

Wake up!

Let's talk about fatigue in the classroom

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Option Schools, Inc. Annual Meeting
May 3, 2016



Acknowledgements

- Faculty Investigators

- Fred H. Bess
- Stephen Camarata
- Ben W. Y. Hornsby
- Alexandra Key

- Lab Members (previous and current)

- Nicholas Bennett
- Angela Chen
- Hilary Davis
- Tonia Davis
- Stone Dawson
- Andy DeLong
- Caralie Focht
- Emily Fustos
- Elizabeth Geller
- Olivia Gutierrez
- Amanda Headley
- Dorita Jones
- Ralph Leverett
- Lindsey Rentmeester

- Project/Staff Funding

- Institute of Education Sciences, U.S. Department of Education through grant R324A110266 (Bess, PI) to Vanderbilt University
- Dan and Margaret Maddox Charitable Trust
- American Speech Language and Hearing Association



- Quela Royster
- Rebecca Schoon
- Sara Seckman
- Amelia Shuster
- Beth Suba
- Krystal Werfel

What is Fatigue?



- Occurs in the physical and mental/ cognitive domains
- Subjectively- fatigue is a mood or feeling of tiredness, exhaustion, or lack of energy
- Behaviorally- fatigue affects focus, concentration, alertness, and/or mental efficiency

Fatigue is Common!

Transient fatigue

- Common, even in healthy populations

Recurrent, severe fatigue

- Uncommon in healthy populations, but common in many chronic health conditions
 - Cancer, HIV AIDs, Parkinson's, Multiple Sclerosis



Consequences of Fatigue



Adults

- stress, inattention, reduced concentration, slowed mental processing, and impaired decision-making
- less productive and more prone to accidents
- less active, more isolated, less able to monitor own self-care



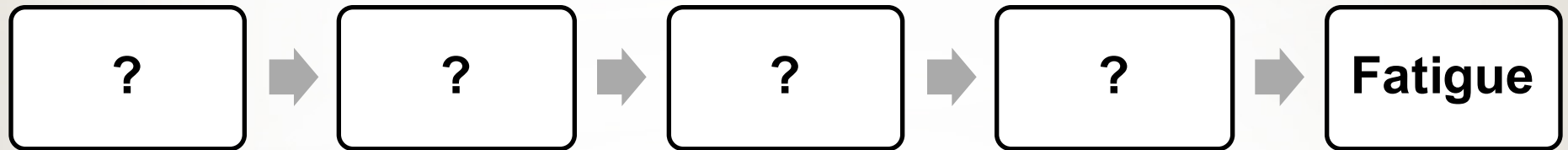
Children

- inattention, reduced concentration, high distractibility
- poorer school achievement, higher absenteeism



Listening-Related

What contributes to [^]fatigue?



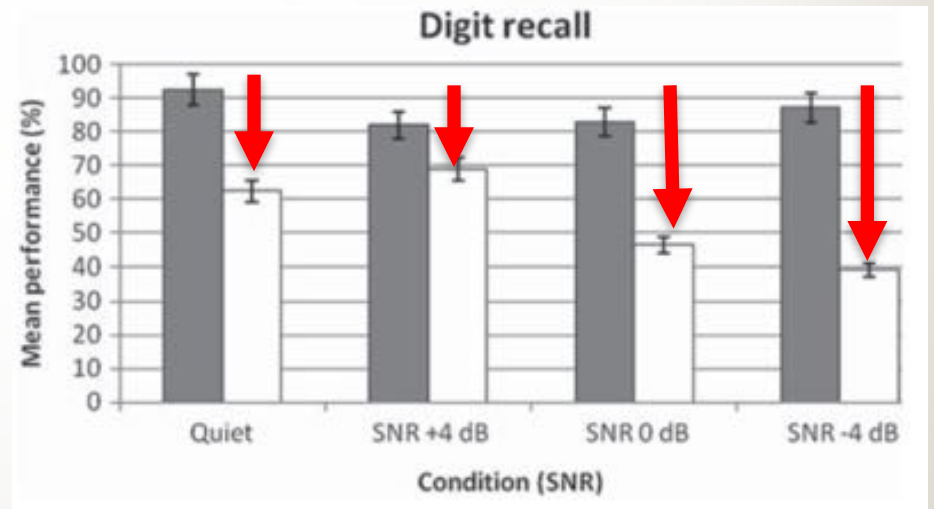
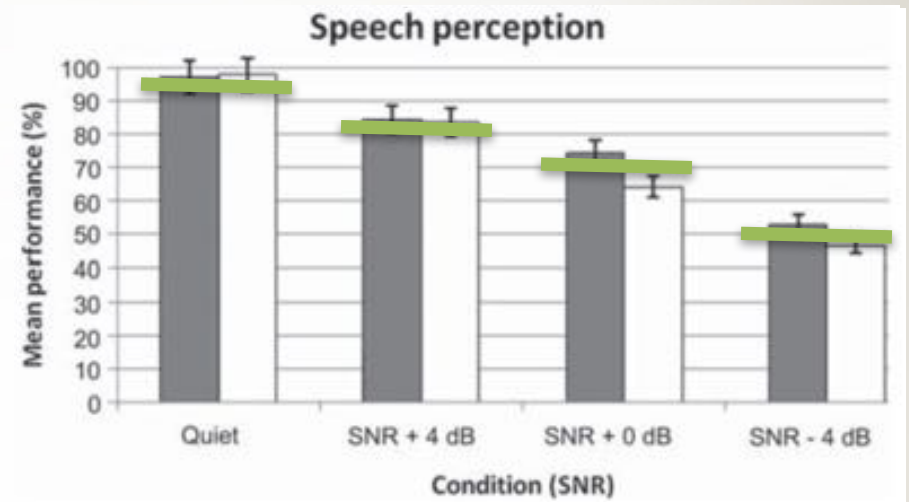
CLASSROOM ~~Degraded~~ Listening Conditions



Consequences of Listening in Noise



Listening effort refers to the allocation of attentional and cognitive resources toward auditory tasks.



Listening-Related

What contributes to [^]fatigue?



Fatigue and Hearing Loss

“...since I lost most of my hearing..., I've had periodic bouts of tiredness that are deeper and of a different quality than I ever experienced before.”

– David Copithorne, 2006



"First thing I do when I get home is take my hearing aids out. I just need a break."

- Student with hearing loss



“Processing and constructing meaning out of half-heard words and sentences. Making guesses and figuring out context. And then thinking of something intelligent to say in response to an invariably random question. It’s like doing jigsaws, Sudoku and Scrabble all at the same time.”

– Ian Noon, 2013

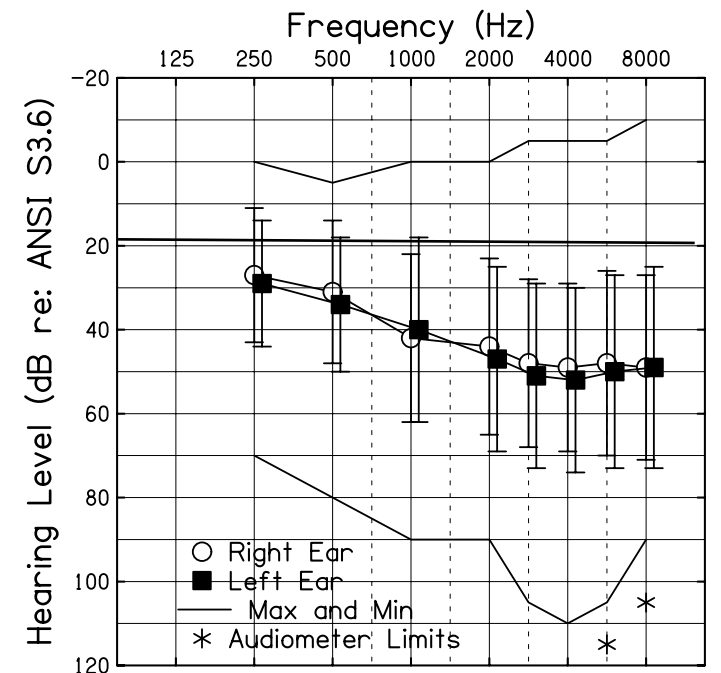
"My child stayed only five minutes at a recent social event. He tends to withdraw and get overwhelmed in big groups of people. He's seeming more frustrated by these experiences."

- Mother of a child with hearing loss

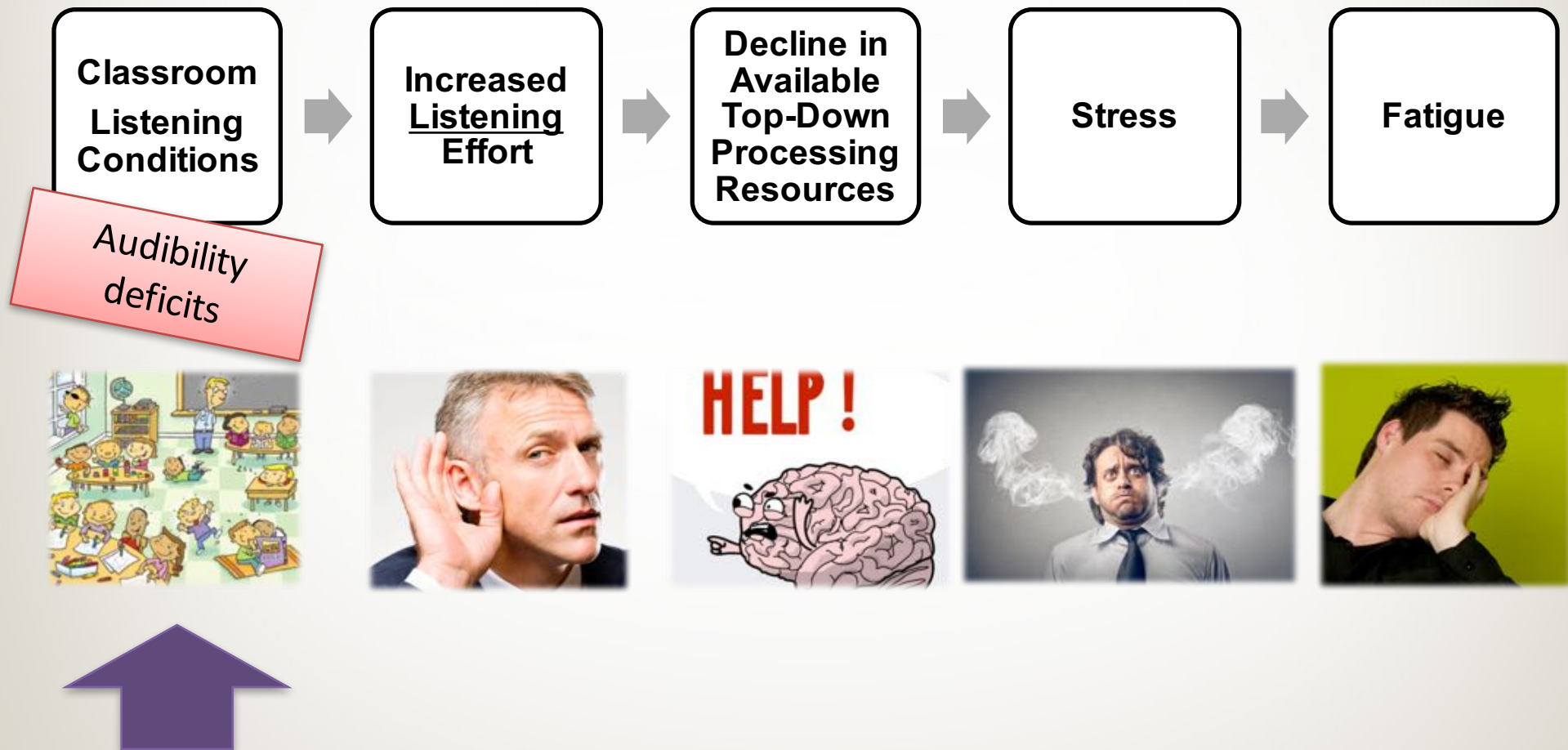


Vanderbilt Study on Listening Effort & Fatigue

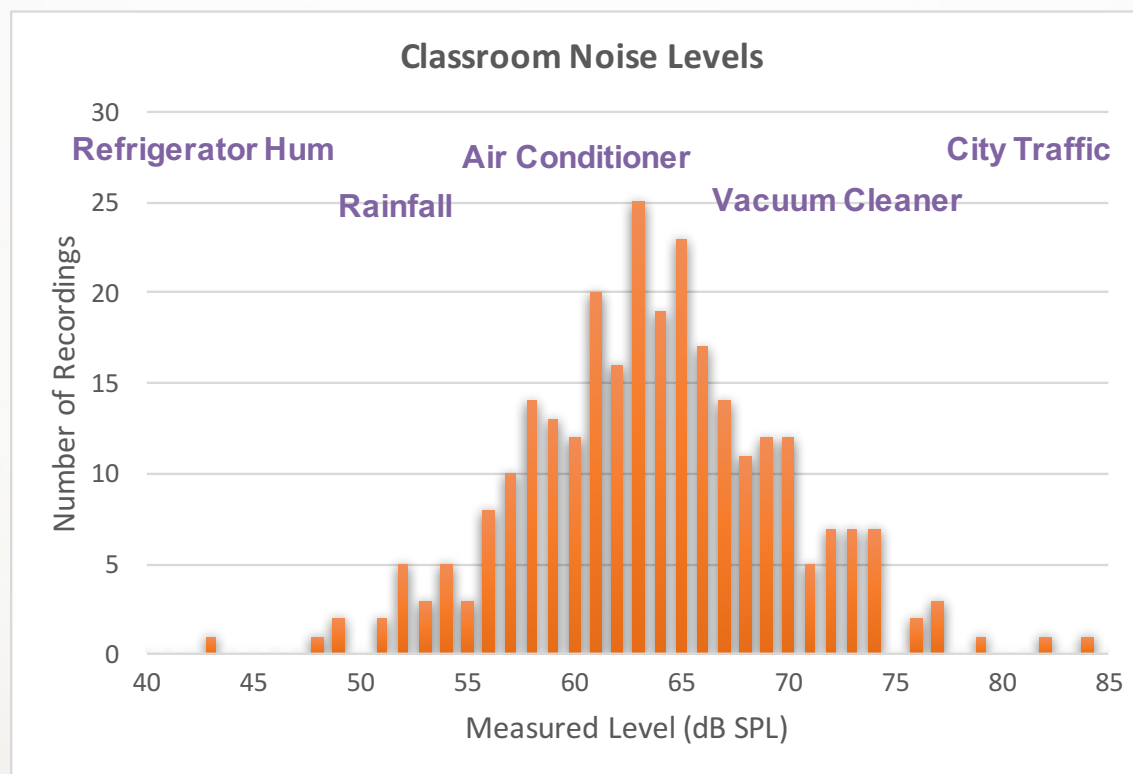
- 6-12 year old children
 - Bilateral, mild to moderately-severe, permanent hearing loss
- Inclusion/Exclusion:
 - No cochlear implant users
 - General education classroom
 - Monolingual English speakers
 - No diagnosis of cognitive impairment, autism, or other developmental disorder
- Experimental group (n=60)
 - 31 males, 29 females
 - Age = 9.96 (1.92) years
- Control Group (n=43)
 - 26 males, 17 females
 - Age = 9.10 (2.32) years



Implications for Children with Hearing Loss



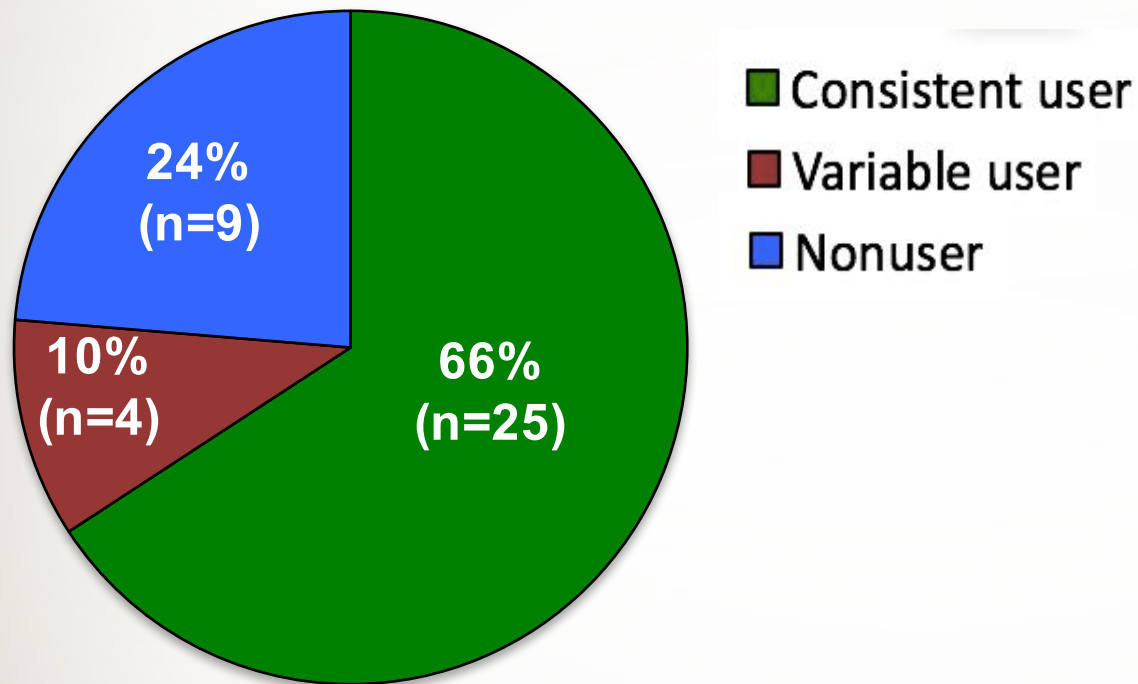
Overall Speech + Noise Levels in Middle Tennessee Classrooms



*Levels of
Common Noises*

Classroom Observations

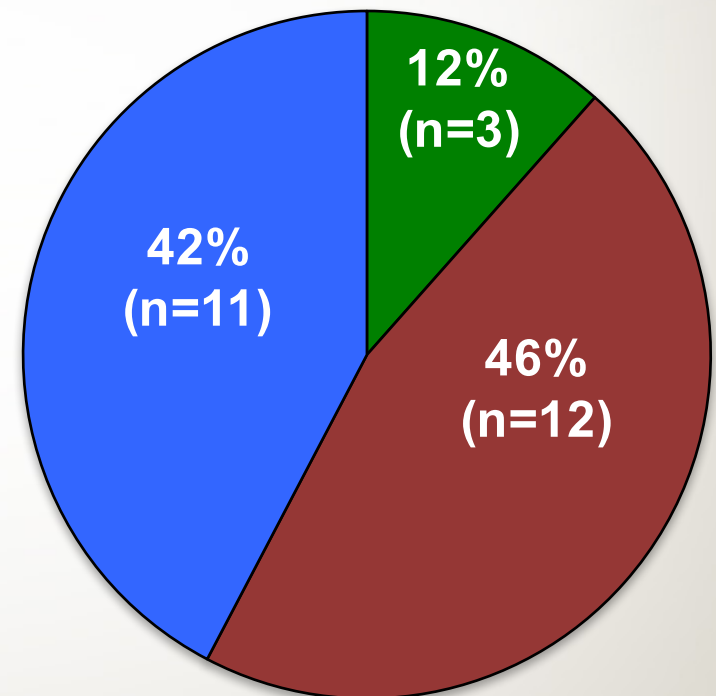
Hearing Aid Use



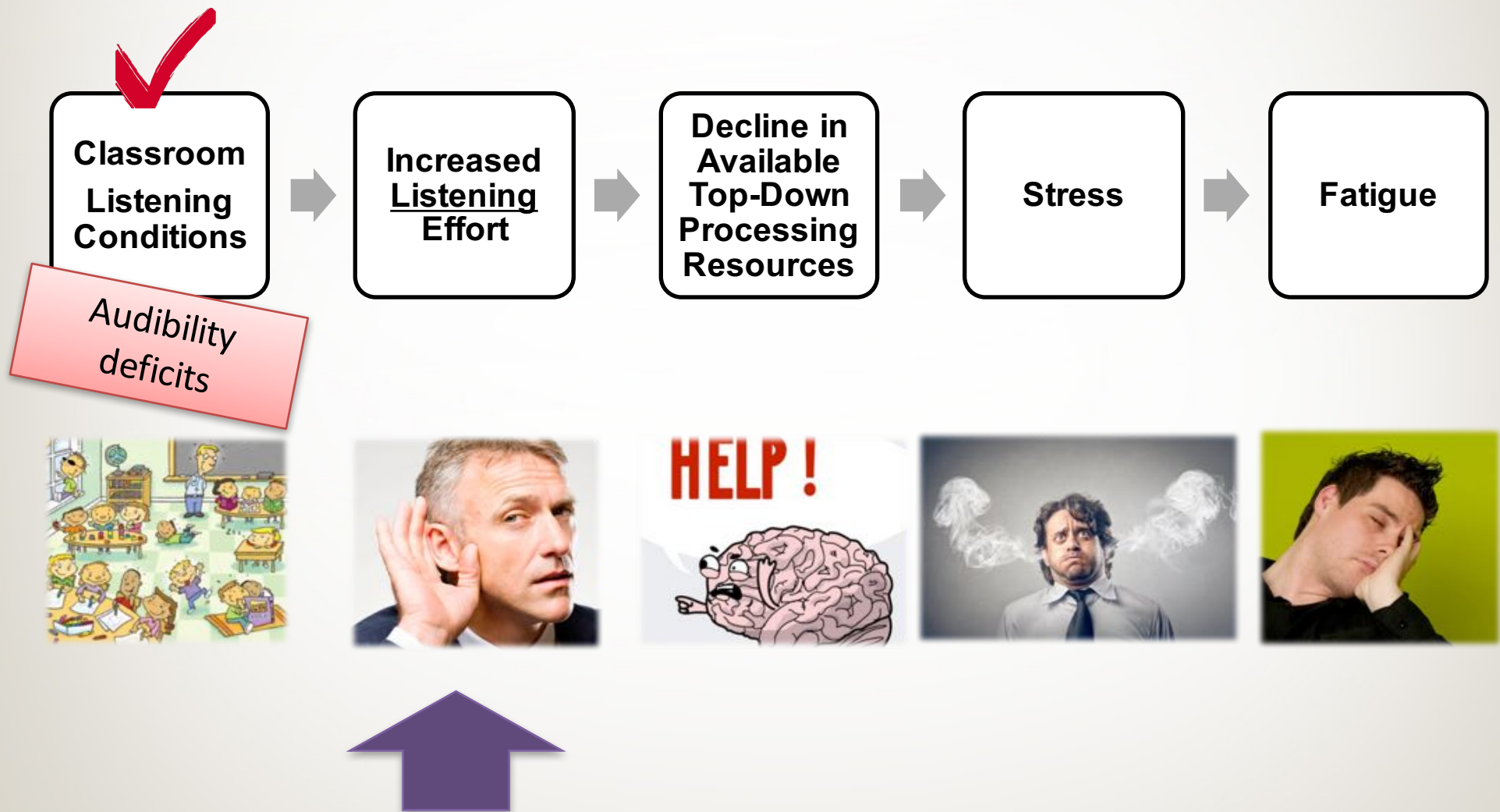
Children with less hearing loss, and those in higher grades (5th-7th) were less likely to use hearing aids in the classroom.

FM system available?
89% of 1st - 4th graders
47% of 5th - 7th graders

FM System Use



Implications for Children with Hearing Loss

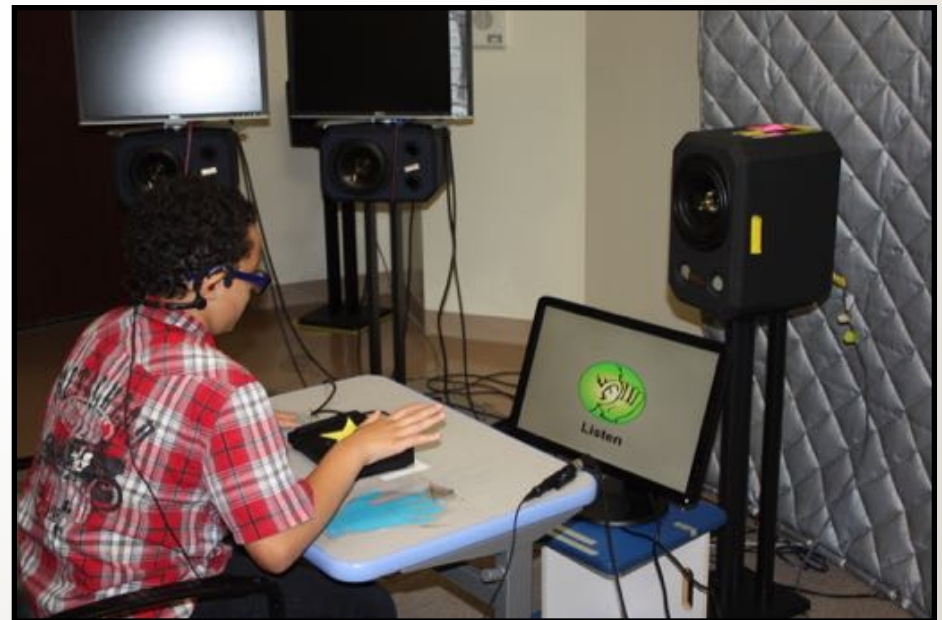


Assessing Listening Effort in the Lab: Dual-Task Paradigm

Primary task: Word Recognition

Secondary task: Visual Reaction Time

Three SNRs ranging from -4 to +12 dB in multi-talker babble



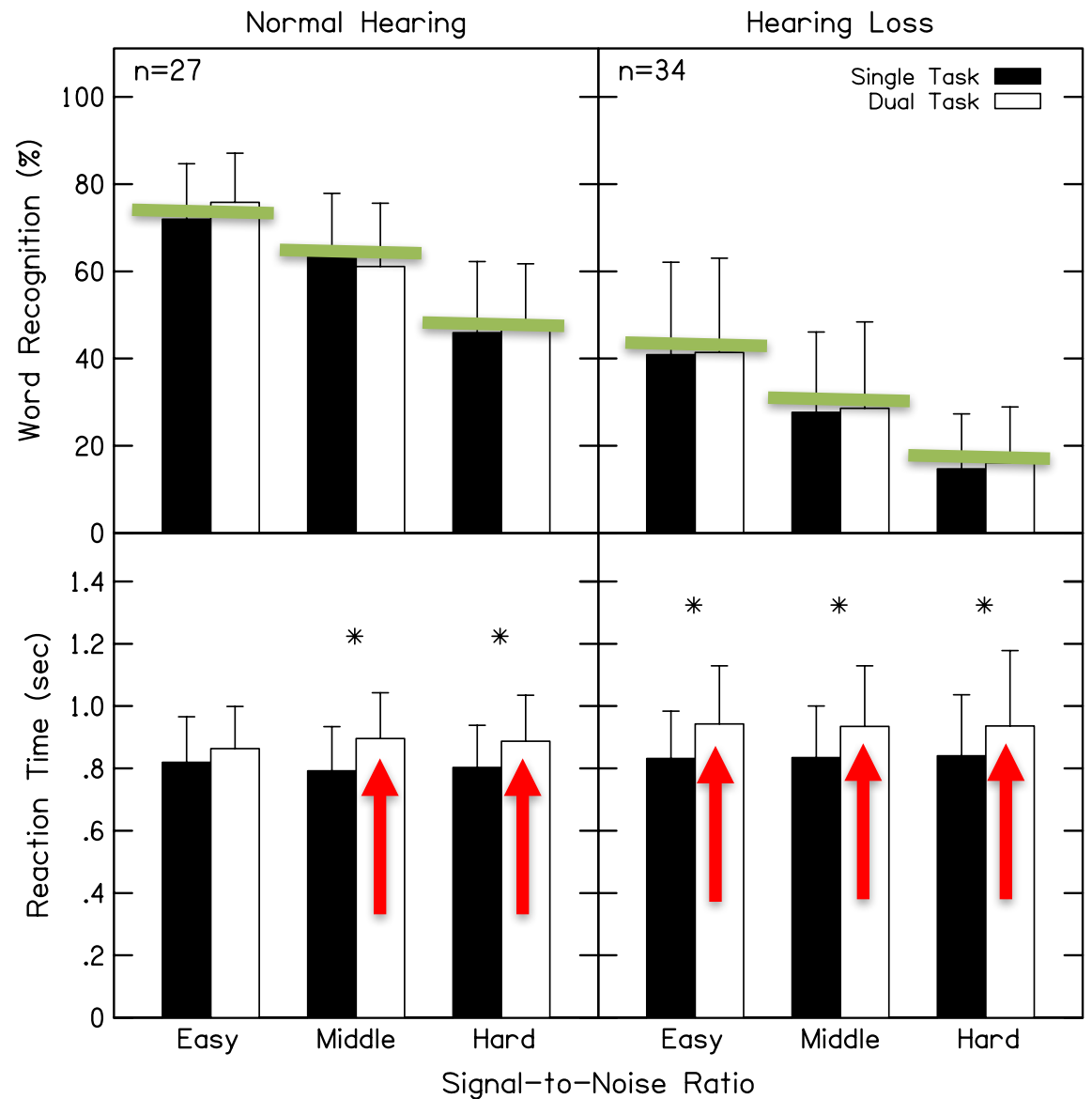
Listening Effort

No difference in word recognition performance between single- and dual-tasks.

Longer response times measured with addition of second task.



Cognitive resources were allocated toward maintaining word recognition performance in the dual-task condition.



Implications for Children with Hearing Loss



Assessing Change in Available Processing Resources

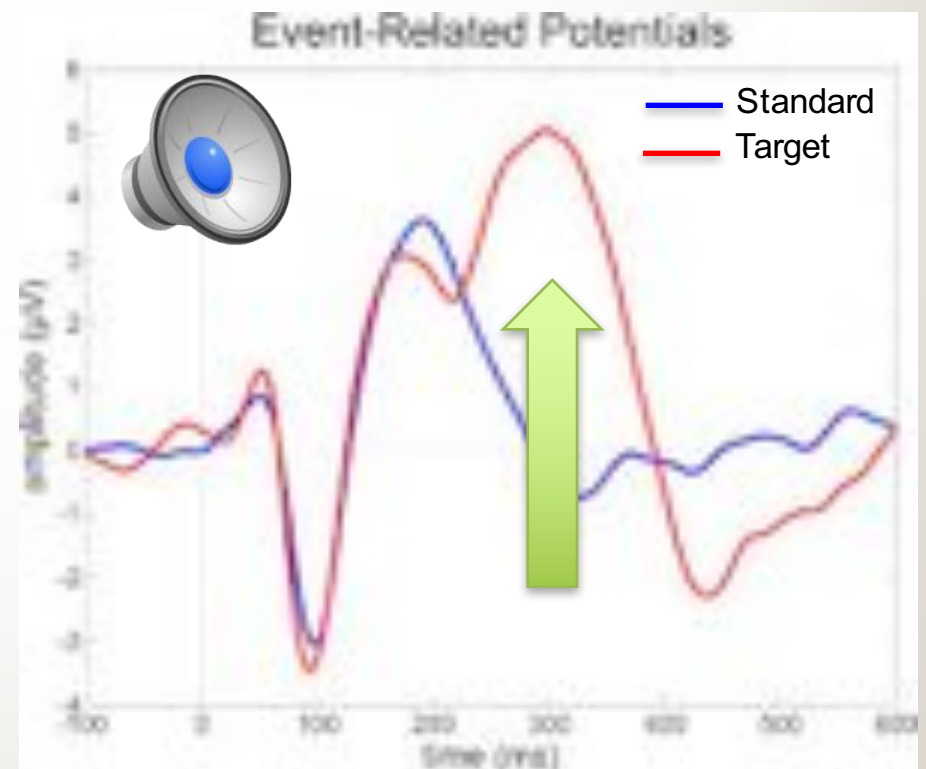
Event-related potentials (ERP) are changes in ongoing EEG activity that are time-locked to the onset of the auditory event.

ERPs reflect changes in brain activity associated with processing of an auditory stimulus.

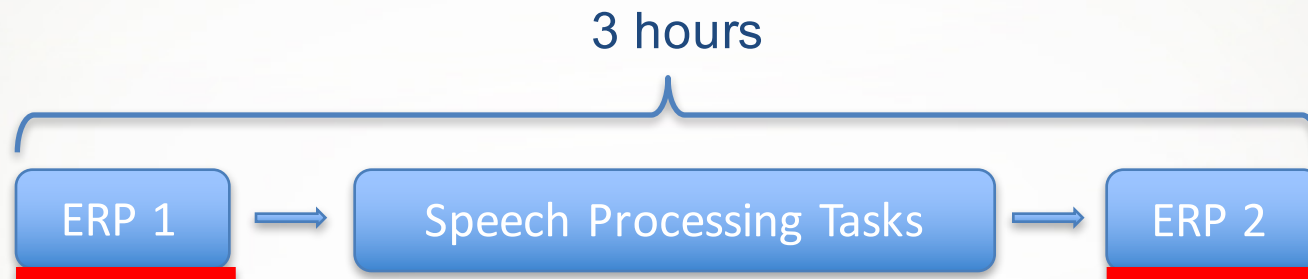
Centro-parietal P300 response

- "Cognitive" potential
- Sensitive to attention

Less available processing resources → reduced amplitude



Assessing Change in Available Processing Resources



Stimuli

- Oddball paradigm (70/30)
- Speech syllables
 - (“gi” and “gu”)
 - 65 dB SPL
- Multi-talker babble
 - +10 dB SNR

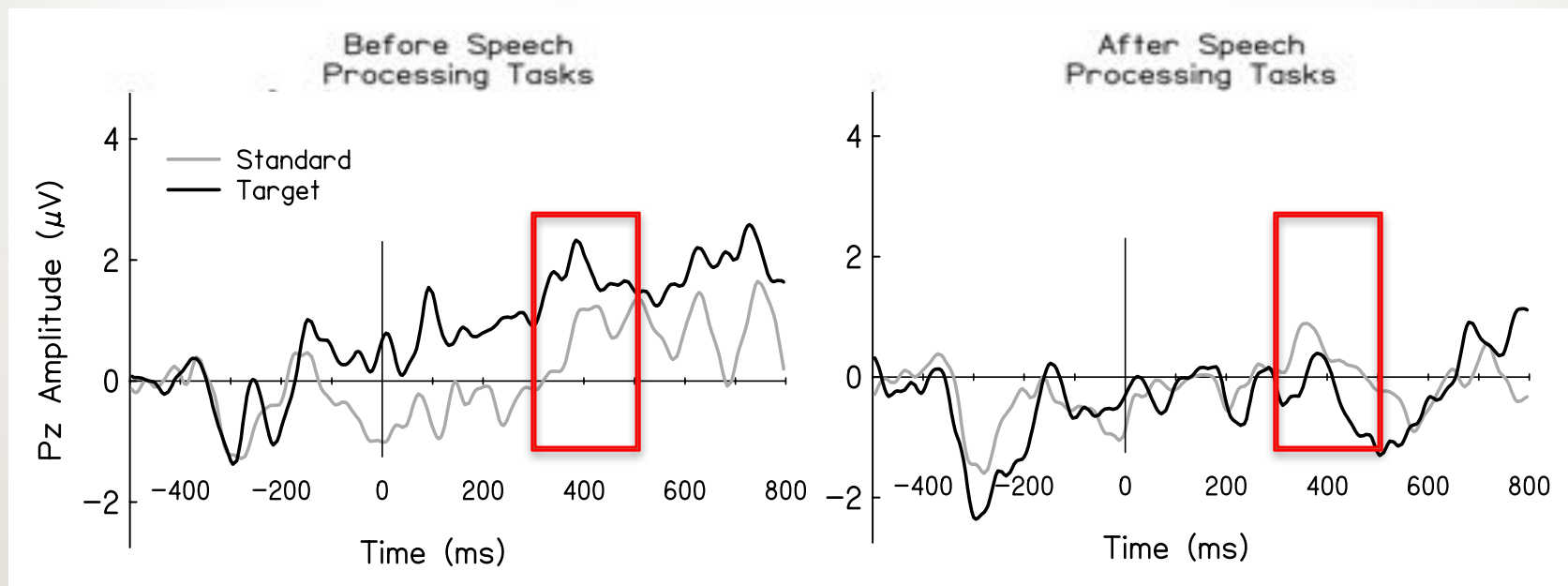
Outcome

- ERP 1 vs ERP 2



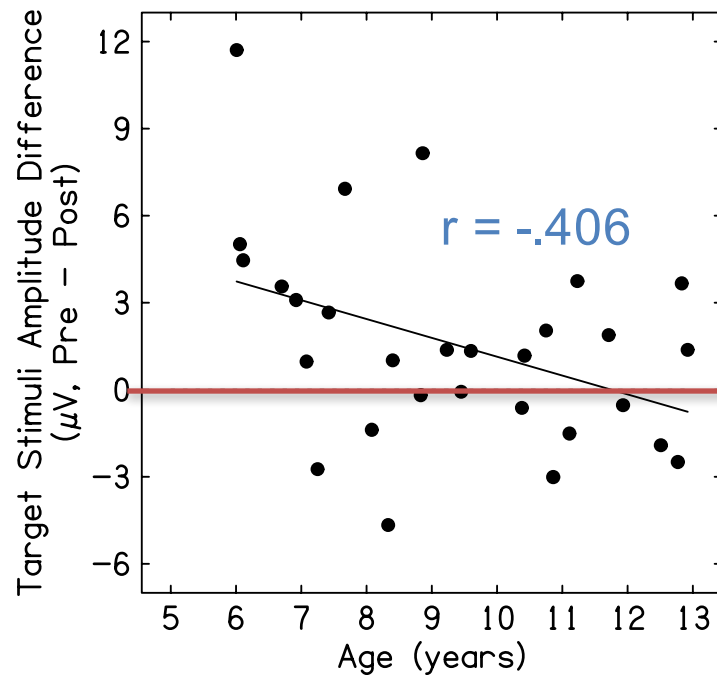
Change in Processing Resources: *Children with Normal Hearing*

Cognitive processing was reduced following sustained speech-processing tasks ($p < .05$).

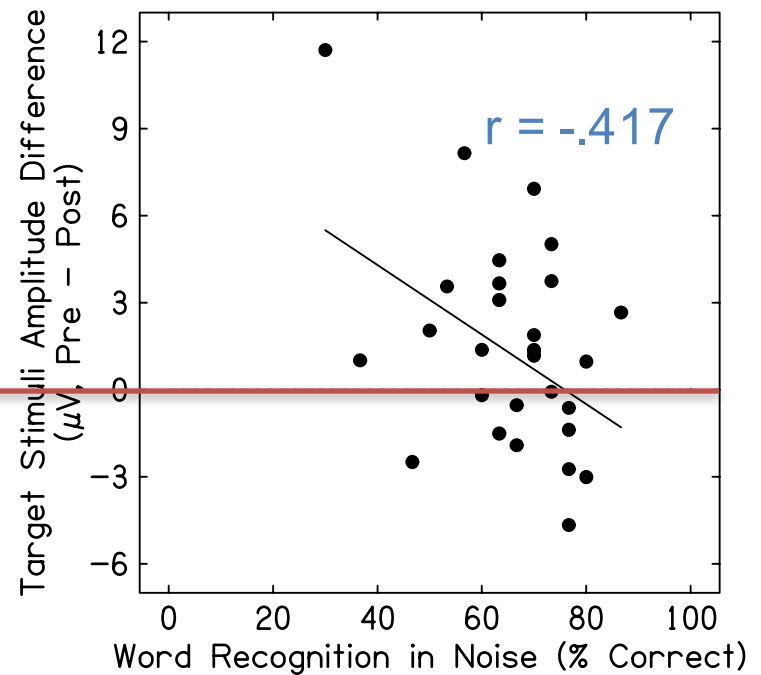


Who's at risk?

Children with Normal Hearing

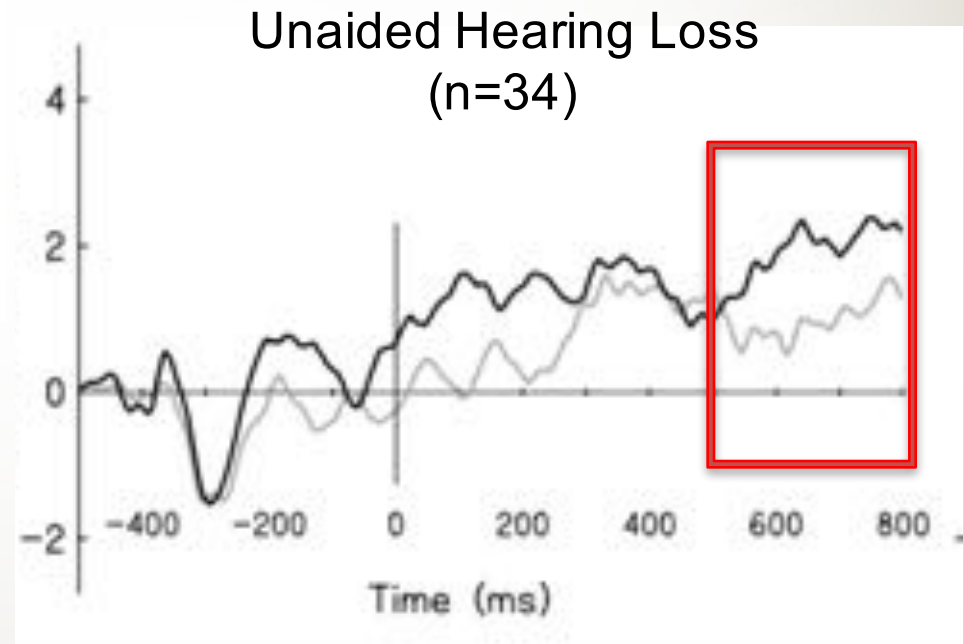
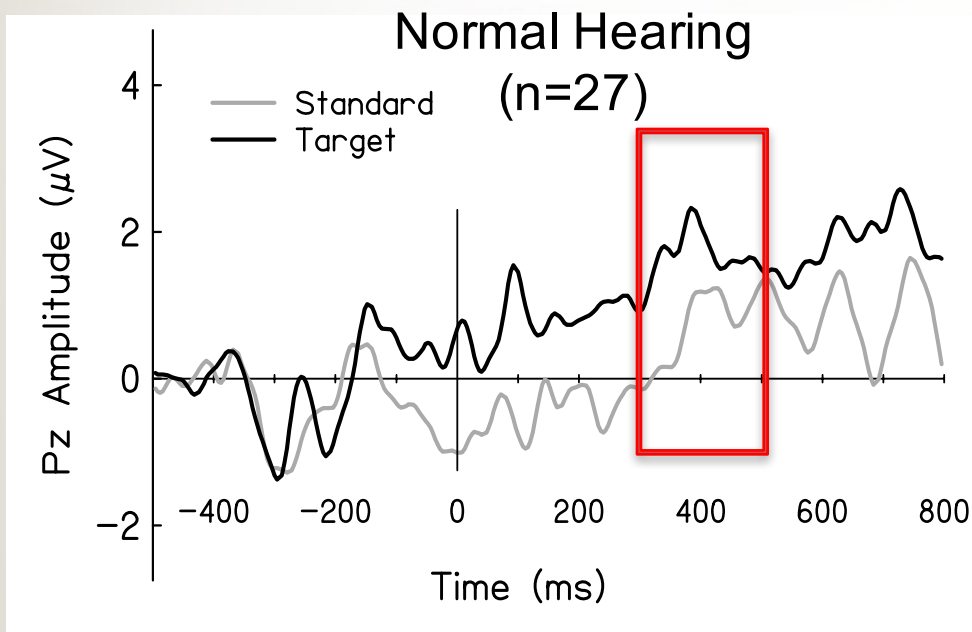


Reduced
Cognitive
Processing



For children with normal hearing, younger children and those who have poorer speech recognition in noise were more likely to show reductions in cognitive processing due to sustained speech-processing.

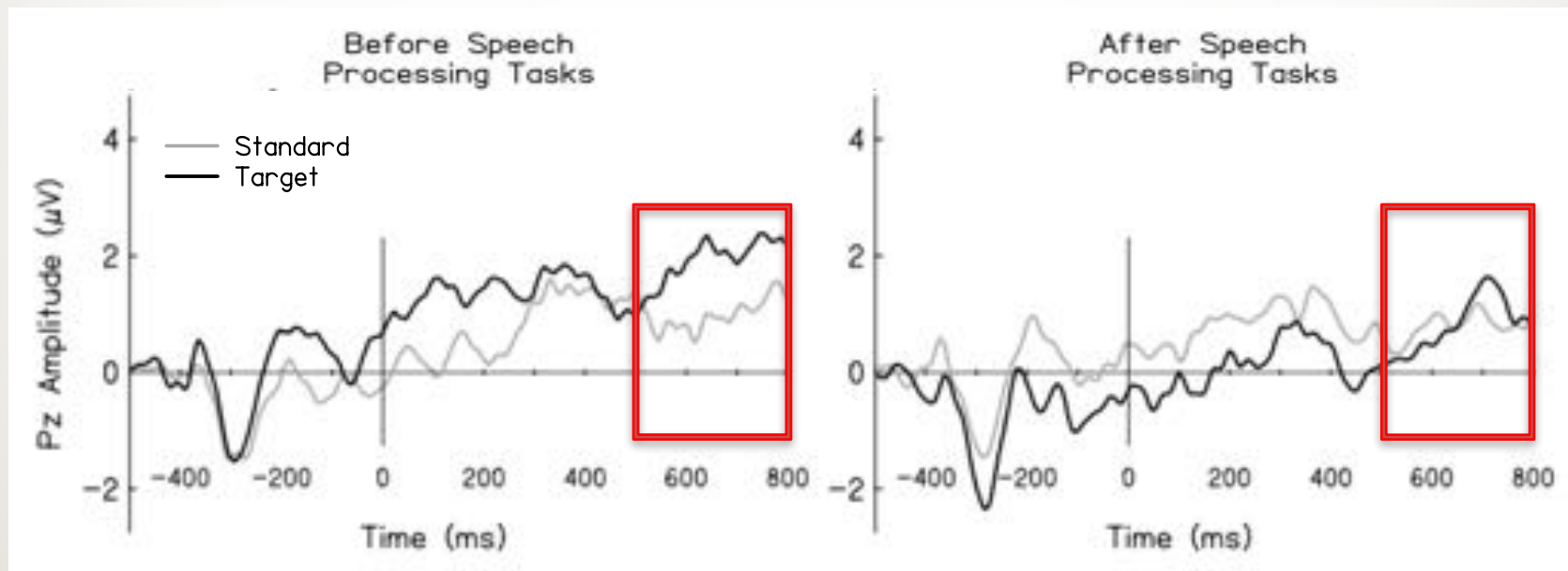
Change in Processing Resources: *Children with Hearing Loss*



Children with hearing loss show delays in cognitive processing when compared to children with normal hearing.

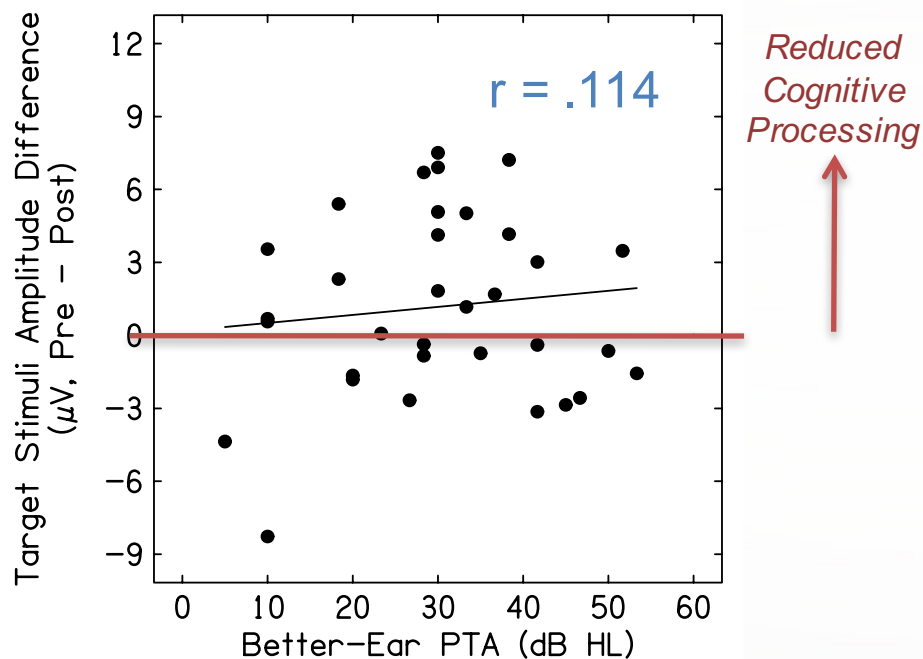
Change in Processing Resources: *Children with Hearing Loss*

Trend for cognitive processing to be reduced following sustained speech-processing tasks ($p=.087$).



Who's at risk?

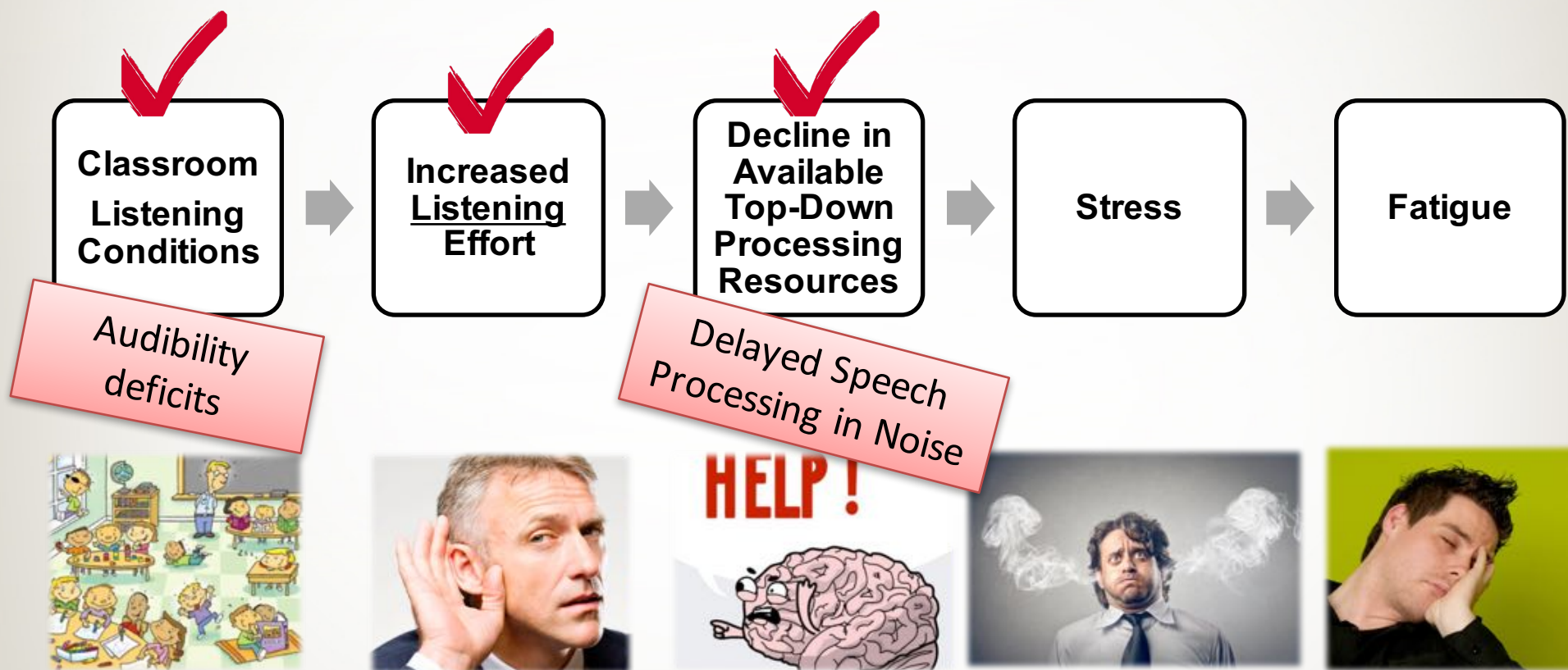
Children with Hearing Loss



Age, Language, Nonverbal Intelligence, or Speech in Noise Recognition did not significantly relate with cognitive processing changes following sustained speech processing.

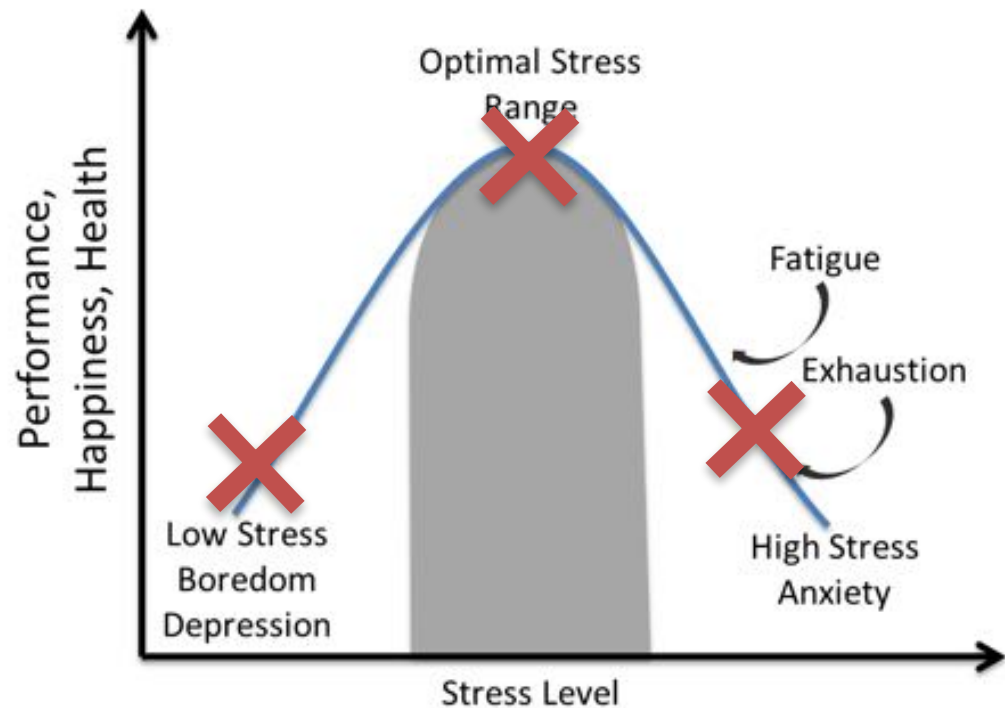
The lack of relationship with degree of hearing loss suggests that all children with hearing loss, even mild hearing loss, are at risk of negative effects of increased listening effort.

Implications for Children with Hearing Loss



Assessing Stress

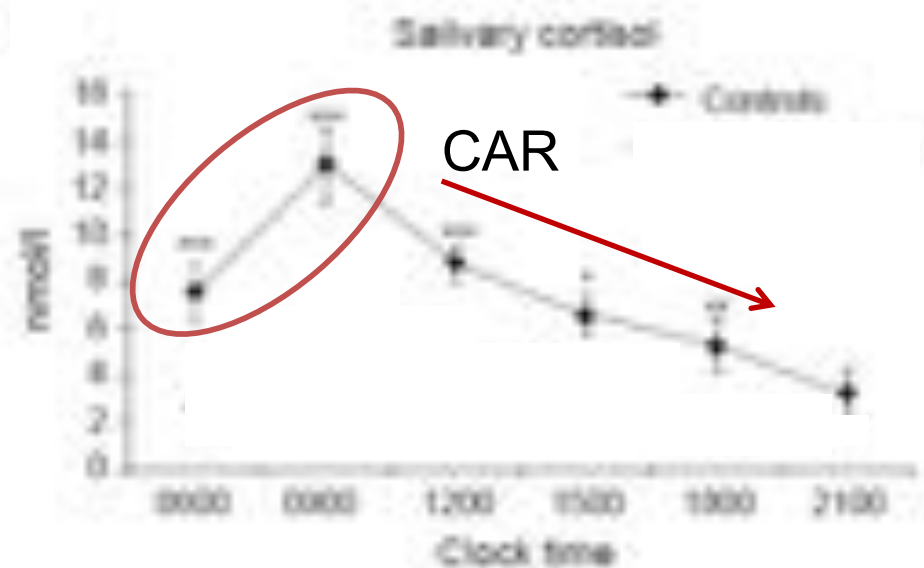
- Stress is the body's reaction to change that requires a physical, mental, or emotional response
 - Stress is caused by good and bad experiences
- **Cortisol** levels provide a physiologic measure of stress
 - Regulated by the hypothalamic-pituitary-adrenal (HPA) axis
 - Related to sugar levels in the blood that fluctuate based on the need to mobilize energy



“Typical” Cortisol Patterns

In non-fatigued individuals, cortisol levels have a typical diurnal pattern

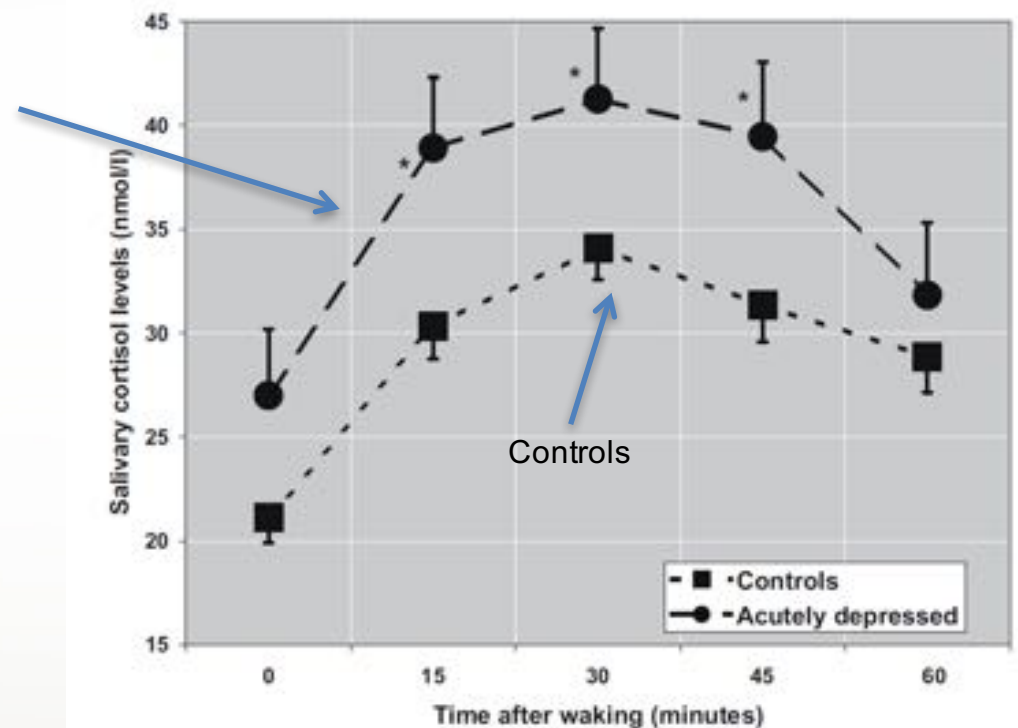
- Build-up of cortisol during sleep
- Rapid rise upon awakening
 - Cortisol Awakening Response; CAR
- Slow decline in cortisol throughout the day



“Atypical” Cortisol Patterns

Sustained stress can lead to abnormal diurnal cortisol patterns

“Elevated” CAR in patients with depression



“Atypical” Cortisol Patterns

Sustained stress can lead to abnormal diurnal cortisol patterns



Reduced response with “Chronic Fatigue Syndrome”

Measuring Salivary Cortisol Levels



- Participants
 - Children with hearing loss (n=32)
 - Control group (n=28)
- Six samples per day
 1. Awakening*
 2. 30 min post-wake up*
 3. 60 min post-wake up*
 4. 10:00 am
 5. 2:00 pm
 6. 8:00 pm*
- Sampled on two separate school days

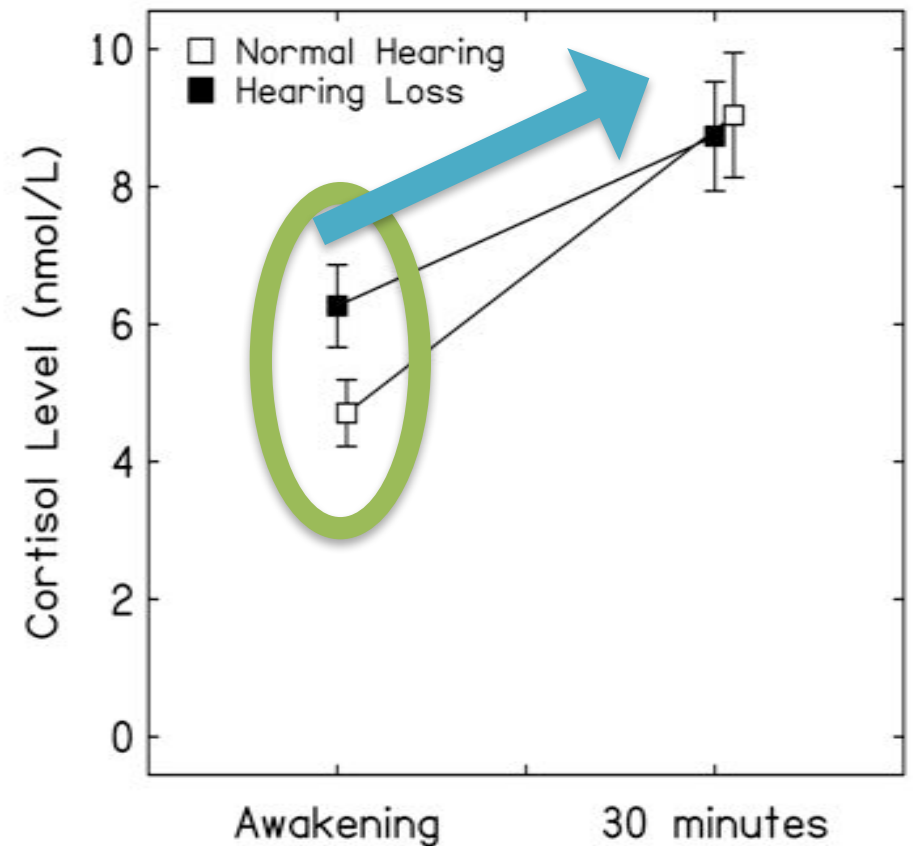
*Samples taken by parents at home

Comparing Measured Cortisol Levels

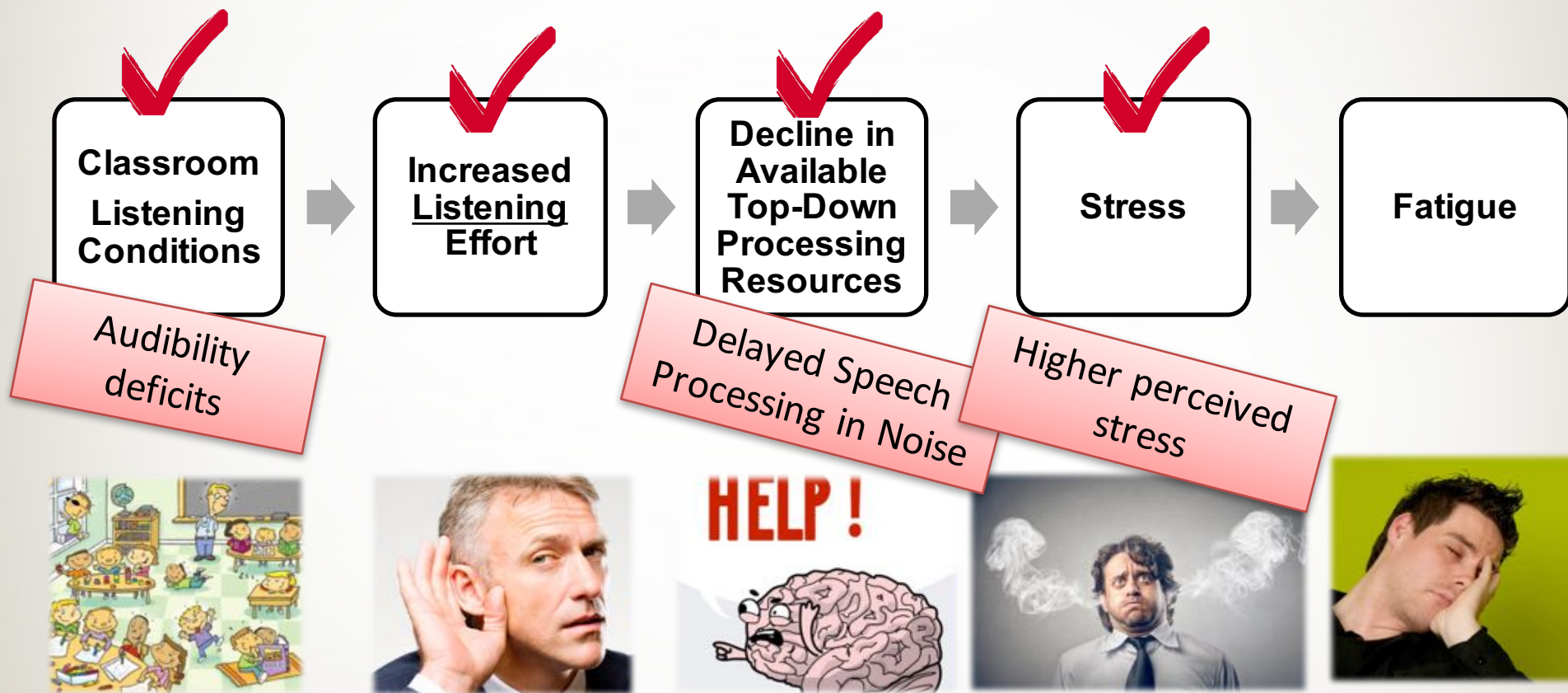
Children with hearing loss have higher cortisol levels at awakening than controls

Children with hearing loss have a reduced CAR compared to controls

Suggests children with hearing loss are experiencing perceived stress and an increased burden of worrying about the upcoming day



Implications for Children with Hearing Loss

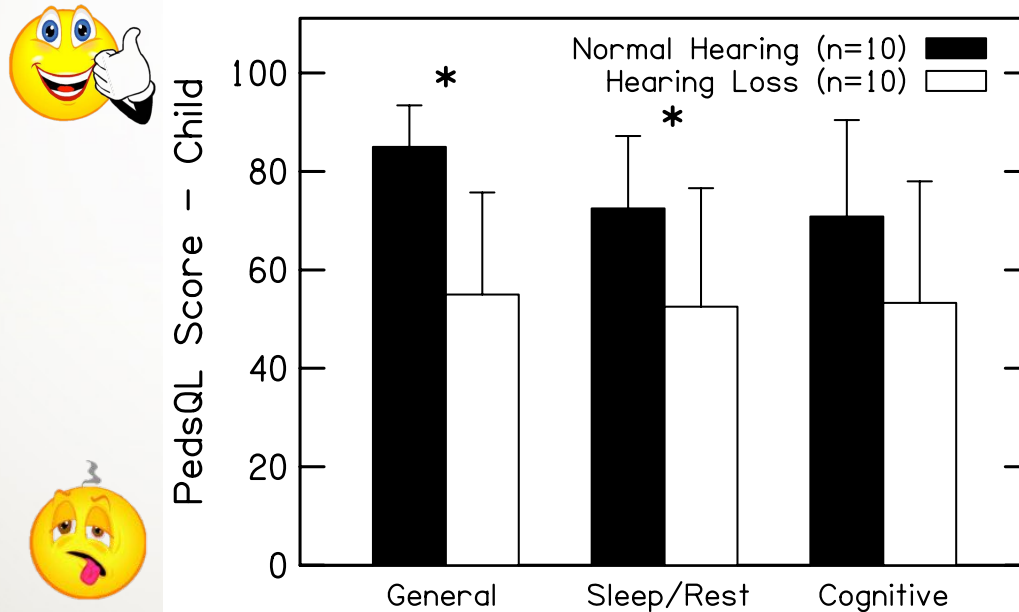


Can we measure the subjective experience of fatigue?



Assessing Fatigue with the PedsQL MFS

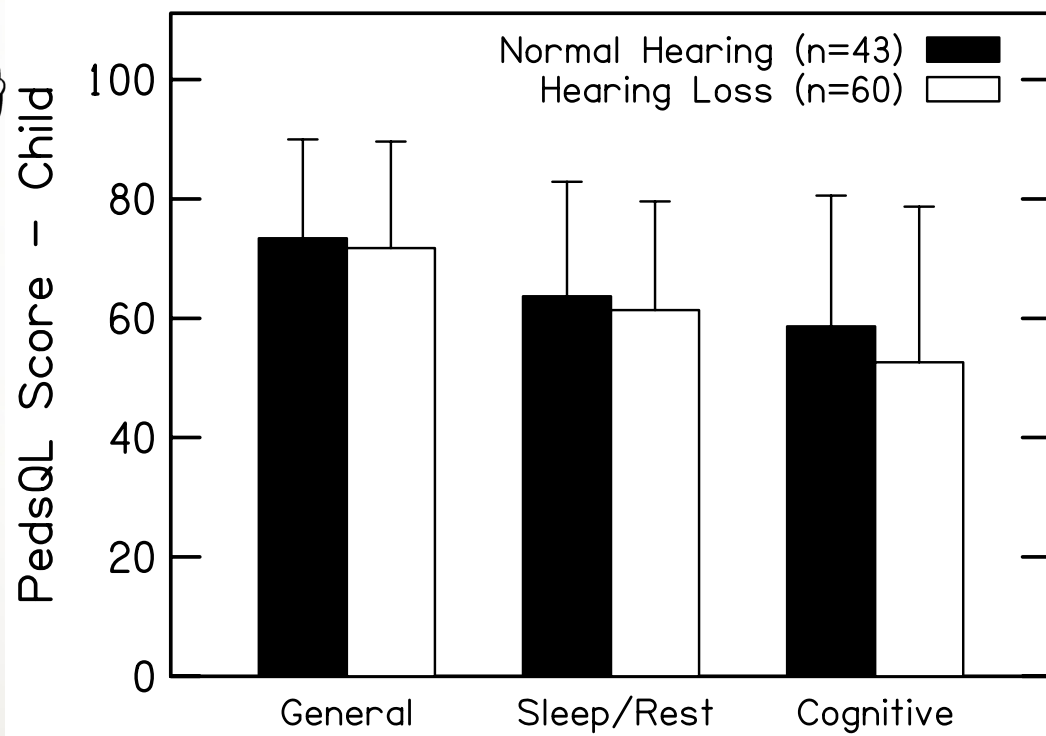
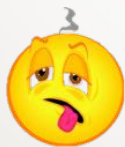
Our preliminary data and data from children with cochlear implants suggests that children with hearing loss report more fatigue on the PedsQL Multidimensional Fatigue Scale



(Hornsby, Werfel, Camarata, and Bess, 2014; Werfel and Hendricks, 2015)

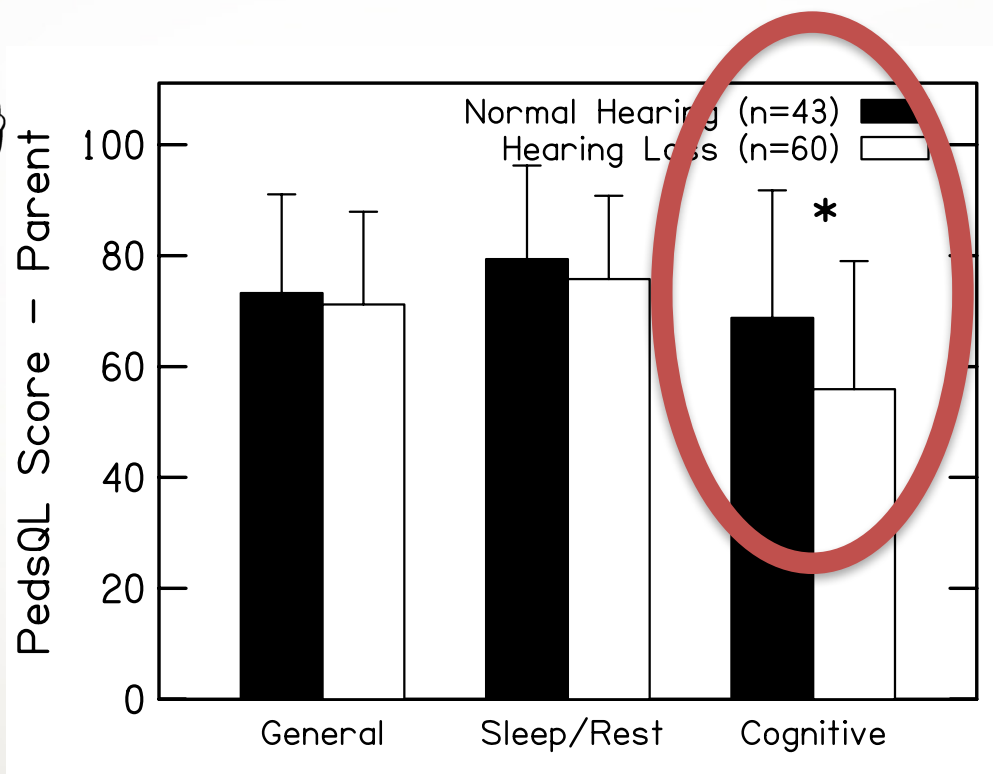
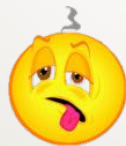
Subjective Fatigue Reports

Children with mild- to- moderately-severe hearing loss do not report more fatigue than peers with hearing loss on the PedsQL Multidimensional Fatigue Scale

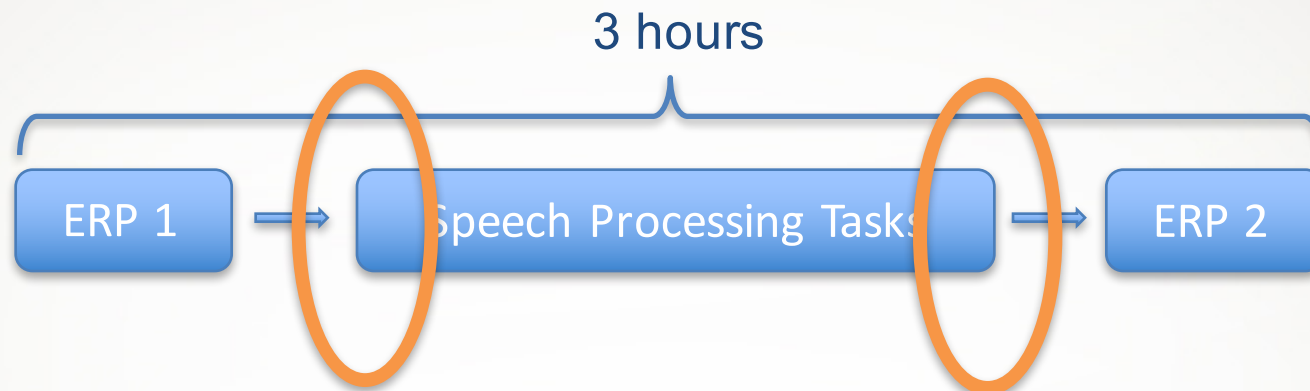


Parent-Reported Fatigue

Parents of children with hearing loss report their child to be more fatigued in the cognitive domain than do parents of children with normal hearing ($p < .05$)



Immediate Fatigue Reports



Response Time



Attention Lapses



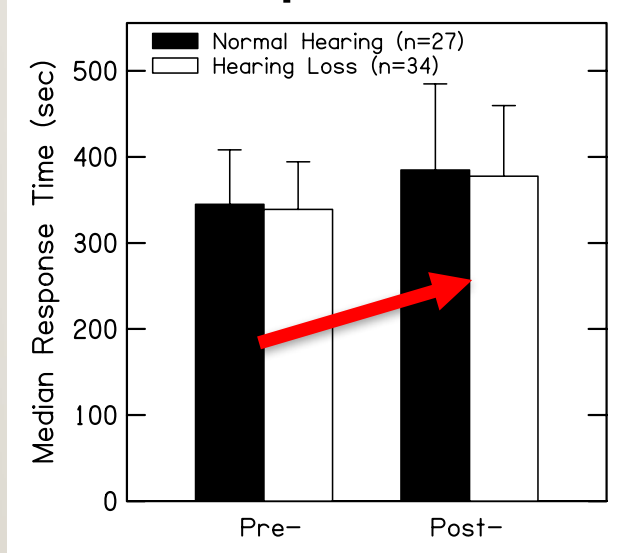
Fatigue Ratings

1. I feel tired
2. It is easy for me to do these things
3. My head hurts
4. It's hard for me to pay attention
5. I have trouble thinking

Immediate Fatigue Reports

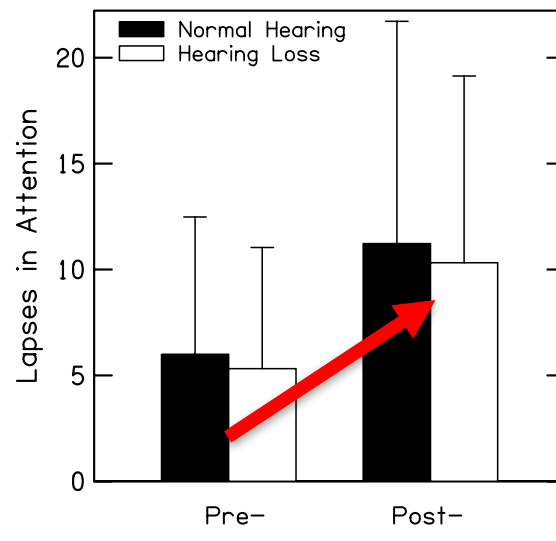
Although both groups showed increased lapses of attention following sustained speech processing, our brief fatigue rating scale did not capture subjective fatigue in children with and without hearing loss.

Response Time



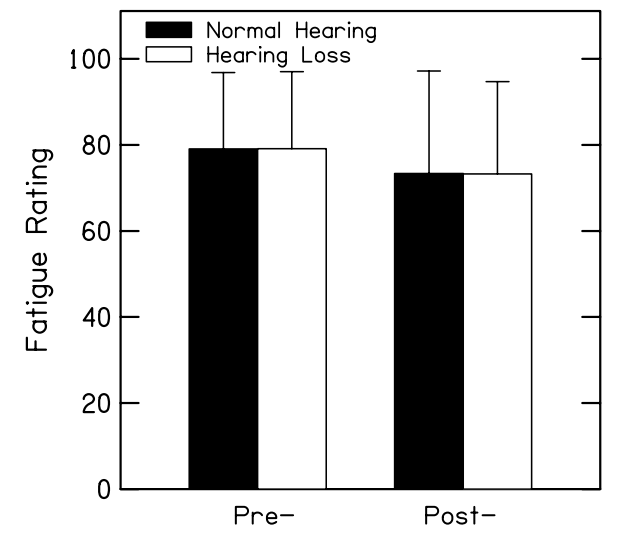
Marginally significant increase in response time ($p=.083$)

Attention Lapses



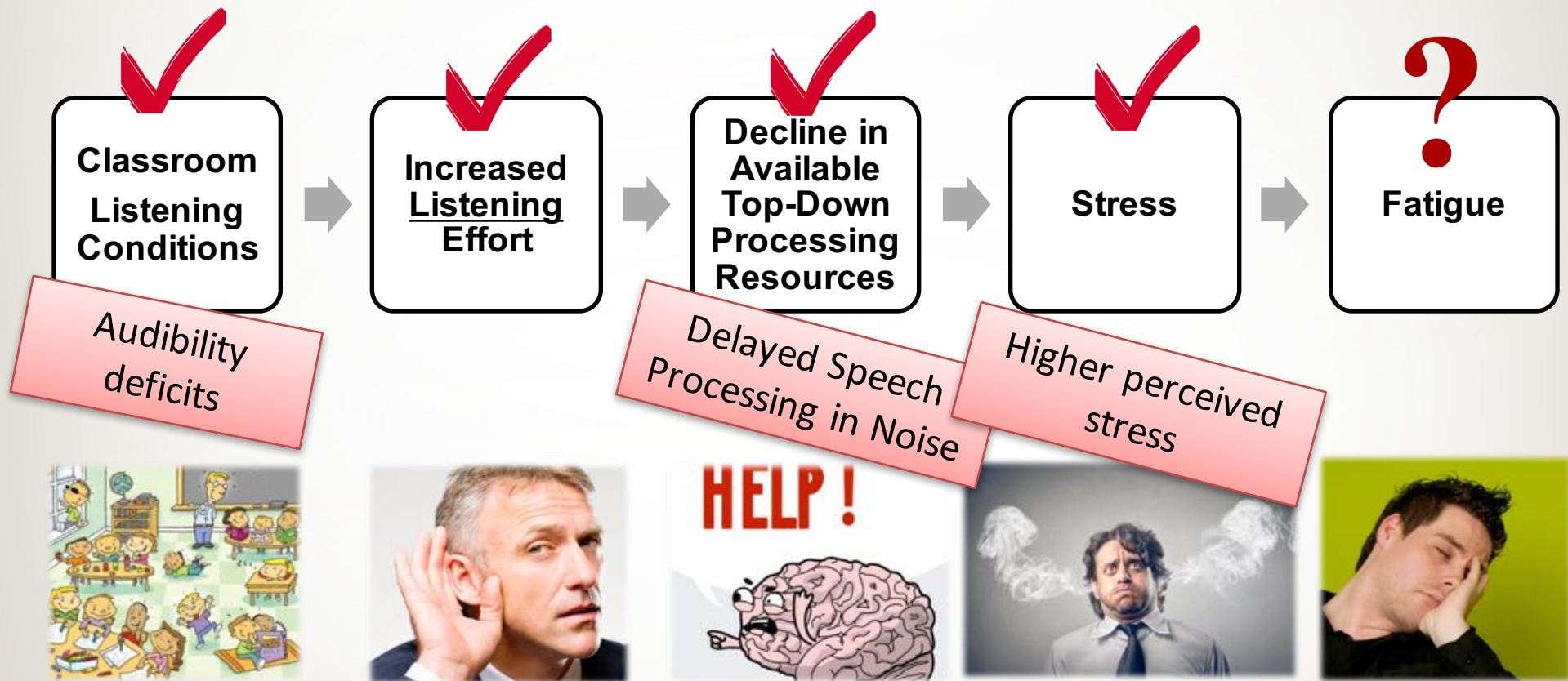
Significant increase in lapses of attention ($p<.05$)

Fatigue Ratings



No change in ratings of fatigue ($p=.929$)

Implications for Children with Hearing Loss



Implications for Practice

Be on the lookout for fatigue!

- Fatigue can manifest itself in a variety of ways
 - tiredness
 - sleepiness in the morning
 - inattentiveness and distractibility
 - mood changes (irritability, frustration, etc.)
 - changes in classroom contributions
 - difficulty following instructions

Implications for Practice

Help us educate the community & the students

- Discuss with families, general education teachers, and other service providers that children with hearing loss are at increased risk for fatigue
 - Importance of listening breaks
 - Arrange lessons so cognitively demanding material is early in the day
- Help students with hearing loss recognize signs of fatigue so they can learn how and when to take listening breaks

Implications for Practice

Monitor actions that may reduce stress/fatigue

- Evidence in adults suggests that properly fitted hearing aids can reduce listening effort and cognitive fatigue (Hornsby, 2013)
- Promote strategies to cope with the increased stress of children with hearing loss
 - Relaxation, avoidance of high-fat diets, and regular exercise can all help reduce the negative effects of stress (McEwen, 1998; Ratey, 2008)

Visit the Listening and Learning Lab's website at
<http://my.vanderbilt.edu/listeninglearninglab>

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The End



That's all.
Thank you for listening!