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Beyond the Audiogram: Assessment and Treatment Challenges in Veterans with Self-Perceived Listening Difficulties

in partnership with University of Pittsburgh

David Jedlicka, AuD



Disclosures

- **Presenter Disclosure:** Financial: David Jedlicka is an employee of the VA Pittsburgh Healthcare System and the University of Pittsburgh. In lieu of an honorarium, a donation has been made to the University of Pittsburgh in the form of AudiologyOnline CEU memberships. Non-financial: David Jedlicka is a member of AVAA, AAA, ATA, ASHA, and NAP.
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- Providers should always evaluate the limitations of diagnostic and screening tools, considering their potential for false results as well as any ethical implications.
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Learning Outcomes

After this course, participants will be able to:

- List clinical measures that are most effective in identifying those with self-perceived listening difficulties without measured hearing loss.
- Describe the expected differences in outcomes between veterans fit with hearing aids for the purposes of treating hearing loss compared to those fit with hearing aids for self-perceived listening difficulties without hearing loss.
- Explain the differences in the most commonly occurring comorbidities between those seeking treatment for hearing loss compared to those seeking treatment for self-perceived listening difficulties without measured hearing loss.



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Today's Focus

- Review the history of adults presenting to audiology clinics reporting difficulties despite no measured hearing loss
 - Self-Perceived Listening Difficulties (SPLD)
- Discussion of 2 previously proposed test batteries
- Presentation of 2 research projects
 - Literature review of measures completed among individuals with SPLD
 - Review of hearing aid outcomes of those with SPLD fit with low-gain amplification as a treatment

Self-Perceived Listening Difficulties (SPLD)

- 10% of patients seeking audiological care for perceived hearing difficulties, specifically in noise, will have no measurable hearing loss
- In adults, this phenomenon was first termed selective dyacusis
- Other terms such as King-Kopetzky Syndrome, idiopathic discriminatory dysfunction, obscure auditory dysfunction, auditory processing disorder, hidden hearing loss, cochlear synaptopathy, and now self-perceived listening difficulties have been used
- The first recommended test battery for this population was recommended in 1992 by Saunders et al.

The First Test Battery (Saunders et al., 1992)

- 4 Categories of Measures:
 - General
 - Obscure Auditory Dysfunction Interview, Institute of Hearing Research hearing questionnaire, pseudo-free-field speech-in-noise test.
 - Psychoacoustic
 - Pure tone audiometry, MLD-500, OAEs, and noise emission rating.
 - Central
 - Word monitoring in sentences test, audiovisual adaptive sentence test, and a dichotic listening test
 - Personality
 - Crown-Crisp Experimental Index and PS discrepancy (measures degree of misjudgment in hearing ability by subtracting self-assessed performance from actual performance)

Recommended Test Battery for Veterans (Tepe et al., 2020)

Table 2. Sample minimum behavioral test battery for the assessment of central auditory processing functions in service members and veterans.

Function	Test	Stimuli	Lesion site(s)	Sensitivity/specificity in adults	Findings in service members/veterans
Binaural interaction	MLD	Tones (500 Hz)	Brainstem ^{a-c}	MLD ^{c,h-k} 40%–75%/77%–94%*	Gallun, Diedesch, et al. (2012) Jabbari et al. (1987) Kubli et al. (2017)
Temporal processing: sequencing	FPT	Tones (880 Hz, 1122 Hz)	CC ^{a,d} Cortex ^{a,e}	FPT ^{l-n} 75%–90%/90%–100%	Gallun, Diedesch, et al. (2012) Gallun et al. (2016)
Temporal processing: resolution	GIN	Broadband noise/silence		GIN ^e 67%/94%	Gallun, Diedesch, et al. (2012) Gallun et al. (2016) Saunders et al. (2015)
Dichotic listening	DDT or SSW	Digits (DDT) or speech (SSW)	Brainstem, CC, cortex ^{a,f,g}	DDT ^{n,o} 70%–90%/80%–90% SSW ^{p,q} 33%–46%/70%–96%	DDT: Gallun et al. (2016) SSW: Gallun, Diedesch, et al. (2012); Saunders et al. (2015)
Monaural low redundancy	LPFS	Speech	Brainstem, cortex ^a	LPFS ^{n,r} 50%–65%/72%	Oleksiak et al. (2012)

Note. MLD = masking level difference; FPT = Frequency Pattern Test; CC = corpus collosum; GIN = Gaps-in-Noise test; DDT = Dichotic Digits Test; SSW = Staggered Spondaic Words test; LPFS = low-pass filtered speech.

^aMusiek & Chermak (2014). ^bNoffsinger et al. (1982). ^cLynn et al. (1981). ^dMusiek et al. (1980). ^eMusiek et al. (2005). ^fMusiek (1983a). ^gMusiek (1983b). ^hHannley et al. (1983). ⁱHendler et al. (1990). ^jMueller & Beck (1987). ^kNoffsinger (1982). ^lMusiek & Pinheiro (1987). ^mMusiek et al. (1990). ⁿMusiek et al. (2011). ^oHurley & Musiek (1997). ^pMueller (1987). ^qMueller et al. (1987). ^rKarlsson & Rosenhall (1995).

*Sensitivity and specificity values have not been reported for the MLD test in the published literature. Estimates shown here are derived from studies involving patients with confirmed brainstem and/or cortical lesions. Abnormal MLD findings are widely reported in patients with pontomedullary lesions; MLD findings are typically normal in patients with pathology above the superior olivary complex.

Research Article

Evaluation of Diagnostic Measures in Veterans With Self-Perceived Hearing Handicap Despite Normal Audiometric Thresholds: A Rapid Scoping Review

David P. Jedlicka,^{a,b}  Hari Bharadwaj,^a Elaine Morner,^a  Aravind Parthasarathy,^a
and Catherine V. Palmer^{a,c} 

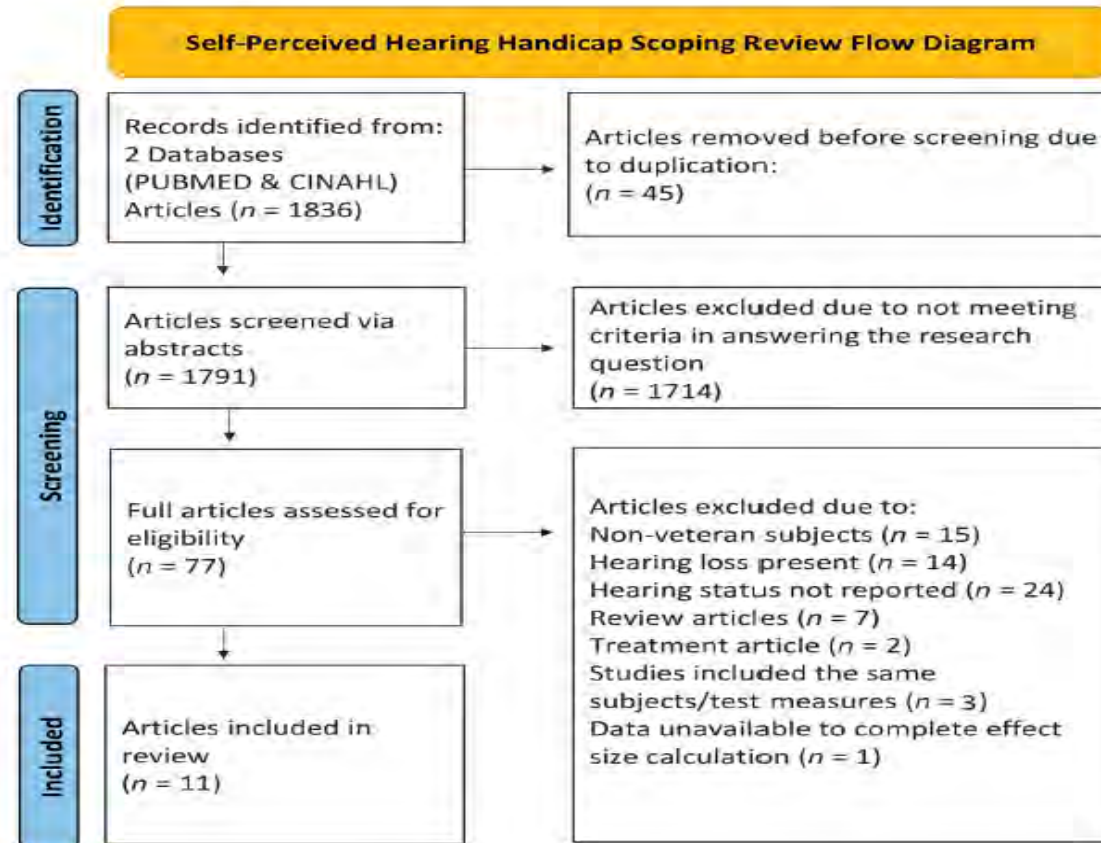
Study 1: Research Aim

- Do any currently implemented assessment measures available to audiologists and reported in the literature show significant differences among veterans and the military population with SPLD compared to those without measured hearing loss and no self-perceived hearing handicap?

The Rapid Scoping Review Process

- Study 1

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analysis flow diagram for article inclusion.



5 Categories

- The test measures were grouped into 1 of 5 categories
 - **Hearing Questionnaires**
 - (Only group to find differences between groups for all measures)
 - **Electrophysiological Tests**
 - **Speech Testing**
 - **Auditory Processing Disorder Testing**
 - **Non-Audiological Tests**

What Made the Cut?

Table 4. Test measures by included articles.

Study	Questionnaires	Electrophysiological testing	Speech tests	Auditory processing disorder tests	Non-audiological tests
Bramhall et al., 2021		ABR, EFR			
Bramhall et al., 2021		MEMR			
Bressler et al., 2017	SSQ	EFR			
Gallun et al., 2012		ABR		DD, GIN, MLD-500, SSW	
Gallun et al., 2016	HHIA			GIN, MLD-500, SSW	MMSE, PC-PTSD
Jedlicka & Zhen, 2023	HHIA				
Koebli et al., 2020				SCAN 3A	ACT, CASL, CELF-5, SDMT, TMT
Kubli et al., 2017		ABR, P300		MLD-500	
Papesh et al., 2019	FHQ, HHIA	ASR, P200	AzBio, CNC	SSW	
Papesh et al., 2021			AzBio, BKB-SIN		
Saunders et al., 2015			HINT, LiSN-S	SSW	
Saunders et al., 2018				SSW	

Note. ABR = auditory brainstem response; EFR = envelope following response; MEMR = middle ear muscle reflex; SSQ = Speech, Spatial, and Qualities of Hearing Scale; DD = dichotic digits; GIN = gaps in noise test; MLD-500 = Masking Level Difference–500 Hz; SSW = Staggered Spondaic Words; HHIA-S = Hearing Handicap Inventory for Adults (Screening Version); MMSE = Mini-Mental Status Examination; PC-PTSD = Primary Care Posttraumatic Stress Disorder Screen; ACT = Auditory Consonant Trigrams Test; CASL = Comprehensive Assessment of Spoken Language; CELF-5 = Clinical Evaluation of Communication Skills–Fifth Edition: Metalinguistics; SDMT = Symbol Digits Modality Test; TMT = Trail Making Test; FHQ = mean Functional Hearing Questionnaire; ASR = Acoustic Startle Reflex; CNC = consonant–nucleus–consonant words; SSW = Staggered Spondaic Word; AzBio = AzBio Sentences; BKB-SIN = Bamford–Kowal–Bench speech-in-noise test; HINT = Hearing in Noise Test; LiSN-S = Listening in Spatialized Noise Test.

Process to Identify Group Differences

- Identify each test which found a significant difference between self-perceived hearing handicap groups and control groups
 - Use normative data if the study did not include a control group
- Use effect size to determine how different the groups are.
- Do we use the popular Cohen's d effect size measure?
 - NOPE! We are going to use Hedges' g .

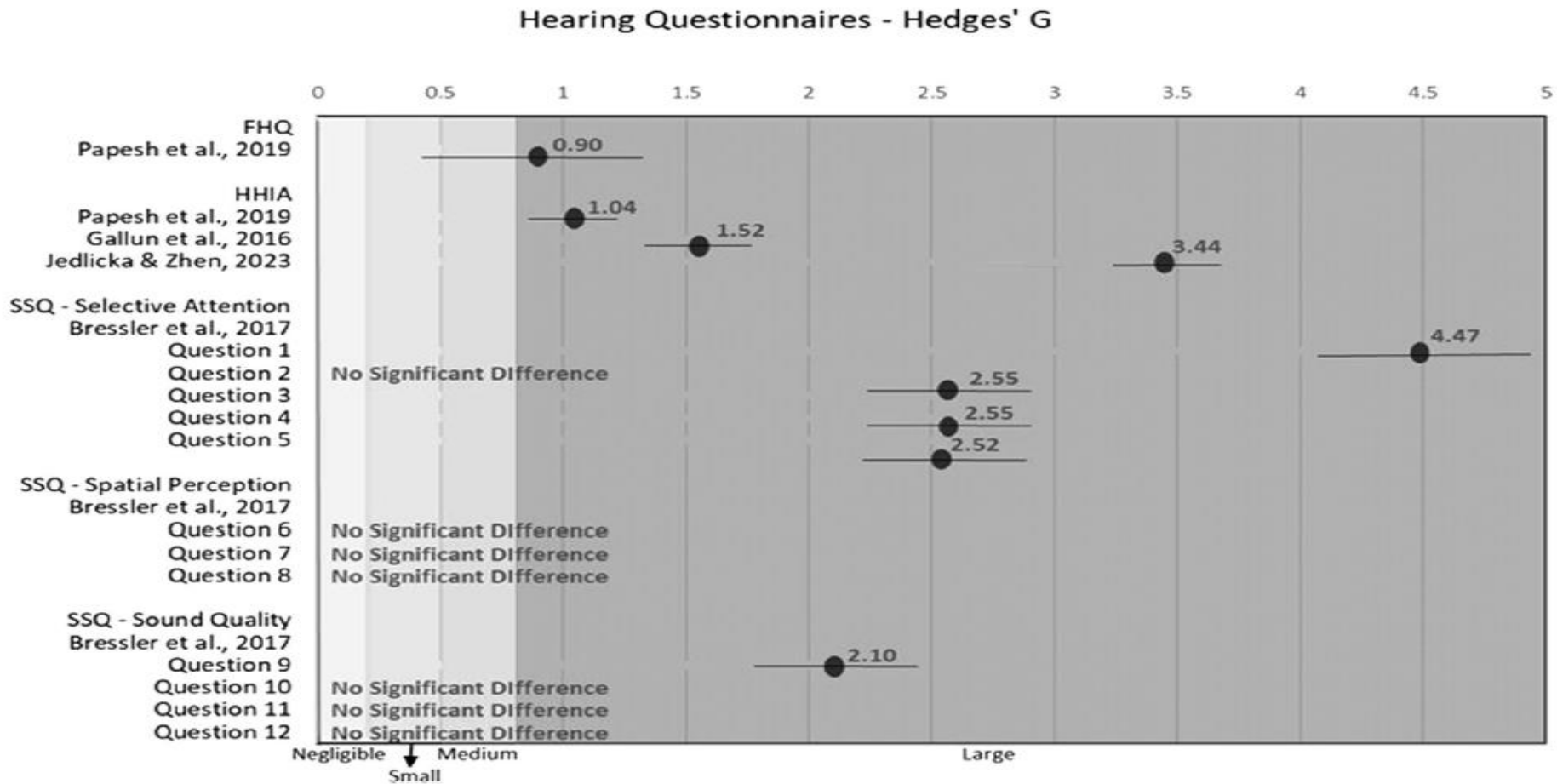
Hedges' g

- So, what is Hedges' g?
- It's similar to Cohen's d, except!
- It removes nonnegligible biases for small sample sizes
- Same significance levels are used
- $0 - 0.2$ = Negligible
- $0.2 - 0.5$ = Small
- $0.5 - 0.8$ = Moderate
- > 0.8 = Large

What Did We Find?

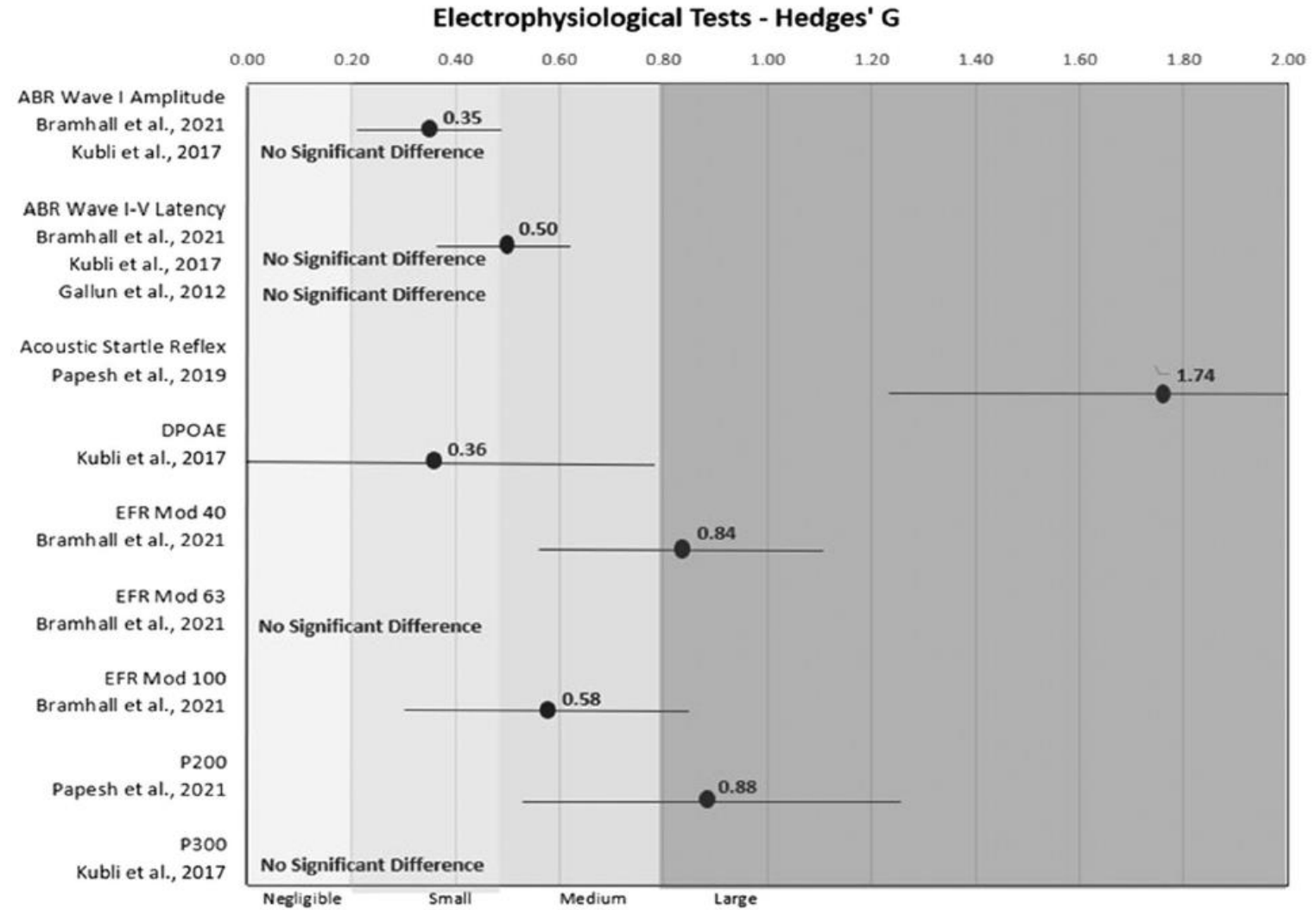
Study 1

Hearing Questionnaires



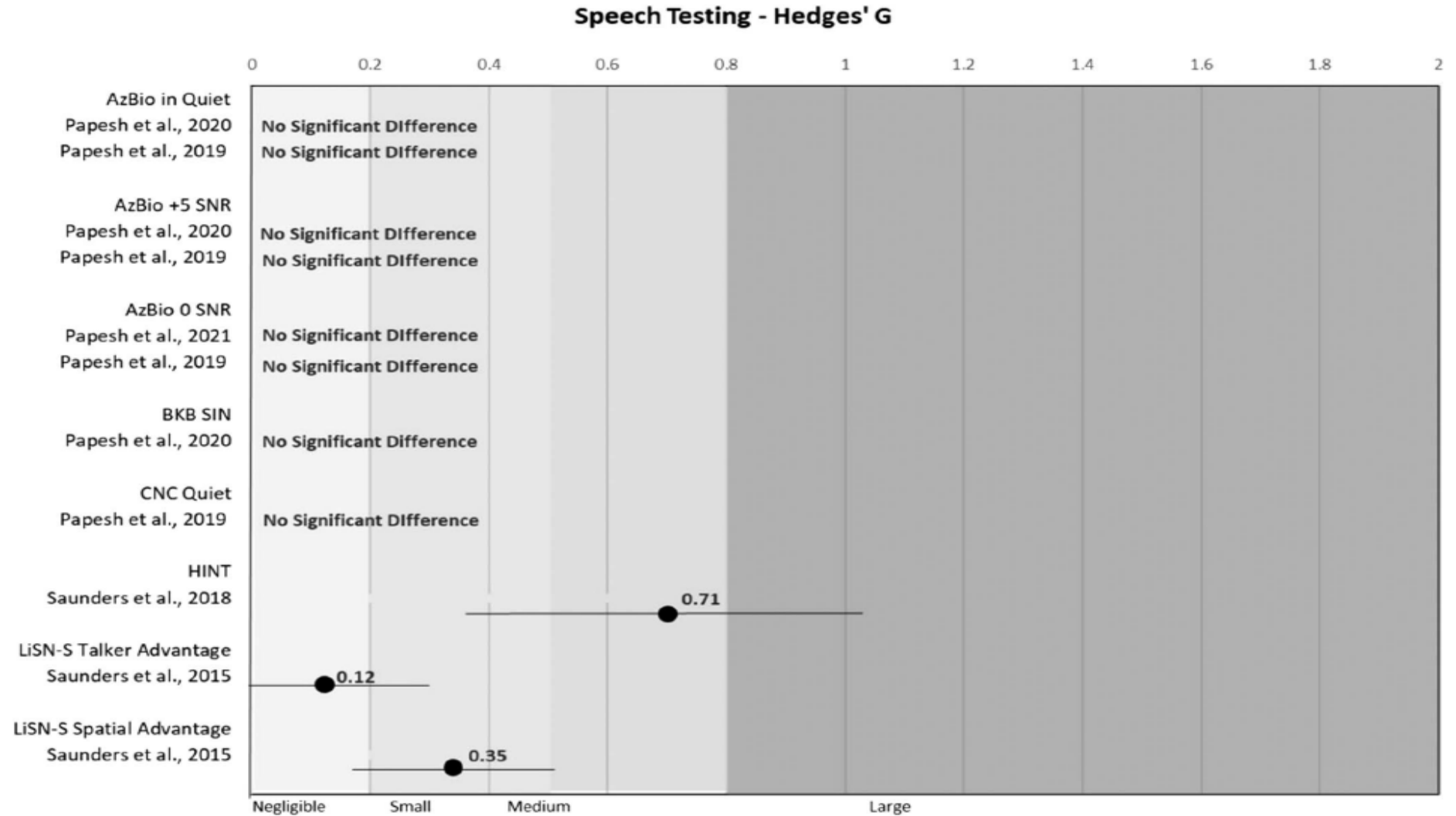
Study 1

Electrophysiological Tests



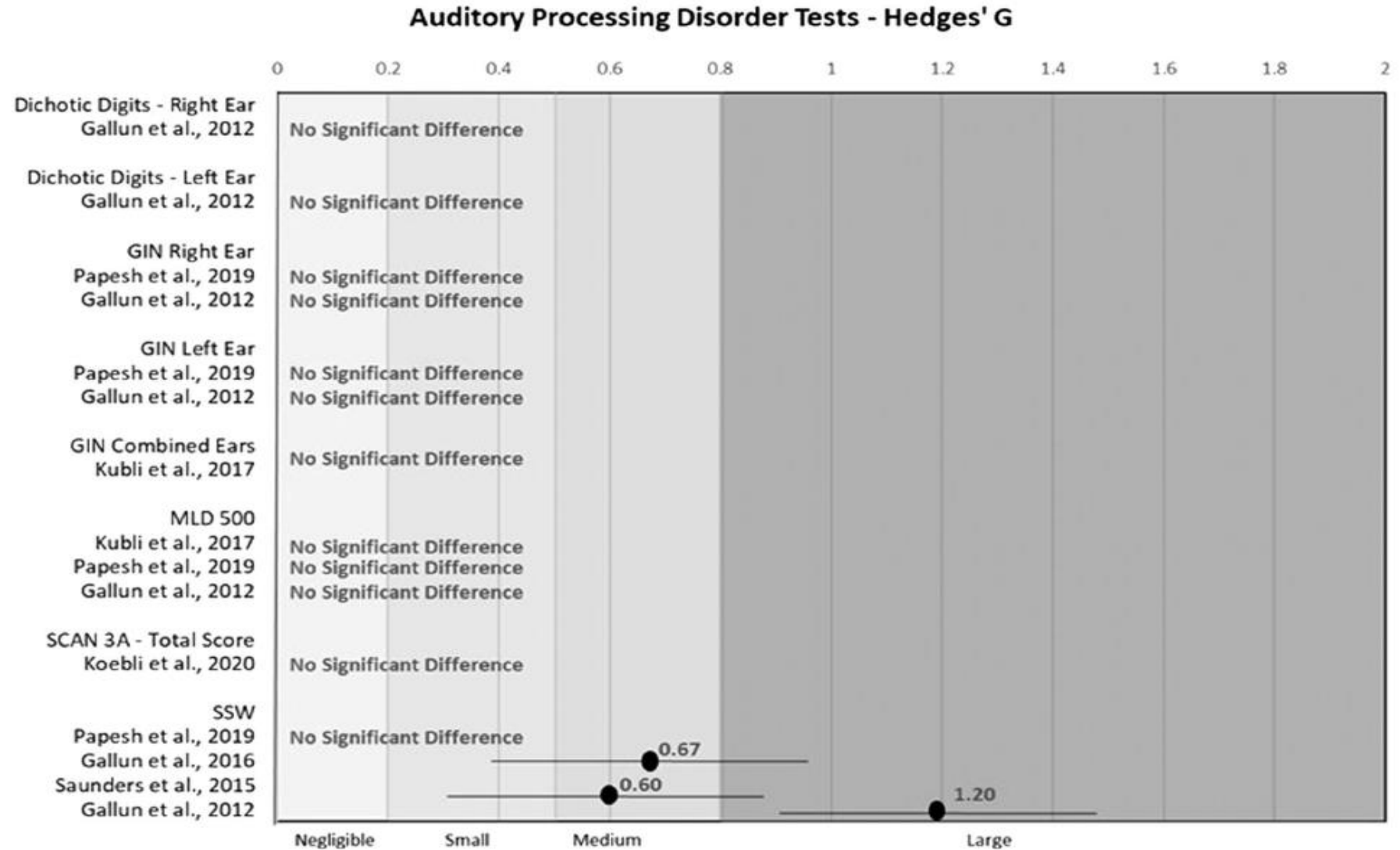
✓ Study 1

Speech Testing

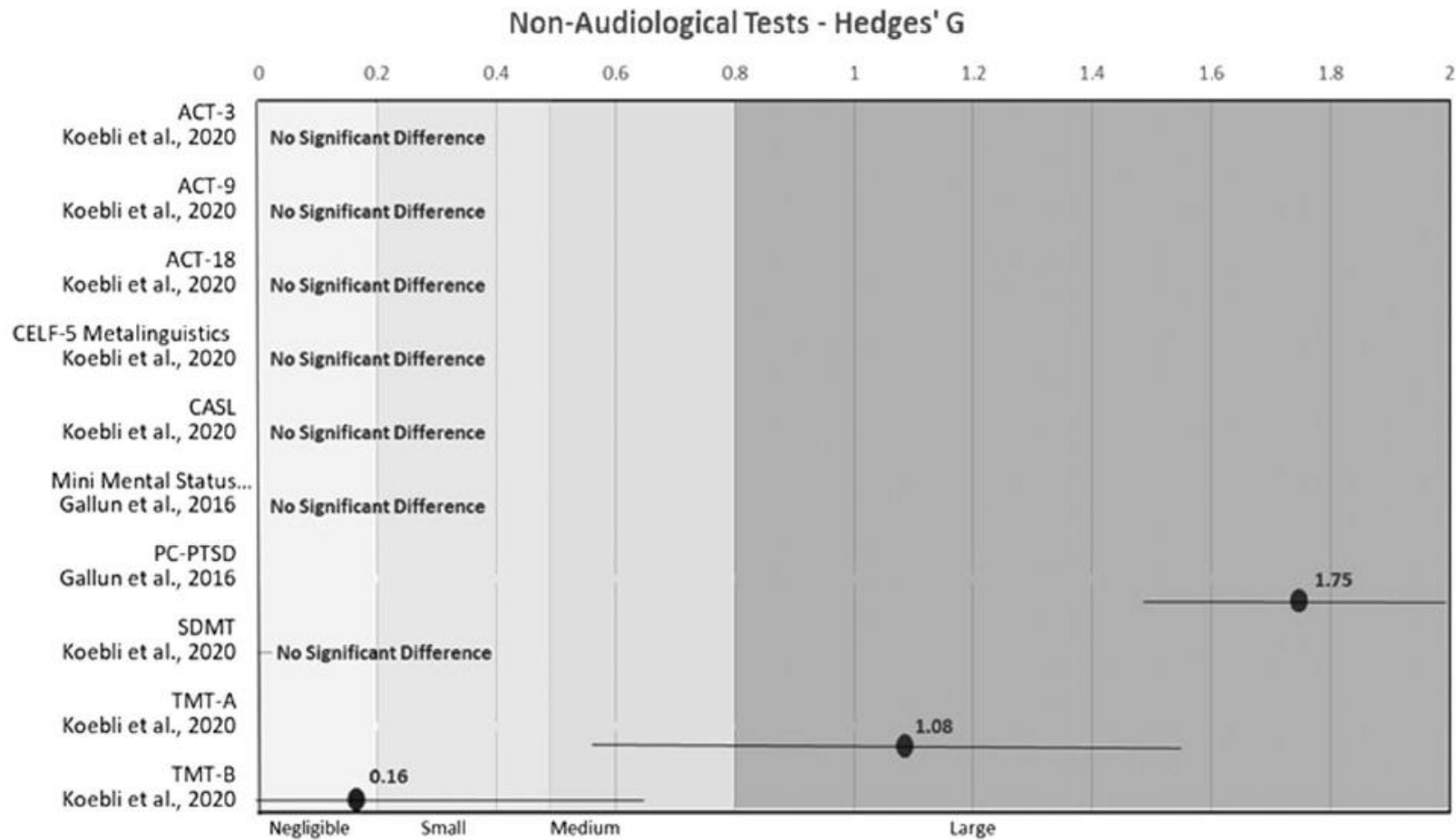


✓ Study 1

Auditory Processing Disorder Tests



Non-Audiological Tests

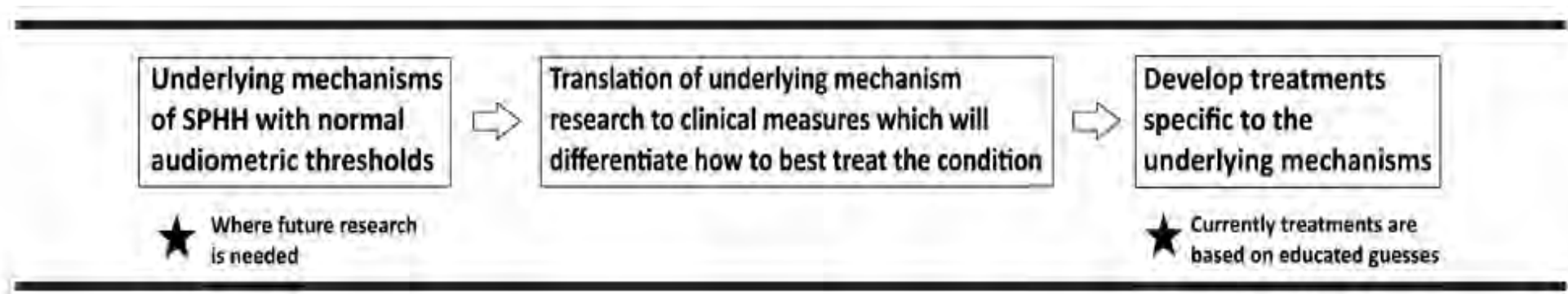


Non-Audiological Tests - PTSD

- The large effect size for PTSD is consistent with previous research that indicate PTSD and the associated co-morbidities are a predictor of SPLD (Jedlicka and Zhen, 2023).
- Most prevalent co-morbidities among Veterans with SPLD include:
 - Tinnitus
 - Anxiety
 - Depression
 - Insomnia
 - **PTSD**
 - Low back pain
 - Anger
 - Hypervigilance
 - Tobacco use
 - Adjustment disorder
 - Sleep apnea

Take Home Messages

- Questionnaires are our best tool to identify who has SPLD
- Traditional APD tests aren't sensitive enough to identify differences
- Electrophysiological measures have promise, but
 1. many aren't standard clinical measures
 2. even if abnormalities are present, how does that guide treatment?



Research Article

Hearing Aid Use Among Veterans With Hearing Loss and Veterans With Normal Audiometric Thresholds Due to Self-Perceived Listening Difficulties

David P. Jedlicka,^{a,b}  Hari Bharadwaj,^a  Elaine Mormer,^a  Aravind Parthasarathy,^a 
and Catherine V. Palmer^{a,c} 

Study 2: Research Aims

1. Compare hearing aid use in a group of veterans with hearing loss and a group of veterans without measured hearing loss who present with self-perceived listening difficulties (SPLD) and no measured hearing loss.
2. Other research stated cost was a reason participants in SPLD treatment studies elected to not purchase hearing aids despite reporting benefit. This study removes the cost barrier to study effectiveness of treatment using HAs.

Inclusion Criteria

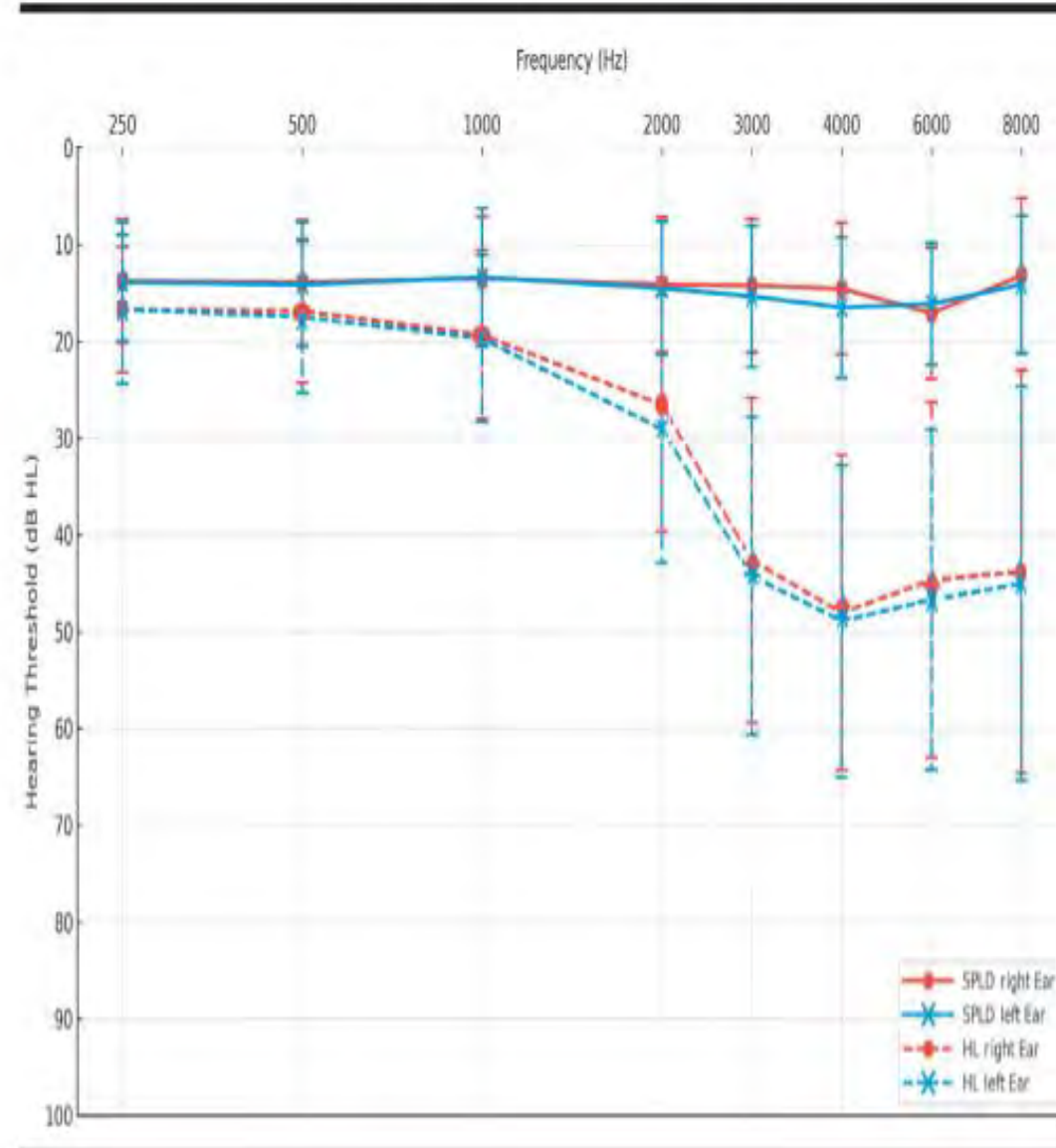
- Veterans who received care through the VA Pittsburgh Healthcare System
- Age range: **18–51 years**
- New hearing aid users
- Fitted with:
 - Open-fit behind-the-ear (BTE) or receiver-in-canal (RIC) devices
 - Zinc air batteries (size 312 or 13)
- Hearing aids fitted between **October 2009 and October 2018**
- Identified through:
 - ICD diagnostic codes
 - HCPCS code V5020 (Conformity Evaluation) indicating hearing aid fitting

✓ Study 2

Audiogram Comparison

- Study 2

Figure 1. Averaged pure-tone audiometric thresholds. SPLD = self-perceived listening difficulties; HL = hearing loss.



Client Oriented Scale of Improvement (COSI)

COSI goal	HL (n)	SPLD (n)	% HL	% SPLD
TV	91	7	48.92%	8.64%
Conversations	55	10	29.57%	12.35%
Background noise	54	34	29.03%	41.98%
Telephone	46	7	24.73%	8.64%
Tinnitus	38	8	20.43%	9.88%
Spouse/partner	34	10	18.28%	12.35%
Groups	29	1	15.59%	1.23%
Family	27	6	14.52%	7.41%
Work	26	1	13.98%	1.23%
Children	12	3	6.45%	3.70%
Classroom	11	6	5.91%	7.41%
Meetings	11	1	5.91%	1.23%
Radio	9	0	4.84%	0.00%
Restaurants	6	1	3.23%	1.23%
Overall	6	0	3.23%	0.00%
Clarity	5	0	2.69%	0.00%
Crowds	5	0	2.69%	0.00%
Distance	5	0	2.69%	0.00%
Grandchildren	5	0	2.69%	0.00%
Car	4	0	2.15%	0.00%
Public	3	4	1.61%	4.94%

Note. *n* = number participants in each group (HL and SPLD) who identified each COSI goal as a priority. Percentages (%) represent the proportion of participants within each group who selected that goal. COSI = Client Oriented Scale of Improvement; HL = hearing loss; SPLD = self-perceived listening difficulties.

Findings

Table 3. Group comparisons of age, hearing aid data logging, return visits, and prehearing/posthearing aid fitting Hearing Handicap Inventory for Adults Screening Version (HHIA-S) scores.

Category	Age	Hearing aid data logging	% of participants with a return visit	Average # of return visits	HHIA-S score (prefitting)	HHIA-S score (postfitting)
Hearing loss (n)	186	70	80	80	183	89
SPLD (n)	81	12	22	22	62	10
Hearing loss	43.9 (12.45)	7.41 (3.52) hr	43.55%	2.2 (2.34)	29.34 (6.81)	4.83 (5.28)
SPLD	33.58 (10.12)	3.38 (3.26) hr	27.16%	1.32 (0.51)	27.42 (7.08)	5.00 (4.12)
Test statistic	$t(154) = 10.29$	$t(16) = 3.92$	$\chi^2(1, n = 267) = 5.35$	$t(264) = 4.42$	$t(113) = 1.96$	$t(14) = 0.12$
p value	$p < .05^*$	$p < .05^*$	$p < .05^*$	$p < .05^*$	$p > .05$	$p > .05$
Effect size	0.87 (Hedges's g)	1.16 (Hedges's g)	0.15 (phi Φ)	0.42 (Hedges's g)		

Note. SPLD = self-perceived listening difficulties.

*Indicates result is significantly different.

Hearing Aid Supply Order

- Study 2

Group	Batteries ordered 6–12 months after initial fitting	Batteries ordered 12–24 months after initial fitting	Batteries ordered 24+ months after initial fitting	Hearing aid supplies ordered at any point after initial fitting
SPLD ($n = 81$)	6 (7.41%)	7 (8.64%)	8 (9.88%)	6 (7.41%)
Hearing loss ($n = 186$)	80 (43.01%)	84 (45.16%)	91 (48.92%)	90 (48.39%)
Test statistic	$\chi^2(1, n = 267) = 31.15$	$\chi^2(1, n = 267) = 31.89$	$\chi^2(1, n = 267) = 35.22$	$\chi^2(1, n = 267) = 39.39$
p value	$p < .05^*$	$p < .05^*$	$p < .05^*$	$p < .05^*$
Phi (Φ)	0.35	0.35	0.37	0.39

Note. Counts and percentages represent the number of veterans in each group who placed at least one order for hearing aid batteries or supplies (domes, tubes, wax filters) during the specified postfitting intervals. SPLD = self-perceived listening difficulties.

*Indicates result is significantly different.

Comorbidity Comparison

Comorbidities	Tinnitus	PTSD	Mental health	Pain	Sleep	TBI
Hearing loss (n)	168	43	103	112	62	8
SPLD (n)	70	51	73	69	51	21
Hearing loss (%)	90.32	23.12	55.38	60.22	33.33	4.3
SPLD (%)	86.42	62.96	90.12	85.19	62.96	25.93
Test statistic	$\chi^2(1, n = 267) = 0.53$	$\chi^2(1, n = 267) = 37.54$	$\chi^2(1, n = 267) = 28.80$	$\chi^2(1, n = 267) = 14.99$	$\chi^2(1, n = 267) = 19.10$	$\chi^2(1, n = 267) = 25.07$
p value	$p > .05$	$p < .05^*$	$p < .05^*$	$p < .05^*$	$p < .05^*$	$p < .05^*$
Phi (Φ)		0.38	0.34	0.25	0.28	0.32

Note. Comparison of diagnosed comorbidities by group. PTSD = posttraumatic stress disorder; TBI = traumatic brain injury; SPLD = self-perceived listening difficulties.

* $p < .05$ is significant.

Comorbidity Comparison

- Comorbidity findings consistent with Jedlicka and Zhen, 2023.
- HHIA scores can be predicted with the following formula
 - $HHIA = 1.573 + 6.409 \times \text{hypervigilance} + 6.006 \times \text{tinnitus} + 5.029 \times \text{sleep disorders} + 4.937 \times \text{PTSD} + 3.862 \times \text{anxiety} + 3.051 \times \text{psychological disorders}$
(1 if present, 0 if absent)

Take Home Messages

- SPLD Users =
 - Fewer hours of daily use (with large effect size)
 - Fewer return visits
 - Significantly fewer battery and supply orders
- Objective indicators suggest minimal or discontinued long-term use
- SPLD group has significantly more comorbidities
- HHIA scores improved despite limited use of hearing aids

How Can We Continue to Improve?

Clinicians

- Use clinic time wisely
- Believe your patients
- Don't provide band-(hearing)-aid treatment
- Put on your counseling hat
- Lean into the whole health model (think outside of the ears!)

Researchers

- Change the way we research this phenomenon to think outside of the measures in which we are comfortable
- Identify the source or sources and cure the root issue rather than managing the symptoms

Questions?

Contact: David.Jedlicka@va.gov





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