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How Hearing Aid Sound Quality Can Improve Patients' Moods

Erin M. Picou, AuD, PhD, CCC-A

Disclosures

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Learning Outcomes

After this course, participants will be able to:

- Describe types of affective phenomena generally and define mood specifically.
- Discuss research findings demonstrating the importance of optimized hearing aid sound quality for mood.
- List 3 clinical tips that might individualize optimum hearing aid sound quality.

Thank you!

WS Audiology

Laura Winther Balling



Eric Branda



Vanderbilt Health

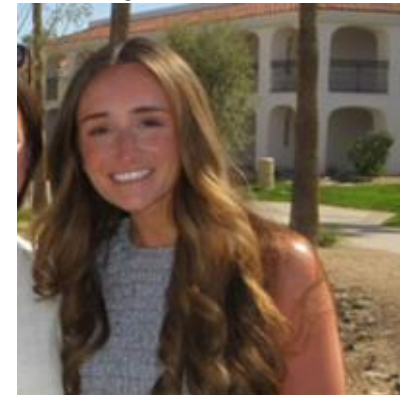
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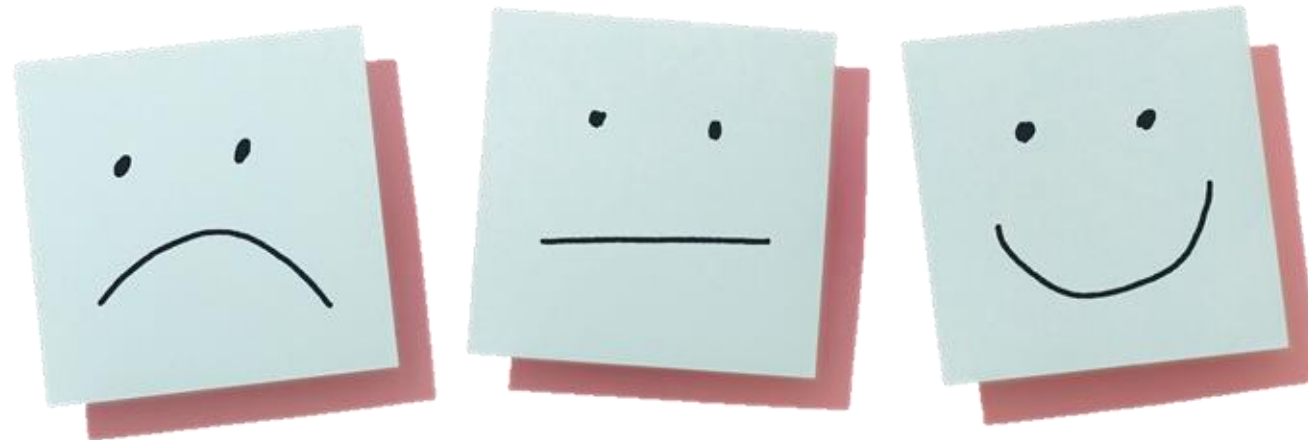
Kjersten Branscome



Taylor Dalzell



How are you feeling?



Optimizing Hearing Aid Sound Quality for Individuals Can Improve Mood

Agenda

- What is mood?
- What is sound quality?
- How can sound quality affect mood?
 - Hearing aid gain
 - Hearing aid sound design
- How can I achieve this for my patients?

What is Mood?

Mood is One of Several Affective Phenomena

Mood

- Diffuse affective state, lower intensity, without an acute cause, long duration

Emotion

- Quick, directed at an object or event

Feeling

- Subjective representation of the emotion

Attitude

- Long enduring, beliefs, preferences, predispositions

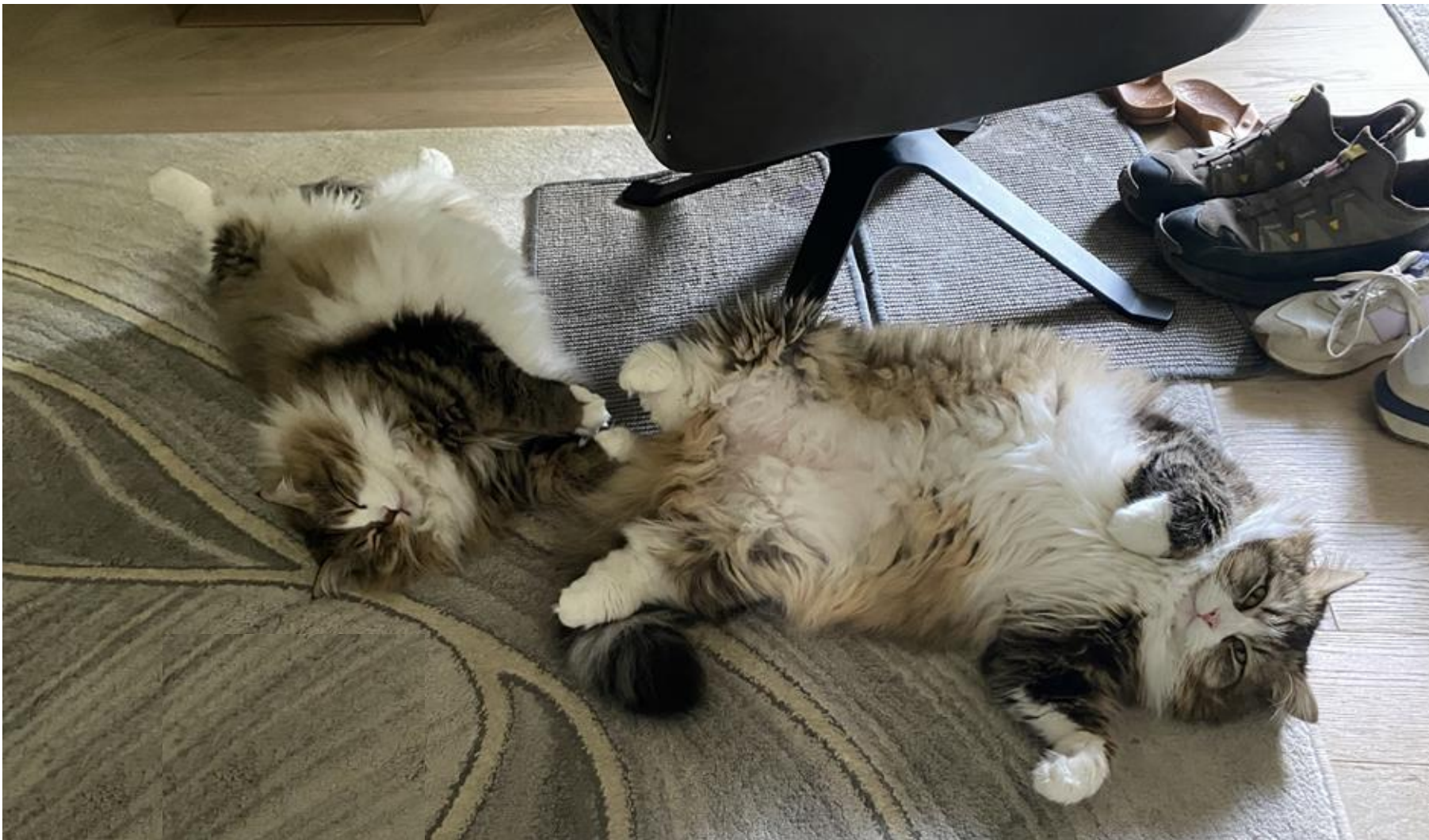
Affective style

- Stable disposition that biases an individual

Temperament

- Affective style apparent early in life, might be genetic

✓ What is Mood?



Examples of Affective Phenomena

Mood

- I am feeling content while looking at fluffy cats

Emotion

- I am feeling happy because I saw these cats

Feeling

- Happy is the word I associate with these sensations

Attitude

- I love cats (but that could change)

Affective style

- I approach life with humor

Temperament

- I have always been easy going, like these cats

Types of Mood

- Good ↔ Bad
- Specific mood states
 - Esteem-related affect
 - Vigor
 - Fatigue
 - Anger
 - Tension

Types of Mood

- Good ↔ Bad
- Specific mood states
 - Esteem-related affect: confident, competent, satisfied, ashamed, proud
 - Vigor: lively, active, energetic, full of pep, vigorous
 - Fatigue: worn out, fatigued, exhausted, weary, bushed
 - Anger: bitter, angry, resentful, grouchy, annoyed, furious
 - Tension: uneasy, tense, anxious, on edge, restless, nervous

Factors that Affect Mood

Basic needs

- Hunger
- Thirst
- Physical fatigue

Comfort and sensory experiences

- Light (*Basishvili et al., 2019; Borisuit, Linhart, Scartezzini, & Münch, 2015*)
- Temperature (*Bergefurt, Weijs-Perrée, Appel-Meulenbroek, & Arentze, 2022*)
- Clothing (*Kang et al., 2013; Moody et al., 2010*)

Mood and Hearing Loss

- Adults hearing loss might report similar moods in *general* as their peers with normal hearing (*Preminger & Meeks, 2010*)
- Most studies focus on fatigue/vigor
- Results of general fatigue and hearing loss mixed
 - Reduced vigor (*Hornsby & Kipp, 2016*)
 - Increased fatigue (*Alhanbali, Dawes, Lloyd, & Munro, 2017; Hornsby & Kipp, 2016*)
 - Especially among people who are employed (Hétu et al., 1988; Kramer, Kapteyn, & Houtgast, 2006)

Listening-Related Fatigue



- Negative mood state
- From sustained levels of high listening effort (*Davis et al., 2021*)
 - Background noise, reverberation (Pichora-Fuller et al., 2016)
 - Hearing loss (*Davis et al., 2021*)
- Mediated by success importance and reward (*Boksem & Tops, 2008; Davis et al., 2021; Hockey, 1997*)
- Linked to overall well-being (*Holman et al., 2021*)

Listening-Related Fatigue and Hearing Technologies

- Relationship is complicated
- Empirical evidence shows reduced fatigue with device use
 - Hearing aids (*Holman, Drummond & Naylor, 2021*)
 - Cochlear implants (*Hornsby et al., 2024*)
- Anecdotal and clinical reports increase fatigue with device use
 - Cochlear implant users (*Hughes et al., 2018*)



What is Sound Quality?

Sound Quality: Intuitive But Complex

- Potential Contributors

- Naturalness
- Clarity
- Loudness
- Noisiness
- Distortion
- Bandwidth

- Listener Defined

- Past experiences
- Feature importance
- Perception
- Preferences

Sound Quality is Highly Personal

- Considerable inter-individual variability in sound quality preferences
 - *Dreschler, Keidser, Convery, & Dillon, 2008; Keidser, 1996; Keidser et al., 2005; Nelson, Perry, Grogan, & VanTasell, 2018*
- Predicting sound quality preferences based on individual factors difficult
 - *Mackersie et al., 2020; Perry et al., 2019; Søgaaard Jensen et al., 2019*
- Approaches to optimizing sound quality for an **individual** rely on allowing listeners to control settings and make changes

Benefit of Optimizing Sound Quality

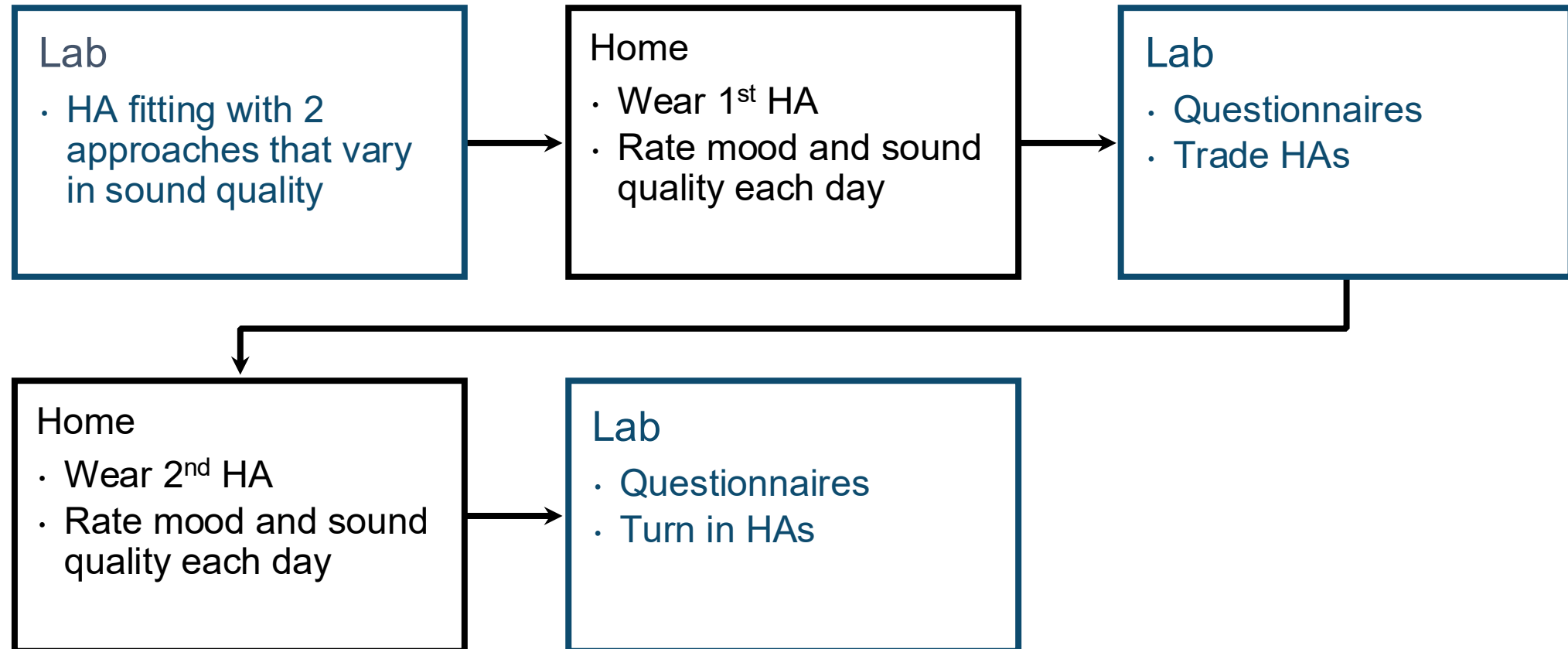
- Perceived sound quality is related to hearing aid outcomes
(*Bannon et al., 2023; Picou, 2022; Wong et al., 2003*)
 - Benefit
 - Satisfaction
 - Use



How Can Sound Quality Affect Mood?

General approach to studying sound quality and mood

General Approach



Daily Ratings of Sound Quality

How would you rate the sound quality of the hearing aids in the situations that you have been in throughout today?

* must provide value

Poor Acceptable Excellent



Poor = 0
Acceptable = 5
Excellent = 10

Profile of Mood States (POMS)¹

- List of adjectives – respondents rate how they feel (*right now at the end of the day*)
- 3 subscales in this study²:
 - Esteem-Related Affect: confident, competent, satisfied, ashamed*, proud
 - Fatigue: worn out*, fatigued*, exhausted*, weary*, bushed*
 - Vigor: lively, active, energetic, full of pep, vigorous

	Not at all	A little	Moderately	Quite a lot	Extremely
Full of pep * must provide value	☐	☐	☐	☐	☐
					reset
Satisfied * must provide value	☐	☐	☐	☐	☐
					reset
Proud * must provide value	☐	☐	☐	☐	☐
					reset

1- McNair, D.; Lorr, M.; Dappleman, L. (1971). *POMS Manual for the Profile of Mood States*. San Diego, CA: Educational and Industrial Testing Service.

² Grove, J. R., & Prapavessis, H. (1992). Preliminary evidence for the reliability and validity of an abbreviated Profile of Mood States. *International Journal of Sport Psychology*, 23(2), 93–109

Vanderbilt Fatigue Scale – Adults – 10 item

Hornsby, Camarata, Cho, Davis, McGarrigle, & Bess (2023) Ear & Hearing, 44, 1251–1261

10 items

I feel worn out from everyday listening

Feeling tired from listening causes strain on my relationships

- Never/almost never (0)
- Rarely (1)
- Sometimes (2)
- Often (3)
- Always/always (4)

Higher summed scores indicate more frequent listening-related fatigue

Two Types of Sound Quality Manipulation

Participants individualize hearing aid gain settings to create settings within one hearing aid

- Optimal sound quality
- Worse but tolerable sound quality

Fit participants with 2 different hearing aid brands, which vary in their sound design

- Widex
- Signia

How Can Sound Quality Affect Mood?

Hearing aid gain



Two Types of Sound Quality Manipulation

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- Optimal sound quality
- Worse but tolerable sound quality

Fit participants with 2 different hearing aid brands, which vary in their sound design

- Widex
- Signia

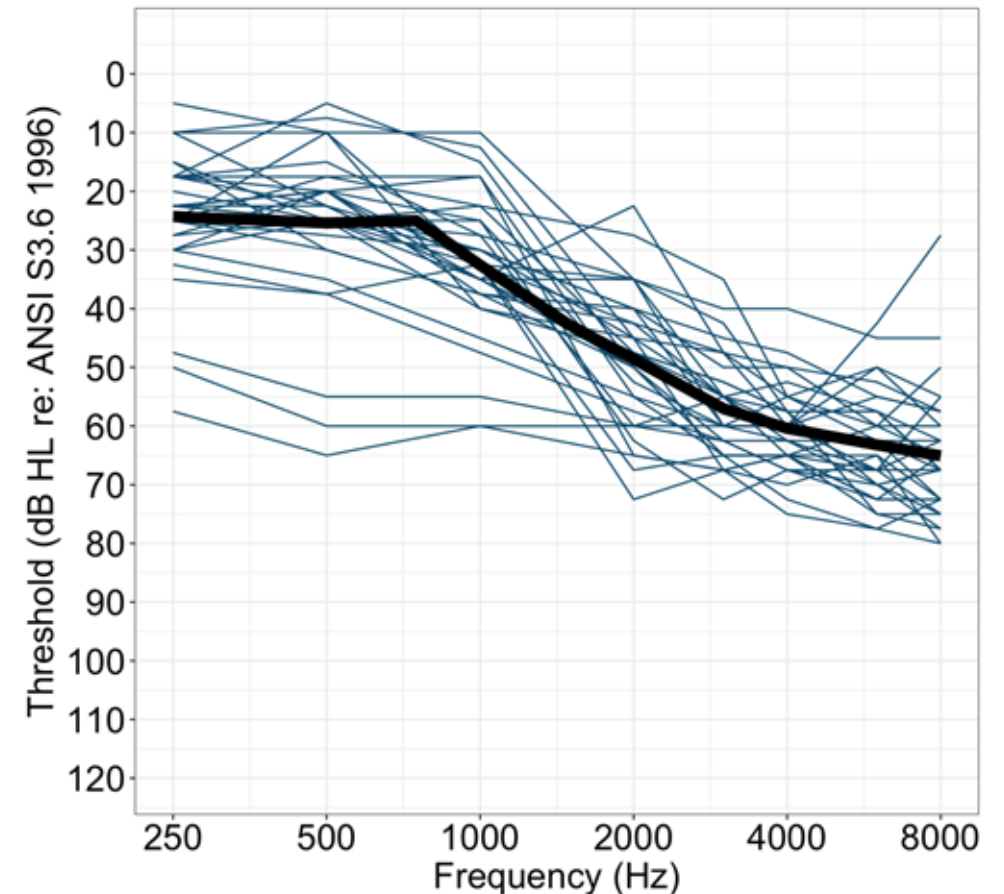
Creating Programs with Preferred Sound Quality in the Laboratory

- Started with fit to NAL-NL2 (MOMENT 440 RIC)
- Instructed to create a 'good' sound quality program and a worse but 'tolerable' program
- Programs created while listening to sounds at 60 dBA in laboratory (participant controlled which sounds and the app with experimenter support)
- English speech, non-English speech, classical music, non-classical music, animal sounds, laughter

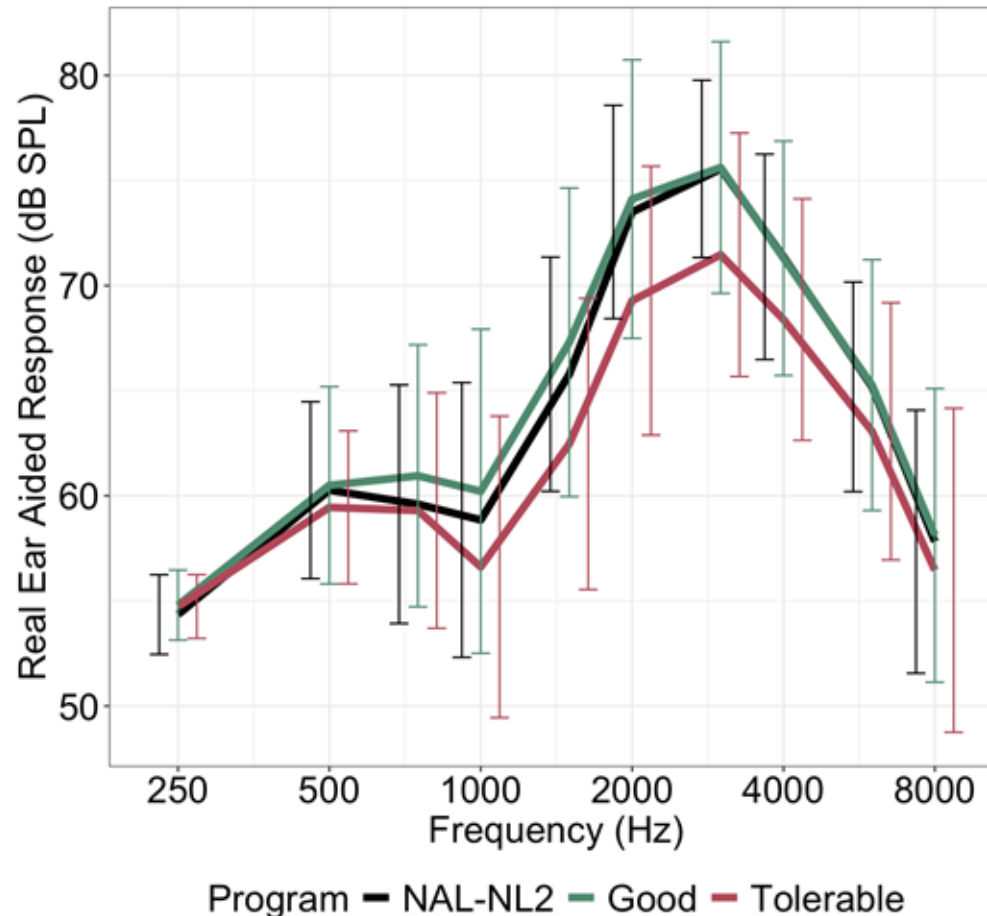


Participants

- 30 adults with hearing aid experience
- 51–80 years old (median = 74 years)
- Rated sound quality as being important
- Exclusions:
 - Neurogenic or cognitive disorders,
 - Taking psychotropic medication (e.g., anti-depressants)
 - Not fluent in English



‘Good’ Programs Had Similar Gain to NAL-NL2; ‘Tolerable’ Programs Had Slightly Less Gain

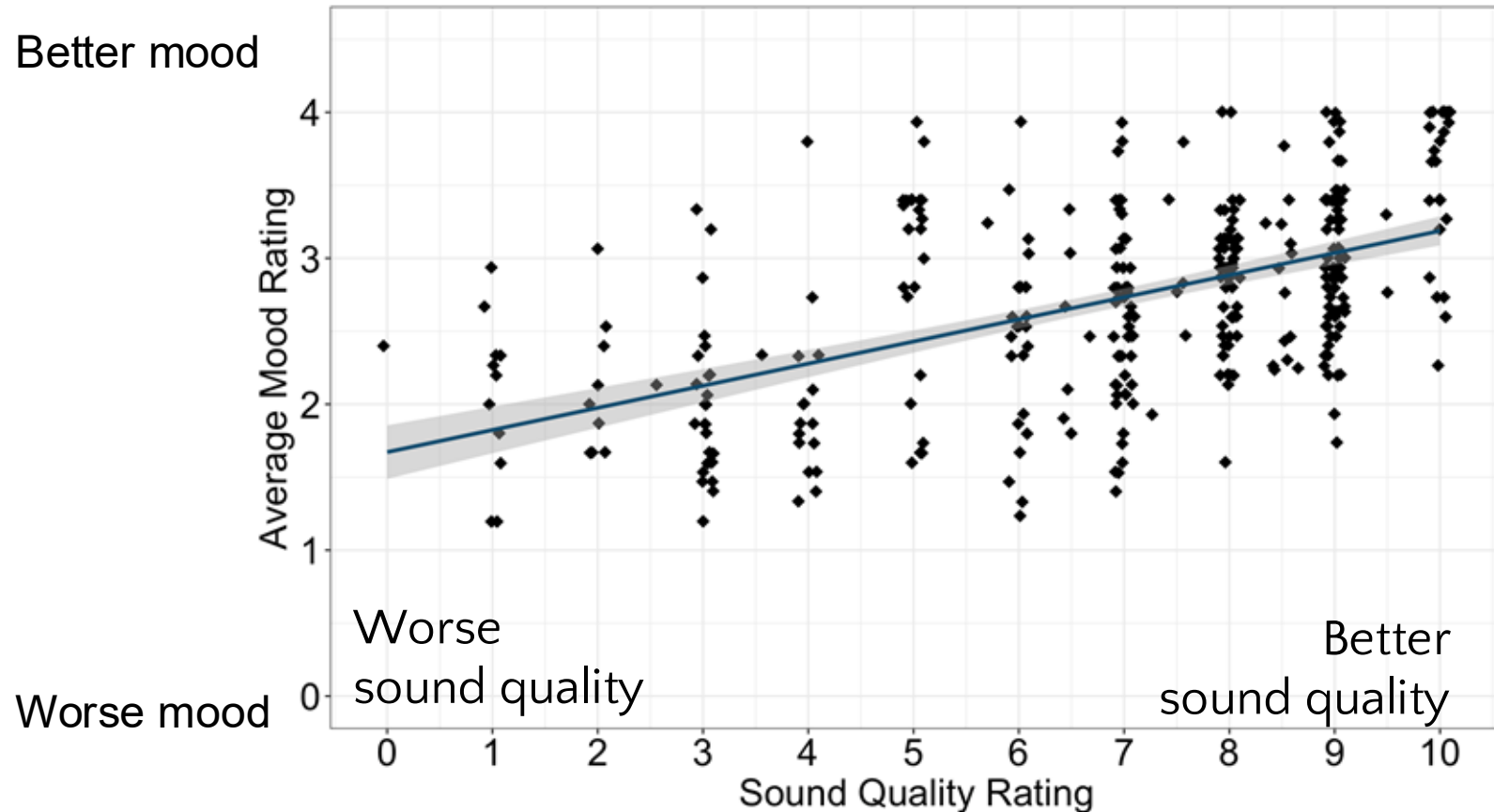


Gain differences did not result in:

- Different speech-in-noise scores
- Different hearing aid use time

Data from:
Picou, Balling, Dalzell, Branscome, &
Branda (2026). *Trends in Hearing*, 30.

Sound Quality Ratings are Related to Mood at the End of the Day



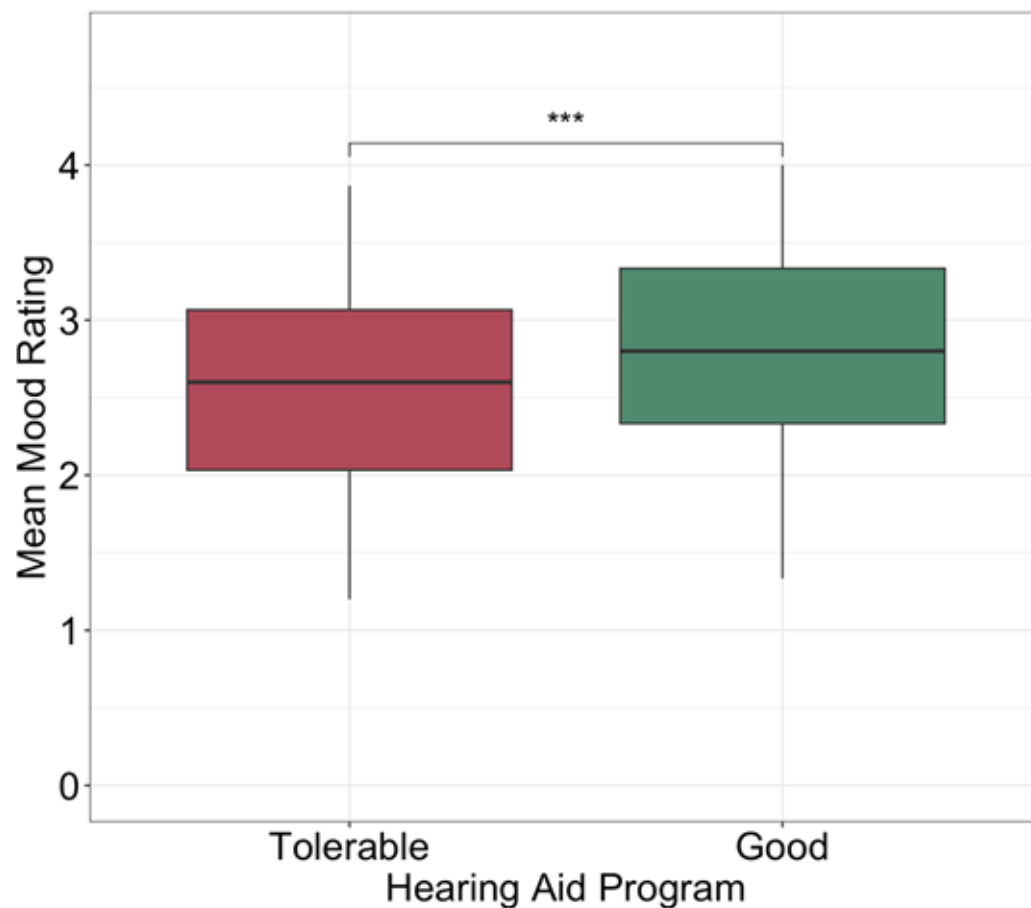
Mean rating across three subscales of esteem, vigor, and affect

Better hearing aid sound quality during the day related to better ratings of mood

Data from: Picou, Balling, Dalzell, Branscome, & Branda (2026). Trends in Hearing, 30.

Mood was Better with the ‘Good’ Program

Better mood



Mean ratings of mood were higher with the “Good” program than with the “Tolerable” program

Effect of program is over and above the sound quality ratings

Data from: Picou, Balling, Dalzell, Branscome, & Branda (2026). Trends in Hearing, 30.

Worse mood



Not All Participants Preferred their ‘Good’ Program

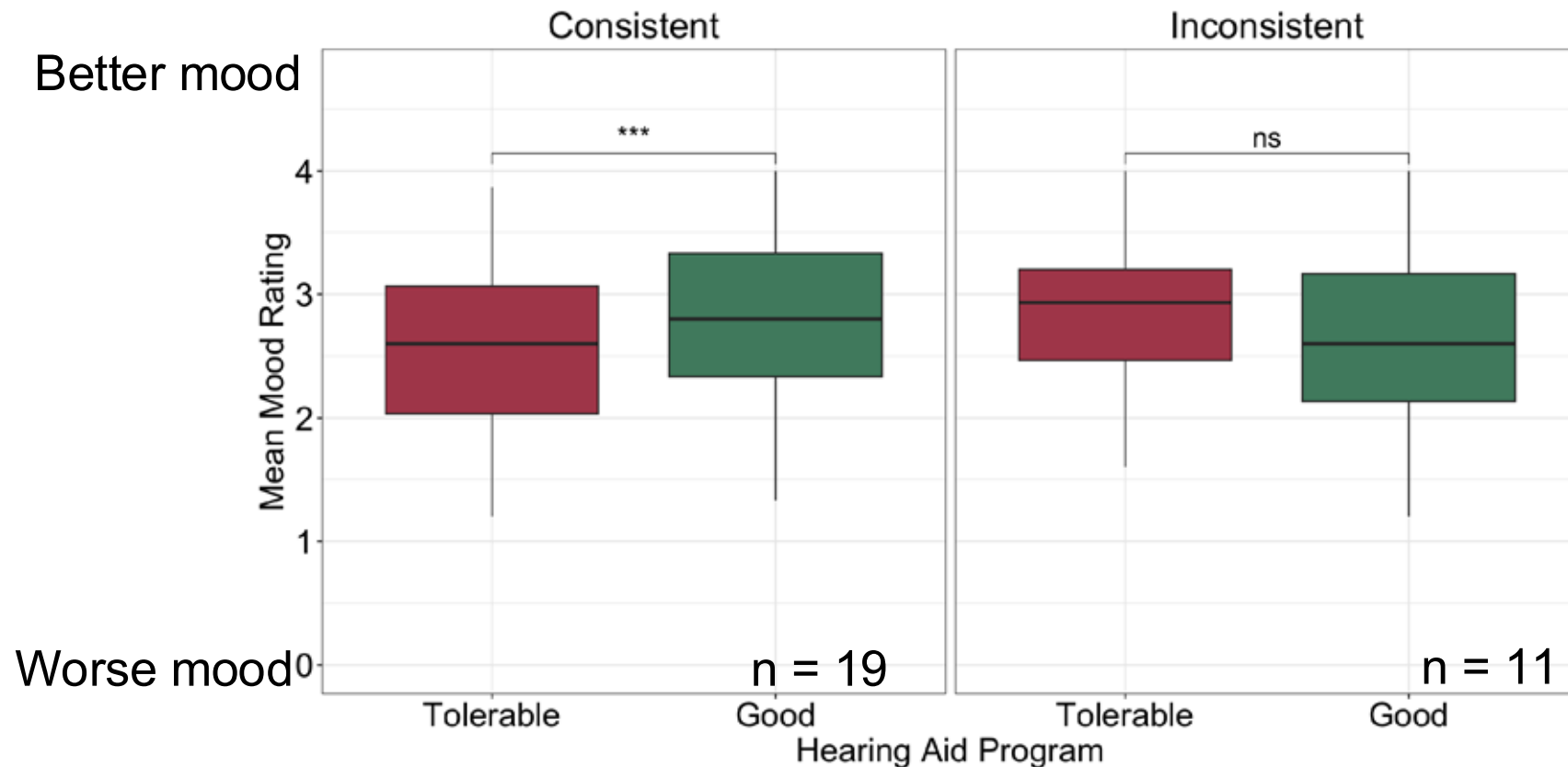
Most (19/30) shared comments about the week that were **consistent** with the expectations for the ‘good’ program

- “Amazed at how clear they were and how well I was hearing.”
- “Sound quality was good, better than my own hearing aids.”

Many (11/30) shared comments about the week that were **inconsistent** with the expectations for the ‘good’ program

- “Nothing enjoyable”
- “It's not been a good week” and “it felt like torture”

Mood was better with the 'good' program, but only for those who were consistent in their preferences



Interpretation of the Findings

- When in the preferred program, mood at the end of the day was better
- Preferred program definitions were somewhat surprising
 - Preferred program for most (but not all)
 - Achievable through setting it in the lab
 - Similar to NAL-NL2 targets
 - Preferred program for some
 - Required home trial to determine which preferred
 - Only slightly less gain than NAL-NL2
- Prescriptive target and adjustments in the lab a good *starting point*

Hearing Aid Sound Quality Related to Mood at the End of the Day

Auditory experiences can affect mood at the end of the day

For most participants, individualized gain settings in the lab resulted in better mood at the end of the day

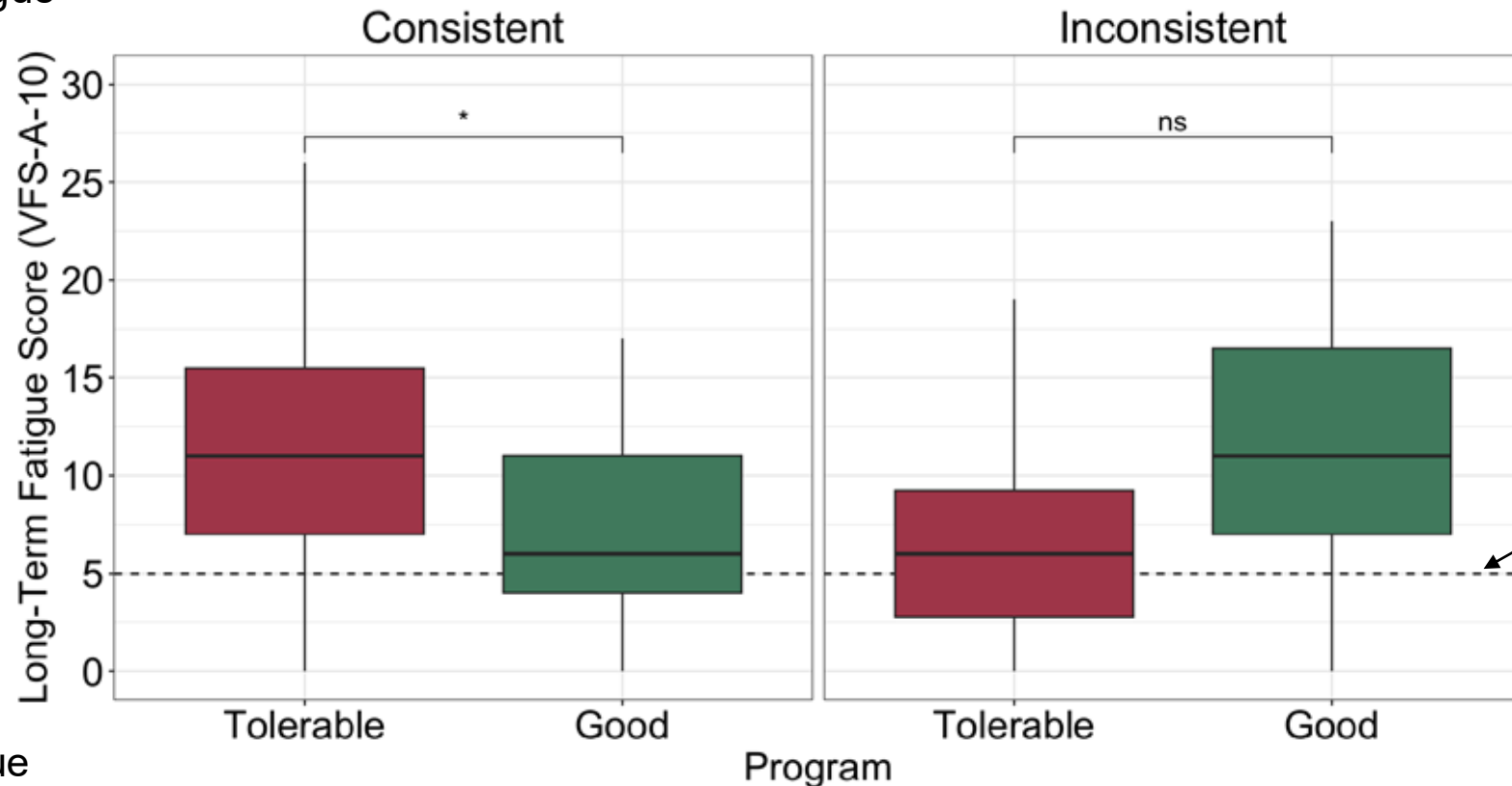
- Not at the expense of other outcomes (e.g., speech-in-noise performance, hours of use per day)

Individualization approach did not work for all participants

- ~1/3 did not like their 'good' program at home
- No identifiable demographic or audiometric factors that were different between those with consistent and inconsistent preferences

Listening-related fatigue was better in the ‘good’ program, but only for those with consistent preferences

More frequent fatigue



Less frequent fatigue

Hearing aid sound quality related to listening-related fatigue at the end of the week

Auditory experiences can affect mood (listening-related fatigue) at the end of the week

Using the “preferred” program, ratings of listening-related fatigue were generally similar to ratings of listening-related fatigue from adults with typical hearing

Using a “non-preferred” program increased listening-related fatigue

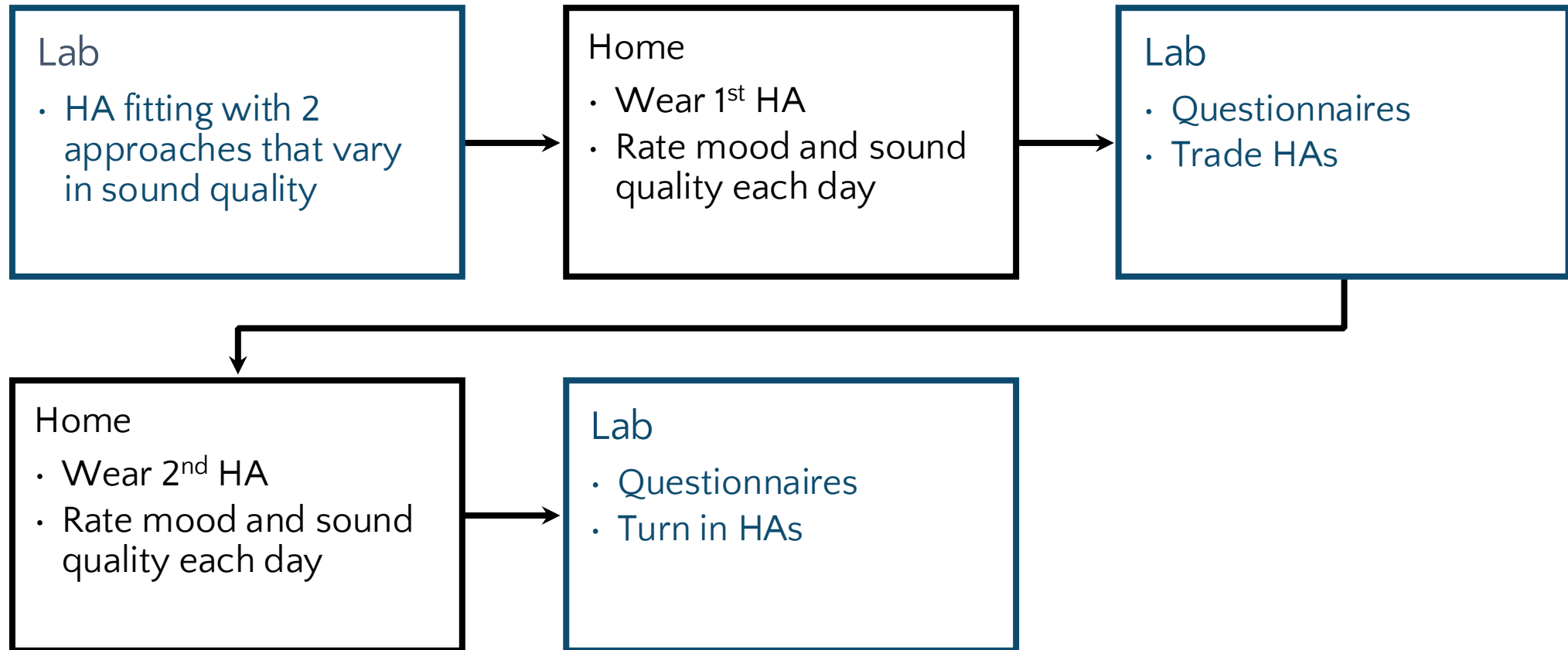
Effects not driven by audibility or speech-in-noise performance in a measured way

How Can Sound Quality Affect Mood?

Hearing aid sound design



General Approach

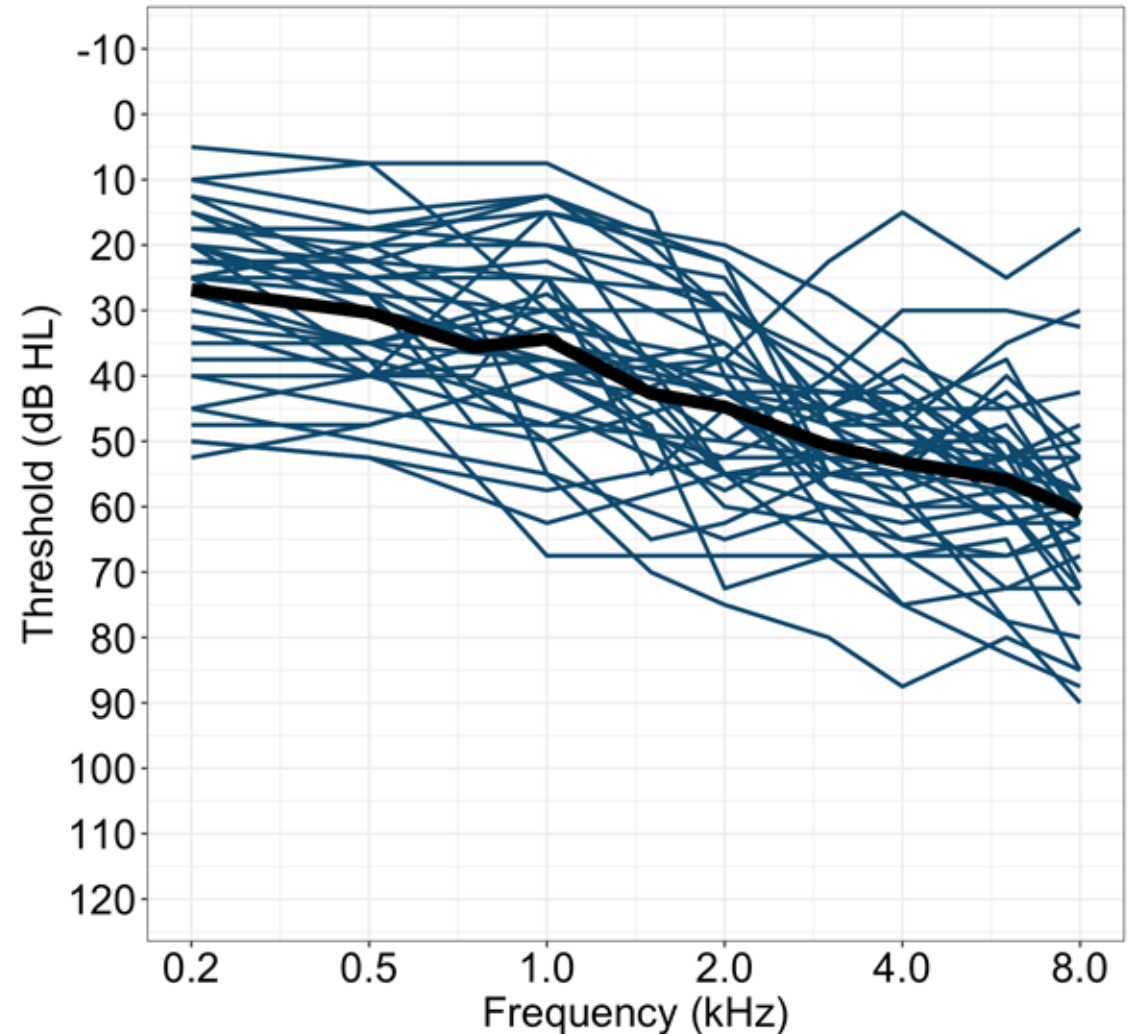


Types of Mood

- Specific mood states
 - Esteem-related affect: *confident, competent, satisfied, ashamed, proud*
 - Vigor: *lively, active, energetic, full of pep, vigorous*
 - Fatigue: *worn out, fatigued, exhausted, weary, bushed*
 - Anger: *bitter, angry, resentful, grouchy, annoyed, furious*
 - Tension: *uneasy, tense, anxious, on edge, restless, nervous*

Participants

- 40 adults with hearing aid experience
- Only 2 reported sound quality not important to them
- 42 - 70 years old (median = 70.5 years)
- Additional exclusion
 - Experience with a WSA brand of hearing aids



Hearing Aid Fittings

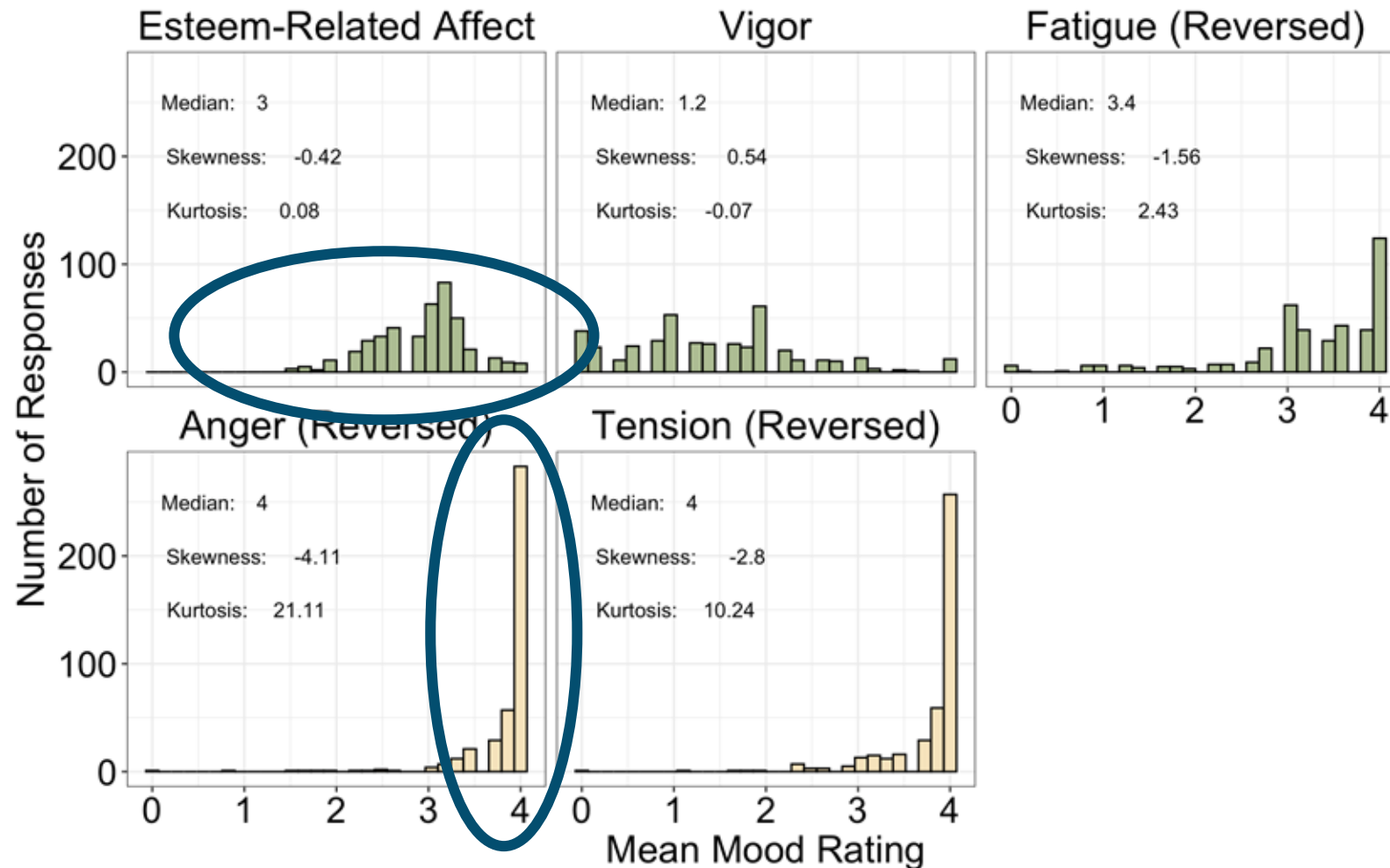
- All participants were fit with 2 sets of study hearing aids
- Proprietary gain prescription
- Receiver-in-canal
- Widex Allure RIC R D 440
- Signia Integrated Xperience (IX) Pure C&G 7X



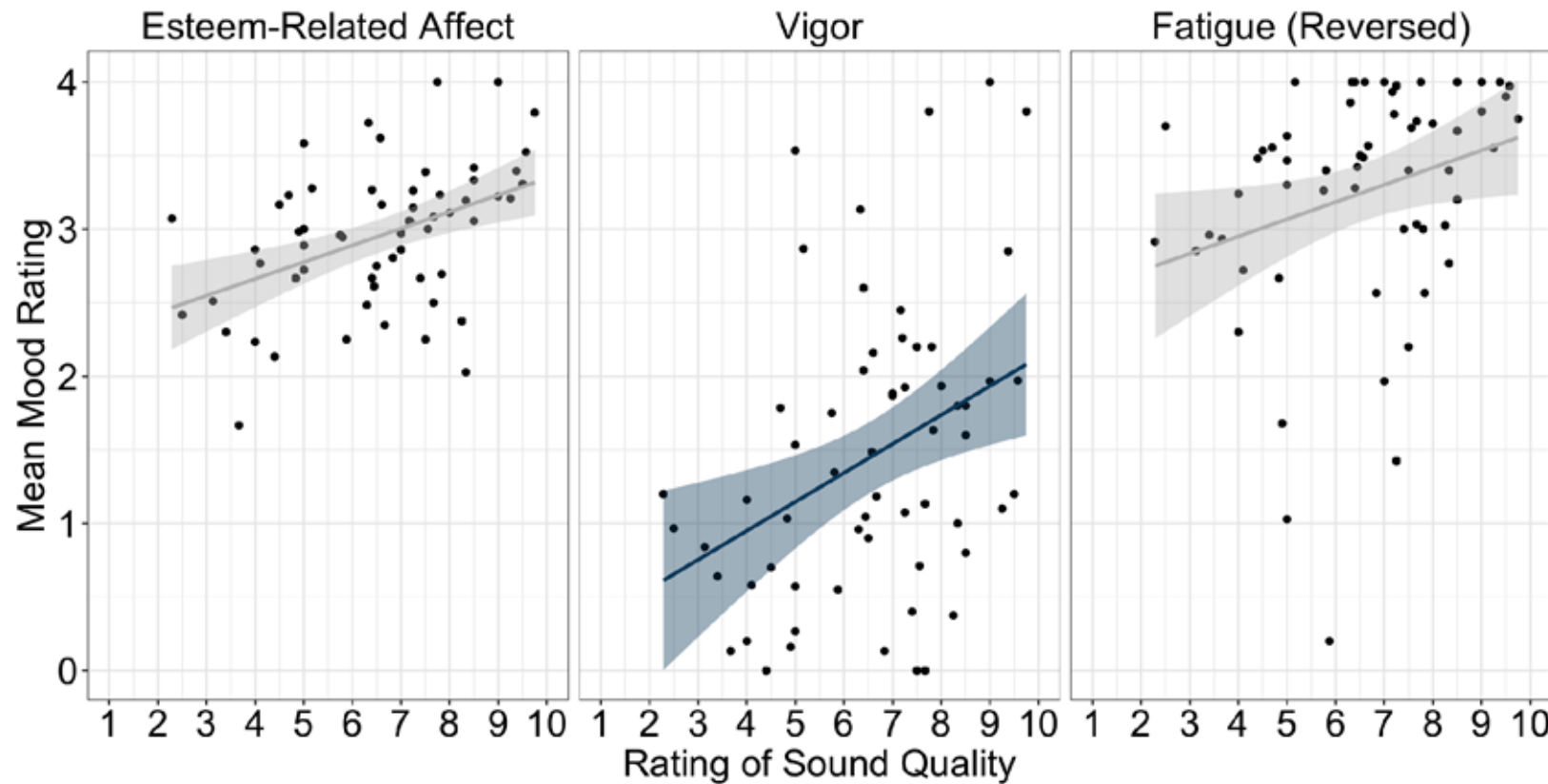
Same Company, Different Sound Design Philosophies

- Widex
 - Less is more
 - Natural sound
 - Time domain processing
- Signia
 - Noise management
 - Focus on speech processing
 - Frequency domain processing

Participants Were Not Generally Angry or Tense



Ratings of Sound Quality and Mood Were Significantly Related



Mean ratings for each participant in each week

Ratings of fatigue and esteem were high, indicating low fatigue and high esteem

Ratings of vigor were lower and more variable

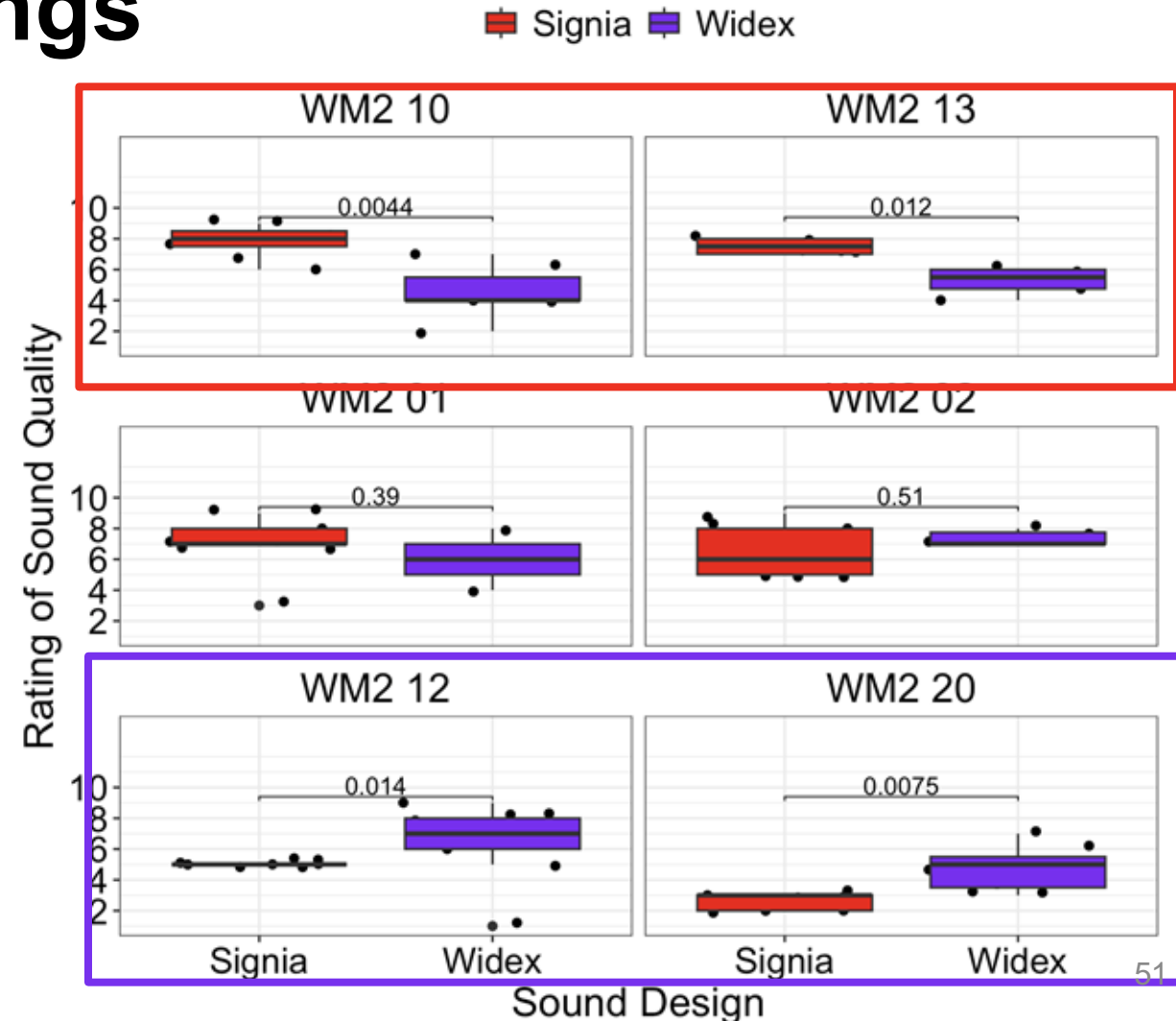
Significant relationship between sound quality and ratings of vigor and esteem

Defining “Preferred” Sound Design Based on Daily Sound Quality Ratings

Evaluated sound quality ratings for each participant in both weeks

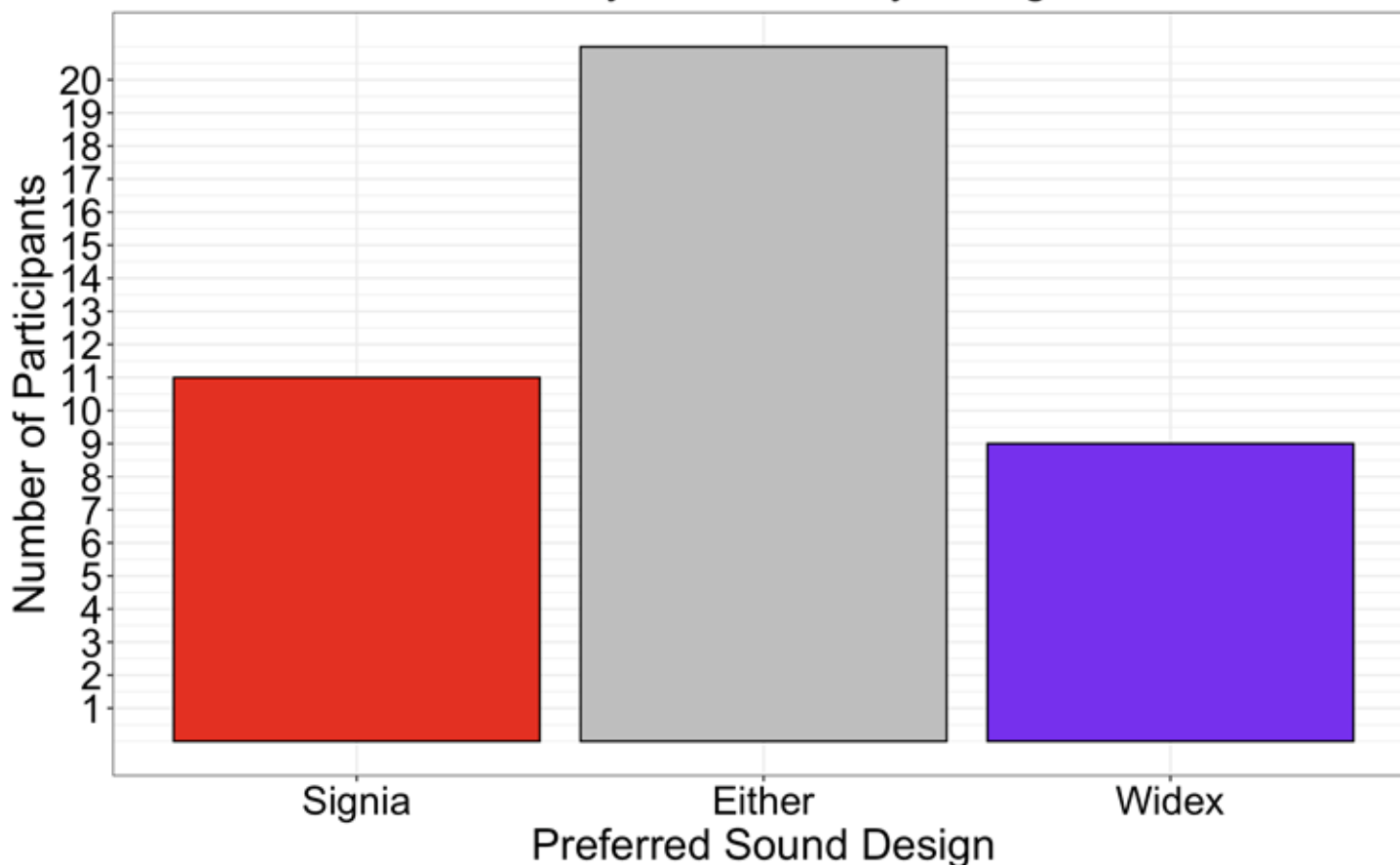
Assigned “preference” based on significant difference in sound quality ratings that favored one sound design or the other

If there was no difference between the sound design, they were assigned to an “either” category



Assigned Preferences Based on Sound Quality Ratings

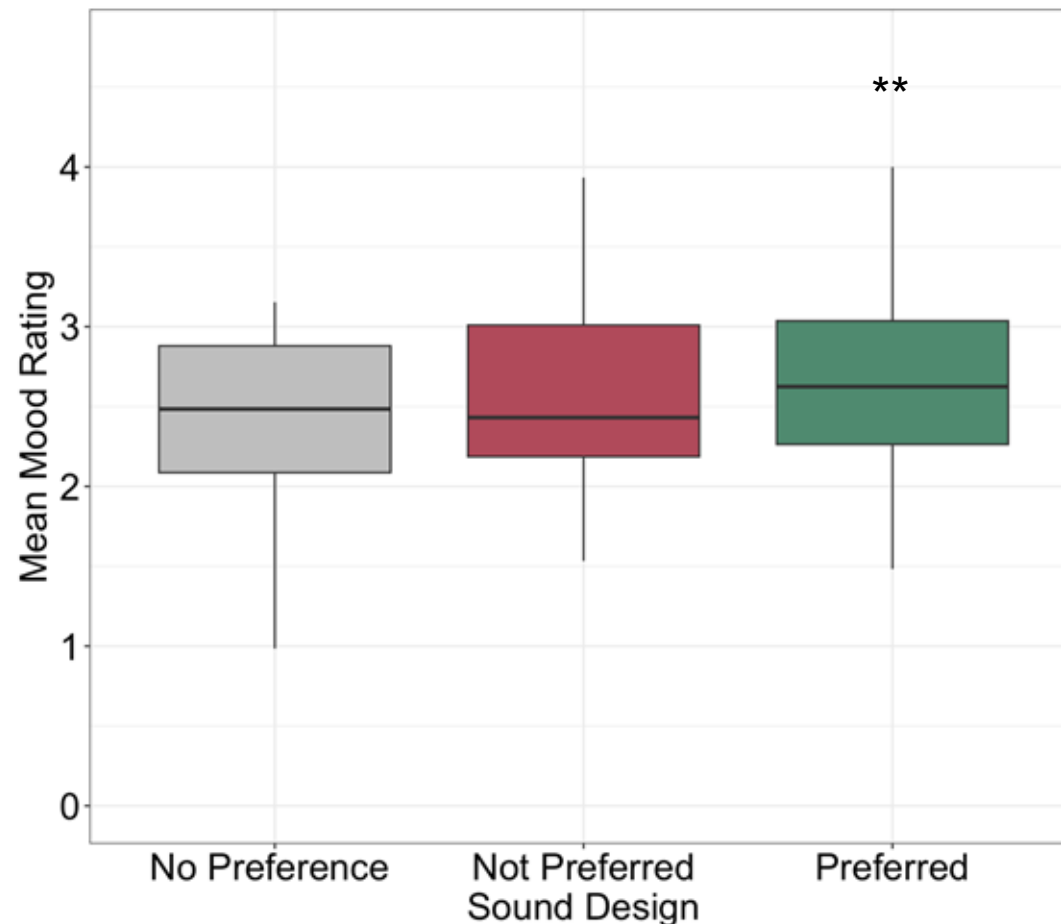
Preference Based on Daily Sound Quality Ratings



Most did not rate the sound quality of the two sound designs as significantly different

Approximately even split between Signia and Widex preferences based on sound quality ratings during the day

Mood at the End of the Day Related to Sound Quality Preferences

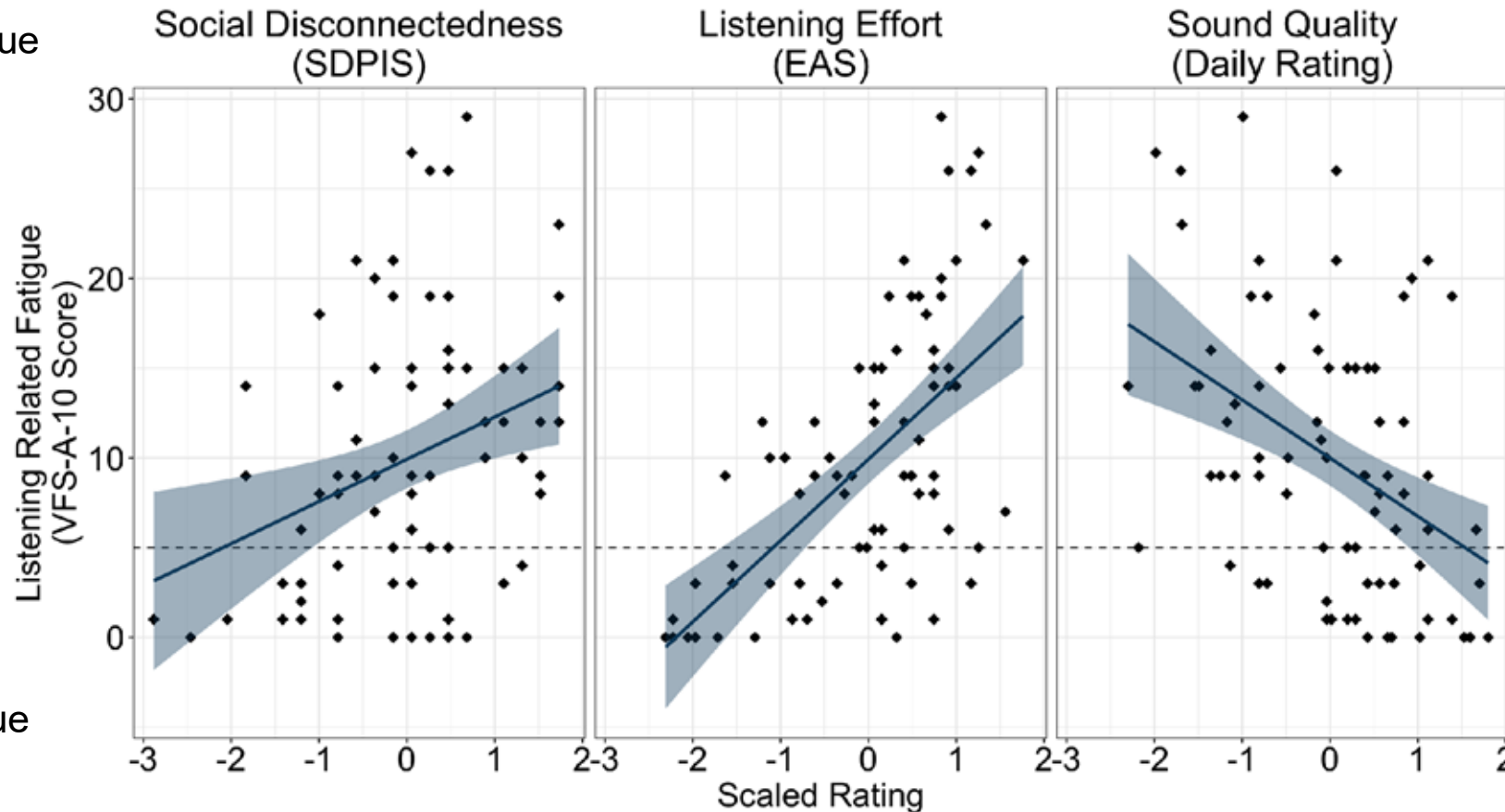


Ratings of mood were better for people who were wearing their preferred **sound design**

Preference based on highest sound quality ratings

Better Sound Quality Related to Less Frequent Listening-Related Fatigue

More frequent fatigue



Less frequent fatigue

...even when accounting for differences in listening effort and social participation

Interim Summary and Conclusions

Sound quality is related to mood at the end of the day

- Correlations between mood and ratings of sound quality
- Ratings of mood are better in a preferred hearing aid setting
 - 'Good' hearing aid frequency shape individually set in the laboratory
 - Preferred hearing aid sound design based on sound quality ratings in the field

Importance of sound quality exists even within well-fit, premium-level devices

Control Variables that are ***Not*** Driving the Findings

- Age
- Degree of hearing loss
- Social participation (general mood)
- Speech intelligibility
- Deviation from NAL-NL2 targets
- Being fit with unrealistic devices or gain settings
 - Changes were made in the app (gain study)
 - Differences between premium devices (sound design study)

How Can I Achieve Improved Mood for My Patients?

Need to Optimize Sound Quality for Individual Patients

Use same sound design and hearing aid gain for everyone (uniform approach)

Start with a similar approach for everyone and change based on patient feedback (adjustment approach)

Predict sound design preferences before (predictive approach)

Combination of above plus a field trial (combination approach)

Uniform Approach

- Examples
 - First-fit approach
 - Matching to prescriptive fitting
 - Focusing on only one sound design
- Difficult because same approach doesn't work for everyone
 - Clinical experience
 - Gain preference studies
 - Brand preference studies
 - Current mood work reviewed (both gain and sound design)

Adjustment Approach

- Example
 - Prescription/first fit □ ‘How does that sound’?
(Jenstad et al., 2003; Anderson et al. 2018)
- Difficult because might not be efficient or successful
 - Differences might be difficult to hear *(Whitmer et al., 2022)*
 - Patient descriptions might be difficult to interpret *(Caswell-Midwinter & Whitmer 2021)*
 - Experience can be frustrating *(Cunningham et al., 2001)*

Predictive Approach

- Example
 - Select a brand based on its reputation for success with people who have moderate loss
- Difficult because sound preferences are not easy to predict based on traditional variables
 - Age
 - Gender
 - Degree of hearing loss
 - Aided speech in noise performance (dB SNR loss on QuickSIN)
 - Duration of hearing loss
 - Duration of hearing aid use

Combination Approach

- Pre-select most appropriate device and gain, adjust it in the clinic, encourage a field trial, adjust again
 - Adjustments would be with apps or in the clinic or both
- Potential benefits
 - Homes offer exposure to typical soundscapes
 - Time and space to try out settings
 - Investment in the process

Individualization is Key

- Personalization important based on patient experiences
- Strategies for adjustments
 - Changing sound design (e.g., brand)
 - Adjusting away from prescriptive targets
 - Based on in-clinic reports
 - Based on home trial
 - Providing the app
 - With instruction and professional recommendations

Benefits of Connecting Patients with the “Right” Sound Design

- Mood and listening related fatigue
- Behavior / lifestyle changes

At dinner, outdoors, was able to hear better than I'm generally used to, but realize I've somewhat picked up the habit of assuming I'm not going to be much involved in the conversation. (Signia)

I played my musical instrument today (mountain dulcimer) and was very happy with the tone of what I was hearing — a warm tone with no tinny harshness. It was a pleasure to play music. I usually have to convince myself to trust the fact that I know my instrument has a warm & wonderful tone and that others aren't hearing the harshness that I was hearing through the hearing aids that I own. (Widex)

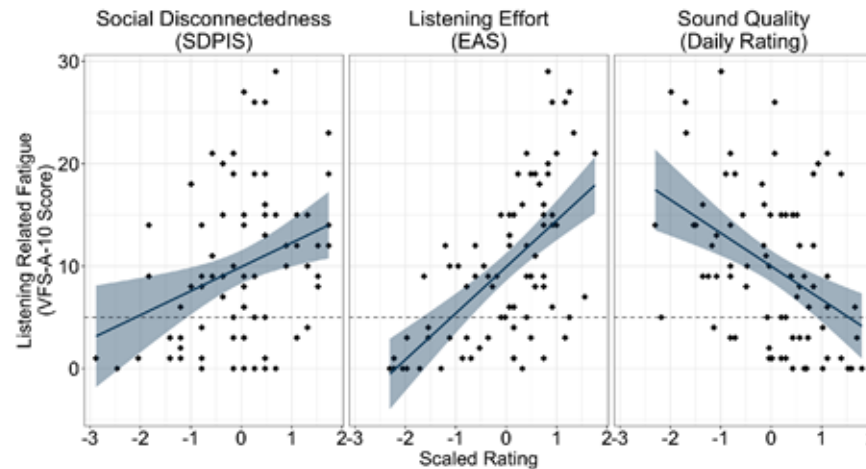
Take Away Points

- Evidence that hearing aid sound quality can improve mood
 - Vigor, esteem, fatigue (end of day)
 - Listening-related fatigue (over the week)
- Personalization is important
 - No approach, gain configuration, sound design worked for everyone
 - Patients' preferences changed between clinic and home settings
 - Sound quality at home was related to mood and rewarding behavior changes

✓ Summary

Thank You!

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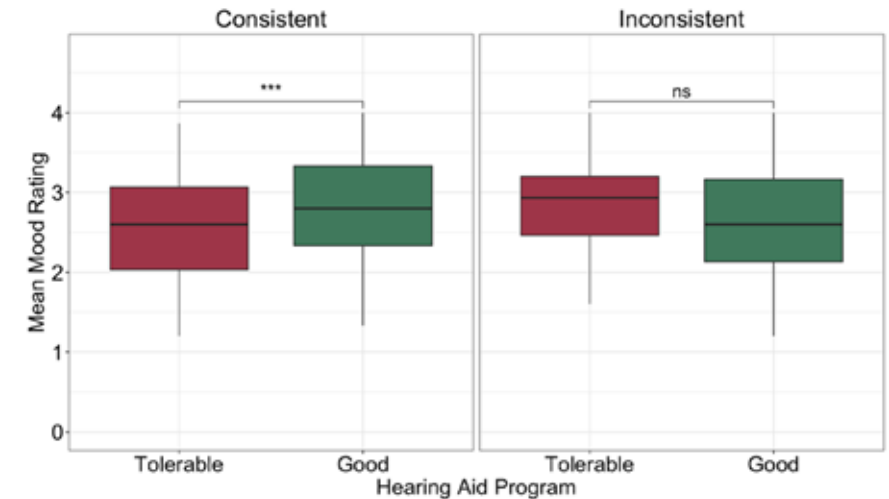
What I want you to remember from today...

Sound quality is related to mood at the end of the day

- Correlations between sound quality and mood
- Higher mood in preferred sound design

Sound quality is personal

- Predicting preferred sound quality is difficult
- Experiences at home can be beneficial in a 'combination' approach to sound quality optimization





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