Vanderbilt Bill Wilkerson Center

Too Tired to Listen?

Quantifying Listening-related Fatigue using the Vanderbilt Fatigue Scale

Hornsby, B., Camarata, S., Davis, H. Cho, S-J., & Bess, F.

AAA 2018

Nashville, TN, USA

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Disclosures

- All authors are employed by Vanderbilt University (VU) and Vanderbilt University Medical Center (VUMC)

- Financial Disclosures- this work has been supported by federal and industry grant mechanisms
  - IES #R324A110266 (Bess, PI)
  - IES #R324A150029 (Bess, PI)
  - NIH R21 DC012865-01A1 (Hornsby, PI)
  - Starkey, Inc (Hornsby, PI)

- Nonfinancial Disclosures
  - None

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Acknowledgements

- Lab Members and Collaborators
  - Fred Bess
  - Stephen Camarata
  - Sun-Joo Cho
  - Hilary Davis
  - Ben Hornsby
  - Sasha Key
  - Caitlin Dold
  - Aimee Grisham
  - Keren Rosario-Ortiz
  - Sam Sekator
  - Maureen Virts

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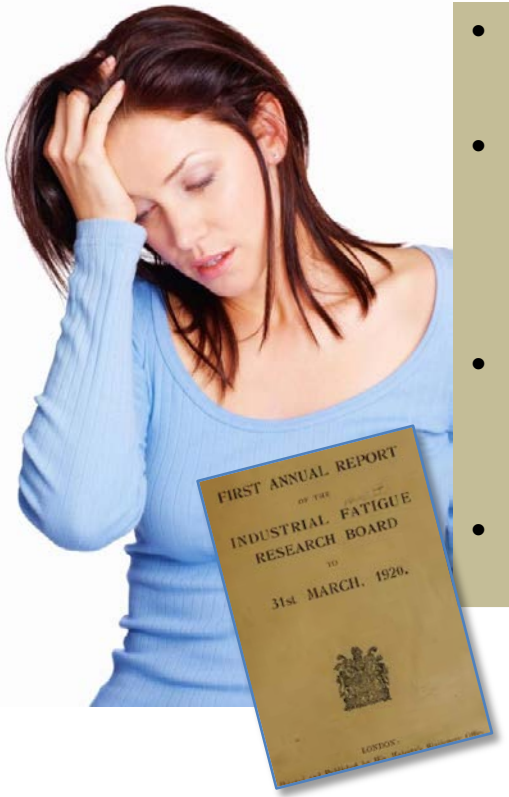
What is fatigue?

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
  - Quantified via questionnaires and survey instruments
- **Behavioral (Cognitive) fatigue** is an outcome, a decrement in performance
  - Quantified via changes in physical or mental performance over time
- **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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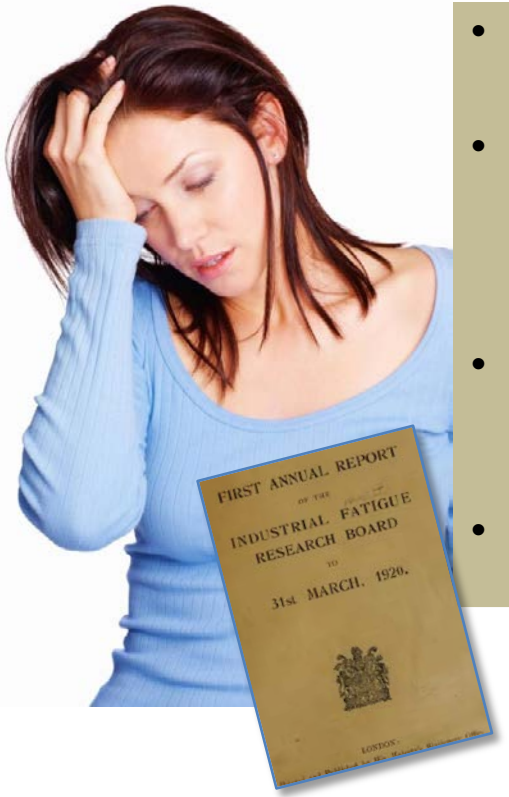

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Consequences of fatigue

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

Amato, et al. 2001; van der Linden et al. 2003; DeLuca, 2005; Eddy and Cruz, 2007; Ricci et al. 2007

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Who Has Fatigue?

- **Everybody!**-
  - Complaints of **mild transient** fatigue are common even in healthy populations
- **Severe, recurrent fatigue-** is NOT common in healthy populations but is common in many chronic health conditions
  - Cancer, HIV AIDs, Parkinson's, MS
- Very little work examining fatigue associated with hearing loss in adults or children

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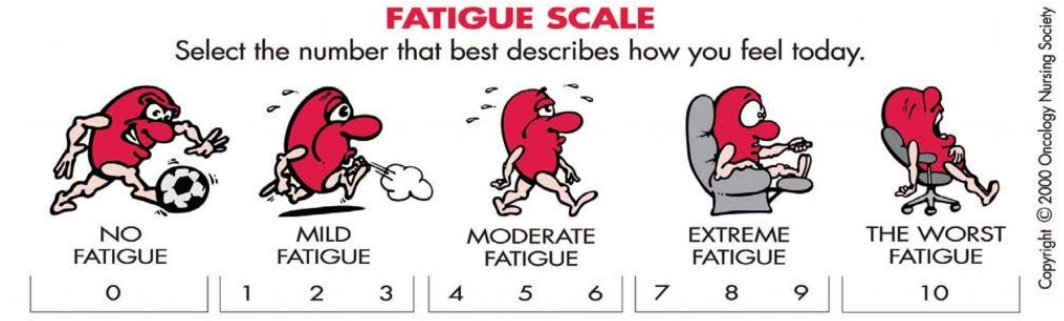
Quantifying Fatigue Subjectively

- Subjective measures include surveys, rating scales and questionnaires that ask about mood or feelings
- Fatigue scales may be
  - Uni-dimensional: Assumes all fatigue is similar
    - Measured using a single scale



See e.g., Dittner et al., 2004 for review

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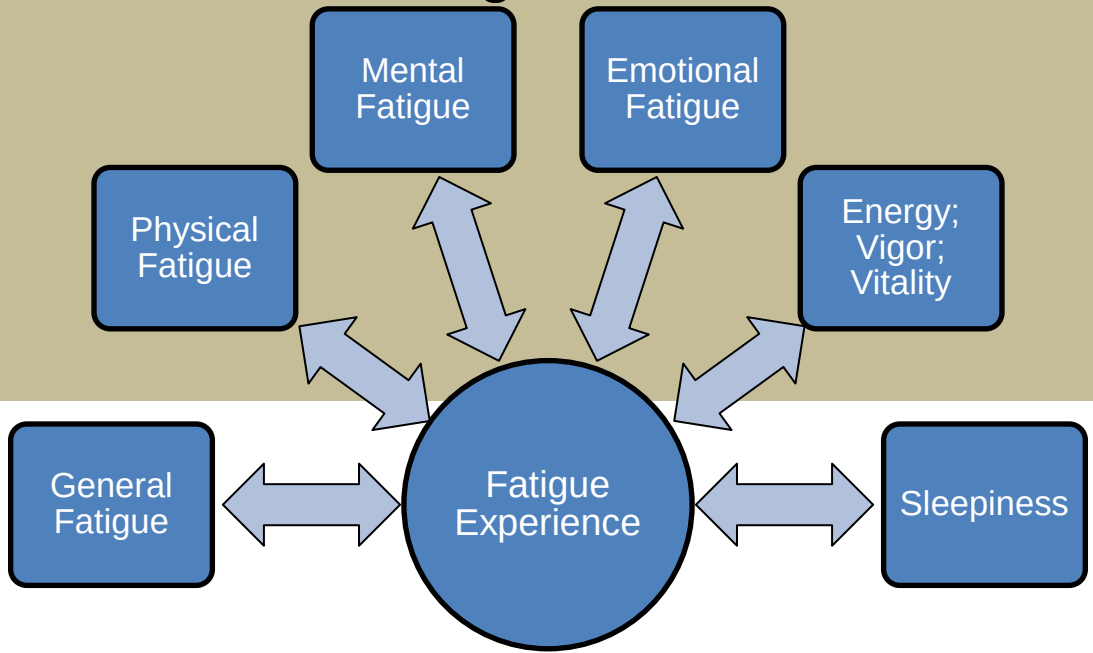
Quantifying Fatigue Subjectively

- Or multidimensional: Requiring multiple scales to measure various dimensions of fatigue



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Quantifying Fatigue Subjectively

- *Many options, but none are specific to hearing loss or focus on listening-related fatigue*

See Hornsby, Naylor and Bess, 2016 for review

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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

- What do the data say?

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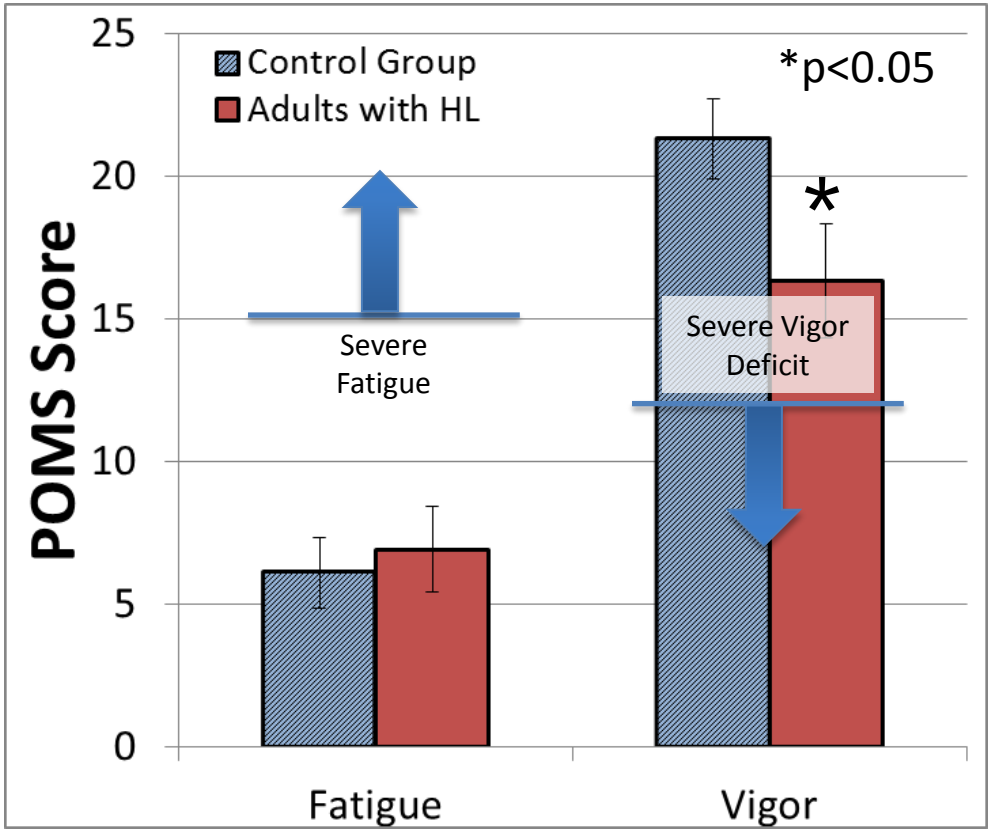
Subjective fatigue in Adults with HL



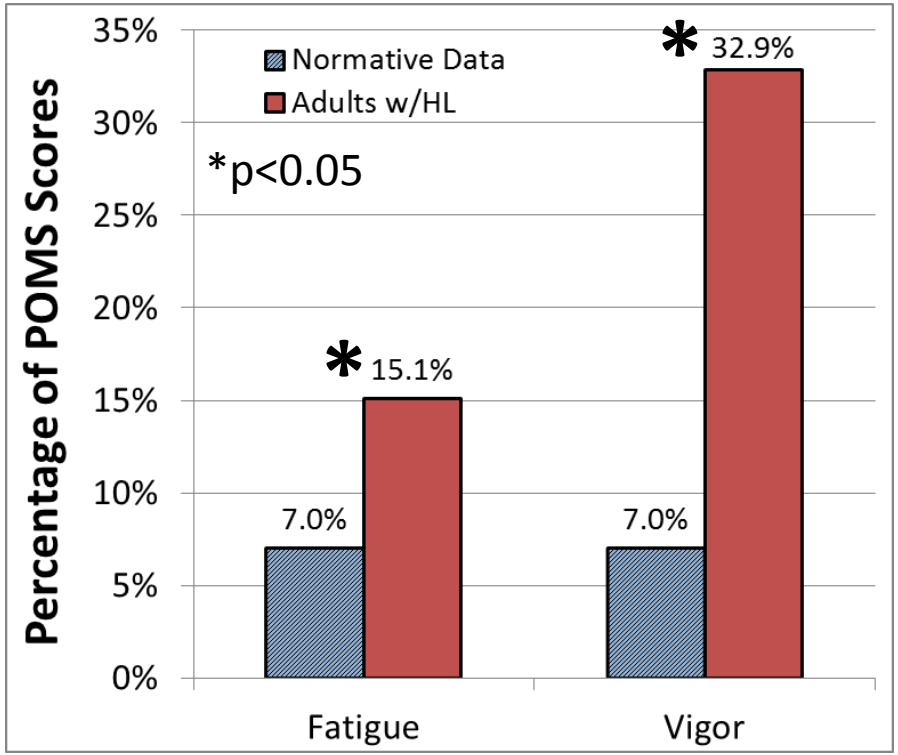
POMS= Profile of Mood States (McNair et al., 1971)

- 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

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

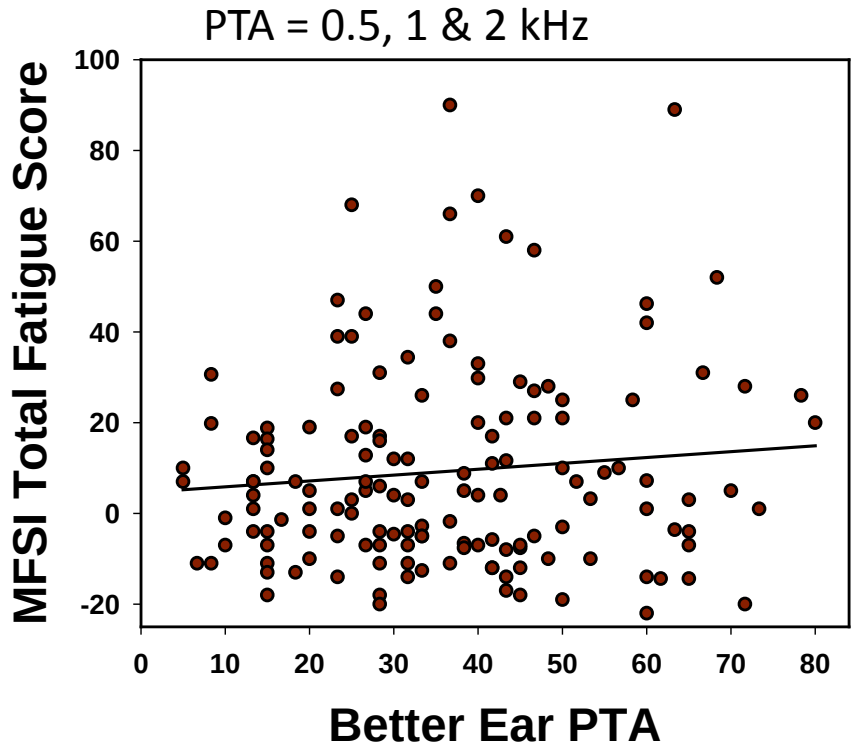
Adults with HL are at increased risk for **severe** fatigue and vigor deficits

- **More than twice** 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



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

But… fatigue was not associated with degree of hearing loss



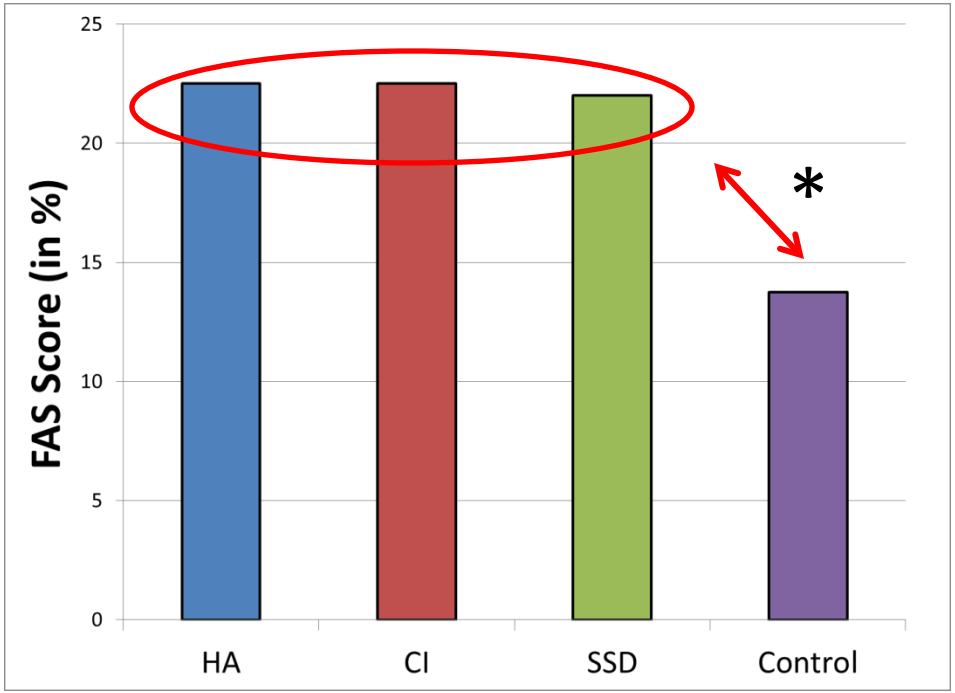
Hornsby, B. & Kipp, A. (2016)

- Surprisingly, **no association** bw degree of loss and any fatigue/vigor domain
  - Similar result for POMS data as well
    - N= 143
    - Age range: 22-94 years
    - PTAs: 5-80 dB (Median: 33 dB)

MFSI= Multidimensional fatigue symptom inventory- short form

Type of hearing loss and fatigue

- Used a generic measure (FAS) to examine differences in fatigue bw hearing loss groups
  - HA, CI, SSD (n=50 adults/group)
- No signficant differences in fatigue bw HL groups
  - But all HL groups reported more fatigue than NH controls



Modified from Alhanbali et al., 2017

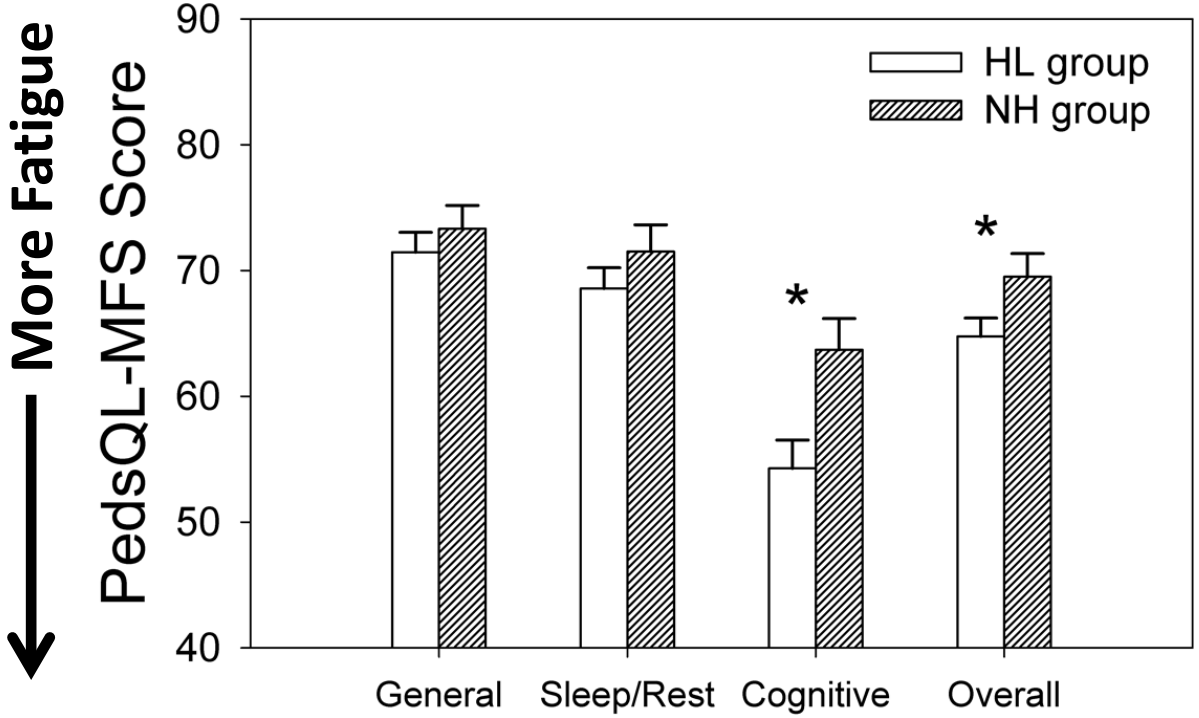
- Fatigue measure- Fatigue Assessment Scale (FAS)

Similar findings in Children with HL (CHL)

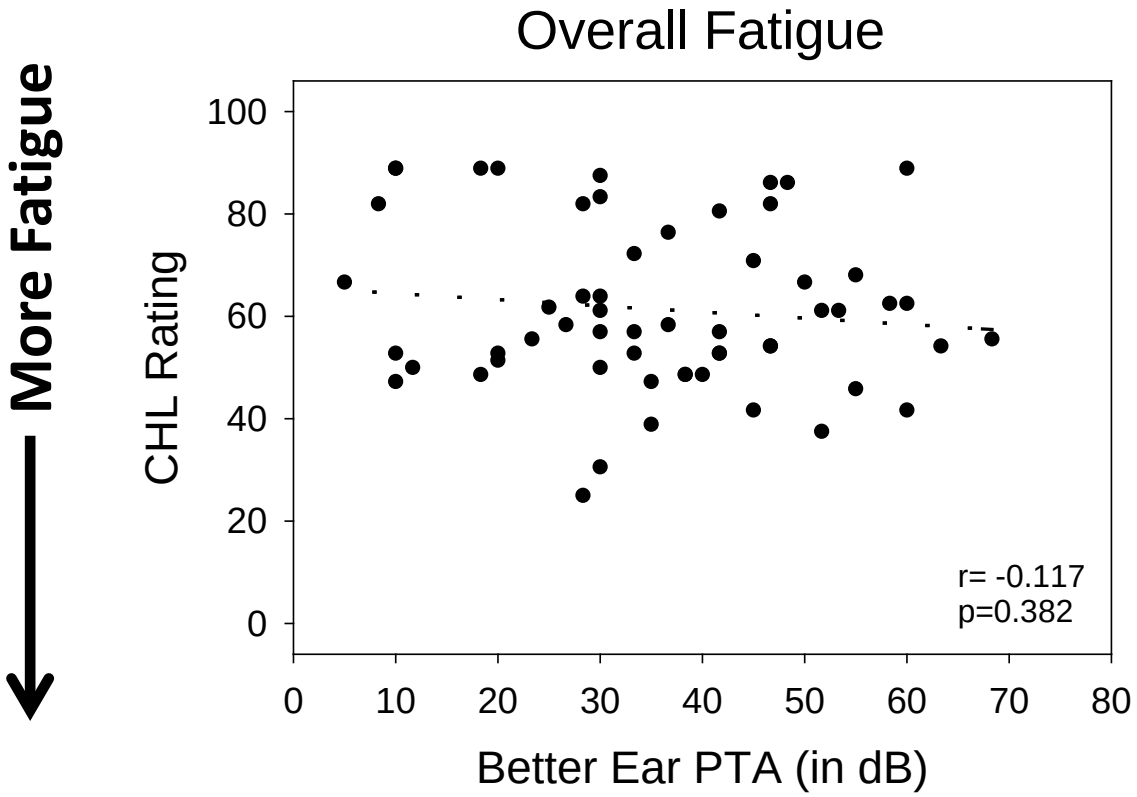
- CHL report more overall and cognitive fatigue than children without HL

- CHL (n=60) and CNH (n=43)
  - 6-12 years olds
  - Bilateral, mild to moderately-severe HL

From Hornsby et al., 2017



But… fatigue ratings in CHL are NOT associated with degree of hearing loss



- No association between degree of loss and fatigue
  - Regardless of domain, or PTA measure
  - Same as adult data

Take Home Points

- ***Generic*** fatigue measures suggest, in everyday settings adults & children with HL are at increased risk for fatigue,
    - Especially for more **severe** fatigue and vigor deficits
- The risk is ***not*** associated with the degree of HL
    - Generic measures may underestimate fatigue severity in adults and children with HL

- These findings highlight the need for a tool *specifically* designed to assess listening-related fatigue

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The Vanderbilt Fatigue Scale (VFS) for Adults and Children with Hearing Loss

- Phase I- Defining the problem (Davis)
  - Focus groups and interviews
- Phase II- Item creation (Davis)
- Phase III- Initial data collection (Camarata)
  - item analysis (IIIa), item reduction (IIIb) and preliminary scale assessment (IIIc)
- Phase IV- Collection and preliminary analyses of validation data (Camarata)
- Summary/Conclusions (Hornsby)

Listening-Related Fatigue Scales: Current Work

- Vanderbilt Fatigue Scale-AHL (Adults with Hearing Loss)
- Vanderbilt Fatigue Scale-CHL (Children with Hearing Loss)
  - Pediatric Version
  - Caregiver Version
  - Teacher/Service Provider Version

GOAL: create and validate a measure to quantify fatigue in individuals with hearing loss with specific focus on listening-related issues.

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Phase I: Defining the Issues

"I went to a great conference today. It was riveting and I was hooked on pretty much every word. And then I got home and **collapsed** on the sofa. I've had to **turn my ears off to rest** in silence and my eyes are burning.

..the impact of deafness doesn't just manifest itself in communication. It's about the **energy** involved in lipreading and **being attentive all day long**.

Processing and **constructing meaning** out of half-heard words and sentences. **Making guesses** and figuring out context. And **thinking of something intelligent** to say in response to an invariably random question.

It's like doing **jigsaws, Sudoku, and Scrabble** all at the same time."

Ian Noon blog post

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Fatigue Scale Development Process

- Phase I: Defining listening-related fatigue and issues
  - Literature Review: background theory and constructs
  - Focus Groups: individual experiences
- Phase II: Item Development and Revisions
  - Focus group data review
  - Expert review
  - Cognitive interviews
    - AHL, CHL, parents, and teachers

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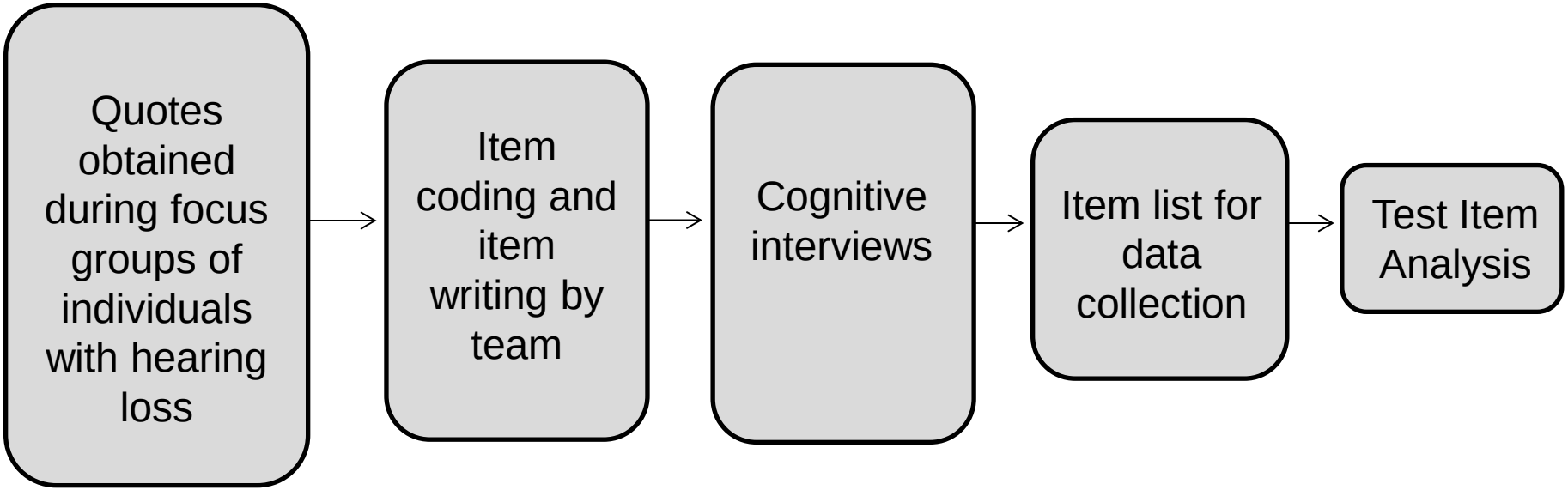
Item Development Overview



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Phase I: Focus Groups

DEFINITION: Specialized groups in terms of purpose, size, composition, and procedures

PURPOSE: thoughtfully explore through discussion a topic or phenomena of interest to researchers

GOALS: extract qualitative data on the topic at hand through group member interactions and discussion

Content validity: the extent to which a measure represents all facets of a given construct

Phase I: Focus Groups

- Focus groups of adults with hearing loss
  - N=8 groups, 42 adults with hearing loss
  - Mild to moderate HL, two age groups
- Focus groups/interviews with children with hearing loss (CHL), their parents and their teachers
  - N=9 groups, 17 parents, 28 teachers/school service providers, 23 children with hearing loss

MODERATOR'S GUIDE
How often do you feel physically or emotionally tired due to difficulty listening?
How many different kids of listening situations cause you to feel physically or emotionally tired due to difficulty listening?
What coping strategies do you/the student use to recover from fatigue?
Is fatigue from listening a problem for your student?

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Phase I: Defining the Issues

Listening-Related Fatigue

"In the cafeteria, they try to listen but that's their starting time of "fading down" so they just kind of take it a break time. I've had my one student, she sometimes just **takes her implant off and even turns the volume down on her hearing aid and that's like her time to just sit and not have to listen**."
–Deaf education teacher

"When I get home at night I'm more tired than you are because I've had to listen all day…**Mentally making myself aware**…, you got to be tuned into everything going on around you…"
-adult with hearing loss

*"I **gave up**…after the evening was over, I was **physically tired**…I was **exhausted** afterwards…"*
-adult with hearing loss after eating at a restaurant with friends

*"Yeah, **you wanna give up**. You just don't want to try anymore because you know you won't actually get what they're trying to say or sometimes you think it's just you. Maybe I need to try a little harder to listen but when you do try, you **put all of your focus on what they're trying to say and you still can't hear them**."*
–teen with bilateral hearing aids

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Phase I: Defining the Issues-CHL

"Fatigue sounds like phantom,

so maybe a squid?"

PARENT AND TEACHER PROXY REPORT

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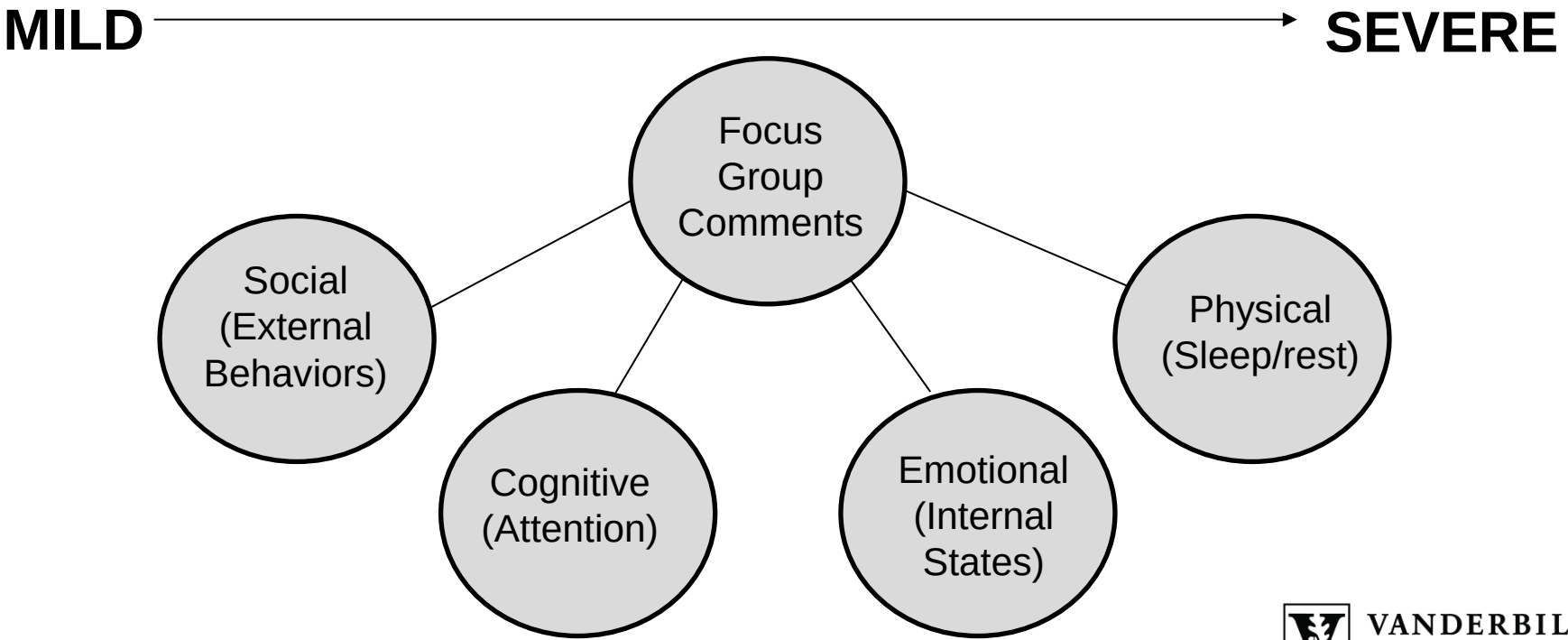
Phase II: Item Development

- Focus group audio recordings transcribed
- Multi-disciplinary team created a coding strategy to organize and analyze the participant comments
  - Common themes, modified as new themes emerged
- Each transcription was coded by two trained lab staff members
  - Each statement was given at least one code (up to 5)
  - Agreement verified by third reviewer

Phase II: Item Development



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Phase II: Construct Map-AHL

Level	D2: Cognitive (Attention)
3-Severe Fatigue (observed in a wide range of listening situations)	**Behaviors:** becomes *unwilling/unable to maintain effort and attention* when completing even routine mental activities. **Shuts down, gives up***.*
2-Moderate Fatigue (observed in moderately challenging listening situations)	**Behaviors:** must apply *substantial mental effort* to overcome difficulties remaining attentive. May **tune/zone out.** May need prompting.
1-Mild Fatigue (observed in very challenging situations only)	**Behaviors: Some difficulty** following fast-paced conversation and remaining attentive.

Phase II: Item Development

"At lunch I go to the car and sit…by myself. That gives me an hour of not having to listen or concentrate on anything."

I need a listening break during the work day.

I need time to relax after listening for a long time.

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Phase II: Item List Development-AHL

- 300 items created
- Team review reduced to 103 items

	Cognitive	Physical	Emotional	Social
Severe	10	11	10	8
Moderate	15	12	13	8
Mild	4	4	4	4
Total	**29**	**27**	**27**	**20**

- Cognitive Interviews (N=7)

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Sample Items from the VFS-AHL

Never/Almost Never	Rarely	Sometimes	Often	Always/Almost Always
O	O	O	O	O

- It takes a lot of energy to listen and understand.
- How often do you feel tired due to trouble hearing and understanding?

-Frequency Scale

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
O	O	O	O	O

- Listening fatigue is a daily struggle.
- Having to tell people that it is hard for me to understand them is emotionally draining.

-Agreement Scale

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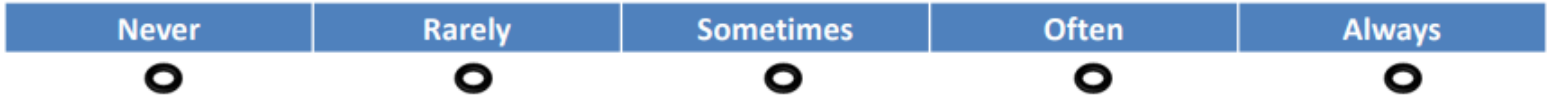
Sample Items from the VFS-CHL



- I use a lot of energy trying to understand what others are saying.
- I get annoyed when I have to listen in a noisy place.
- I get stressed when I have difficulty understanding others.
- I get sleepy after listening for a long time.
- I need a break after listening in a noisy place.

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Phase III: Preliminary Data Collection

- Preliminary version of the scale
  - 103 items
  - N=581 adults
    - Online and paper

VFS-CHL Phase III Data Collection
60 items

- N=393 parents
- N=160 children
- N=304 teachers

Field Testing:
Summer/Fall 2018

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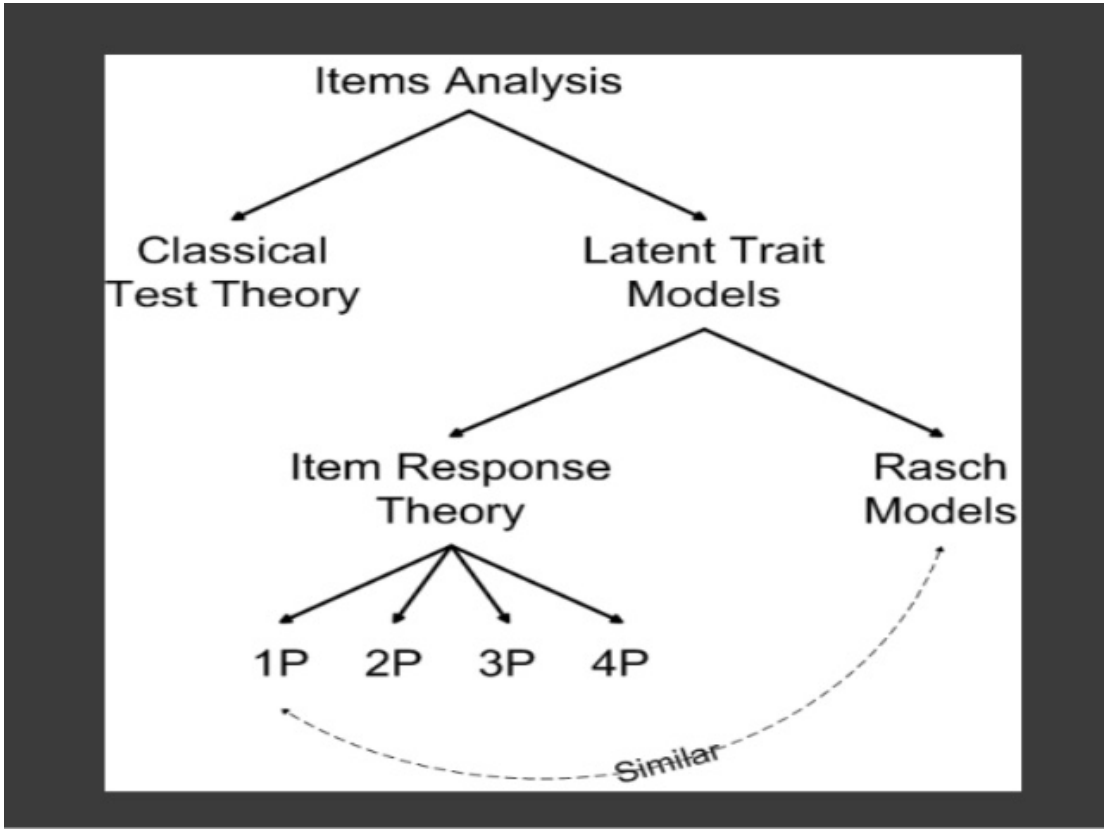
Phase IIIa: Initial Item Assessment

- 103 test items were assessed
  - Items covered 4 domains of mild-severe listening-related fatigue,
  - 581 adults with (n=434) and without (n=147) hearing loss
    - Data collected online and in person via paper/pencil
- Item Response Theory (IRT) was used to identify high quality items
  - High information items
  - Appropriate threshold order and good separation between response thresholds (good discrimination)
- Exploratory factor analysis found all items loaded on a single factor
- Hypothesized item severity (mild, moderate, severe) was examined and items deemed incorrectly categorized in terms of severity were recoded.

Item Response Theory

- How do we select the ”best” items for a test?
- How many items are needed?
- Do two items test the same “factor?”
- Goal- optimal number (and difficulty range)

Classical vs Item Response Models



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CTT	IRT
The **test** is the unit of analysis	The **item** is the unit of analysis
Measures with **more items (longer) are** more reliable than their counterparts	Measures with **fewer items (shorter) can** be more reliable than their counterparts
Comparing scores from different measures can only be done when the test forms/measures are **parallel**	Item responses of different measures can be compared as long as they are measuring the **same latent trait**
Item properties **depend** on a representative sample	Item properties **don't depend** on a representative sample
Position on the latent trait continuum is derived by **comparing the test score** with scores of the reference group	Position on the latent trait continuum is derived by **comparing the distance** between items on the ability scale
All items on the measure must have the **same** response categories	Items on the measure can have **different** response categories

Modified from:
https://www.mailman.columbia.edu/research/population-health-methods/item-response-theory

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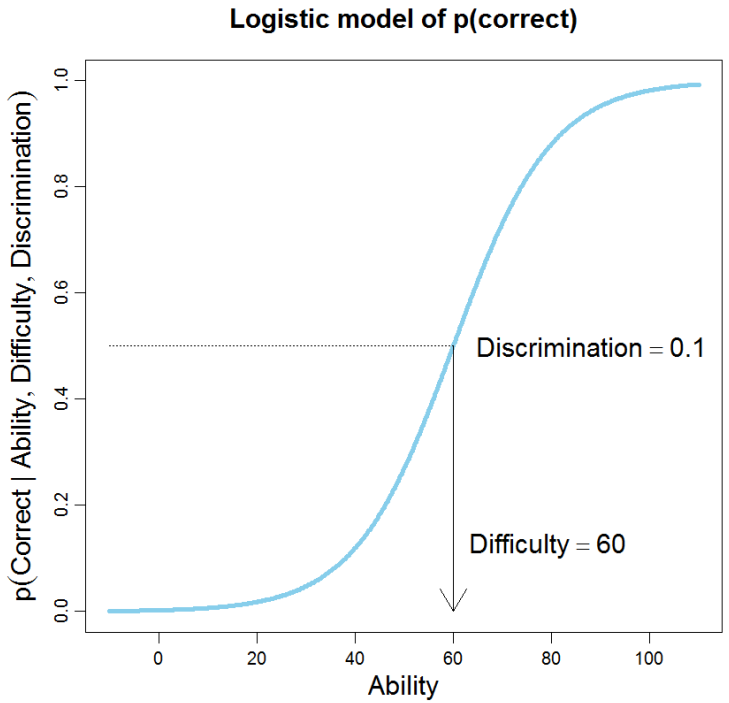
How are items behaving in the scale?

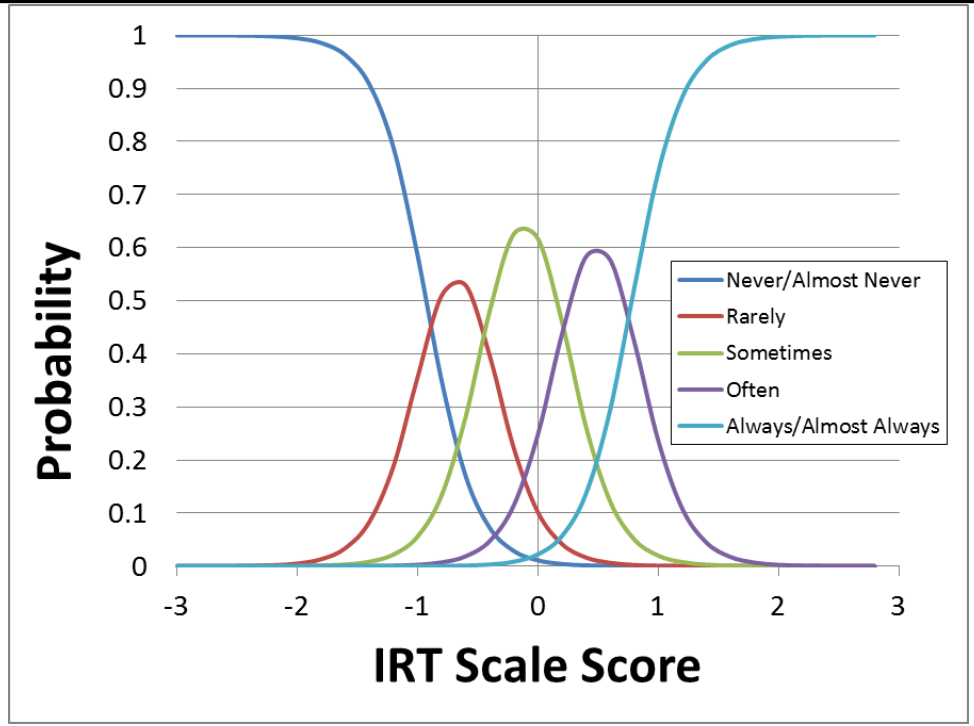


Each item has its own logistic curve, specified by difficulty and discrimination

Ability [difficulty] scale is arbitrary.
Abilities can be below 0 and above 100.

I become mentally tired when it is hard to listen.

- Category response curves for a single test item
  - Probability of choosing a response option based on the individuals level of fatigue
- Responses for this item are ordered and steep response slopes indicate good item discrimination



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Phase IIIb: Item Reduction

- Based on IRT analyses and internal review, **61** unique, high quality, items were selected for additional external review and analysis
- Eleven, external, content experts reviewed items for relevance and clarity
  - 95% of items were judged as “Quite” or “Highly” relevant by >50% of the reviewers
  - These items were revised based on content expert feedback to improve clarity.

Phase IIIb: Item Reduction

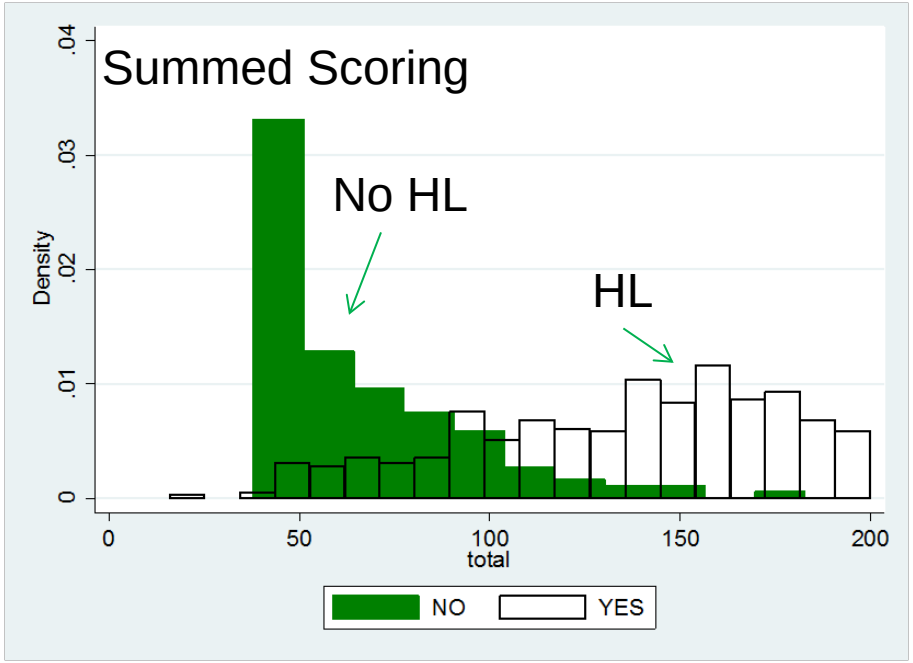
- This information was used to select items for
  - A 40 item multidimensional scale for research purposes
    - 10 items/domain; 1 mild, 4 moderate, 5 severe items
    - Designed for research purposes (e.g., interest in multiple domains or high test information)
  - A 10 item unidimensional scale for clinical use
    - 4 physical, 3 social, 2 cognitive, 1 emotional items
      - 1 mild, 2, moderate, 7 severe items

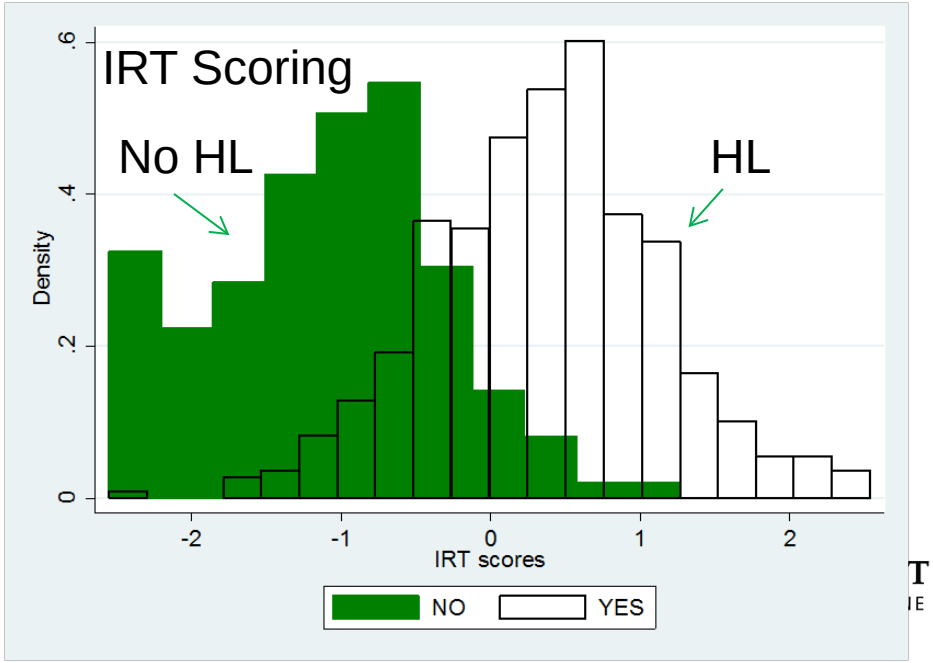
Phase IIIc: Subscale assessment

- These subset scales were analyzed using IRT methods to examine
  - measurement invariance and
  - test information/reliability

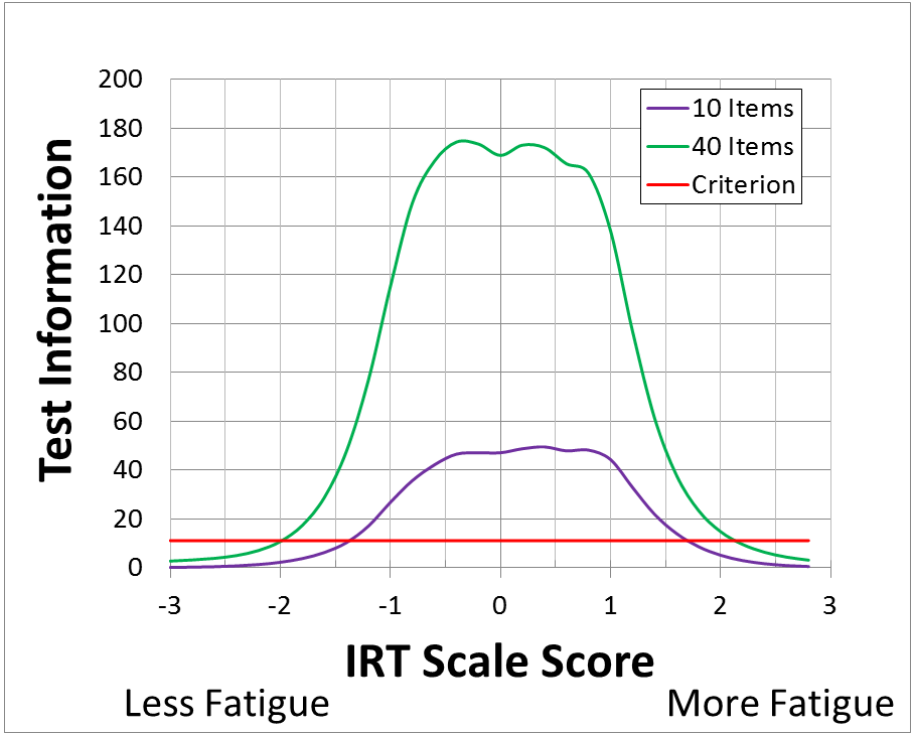
Advantage of IRT scoring

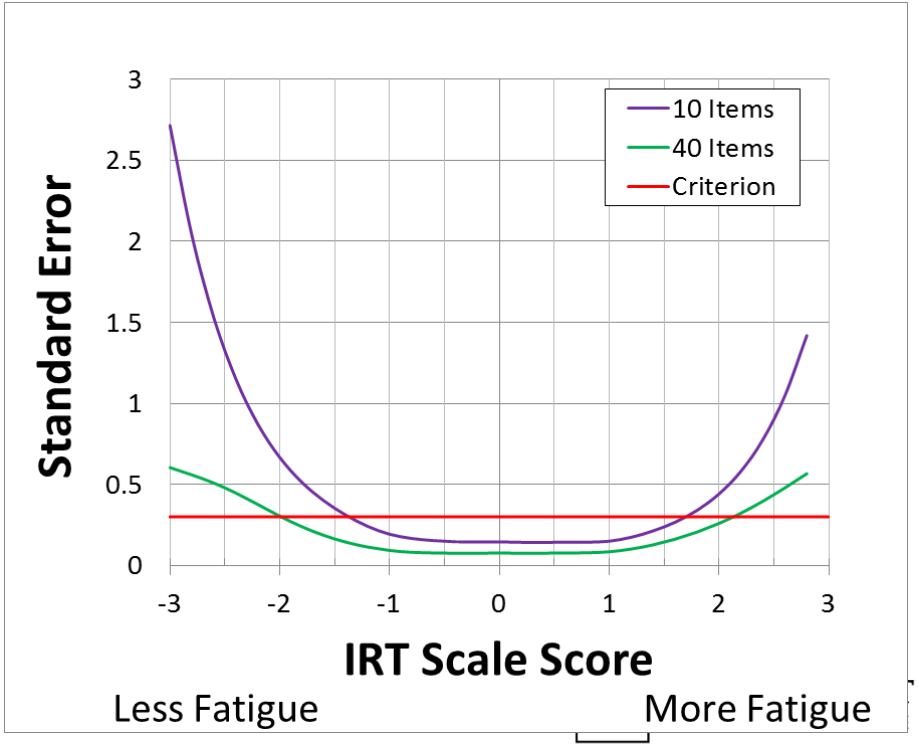
- Response distributions of summed scores versus IRT scale scores for the 40 item scale





Phase IIIc: Subscale assessment





Phase IIIc: Subscale assessment

- Used differential item functioning to examine measurement invariance for 40 item scale
  - No items affected by age (18-88 years old),
  - gender, or
  - Self-reported hearing loss
- Suggests scale scores are reliable across age, gender and hearing loss groups

Phase IV: VFS-AHL-10 Validation

- Sample includes 463 adults with (n=265) and without (n=198) HL
  - Data collected online and in person
- Data analyses are ongoing but initial analyses confirms high test information and good test-retest reliability
  - And sensitivity to effects of hearing loss

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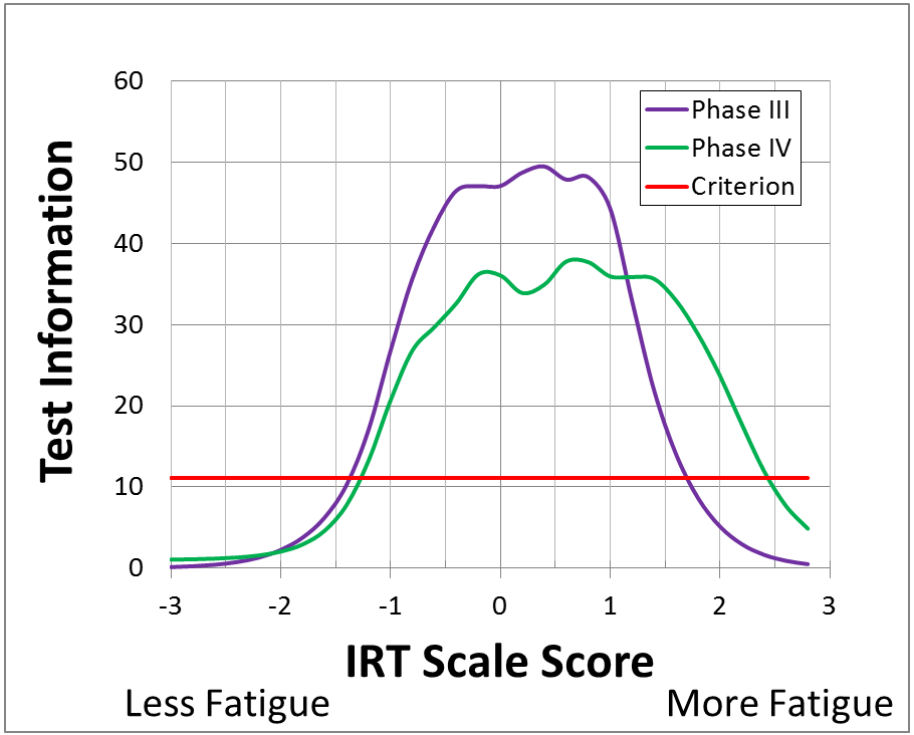
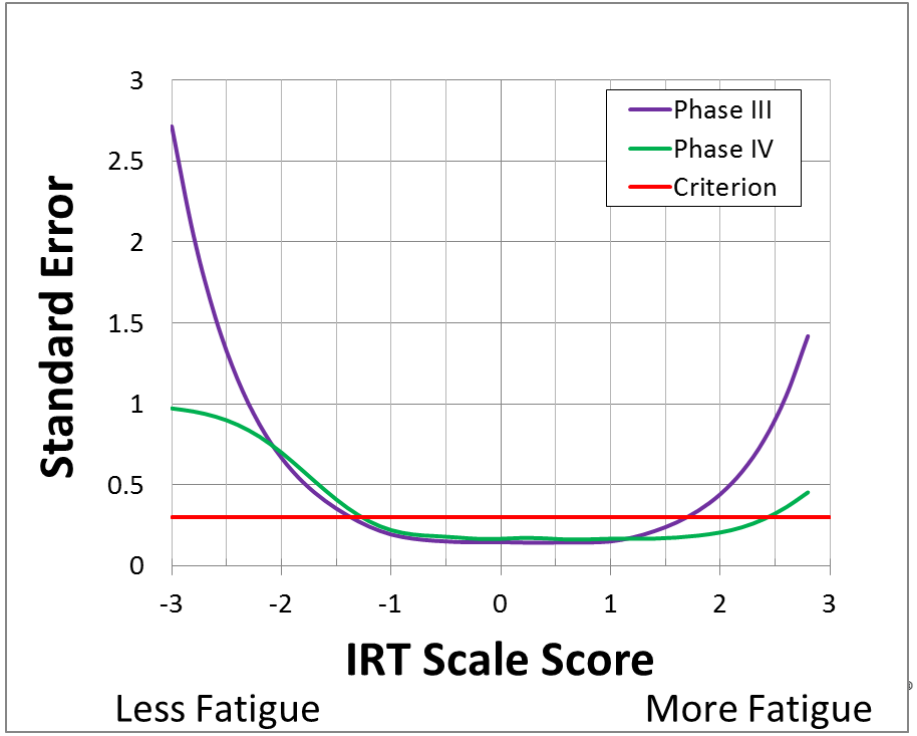
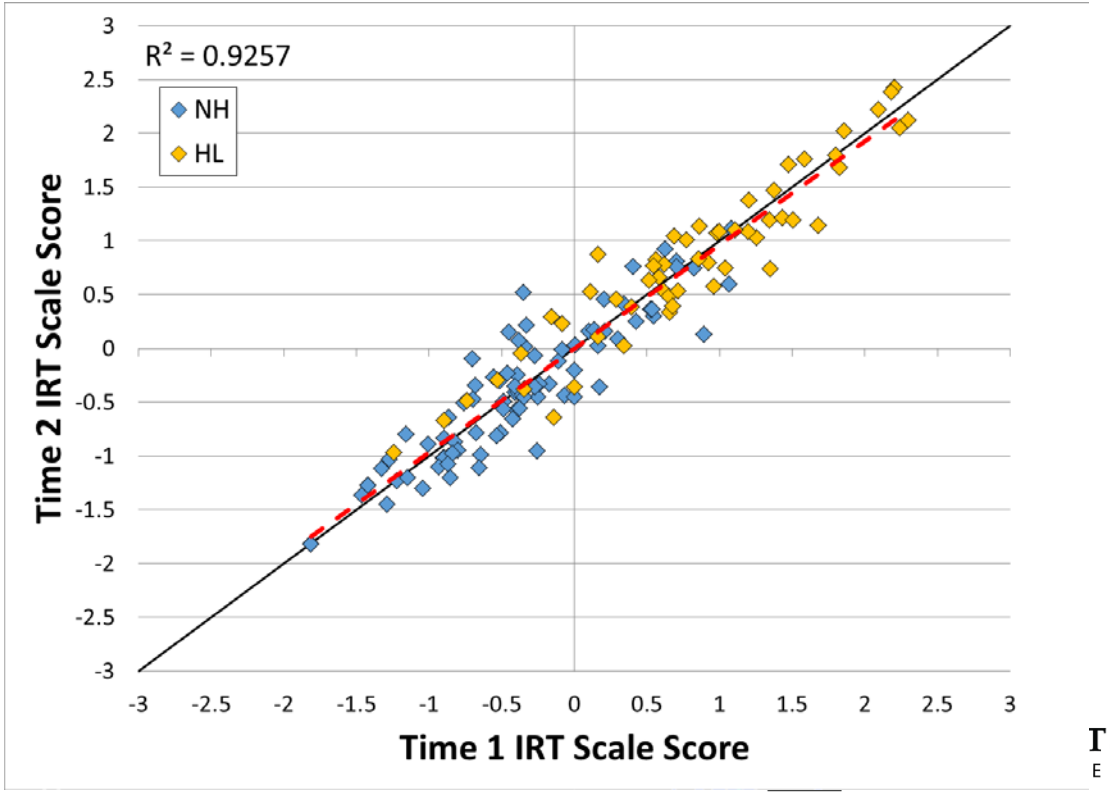
VFS-AHL-10: Phase III vs IV





VFS-AHL-10: Test-retest reliability

- Adults with (n=55) and without (n=90) HL completed the scale twice
- Mean time bw testing was 29 days (5-90 day range)



VFS-AHL-10 Construct Validity

- Our scale appears to have construct validity for people with hearing loss
- Along with responses to the 10-item scale we collected data using two other generic fatigue measures (POMS- Fatigue and Vigor subscales) and Fatigue Assessment Scale (FAS) and the HHIE/A.

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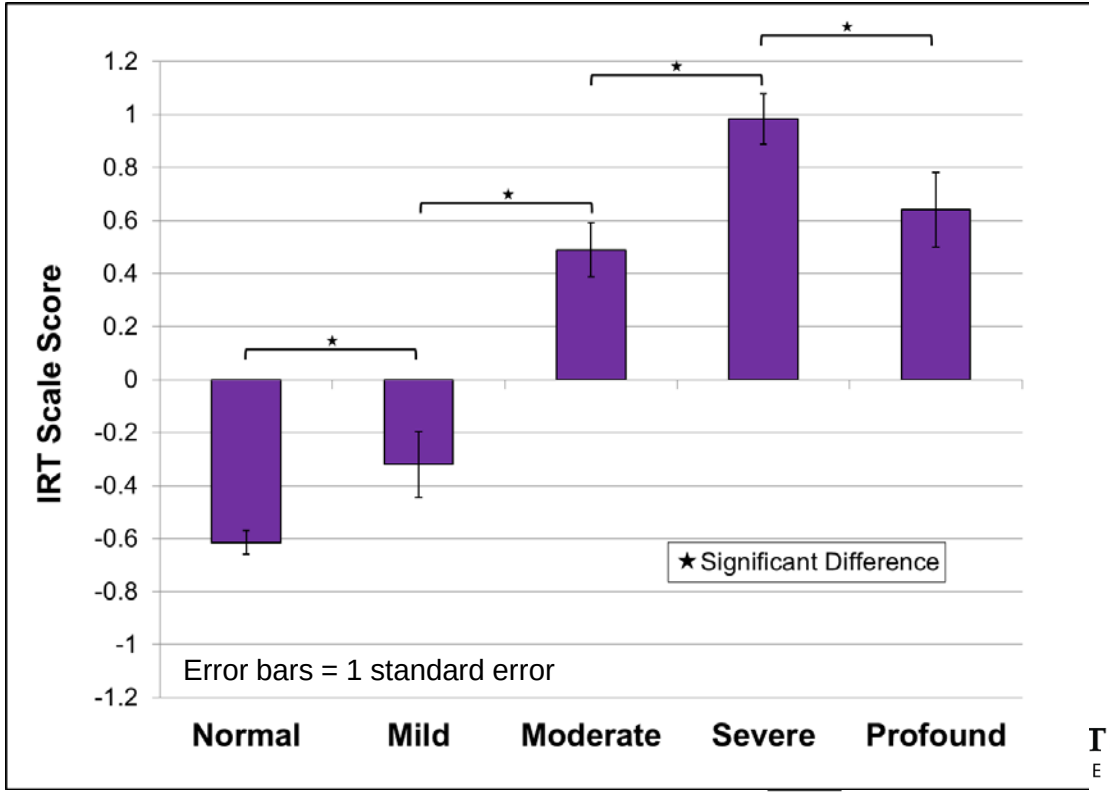
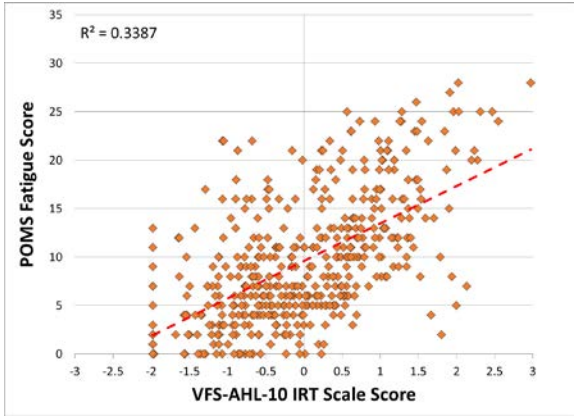
VFS-AHL-10 and self-reported HL

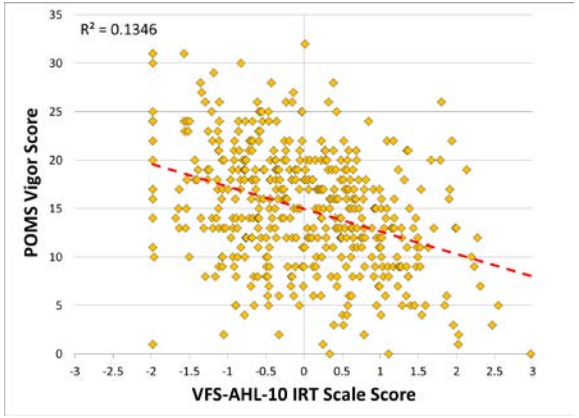
- VFS-AHL-10 is sensitive to effects of self-reported HL on listening-related fatigue
- Note significant decrease in fatigue as self-reported loss increases from severe to profound

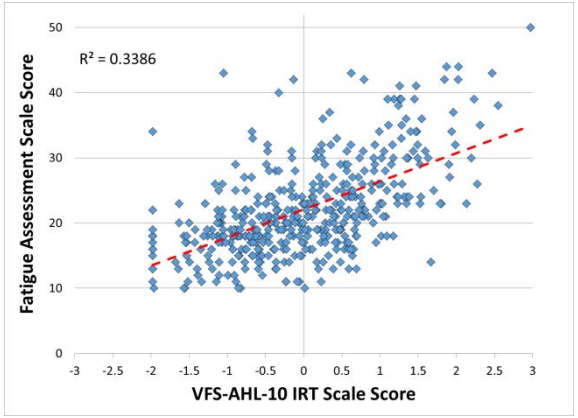


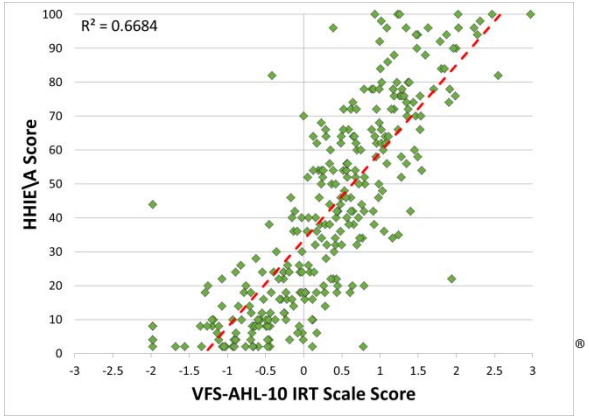
VFS-AHL-10: Concurrent Validity

- VFS scores show weak to moderate correlations with generic fatigue (FAS and POMS fatigue) and vigor measures
- A stronger association is noted with perceived hearing difficulties (HHIE/A)









VFS-AHL-10: Concurrent Validity

- VFS scores show weak to moderate correlations with generic fatigue (FAS and POMS fatigue) and vigor measures
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Correlations

			VFS-AHL-10	POMS Fatigue	POMS Vigor	FAS	HHIE\A Total
Spearman's rho	VFS-AHL-10	Correlation Coefficient	1.000	.568**	-.343**	.560**	.841**
		Sig. (2-tailed)	.	.000	.000	.000	.000
		N	463	457	457	437	298
	POMS Fatigue	Correlation Coefficient	.568**	1.000	-.589**	.732**	.549**
		Sig. (2-tailed)	.000	.	.000	.000	.000
		N	457	457	457	435	295
	POMS Vigor	Correlation Coefficient	-.343**	-.589**	1.000	-.613**	-.344**
		Sig. (2-tailed)	.000	.000	.	.000	.000
		N	457	457	457	435	295
	FAS	Correlation Coefficient	.560**	.732**	-.613**	1.000	.514**
		Sig. (2-tailed)	.000	.000	.000	.	.000
		N	437	435	435	437	281
	HHIE\A Total	Correlation Coefficient	.841**	.549**	-.344**	.514**	1.000
		Sig. (2-tailed)	.000	.000	.000	.000	.
		N	298	295	295	281	298

**. Correlation is significant at the 0.01 level (2-tailed).

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Conclusions

- Listening-related fatigue in AHL appears to be a unidimensional construct
  - Dimensionality may vary for CHL depending on the respondent (child, parent, teacher)
- The VFS-AHL (10 and 40 item versions) is an ecologically valid measure of listening-related fatigue
  - Good content validity (40 and 10 item)
  - Good construct and concurrent validity (10 item)
  - Good test-retest reliability (10 item)

Next Steps

- See our posters this Friday for more information
  - PP1345: Tired from Listening? Exploring associations between listening-related fatigue and fatigability
  - PP1144: My Ears are Exhausted! Development of a Fatigue Scale for Children with Hearing Loss
- Complete analyses of VFS-AHL-10 validation data
- Collect validation and reliability data using the 40 item scale
- Create IRT scoring algorithm and matrix for relating IRT scores and summed scores

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Thanks for Listening!

Questions?

For more information check out our lab websites:
https://my.vanderbilt.edu/listeninglearninglab/

https://my.vanderbilt.edu/hearingandcommunicationresearch/

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