

1. This document was created to support maximum accessibility for all learners. If you would like to print a hard copy of this document, please follow the general instructions below to print multiple slides on a single page or in black and white.
2. This handout is for reference only. Non-essential images have been removed for your convenience. Any links included in the handout are current at the time of the live webinar, but are subject to change and may not be current at a later date.
3. Copyright: Images used in this course are used in compliance with copyright laws and where required, permission has been secured to use the images in this course. All use of these images outside of this course may be in violation of copyright laws and is strictly prohibited.
4. Social Workers: For additional information regarding standards and indicators for cultural competence, please review the NASW resource: [Standards and Indicators for Cultural Competence in Social Work Practice](#)
5. Need Help? Select the “Help” option in the member dashboard to access FAQs or contact us.

#### How to Print Handouts

- |                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>▪ On a Mac<ul style="list-style-type: none"><li>▪ Open PDF in Preview</li><li>▪ Click File</li><li>▪ Click Print</li><li>▪ Click dropdown menu on the right “preview”</li><li>▪ Click layout</li><li>▪ Choose # of pages per sheet from dropdown menu</li><li>▪ Checkmark Black &amp; White if wanted.</li></ul></li></ul> | <ul style="list-style-type: none"><li>▪ On a PC<ul style="list-style-type: none"><li>▪ Open PDF</li><li>▪ Click Print</li><li>▪ Choose # of pages per sheet from dropdown menu</li><li>▪ Choose Black and White from “Color” dropdown</li></ul></li></ul> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

*No part of the materials available through the continued.com site may be copied, photocopied, reproduced, translated or reduced to any electronic medium or machine-readable form, in whole or in part, without prior written consent of continued.com, LLC. Any other reproduction in any form without such written permission is prohibited. All materials contained on this site are protected by United States copyright law and may not be reproduced, distributed, transmitted, displayed, published or broadcast without the prior written permission of continued.com, LLC. Users must not access or use for any commercial purposes any part of the site or any services or materials available through the site.*





# Beyond the Ear: Effects of Adult-Onset Hearing Loss and Hearing Treatment on Neurocognitive Function & Well-Being

Hannah Glick, AuD, PhD, CCC-A

# Hannah Glick, PhD, AuD, CCC-A



Dr. Hannah Glick is a dually-trained audiologist and cognitive neuroscientist. She currently serves as an assistant professor at the University of Northern Colorado. Dr. Glick completed her AuD and combined triple PhD at the University of Colorado-Boulder. Her research (through funding from the National Institutes of Health, the National Speech-Language-Hearing Association, and the Hearing Industry Research Consortium) focuses on the effects of hearing loss, audiologic treatment, and aural rehabilitation on neuroplasticity, cognition, and overall well-being. Her work has been featured in scientific publications and book chapters around the world and she has given numerous research and clinical presentations nationally. With professional experience extending across healthcare, academic, industry, government, and entrepreneurial settings, Dr. Glick brings a fresh perspective on the profession of audiology. In addition to research, Dr. Glick enjoys supporting individuals with hearing loss and their families at all stages in their journey. A skilled teacher and mentor, she also enjoys teaching and mentoring undergraduate and graduate students, helping them to identify their strengths and interests and to discover meaningful careers.

# Disclosures

- **Presenter Disclosure:** Financial: Hannah Glick is employed by the University of Northern Colorado and is the Owner of the HEARO Project, LLC, an audiology consulting agency. She received an honorarium for this presentation. Non-financial: Hannah Glick serves on the advisory board of Cognivue, LLC, a cognitive screening company.
- **Content Disclosure:** This learning event does not focus exclusively on any specific product or service.
- **Sponsor Disclosure:** There is no external sponsor for this course.

# Learning Outcomes

After this course, participants will be able to:

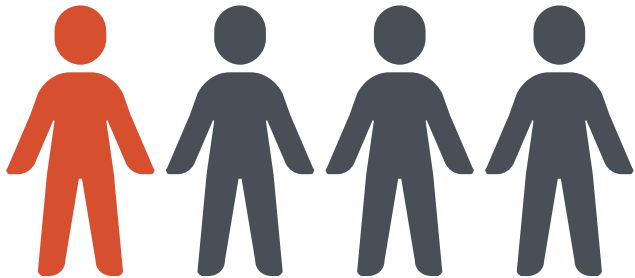
- Summarize current scientific understanding of the effects of adult-onset untreated hearing loss on neurocognitive function and well-being.
- Describe how to educate patients and non-scientific audiences about current scientific evidence regarding the effects of audiological intervention on neurocognitive function and well-being in adults with hearing loss.
- Discuss potential impacts of current research evidence regarding neurocognitive function before and after treatment with hearing aids in adult-onset hearing loss on early screening, identification, and intervention/rehabilitation.

# Introduction



Meet my grandmother

# Background



- By 2050, it is estimated that 1 in 4 people will have a hearing loss

World Health Organization (2023)

# Background

**1** Hypertension

**2** Arthritis

**3** Hearing Loss

- Hearing loss is the 3rd leading chronic physical condition in the US.
- It is more common than diabetes or cancer

Blackwell et al. (2014)

# Background



- Less than 10% of adults over age 45 years with hearing loss report using hearing aids

CDC (2023)

# Background



**1.9X**

- Adults ages 55 years and older have almost 2X increased risk of acquiring dementia

Livingston et al. (2017, 2020)

# Current Hypotheses

Sensory Deprivation Hypothesis

Information Degradation Hypothesis

Common Cause Hypothesis

# Current Hypotheses

Sensory Deprivation Hypothesis

Information Degradation Hypothesis

Common Cause Hypothesis

# Current Hypotheses

Sensory Deprivation Hypothesis

Information Degradation Hypothesis

Common Cause Hypothesis

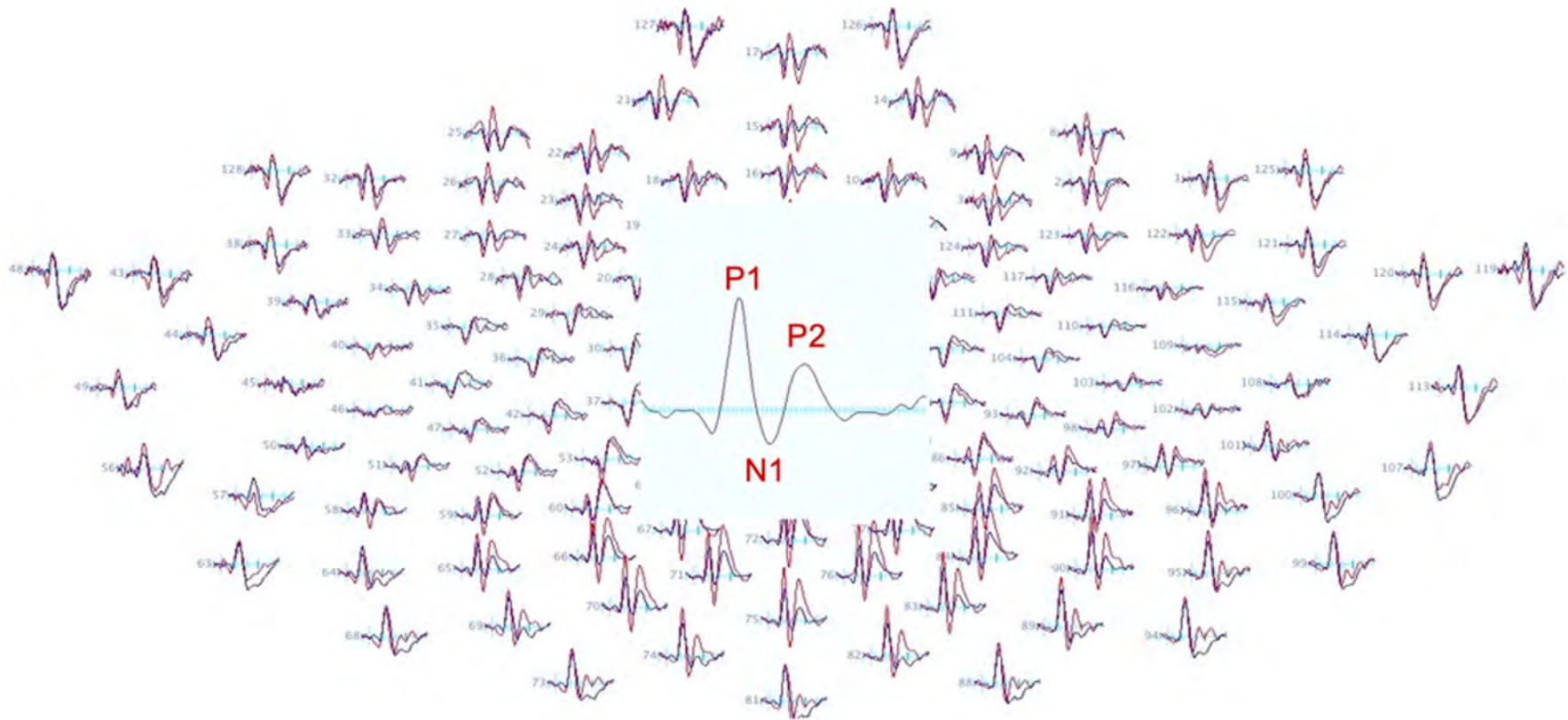
# Current Hypotheses

Sensory Deprivation Hypothesis

Information Degradation Hypothesis

Common Cause Hypothesis

# Cortical Evoked Potentials



# Cross-Modal Sensory Neuroplasticity

- Recruitment of cortical resources in the deprived modality by an intact sensory modality

Example:

- Hearing loss
- Auditory cortical resources recruited for visual or somatosensory processing

# Cortical Resource Allocation

- Recruitment of additional or alternative brain networks

Example:

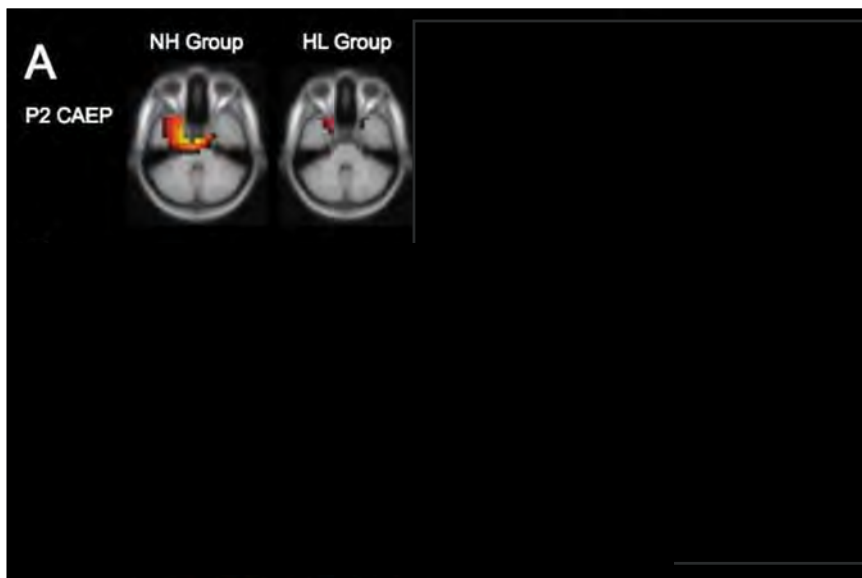
- Hearing loss
- Attentional and cognitive networks recruited more for auditory processing

# Key Finding #1

1. Brain reorganization is evident even in "mild" adult-onset hearing loss

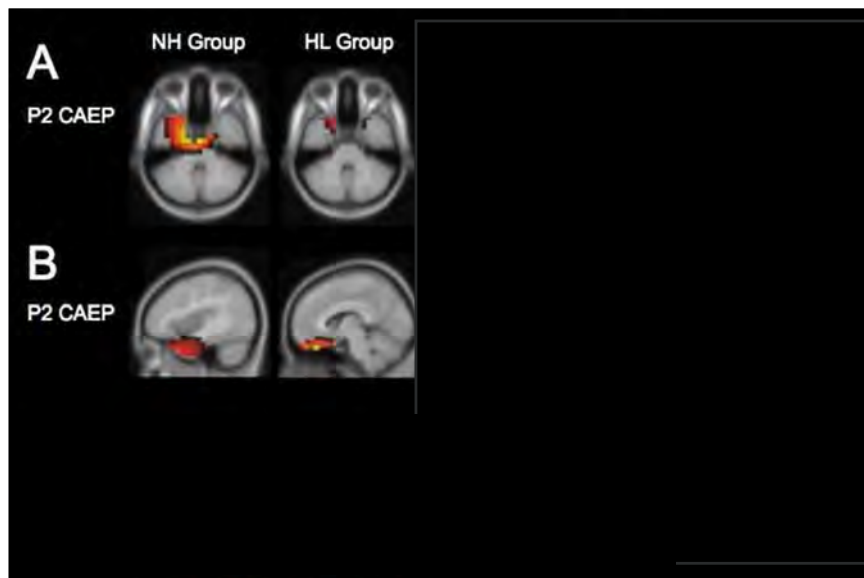
# Brain reorganization is evident in “mild” adult-onset hearing loss

- A. Reduced neural activity in the auditory cortex when listening



Glick & Sharma (2017)  
Campbell & Sharma (2013)  
Campbell & Sharma (2014)

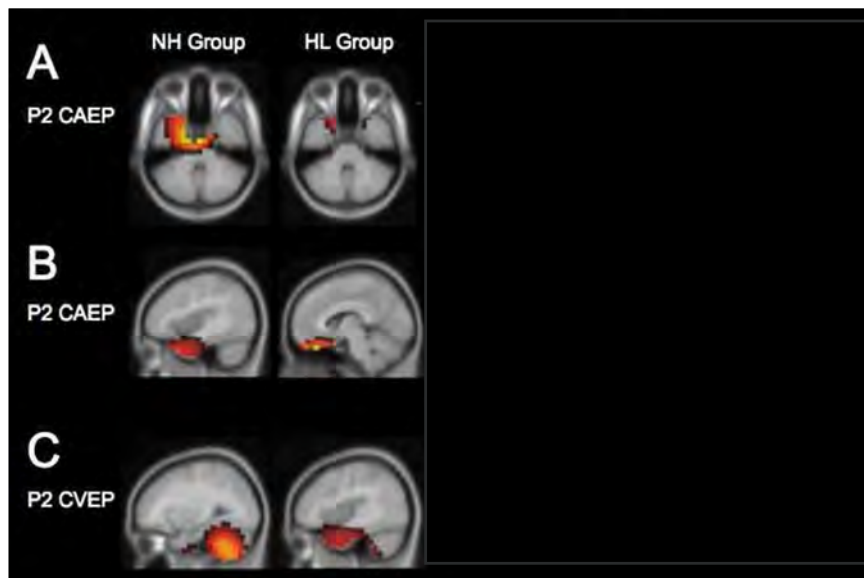
# Brain reorganization is evident in “mild” adult-onset hearing loss



- A. Reduced neural activity in the auditory cortex when listening
- B. Compensatory recruitment of frontal and pre-frontal cortex when listening

Glick & Sharma (2017)  
Campbell & Sharma (2013)  
Campbell & Sharma (2014)

# Brain reorganization is evident in “mild” adult-onset hearing loss



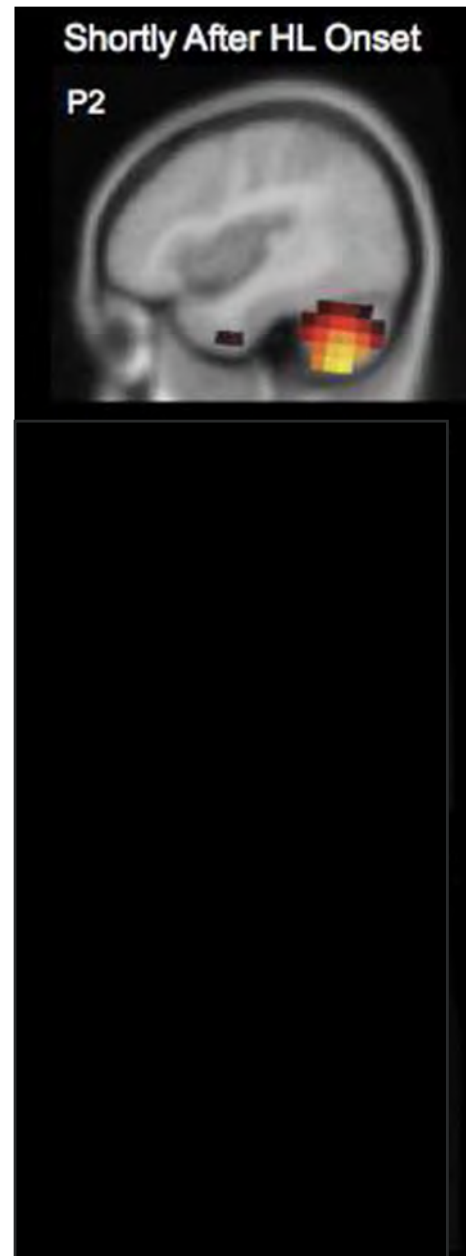
- A. Reduced neural activity in the auditory cortex when listening
- B. Compensatory recruitment of frontal and pre-frontal cortex when listening
- C. Cross-modal re-organization of auditory cortex by vision

Glick & Sharma (2017)  
Campbell & Sharma (2013)  
Campbell & Sharma (2014)

## Key Finding #2

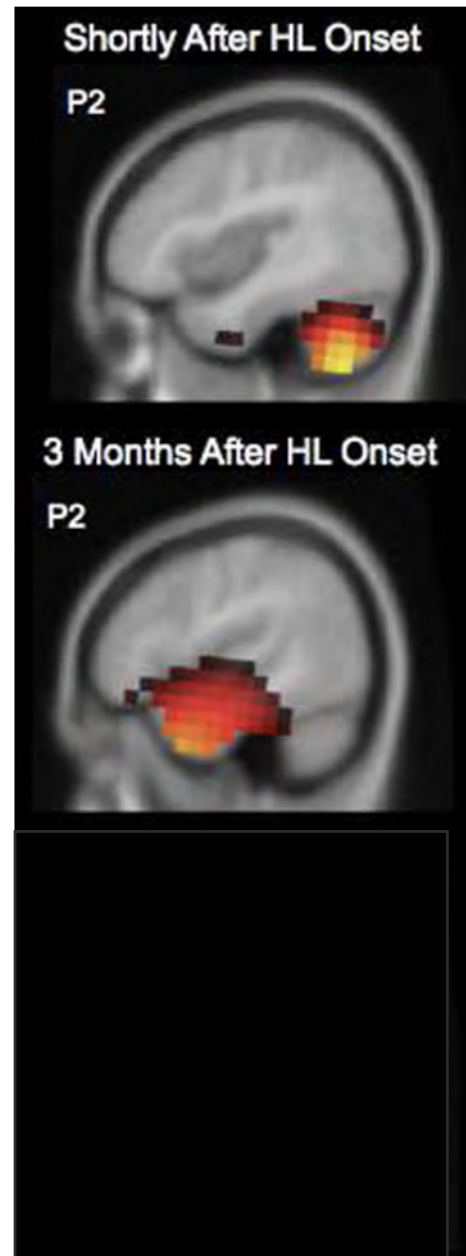
2. Brain reorganization occurs within months of hearing loss onset

Brain  
reorganization  
occurs within  
months of  
hearing loss  
onset



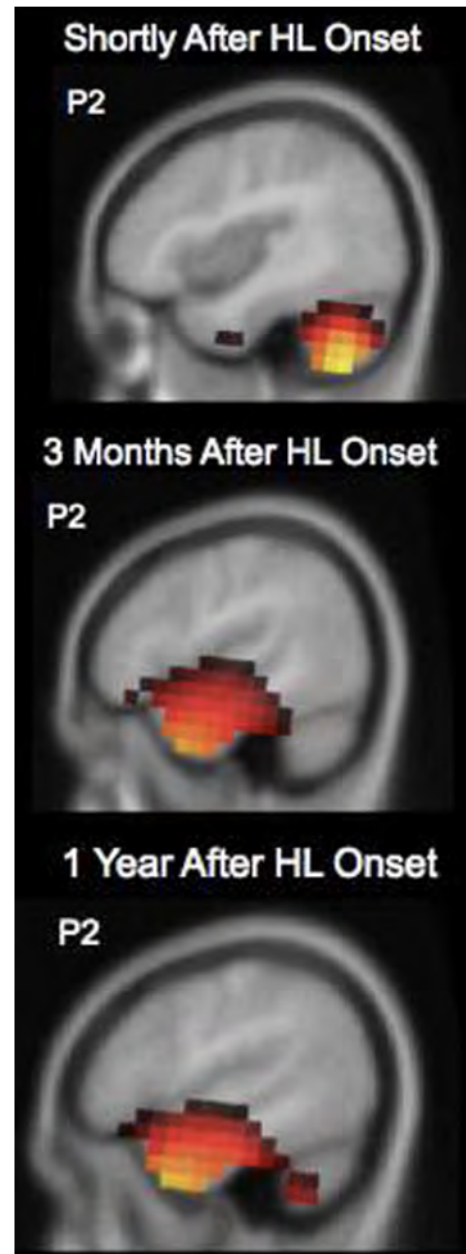
Glick & Sharma (2017)

Brain  
reorganization  
occurs within  
months of  
hearing loss  
onset



Glick & Sharma (2017)

Brain  
reorganization  
occurs within  
months of  
hearing loss  
onset

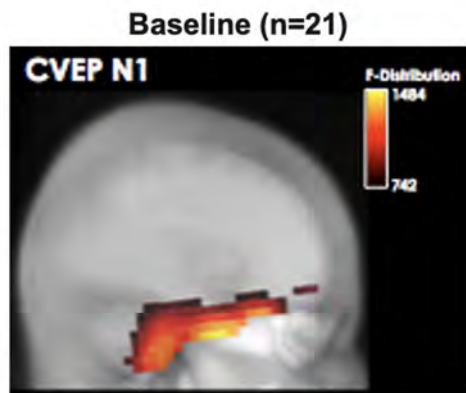


Glick & Sharma (2017)

## Key Finding #3

3. Treatment of hearing loss can restore more typical brain function

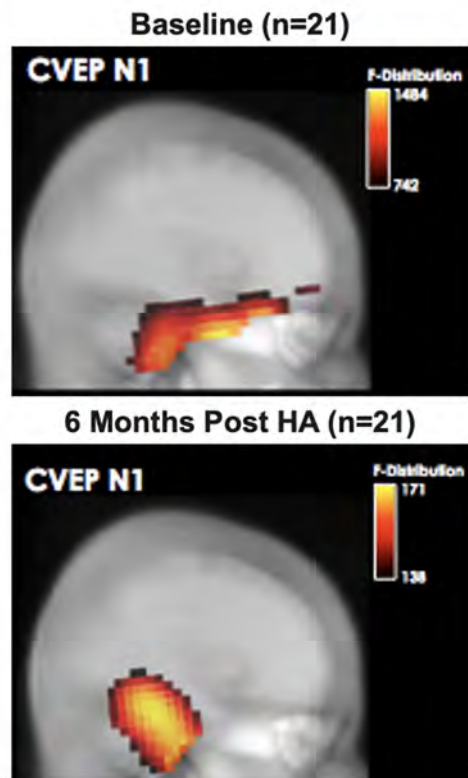
# Treatment of hearing loss can restore more typical brain function



- Cross-modal re-organization of auditory cortex for visual processing
- Compensatory recruitment of frontal and pre-frontal cortex

Glick & Sharma (2020)

# Treatment of hearing loss can restore more typical brain function



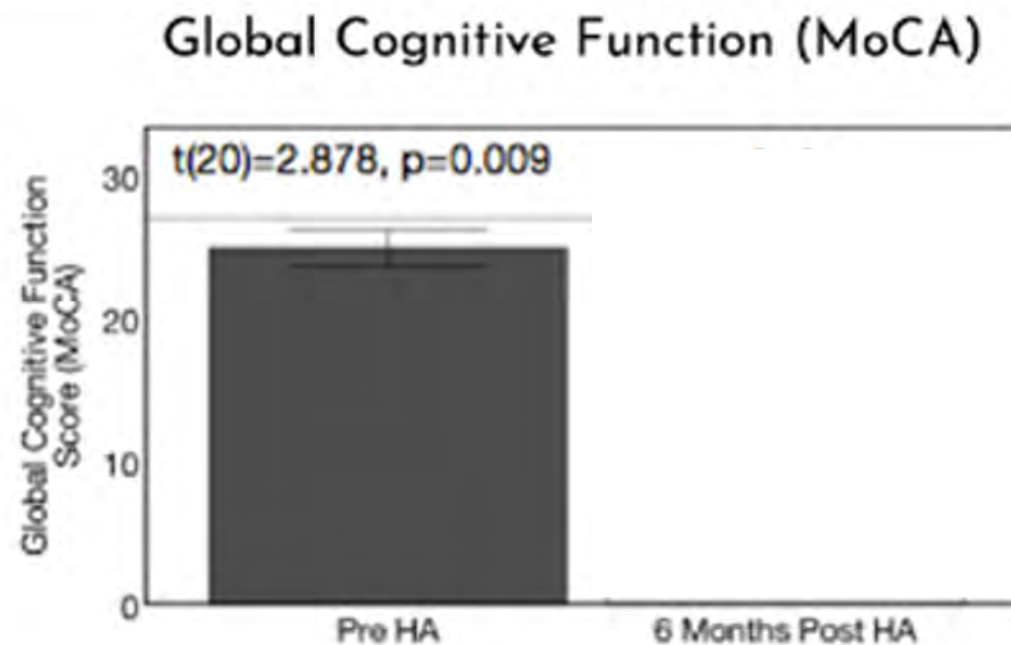
- Reversal in cross-modal reorganization of auditory cortex by vision
- Reduction in recruitment of frontal and pre-frontal cortex

Glick & Sharma (2020)

## Key Finding #4

4. Treatment of hearing loss can improve cognitive function

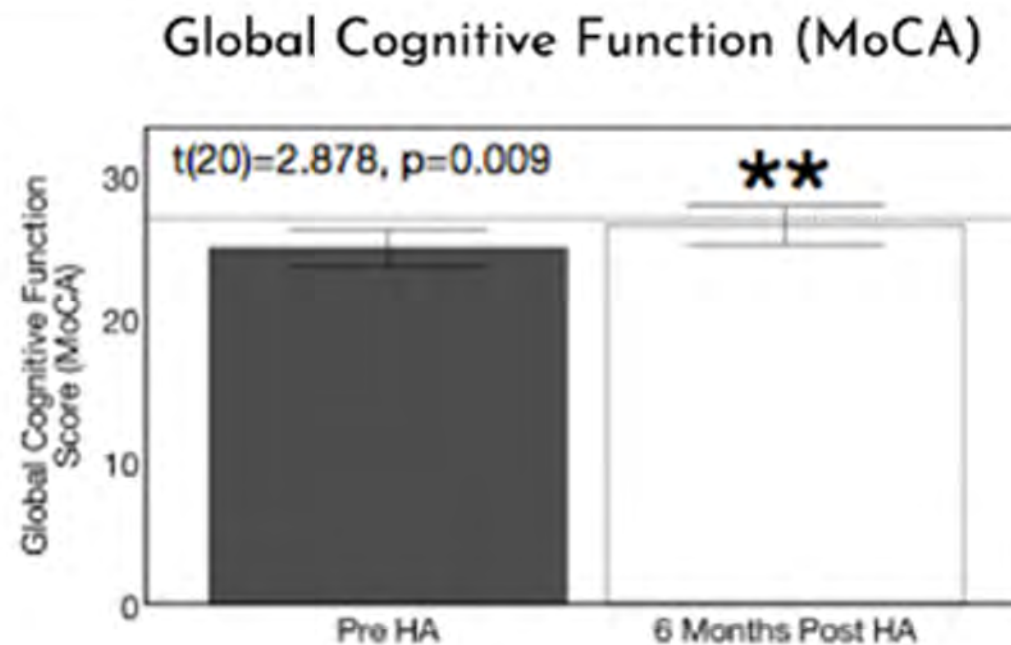
# Treatment of hearing loss can improve cognitive function



Note: Hearing loss group acutely aided at baseline cognitive test session and aided at 6-month follow-up testing

Glick & Sharma (2020)

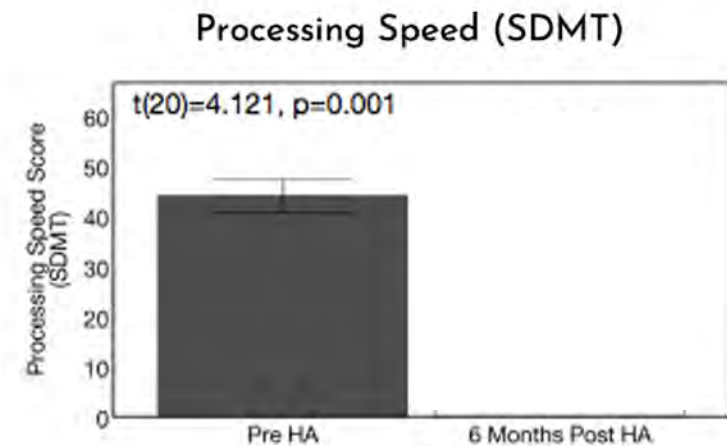
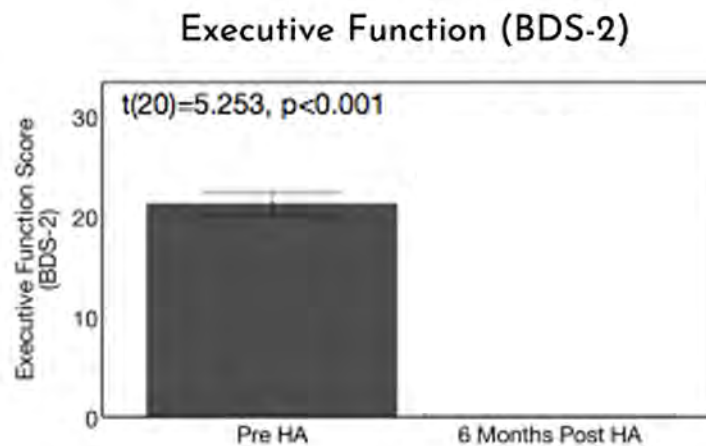
# Treatment of hearing loss can improve cognitive function



Note: Hearing loss group acutely aided at baseline cognitive test session and aided at 6-month follow-up testing

Glick & Sharma (2020)

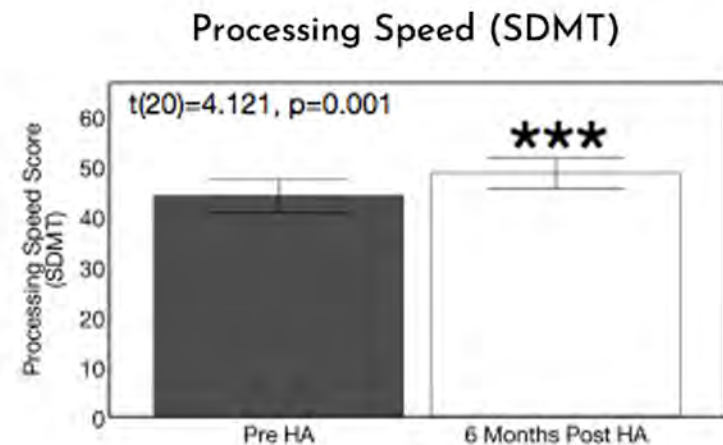
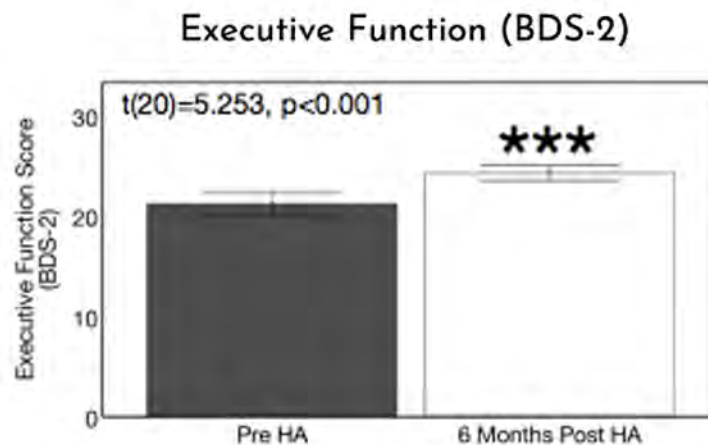
# Treatment of hearing loss can improve cognitive function



Note: Hearing loss group acutely aided at baseline cognitive test session and aided at 6-month follow-up testing

Glick & Sharma (2020)

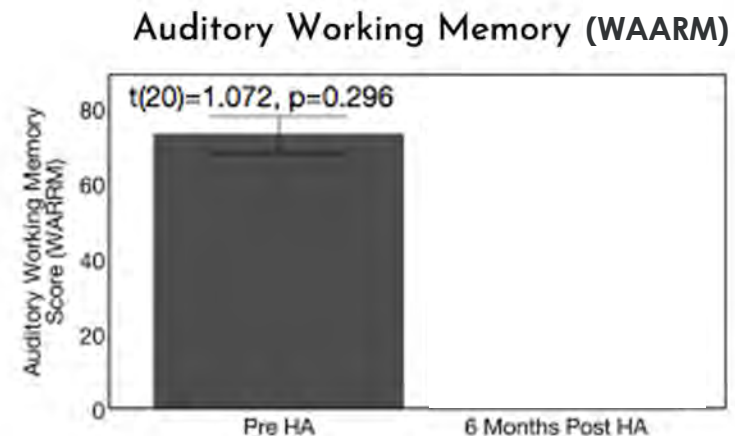
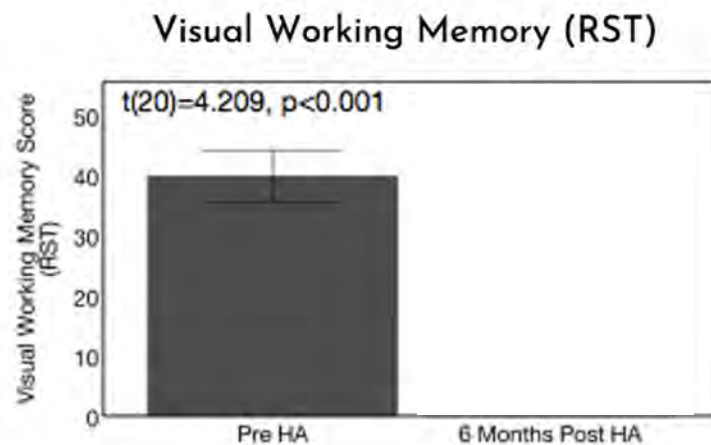
# Treatment of hearing loss can improve cognitive function



Note: Hearing loss group acutely aided at baseline cognitive test session and aided at 6-month follow-up testing

Glick & Sharma (2020)

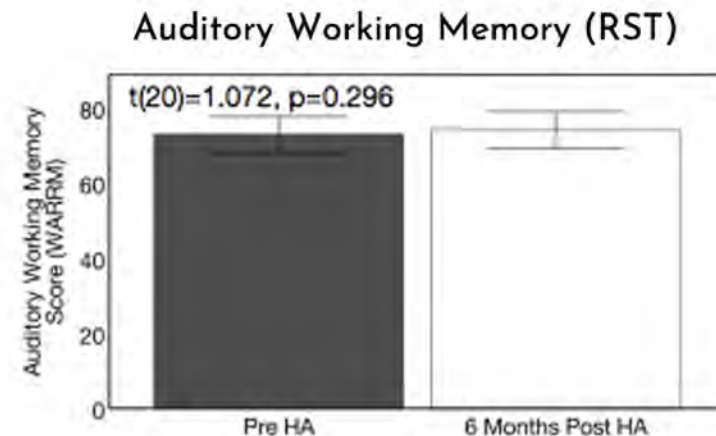
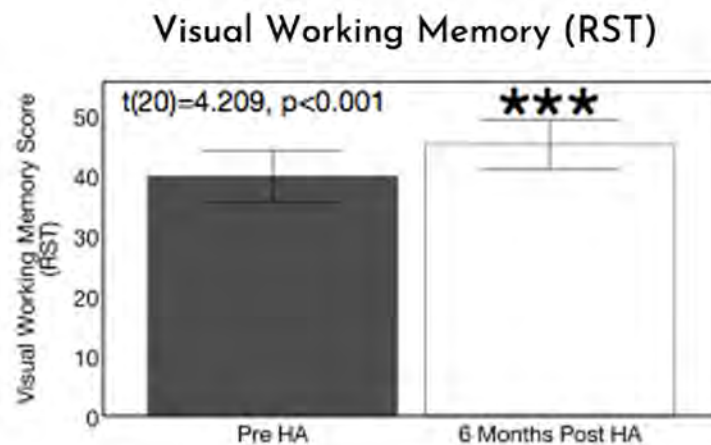
# Treatment of hearing loss can improve cognitive function



Note: Hearing loss group acutely aided at baseline cognitive test session and aided at 6-month follow-up testing

Glick & Sharma (2020)

# Treatment of hearing loss can improve cognitive function



Note: Hearing loss group acutely aided at baseline cognitive test session and aided at 6-month follow-up testing

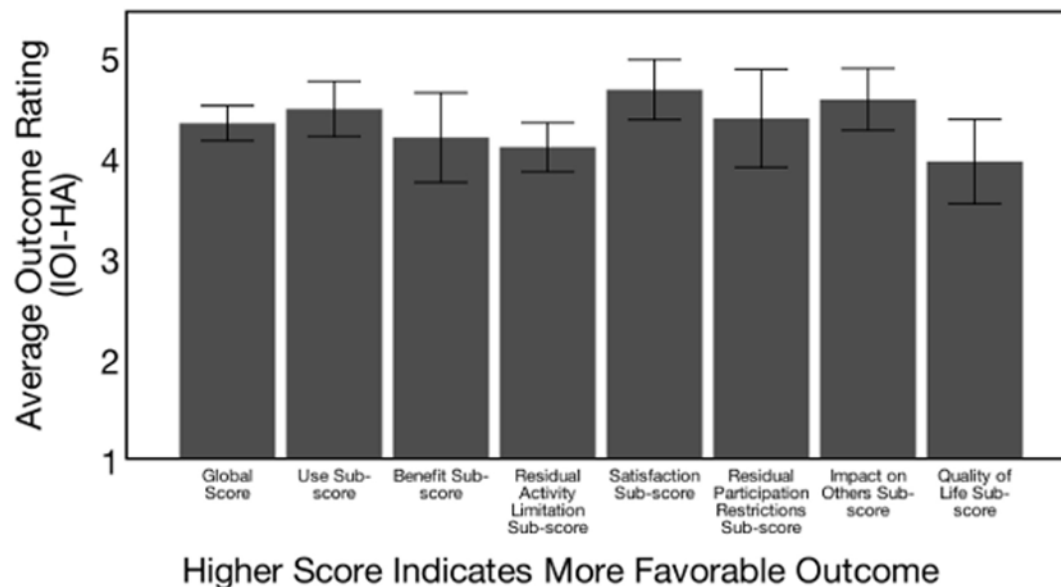
Glick & Sharma (2020)

## Key Finding #5

5. Treatment of hearing loss can improve functional outcomes and well-being

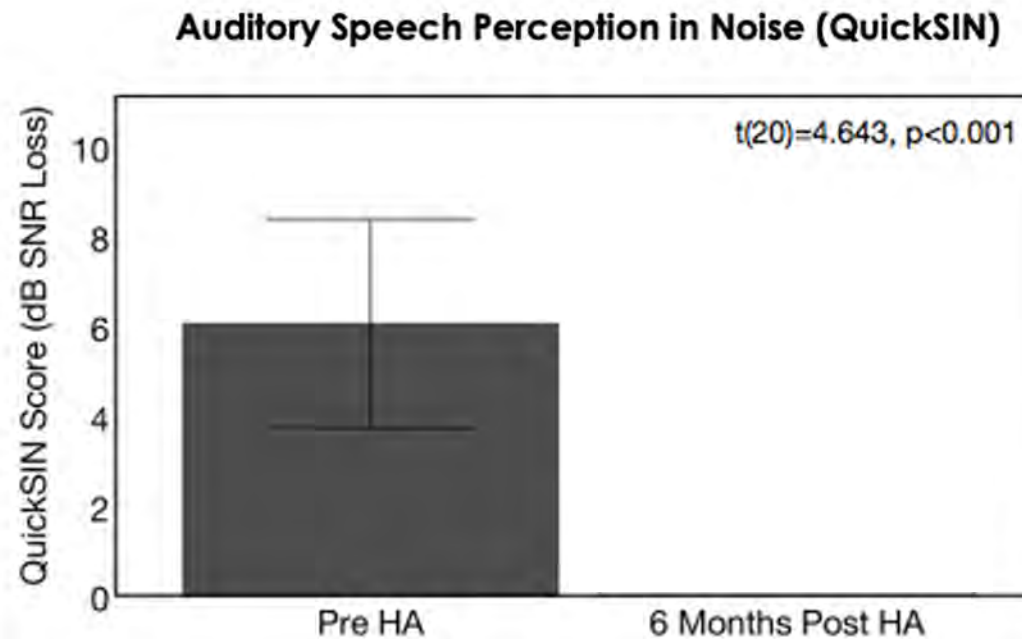
# Treatment of hearing loss can improve functional outcomes and well-being

## International Hearing Aid Outcome Inventory (IOI-HA)



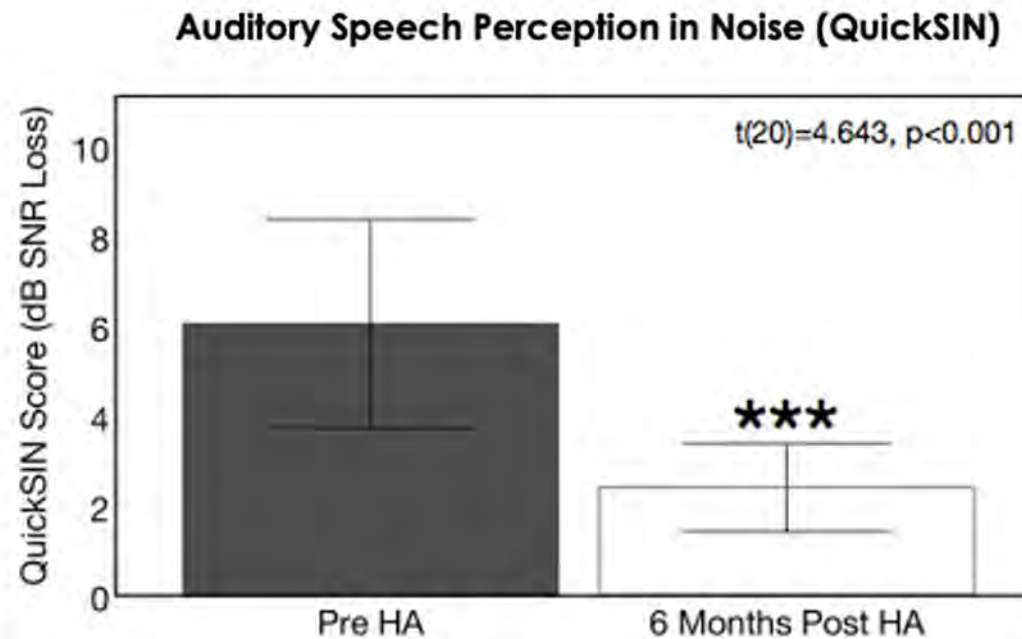
Glick & Sharma (2020)

# Treatment of hearing loss can improve functional outcomes and well-being



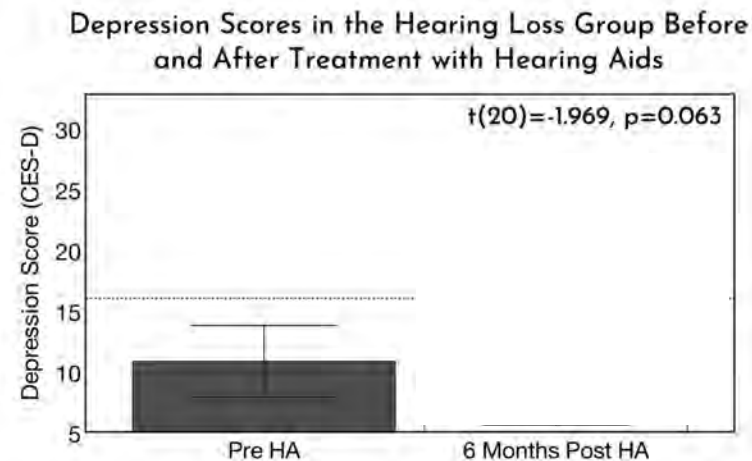
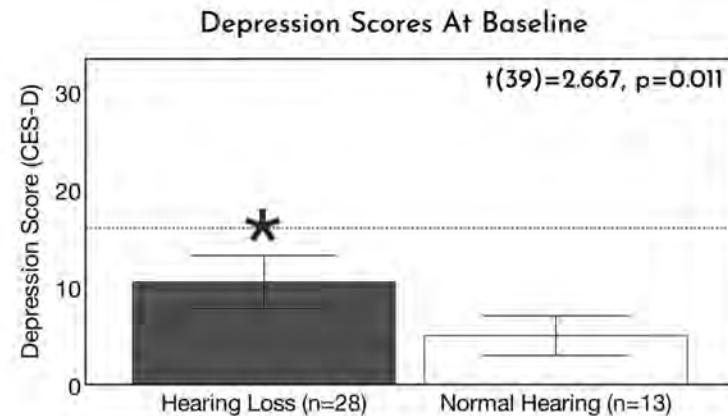
Glick & Sharma (2020)

# Treatment of hearing loss can improve functional outcomes and well-being



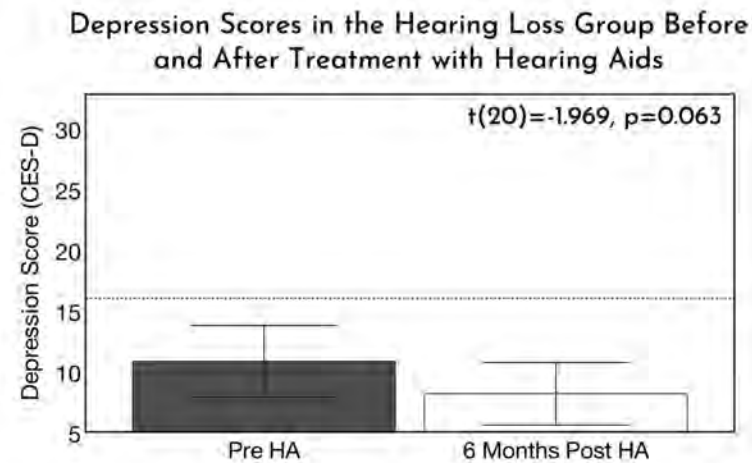
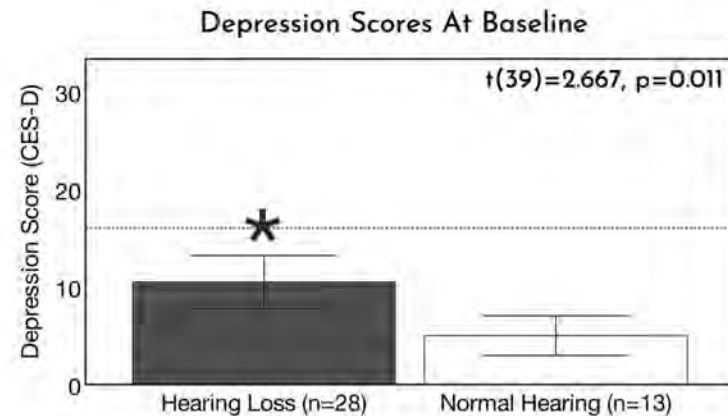
Glick & Sharma (2020)

# Treatment of hearing loss can improve functional outcomes and well-being



Glick & Sharma (in preparation)

# Treatment of hearing loss can improve functional outcomes and well-being



Glick & Sharma (in preparation)

# Key Findings: Review

1. Brain reorganization is evident even in "mild" adult-onset hearing loss
2. Brain reorganization occurs within months of hearing loss onset
3. Treatment of hearing loss can restore more typical brain function
4. Treatment of hearing loss can improve cognitive function
5. Treatment of hearing loss can improve functional outcomes and well-being

# Food for Thought

- Routine screens like mammograms are standard of care for adults in midlife.

Why not hearing screenings?

# Food for Thought

- The effects of auditory deprivation on the brain may take place even before these changes show up on a conventional audiogram

Could neuroimaging methods help us identify early indicators of auditory deprivation sooner?

# Food for Thought

- The average adult has hearing loss for over a decade before seeking treatment

Are we waiting too long to intervene, after the brain has already re-organized extensively?

# Food for Thought

- Cognitive screening, real-word speech-in-noise testing, and subjective questionnaires provide evidence of hearing aid benefit

Should audiologists incorporate more holistic outcome measures to monitor treatment success?

Thank you for listening!

# References

Blackwell, D. L., Lucas, J. W., & Clarke, T. C. (2014). Summary health statistics for U.S. adults: national health interview survey, 2012. Vital and health statistics. Series 10, Data from the National Health Survey, (260), 1-161.

Campbell, J., & Sharma, A. (2013). Compensatory changes in cortical resource allocation in adults with hearing loss. *Frontiers in systems neuroscience*, 7, 71.  
<https://doi.org/10.3389/fnsys.2013.00071>

Campbell, J., & Sharma, A. (2014). Cross-modal re-organization in adults with early stage hearing loss. *PloS one*, 9(2), e90594.  
<https://doi.org/10.1371/journal.pone.0090594>

Center for Disease Control and Prevention (2023). QuickStats: Percentage of Adults Aged ≥45 Years Who Use a Hearing Aid, by Sex and Age Group - National Health Interview Survey, United States, 2021. *Morbidity and mortality weekly report*, 72(6), 163.

# References (cont.)

Glick, H., & Sharma, A. (2017). Cross-modal plasticity in developmental and age-related hearing loss: Clinical implications. *Hearing research*, 343, 191–201. <https://doi.org/10.1016/j.heares.2016.08.012>

Glick, H. A., & Sharma, A. (2020). Cortical Neuroplasticity and Cognitive Function in Early-Stage, Mild-Moderate Hearing Loss: Evidence of Neurocognitive Benefit From Hearing Aid Use. *Frontiers in neuroscience*, 14, 93. <https://doi.org/10.3389/fnins.2020.00093>

Livingston, G., Huntley, J., Sommerlad, A., et al (2020). Dementia prevention, intervention, and care: 2020 report of the Lancet Commission. *Lancet* (London, England), 396(10248), 413–446. [https://doi.org/10.1016/S0140-6736\(20\)30367-6](https://doi.org/10.1016/S0140-6736(20)30367-6)

Livingston, G., Sommerlad, A., Orgeta, V., et al. (2017) Dementia prevention, intervention, and care. *Lancet* (London, England), 390(10113), 2673–2734. [https://doi.org/10.1016/S0140-6736\(17\)31363-6](https://doi.org/10.1016/S0140-6736(17)31363-6)

# References (cont.)

World Health Organization (2023). Deafness and hearing loss.  
[https://www.who.int/health-topics/hearing-loss#tab=tab\\_1](https://www.who.int/health-topics/hearing-loss#tab=tab_1)