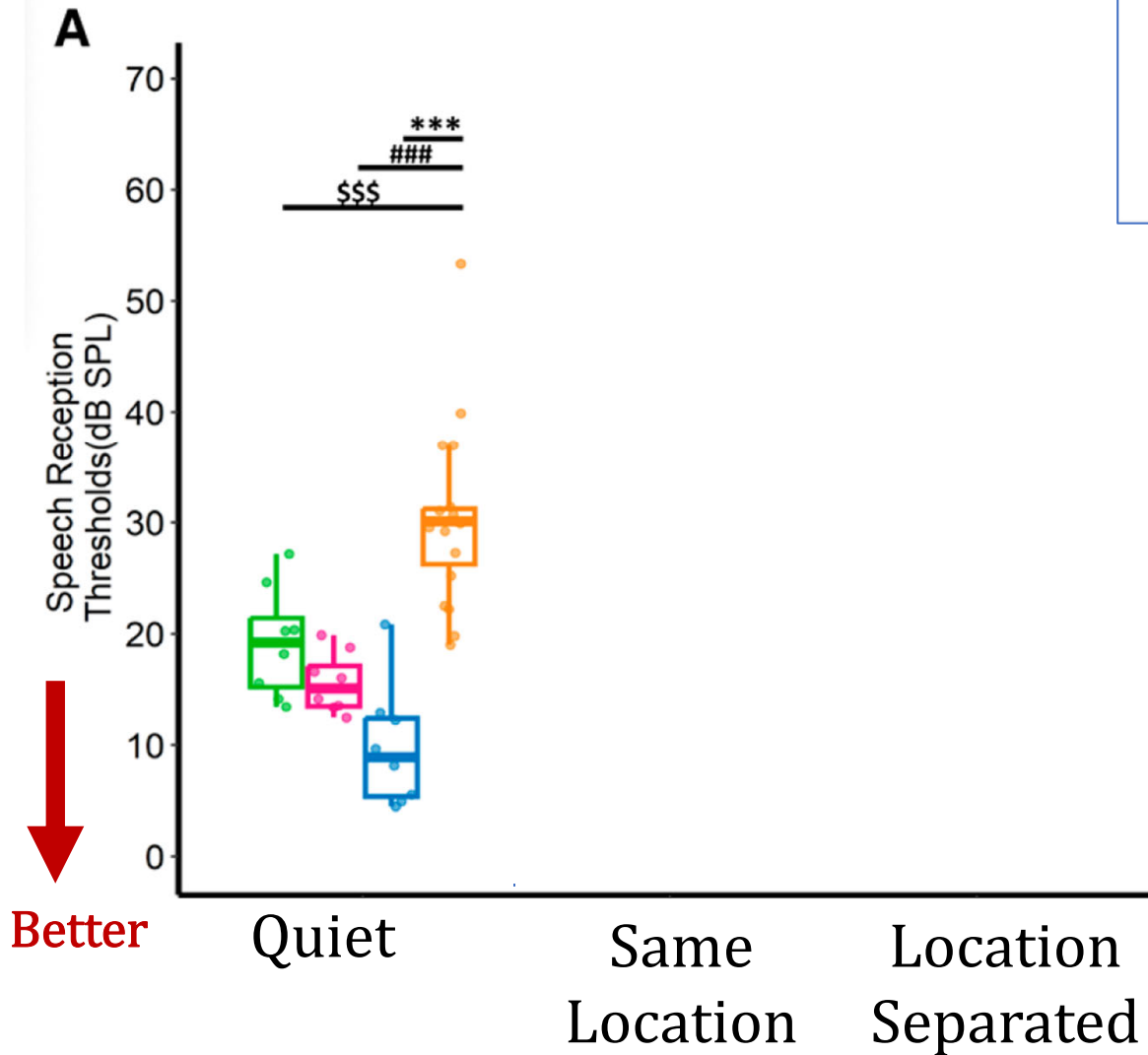
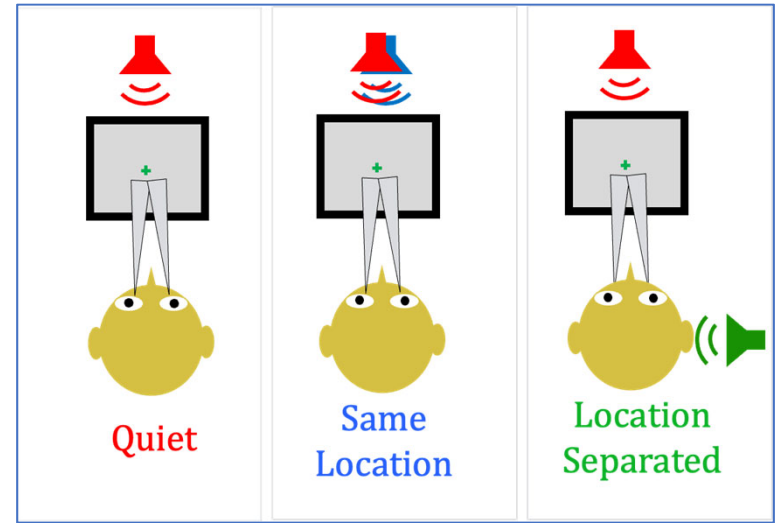
# “Listening game” with spondees (within the vocabulary)



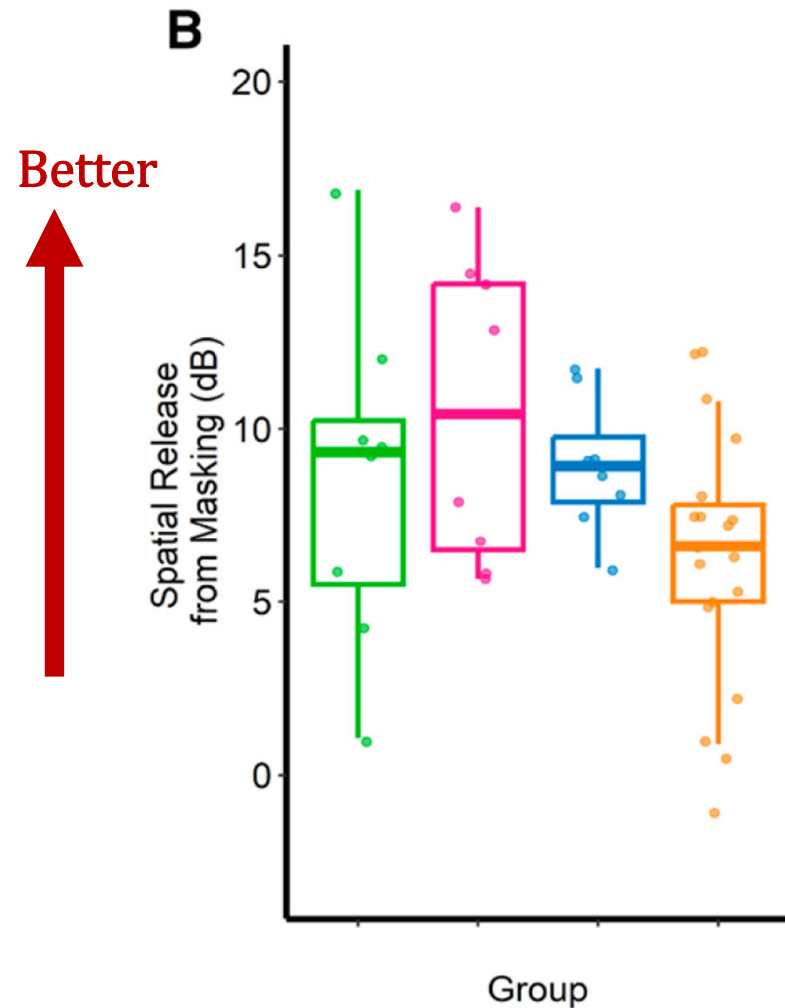
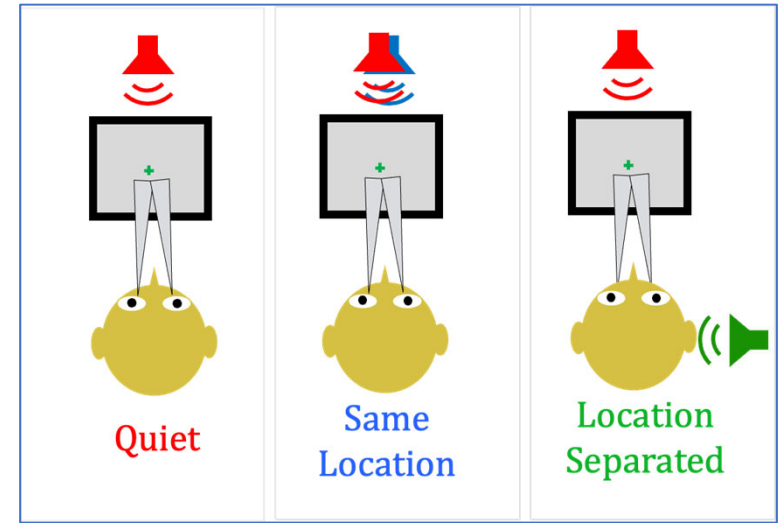
# Speech Understanding



# Speech Understanding



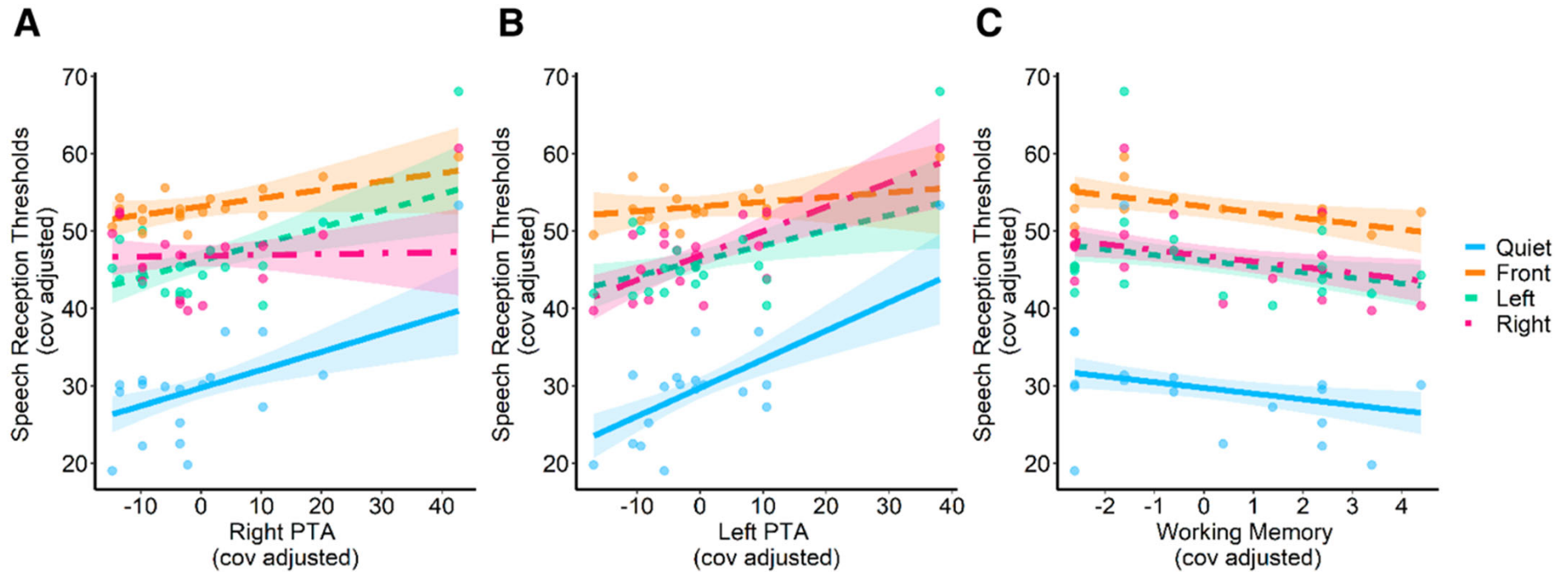
# Benefit from separating locations of speech and noise



- 5-year-old children without DS<sup>^</sup>
- 8-year-old children without DS<sup>^</sup>
- Adults without DS<sup>^</sup>
- Young adults with DS

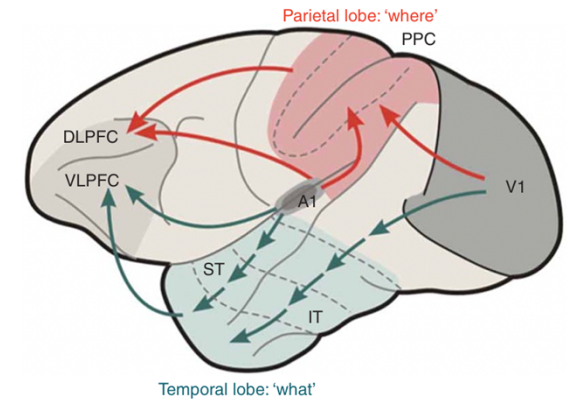
<sup>^</sup>Comparison data of individuals without DS:  
Misurelli and Litovsky, 2015

# Hearing Loss and Performance

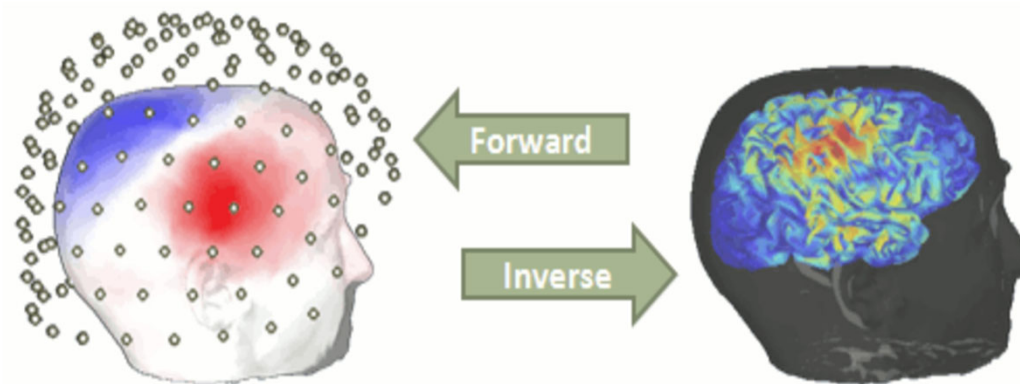
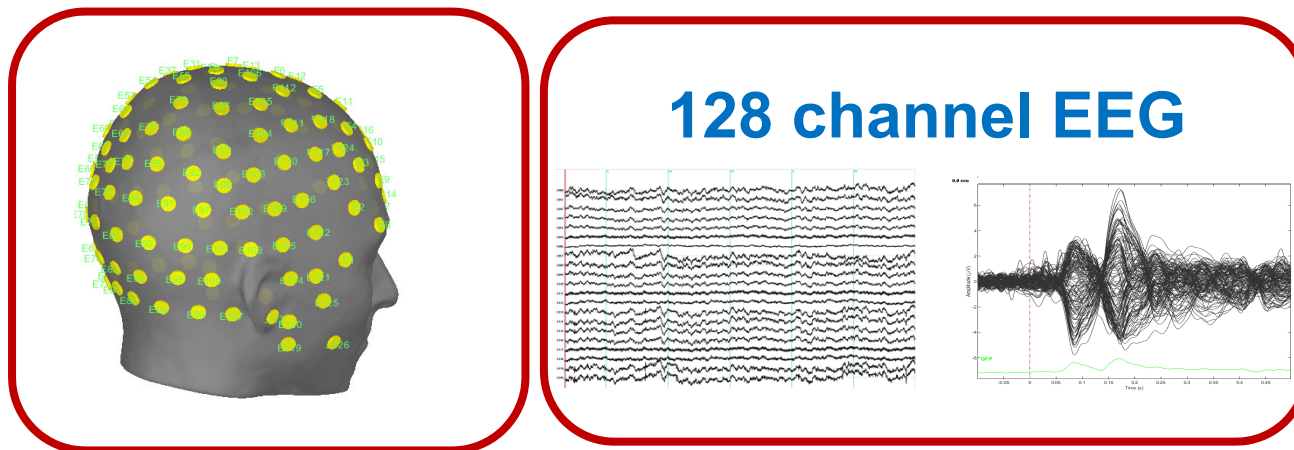


# Conclusions

- We studied how young adults with DS were able to localize sounds, and to understand speech, in Quiet and with background sounds.
- We observed higher accuracy during spatial hearing tasks(WHERE) as compared with speech recognition tasks (WHAT).
- Auditory processes in the “WHERE” pathways appear to be a relative strength than those associated with “WHAT” pathways in young adults with DS.
- Hearing loss, and auditory working memory impairments contributed to difficulties in speech recognition in the presence of speech interferers.
- Future larger-sized samples are needed to replicate and extend our findings.

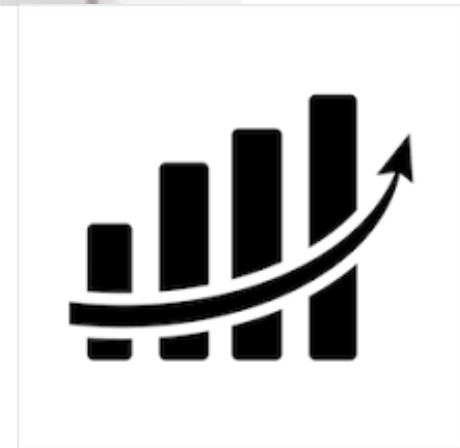


Ongoing studies on **brain function** and **brain structure**:  
Using EEG from individuals with DS to estimate neural generators linked to altered auditory processing in young adults with DS.  
→ Linking auditory response measures (function) with brain mapping and structure analysis (MRI)



# We need to understand hearing loss!

- Consequences for everyday functioning
- Impact on cognition and language
- Brain maturation?
- Long-term relationships to other conditions such as dementia?



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# Thank you and Questions

- **Thank you to**
  - **our participants and their families**
  - **Members of the Binaural Hearing and Speech Lab**
  - **Waisman Center**
  - **NIH-NICHD, NIH-NIDCD**