



# Vanderbilt Bill Wilkerson Center

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

Benjamin W. Y. Hornsby

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# Acknowledgements

## ■ Collaborators

- Dan Ashmead
- **Fred Bess**
- Stephen Camarata
- Aaron Kipp
- Sasha Key
- Ronan McGarrigle

## ■ Lab Group(s) members

- Hilary Davis
- Sam Gustafson
- Virginia Rich
- Maureen Virts
- Ye Wang

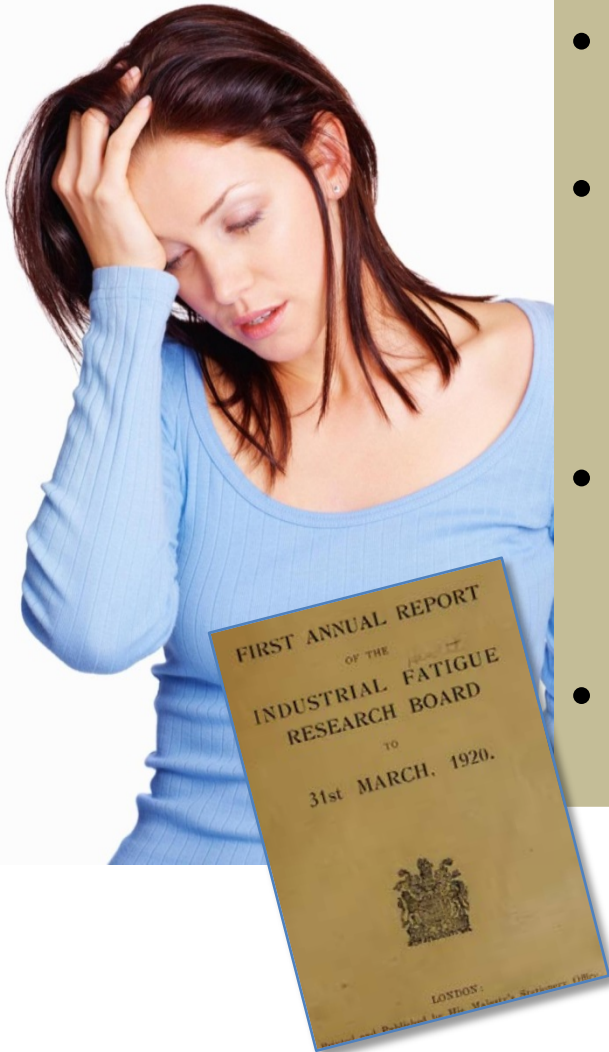
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# What is fatigue?

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

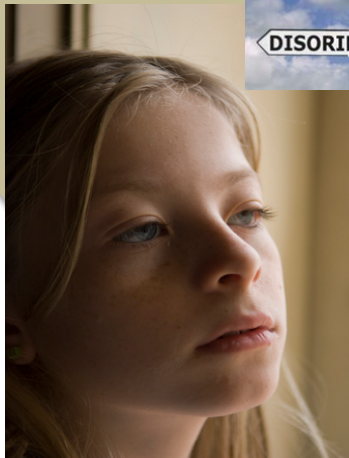
Severe, recurrent fatigue- is not common in healthy populations

-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
  - Multi-dimensional
- Many options, none specific to hearing loss or focus on listening-related fatigue

“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?”***

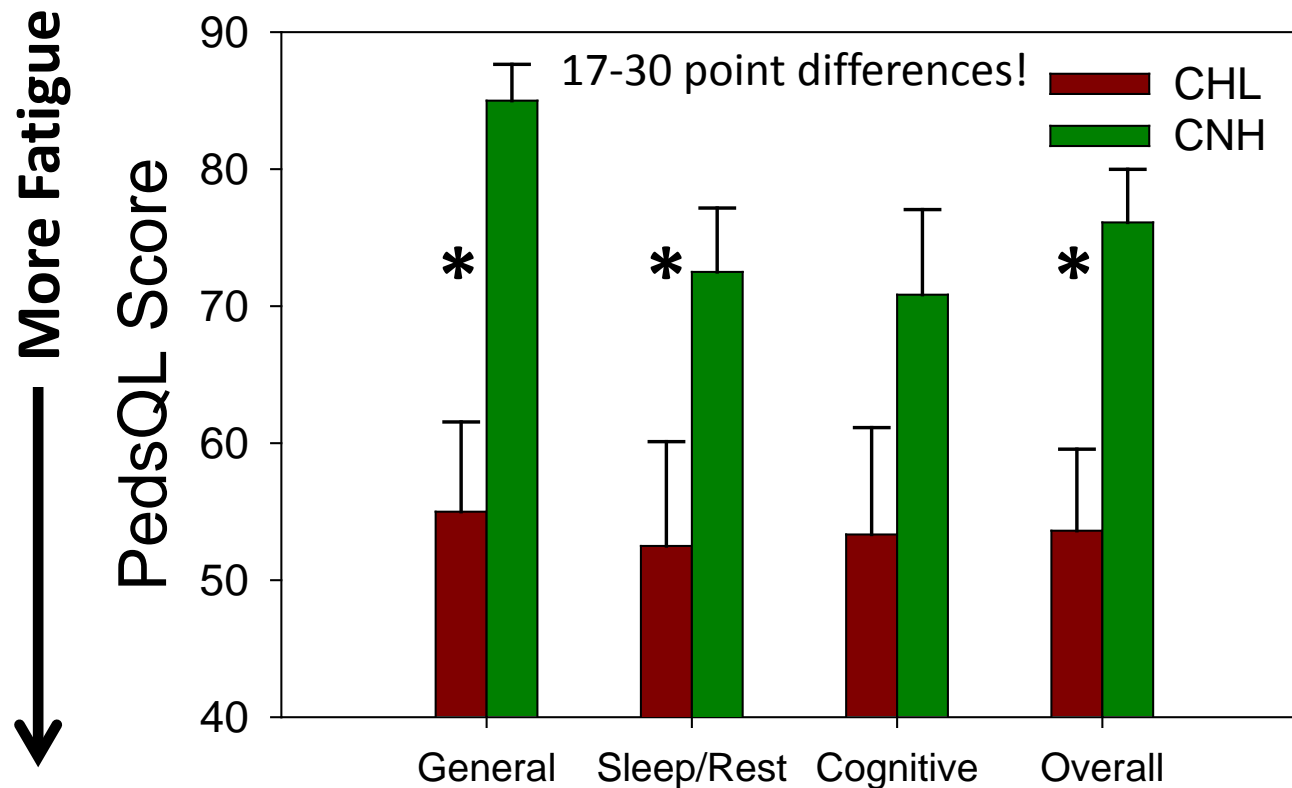
|   | Not at all  | Sometimes   | A lot   |            |
|---|---|---|---|------------|
|   |  |  |  |            |
| Item  | 0   | 2   | 4   | Construct  |
| Do you feel tired                                   |   |   |   | General    |
| Do you sleep a lot                                  |   |   |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

# 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)

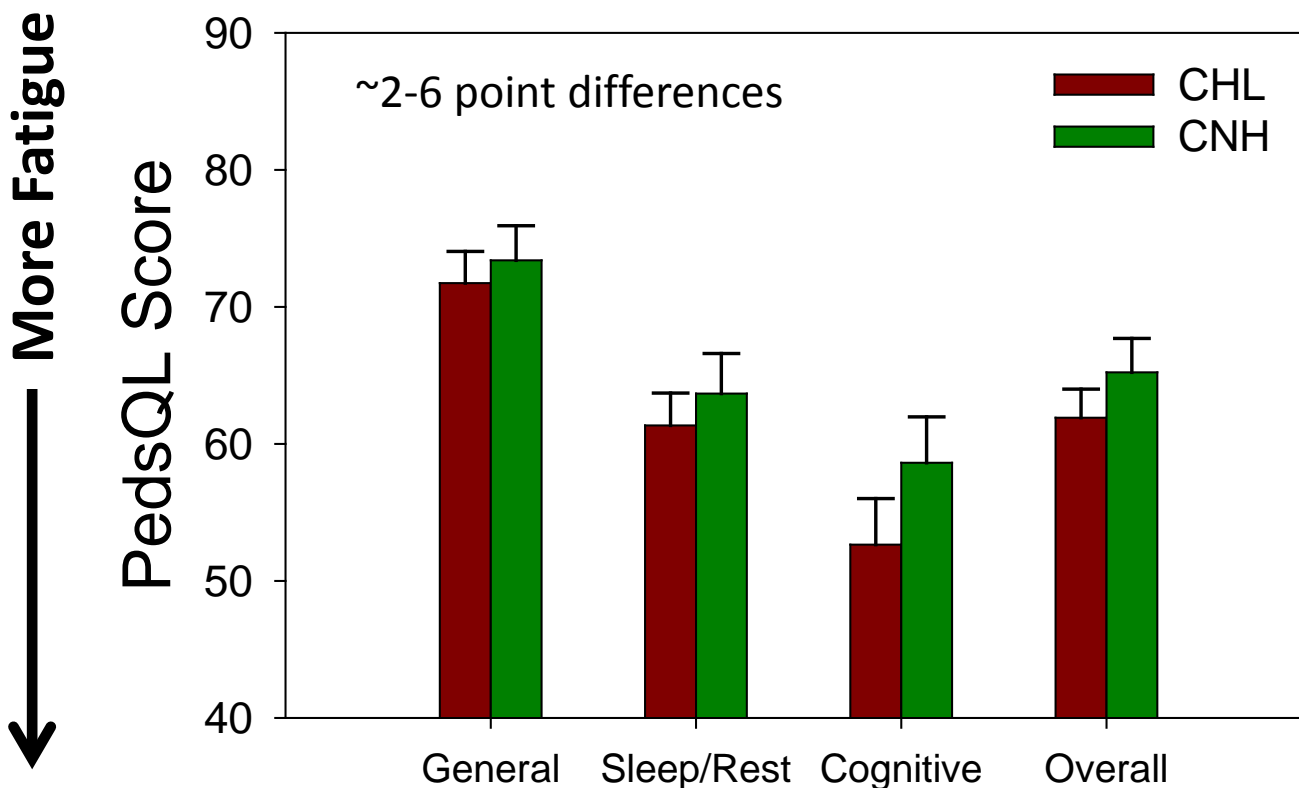
PedsQL-MFS: Pediatric Quality of Life-  
Multidimensional Fatigue Scale (Varni et al., 2002)



- CHL reported significantly more fatigue. Pervasive across domains

Hornsby, et al., (2014)

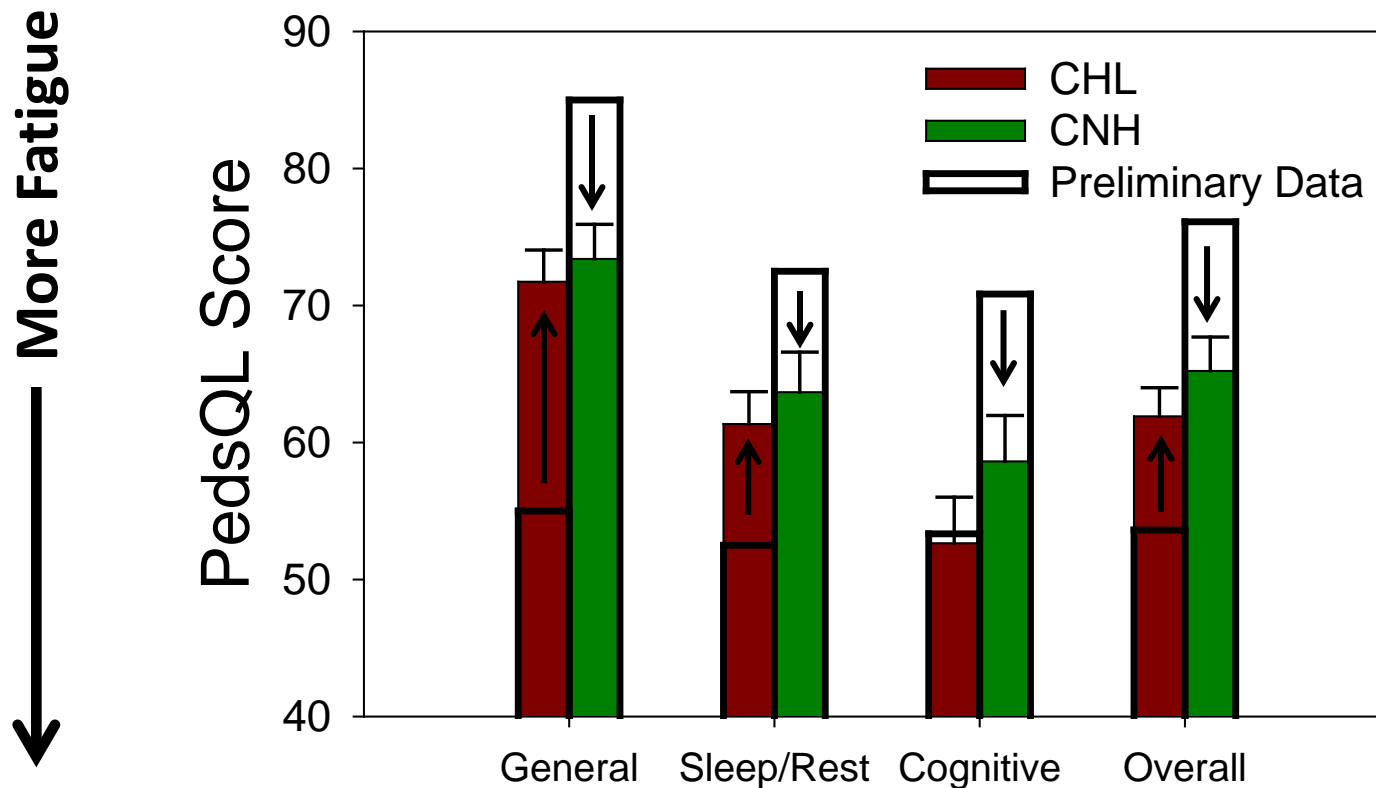
# Full Data Set (n=60 CHL; 43 CNH)



- 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

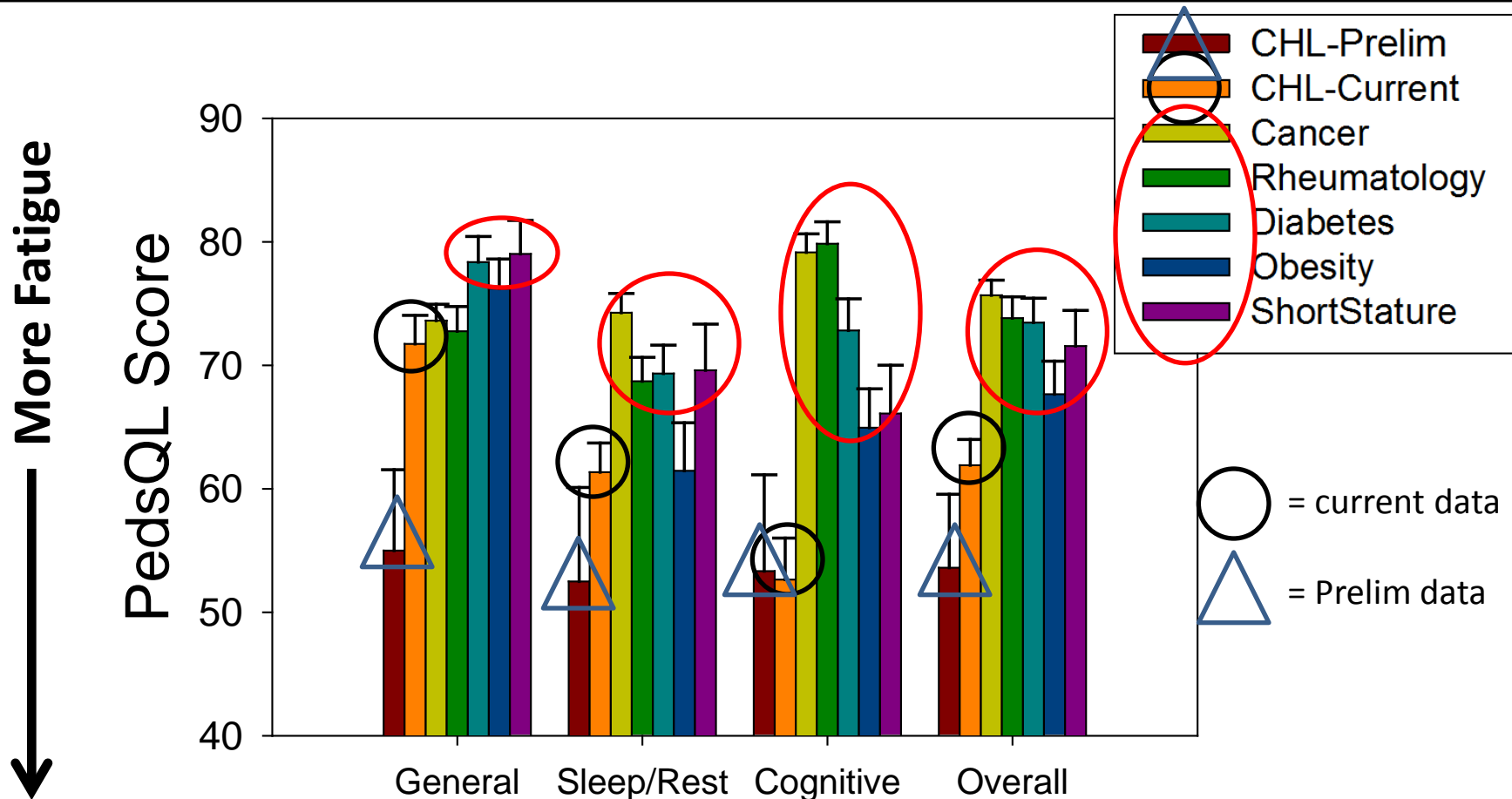
# Why the smaller effect of hearing loss?



- 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~~

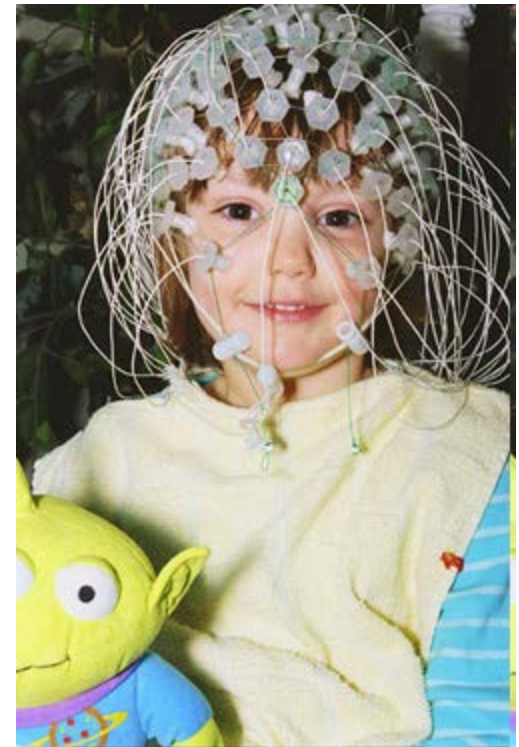
- A decline in (cognitive) task performance due to sustained (mental) demands

**Physiologically—**

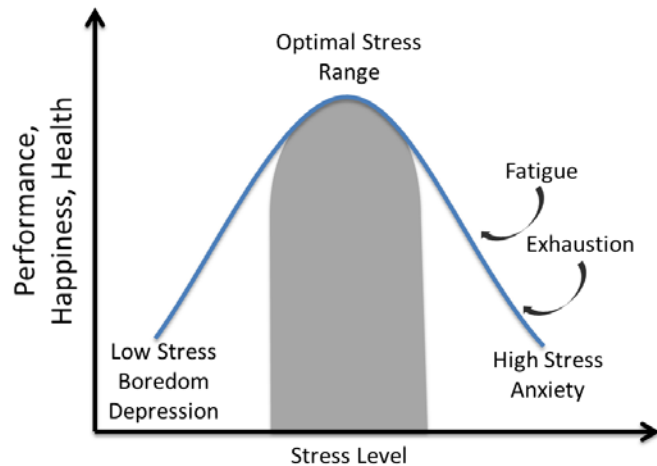
- Physiologic changes or biomarkers associated with mental fatigue

# 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



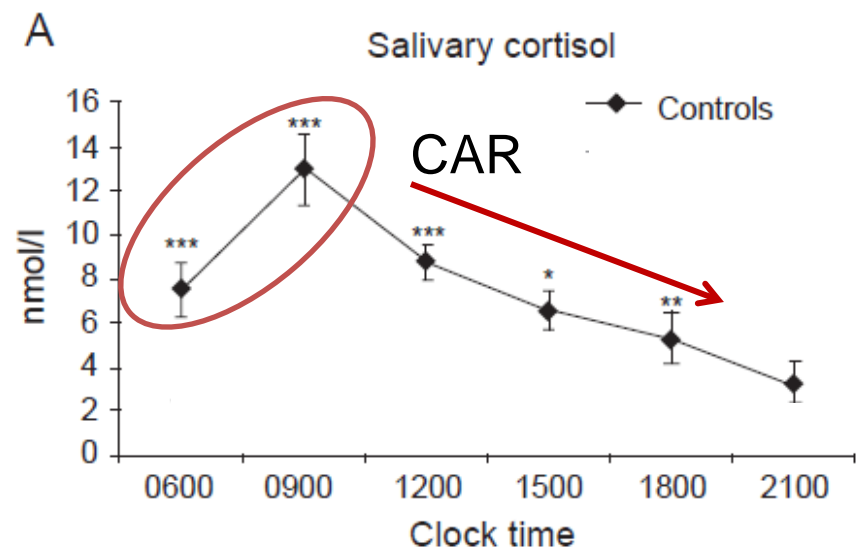
# PHYSIOLOGIC MARKERS: STRESS, CORTISOL AND FATIGUE



- 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

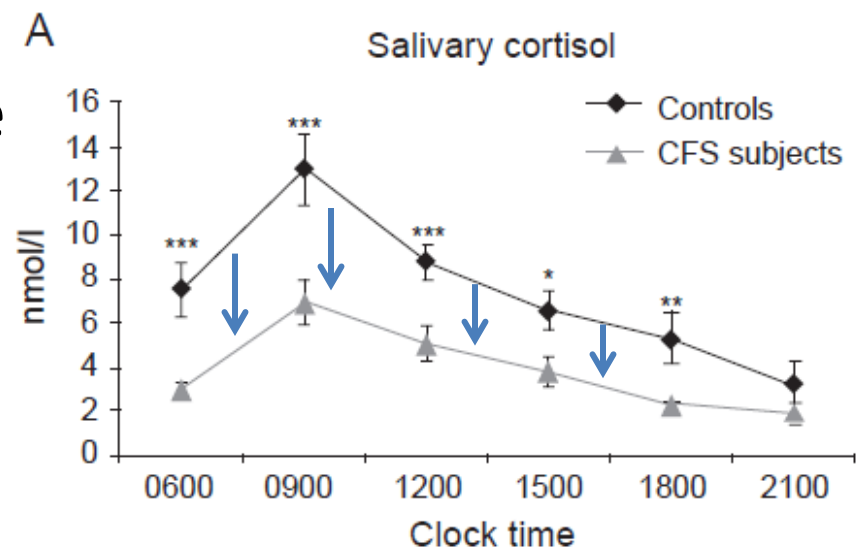
- In non-fatigued individuals, cortisol levels have a typical diurnal pattern
  - Build-up of cortisol during sleep
  - Rapid rise upon awakening
    - Cortisol Awakening Response; CAR
  - Slow decline in cortisol throughout the day



# “Abnormal” Diurnal Salivary Cortisol Patterns During the Day

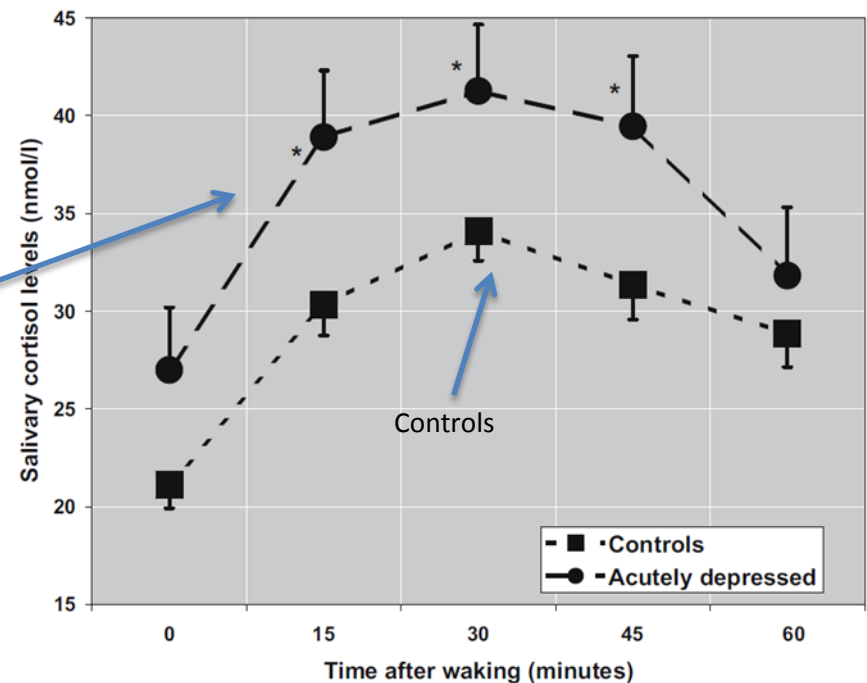
- Sustained stress or fatigue can lead to abnormal diurnal cortisol patterns

- Reduced response with “Chronic Fatigue Syndrome”



# “Abnormal” Cortisol Awakening Response

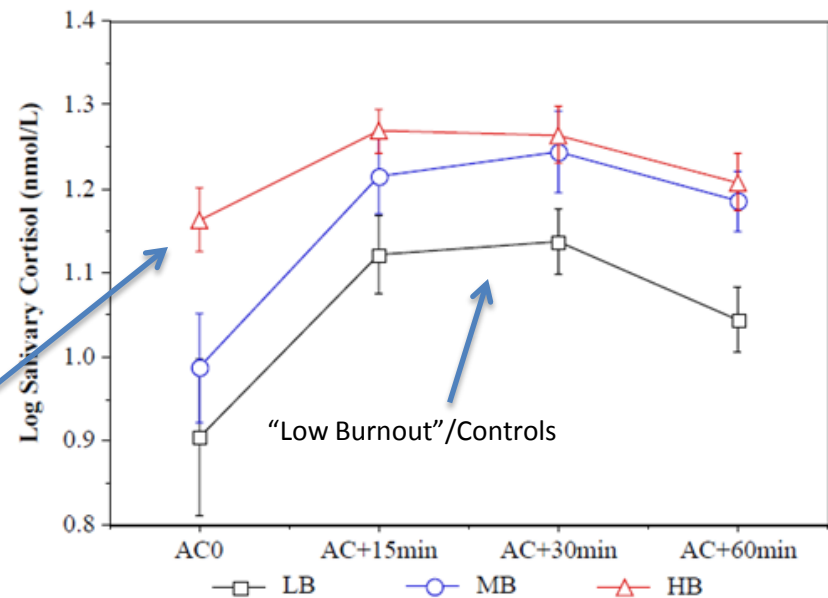
- Sustained stress or fatigue can lead to abnormal diurnal cortisol patterns
  - Reduced response with “Chronic Fatigue Syndrome”
  - “Elevated” CAR in patients with depression





# “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

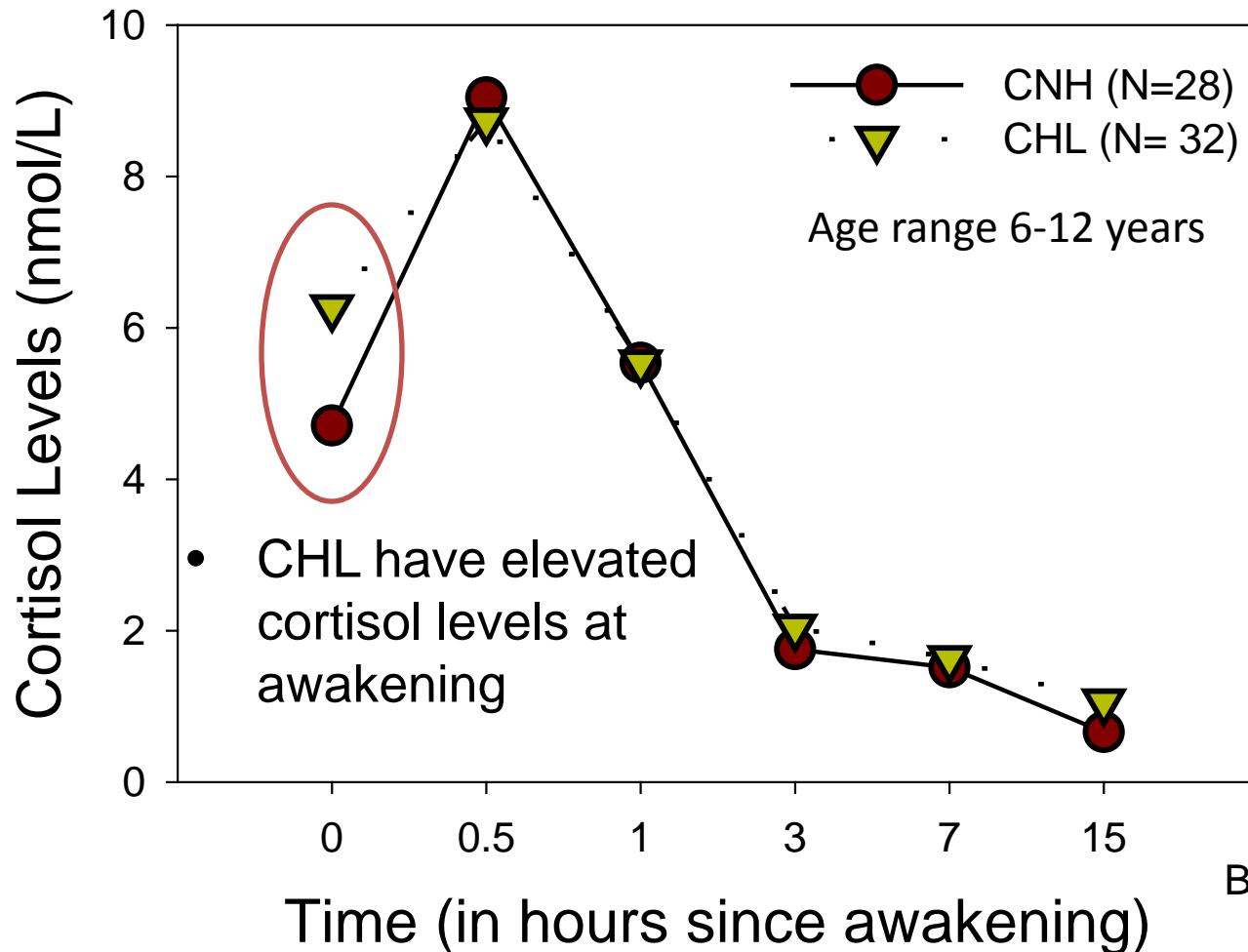
Booklet



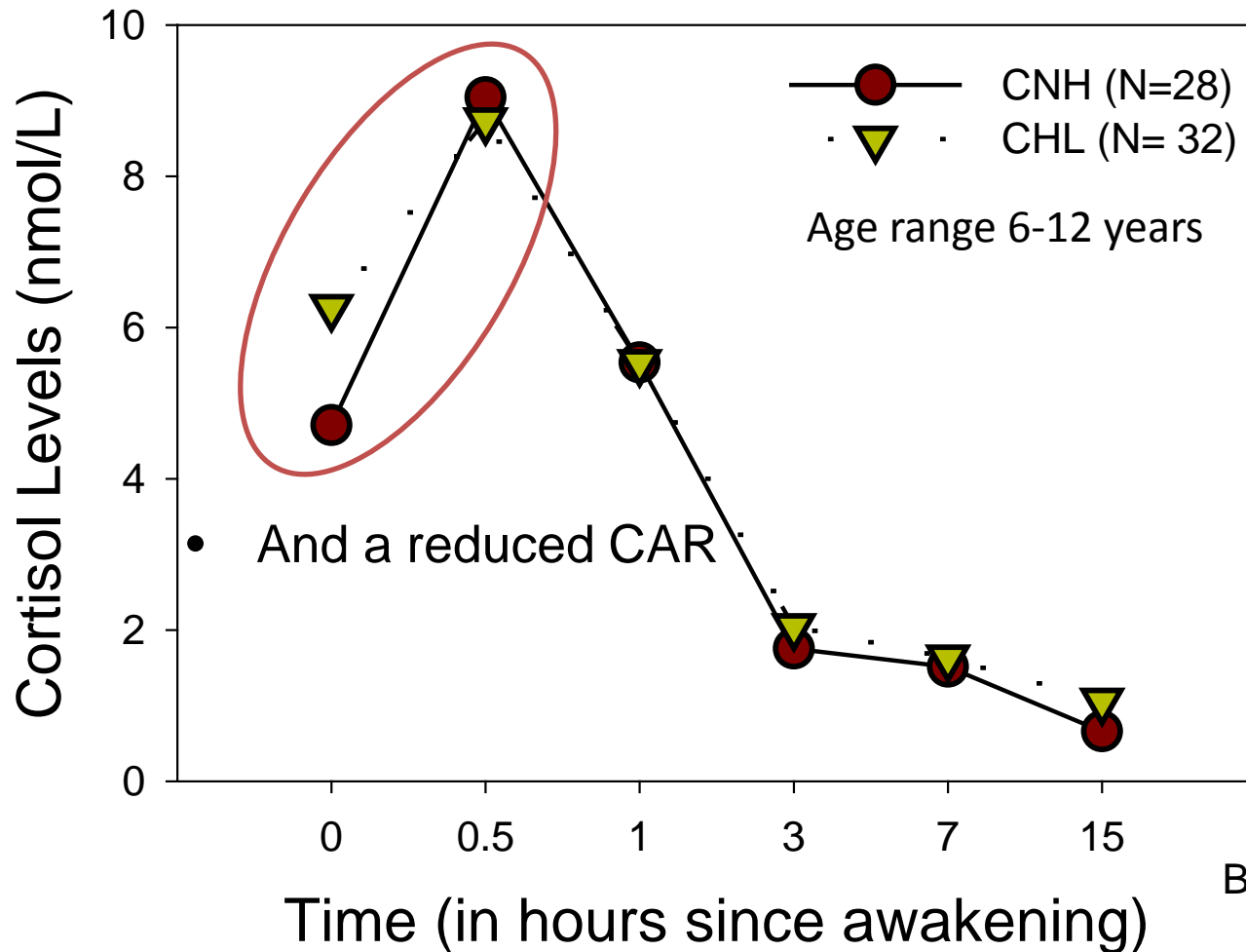
- Six samples taken: **awakening\***, **30\*** & **60\* min post**, **10am**, **2pm**, **8pm\***
  - Procedure repeated a second time several weeks later
- Cortisol levels can be “easily” obtained from saliva samples
  - Easier to collect than some other biologic materials (e.g., hair, urine)

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

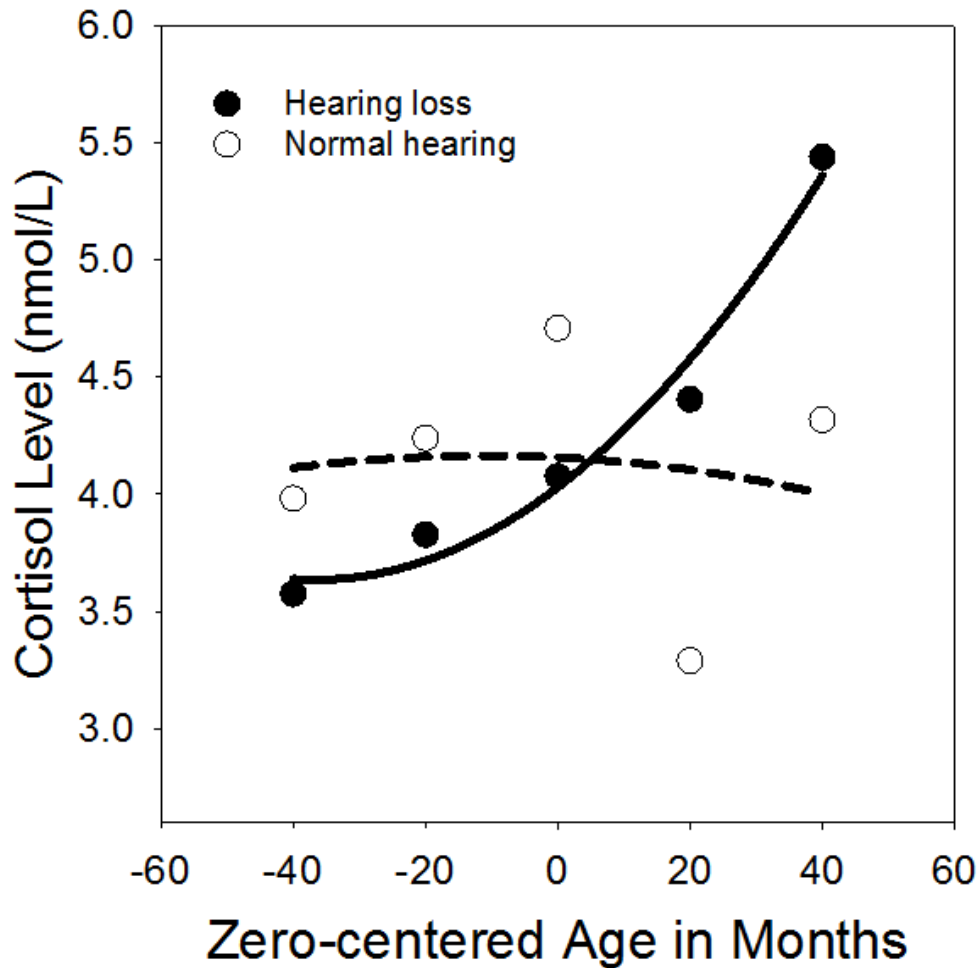
# Diurnal Salivary Cortisol Patterns in CHL & CNH



# Diurnal Salivary Cortisol Patterns in CHL & CNH



# 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

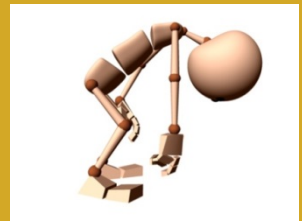
- Be on the lookout for fatigue!
  - Fatigue can manifest itself in a variety of ways
    - tiredness
    - sleepiness in the morning
    - inattentiveness and distractibility
    - mood changes (irritability, frustration, etc.)
    - changes in classroom contributions
    - difficulty following instructions

# Implications for Practice

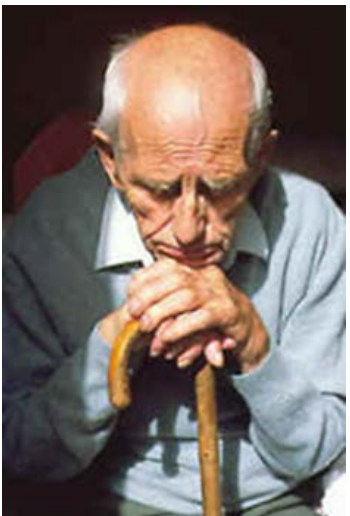
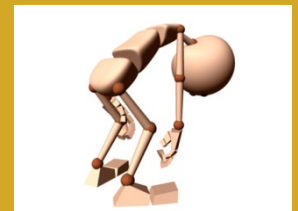
- Help us educate the community & the students
  - Discuss with families, general education teachers, and other service providers that children with hearing loss are at increased risk for fatigue
    - Importance of listening breaks
    - Arrange lessons so cognitively demanding material is early in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