Measuring Fatigue in School-Age Children with Hearing Loss

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- Nia Potier
What is fatigue?

- 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)

See Hornsby, Naylor & Bess, 2016 for review
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
- Vey little work examining 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
A variety of approaches have been used:

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

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

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

See e.g., Dittner et al., 2004 for review
Quantifying Fatigue Subjectively

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  - Or Multidimensional: Assess various dimensions of fatigue

See e.g., Dittner et al., 2004 for review.
Dimensions of Subjective Fatigue

- Dimensions of fatigue and related constructs identified via surveys, interviews and focus groups

![Diagram showing the dimensions of subjective fatigue]

- General Fatigue
- Physical Fatigue
- Mental Fatigue
- Emotional Fatigue
- Energy; Vigor; Vitality
- Sleepiness
Quantifying Fatigue Subjectively

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- Fatigue scales may be:
  - Uni-dimensional: Assess “general” fatigue
    - a composite fatigue measure
  - Or 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.
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

• What do the data say?
Subjective fatigue in people with HL

• Is subjective fatigue a problem for people with hearing loss?
  – Using validated, generic, measures are problems of fatigue or vigor deficits increased in adults (AHL) or children with HL (CHL)?
  – If so, what factors modulate their fatigue?

• Let’s start with adults-
Severe Fatigue
Severe Vigor Deficit
*p<0.05

Compared to POMS normative data, older adults seeking help for HL report
– similar fatigue but
– significantly lower vigor

Age range: 55-94 years
N= 116

Hornsby, B. & Kipp, A. (2016)
Adults with HL are at increased risk for **severe** fatigue and vigor deficits

- **More than twice** as likely to report severe fatigue and
- **More than 4 times** as likely to report severe vigor deficits!
- Severe = >1.5 st. dev. above mean

Hornsby, B. & Kipp, A. (2016)
Subjective fatigue in **Adults** with HL

- Is subjective fatigue a problem for people with hearing loss?
  - Using validated, generic, measures are problems of fatigue or vigor deficits increased in adults with HL (AHL)? [Yes, partly- esp. severe]
Subjective fatigue in Adults with HL

- Is subjective fatigue a problem for people with hearing loss?
  - Using validated, generic, measures are problems of fatigue or vigor deficits increased in adults with HL (AHL)? [Yes, partly- esp. severe]
  - What factors modulate fatigue in AHL?
    - Objective hearing difficulty (i.e., PTA)?
Hornsby, B. & Kipp, A. (2016)

- Surprisingly, **no association** bw degree of loss and any fatigue/vigor domain
  - Similar result for POMS data as well

- N= 143
- Age range: 22-94 years
- PTAs: 5-80 dB (Median: 33 dB)
Type of hearing loss and fatigue

- Alhanbali et al (2017) assessed subjective fatigue and effort in four adult groups:
  - NH & HL (HA, CI & SSD)
  - Age matched groups
  - N= 50/group

- All HL groups reported more fatigue and effort
  - No differences in fatigue bw HL groups
  - Much larger effects of HL on effort than fatigue

- Fatigue measure- Fatigue Assessment Scale (FAS)
- Effort measure- 5 item scale from SSQ + other source
Is subjective fatigue a problem for people with hearing loss?

- Using validated, generic, measures are problems of fatigue or vigor deficits increased in adults with HL (AHL)? [Yes, partly- esp. severe]

- What factors modulate fatigue in AHL?
  - Objective hearing difficulty (i.e., PTA)? [No!]
  - Perceived hearing difficulty (HHIE/A)?
Hearing handicap and fatigue

- Strong relationship between hearing handicap and subjective fatigue
  - Fatigue increases with increases in hearing handicap
  - Esp. for “significant” handicap scores (HHIE/A scores >42)

Hornsby, B. & Kipp, A. (2016)
Take Home Points- Adults

• Generic fatigue measures suggest, in everyday settings
  – Fatigue and vigor deficits are increased in at least a subset of adults with HL,
    • Especially risk for more severe fatigue and vigor deficits
• This increased risk is not associated with the magnitude of hearing loss
  – But is associated with perceived hearing difficulties (i.e., psychosocial consequences of hearing loss- HHIE/A scores)
What about kids with hearing loss?
Hearing Loss, Listening Effort and Fatigue - Child and Parent Report

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

“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

“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
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• What do the data say?
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>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>I feel tired</td>
<td></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>
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<tr>
<td>It is hard for me to keep my attention on things</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</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>
</tr>
</thead>
<tbody>
<tr>
<td>Do you feel tired</td>
<td>0</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Do you sleep a lot</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is it hard for you to keep your attention on things</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This version is for children 5-7 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
  • But neither version was designed to assess listening-related fatigue

<table>
<thead>
<tr>
<th>Item</th>
<th>0</th>
<th>2</th>
<th>4</th>
<th>Construct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you feel tired</td>
<td></td>
<td></td>
<td></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 your attention on things</td>
<td></td>
<td></td>
<td></td>
<td>Cognitive</td>
</tr>
</tbody>
</table>

This version is for children 5-7 years
Subjective fatigue in children with HL

- CHL reported significantly more fatigue. Pervasive across domains

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

* p< 0.05

17-30 point differences!
Subjective fatigue in children with HL

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

- 10 CNH and CHL Aged: 6 – 12 years
  - Mean age=10 years old
- Wide range of losses and amplification
  - 4 symmetric mild-moderate losses; bilateral hearing aids
  - 2 asymmetric losses; unilateral hearing aids
  - 4 CI users with bilateral profound losses

Subjective fatigue in Children with HL

Full study results

- Participants
  - CNH and CHL (6-12 years old)
    - and their parents
  - Bilateral, mild to moderately-severe HL
  - Inclusion/Exclusion:
    - No CI users
    - No diagnosis of cognitive impairment, autism or developmental disorder

- Experimental (CHL) group (n=60)
  - 31 males (52%), 29 females
  - Age = 10.0 (1.9) years

- Control (CNH) Group (n=43)
  - 26 males (60%), 17 females
  - Age = 9.1 (2.3) years

Hornsby, et al., (in review)
Subjective fatigue in Children with HL

Analysis approach:

• Child and parent data analyzed using mixed model ANOVAs and a correlation approach
  – Examined group effects
    • Hearing loss vs No hearing loss
    • Parent vs child report
  – Examined factors associated with individual variability in fatigue ratings
    • Better ear-PTA, measures of language (CELF), receptive vocabulary (PPVT) and non-verbal intelligence (TONI)
Effect of Hearing Loss

- Current data shows main effect of HL but much smaller effects
  - No interaction with Parent/Child report

![Graph showing mean PedsQL-MFS scores for HL and NH groups](image)

- More Fatigue
- Mean data collapsed across parent/child reports
  - * p<0.05
  - Only 2-9 point differences!

- General
- Sleep/Rest
- Cognitive
- Overall
Effect of Hearing Loss- Child data only

- Current data shows main effect of HL but much smaller effects
  - No interaction with Parent/Child report

Mean data based on child report only

- ~2-6 points for child only data
Why a smaller effect of hearing loss?

Child data only; preliminary data and full data set

- Differences reflect **less** fatigue in children with HL and **more** fatigue in our normal hearing children

![Bar chart showing PedsQL-MFS Score](chart.png)

- General
- Sleep/Rest
- Cognitive
- Overall
Do our **CNH** report high fatigue? - Yes

Our **CNH** compared to other *control* groups

![Bar chart showing fatigue scores for different conditions and comparisons](chart.png)

- Compared to prior data our current *control* group reports more, or similar, fatigue across multiple domains.

Our **CNH** compared to other *control* groups (downward arrow indicates current data):

- General
- Cognitive
- Sleep/Rest
- Overall

PedsQL-MFS Score

<table>
<thead>
<tr>
<th>Condition</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNH_Curr</td>
<td>80</td>
</tr>
<tr>
<td>MS</td>
<td>70</td>
</tr>
<tr>
<td>ALL</td>
<td>60</td>
</tr>
<tr>
<td>IBD</td>
<td>50</td>
</tr>
</tbody>
</table>

**CNH** compared to other *control* groups:

- CNH_Curr
- MS
- ALL
- IBD

**Compared to prior data our current *control* group reports more, or similar, fatigue across multiple domains.**
Do our CHL report less fatigue? - No

- Compared to other control groups our CHL report more, or similar, fatigue across multiple domains.
Do our **CHL** report less fatigue than kids w/other chronic conditions? - No

- Our current CHL report **similar, or more, fatigue** compared to other chronic conditions
Factors influencing fatigue in CHL

• What factors modulate fatigue in CHL?
  – Degree of hearing loss (PTA)?
  – Intelligence, language or receptive vocabulary?
    • TONI, CELF, PPVT
Fatigue ratings in CHL are NOT associated with degree of hearing loss

- No association between degree of loss and fatigue
  - Regardless of domain, or PTA measure
  - Same as adult data
Factors influencing fatigue in CHL

• What factors modulate fatigue in CHL?
  – Degree of hearing loss (PTA)? [No!]
• What about Intelligence (TONI), language (CELF) or receptive vocabulary (PPVT)?
  – Results varied with domain
• **General and Sleep/Rest fatigue:** No associations with any measure (TONI, CELF or PPVT)
• **Cognitive and Overall fatigue:** Significant association with CELF and PPVT (but not TONI)
Cognitive fatigue ratings ARE associated with language ability (CELF scores)

- Similar association b/w CELF and Cognitive Fatigue seen in CNH (r=0.36, p=0.02)

- Similar, but weaker, correlations seen for
  - CELF and Overall fatigue
  - PPVT and Cognitive fatigue
Can a parents report be used as a proxy for child ratings?

No... 😞
Effect of Parent/Child report

Parents generally underestimate the child’s fatigue

- No interaction with HL group
Parent-Child Correlations

- Correlations between parent and child ratings were weak (general, cognitive, overall), or not significant (Sleep/Rest)
  - Consistent with prior work in this area

*Similar, or poorer, correlations observed across all domains*
Polling Question!

• Subjective fatigue:
  A. Is strongly associated with degree of hearing loss in both adults and children
     - Those with more hearing loss report more fatigue
  B. In children with hearing loss is, on average, similar to or greater than that experienced by children with other severe chronic health problems
     - Like cancer or multiple sclerosis
  C. The PedsQL-MFS was specifically designed to measure fatigue issues in children with hearing loss
Developing a Listening-Related Fatigue Scale

The Vanderbilt Fatigue Scale (VFS)
For adults: VFS-AHL
For children: VFS-CHL
Fatigue Scale Development Process

• Phase 1: Defining the issues
  – Literature Review: Background theory & constructs
  – Focus groups: Individual percepts

• Phase 2: Item Development
  – Expert review
  – Cognitive interviews
    • Stakeholders- Adults & CHL, parents and teachers

• Phase 3: Initial Psychometric Evaluation
Phase 1: Defining the issues - AHL

“I avoid a lot of situations probably more than I used to just because I'm, I just don't have the energy for it,...”

“It's tiring because you're working, you're working,..., I would say twice as hard as anyone else in the room probably. And then emotionally, it's just frustrating and sad...”

“I gave up,... after the evening was over, I was physically tired... I was exhausted afterwards.” (after eating out with friends)

“When I get home at night I’m more tired than you are because I’ve had to listen all day...Mentally making myself aware..., you got to be tuned in to everything going on around you,...”
### Initial Construct Map - AHL

<table>
<thead>
<tr>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>3 - Severe Fatigue</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 - Moderate Fatigue</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 - Mild Fatigue</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Level</td>
<td>D1: Emotional (Internal states)</td>
<td>D2: Cognitive (Attention)</td>
<td>D3: Social (External behaviors)</td>
<td>D4: Physical (Sleep/Rest)</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>3- Severe Fatigue</td>
<td><strong>Behaviors:</strong> Becomes extremely sad, upset, angered, stressed and/or emotionally exhausted by listening difficulties /fatigue.</td>
<td><strong>Behaviors:</strong> Becomes unwilling /unable to maintain effort and attention when completing even routine mental activities. Becomes very unfocused and/or consciously decides to disengage (e.g., shuts down, gives up). <strong>Situations:</strong> Across a wide range of easy-challenging listening situations.</td>
<td><strong>Behaviors:</strong> Social life is severely impacted by listening fatigue. Exhibits avoidance behaviors and isolates oneself from social gatherings to cope with listening fatigue. <strong>Situations:</strong> Across a wide range of easy-challenging listening situations.</td>
<td><strong>Behaviors:</strong> Feels exhausted, drained and/or worn out from listening. Requires naps, additional sleep, and/or silent time to recover from listening fatigue. Regular breaks need to be scheduled into the day. Reports of significant sleep problems. Reports significant headache problems. Reports need to remove hearing device. <strong>Situations:</strong> Across a wide range of easy-challenging listening situations.</td>
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<td><strong>Behaviors:</strong> Becomes stressed, sad, frustrated, upset and/or emotionally tired by listening difficulties/fatigue. <strong>Situations:</strong> Moderately-challenging listening situations or worse.</td>
<td><strong>Behaviors:</strong> Must apply substantial mental effort to overcome difficulties remaining attentive when listening and following conversations. May tune/zone out. May need prompting. <strong>Situations:</strong> Moderately-challenging listening situations or worse.</td>
<td><strong>Behaviors:</strong> Social life is moderately impacted by listening fatigue. May avoid and/or withdraw from certain social gatherings. <strong>Situations:</strong> Moderately-challenging listening situations or worse.</td>
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</tr>
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<td><strong>Behaviors:</strong> Becomes irritated, embarrassed or anxious from listening difficulties/fatigue. <strong>Situations:</strong> Very challenging listening situations only.</td>
<td><strong>Behaviors:</strong> Some difficulty following fast-paced conversations and remaining attentive. <strong>Situations:</strong> Very challenging listening situations only.</td>
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</table>
Sample items from the VFS-AHL

- **Frequency Scale**

- **Agreement Scale**

- It takes a lot of energy to listen and understand.
- How often do you feel tired due to trouble hearing and understanding?

- Listening fatigue is a daily struggle.
- Having to tell people that it is hard for me to understand them is emotionally draining.
Phase 3: Pilot Testing- AHL

- Data from online and hard copy instruments
  - N= ~500
- Analyses are ongoing...
  - Initial work is promising
  - More later...

![Bar chart showing mean frequency of problems across different types of hearing loss (No HL, Mild, Moderate, Severe, Profound) for four categories: Cognitive, Emotional, Physical, Social.](chart.png)
What about kids with hearing loss?
We know that kids are not little adults!

• Moderator: “So... 'fatigue', what do you think of when you hear that word?“

• Child: “I never heard that word, so, like, fatigue sounds like phantom, so maybe a squid?”
Phase 1: Defining the issues-CHL

“It’s also frustrating well like when I come home... if you work hard on that day, you are really tired that you can’t move, and so sometimes I just go to sleep, take a nap.”

“I mean, it's just tiring, it's just,... like constantly having to do all these things so that I can make sure that I can hear people like this, or, What? What'd you say? Or having people get annoyed by it,...”

“I feel like my ears are about to fall off.”

“Yeah because you're trying to listen,... you got to kind of use half your energy to listen to them,.,”

“It’s like my brain’s getting, um, very tired of hearing things.”

“Social-Emotional (Internal-External Behaviors)"

“Physical (Sleep/Rest)"

“Cognitive (Attention)"

“Listening-Related Fatigue"
Sample items from the VFS-CHL

- I use a lot of energy trying to understand what others are saying.
- I get annoyed when I have to listen in a noisy place.
- I get stressed when I have difficulty understanding others.
- I get sleepy after listening for a long time.
- I need a break after listening in a noisy place.
Take Home Points

- School-age children with mild-moderately severe HL
  - Experience more fatigue, especially cognitive 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
- Higher fatigue ratings are
  - Are not modulated by degree of hearing loss
  - But are associated with poor language abilities (CELF scores), in both CHL and CNH
- Parent and child report, using a generic scale, provides distinct information
- A listening-related fatigue scale is under development!
Implications for Practice

• Be on the lookout for fatigue!

  – Fatigue can manifest itself in a variety of ways
    • general reports of 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 CHL are at increased risk for fatigue
    • Importance of listening breaks
    • Arrange lessons so cognitively demanding material is covered 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
  
  – Some, limited, evidence to suggest that properly fitted hearing aids can reduce listening effort and cognitive fatigue in adults (Hornsby, 2013)
    • Similar work in children is lacking
  
  – 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