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
“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

“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
Is fatigue more of a problem for CHL?
– Anecdotal reports suggest yes but empirical work is lacking
• **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
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>
</tr>
</thead>
<tbody>
<tr>
<td>I feel tired</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>I sleep a lot</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>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Varni et al., 2002
SUBJECTIVE FATIGUE IN AGE MATCHED CHL & CNH

• 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
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 CAR highlighted.](image)
Subjective and objective measures suggest fatigue is a significant problem for CHL.

Can we measure this in the laboratory?
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
LABORATORY ASSESSMENT OF SPEECH PROCESSING RELATED FATIGUE

• 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

Baseline Measures of Fatigue → Conduct Various Sustained Speech Processing Tasks

Monitor Fatigue
LABORATORY ASSESSMENT OF SPEECH PROCESSING RELATED FATIGUE

Speech Processing Tasks

• 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
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
• Schematic timeline of study tasks and measurement points

~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
### RESULTS: OBJECTIVE- PVT DATA

- Significant main effect of time- all groups demonstrate objective fatigue
  - But no group x time interaction
• ERPs- physiologic marker of fatigue
• Relationships between subjective/objective fatigue measures and
  – Speech task performance
  – Individual variables
  • Demographic
  • Audiologic
  • Academic
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

Experiment 4: Fatigue effects on learning skills important for school performance
Two assessment sessions:

Pre: non-school day in AM
Post: school day in PM after school

**Higher scores indicate LESS fatigue**
Fatigue in CHL
(Effects on Literacy-Related Skills)

Articulation
Spelling
Phonological Processing
  • Phonological Awareness
  • Phonological Memory
  • Phonological Recoding
Reading
  • Word Identification (timed and untimed)
  • Word Attack (timed and untimed)
  • Word Comprehension (synonyms, antonyms, analogies)
  • Passage Comprehension
  • Oral Reading Fluency
Articulation (Arizona-3)

**not a standard score**

$d = .04$

Individual Performance

21%
Spelling (TWS-4)

$d = 0.08$

Individual Performance

37%
Phonological Processing (CTOPP)

Phonological Awareness

Phonological Memory

Phonological Recoding

$d = .09$

$d = .26$

$d = .24$
Phonological Processing (CTOPP)

**Phonological Awareness**
- Difference in Standard Score
- 58%

**Phonological Memory**
- Difference in Standard Score
- 63%

**Phonological Recoding**
- Difference in Standard Score
- 63%
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.
Oral Reading Fluency
(WRMT-III)

$d = .00$

Individual Performance

47%
Reading Comprehension
(WRMT-III)

$d = .23$

Individual Performance

58%
Fatigue in CHL
(Effects on Literacy-Related Skills)

Fatigue appears to negatively impact at least some literacy and literacy-related skills for at least some children with hearing loss.
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
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

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THANK YOU
Nonverbal Intelligence (TONI-4)

Standard Score

\[ d = 1.33 \]
Language

CELF-4 (Total Language)

$\text{CHL}$ $\text{CNH}$

$\text{Standard Score}$

$\text{110}$ $\text{120}$

$d = 1.96$

PPVT-4 (Receptive Vocab)

$\text{CHL}$ $\text{CNH}$

$\text{Standard Score}$

$\text{110}$ $\text{120}$

$d = 1.61$