Measuring Fatigue in School-Age Children with Hearing loss

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Measuring Fatigue in School-Age Children with Hearing Loss

Institute for Educational Sciences
Goal 1
Identification
IES Goal 1

“Conduct small-scale descriptive studies using primary data collection to identify existing programs and practices that may be associated with better academic outcomes, and examine factors and conditions that may mediate or moderate the effects of these programs and practices.”
IES Funding “Goals”

- Goal 1
  - Identification Projects
- Goal 2
  - Development Projects
- Goal 3
  - Efficacy and Replication Trials
- Goal 4
  - Scale-up Evaluations
- Goal 5
  - Measurement Projects
A Clinical Study on Fatigue in CHL
“....... I can attest to the **FATIGUE** caused by prolonged intensive listening in noise through hearing aids.......so much effort was being devoted to getting the signal that I sometimes missed part of the message”.

Mark Ross, 2006, 2012
Pediatric Audiologist
HEARING LOSS AND FATIGUE

Fatigue is a common sequelae of hearing loss and significantly impacts quality of life.

Listening is exhausting!!!

“…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.”

Copithorne, 2006
Description of Fatigue

“When you are hard of hearing you struggle to hear; when you struggle to hear you get Tired; when you get tired you get frustrated; when you get frustrated you get bored; when you get bored you Quit.”

Pichora-Fuller, 2003
What Do Teachers Say?

“My children are exhausted by the end of the school day!”

“The kids are so tired—they are ready to go home.”

“Robbie’s mother says he has to take a nap almost every day after school.”

“From mid afternoon on we focus on activities that don’t require much mental effort.”
WHAT IS FATIGUE?

Occurs in the physical and mental/cognitive domains;

Defined as a mood or feeling of tiredness, exhaustion or lack of energy

Effects focus, concentration, alertness and/or mental energy and efficiency

“Nothing so fatiguing as the eternal hanging on of an uncompleted task”

---- William James, 1881
WHO HAS FATIGUE?

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

Recurrent fatigue
- Common in many chronic health conditions
- Cancer, HIV AIDS, Parkinson’s, MS
- Almost no work on hearing loss and fatigue--

Especially Kids!
CONSEQUENCES OF FATIGUE

Adults—
- Stress, inattention, concentration, mental processing, and decision-making
- 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
FATIGUE IN CHILDREN WITH HEARING LOSS

• Is fatigue more of a problem for CHL?
  – Anecdotal reports suggest yes but empirical work is lacking
FATIGUE IN CHL
(Participants)

- **Goal:** 45 CHL & 45 CNH
  - All: 6-12 years old
  - CHL: Mild-Severe SNHL
- **Inclusion/Exclusion:**
  - General education classroom
  - Monolingual English speakers
  - No diagnosis of cognitive impairment, autism or developmental disorder
- **To date:**
  - 30 CNH (mean = 8.3 years)
  - 13 CHL (mean = 10.4 years)
Subjective Assessment of Fatigue in the Child’s Own Environment

Initial Visit: Demographic data, audiological exam, TONI, CELF, PPVT, parent training for later experiments and a subjective measure of fatigue
Preliminary data from 10 CNH and 10 CHL:

- CHL had a 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)

The PedsQL MFS: Pediatric Quality of Life Multidimensional Fatigue Scale

- Assesses general, sleep/rest, and cognitive fatigue and provides a “Total” fatigue score
- Used in children with multiple chronic conditions
  - cancer, diabetes, rheumatic disease

*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>
</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>General</td>
</tr>
<tr>
<td>I sleep a lot</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sleep/Rest</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>Cognitive</td>
</tr>
</tbody>
</table>

Varni et al., 2002
• CHL reported significantly more fatigue. Pervasive across domains

SEVERE DEFICITS ARE COMMON IN AHL

- **Adults with HL** were twice as likely to report severe (>1.5 st. dev above mean) fatigue deficits and
- 4 times as likely to report severe vigor deficits!

116 **adults** with hearing complaints completed **Profile of Mood States** (POMS) a validated measure of fatigue and vigor

Hornsby and Kipp, AAS 2013
**FATIGUE IN CHL**
*(Clinical Measures)*

**Initial Visit:** Demographic data, audiological exam, TONI, CELF, PPVT, parent training for later experiments and a **subjective measure of fatigue**

**Experiment 1:** Salivary cortisol levels sampled six times throughout the day; each child sampled on two separate days

**Objective assessment** of stress, which can be associated with fatigue, in the child’s own environment.
A Physiologic Marker in Fatigue Research

Experiment 1: Cortisol Levels in CHL & CNH

- Stress is the body’s reaction to change that requires a physical, mental or emotional response
  - Stress is caused by both good experiences
    - and bad experiences

- Cortisol provides a physiologic/objective measure of stress that is associated with fatigue
Salivary Cortisol Levels in CHL & CNH (Experiment 1)

- Samples at awakening, 30 & 60 min post, 10 AM, 2 PM, 8 PM
- Samples stored in refrigerator
- Sampling procedure repeated several weeks later

![Graph showing cortisol levels over time with labels for Awakening, 30m-post wake-up, 60m-post wake-up, 10:00am, 2:00pm, and 8:00pm. The graph compares Hearing Loss (n=12) and Normal Hearing (n=30).]
Subjective and objective measures suggest fatigue is a significant problem for CHL. Can we measure this in the laboratory?
**FATIGUE IN CHL**
*(Clinical Measures)*

**Initial Visit:** Demographic data, audiological exam, TONI, CELF, PPVT, parent training for later experiments and a **subjective measure of fatigue**

**Experiment 1:** Salivary cortisol levels sampled six times throughout the day; each child sampled on two separate days

**Experiment 2:** Listening effort during speech processing tasks

**Experiment 3:** P300 measures

**Laboratory assessment** of speech processing-related fatigue
What causes fatigue in CHL?

- We hypothesize that **sustained** mental demands required to overcome auditory deficits are a primary factor.
• Listening effort and fatigue (subjective and objective) are assessed during a series of cognitively demanding and sustained, primarily speech based, tasks  
  – Total time ~ 2.5-3.5 hours

• CHL are tested unaided and aided
• Simple Speech Measures
  – CRM recognition- 0 dB SNR (cafeteria babble)
    • Coordinate Response Measure (Bolia et al., 2000)
      – E.g., Ready “Charlie” go to “Blue” “Five” now
  – Word recognition in noise
    • Isophonemic AB word lists (Boothroyd, 2008)
    • 3 SNRs (-4, 0, +4 dB; multitalker babble)
Speech Processing Tasks

• Complex Speech Measures
  – Dual Task- assesses changes in listening effort across conditions via secondary task performance
    • Isophonemic word recognition (primary task) and visual reaction time (secondary task)
    • 3 SNRs (-4, 0, +4 dB)
  – Speech Vigilance Task- CRM at 0 dB SNR
    • Requires sustained auditory attention
      – Measures of accuracy and processing speed
LABORATORY ASSESSMENT OF SPEECH PROCESSING RELATED FATIGUE

Fatigue Measures

- Physiologic measure of fatigue
  - ERPs- P300 (oddball paradigm). Two (2) measures pre and post speech tasks
    - Not discussed today

- Subjective measure of fatigue (Right Now)
  - 5 items (e.g., I feel tired), responses on a 5-point scale. Assessed six (6) times during testing

- Behavioral measure of fatigue
  - Psychomotor Vigilance Task (PVT). Visual measure of sustained attention which is sensitive to fatigue
    - Assessed three (3) times during testing
LABORATORY ASSESSMENT OF SPEECH PROCESSING RELATED FATIGUE

- Schematic timeline of study tasks and measurement points

- Fatigue Scale 1
- Fatigue Scale 2
- CRM
- Secondary Task
- Primary Task
- Fatigue Scale 3
- Fatigue Scale 4
- CRM
- Vigilance
- Fatigue Scale 5
- Fatigue Scale 6
- ERP
- ERP
- PVT1
- Break
- PVT2
- PVT3

~2.5-3.5 hours
RESULTS: SUBJECTIVE RATINGS

- Significant interaction bw time and group
  - Unaided fatigue scores increased more than NH or Aided bw T2 and T3
• Significant main effect of time - all groups demonstrate objective fatigue
  – But no group x time interaction
FUTURE ANALYSES

• ERPs - physiologic marker of fatigue
• Relationships between subjective/objective fatigue measures and
  – Speech task performance
  – Individual variables
    • Demographic
    • Audiologic
    • Academic
FATIGUE IN CHL
(Clinical Measures)

Initial Visit: Demographic data, audiological exam, TONI, CELF, PPVT, parent training for later experiments and a subjective measure of fatigue

Experiment 1: Salivary cortisol levels sampled six times throughout the day; each child sampled on two separate days

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Experiment 4: Fatigue effects on learning skills important for school performance
Nonverbal Intelligence
(TONI-4)

\[ d = 1.33 \]
**Language**

**CELF-4 (Total Language)**

- CHL: [Standard Score]
- CNH: [Standard Score] \(d = 1.96\)

**PPVT-4 (Receptive Vocab)**

- CHL: [Standard Score]
- CNH: [Standard Score] \(d = 1.61\)
Fatigue in CHL
(Effects on Literacy-Related Skills)

Two assessment sessions:
Pre: non-school day in AM
Post: school day in PM after school

**Higher scores indicate LESS fatigue**
Articulation
(Arizona-3)

Arizona Total Score

Pre                      Post

$d = .04$

**not a standard score**
Phonological Processing (CTOPP)

Phonological Awareness

- Pre: Standard Score
- Post: Standard Score

$d = .09$

Phonological Memory

- Pre: Standard Score
- Post: Standard Score

$d = .26$

Phonological Recoding

- Pre: Standard Score
- Post: Standard Score

$d = .24$
Spelling
(TWS-4)

$\bar{d} = .08$
Group means appear to indicate no effect of fatigue on word recognition, even timed. However...
Individual performance indicates that, as hypothesized, fatigue plays a larger role in timed word recognition for CHL.
Word Recognition

Difference in Standard Score

-15
-10
-5
0
5
10
15

Untimed
Timed
Oral Reading Fluency
(WRMT-III)

Pre  Post

Standard Score

$\text{d} = .00$
Oral Reading Fluency (WRMT-III)

Difference in Standard Score

47%
Reading Comprehension (WRMT-III)

Pre                                Post
Standard Score

$d = .23$
Reading Comprehension
(WRMT-III)

Difference in Standard Score
A Clinical Study of Fatigue: Summing Things up

- Subjective data confirm:
  - fatigue is increased in adults and children with HL,
  - risk for more severe fatigue is increased in these groups
  - fatigue affects some skills important for classroom learning

- This ongoing project explores fatigue in CHL
  - Subjectively (PedsQL) and objectively (Cortisol) in everyday environments
  - Due to sustained speech processing demands in a laboratory setting (Fatigue scale/PVT/ERP)
  - And its impact on skills important for classroom learning
“The research reported here was supported by the Institute of Education Sciences, U.S. Department of Education, through Grant R324A110266 (Bess, PI) to Vanderbilt University. The opinions expressed are those of the authors and do not represent views of the Institute or the U.S. Department of Education”.

ACKNOWLEDGEMENTS

Staff, Students and Collaborators

Listening & Learning Lab
(Past and Present)

- Krystal Werfel
- Lindsey Rentmeester
- Samantha Gustafson
- Andy DeLong
- Amelia Shuster
- Doug Sladen
- Tonia Davis
- Emily Fustoz
- Amanda Headly

Collaborators

- Ralph Leverett
- Jeannie Luckey
- Vicki Powers
- Matthew Revi

Sites

Nashville Public Schools; Williamson, Maury and Jackson Co Schools
and West TN School for the Deaf