The Hearing-Cognition Relationship and Auditory (Brain) Training Web Seminar
Recorded June 18, 2014

THE HEARING-COGNITION RELATIONSHIP AND AUDITORY (BRAIN) TRAINING
What We Know, What We Don’t

Presented by Jennifer J. Lister
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USF Neurophysiology of Aging Laboratory
Department of Communication Sciences and Disorders and School of Aging Studies
Funded by the National Institutes on Aging and USF Health Byrd Alzheimer’s Research Institute

People
- http://csd.cbcs.usf.edu/
- http://agingstudies.cbcs.usf.edu/
- http://agingstudies.cbcs.usf.edu/brainfitness/

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COMMUNICATION SCIENCES & DISORDERS
Creating pathways to communication by bridging research to practice.

- Department Established in 1967
- Doctor of Audiology Program Established in 1969
- Audiologists
- Speech-Language Pathologists,
- Sign Language Interpreters
Learning Outcomes

Upon completion, each participant in the eAudiology Web seminar will be able to:

1. Describe the relationship between:
   a. peripheral hearing status and cognition
   b. central auditory processing and cognition
2. Identify the most promising of the proposed underlying mechanisms of the hearing-cognition relationship.
3. Identify potential auditory-based treatments for cognitive decline.

Abstract

The relationship between hearing and cognition is complex, intriguing, and not well understood. In the University of South Florida Neurophysiology of Aging Laboratory, this relationship is being examined in the context of five theoretical mechanisms, using both behavioral and neurophysiological measures. The most promising mechanisms will be described, with supporting data. Then, evidence will be presented from an investigation of auditory-based training methods that may enhance processing speed and memory, thereby attenuating the effects of cognitive decline.
What We Know: Hearing

• Both peripheral hearing loss and central auditory processing disorders become more common with advancing age.
  • Peripheral Hearing Loss:
    • ~36 million Americans have it
    • 3rd most prevalent chronic health condition of older adults
  • Central Auditory Processing Disorder:
    • ~23-76% of older adults

(Cruickshanks et al., Am J Epidemiol, 1998; Cooper & Gates, Ear & Hearing, 1991; Golding et al., JAAA, 2004)

Common Complaints of Older Adults

“I can hear people talking but can’t understand what they are saying.”

“If they spoke more slowly (or more clearly), I could understand what they are saying.”

Effects of Age-Related Hearing Loss

• Hearing Loss ➔ Frustration
  • Associated with
    • Sadness and depression
    • Worry and anxiety
    • Paranoia
    • Emotional turmoil and insecurity

(National Council on Aging, 1999)
Hearing loss in older adults results in an increased likelihood of:

- Depression:
  - Odds Ratio = 1.8 (95% Confidence Interval: 1.1-2.7)

- Decreased Self-Sufficiency in Activities of Daily Living:
  - Odds Ratio = 2.1 (95% Confidence Interval: 1.4-3.2)

Hearing loss in older adults results in an increased likelihood of:

- Reduced walking speed

Hearing Loss in older adults results in an increased likelihood of:

- Risk of falls

References:

Carabellese, Appollonio, Rozzini et al., *JAGS*, 1993

Li et al., *Gait & Posture*, 2013

Lin et al., *Arch Int Med.*, 2012
Hearing loss in older adults results in an increased likelihood of:

- > 10 days of self-reported poor mental health
  - Odds Ratio = 1.57 (95% CI: 1.20 - 2.06)
- > 10 days of self-reported poor physical health
  - Odds Ratio = 1.36 (95% CI: 1.06 – 1.74)
- Hospitalization within the past year
  - Odds Ratio = 1.32 (95% CI: 1.07 – 1.63)
- Number of hospitalizations in the past year
  - Odds Ratio = 1.35 (95% CI: 1.09 – 1.68)

(Gerther et al., JAMA, 2013)

Hearing Loss and Dementia

Comparison of Symptoms

<table>
<thead>
<tr>
<th>Alzheimer’s Disease</th>
<th>Untreated Hearing Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression, anxiety, disorientation</td>
<td>Depression, anxiety, feelings of isolation</td>
</tr>
<tr>
<td>Reduced language comprehension</td>
<td>Reduced communication ability</td>
</tr>
<tr>
<td>Impaired memory</td>
<td>Lessened cognitive input</td>
</tr>
<tr>
<td>Inappropriate psychosocial responses</td>
<td>Inappropriate psychosocial responses</td>
</tr>
<tr>
<td>Loss of ability to recognize</td>
<td>Lessened mental scores</td>
</tr>
<tr>
<td>Denial, defensiveness, negativity</td>
<td>Denial, heightened defensiveness, negativity</td>
</tr>
<tr>
<td>Distrust, suspiciousness of others</td>
<td>Distrust, paranoia re: others are talking about them</td>
</tr>
</tbody>
</table>

(Chartrand, The Hearing Review, 2001)
Facts about Cognitive Decline

- Most devastating and feared condition that older adults face.
- How many have Mild Cognitive Impairment (MCI)?
  - 19% of those < 75 years of age
  - 29% of those 85+ years of age
  - 22.6% overall
- About 12% of those with MCI convert to dementia per year.

(RELATIONSHIP BETWEEN PERIPHERAL HEARING STATUS AND COGNITION)

- Lin (2011) The Journals of Gerontology Series A: Biological Sciences and Medical Sciences - NHANES
- Lin (2011) Neuropsychology - BLSA
- Lin, Yaffe, Xia, Xue, Harris, Purchase-Helzner, Satterfield, Ayanayon, Ferrucci, & Simonsick (2013) JAMA Internal Medicine - Health ABC
- Harrison, Lister, Lin, Betz, & Edwards (under revision) Ear and Hearing – SKILL
- Matthews, Lister, Edwards, Lin, Betz, & Harrison (2014) – Poster at AudiologyNOW! in Orlando

Epidemiologic Analyses

- **NHANES:** National Health and Nutrition Examination Survey
  - Cross-sectional, representative sample of U.S. population
- **BLSA:** Baltimore Longitudinal Study of Aging
  - Ongoing prospective study of older adults since 1958
- **Health ABC:** Health, Aging, & Body Composition Study
  - Prospective, population-based study of ~3000 adults 70 years and older
- **SKILL:** Staying Keen in Later Life
  - Cognitive, sensory and functional abilities of older adults from the Southeast region of the United States
### The Hearing-Cognition Relationship and Auditory (Brain) Training Web Seminar
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<table>
<thead>
<tr>
<th>ARTICLE</th>
<th>MAJOR FINDING</th>
<th>RELATIONSHIP</th>
<th>WEAKNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lin (Michaël) et al. (2011)</td>
<td>Greater hearing loss significantly associated with poorer cognition, adjusted for demographic and physical covariates.</td>
<td>Yes</td>
<td>Single mental status variable. MMSE.</td>
</tr>
<tr>
<td>Pearson et al. (2013)</td>
<td>Hearing impairment associated with poor performance on a serial word recall task.</td>
<td>Yes</td>
<td>Single mental status variable. MMSE.</td>
</tr>
</tbody>
</table>

### 6-Year Longitudinal Study
- Health ABC cohort
- ~2000 older adults
  - 822 with normal hearing
  - 1162 with hearing loss
- Older adults with hearing loss had:
  - 30-40% greater rate of cognitive decline
  - 24% greater risk for cognitive impairment

(Lin et al., *JAMA Internal Medicine, 2013 – Health ABC*)

### From Our Lab
- 894 older adults from the SKILL study cohort completed a baseline evaluation consisting of cognitive and audiometric tests.
  - Pure-tone hearing thresholds at 0.5, 1, and 2 kHz in each ear.
  - 10 measures of cognition.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean or (%)</th>
<th>SD or (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>73.47</td>
<td>6</td>
</tr>
<tr>
<td>Education (years)</td>
<td>13.98</td>
<td>2.69</td>
</tr>
<tr>
<td>Female</td>
<td>(57.8)</td>
<td>(517)</td>
</tr>
<tr>
<td>White</td>
<td>(88.7)</td>
<td>(793)</td>
</tr>
<tr>
<td>Black</td>
<td>(10.5)</td>
<td>(94)</td>
</tr>
<tr>
<td>MMSE</td>
<td>28.17</td>
<td>1.9</td>
</tr>
</tbody>
</table>

(Harrison, Lister, Lin, Betz, & Edwards, *Ear & Hearing*, under revision; Matthews, Lister, Edwards, Ar, Betz, & Harrison, 2014 – Poster at AudiologyNOW! in Orlando)
<table>
<thead>
<tr>
<th>Measure Name</th>
<th>Targeted Ability</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digit Symbol Substitution</td>
<td>Speed of processing</td>
<td>Number correct</td>
</tr>
<tr>
<td>Digit Symbol Copy</td>
<td>Speed of processing</td>
<td>Total time to complete task in seconds</td>
</tr>
<tr>
<td>Trail Making Test Part A</td>
<td>Speed of processing</td>
<td>Total time to complete task in seconds</td>
</tr>
<tr>
<td>Letter and Pattern Comparison</td>
<td>Speed of processing</td>
<td>Sum of correctly identified pairs</td>
</tr>
<tr>
<td>Useful Field of View (UFOV®)</td>
<td>Speed of processing</td>
<td>Threshold display speed in ms across 4 subtests</td>
</tr>
<tr>
<td>Trail Making Test Part B</td>
<td>Executive function; inhibition; set-shifting</td>
<td>Total time to complete task in seconds (480 s max.)</td>
</tr>
<tr>
<td>Stroop Color Word Test</td>
<td>Executive function; inhibition</td>
<td>Completion reaction time difference in seconds between ink color naming and color block naming tasks, adjusted for number of uncorrected mistakes during color naming task</td>
</tr>
<tr>
<td>Digit Span</td>
<td>Memory (verbal memory span)</td>
<td>Number of series correctly repeated</td>
</tr>
<tr>
<td>Spatial Span</td>
<td>Memory (spatial memory span)</td>
<td>Number of series correctly replicated</td>
</tr>
<tr>
<td>Hopkins Verbal Learning Test</td>
<td>Memory (verbal episodic)</td>
<td>Total number of words recalled across 3 free recall trials</td>
</tr>
</tbody>
</table>

**Speed of Processing**

**Digit Symbol Substitution and Copy**
Enter the symbol for each digit – time limited

**Trail Making Part A**
Connect the dots as quickly as possible in numerical order
Letter and Pattern Comparison
Determine if pairs of letters or patterns are the same or different – time limited

Useful Field of View (UFOV®)
Identify or discriminate object in center, locate object in periphery

Trail Making Part B
Connect the dots as quickly as possible in order alternating between numbers and letters
**Executive Function**

**Stroop Test**
Name the color of the ink

<table>
<thead>
<tr>
<th>Green</th>
<th>Red</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Yellow</td>
</tr>
<tr>
<td>Red</td>
<td>Blue</td>
</tr>
<tr>
<td>Green</td>
<td>Blue</td>
</tr>
<tr>
<td>Blue</td>
<td>Green</td>
</tr>
<tr>
<td>Blue</td>
<td>Yellow</td>
</tr>
<tr>
<td>Green</td>
<td>Black</td>
</tr>
</tbody>
</table>

**Memory**

**Digit Span**
Remember and repeat strings of numbers

<table>
<thead>
<tr>
<th>Digit</th>
<th>Examine</th>
<th>Repeat</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-digit</td>
<td>2-4-1</td>
<td>2-4-1</td>
</tr>
<tr>
<td>2-digit</td>
<td>3-6-2, 7-9-2</td>
<td>3-6-2, 7-9-2</td>
</tr>
<tr>
<td>3-digit</td>
<td>2-4-6, 3-5-6</td>
<td>2-4-6, 3-5-6</td>
</tr>
<tr>
<td>4-digit</td>
<td>5-7-9-1, 2-3-4-5</td>
<td>5-7-9-1, 2-3-4-5</td>
</tr>
</tbody>
</table>

**Spatial Span**
Remember and reproduce order of pegs

<table>
<thead>
<tr>
<th>1-digit</th>
<th>Examine</th>
<th>Repeat</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-digit</td>
<td>3-6-2, 7-9-2</td>
<td>3-6-2, 7-9-2</td>
</tr>
<tr>
<td>3-digit</td>
<td>2-4-6, 3-5-6</td>
<td>2-4-6, 3-5-6</td>
</tr>
<tr>
<td>4-digit</td>
<td>5-7-9-1, 2-3-4-5</td>
<td>5-7-9-1, 2-3-4-5</td>
</tr>
</tbody>
</table>
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**Hopkins Verbal Learning Test (HVLT)**
Remember and repeat 12 words:
- Lion
- Emerald
- Horse
- Tent
- Sapphire
- Hotel
- Cave
- Opal
- Tiger
- Pearl
- Cow
- Hut

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### Hearing Status of Participants

<table>
<thead>
<tr>
<th>Peripheral Hearing Status</th>
<th>% Left Ear</th>
<th>% Right Ear</th>
<th>% Better Ear</th>
<th>% Poorer Ear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Hearing (PTA&lt;25 dB HL)</td>
<td>57.3</td>
<td>57.8</td>
<td>66.6</td>
<td>48.5</td>
</tr>
<tr>
<td>Mild (PTA = 26-40 dB HL)</td>
<td>28.5</td>
<td>29.5</td>
<td>24.6</td>
<td>33.4</td>
</tr>
<tr>
<td>Moderate (PTA = 41-70 dB HL)</td>
<td>12.9</td>
<td>11.2</td>
<td>8.4</td>
<td>15.8</td>
</tr>
<tr>
<td>Severe (PTA = 71-90 dB HL)</td>
<td>1.2</td>
<td>1.0</td>
<td>0.34</td>
<td>1.9</td>
</tr>
</tbody>
</table>

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### Multiple Regression Analyses

- Step 1 - Known risk factors for peripheral hearing loss (age, race, sex, education, diabetes, hypertension, stroke, heart disease, and depression) were entered.
- Step 2 - PTA of the better hearing ear was entered.
- PTA significantly related to a broad range of cognitive measures across domains.
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### Cognitive Measure % of Variance Accounted for by PTA

<table>
<thead>
<tr>
<th>Cognitive Measure</th>
<th>% of Variance Accounted for by PTA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digit Symbol Substitution</td>
<td>0.7%*</td>
</tr>
<tr>
<td>Digit Symbol Copy</td>
<td>0.6%*</td>
</tr>
<tr>
<td>Trail Making Test Part A</td>
<td>0.3%</td>
</tr>
<tr>
<td>Letter Comparison</td>
<td>0.7%*</td>
</tr>
<tr>
<td>Pattern Comparison</td>
<td>1.0%*</td>
</tr>
<tr>
<td>UFOV®</td>
<td>0.6%*</td>
</tr>
<tr>
<td>Trail Making Test Part B</td>
<td>1.7%*</td>
</tr>
<tr>
<td>Stroop</td>
<td>0.5%*</td>
</tr>
<tr>
<td>Digit Span</td>
<td>0.7%*</td>
</tr>
<tr>
<td>Spatial Span</td>
<td>0.4%*</td>
</tr>
<tr>
<td>Hopkins Verbal Learning</td>
<td>2.2%*</td>
</tr>
</tbody>
</table>

---

**Polling Question 1**

The relationship between peripheral hearing and cognition is ___________.

A. Weak  
B. Moderate  
C. Strong
RELATIONSHIP BETWEEN CENTRAL AUDITORY PROCESSING AND COGNITION

- Brandino, Matthews, Valdés, Lister, Harrison, Andel, & Edwards (2014) - Poster at AudiologyNOW! in Orlando

<table>
<thead>
<tr>
<th>ARTICLE</th>
<th>HEARING MEASURE</th>
<th>MAJOR FINDING</th>
<th>RELATIONSHIP ?</th>
<th>WEAKNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gates et al. (2011)</td>
<td>CAP</td>
<td>Scores on 3 tests of CAP significantly poorer in those identified with dementia.</td>
<td>Yes</td>
<td>Consensus dx of dementia.</td>
</tr>
<tr>
<td>Gates et al. (1996)</td>
<td>Peripheral &amp; CAP</td>
<td>No group differences in peripheral hearing measures. CAP poorer in participants with mild probable AD than in CNOA.</td>
<td>No (peripherally) Yes (CAP)</td>
<td>Single mental status variable – MMSE. Single CAP variable – SSI. Clinical Dementia Rating (CDR) used to group participants. No other cognitive tests performed.</td>
</tr>
</tbody>
</table>

From Our Lab

**Two Groups, defined by Montreal Cognitive Assessment (MoCA):**
- Mild Cognitive Impairment (MCI) – score = 20-25
- Non-MCI – score ≥ 26

**Replicate 1 Participants:**
- 21 with Mild Cognitive Impairment (MCI)
- 16 Healthy Older Adult Controls (non-MCI)

**Central Auditory Processing Measures:**
- Synthetic Sentence Identification, Ipsilateral Competing Message (SSI-ICM)
- Dichotic Sentence Identification (DSI)
- Time Compressed Speech (TCS)
- Adaptive Tests of Temporal Resolution (ATTR) both within-channel (WC) and across-channel (AC)

(Brandino, Matthews, Valdés, Lister, Harrison, Andel, & Edwards, 2014; Poster at AudiologyNOW! in Orlando)
From Our Lab

Replicates 2 Participants:
14 with Mild Cognitive Impairment (MCI)
18 Healthy Older Adult Controls (non-MCI)

In addition to the measures completed in Replicate 1:

Peripheral Auditory Measures:
Pure tone audiometry from .25 to 8 kHz, bilaterally
3-frequency pure tone average (3PTA), bilaterally (.5, 1, 2 kHz)
4-frequency pure tone average (4PTA), bilaterally (.5, 1, 2, 4 kHz)
Speech recognition threshold (SRT), bilaterally

Central Auditory Processing Measures:
Dichotic Digits Test - Free Recall (DDT)
Words in Noise (WIN)

From Our Lab

• No significant differences between MCI and Non-MCI (ps>0.05) for:
  • gender, age, education, or race
  • peripheral hearing status (3PTA, 4PTA, or SRT) for either ear

![Central Auditory Processing Measure](Replicates 1 & 2 (n=69))
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Replicates 1 & 2 (n=69)

![Central Auditory Processing Measure](image1)

Replicate 2 Only (n=32)

![Central Auditory Processing Measure](image2)

Replicate 2 Only (n=32)

![Central Auditory Processing Measure](image3)
Conclusions

- Peripheral hearing *not* differentially impaired in MCI.
- Central auditory processing significantly poorer in MCI.
- Such measures may be useful in the assessment/identification of cognitive impairment.
- Why?
  - Inadequate upstream delivery of information due to age-related deficits in central auditory processing may more fundamentally affect cognitive function than peripheral hearing, making central auditory processing the underlying source of any link between hearing and cognition.

Polling Question 2

Which central auditory measure shows the largest effect of cognitive impairment?

A. SSI
B. DSI
C. ATTR

MECHANISMS OF THE HEARING-COGNITION RELATIONSHIP

- Baltes & Lindenberger (1997) - *Psychology and Aging*
- Fluegel, Matthews, Harrison, Lister, Edwards, & Andel (2014) – Poster at AudiologyNOW! in Orlando
- Jorgensen, L., Palmer, C.V., Pratt, S., Erickson, K., Moricneff, D. (under review) JAAA
5 Potential Mechanisms

1. **Overdiagnosis:**
   - Cognitive impairment may be overdiagnosed in those with hearing loss or vice versa

2. **Widespread Neural Degeneration:**
   - Widespread neural degeneration may cause decline in both hearing and cognition

3. **Sensory Degradation:**
   - Hearing loss may result in the loss or degradation of sensory input to the brain

4. **Cognitive Reserve:**
   - Hearing loss may result in depletion of cognitive reserve ("effortful listening")

5. **Social Isolation/Depression:**
   - Hearing loss may result in social isolation/depression that ultimately causes cognitive decline

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**Mechanism 1: Overdiagnosis**

- Impact of undiagnosed hearing loss and decreased audibility on performance on the Mini Mental State Examination (MMSE).
- 125 young adults in 5 groups — different simulated audibility.
- MMSE performance significantly affected by audibility of questions.
- Young adults incorrectly identified as having cognitive decline when audibility reduced.
- Deficits in MMSE performance may be explained by diminished auditory function.

(Jorgensen, L., Palmer, C.V., Pratt, S., Erickson, K., Moncrieff, D., JAAA, under review)

---

**Mechanism 1: Overdiagnosis**

- From Our Lab
  - Presented earlier
  - Best Practices Assessment of Hearing and Cognition
  - No relationship between peripheral hearing and cognition
  - Significant relationship between specific central auditory measures and cognition
### Mechanism 5: Social Isolation/Depression

- **NHANES**
  - Prevalence of moderate to severe depression:
    - 4.9% for those reporting excellent hearing
    - 11.4% for those reporting a little trouble or greater
  - Multivariate odds ratios (ORs) for depression were:
    - 1.4 (95% CI, 1.1-1.8) for good hearing
    - 2.4 (1.7-3.2) for moderate trouble
- **From Our Lab:**
  - Mediation analyses not complete but…..
  - Hearing is not correlated with scores on the Center for Epidemiological Studies Depression Scale (CES-D).

*(Li et al., *JAMA Otolaryngology*, 2014)*

### MECHANISM 2, 3 AND 4

2. Widespread Neural Degeneration
3. Sensory Degradation
4. Cognitive Reserve

### Common Cause or Modifiable Risk Factor?

- **HEARING**
- **Sensory Degradation**
- **Cognitive Reserve**
- **COGNITION**
- **Widespread Neural Degeneration (Common Cause)**
Hearing Loss & Reduced Cortical Volume

(Husain et al., Brain Research, 2010; Peelle et al., J. Neuroscience, 2011; Eckert et al., JARO, 2012)

How to Evaluate Mechanisms 2, 3, 4?

1. Electrophysiological Evaluation
2. Longitudinal Assessment

We are currently doing both.....

1. Electrophysiological Evaluation
   - Auditory Brainstem Response (ABR)
   - Event-related Potentials (ERPs)
P1-N1-P2 Background
Reflective of synchronous neural activity of thalamocortical structures of the central auditory system in response to acoustic changes (Billings et al., 2009).

From Our Lab: Participants

<table>
<thead>
<tr>
<th>Variable</th>
<th>MCI (n=13)</th>
<th>Non-MCI (n=20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1-N1-P2 Background</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ERP Task

- **Passive**
  - Participants watched close-captioned movie, ignored stimuli.

- **Stimuli**
  - Speech (/ba/)
  - 1000 Hz pure tone (PT)
  - Separate blocks of 300 stimuli
  - 100 ms duration
  - 85 dB SPL
  - Interstimulus interval of 2.5 sec

(Gokob et al., Clin Neurophysiol, 2002)
Stimulus (Speech/PT) Effects:
Significantly longer latencies for speech compared to PT for P1, \( p < .001 \) and N1, \( p < .001 \); P2 was not significant (\( p > .05 \)).

Group (MCI/Non-MCI) Effects:
MCI have significantly longer P2 latency, \( p = .008 \), compared to non-MCI for PT. Larger P1 and P2 amplitudes for non-MCI compared to MCI; N1 amplitude did not follow this trend.
Conclusions

- At electrode FCZ, P1 and P2 are smaller for those with MCI.

- Novel frontopolar N1:
  - Defined the groups across stimuli and electrodes
  - Larger for MCI, especially for speech.
  - Not previously been reported in the literature.

- An increased N1 amplitude in the frontopolar region and reduced P1 and P2 amplitudes at FCZ may serve as potential indicators of early-stage cognitive impairment.

Which mechanism has the most support thus far?

**Cognitive Reserve**
Stay Tuned…
- P3 data will be out soon
- ABR data coming soon after that

2. Longitudinal Assessment
- Ongoing

Polling Question 3
Which of the 5 potential mechanisms of the hearing-cognition relationship is supported by our data?

A. Widespread degeneration
B. Social isolation/depression
C. Cognitive reserve
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Benefits of studying the hearing-cognition relationship?

• Determine and implement the most effective assessments
  • Less invasive, costly, and time-consuming than current tests of cognitive decline
  • Early indicators of cognitive decline may be found using auditory measures, before symptoms are outwardly visible.

• Determine and implement the most effective treatments
  • Treating hearing loss may prevent or delay the onset of cognitive symptoms or attenuate existing cognitive symptoms.
  • Treatment for cognitive decline and/or hearing loss can begin at the earliest juncture, when treatment is most effective.

AUDITORY-BASED TREATMENTS FOR COGNITIVE DECLINE

• Clifton, Lister, Eddins, Edwards, & O’Brien (2013) – Poster presented at Seventh International Adult Aural Rehabilitation Conference, St. Petersburg Beach, FL
• O’Brien, Peronto, Lister, & Edwards (2013) - Poster presented at International Conference on Aging and Cognition, Dortmund, Germany

From Our Lab

• P3b
  • Event-related potential
  • Parietal cortex positivity seen approximately 300-800 ms after stimulus presentation
  • Reflects attentional processing of acoustic differences between stimuli

• Oddball Stimulus Paradigm
  • Frequent: 1000 Hz pure tone – 80%
  • Deviant: 1500 Hz pure tone – 20%
  • 80 dB SPL
  • 60 ms duration
### From Our Lab

#### Participants
- 13 older adults (ages 58-82 years, mean = 67.1 years)
- No history of neurological disease with adequate cognitive status (Mini-Mental State Examination > 24)
- No previous auditory or cognitive training programs completed
- Fluent English speakers

#### Trained Group
- 6 older adults (ages 58-80 years, mean = 66.3 years)
- Brain Fitness program

#### Control Group
- 7 older adults (ages 61-82 years, mean = 67.9 years)
- 10 week waiting period (no training)

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#### High or Low?
**Identify order of tone sweeps; shorter & faster sweeps**

#### Tell Us Apart
**Discriminate syllables; decreasing differences between syllables & increasing speed**

#### Match It!
**Identify & remember speech syllables; increasing number of items & speed**

#### Sound Replay
**Remember & identify order of words; increasing number of words & speed**
Listen and Do
Remember & follow instructions; increasing complexity of instructions & speed

Story Teller
Comprehend story & answer questions; increasing story length & speed

The two groups did not differ significantly at baseline for P3b amplitude or latency, age, education, MMSE, or pure tone hearing (p>0.05)

No significant training effect for latency.
Trend for reduced amplitude following training.

Treating Hearing Loss = Treating Cognitive Impairment?

- It is unknown whether treating hearing loss will prevent, delay, or reverse cognitive decline
- Need a randomized clinical trial:
  - Treat hearing loss and determine risk of cognitive decline
  - Lin, Chisolm, Eddins – NIH R34 grant
Polling Question 4
Treating hearing loss by fitting hearing aids will improve cognition.

A. True
B. False

IOM Workshop on Hearing Loss & Healthy Aging

- Hearing loss in aging independently associated with
  - Cognitive & physical functional decline
  - An increased risk of developing dementia
  - Increased rates of hospitalization and health care utilization


QUESTIONS?
To ask a question, please type your question into the chat box in the lower left corner of the screen and click on the “Send” button located right below the box.
The Hearing-Cognition Relationship and Auditory (Brain) Training Web Seminar
Recorded June 18, 2014

THANK YOU!

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