



Vanderbilt Bill Wilkerson Center

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

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■ Lab Group(s) members

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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

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



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

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

Quantifying fatigue and its effects



A variety of approaches have been used:

Subjectively—

- Using questionnaires and survey instruments

Behaviorally— ~~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

Quantifying Fatigue Subjectively

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- Fatigue scales measure multiple dimensions of fatigue
 - Uni-dimensional
 - a
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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!

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 ...*

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




This version is for children 8-12 years

Varni et al., 2002

The PedsQL MFS: Pediatric Quality of Life Multidimensional Fatigue Scale

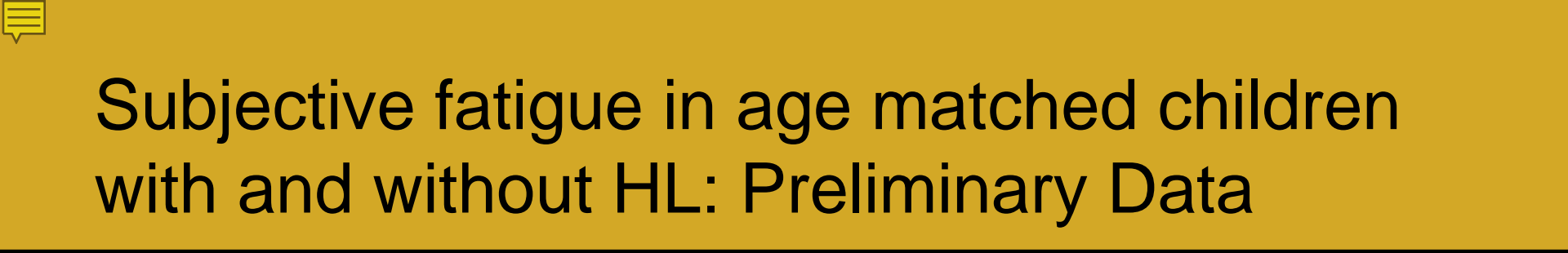
- Assesses general, sleep/rest, and cognitive fatigue and provides a “Total” fatigue score
 - Parent version also available
 - Version for younger children also available

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?”

	Not at all	Sometimes	A lot	
				
Item	0	2	4	Construct
Do you feel tired				General
Do you sleep a lot				Sleep/Rest
Is it hard for you to keep your attention on things				Cognitive

This version is for children 5-7 years

Varni et al., 2002

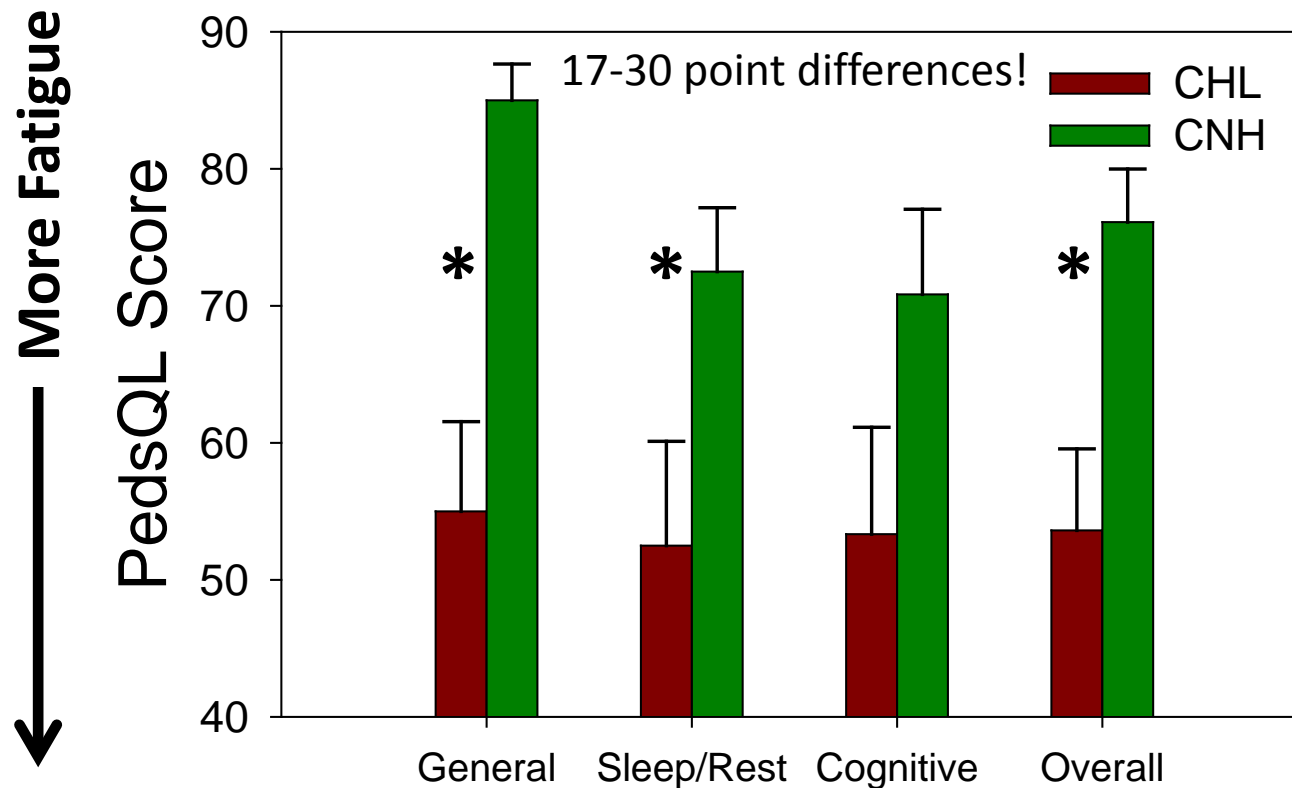


Subjective fatigue in age matched children with and without HL: Preliminary Data

- 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)

Preliminary Results (n=10/group)

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

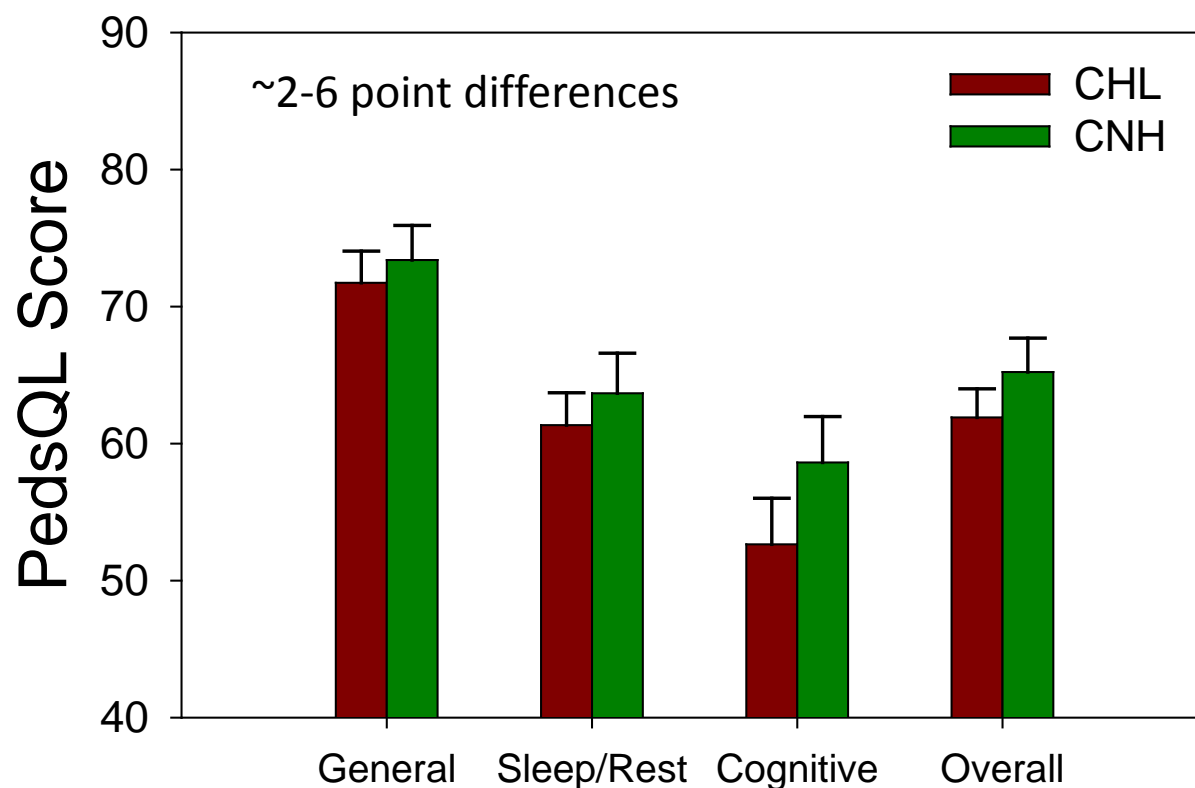


- CHL reported significantly more fatigue. Pervasive across domains

Hornsby, et al., (2014)

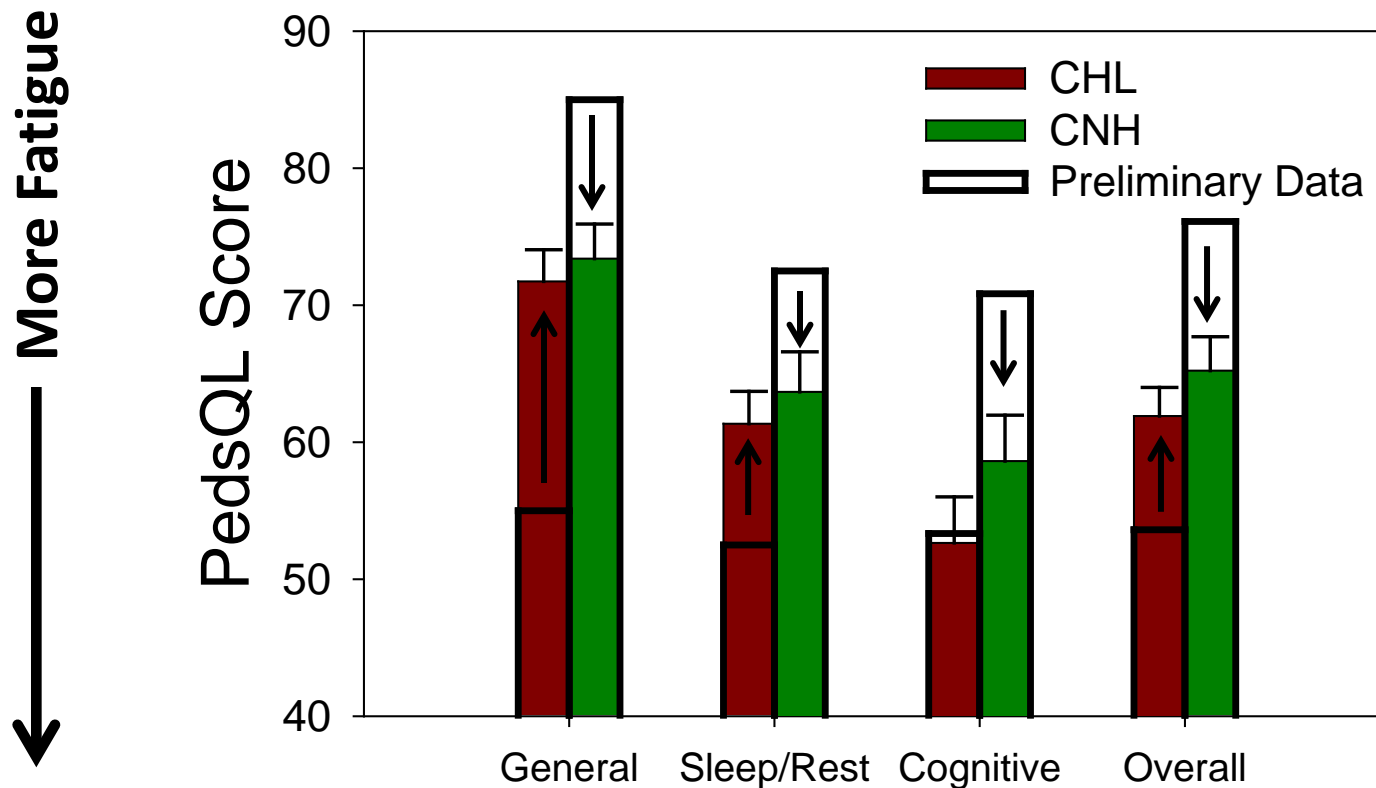
Full Data Set (n=60 CHL; 43 CNH)

More Fatigue
↓



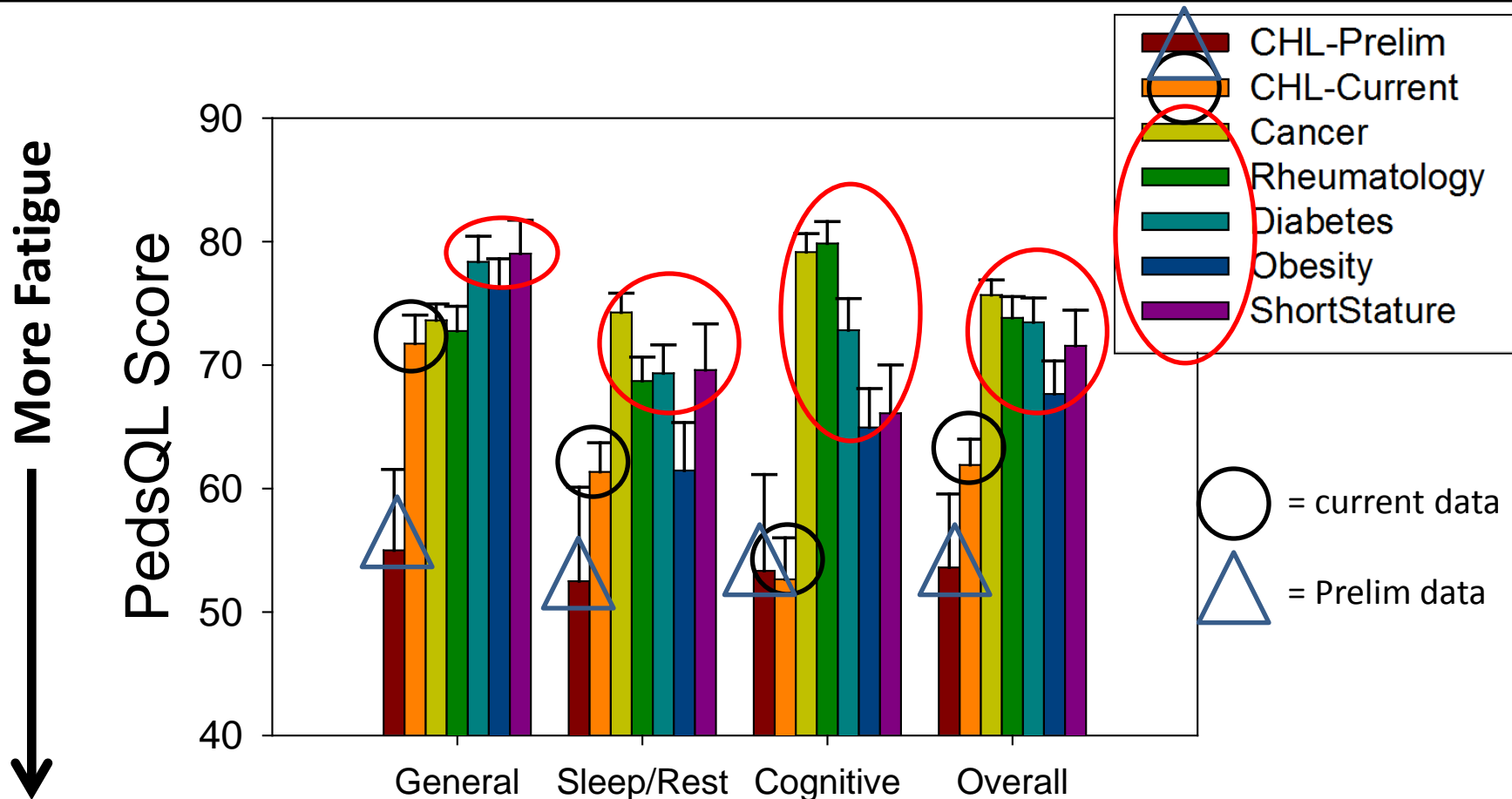
- 6-12 year old CHL & CNH
 - CHL had mild to mod-severe losses AU
 - No CI users
- Preliminary analyses shows main effect of HL but much smaller effects- data analyses are ongoing

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— ~~and performance decrement~~

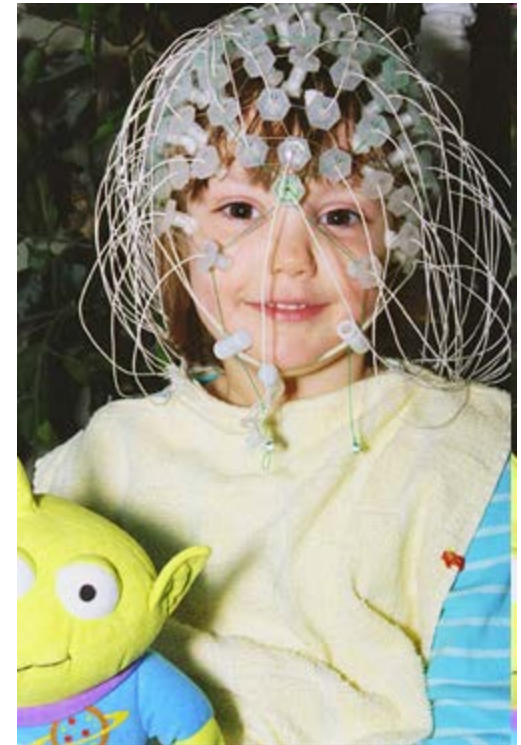
- A decline in (cognitive) task performance due to sustained (mental) demands

Physiologically—

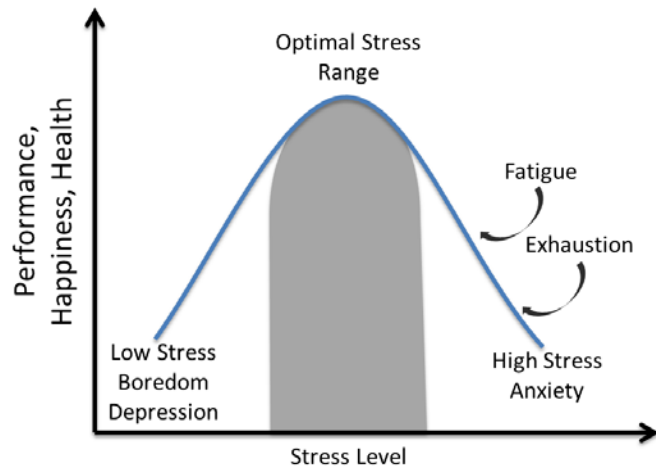
- Physiologic changes or biomarkers associated with mental fatigue

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



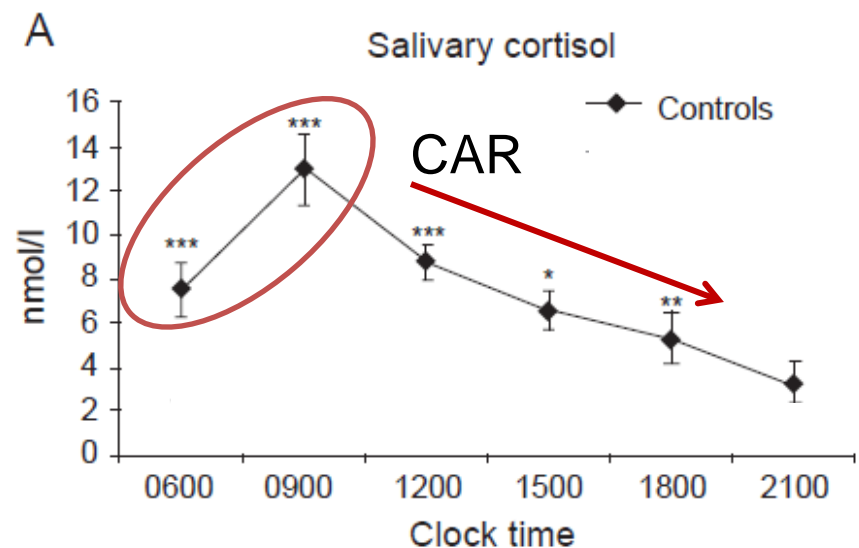
PHYSIOLOGIC MARKERS: STRESS, CORTISOL AND FATIGUE



- 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

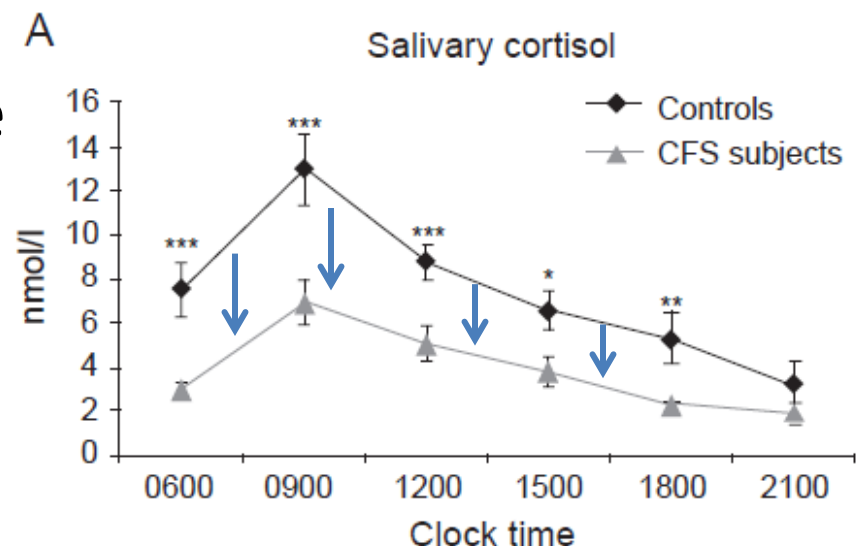
- In non-fatigued individuals, cortisol levels have a typical diurnal pattern
 - Build-up of cortisol during sleep
 - Rapid rise upon awakening
 - Cortisol Awakening Response; CAR
 - Slow decline in cortisol throughout the day



“Abnormal” Diurnal Salivary Cortisol Patterns During the Day

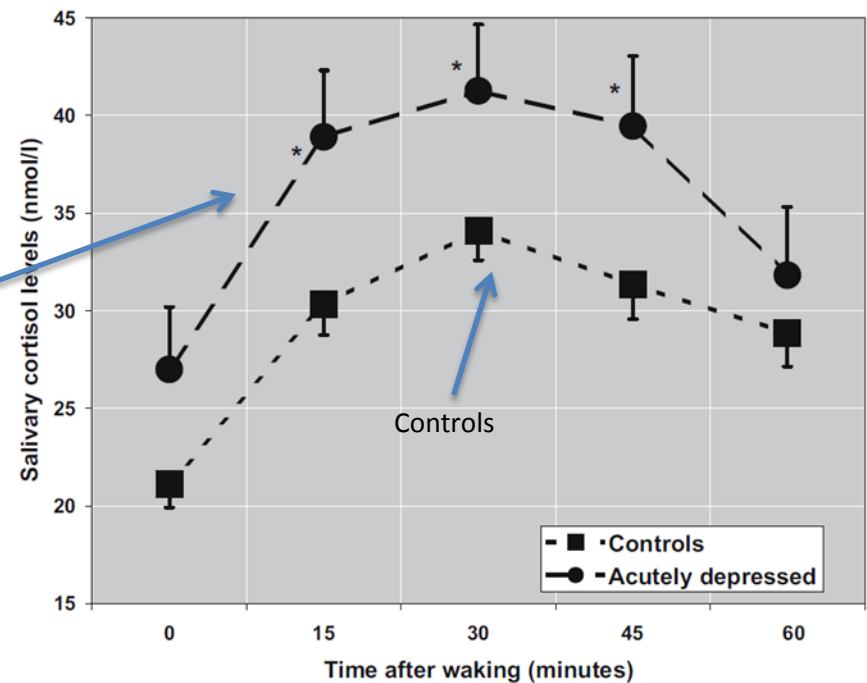
- Sustained stress or fatigue can lead to abnormal diurnal cortisol patterns

- Reduced response with “Chronic Fatigue Syndrome”



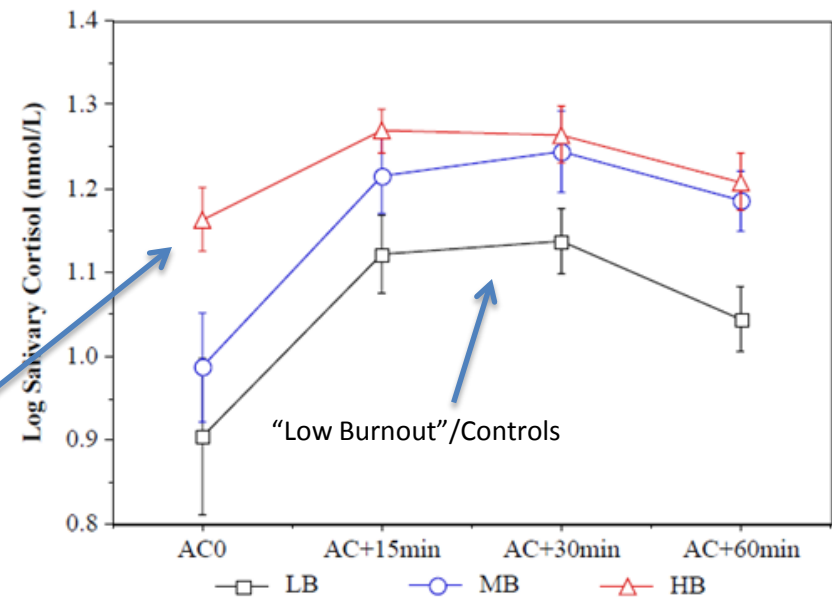
“Abnormal” Cortisol Awakening Response

- 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

Bess et al., (2016)

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

Bess, et al., (2016). Salivary Cortisol Profiles of Children with Hearing Loss. *Ear and Hearing*, 37(3), 334-344.

Measuring Salivary Cortisol Levels in CHL & CNH

Bess et al., (2016)

- 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

Measuring Salivary Cortisol Levels in CHL & CNH

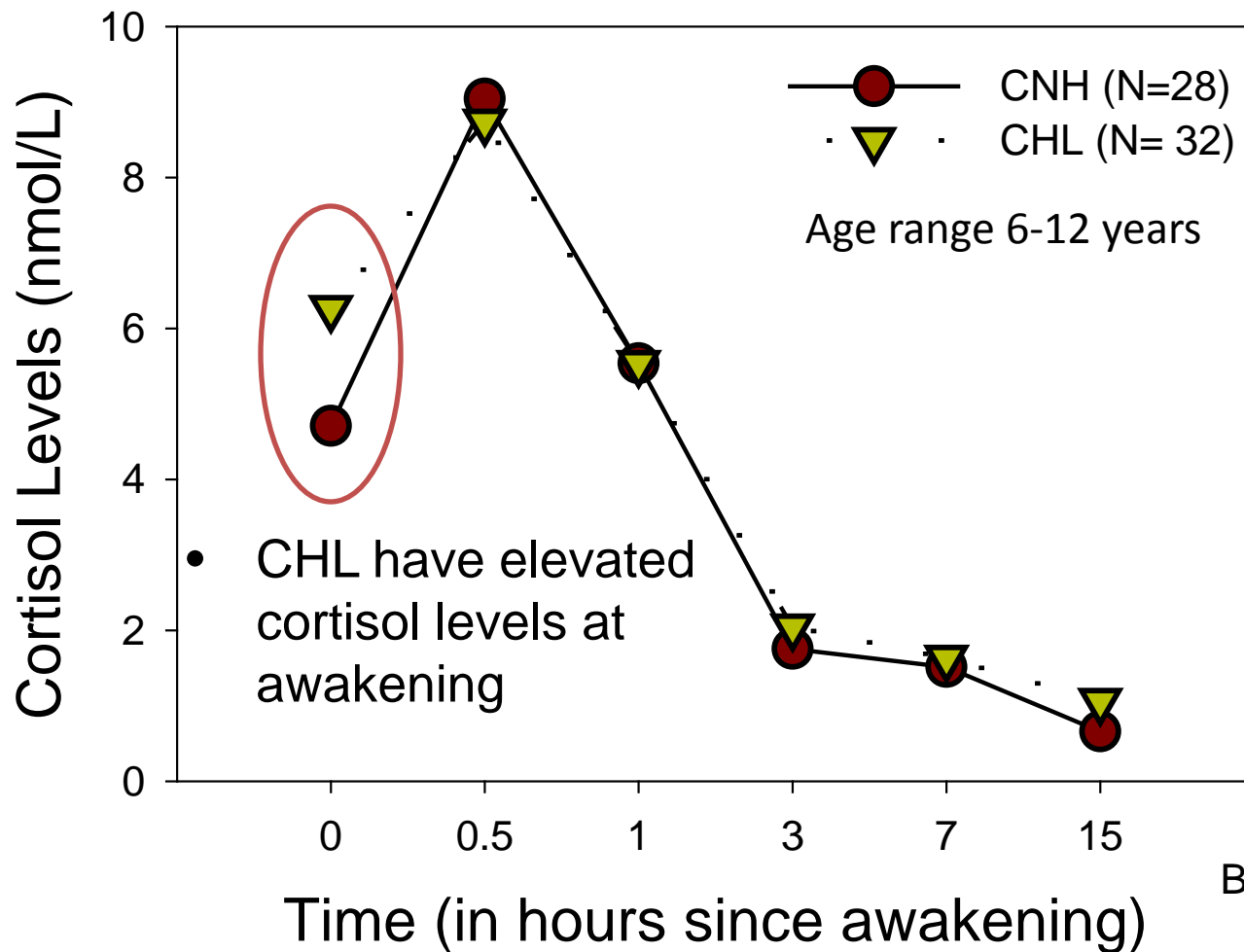
Booklet



- 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)

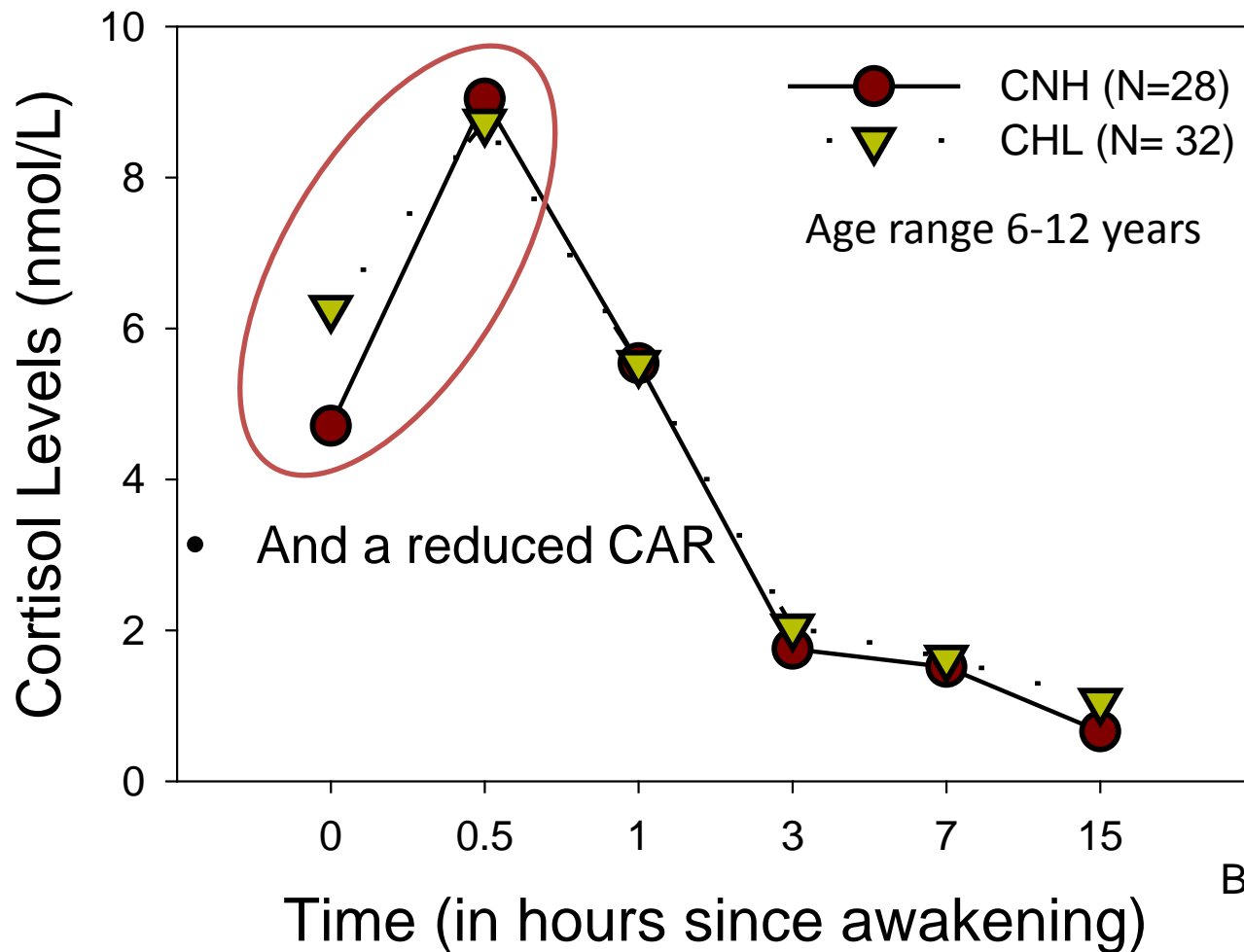
***Samples taken by parents at home-**
Other samples taken at school by research staff

Diurnal Salivary Cortisol Patterns in CHL & CNH



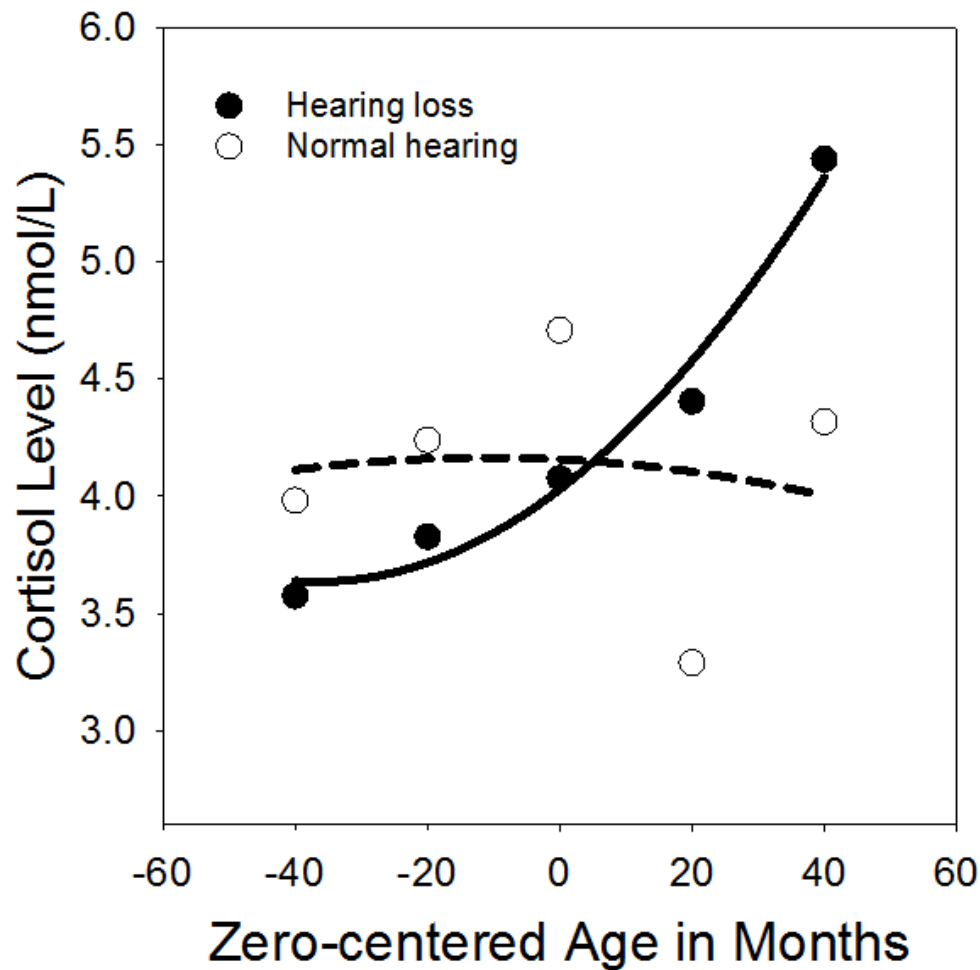
Bess et al., (2016)

Diurnal Salivary Cortisol Patterns in CHL & CNH



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

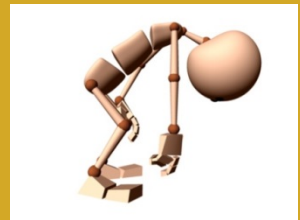
- Be on the lookout for fatigue!
 - Fatigue can manifest itself in a variety of ways
 - tiredness
 - sleepiness in the morning
 - inattentiveness and distractibility
 - mood changes (irritability, frustration, etc.)
 - changes in classroom contributions
 - difficulty following instructions

Implications for Practice

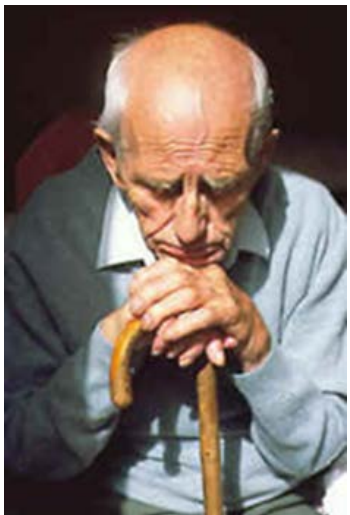
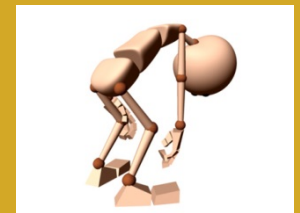
- Help us educate the community & the students
 - Discuss with families, general education teachers, and other service providers that children with hearing loss are at increased risk for fatigue
 - Importance of listening breaks
 - Arrange lessons so cognitively demanding material is early in the day
 - 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>