Understanding listening-induced fatigue in school-age children with hearing loss

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What is fatigue?

See Hornsby, Naylor & Bess, 2016 for review

- No universally accepted definition exists
  - Occurs in the physical and mental domains
- **Subjective fatigue** is an ongoing “state”, a mood or feeling of tiredness, exhaustion or lack of energy, a reduced desire or motivation to continue a task
- **Behavioral (Cognitive) fatigue** is an outcome, a decrement in performance
  - Physical or mental performance
- **Physiologic measures** can be used as indirect markers of subjective and behavioral fatigue

“[I recommend] that the term fatigue be absolutely banished from precise scientific discussion”.

----Muscio (1921)
Who Has Fatigue?

Everybody!
Complaints of mild transient fatigue are common even in healthy populations.

Severe, recurrent fatigue is not common in healthy populations.
- Common in many chronic health conditions
  - Cancer, HIV AIDS, Parkinson’s, MS
- Almost no work on hearing loss and fatigue--

Especially Kids!
Consequences of severe, recurrent fatigue

**Adults**—
- Inattention, lack of concentration, poor mental processing and decision-making skills
- Less productive and more prone to accidents
- Less active, more isolated, less able to monitor own self-care

**Children w/ Chronic Illnesses**—
- Inattention, concentration, 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
Is fatigue a problem for people with hearing loss?

“....... I can attest to the FATIGUE caused by prolonged intensive listening in noise through hearing aids.......”.

Mark Ross, 2006, 2012
Pediatric Audiologist
Hearing Loss, Listening Effort and Fatigue- Child and Parent Report

“My child will zone out or go into a bubble when she needs a break from listening.”
- Parent of a child with hearing loss

“My child will withdraw at the end of a long day of listening.”
- Parent of a child with hearing loss

“Trying harder to listen and understand drains me and makes me feel down.”
- Student with hearing loss

“My brain needs a rest from listening.”
- Students with hearing loss

"First thing I do when I get home is take my hearing aids out. I just need a break.”
- Student with hearing loss
A variety of approaches have been used:

**Subjectively**—
- Using questionnaires and survey instruments

**Behaviorally**— task performance decrement
- A decline in (cognitive) task performance due to sustained (mental) demands

**Physiologically**—
- Physiologic changes or biomarkers associated with mental fatigue
Quantifying Fatigue Subjectively

- Subjective measures include surveys, rating scales and questionnaires that ask about mood or feelings.
- Fatigue scales may be:
  - Uni-dimensional: Assess “general” fatigue
    - a composite fatigue measure
  - Multidimensional: Assess various dimensions of fatigue
- Many options, none specific to hearing loss or focus on listening-related fatigue.

see e.g., Dittner et al., 2004 for review.
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"Fatigue Sounds Like Phantom, So Maybe a Squid?" Subjective Reports of Listening-Related Fatigue in Children with Hearing Loss

For more information check out Hilary Davis’s poster at tonight’s poster session!

see e.g., Dittner et al., 2004 for review
The PedsQL MFS: Pediatric Quality of Life Multidimensional Fatigue Scale

- Assesses general, sleep/rest, and cognitive fatigue and provides a “Total” fatigue score
  - Parent version also available
    - Asks about persistent fatigue—over the past month

In the past **ONE month**, how much of a **problem** has this been for you …

<table>
<thead>
<tr>
<th>Item</th>
<th>Never</th>
<th>Almost Never</th>
<th>Sometimes</th>
<th>Often</th>
<th>Almost Always</th>
<th>Construct</th>
<th>General</th>
<th>Sleep/Rest</th>
<th>Cognitive</th>
</tr>
</thead>
<tbody>
<tr>
<td>I feel tired</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I sleep a lot</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It is hard for me to keep my attention on things</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*This version is for children 8-12 years*  

*Varni et al., 2002*
The PedsQL MFS: Pediatric Quality of Life Multidimensional Fatigue Scale

• Assesses general, sleep/rest, and cognitive fatigue and provides a “Total” fatigue score
  • Parent version also available
  • Version for younger children also available

*Think about how you have been doing for the past few weeks. Please listen carefully to each sentence and tell me “How much of a problem this is for you?”*

<table>
<thead>
<tr>
<th>Item</th>
<th>Not at all</th>
<th>Sometimes</th>
<th>A lot</th>
<th>Construct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you feel tired</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>General</td>
</tr>
<tr>
<td>Do you sleep a lot</td>
<td></td>
<td></td>
<td></td>
<td>Sleep/Rest</td>
</tr>
<tr>
<td>Is it hard for you to keep</td>
<td></td>
<td></td>
<td></td>
<td>Cognitive</td>
</tr>
<tr>
<td>your attention on things</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Subjective fatigue in age matched children with and without HL: Preliminary Data

• Used PedsQL-MFS to quantify fatigue

• Participants:
  – 10 CNH (Mean =10 y.o., range 6–12 years)
  – 10 CHL (Mean =10 y.o., range 6–12 years)

  • Wide range of losses and amplification
    – 4 symmetric mild-moderate losses; bilateral hearing aids
    – 2 asymmetric losses; unilateral hearing aids
    – 4 bilateral profound losses
      » 2 bilateral CI users
      » 1 CI(R)/HA(L)
      » 1 CI(R)/Unaided(L)

Hornsby, Werfel, Camarata, and Bess (2014). Subjective Fatigue in Children with Hearing Loss, AJA.
Preliminary Results (n=10/group)

PedsQL-MFS: Pediatric Quality of Life-Multidimensional Fatigue Scale (Varni et al., 2002)

- CHL reported significantly more fatigue.
  Pervasive across domains

* p< 0.05

Full Data Set (n=60 CHL; 43 CNH)

- Preliminary analyses show a main effect of HL but much smaller effects. Data analyses are ongoing.
- 6-12 year old CHL & CNH:
  - CHL had mild to mod-severe losses AU
  - No CI users
- More Fatigue:
  ~2-6 point differences

PedsQL Score

- General
- Sleep/Rest
- Cognitive
- Overall

The diagram shows the PedsQL scores for General, Sleep/Rest, Cognitive, and Overall for both CHL and CNH groups. The scores are represented with error bars indicating variability. The CHL group shows slightly higher scores in most categories, with notable differences in the General and Cognitive subcategories.
Why the smaller effect of hearing loss?

- Differences reflect **less** fatigue in children with HL and **more** fatigue in our normal hearing children.
Fatigue in CHL and children with other chronic health conditions

- Our larger group of CHL reports *similar, or more, fatigue* compared to children with other chronic conditions.
Limitations of Subjective Measures

- Subjective measures alone provide an incomplete assessment of fatigue
  - Subject to bias
  - The physiologic mechanisms responsible for the rating may be variable or unknown
  - Often uncorrelated with severity of conditions associated with the fatigue
    - And other fatigue measures (e.g., behavioral, physiologic)
- Highlights the need for alternative measures
Quantifying fatigue and its effects

A variety of approaches have been used:

**Subjectively**—
- Using questionnaires and survey instruments

**Behaviorally**— a performance decrement
- A decline in (cognitive) task performance due to sustained (mental) demands

**Physiologically**—
- Physiologic changes or biomarkers associated with mental fatigue
Physiologic Markers of Fatigue

- Monitor physiologic changes associated with mental fatigue
  - Cortisol measures
    - Hicks and Tharpe, 2002; Tops et al., 2006; Bess, et al., 2016
  - EEG measures
    - Murata et al., 2005; Trejo et al., 2004
  - Skin Conductance
    - Darrow and Solomon, 1934; Segerstrom and Nes, 2007
  - fMRI measures
    - Caseras et al., 2006; Caldwell et al., 2010

- Provide important physiologic correlates to acute/transient and persistent/long term fatigue
• Stress is the body’s reaction to change that requires a physical, mental or emotional response
  • Stress can be caused by good experiences and bad experiences
• **Cortisol** levels provide a physiologic/objective measure of stress that is associated with fatigue
  • Regulated by the hypothalamic-pituitary-adrenal (HPA) axis
  • Cortisol levels are not a direct indicator of fatigue
“Typical” Diurnal Salivary Cortisol Patterns During the Day

- 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

“Abnormal” Diurnal Salivary Cortisol Patterns During the Day

• Sustained stress or fatigue can lead to abnormal diurnal cortisol patterns
  – Reduced response with “Chronic Fatigue Syndrome”

“Abnormal” Cortisol Awakening Response

• Sustained stress or fatigue can lead to abnormal diurnal cortisol patterns

  – Reduced response with “Chronic Fatigue Syndrome”
  – “Elevated” CAR in patients with depression

“Abnormal” Cortisol Awakening Response

• Sustained stress or fatigue can lead to abnormal diurnal cortisol patterns
  – Reduced response with “Chronic Fatigue”
  – “Elevated” CAR in patients with depression
  – And high burnout
    • On sick leave due to burnout

Measuring Salivary Cortisol Levels in CHL & CNH

• Study Questions:
  – Do overall cortisol levels/patterns differ in CHL and CNH?
  – Does the CAR differ between groups?

Measuring Salivary Cortisol Levels in CHL & CNH

• Participants: CHL (n=32) & CNH (n=28)
  – Age range: 6-12 year old
  – CHL: Mild-Severe SNHL

• Inclusion/Exclusion:
  – No cochlear implant users
  – General education classroom
  – Monolingual English speakers
  – No diagnosis of cognitive impairment, autism or developmental disorder

Bess et al., (2016)
Measuring Salivary Cortisol Levels in CHL & CNH

- **Six samples taken:** awakening*, 30* & 60* min post, 10am, 2pm, 8pm*
  - Procedure repeated a second time several weeks later
- **Cortisol levels can be “easily” obtained from saliva samples**
  - Easier to collect than some other biologic materials (e.g., hair, urine)

*Samples taken by parents at home-
Other samples taken at school by research staff

Bess et al., (2016)
Diurnal Salivary Cortisol Patterns in CHL & CNH

- CHL have elevated cortisol levels at awakening

Bess et al., (2016)
Diurnal Salivary Cortisol Patterns in CHL & CNH

Age range 6-12 years

Bess et al., (2016)
Age, Hearing Loss and Cortisol

- Cortisol levels increase with age for CHL
  - But not CNHL
- Sustained stress due to HL **MAY** be affecting their HPA system, potentially increasing risk for fatigue over time

Bess et al., (2016)
Take Home Points

• School-age children with mild-moderately severe HL
  – Report more fatigue compared to control groups
    • Although, the magnitude is much less than seen in our prior report (i.e., Hornsby et al., 2014).
    – Their fatigue is comparable, or greater, than that reported by children with other chronic health conditions
  • These CHL also display an abnormal stress response
    – Elevated cortisol levels upon awakening and a reduced CAR
    – Cortisol levels appear to increase with age in our CHL
      • Consistent with sustained stress exposure
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

• Look for ways to potentially 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)
Thanks for Listening!

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