Prescription and Verification of Bone Conduction Devices

Bill Hodgetts, PhD

UNIVERSITY OF ALBERTA
FACULTY OF REHABILITATION MEDICINE
Department of Speech Pathology and Audiology

Institute for Reconstructive Sciences in Medicine

Disclosure And Acknowledgements

- Parts of this work has been supported by the western economic partnership grant (WEPA)

- Parts have been supported by a grant from the Oticon Foundation

- Many Thanks to:

  - Susan Scollie, Dylan Scott, Herman Lundgren, Kristina Kuffel, Bill Cole…

Overview

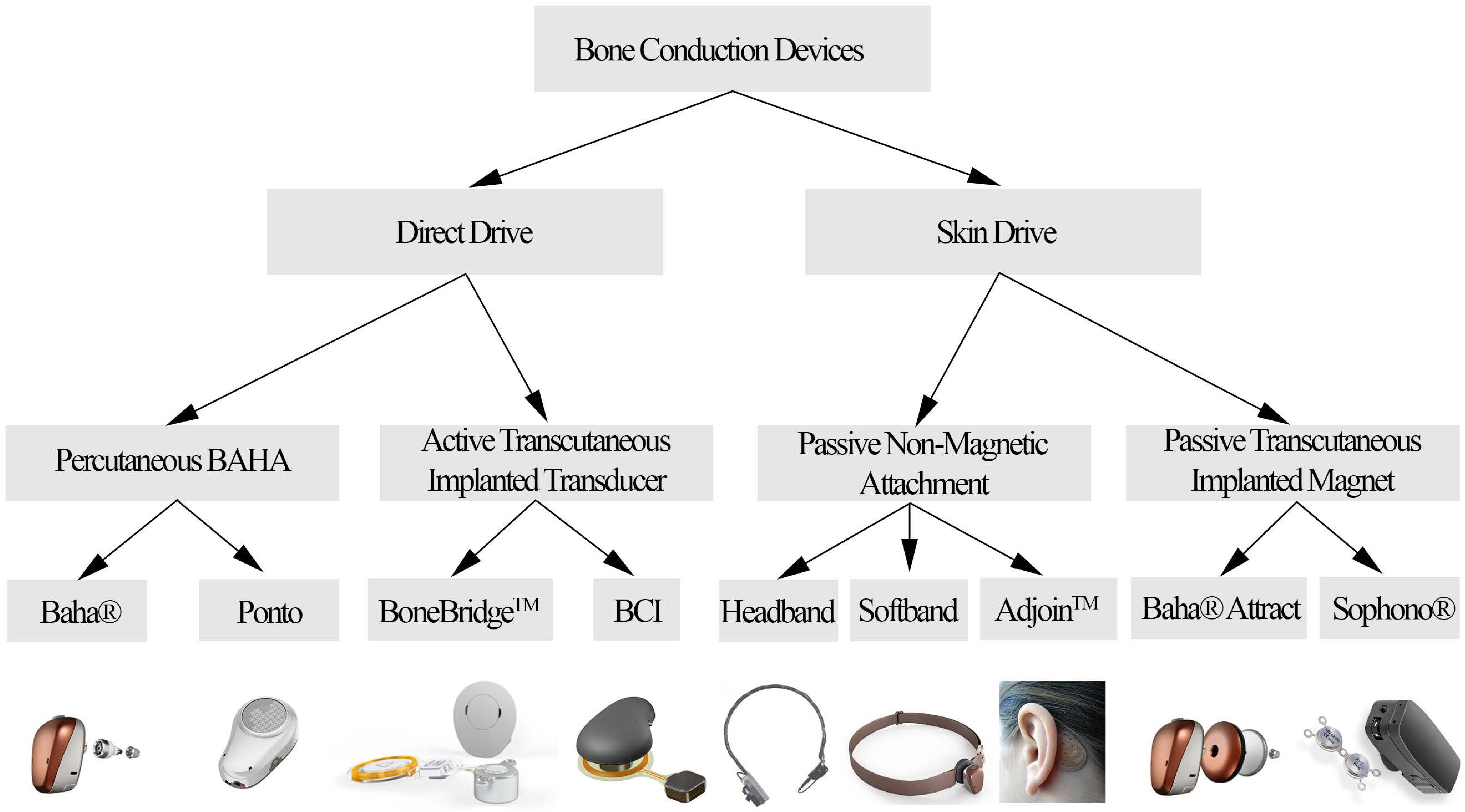
- Take home:
  - We are a long way toward a complete prescription and verification solution for kids and adults with an implant
  - We still struggle to verify and prescribe for soft band fittings but are working hard on a solution for this as well


Research
Clinic
Knowledge to Action Gap

Knowledge to Action Gap

- Clinicians are concerned that they don’t know how to verify the output of BC devices
    - Verification
- Clinicians are concerned that they don’t know how to set the device for best performance and rely on manufacturers’ settings
    - Prescription


AC Thresholds
BC Thresholds
Perceived Handicap
Transcranial Attenuation
Lifestyle
Listening Environments
Transmission From Abutment to Cochlea
Speech Perception
Skin Attenuation
Mech Impedance
Noise Reduction
Gain/ Compression Settings
Maximum Power Output
Frequency Response
Frequency Lowering
Bandwidth
Wireless Tech
Directional Mics
Feedback Management
Good Match


Bone Conduction Devices
Direct Drive
Skin Drive
Percutaneous BAHA
Active Transcutaneous Implanted Transducer
Passive Non-Magnetic Attachment
Passive Transcutaneous Implanted Magnet
Baha®
Ponto
BoneBridge™
BCI
Headband
Softband
Adjoin™
Baha® Attract
Sophono®

Doing well? Carry on… pat on back…

Identification of hearing loss → Treatment Selection → Hearing Aid Fitting → Outcome Measurement

Doing Poorly?

Approaches to Hearing Aid Fitting

Traditional Approach

Clinical Experience + Device capabilities → Assessment

Assessment → Preselection → Evaluation → Selection

Theoretical Approach

Theoretical Rationale + Device Capabilities → Assessment

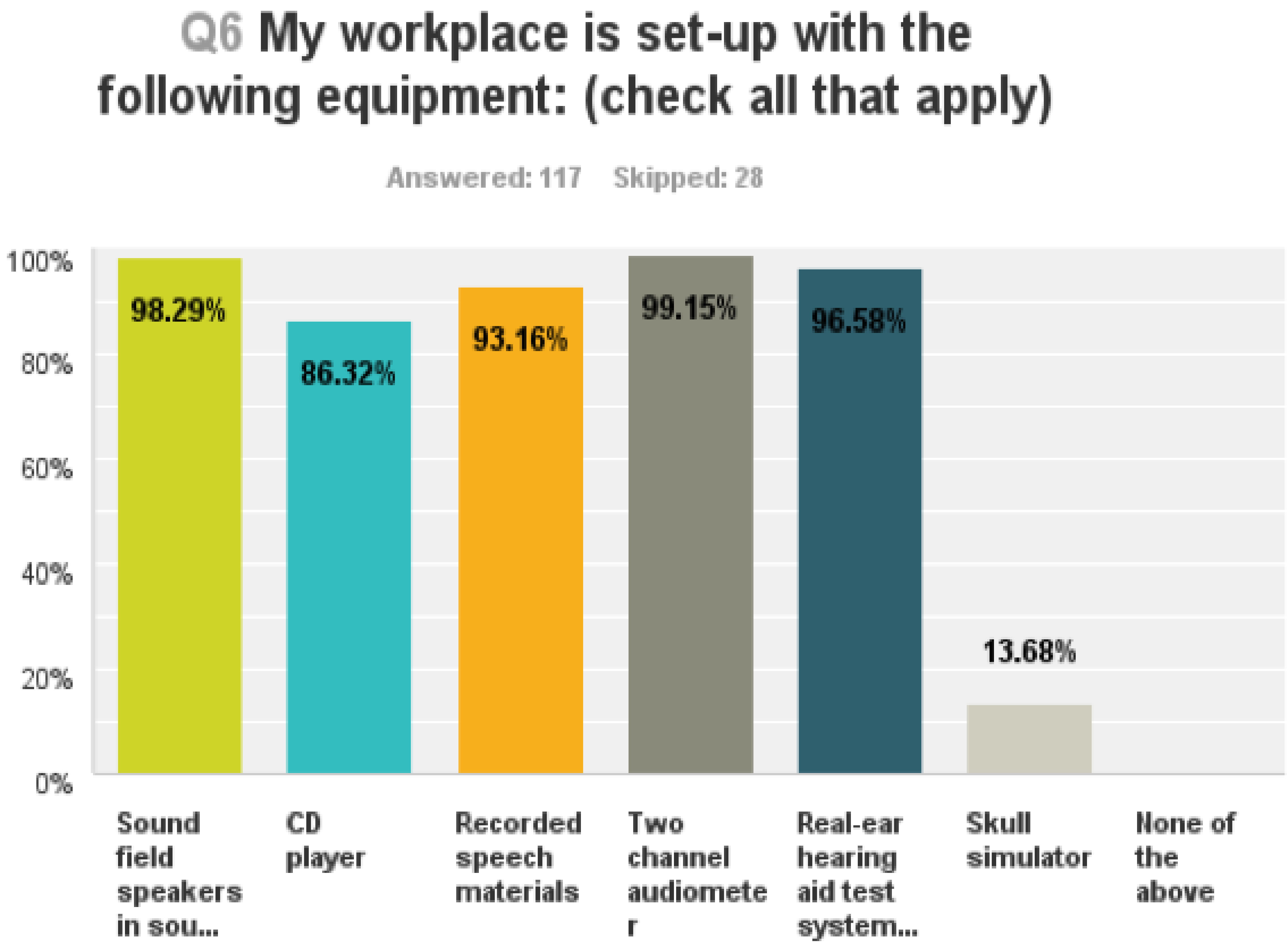
Assessment → Selection/prescription → Verification → Validation/Evaluation

Seewald et al., 1996

Why are we stuck?

- There are evidence-based fitting protocols for air conduction hearing aids to provide optimal amplification to infants and young children (e.g. AAA, 2013, Bagatto et. al, 2010).

Verification Options

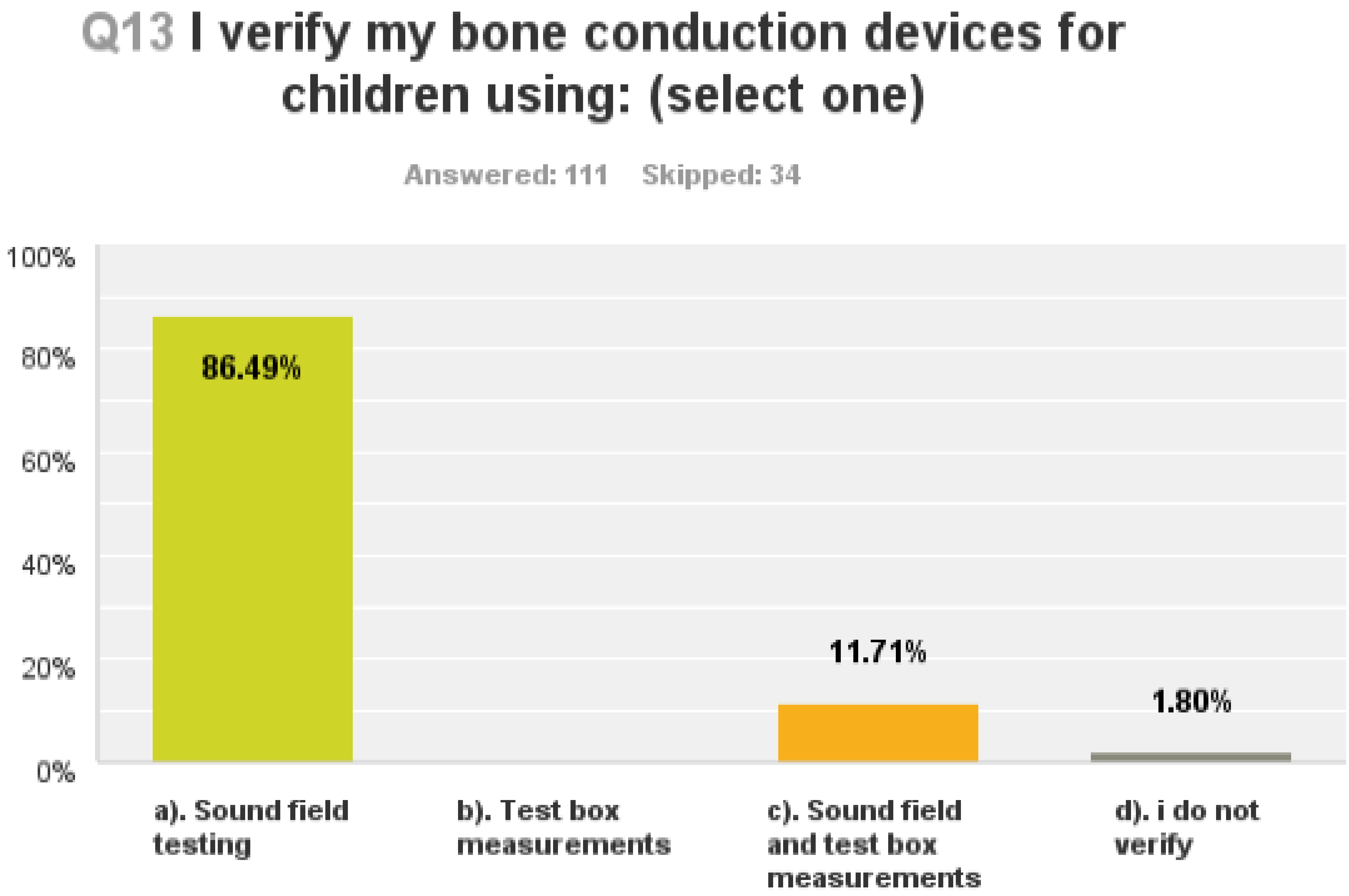


Gordey and Bagatto, 2015

Skull Simulators

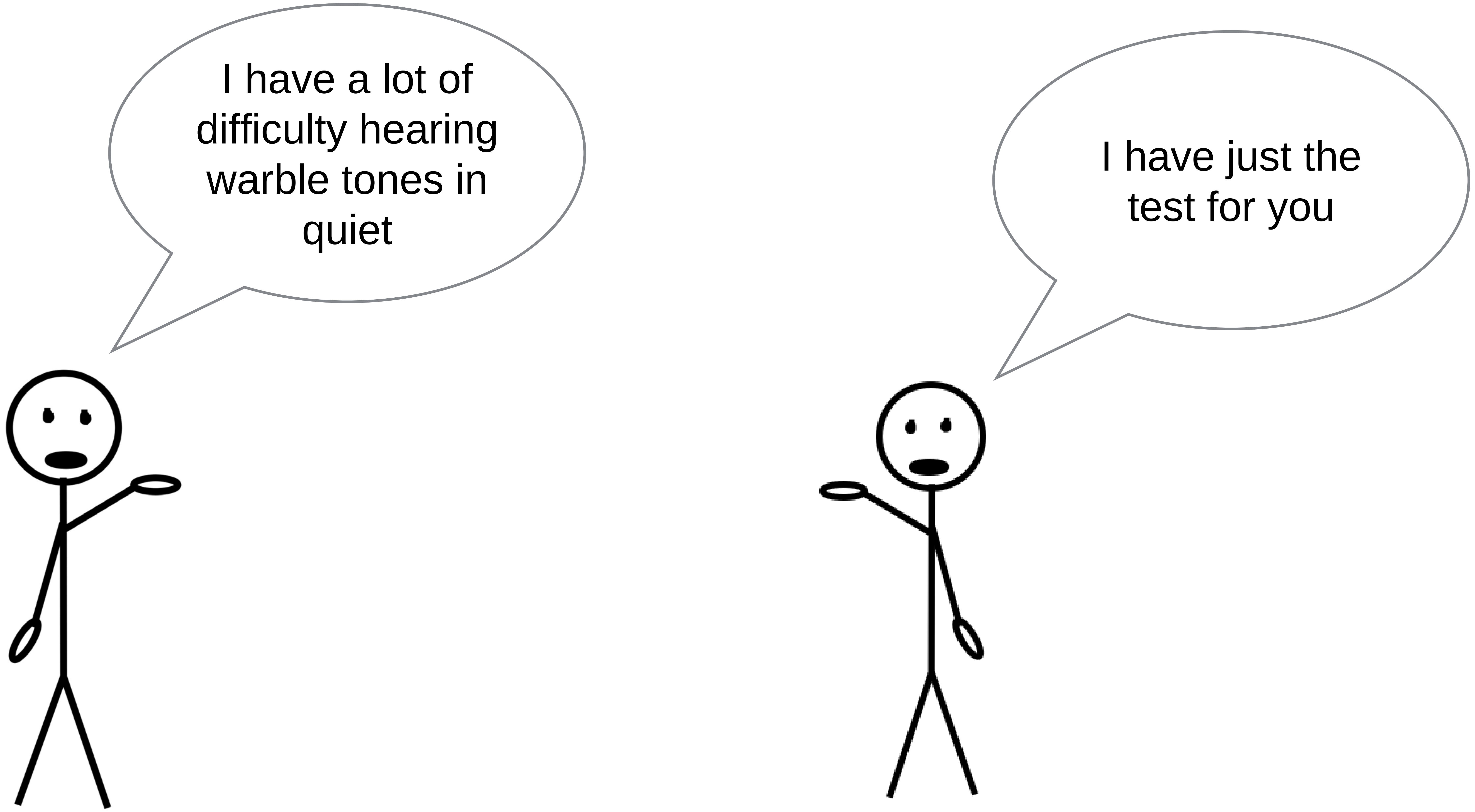
Hodgetts and Scollie, in Review

Verification?



Gordey and Bagatto, 2015

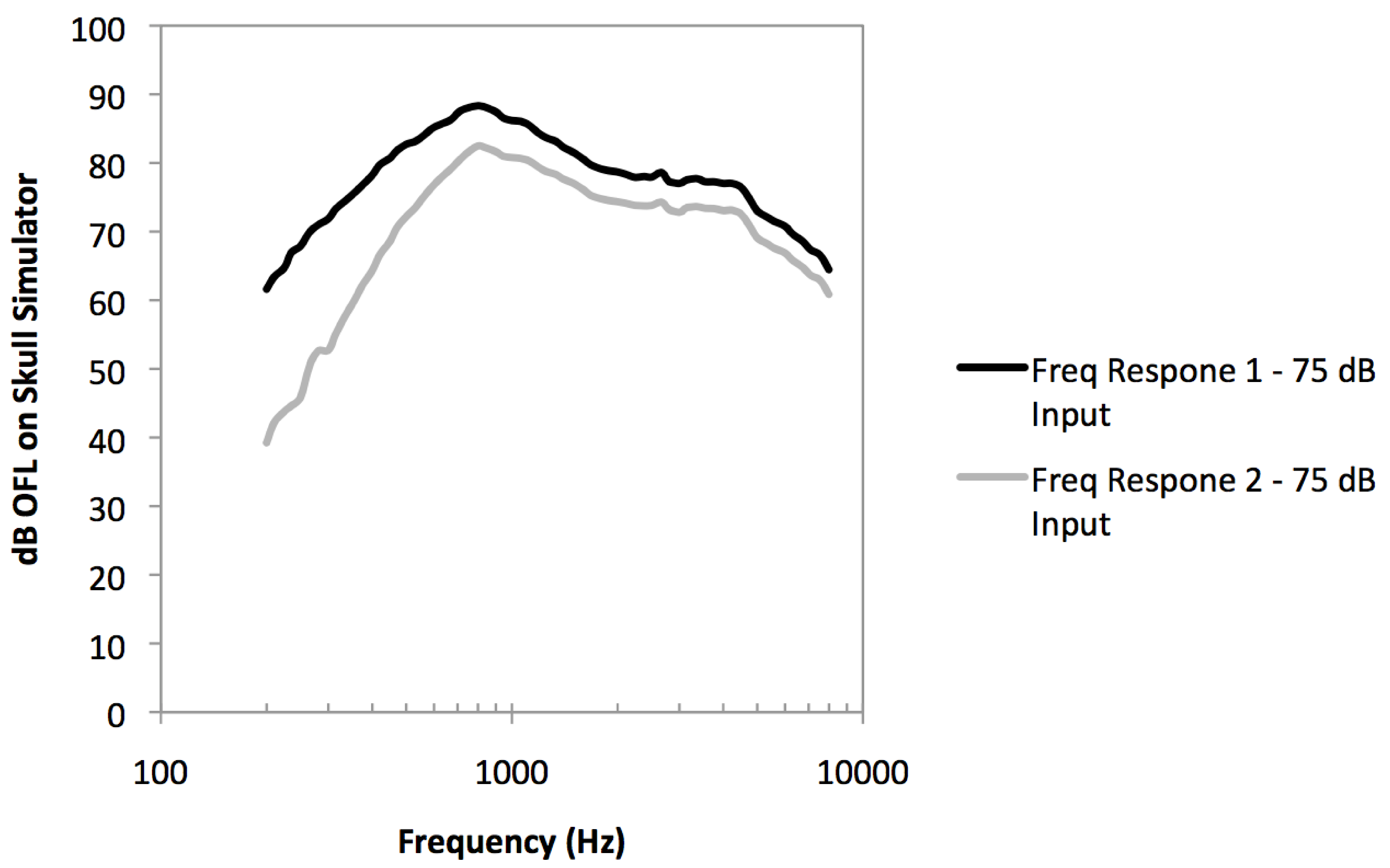
Measures of Audibility?

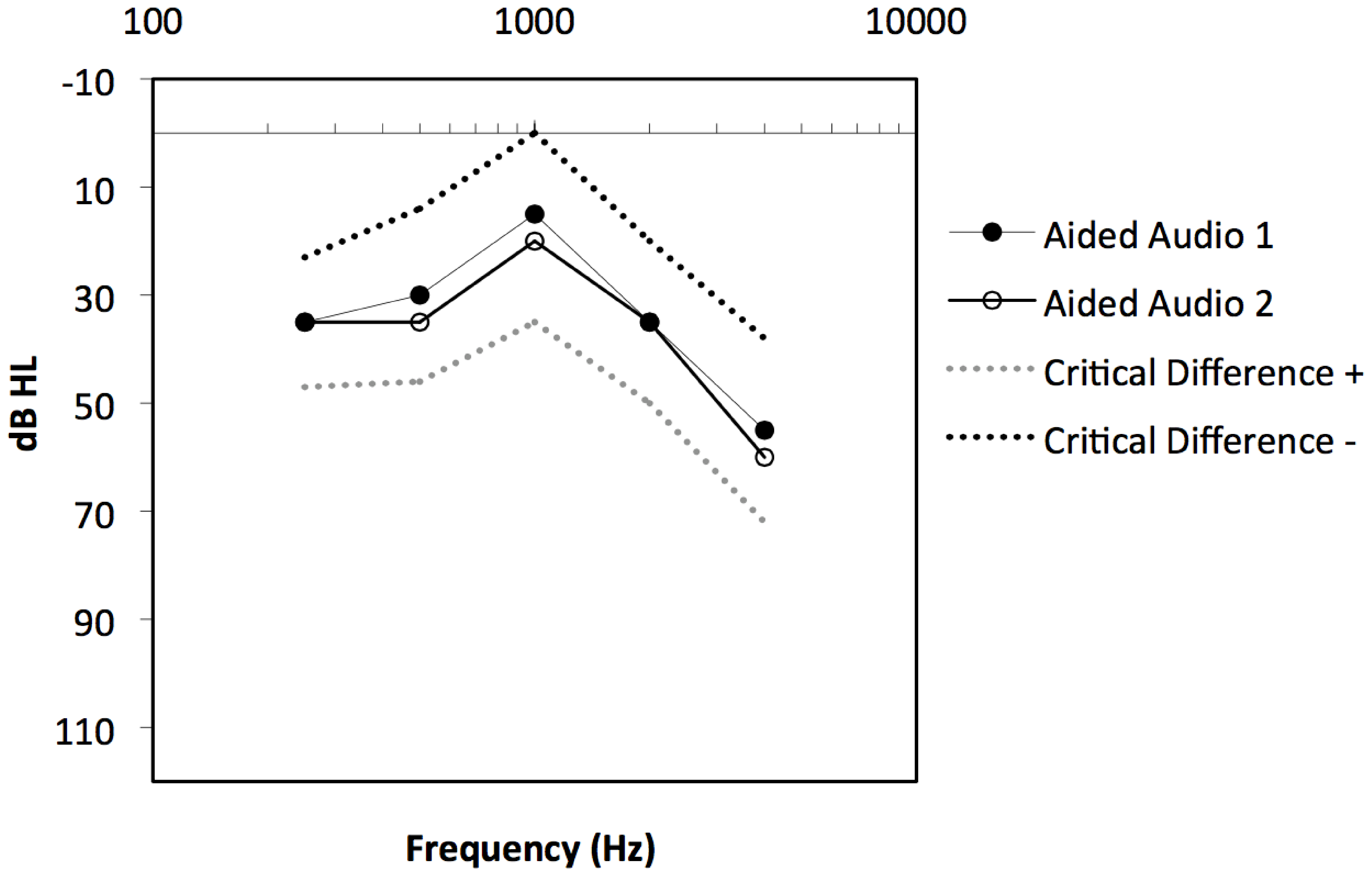


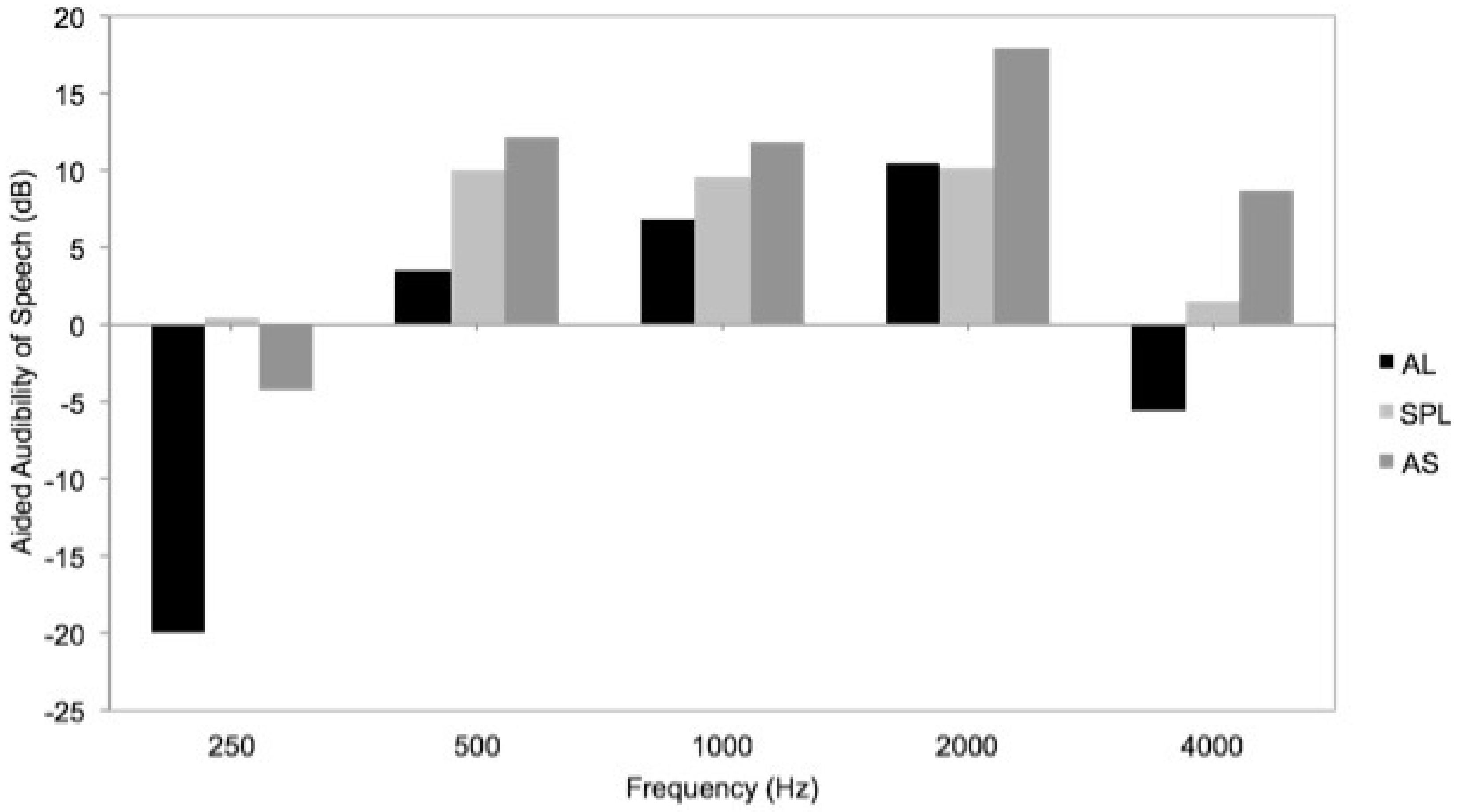
Patient

Clinician

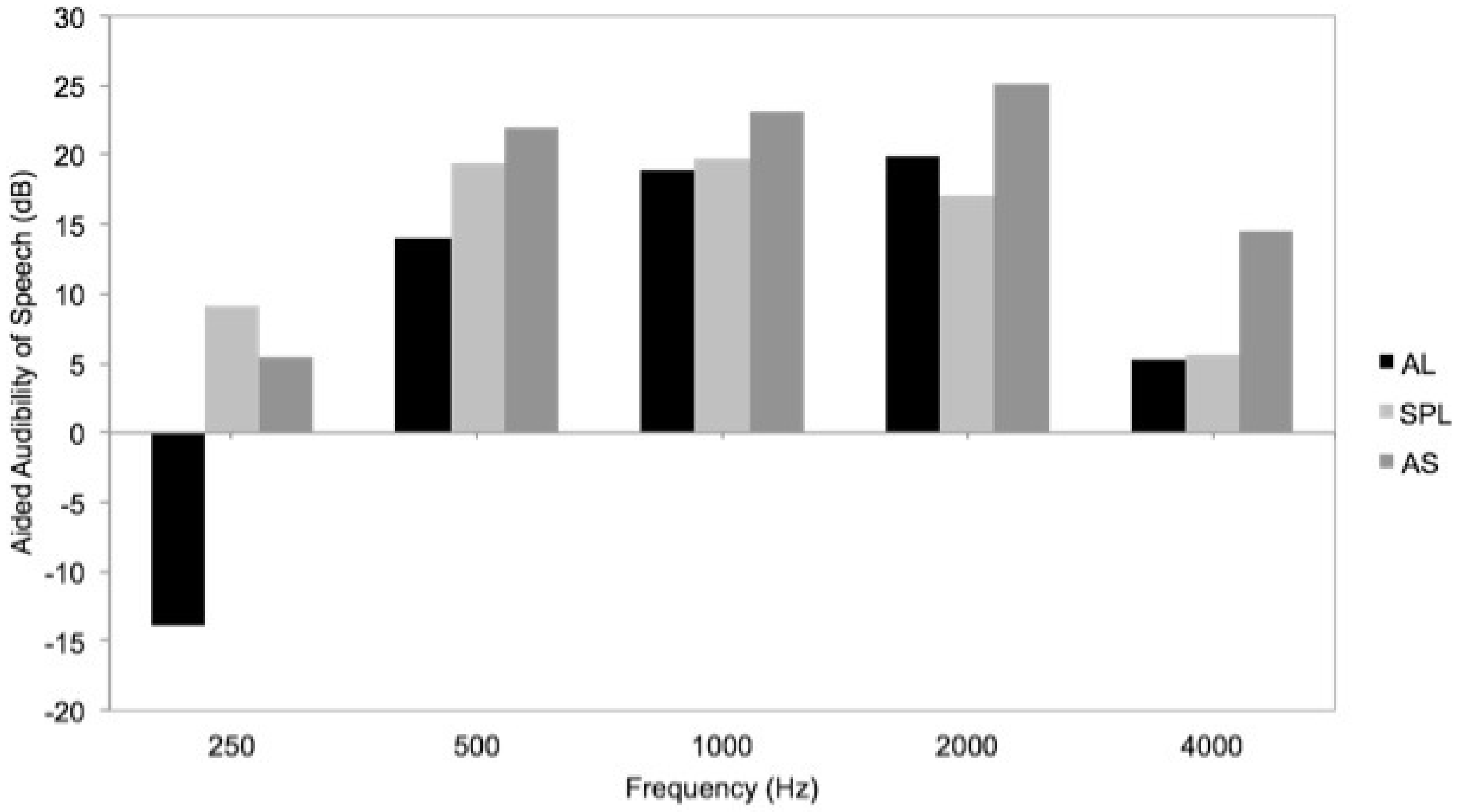
Aided Thresholds



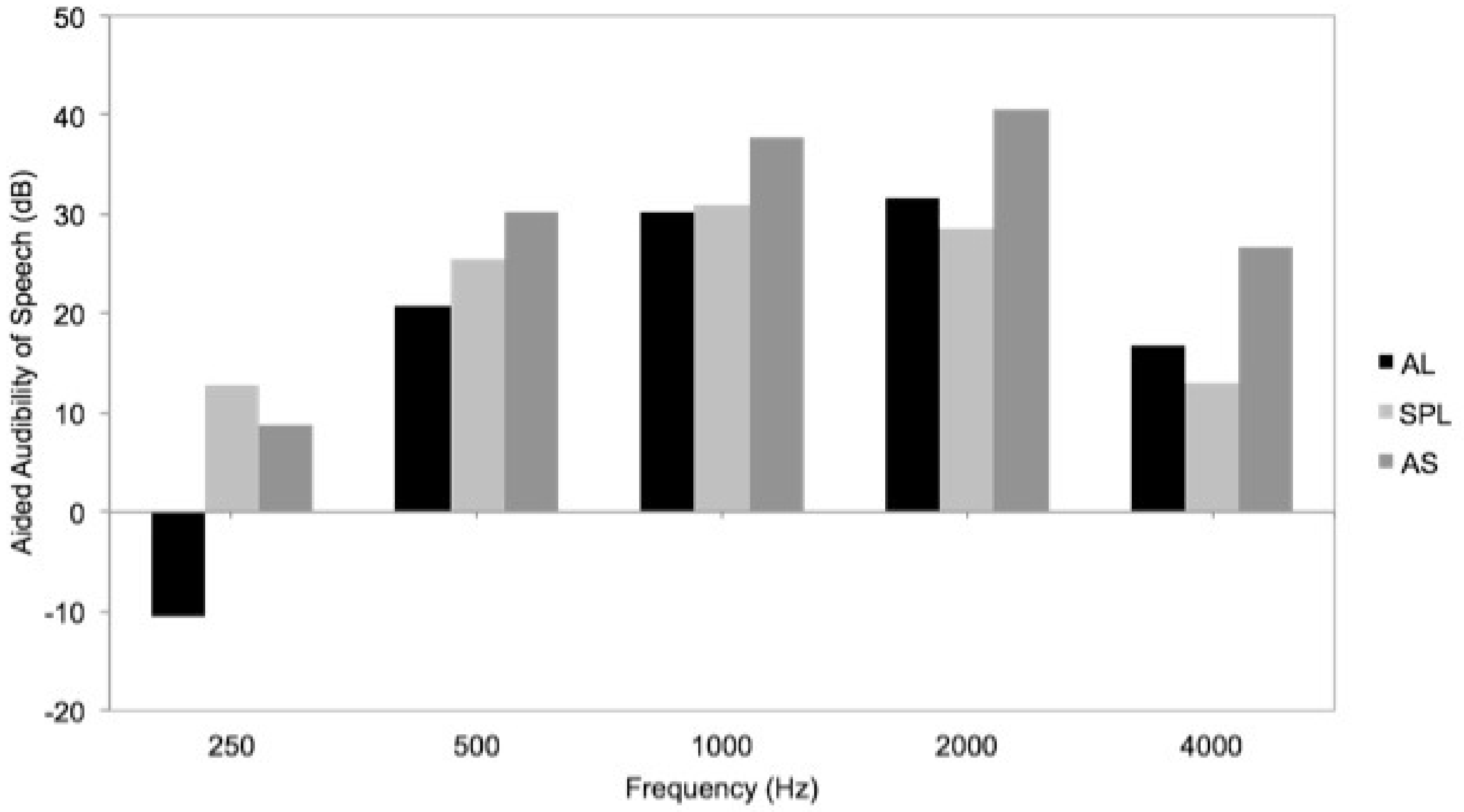




55 dB Input



65 dB Input



75 dB Input

informa
healthcare

Original Article

International Journal of Audiology 2010; 49: 286–295

William E. Hodgetts[*,§]
Bo E.V. Håkansson[+]
Paul Hagler[*]
Sigfrid Soli[#]

*Department of Speech Pathology and Audiology, University of Alberta, Edmonton, Canada
§Institute for Reconstructive Sciences in Medicine (iRSM), Edmonton, Canada

A comparison of three approaches to verifying aided Baha output

Abstract
Objective: The objective of the present study was to compare three methods of estimating the audibility of aided speech using the Baha.
Subjects: 23 Adult Baha users with primarily bilateral conductive hearing loss were recruited from the Bone Conduc-

Sumario
El objetivo del presente estudio fue comparar tres métodos de estimación del nivel de sensación (audibilidad del LTASS) del lenguaje amplificado usando el Baha. Se reclutaron 23 usuarios adultos del Baha, primariamente con hipoacusia conductiva bilateral, del Programa de Amplificación por Con-

Hodgetts et al, 2010

Fundamental goal of a hearing aid fitting

↓

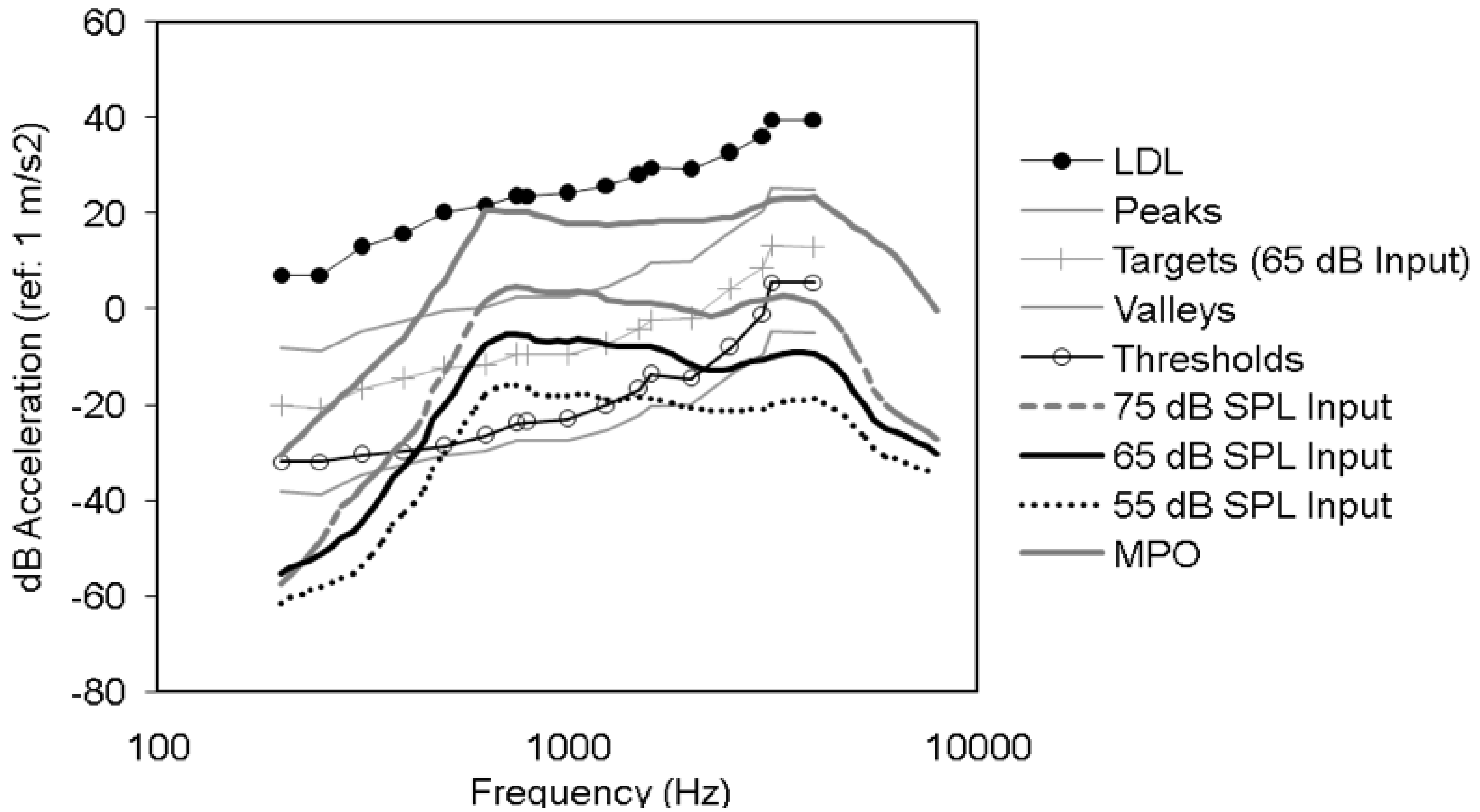
Maximize the audibility of important and useable speech information

↓

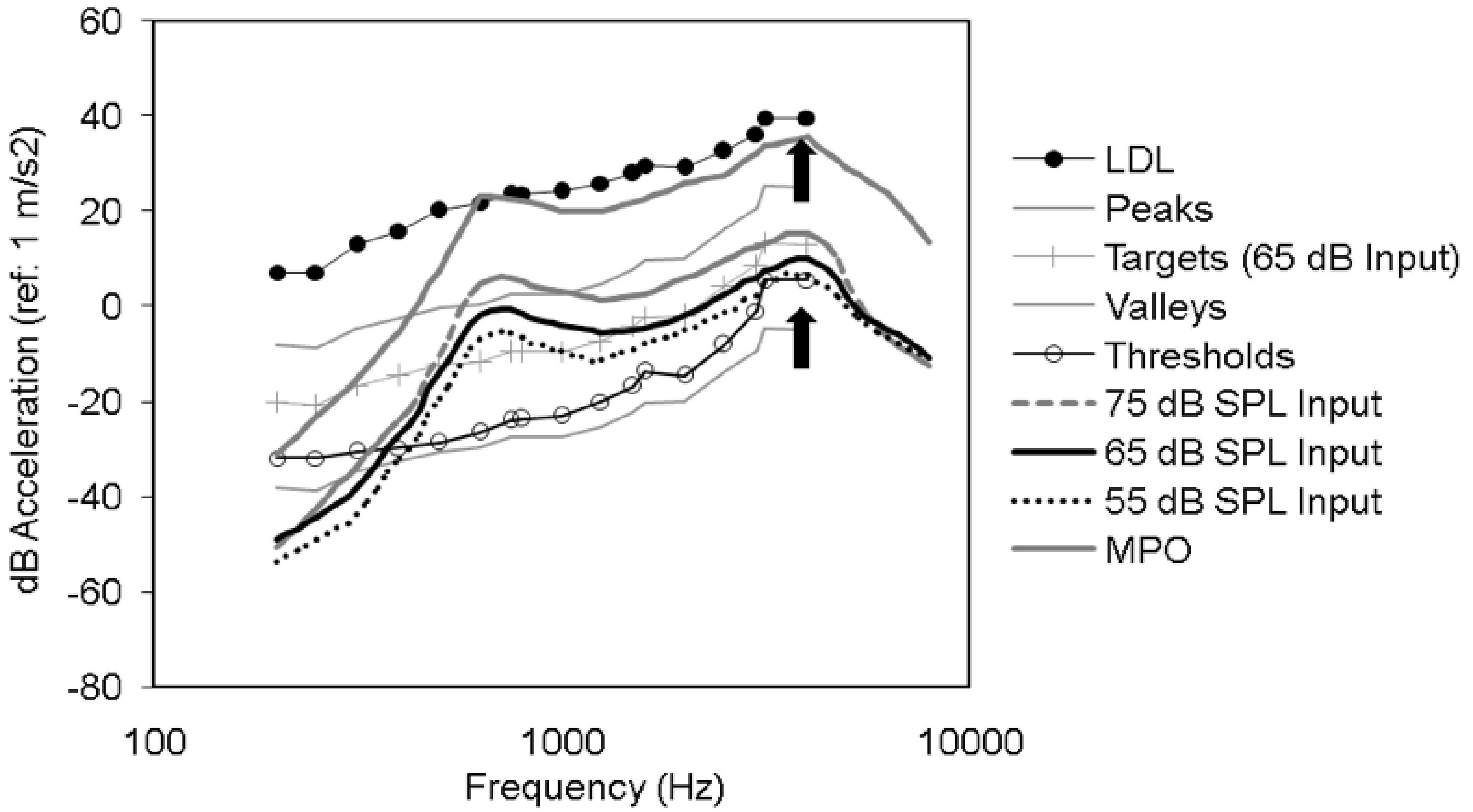
"Although it is true that mere detection of a sound does not ensure its recognition, it is even more true that without detection the probabilities of correct identification are greatly diminished"

David Pascoe, 1980

Previous Work



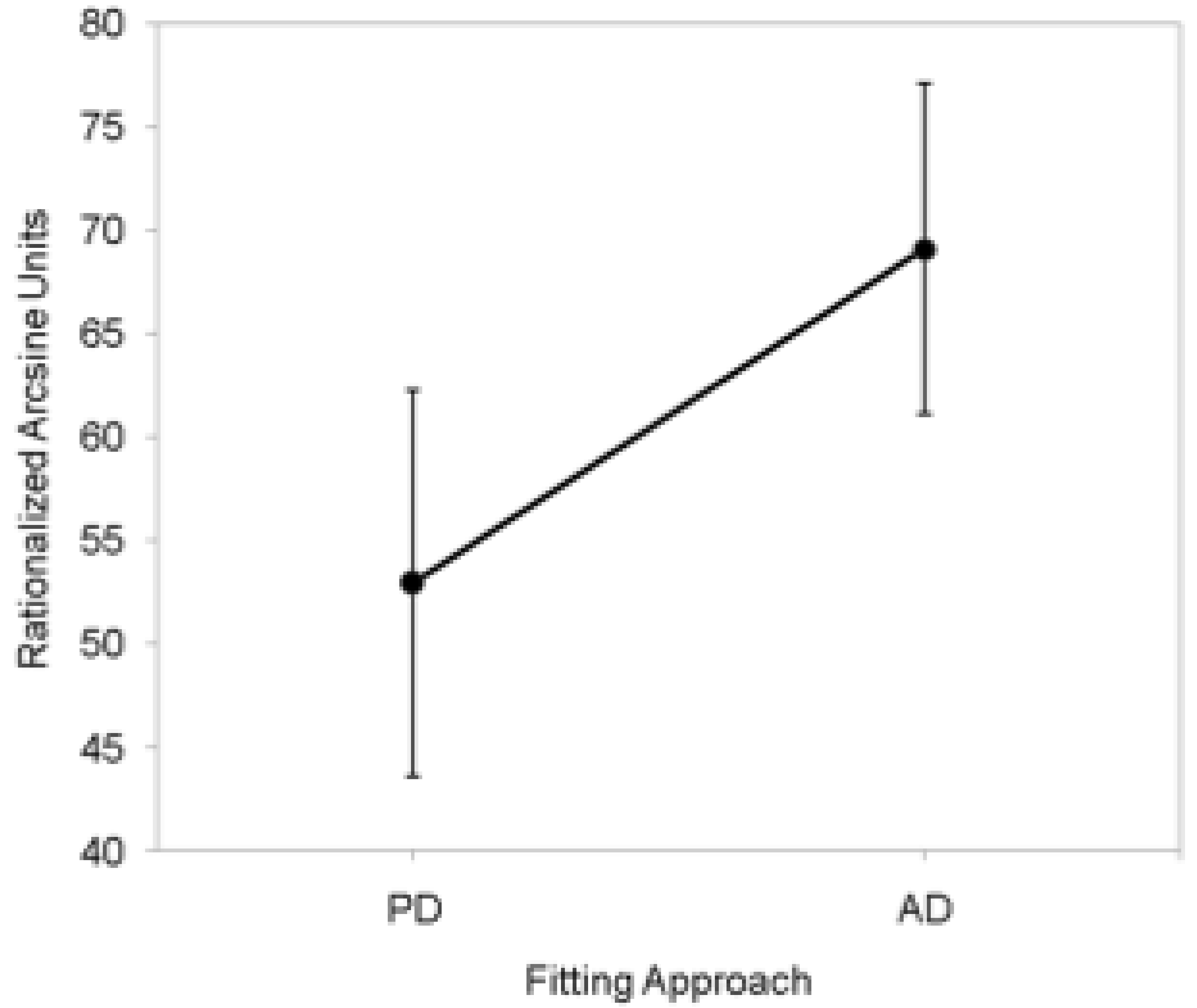
Baha Divino or Classic



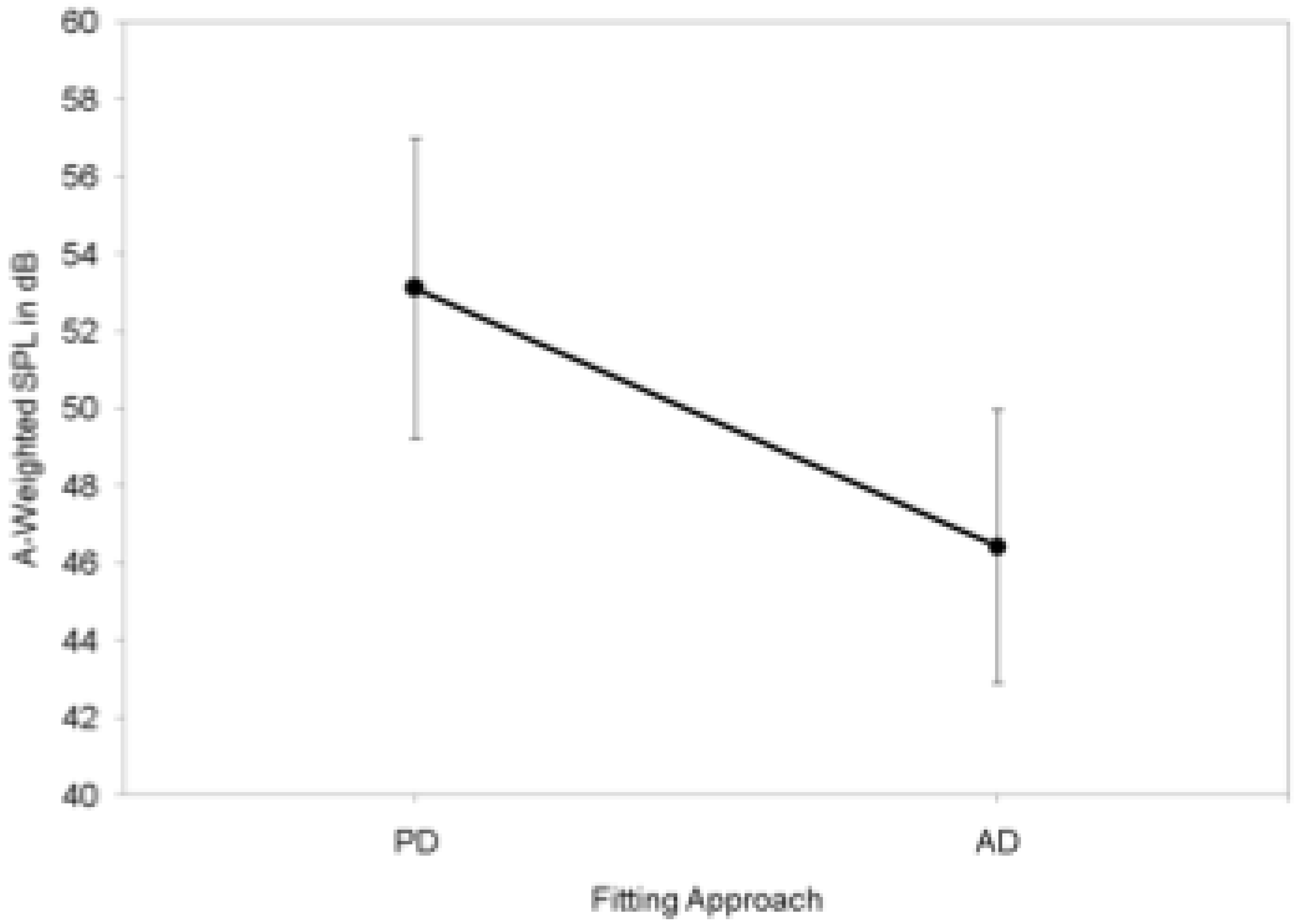
Master BAHA

Hodgetts et al., 2011

N = 16



Consonants in Noise

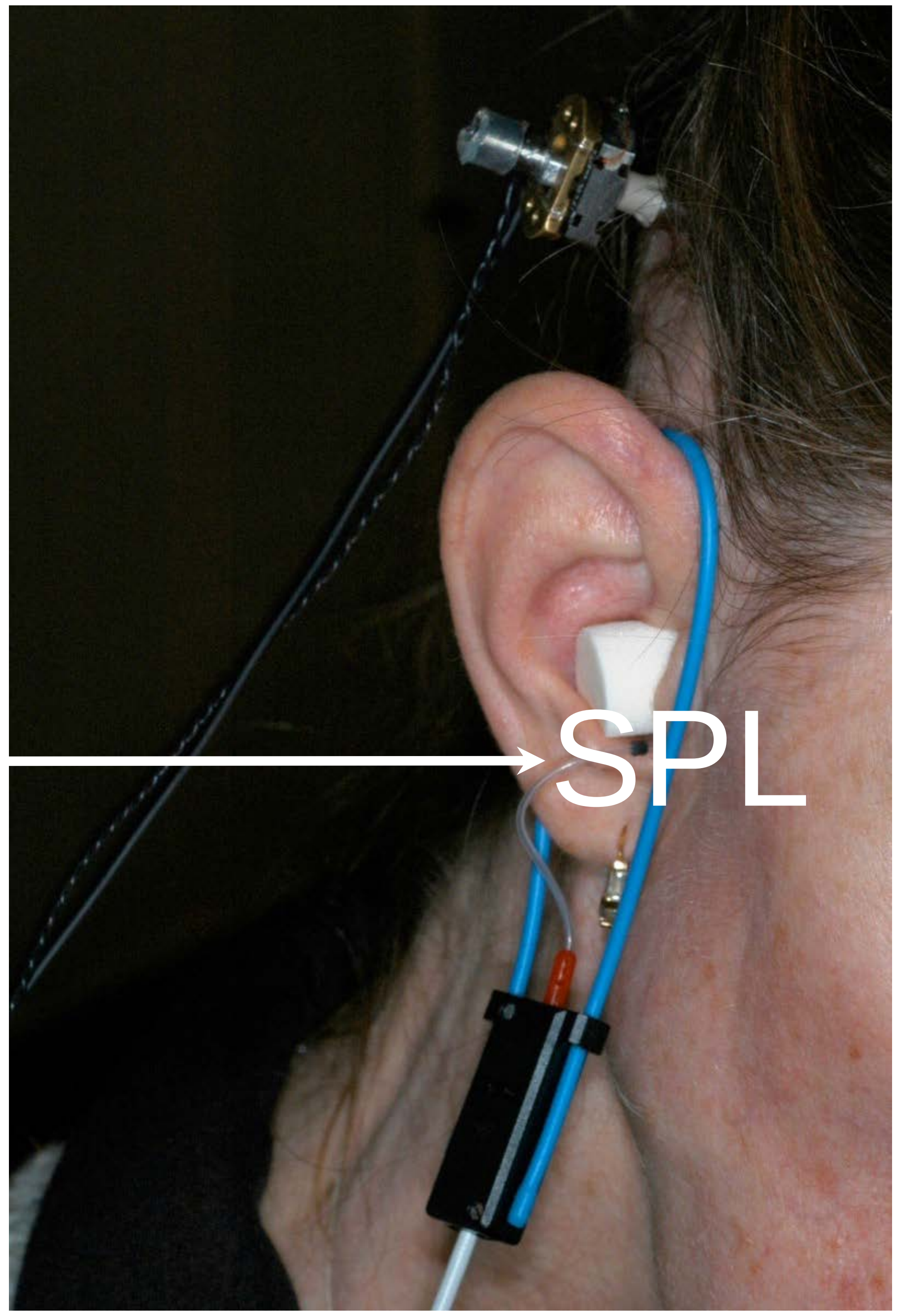


HINT

Hodgetts et al., 2011

Air Conduction

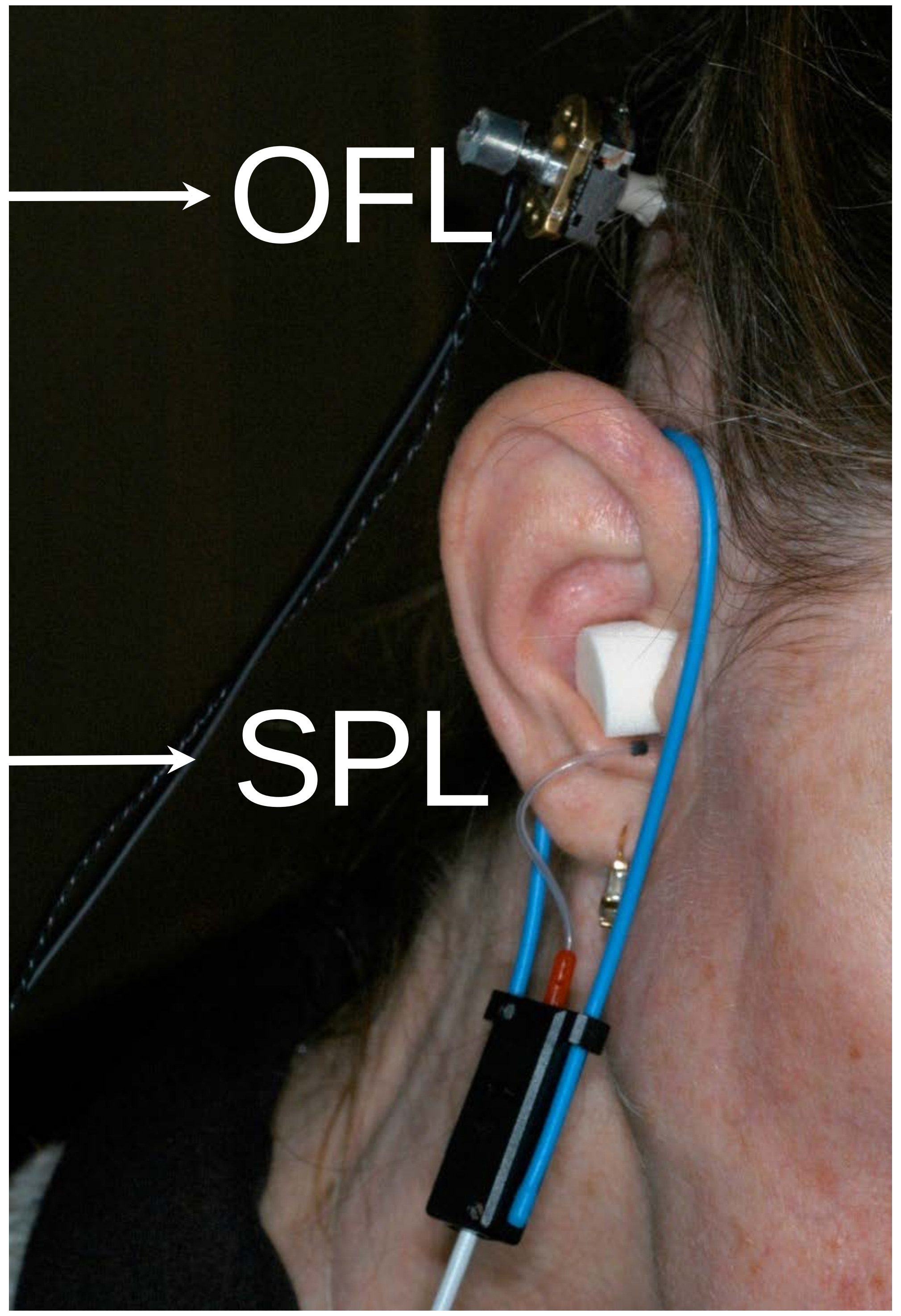
HL → + RETSPL → + RECD → SPL



Bone Conduction

“HL” ⟶ + RETFL ⟶ + RHCD ⟶ OFL

HL ⟶ + RETSPL ⟶ + RECD ⟶ SPL

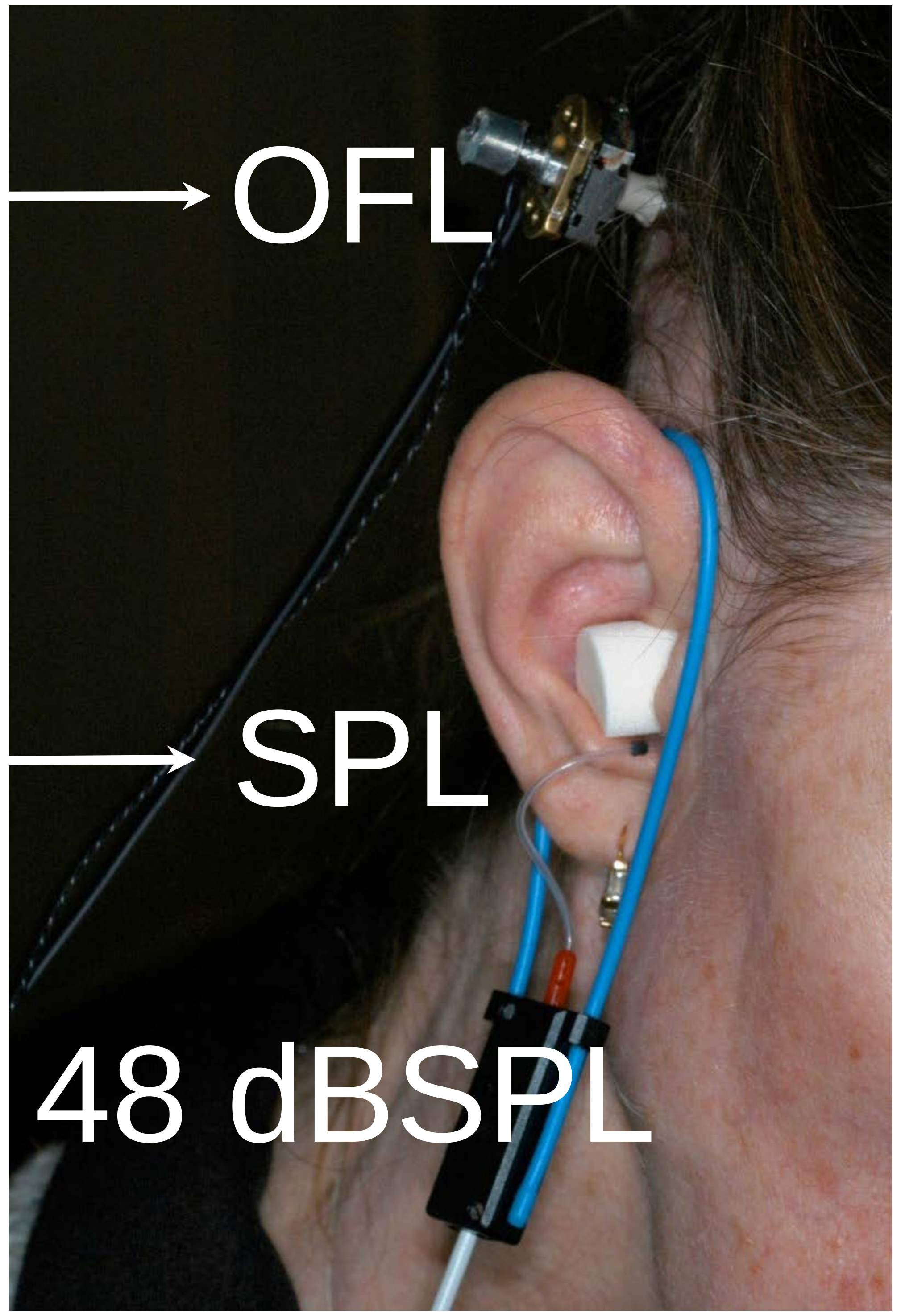


Bone Conduction

"HL" → + RETFL → + RHCD → OFL

HL → + RETSPL → + RECD → SPL

40 HL +3 +5 = 48 dBSPL



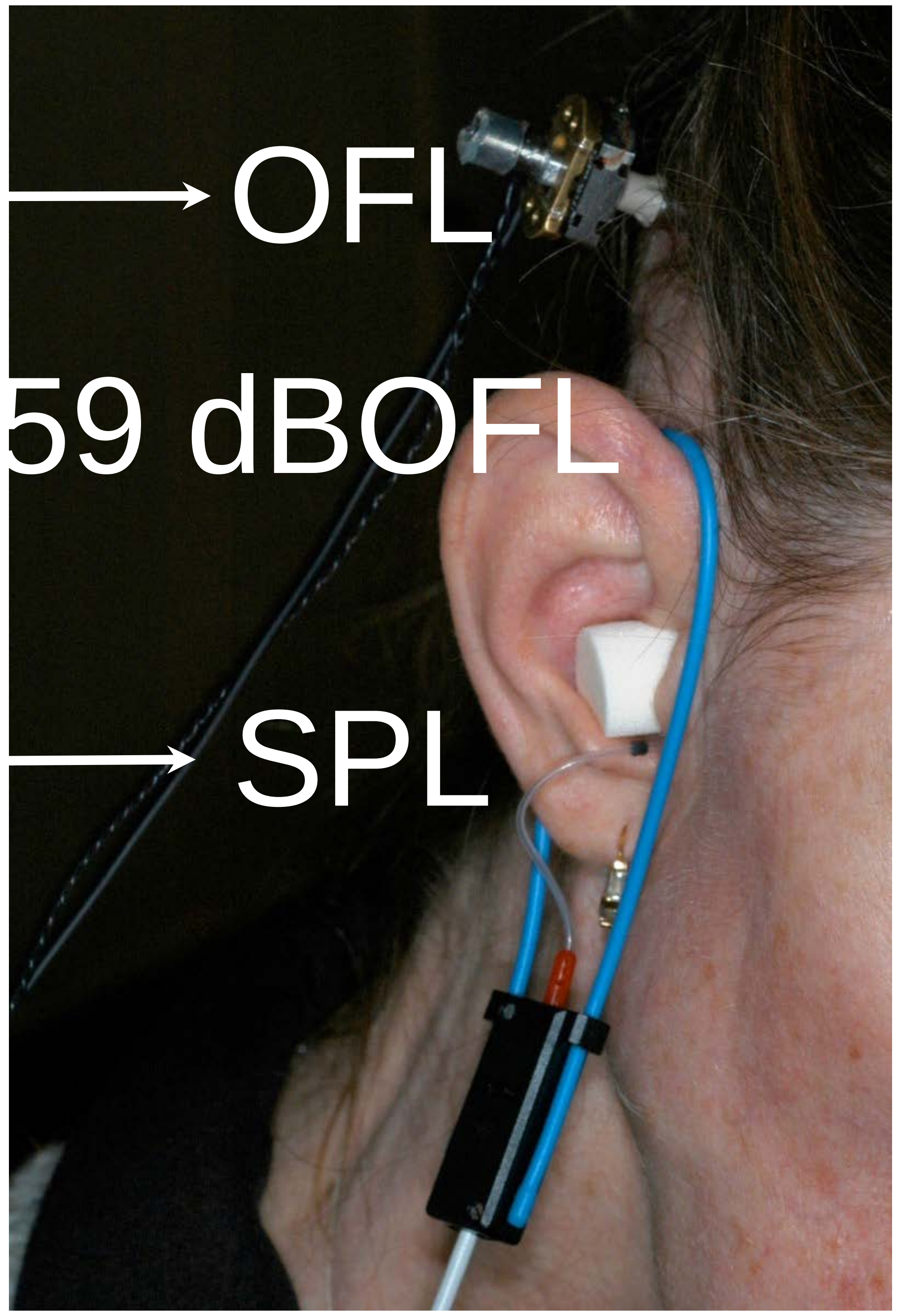
Example
2000 Hz

Bone Conduction

“HL” → + RETFL → + RHCD → OFL

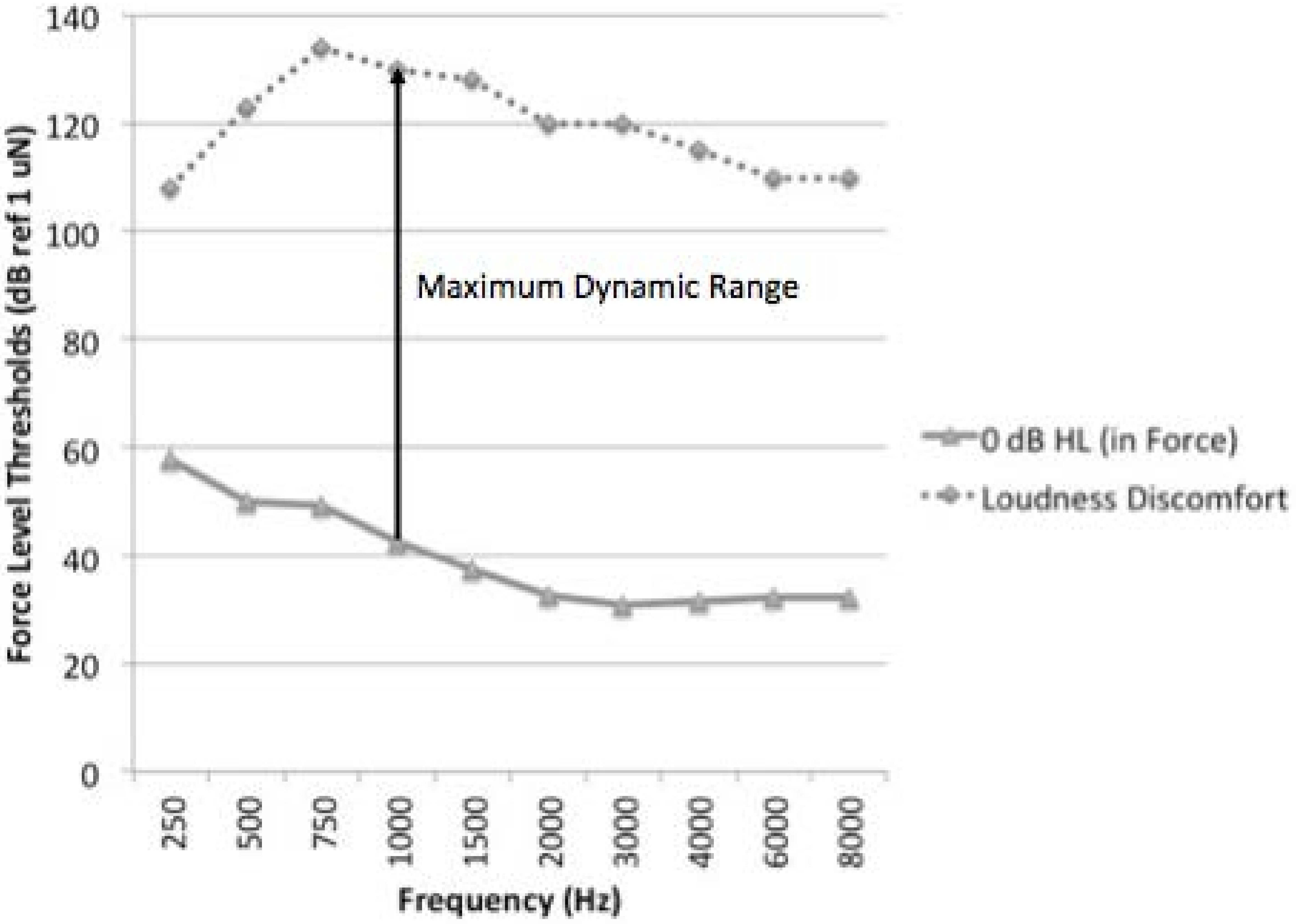
30 “HL” +30 -1 = 59 dBOFL

HL → + RETSPL → + RECD → SPL



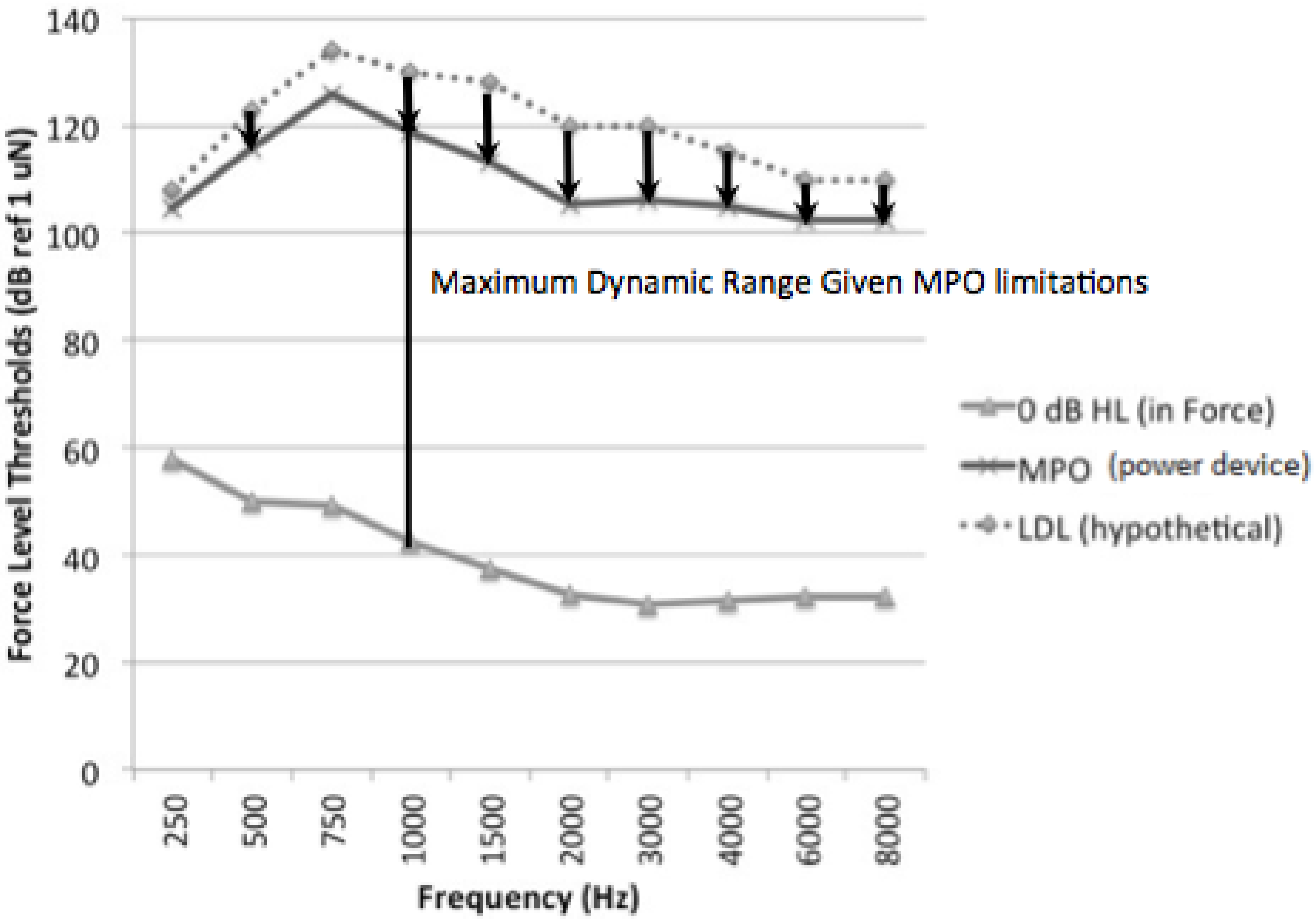
Example
2000 Hz

FLogram



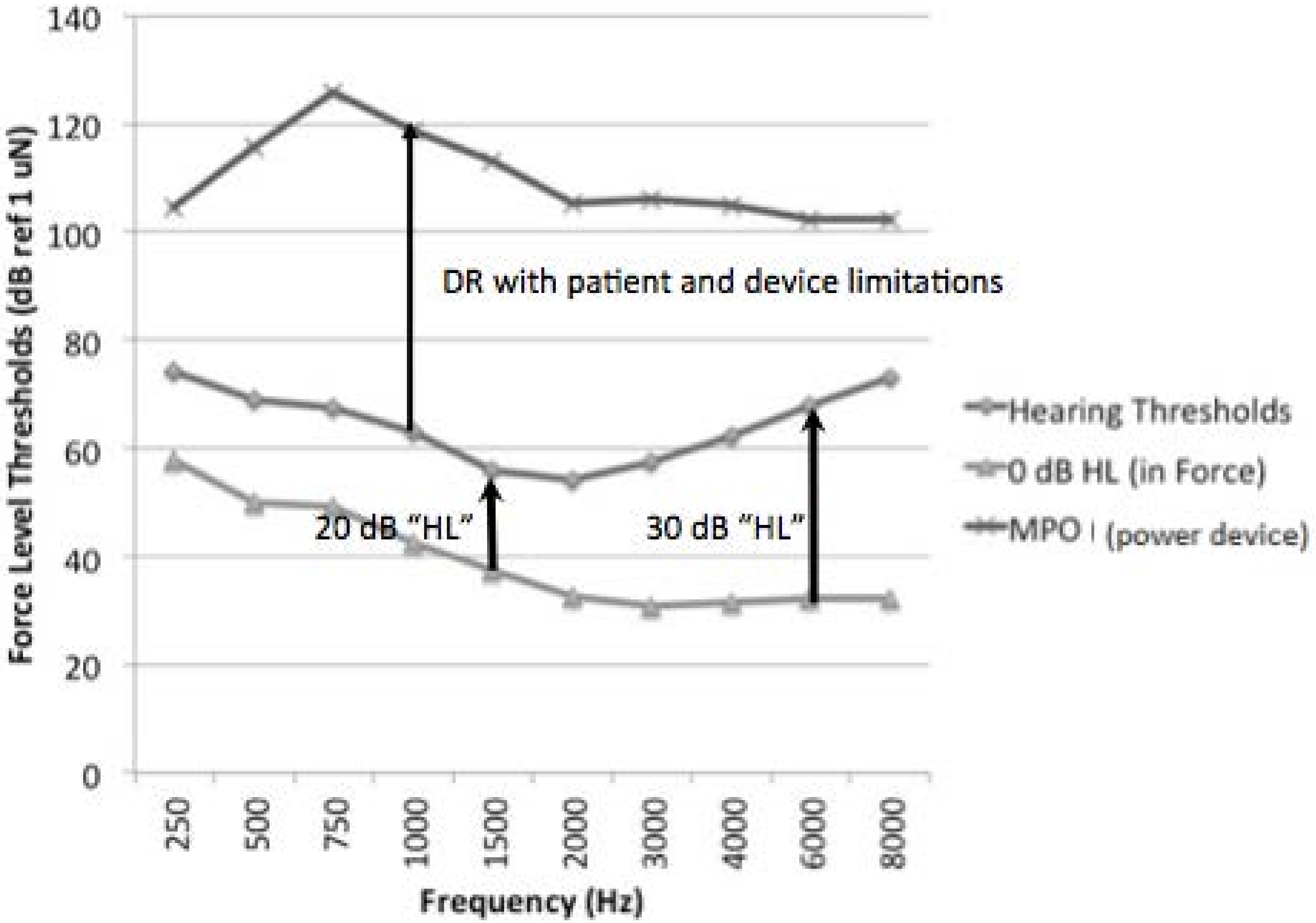
Force Level Thresholds (dB ref 1 uN)
140
120
100
80
60
40
20
0
Maximum Dynamic Range
250
500
750
1000
1500
2000
3000
4000
6000
8000
Frequency (Hz)
0 dB HL (in Force)
Loudness Discomfort

FLogram



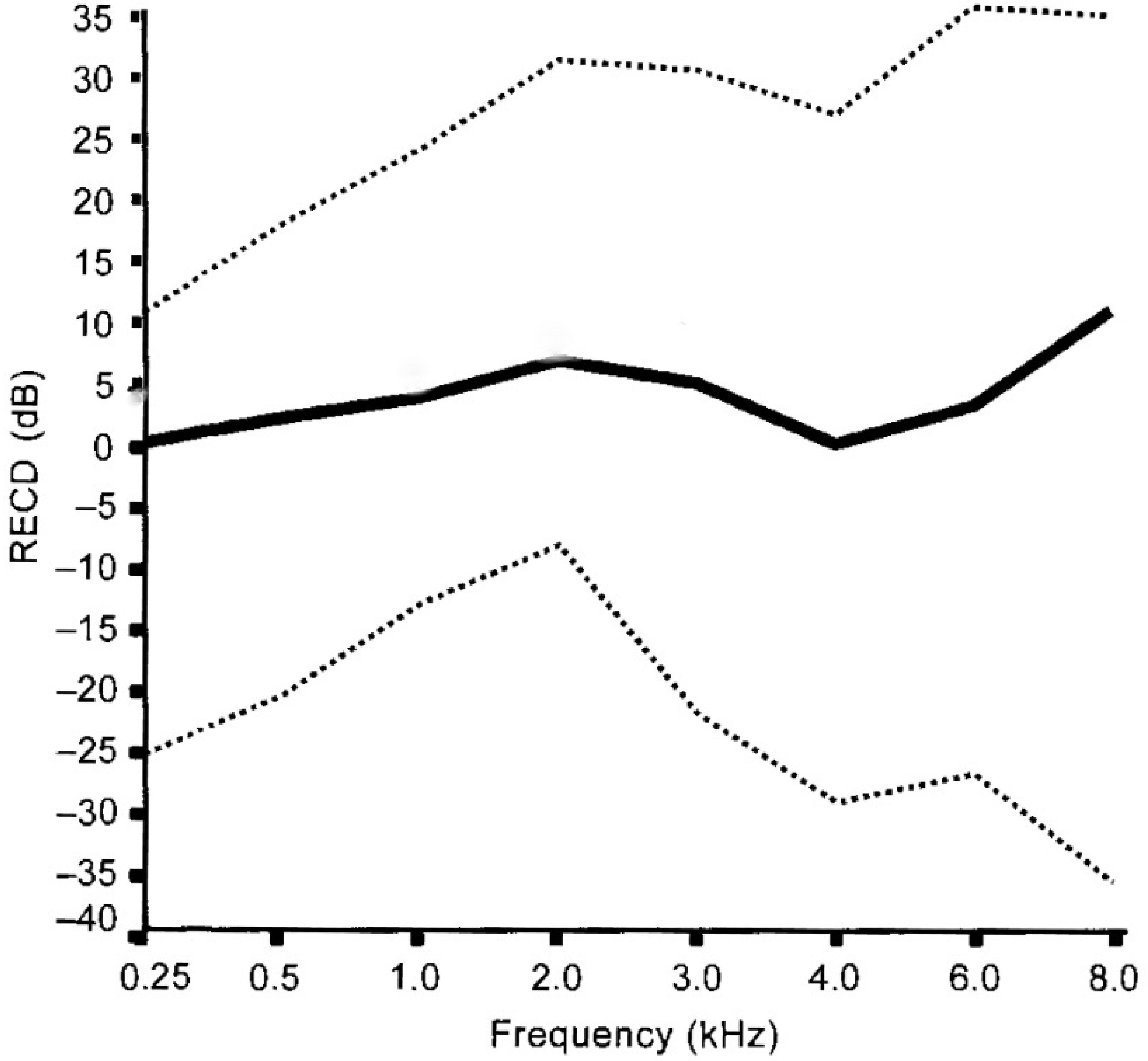
Force Level Thresholds (dB ref 1 uN)
140
120
100
80
60
40
20
0
250
500
750
1000
1500
2000
3000
4000
6000
8000
Frequency (Hz)
Maximum Dynamic Range Given MPO limitations
0 dB HL (in Force)
MPO (power device)
LDL (hypothetical)

FLogram



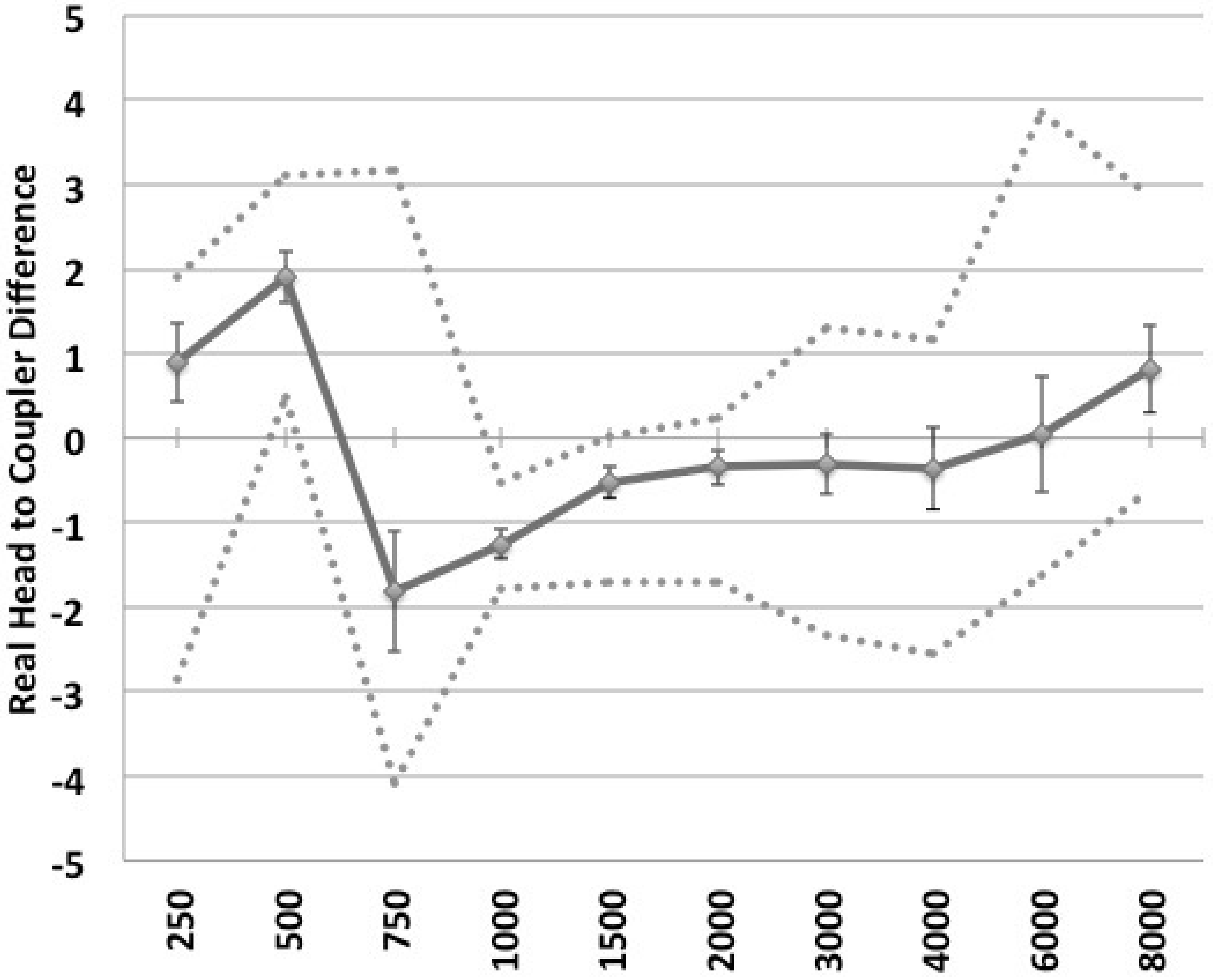
Force Level Thresholds (dB ref 1 uN)
140
120
100
80
60
40
20
0
DR with patient and device limitations
20 dB "HL"
30 dB "HL"
250
500
750
1000
1500
2000
3000
4000
6000
8000
Frequency (Hz)
Hearing Thresholds
0 dB HL (in Force)
MPO (power device)

RECD



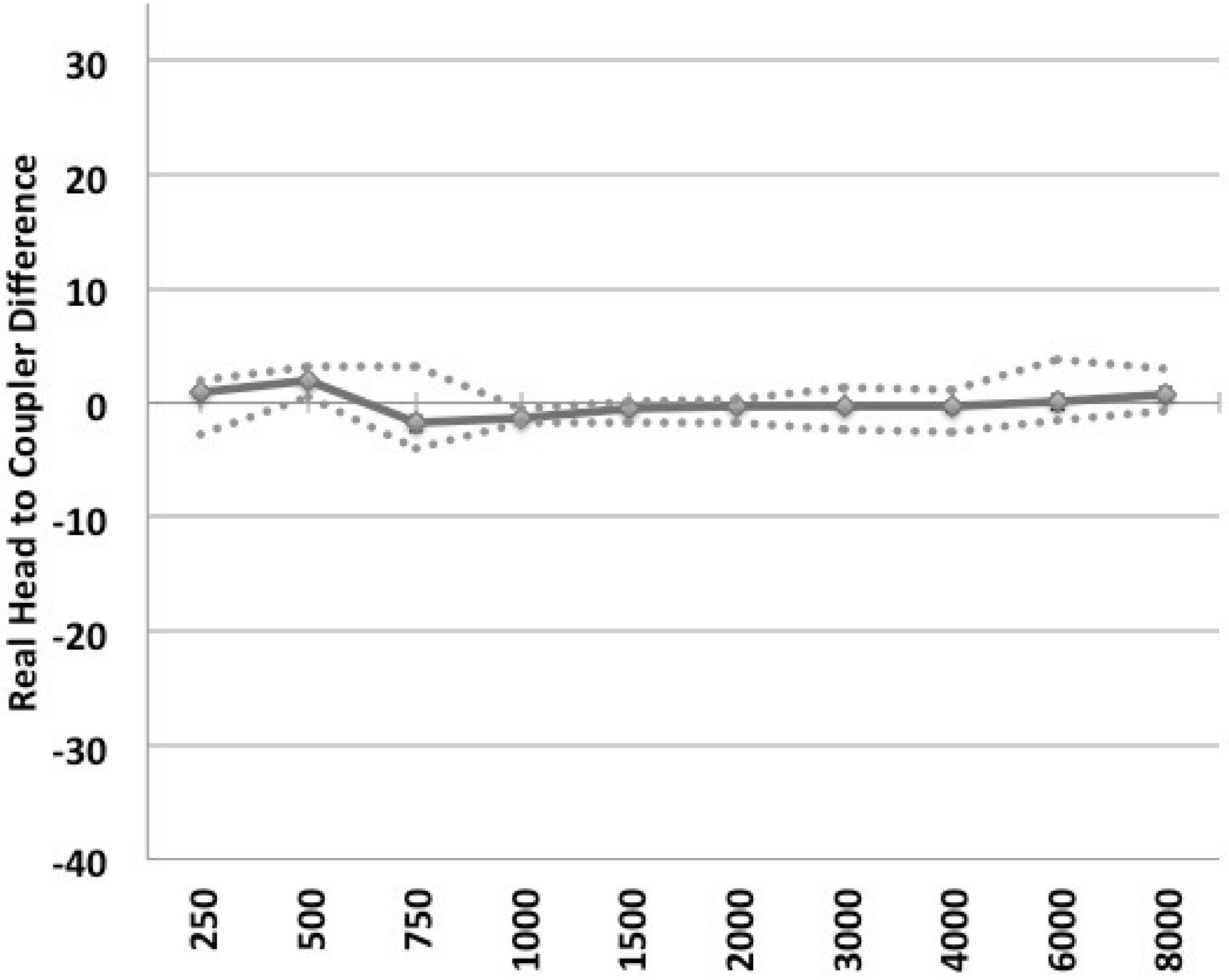
Saunders & Morgan 2003

RHCD



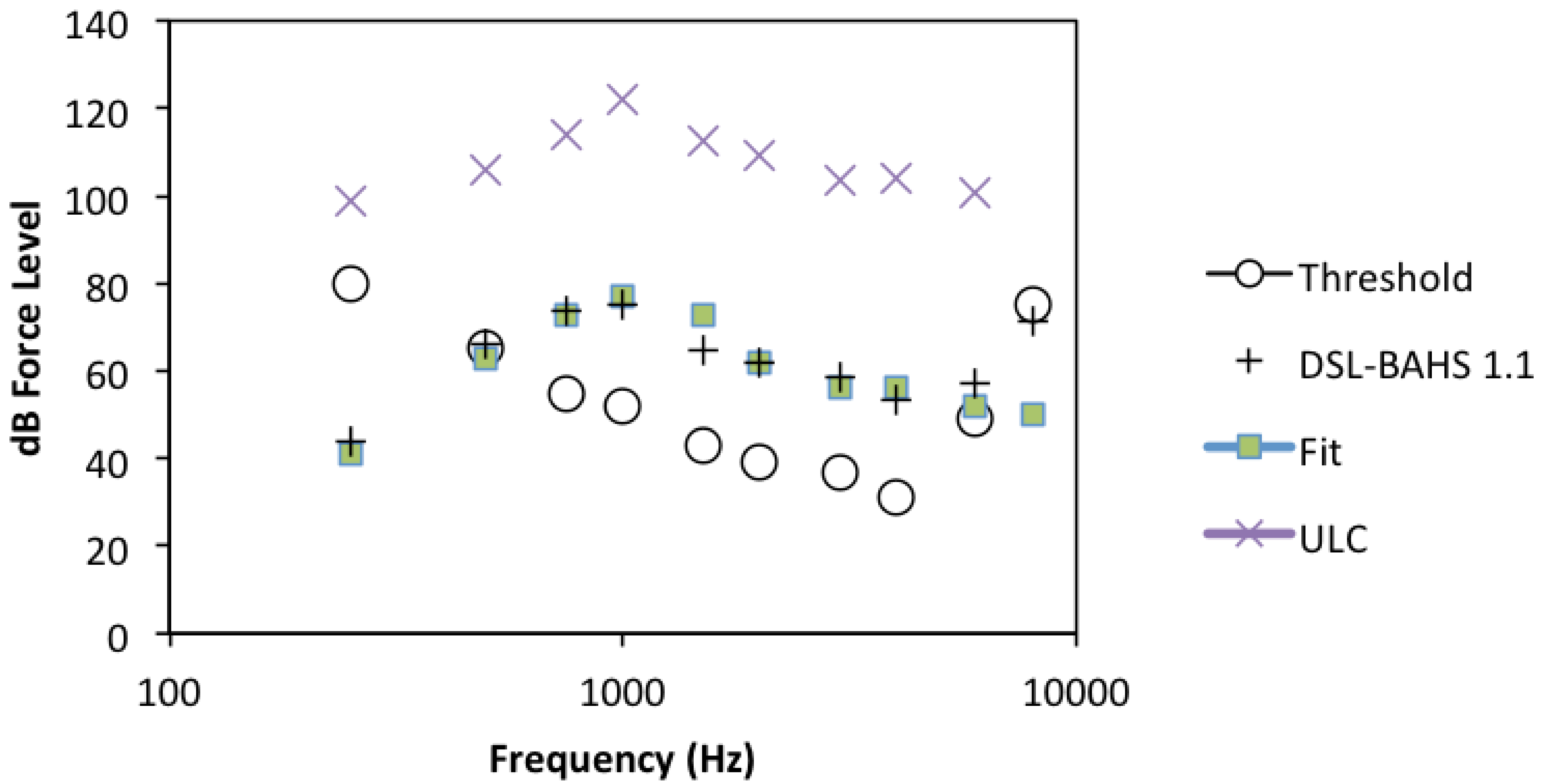
Hodgetts et al. in Review

RHCD on RECD Scale



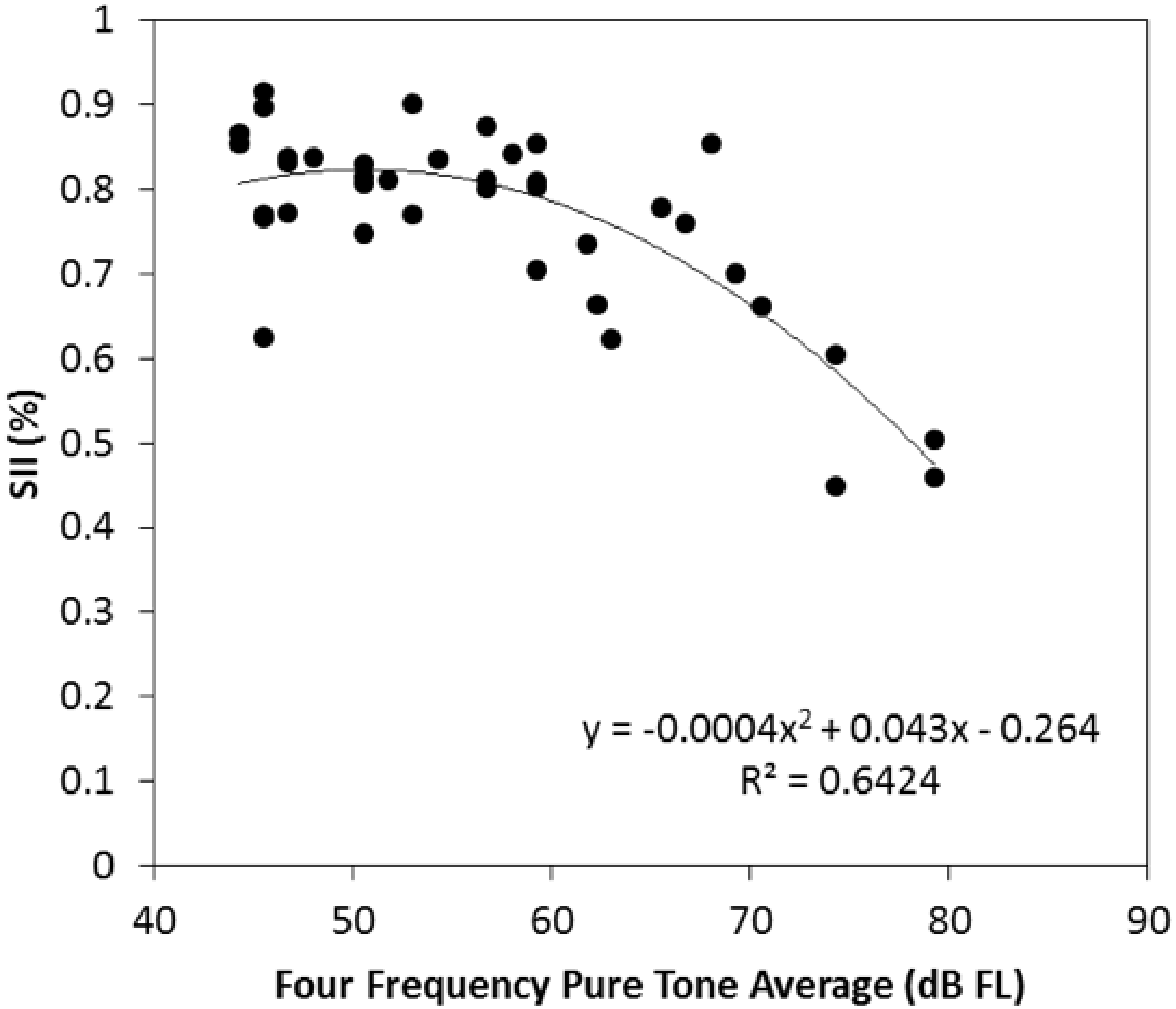
Audibility

- Verification
- Prescription



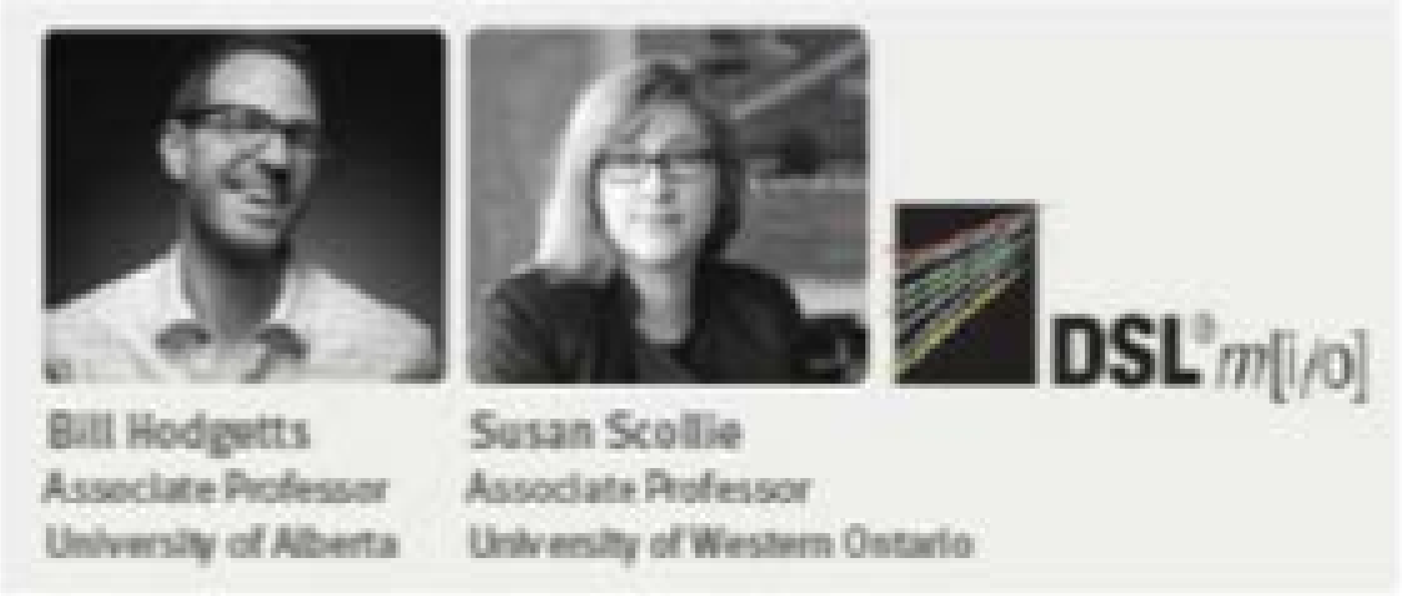
- Device comparisons are suspect in the absence of this info

SII with DSL

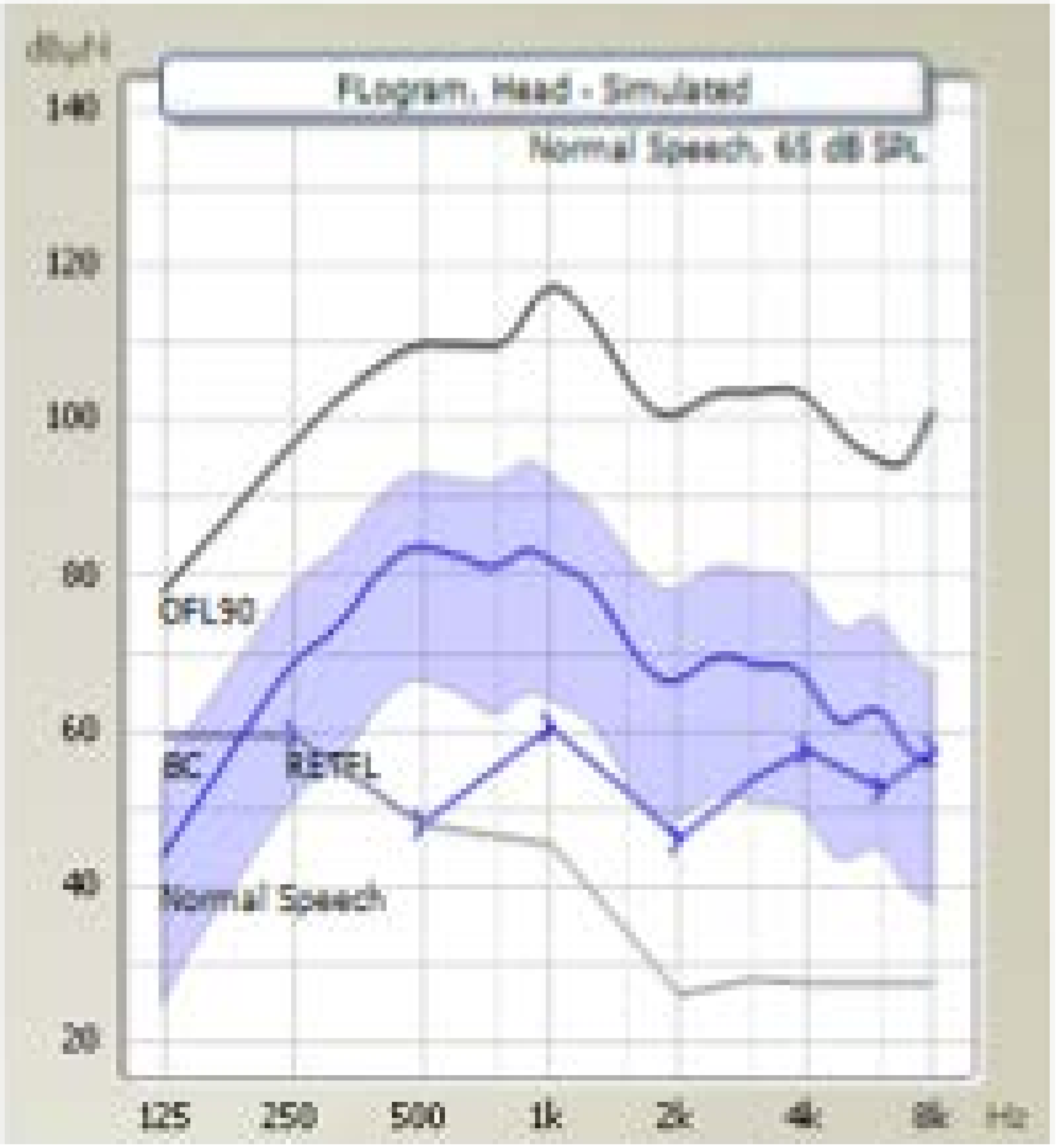


Hodgetts and Scollie, in Review

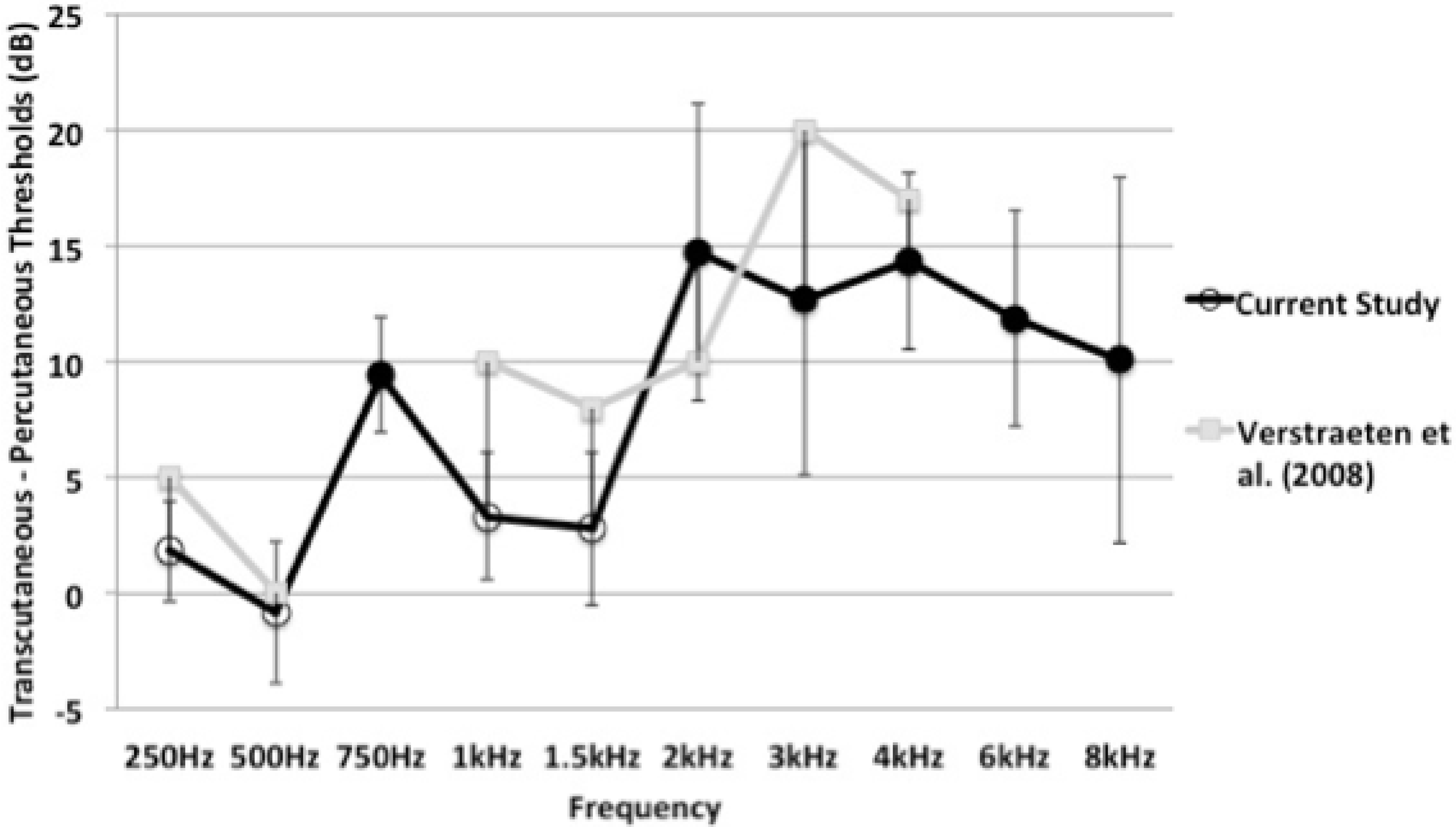
Oticon Medical



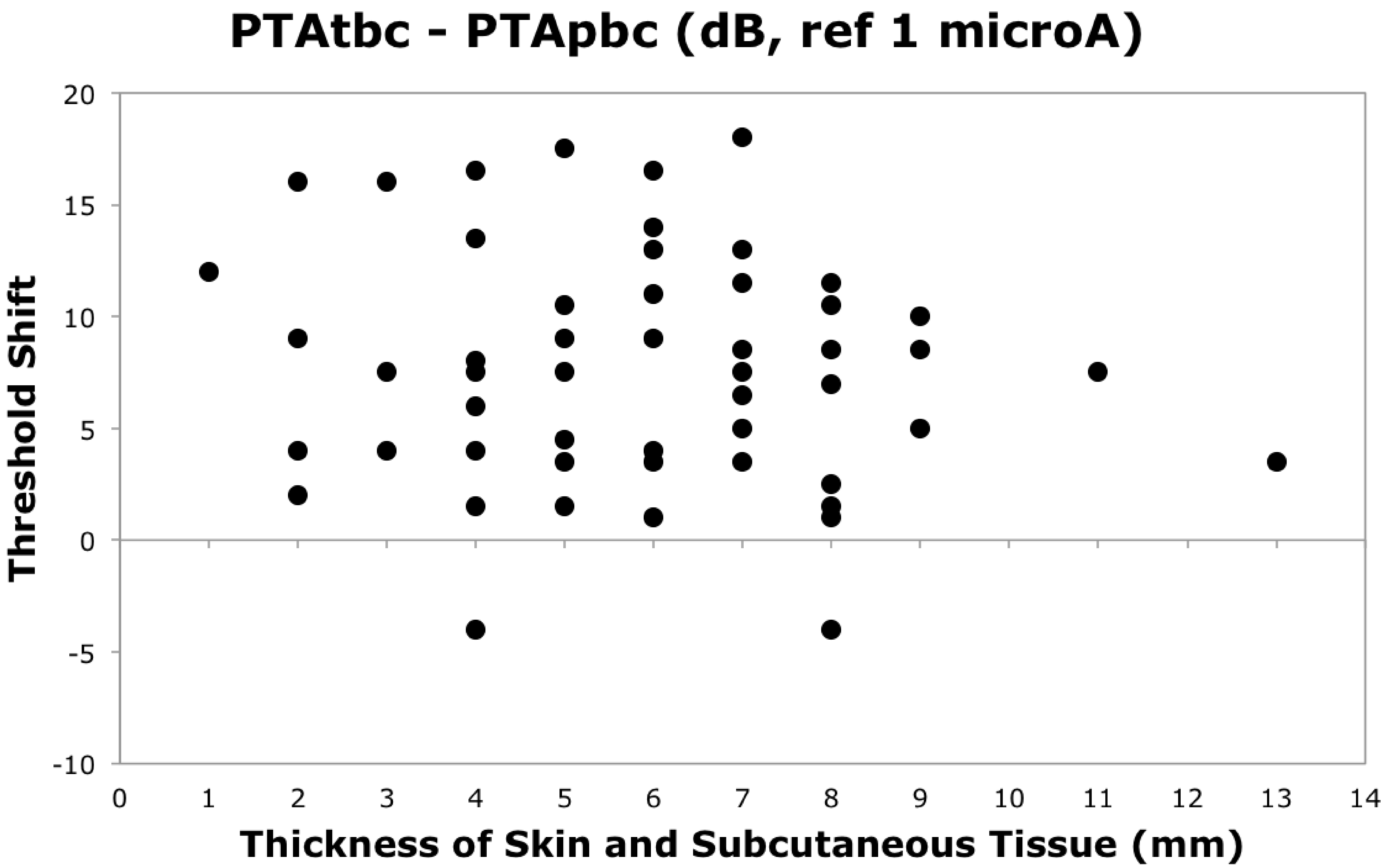
We are in discussions with Cochlear as well



Skin Drive vs Direct Drive



Skin Thickness?



Mylanus et al., 1996

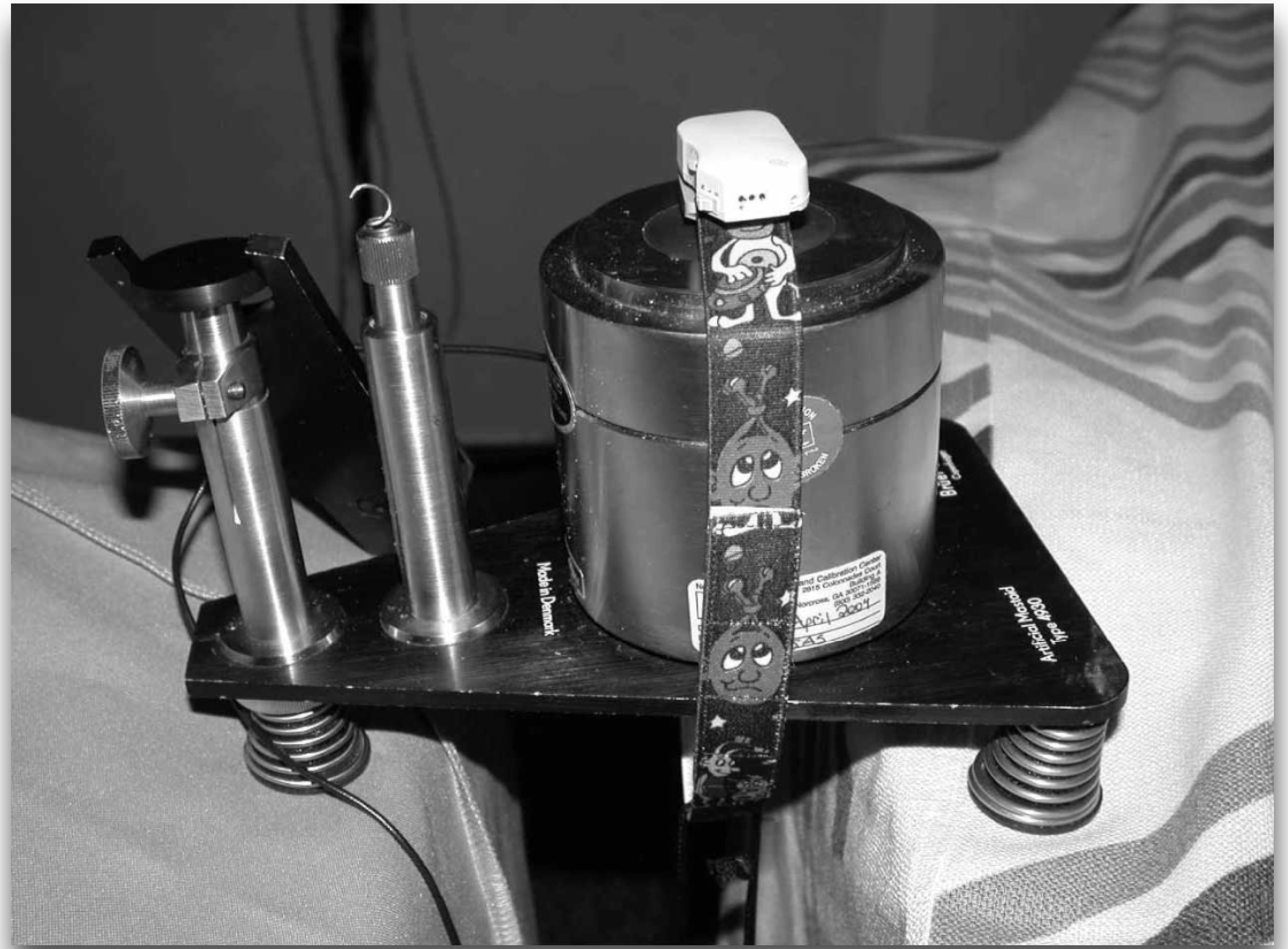
How Tight Should the Softband Be?

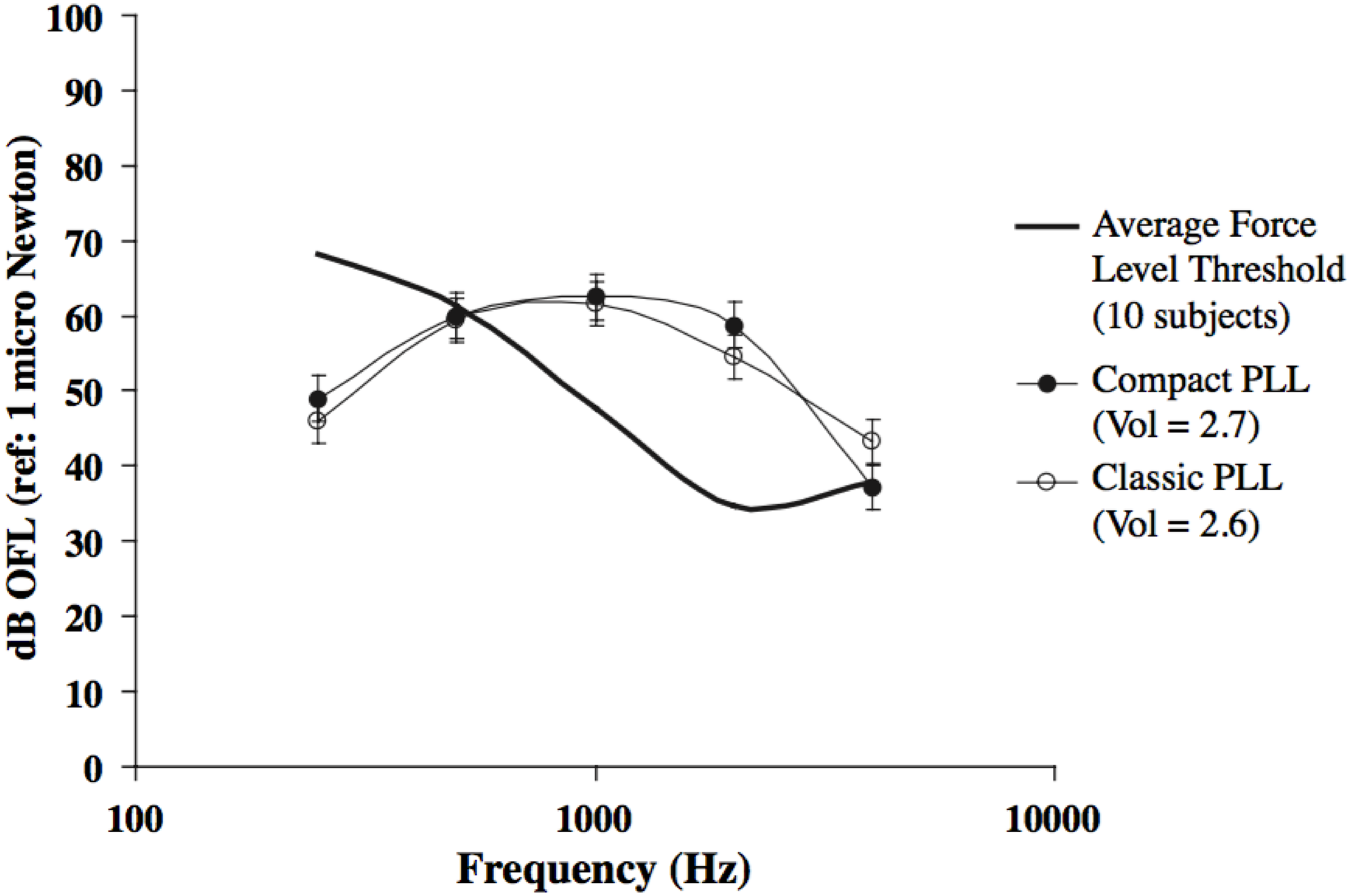
Table 1. Difference in dB OFL (ref: 1 μN) between the 5 N and 2 N contact force conditions. Positive numbers indicate that the OFL was greater for the 5 N condition

		250	*500*	*750*	*1000*	*1500*	*2000*	*3000*	*4000*	*Average*	*SD*
Compact	VC = 1	0	−2	0	2	3	4	4	4	1.88	2.30
	VC = 2	0	0	0	1	3	2	4	4	1.75	1.75
	VC = 3	2	1	2	2	3	4	4	6	3.00	1.60
Classic	VC = 1	0	1	1	2	3	4	3	3	2.13	1.36
	VC = 2	−1	−1	−2	−1	3	3	2	2	0.63	2.07
	VC = 3	−1	−1	0	1	4	5	2	3	1.63	2.26

Hodgetts et al., 2006

Measuring the Softband



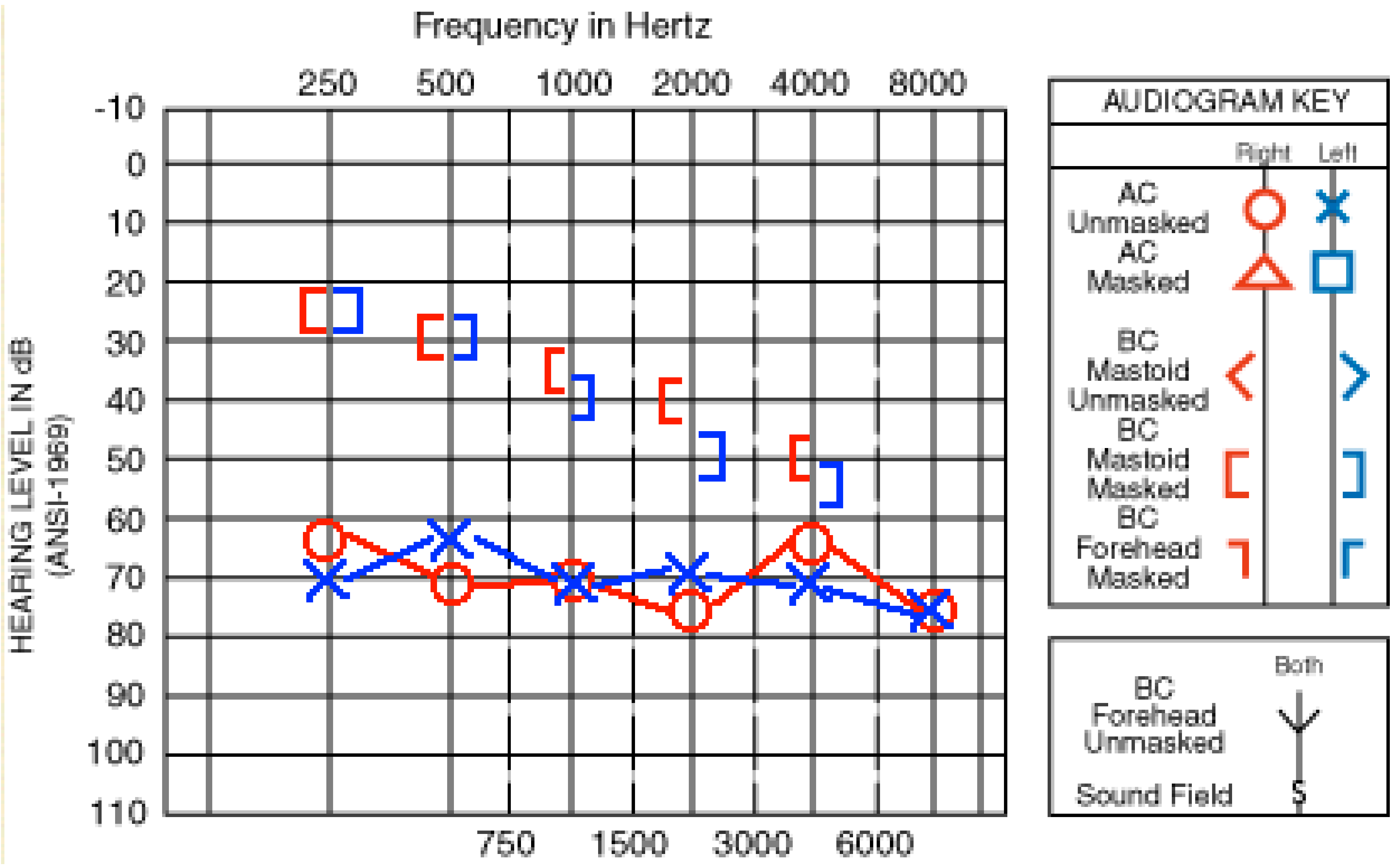


Hodgetts et al., 2006

Case Example

- DW
  - Long standing history of chronic ear disease
  - He has had multiple mastoidectomies and his ears are dry today
  - He’s tried hearing aids in the past, but they always lead to infections and feedback and he’s been advised against their use

DW


Frequency in Hertz
250
500
1000
2000
4000
8000
-10
0
10
20
30
40
50
60
70
80
90
100
110
750
1500
3000
6000
HEARING LEVEL IN dB
(ANSI-1969)
AUDIOGRAM KEY
Right
Left
AC
Unmasked
AC
Masked
BC
Mastoid
Unmasked
BC
Mastoid
Masked
BC
Forehead
Masked
BC
Forehead
Unmasked
Both
Sound Field
S

Power User…

	250	500	750	1000	1500	2000	3000	4000	6000	8000
In-Situ Thresholds	20	20	25	25	30	30	35	40	45	45
RETFLdbc	60	48	48	46	35	26	28	28	27	27
RHCD	1	2	-3	-1	0	0	0	0	1	1
Force Level Thresholds	81	70	70	70	65	56	63	68	73	73
MPO of PPP	100	114	121	118	107	100	101	99	98	97
Dynamic Range	19	44	51	48	43	44	38	32	25	24
Fitting?										

Thank you very much for listening

Any Questions?