Relating Hearing Rehabilitation for Age Related Hearing Loss to Cognitive Decline

Megan Hall and David McGowan
Jake Oleson, PhD, and Melissa Jay, MS

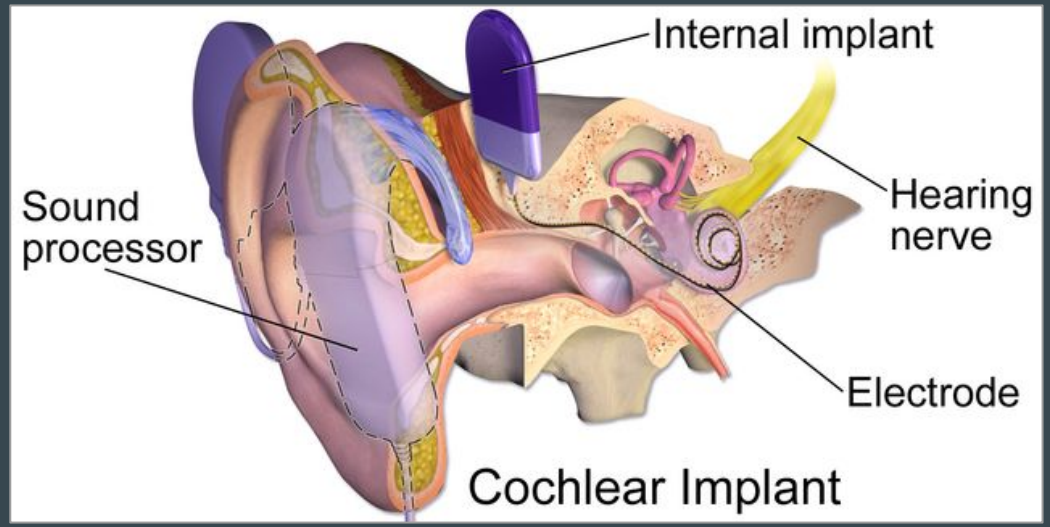
Background

Ecological Momentary Assessment (EMA)

- Self-reported data based on respondents' current/recent environment
- Series of survey questions taken many times
- Via phone at random intervals or when initiated by respondent
  - **Real-world, real-time**

Cochlear Implants

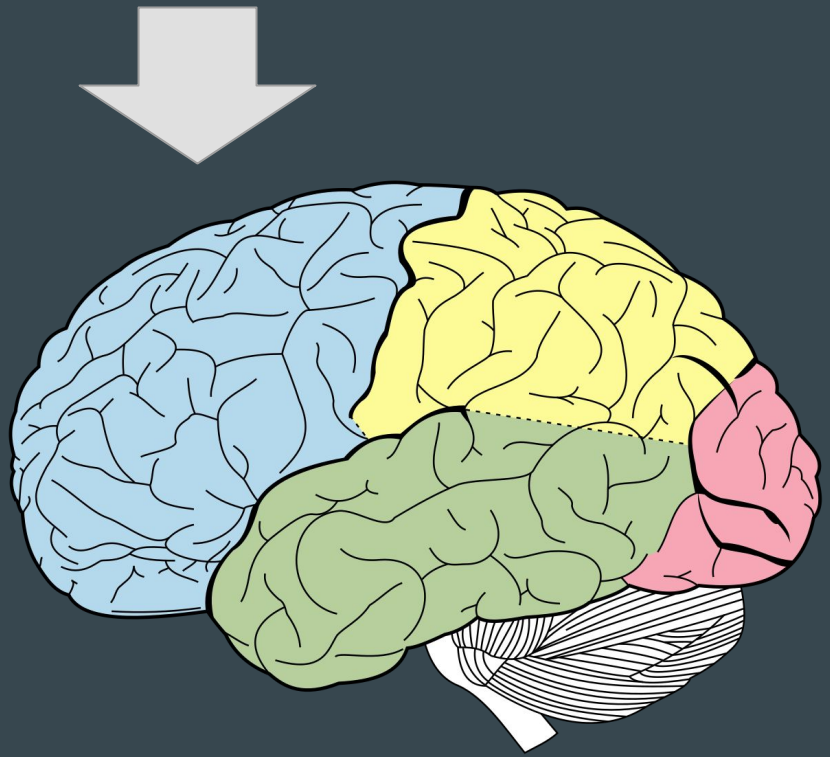
- Remediate hearing loss
- Different from hearing aids
  - Implanted inside the ear
  - Electrical signals
  - Helpful even in severe cases
- Extensive research at University of Iowa



Neuropsychology

- Processing
- Memory
- Attention
- Language

Frontal Lobe



How are neuropsychology measures related to measures of hearing function?

How can we use those relationships to evaluate the effects of cochlear implants on cognition?

Data Description

14 EMA variables

124 participants

12 neuropsych variables

5 cognitive tests

Methods

Methods

Principal Components Analysis

- Transforms correlated variables into uncorrelated variables
  - **Principal Components**
- Accounts for variations in data
- Determines number of factors for factor analysis
  - 3 factors (70% of variance)

Factor Analysis

- Identifies underlying factors that are measured by the data
  - **Latent variables**
- Factors difficult to measure by themselves

Performing Factor Analysis

- Installed ‘psych’ package
- Created correlation matrix with ‘cor’ function
- Utilized ‘principal’ function with 3 factors
- Code run separately for EMA and neuropsych data

```
EMA.cor.mat <- cor(EMA.data)

EMA.fac.load <- principal(EMA.cor.mat, nfactors = 3,
                          rotate = "varimax", scores = T)
```

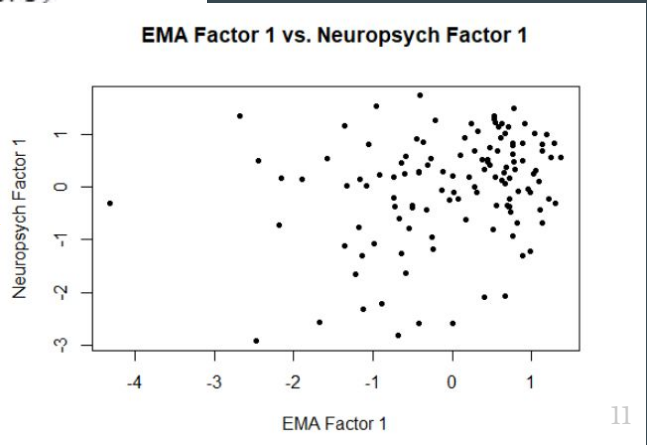
```
> EMA.fac.load
          RC1   RC2   RC3   h2   u2 com
VCavg   -0.15 -0.33  0.64 0.54 0.46 1.6
TFavg   -0.04 -0.44  0.45 0.40 0.60 2.0
NZavg    0.26  0.21  0.61 0.48 0.52 1.6
SNRavg -0.19 -0.04 -0.72 0.56 0.44 1.1
SPavg  -0.68  0.50 -0.19 0.74 0.26 2.0
```

Performing FA - Correlating Factor Scores

- Utilized ‘factor.scores’ function on results of factor analysis
- Created correlation matrix of EMA and neuropsych factor scores
- Conducted Pearson correlation t-tests for significance

```
EMA.fac.sc <- factor.scores(EMA.data, EMA.fac.load)
EMA.scores <- EMA.fac.sc$scores
join.cor.mat <- cor(EMA.scores, Neu.scores)

cor.test(EMA.factor1, Neu.factor1)
cor.test(EMA.factor1, Neu.factor2)
cor.test(EMA.factor1, Neu.factor3)
cor.test(EMA.factor2, Neu.factor1)
cor.test(EMA.factor2, Neu.factor2)
cor.test(EMA.factor2, Neu.factor3)
cor.test(EMA.factor3, Neu.factor1)
cor.test(EMA.factor3, Neu.factor2)
cor.test(EMA.factor3, Neu.factor3)
```



Results

Factor Analysis for EMA

- Factor #1: sound perception and emotional response to hearing
  - Speech perception, listening effort, sound quality, satisfaction, activity restriction, depression, social isolation, anxiety
- Factor #2: sound perception and quality
  - Speech perception, localization, sound quality, satisfaction, importance
- Factor #3: environmental factors
  - Visual communication, noise level, signal to noise ratio

	RC1	RC2	RC3
Visual Communication	-0.15	-0.33	0.64
Talker Familiarity	-0.04	-0.44	0.45
Noise Level	0.26	0.21	0.61
Signal to Noise Ratio	-0.19	-0.04	-0.72
Speech Perception	-0.68	0.50	-0.19
Listening Effort	0.73	-0.38	0.07
Localization	-0.27	0.54	-0.20
Sound Quality	-0.56	0.67	-0.11
Satisfaction	-0.72	0.51	-0.02
Activity Restrication	0.90	-0.17	0.12
Depression	0.94	-0.01	0.07
Social Isolation	0.94	-0.02	0.05
Anxiety	0.93	-0.01	0.11
Importance	-0.01	0.77	0.28

Factor Analysis for Neuropsych

- Factor #1: reasoning and memory
  - (**executive functioning**)
  - Wechsler Adult Intelligence Scale-IV
- Factor #2: verbal learning and memory
  - Hopkins Verbal Learning Test-Revised
- Factor #3: visuoperceptual skills
  - Brief Visuospatial Memory Test-Revised
  - Trail Making Test A
  - Trail Making Test B

	RC2	RC1	RC3
BVMT Total Recall	0.503		0.675
BVMT Delayed Recall	0.371		0.650
Trails A		0.241	0.807
Trails B		0.346	0.694
WAIS Similarities	0.149	0.754	0.174
WAIS Digit Span	0.106	0.668	0.373
WAIS Matrix Reasoning	0.106	0.632	0.275
HVLT Total Recall	0.713	0.444	0.158
HVLT Delayed Recall	0.896	0.285	
HVLT Recog. Discrim.	0.748		
HVLT Retention	0.757		
Word Similarities	0.172	0.840	

Correlating Factor Scores

- Significant relationships (at $\alpha = 0.05$):
  - Verbal skills and emotional response to hearing
  - Executive functioning and environmental sound factors

	Neuro Exec Function	Neuro Verbal Skills	Neuro Visual Skills
EMA Emotional Response	-0.00213402	0.24731594	0.06267506
EMA Sound Perception	0.11841844	0.04373780	0.08322106
EMA Environment	0.31906291	0.01674069	0.10675408

Moving Forward

- Longitudinal data to analyze cochlear implant effectiveness
- Linear mixed regression models on our factor scores

Acknowledgements

- Jake Oleson, PhD
- Melissa Jay, MS
- ISIB Program sponsored by the National Heart, Lung, and Blood Institute (NHLBI), grant # HL-147231
- University of Iowa Cochlear Implant Research Group
  - Camille Dunn, PhD
  - Kristen Caraher, PsyD

Questions?