Effort and Fatigue in Children with Unilateral Hearing Loss—What’s the risk?

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Unilateral Hearing Loss in Children Conference
Philadelphia, PA
October 22-24, 2017
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Funding for portions of the works reported here was provided by
- NIH R21 DC012865-01A1
- IES #R324A110266
- IES #R324A150029
- Starkey, Inc.
- the ASHFoundation and
- the Dan Maddox Foundation
What is fatigue?

See Hornsby, Naylor & Bess, 2016 for review

- No universally accepted definition exists
- **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
  - Often (not always) a consequence of sustained, effortful, physical or mental work
- **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)
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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
- Very limited work on hearing loss and fatigue—
  - *Especially in children*
Severe, recurrent, fatigue negatively affects quality of life

**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

• But why would fatigue be a problem?
  – Active listening can be hard work!

• “I go to bed most nights with nothing left. It takes so much energy to participate in conversations all day, that I’m often asleep within minutes.”
  
  • https://hearingelmo.wordpress.com/2008/06/17/fatigue-fear-and-coping/

  – Some data also supports a link b/w effort and fatigue
Perceived effort and fatigue

Alhanbali et al., 2016

Fatigue Increases
Effort Increases

(R^2 = 0.16, p < 0.05)

- Four groups of adults (N=31) with
  - Bilateral HAs
  - SSD (UHL)
  - CIs
  - Control

-Rated their subjective effort and fatigue experienced on a daily basis
  - Similar trends across all groups

\[ R^2 \text{ Linear} = 0.108 \]
Hearing Loss, Listening Effort and Fatigue

- But why would fatigue be a problem?
  - Active listening can be hard work!

- “I go to bed most nights with nothing left. It takes so much energy to participate in conversations all day, that I’m often asleep within minutes.”

  - So active listening can be hard work, but…
Fatigue - more than just high effort

High effort/difficulty ≠ always lead to fatigue
Fatigue - more than just high effort

- Risk for fatigue increases in:
  - Mentally/physically challenging conditions
    • Requires effortful control to attain/maintain performance
    • Maintaining “acceptable” performance is difficult or not possible
  - Low control conditions
    • Timed or scheduled tasks with limited flexibility
    • Limited ability to modify the task characteristics
  - Important conditions
    • High motivation to succeed, along with
    • Negative consequences for poor performance

Hockey & Earle (2006); Boksem & Tops (2008); Ackerman (2011); Hockey (2013); Earle & Hockey (2015).
A motivational control theory of cognitive fatigue (Hockey, 2013)

- Fatigue is an emotional response serving an adaptive, goal-directed, function
  - forces us to evaluate current goal-directed behaviors in terms of an effort/reward balance

- Fatigue is a “protective” mechanism to help us decide if the effort applied towards a goal is worth the reward.
A motivational control theory of cognitive fatigue (Hockey, 2013)

Goal: Successful Communication

- Successful communication with minimal effort
- Unsuccessful communication with allocated effort

Evaluate effort/reward ratio

- Low reward/benefit: Maintain effort: No change in performance
- Reduce effort: Disengage
- Variable effort: Change goal
- High reward/benefit: Increase effort: Successful communication with allocated effort
- Increase effort: Unsuccessful communication with allocated effort

A simple block diagram interpretation of Hockey's (2013) model
A motivational control theory of cognitive fatigue (Hockey, 2013)

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A simple block diagram interpretation of Hockey’s (2013) model.
Effects of Hearing Loss

• Listening-related fatigue may be associated with factors that increase perceived effort
  – Like unilateral (UHL) or bilateral (BHL) hearing loss

• UHL, or BHL, can ↑ listening difficulties,
  – Which can ↑ listening effort,
  – Which may ↑ risk for fatigue

• and may impact evaluation of effort-reward ratio
So… 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…….”.

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

- 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

POMS = Profile of Mood States (McNair et al., 1971)

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

- More than 2 times 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

**Percentage of adults subjectively reporting severe fatigue and vigor deficits**

Hornsby, B. & Kipp, A. (2016)
Vanderbilt Bill Wilkerson Center

What about kids 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

“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
Hearing Loss, Listening Effort and Fatigue—Child and Parent Report

“First thing I do when I get home is take my hearing aids out. I just need a break.”
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Subjective fatigue in Children with HL

- CHL show more cognitive and overall fatigue than controls
  - No interaction with Parent/Child report


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

- 43 CNH & 60 CHL
- Aged: 6 – 12 years
- Mean data collapsed across parent/child reports
- CHL had bilateral, mild to severe losses
  - No CI users
  - No UHL
Is fatigue a problem for people with UNILATERAL hearing loss?

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

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• Data are limited but....
Some results suggest those with UHL could have similar risk for fatigue—e.g.,

Hornsby, B. & Kipp, A. (2016)

- Surprisingly, no association between degree of loss and fatigue in Adults
  - Where does UHL fit on this continuum?
- But perceived hearing problems and fatigue are related...
  - \( N = 143 \)
  - Age range: 22-94 years
But, in adults, hearing handicap is associated with subjective fatigue

- Fatigue increases with increases in hearing handicap

- And research suggests adults with UHL are at increased risk for hearing handicap
  
  - de Araújo, et al., 2010; Iwasaki, et al., 2013

Hornsby, B. & Kipp, A. (2016)
Some results suggest those with UHL could have similar risk for fatigue—e.g.,

- Likewise, no association between degree of loss and any fatigue domain in children with hearing loss.
- Where does UHL fit on this continuum?
- But language ability may play a role:
  - N = 60
  - Age range: 6-12 years

PTA = 0.5, 1 & 2 kHz

Overall Fatigue

PTA = 0.5, 1 & 2 kHz


- PedsQL-MFS: Pediatric Quality of Life—Multidimensional Fatigue Scale (Varni et al., 2002)
As language ability (CELF score) improves, fatigue is reduced (higher scores)


And children with UHL are at increased risk for poorer language skills
– Lieu et al., 2010

Correlation coefficient: $r = 0.32$, $p = 0.013$
So ancillary data suggests those with UHL could have similar risk for fatigue

- But research actually measuring fatigue in people with UHL is limited
  - Especially in children

- Does the available evidence suggest UHL could increase risk for fatigue?
  - Yes, but we need more evidence...
Fatigue in **Adults with UHL** is similar to adult CI and Bilateral Hearing aid Users

- Alhanbali et al (2016) assessed subjective fatigue in adults with and without HL:
  - NH & HL (HA, CI & SSD)
  - Age matched groups
  - N= 50/group

- All HL groups reported more fatigue than NH
  - But wide variability
  - No differences in fatigue bw HL groups

- Fatigue measure- Fatigue Assessment Scale (FAS)

Modified from Alhanbali et al., 2016
Listening-related fatigue is a problem for some **Adults with UHL** too

- Preliminary data using the 40 item Vanderbilt Fatigue Scale for Adults with Hearing Loss (VFS-AHL)
  - A listening-related fatigue scale

- Internet survey using a draft scale
  - 18-88 years
    - Mean = 50 years
  - Self-reported HL

* $p < .001$

Unpublished data

**Error bars = 1 St. Error**
Listening-related fatigue is a problem for some **Adults with UHL** too

- Preliminary data using the 40 item Vanderbilt Fatigue Scale for Adults with Hearing Loss (VFS-AHL)
  - A listening-related fatigue scale

  ![Fatigue Scale Graph](image)

- “Severe” fatigue problems differs bw groups
  - “Severe” = IRT scores >95th percentile of NH responses

- People w/UHL are **5x more likely to report severe fatigue**

- People with BHL are **10x more likely**!

Unpublished data
Listening-Related fatigue is a problem for some Children with UHL too.

- PedsQL-MFS data from preliminary study
  - N = 10 CHL

  ![Graph showing PedsQL scores for different areas and overall fatigue]
  - Children with the largest asymmetry (n=2) reported the most overall fatigue.

So... Is fatigue a problem for people with UNILATERAL hearing loss?

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• Limited data suggests Yes!
Take Home Points

• Listening-related fatigue is a significant problem for at least some adults and children with **unilateral** (and bilateral) hearing loss
  – Fatigue is NOT modulated by degree of hearing loss
    • But is associated with poor language abilities (CELF scores)
    • And perceived hearing difficulties (in Adults)

• A listening-related fatigue scale for children is under development!
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

  – Help students with hearing loss recognize signs of fatigue so they can learn how and when to take listening breaks

Thanks for Listening!

Visit the Listening and Learning Lab’s website at 
http://my.vanderbilt.edu/listeninglearninglab
Fatigue in CHL compared to children with other chronic health conditions

- Children w/ HL & CIs report **similar, or more, fatigue** than children with other chronic health conditions.
  - Cancer
  - Diabetes
  - Rheumatoid Arthritis
  - Obesity
  - Multiple Sclerosis
  - Short Stature
  - Irritable Bowel Syndrome

\[\downarrow = \text{CHL (Hornsby, et al., 2017)}\]
\[\downarrow = \text{CIs (Werfel, et al., 2016)}\]
Perceived effort and fatigability

RSME: Rating Scale of Mental Effort (Zijlstra, 1993)

- Participants completed a demanding speech task for ~1 hour
  - Required sustained, active, effortful, listening
    - Unaided, speech in noise task
  - Older adults (N=31) with bilateral hearing loss (BHL)
    - Mean age – 71 (63-79) years
    - Mean better ear PTA – 35.6 (25-53) dB

Unpublished data

RSME (Percieved Effort) vs. Change in Fatigue Ratings

-4 dB SNR
-2 dB SNR
0 dB SNR
+2 dB SNR

r = 0.55
p < 0.001