Wake up!

Let's talk about fatigue in the classroom

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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

Amato, et al. 2001; van der Linden et al. 2003; DeLuca, 2005; Eddy and Cruz, 2007; Ricci et al. 2007
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.

Howard et al., 2010; Downs 1982; Pichora-Fuller et al., 1995
What contributes to fatigue?

Classroom Listening Conditions → Increased Listening Effort → Decline in Available Top-Down Processing Resources → Stress → Fatigue

Bess and Hornsby (2014)
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

"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

“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
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

- Classroom Listening Conditions
- Increased Listening Effort
- Decline in Available Top-Down Processing Resources
- Stress
- Fatigue

Bess and Hornsby (2014)
Overall Speech + Noise Levels in Middle Tennessee Classrooms

Levels of Common Noises

Unpublished data
Classroom Observations

Hearing Aid Use

- 24% (n=9) Consistent user
- 66% (n=25) Nonuser
- 10% (n=4) Variable user

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

FM System Use

- 12% (n=3) for 1st-4th graders
- 46% (n=12) for 5th-7th graders
- 42% (n=11) for all

FM system available?

- 89% of 1st-4th graders
- 47% of 5th-7th graders

Davis et al., 2015; Gustafson et al., 2015
Implications for Children with Hearing Loss

- Classroom Listening Conditions
- Increased Listening Effort
- Decline in Available Top-Down Processing Resources
- Stress
- Fatigue

Audibility deficits

Bess and Hornsby (2014)
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
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

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Bess and Hornsby (2014)
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 $\rightarrow$ reduced amplitude
Assessing Change in Available Processing Resources

3 hours

ERPs 1 and 2

Speech Processing Tasks

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 ($p<.05$).

Key, Gustafson, Rentmeester, Hornsby, and Bess, (in review)
Who’s at risk?

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.

Unpublished data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

Gustafson, Hornsby, Bess, and Key (in preparation)
Change in Processing Resources: *Children with Hearing Loss*

Trend for cognitive processing to be reduced following sustained speech-processing tasks \((p=0.087)\).

Gustafson, Hornsby, Bess, and Key (in preparation)
Who’s at risk?

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.

Gustafson, Hornsby, Bess, and Key (in preparation)
Implications for Children with Hearing Loss

- Increased Listening Effort
- Decline in Available Top-Down Processing Resources
- Stress
- Fatigue

Audibility deficits

Delayed Speech Processing in Noise

Bess and Hornsby (2014)
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

Bess, Gustafson, Corbett, Lambert, Camarata, and Hornsby (2016)
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.

Bess, Gustafson, Corbett, Lambert, Camarata, and Hornsby (2016)
Implications for Children with Hearing Loss

Classroom Listening Conditions

Increased Listening Effort

Decline in Available Top-Down Processing Resources

Stress

Fatigue

Audibility deficits

Delayed Speech Processing in Noise

Higher perceived stress

Bess and Hornsby (2014)
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-severely hearing loss do not report more fatigue than peers with hearing loss on the PedsQL Multidimensional Fatigue Scale.

Unpublished data
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

3 hours

ERP 1 → Speech Processing Tasks → ERP 2

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)

Unpublished data
Implications for Children with Hearing Loss

- Classroom Listening Conditions
- Increased Listening Effort
- Decline in Available Top-Down Processing Resources
- Stress
- Fatigue

Audibility deficits

Delayed Speech Processing in Noise

Higher perceived stress

Bess and Hornsby (2014)
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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