Three hearing aid fitting approaches for adults:

Comparing outcome measures of speech intelligibility and subjective rating

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Outline of Presentation

- Introduction
- Background
- Methods
- Results
- Discussion

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Introduction – Aims

1. To examine participants' objective outcome for each of the hearing aid fitting approaches.
2. To explore participants' subjective outcomes for each of the hearing aid fitting approaches.

- First Fit *(QuickFit/ InitialFit)*
- Auto Fit *(AutoREM)*
- Manual Adjustment with REM = "maREM"

Introduction – Hypothesis

H_0: There is no difference between hearing aid fitting approaches in speech intelligibility outcome.

H_1: There is difference between hearing aid fitting approaches in speech intelligibility outcome.

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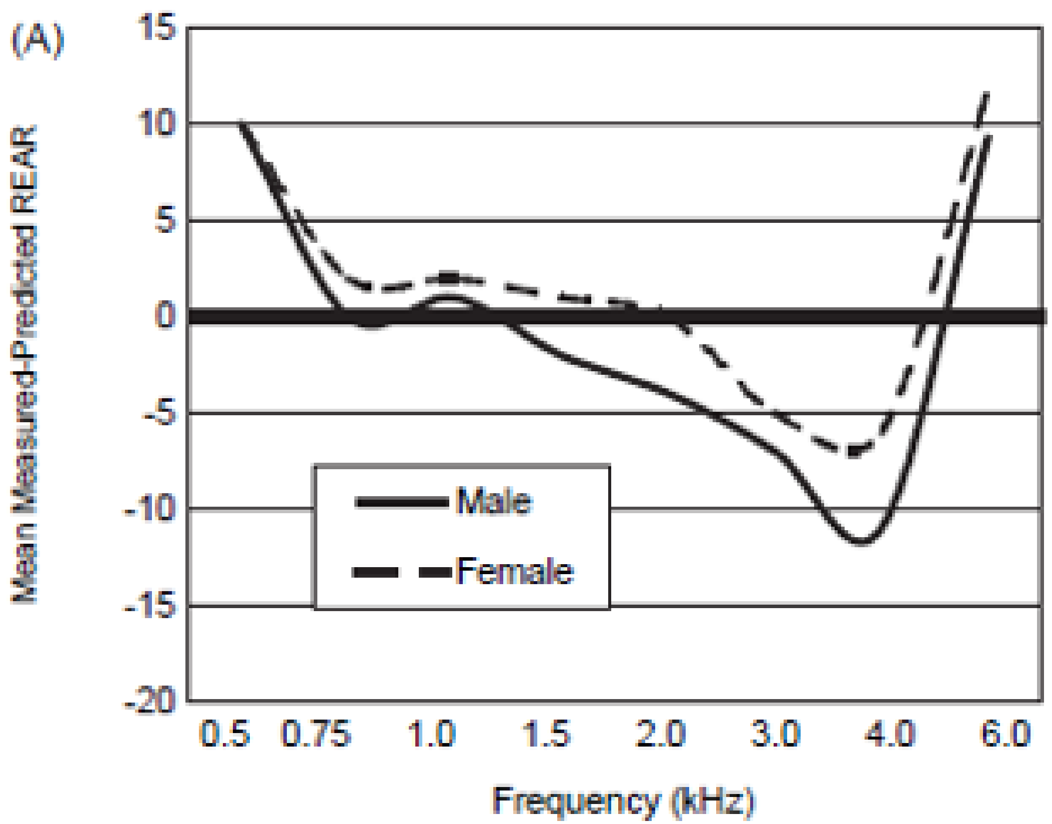
Background – Fitting Approaches

First Fit	maREM	Auto Fit
CORFIG (coupler response for flat insertion gain)	REUG or REUR	REUG

Background – Objective

- Inaccuracy of manufacturers fitting programs' First Fit



Aarts, N.L., & Caffee, C.S. (2005). Manufacturer predicted and measured REAR values in adult hearing aid fitting: accuracy and clinical usefulness. *International Journal of Audiology, 44*(5), 293-301. doi: 10.1080/14992020500057830

Background – Objective

Author	Deviations of First Fit from Target Gain (measured by REM)
Aazh & Caffee (2005)	Up to 88% discrepancy of ±4dB
Aazh, Moore, & Prasher (2012)	71% failed to achieve a match within ±10dB
Aazh & Moore (2007)	65% of fittings failed to achieve ±10dB

Auto Fit – no similar studies conducted

Hearing aid performance

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Hearing aid end-user performance

Background – Subjective

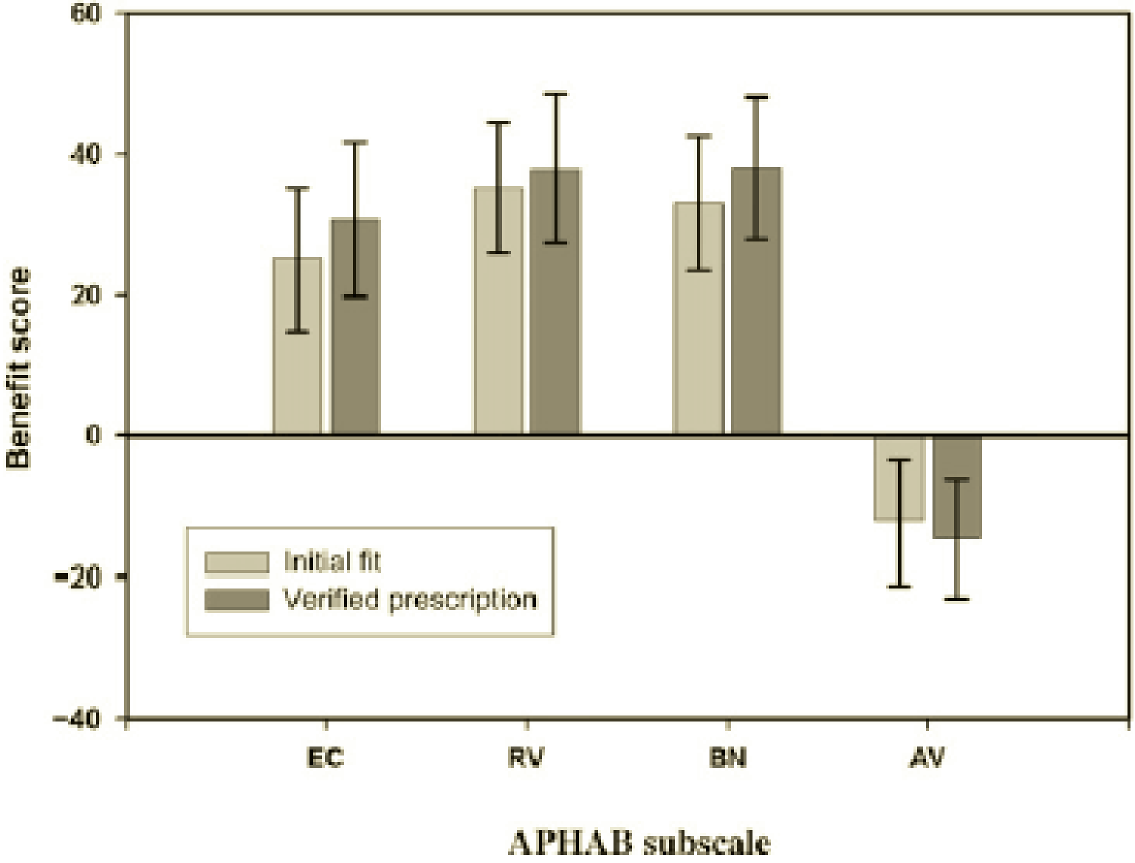

Figure 2. Mean (±2 SE) APHAB benefit scores as a function of type of fitting.

ınd results

st Fit < manual

Abrams, H.B., Chisolm, T.H., McManus, M., & McArdle, R. (2012). Initial-fit approach versus verified prescription: comparing self-perceived hearing aid benefit. *Journal of the American Academy of Audiology, 23*(10), 768-778. doi: 10.3766/jaaa.23.10.3

Outcome Measures of This Study

Objective

- Speech-in-noise test: **Bamford-Kowal-Bench Speech-in-Noise (BKB-SIN)**

Subjective

- Questionnaire: **Speech, spatial, and qualities of hearing scale, 12 questions version (SSQ12)**

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Methods – Inclusion Criteria

- Newly-diagnosed with SNHL
- Of age 21 to 80 years old
- Has no physical or psychological conditions that prevents independent use of hearing aids or ability to respond to self-administered questionnaires
- Has no pre-existing middle ear pathology and/or outer ear anomaly
- Able to communicate via English medium
- Cognitively intact, with Mini Mental State Examination (MMSE) score more than 23

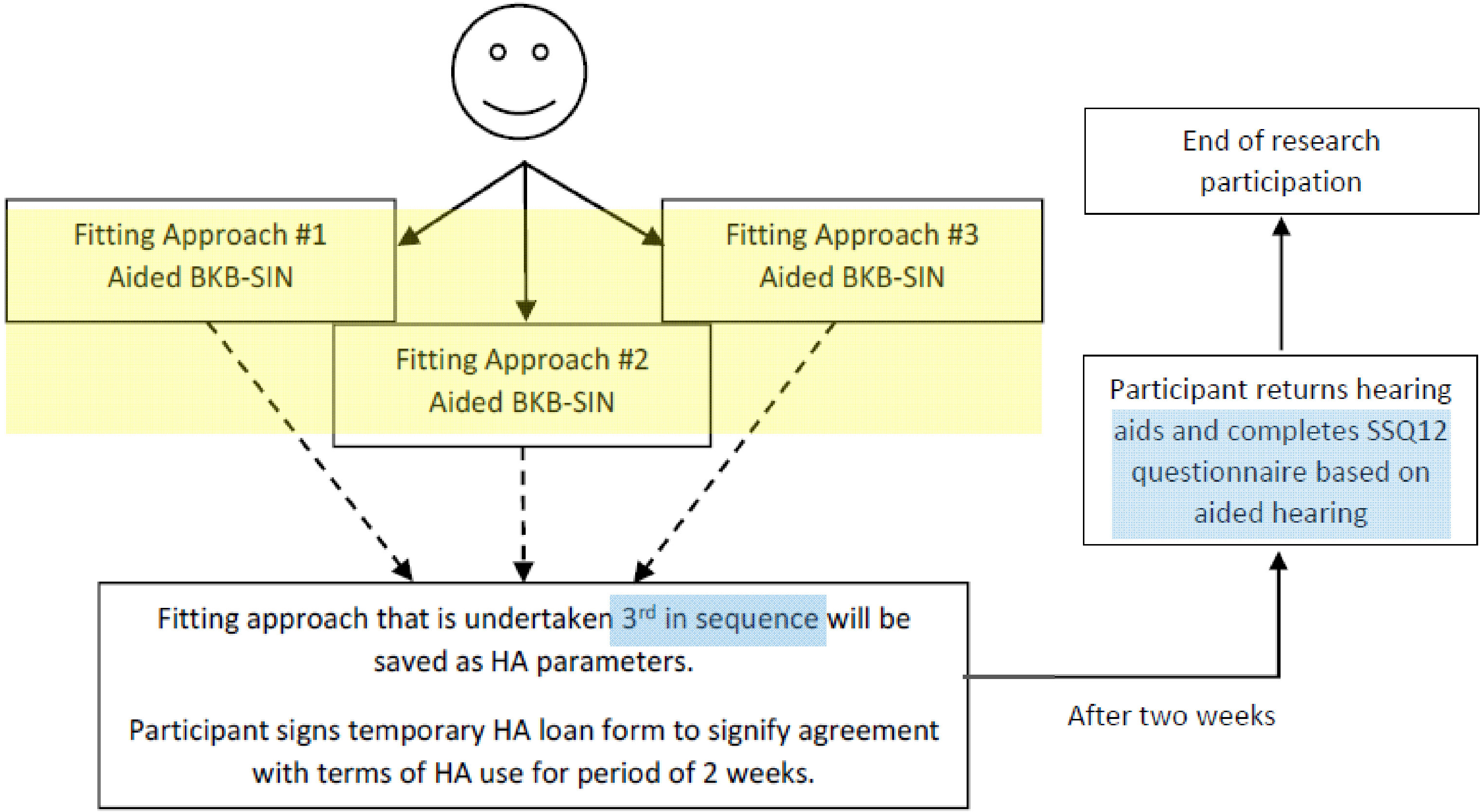
Methods – Exclusion Criteria

- Were pregnant
- Had prior experience with use of hearing aids
- Had previous otolaryngology surgical history
- Had pre-existing otolaryngology medical history, such as but not limited to, Meniere's disease (endolymphatic hydrops), superior canal dehiscence
- Had pre-existing and/or history of mental illness and/or cognitive impairment

Methods – Research Activity

Research activity begins:

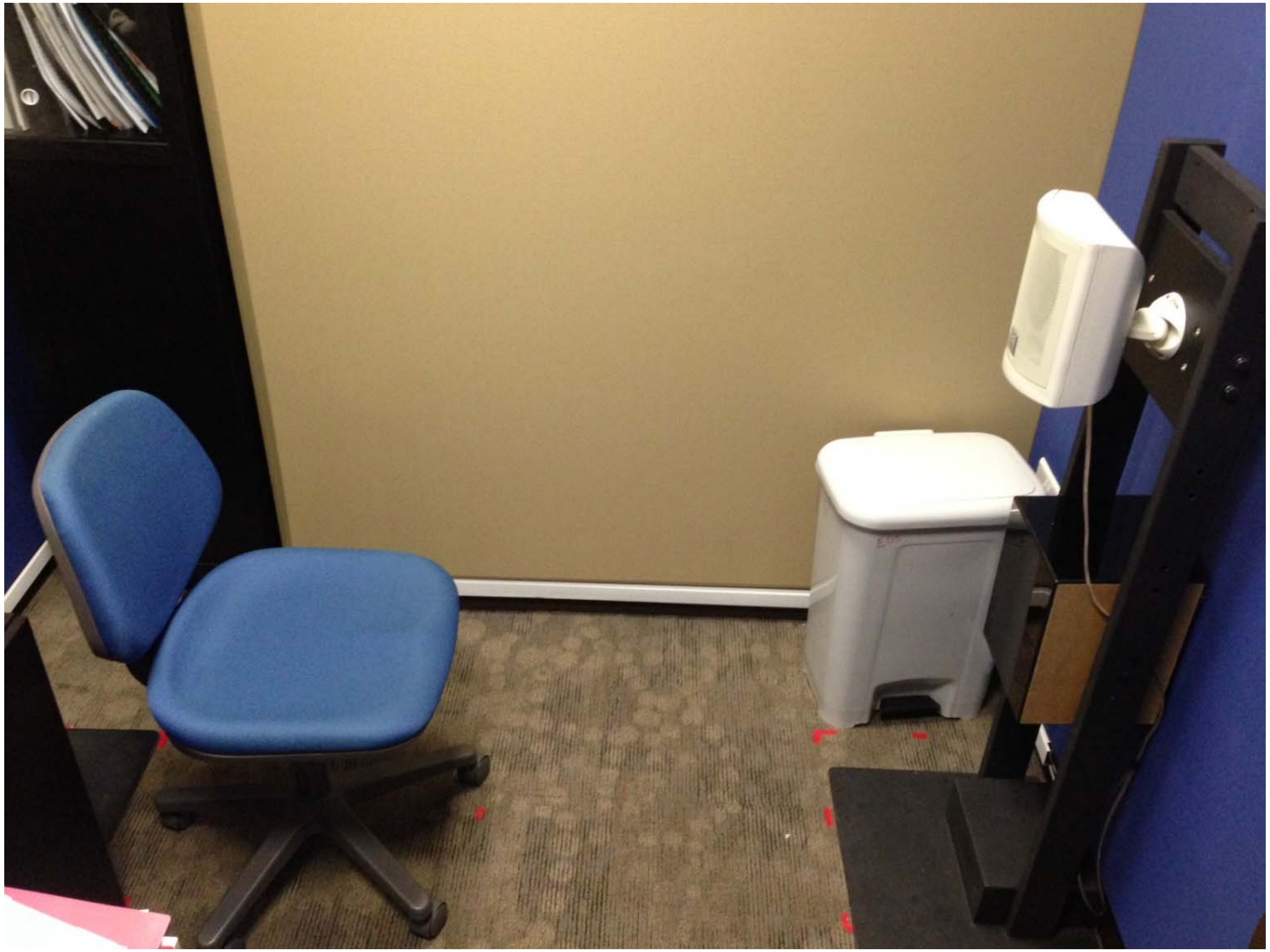
- MMSE screening
- Socio-demographic Profile & Clinical Data
- Questionnaire – SSQ12 (based on unaided hearing)
- Speech test – BKB-SIN (unaided)



Methods – Research Activity

Sequence of fitting approach	Participant recruited in sequence of convenience sampling				
FF → AF → **maREM**	1st	7th	13th	19th	25th
FF → maREM → **AF**	2nd	8th	14th	20th	26th
AF → FF → **maREM**	3rd	9th	15th	21st	
AF → maREM → **FF**	4th	10th	16th	22nd	
maREM → FF → **AF**	5th	11th	17th	23rd	
maREM → AF → **FF**	6th	12th	18th	24th	

Methods – Research Activities



Methods – Research Activities

Methods – Research Activities

Methods – Research Activities

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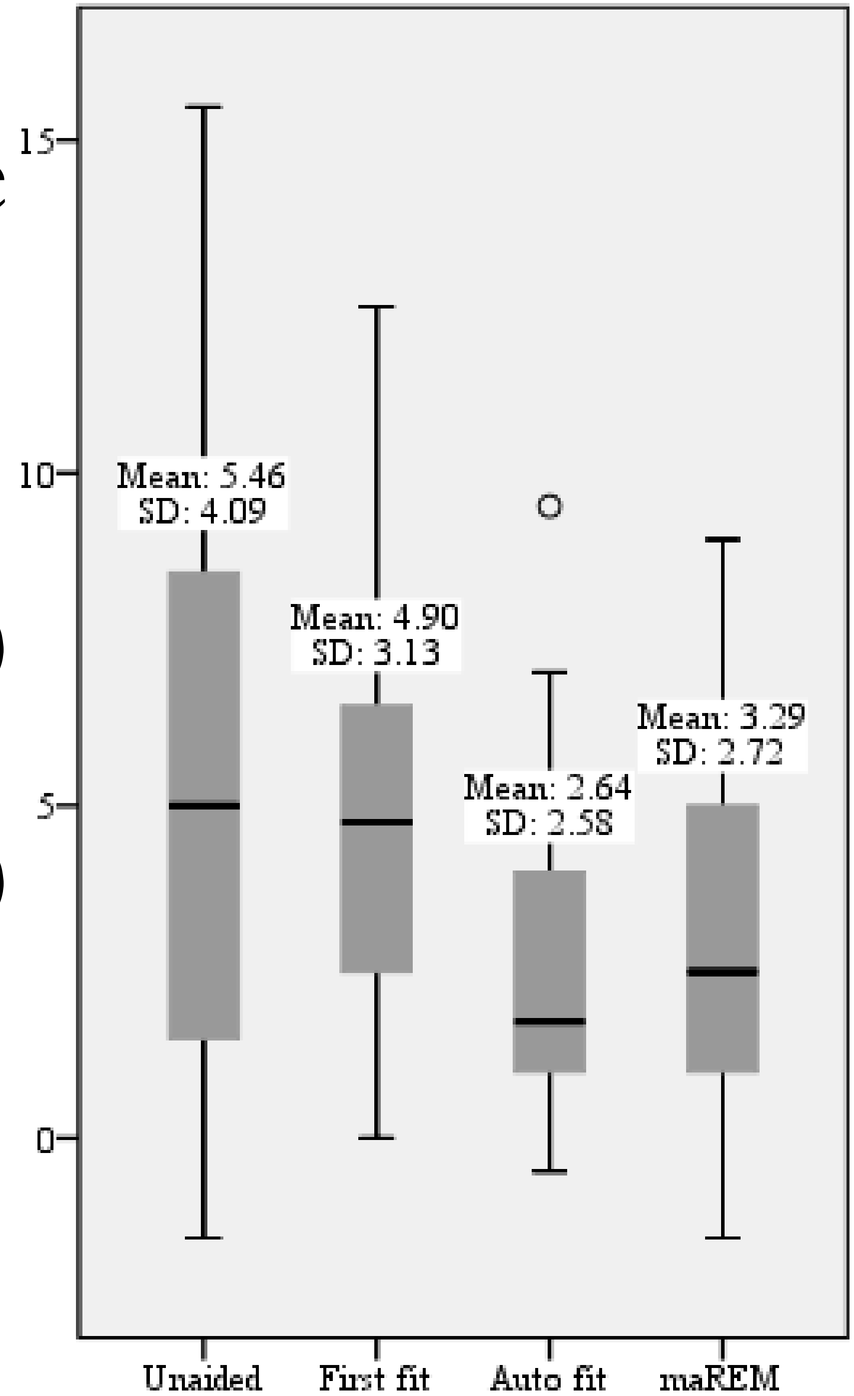
Results

- Data analysis using mixed between-within subjects repeated measure analysis of variance (ANOVA)
- Two parts:
  - Objective findings
  - Subjective findings

Results – Objective

BKB-SIN scores:

- Unaided
  (M = 5.46, SD = 4.09)
- Aided hearing
  (M = 3.61, SD = 2.94)



Results – Objective Findings

Table 6. Comparison of BKB-SIN score within different socio-demographic and clinical characteristics (n = 26)

Factor	Greenhouse-Geisser			
	df	*F*	*p*-value	Partial Eta Squared
Condition of testing	1.71	20.36**	<.000	.610
Condition of testing * Type of ear dome	1.71	2.05	.157	.136
Condition of testing * PTA threshold(s) > 70dBHL	1.71	2.32	.129	.150
Condition of testing * Gender	1.71	2.57	.106	.165
Condition of testing * Age group	3.43	3.61*	.025	.357
Condition of testing * Gender * Age group	1.71	0.87	.419	.062
Error (Condition of testing)	22.27			

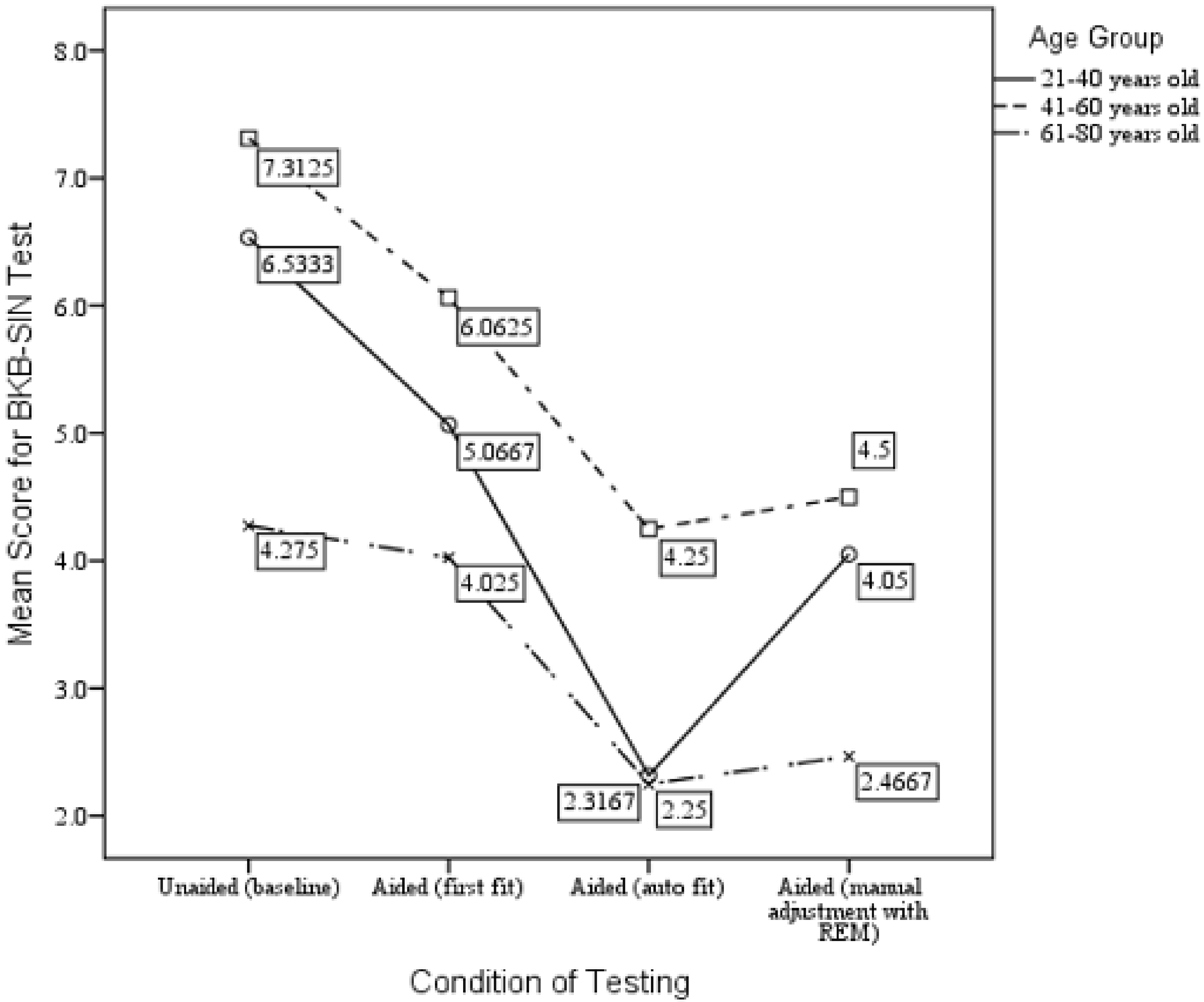
*. Significant level at $p < .05$

**. Significant level at $p < .01$

BKB-SIN: Bamford-Kowal-Bench speech-in-noise

PTA: pure tone audiometry

Figure 2. Profile plot of mean score for BKB-SIN speech test against each condition of testing, delineated by age groups



Results – Objective Findings

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BKB-SIN: Bamford-Kowal-Bench speech-in-noise

PTA: pure tone audiometry

Results – Objective Findings

Table 7. Post hoc comparisons for condition of testing using Bonferroni

	Unaided	Aided (first fit)	Aided (auto fit)	Aided (maREM)
Unaided	1	-1.03	-3.19**	-2.38**
Aided (first fit)		1	-2.16**	-1.35*
Aided (auto fit)			1	0.81
Aided (maREM)				1

Mean differences based on modified population marginal mean are shown

*. Significant level at $p < .05$

**. Significant level at $p < .01$

maREM: manual adjustment with real ear measurement

Statistically significant mean change in BKB-SIN score between unaided and aided condition ($p < .001$) for **auto fit** and **maREM** fitting approaches.

Results – Objective Findings

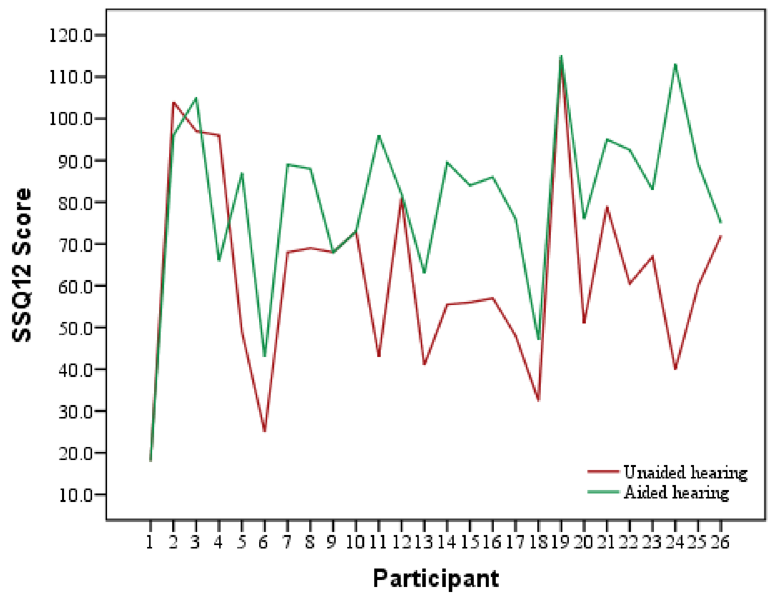
H_0: There is no difference between hearing aid fitting approaches in speech intelligibility outcome.

H_1: There is difference between hearing aid fitting approaches in speech intelligibility outcome.

Results – Subjective Findings

SSQ12 scores:

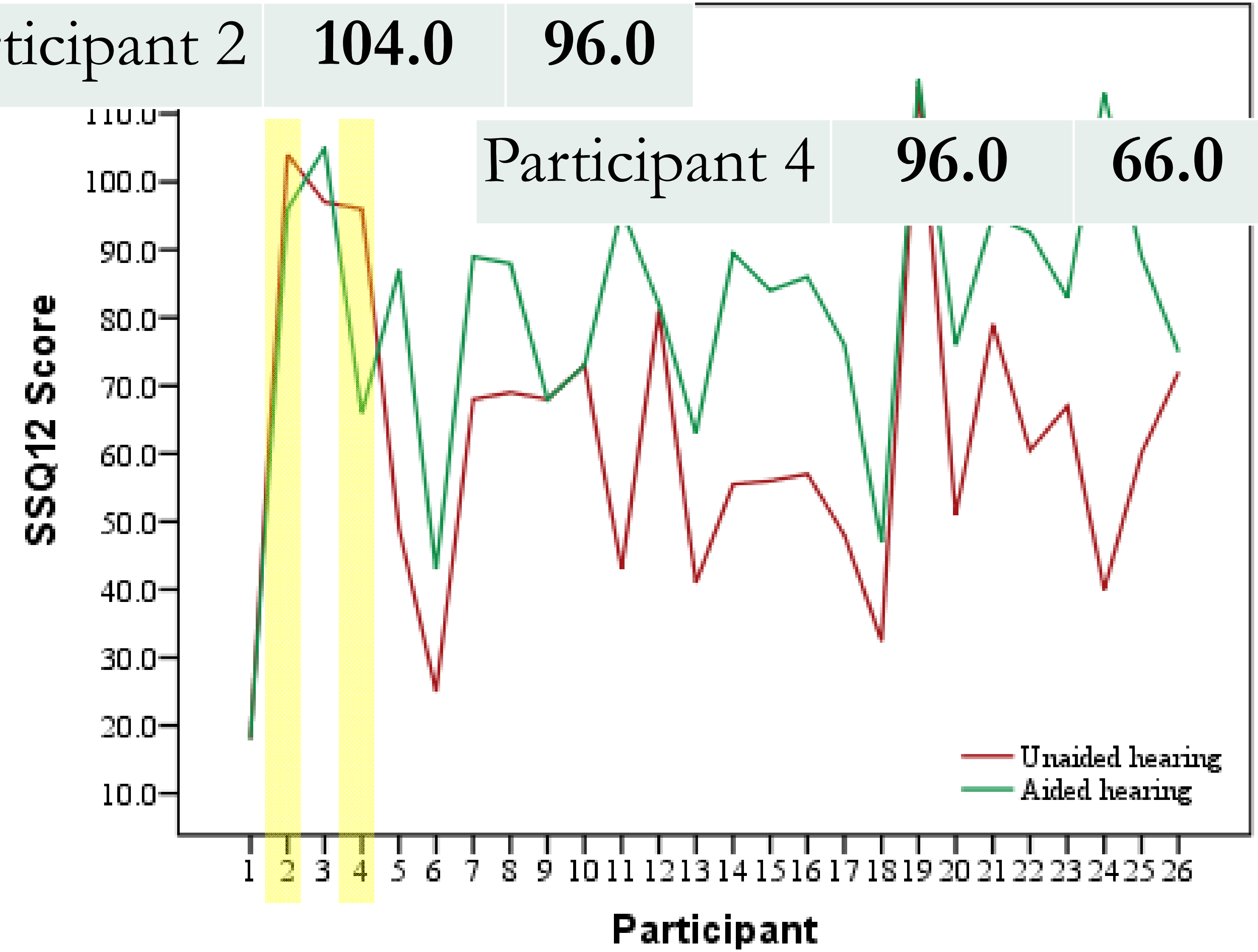
- Unaided hearing (M = 62.48, SD = 23.59
- Aided hearing (M = 80.58, SD = 21.25)



Results – Subjective Findings

Participant 2	**104.0**	**96.0**

Participant 4	**96.0**	**66.0**



Results – Subjective Findings

Table 9. Comparison of SSQ12 score within different characteristics of individual HA use (n = 26)

Factor	**Sphericity Assumed**			
	df	***F***	***p*-value**	**Partial Eta Squared**
Subjective rating	1	12.25	.005*	.527
Subjective rating * Fitting approach	2	.72	.509	.116
Subjective rating * Daily average	2	.05	.948	.010
Subjective rating * Target gain preference	1	4.00	.072	.265
Subjective rating * Fitting approach * Daily average	3	.44	.726	.108
Subjective rating * Fitting approach * Target gain preference	1	.01	.946	.000
Subjective rating * Daily average * Target gain preference	2	.41	.674	.069
Subjective rating * Fitting approach * Daily average * Target gain preference	2	.95	.415	.148
Error (Subjective rating)	11			

* Significant level at $p < .01$

HA: hearing aid

SSQ12: speech, spatial, and qualities of hearing scale 12-questions version

Results – Subjective Findings

Table 10. Post hoc comparisons for fitting approach used to fit HA using Bonferroni

	First fit	Auto fit	maREM
First fit	1	2.56	2.09
Auto fit		1	-0.48
maREM			1

Mean differences based on modified population marginal mean are shown
HA: hearing aids
maREM: manual adjustment with real ear measurement

No significant difference in subjective rating as a function of fitting approach.

Results – Subjective Findings

Abrams, Chisolm, McManus, & McArdle (2012)	**Current Study**
APHAB: verified prescription > initial fit	SSQ12: maREM & auto fit > first fit
No comparison from unaided hearing	Significant improvement from unaided hearing
Preferences: 7 - initial fit 15 - verified prescription	Preferences: 12 - HA at 90% of target 14 - HA at 100% of target

Abrams, H.B., Chisolm, T.H., McManus, M., & McArdle, R. (2012). Initial-fit approach versus verified prescription: comparing self-perceived hearing aid benefit. *Journal of the American Academy of Audiology, 23*(10), 768-778. doi: 10.3766/jaaa.23.10.3

Results – Summary

Objective findings:

Statistically significant improvement in speech intelligibility performance between unaided and aided condition ($p < .001$) for **auto fit** and **maREM** fitting approaches.

Subjective findings:

No significant difference in subjective rating as a function of fitting approach

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Discussion

Objective

Competency in speech test → Aided hearing functional performance

Subjective

Scores in questionnaire → Aided hearing experience

Discussion

Objective

Competency in speech test → Aided hearing functional performance

Meeting target gain optimizes performance

Subjective

Scores in questionnaire → Aided hearing experience

Same optimization is not required to yield positive subjective ratings

Discussion

HA users. Relative to experienced HA users, new HA users preferred progressively less overall gain than prescribed as the hearing loss became more severe. Gain adaptation occurred in new HA users with greater hearing loss, but was not complete 13 months post-fitting, and was not explained by changes in loudness

Keidser, G., O'Brien, A., Carter, L., McLelland, M., & Yeend, I. (2008). Variation in preferred gain with experience for hearing-aid users. *International Journal of Audiology, 47*(10), 621-635. doi: 10.1080/14992020802178722

Discussion

many instances, a careful balance must be maintained between providing the patient with the appropriate gain and frequency response that will allow acclimatization to occur and at the same time avoiding hearing aid settings that will discourage the patient from using amplification. In this article we review several factors related to

"…a careful balance must be maintained between providing the patient with the appropriate gain and frequency response that will allow acclimatization to occur and <u>at the same time avoiding hearing aid settings that will discourage the patient from using amplification</u>…"

Mueller, H. G., & Powers, T. A. (2001). Consideration of auditory acclimatization in the prescriptive fitting of hearing aids. *Seminars in Hearing, 22*(2), 103-124. doi: 10.1055/s-2001-14976

Discussion

If, after adjustment, the patient finds the sound of the hearing aid too loud, use clinical judgement and reduce the acclimatisation/ adaptation level of the aid. Ensure that these changes maintain the frequency shaping that you have set during REM. (If changing the acclimatisation/ adaptation level does not preserve the frequency shaping, then use the gain controls to achieve acceptable loudness levels for the patient.)

"…If, after adjustment, the patient findings the sound of hearing aid too loud, <u>use clinical judgement and reduce the acclimatization/adaption level</u> of the aid…"

British Society of Audiology & British Academy of Audiology. (2007). *Guidance on the use of real ear measurement to verify the fitting of digital signal processing hearing aids*. Retrieved from http://www.thebsa.org.uk/docs/RecPro/REM.pdf.

Discussion

- ✓ New users may prefer lower-than-prescribed gain levels
- ✓ Optimizing prematurely = Risks of new users rejecting HA
- ✓ No standard protocol for fitting *approach* in HAF
- ✓ Speech intelligibility optimized by fitting approach with improved target gain
- ✓ No significant difference in subjective rating as a function of fitting approach

Discussion

- ✓ Auto fit & maREM – similarly effective in optimizing function
- ✓ Optimal fitting = Time-sensitive
- ✓ HA user cooperation & understanding

Discussion

Implications for future practice:

- ✓ <u>Patient education</u>
- ✓ Individualizing care
- ✓ Baseline (unaided hearing)
- ✓ Mediate outcomes to strike a balance

Discussion

Recommendations for future studies:

- Bigger population, using SSQ
- Speech test – Local?
- Different type of HA
- Longitudinal
- Qualitative study?

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Thank you!

Ms. Tan Pay Woon
Ms. Marisel Araw
Ms. Shermin Lim
Mr. Mohammad Hesam Subir
Ms. Grace Yu
Ms. Tan Kah Yee

Dr. Jennifer Martin
Mr. Alan Tseng
Mr. Balakuthalingam Perumal
Dr. Jenny Loo
Ms. Sonia Stasiak
Ms. Imelda Wan

Q&A

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Why NAL-NL2?

The National Acoustic Laboratories of Australia Non-linear version 2 (NAL-NL2) is an update from the purely theoretically-derived version 1 (NAL-NL1), with basis on empirical evidences found since the advent of NAL-NL1 (Keidser, Dillon, Carter, & O'Brien, 2012). **As a prescriptive algorithm, NAL-NL2 maximizes speech intelligibility while keeping the overall loudness to no more than that perceived by a normal-hearing person listening to the same sound** (Keidser et al., 2012; Keidser, Dillon, Flax, Ching, & Brewer, 2011). This **aligns well with the speech intelligibility outcome measure** of this study, so NAL-NL2 was used as the fitting algorithm for all hearing aid fittings.

Why SSQ12? Why not APHAB?

- APHAB unsuitable to be administered for eliciting info for baseline (unaided) hearing & aided hearing → Pre- & post-intervention

Why speech intelligibility?

- Four levels of auditory processing by Erber (1982):
  - Awareness
  - Discrimination
  - Recognition
  - Comprehension

- Real-world situations

Why BKB-SIN?

- Speech-in-noise: to predict real-world performance
- Adapted to 50dBHL?

> Evaluation of speech recognition for rehabilitation purposes should include presenting stimuli at an average conversational level (50 dB HL) to demonstrate to the patient the effects of reduced audibility and potential for improvement with amplification. It may also be helpful to deter-

- From another study

Why do speech test at one seating?

Speech recognition in noise using bilateral open-fit hearing aids: The limited benefit of directional microphones and noise reduction

The test subjects had no prior experience with HAs, and SRTs were obtained for all conditions without any time for adapting to the HAs. An acute testing procedure was considered appropriate, because more acclimatization to some of the test conditions would have put those conditions in favor. Thus, all tested conditions, except the unaided, represented unfamiliar listening situations for all subjects. The study was conducted using one specific HA model (Phonak Exélia Art M) and the fittings were performed using the

Magnusson, L., Claesson, A., Persson, M., & Tengstrand, T. (2013). Speech recognition in noise using bilateral open-fit hearing aids: The limited benefit of directional microphones and noise reduction. *International Journal of Audiology, 52*(1), 29-36. doi: 10.3109/14992027.2012.707335

What is the demographic profile? Does it matter if demographics vary?

Table 4. Sample profile (*n* = 26)

Socio-demographic	***n* (%)**	**Clinical characteristics**	***n* (%)**
Gender		PTA threshold(s) > 70 dBHL	
Male	14 (53.8)	0	14 (53.8)
Female	12 (46.2)	≥ 1	12 (46.2)
Age group		Type of ear dome used for HAs	
21-40	8 (30.8)	Open-fit	21 (80.8)
41-60	6 (23.1)	Closed-fit	5 (19.2)
61-80	12 (46.2)		
Education			
Primary	1 (3.8)		
Secondary	5 (19.2)		
Tertiary	12 (46.2)		
University	8 (30.8)		
Race			
Chinese	23 (88.5)		
Malay	1 (3.8)		
Indian	2 (7.7)		

PTA: pure-tone audiometry
HAs: hearing aids

Clinical profile, on the contrary, has more critical impact on intervention studies (Poulsen et al., 2009)

What is the participants' breakdown for each factor? (Subjective Findings)

	Fitting approach for home use					
	First fit		Auto fit		maREM	
HA use daily average	Participant number					
0-2 hours	9, 12	15	2, 8, 17	5, 23		1, 4, 7, 16, 25
3-5 hours	21	6	20	11	13, 19, 22	
≥ 6 hours	3	18, 24	26	14		10
Participant's target gain preference	90%	100%	90%	100%	90%	100%

Results – Subjective Findings

	SSQ12 unaided	SSQ12 aided	Fitting approach	HA use daily average	Target gain preference
Participant 2	**104.0**	**96.0**	auto fit	0-2 hours	90%
Participant 4	**96.0**	**66.0**	maREM	0-2 hours	100%

SSQ

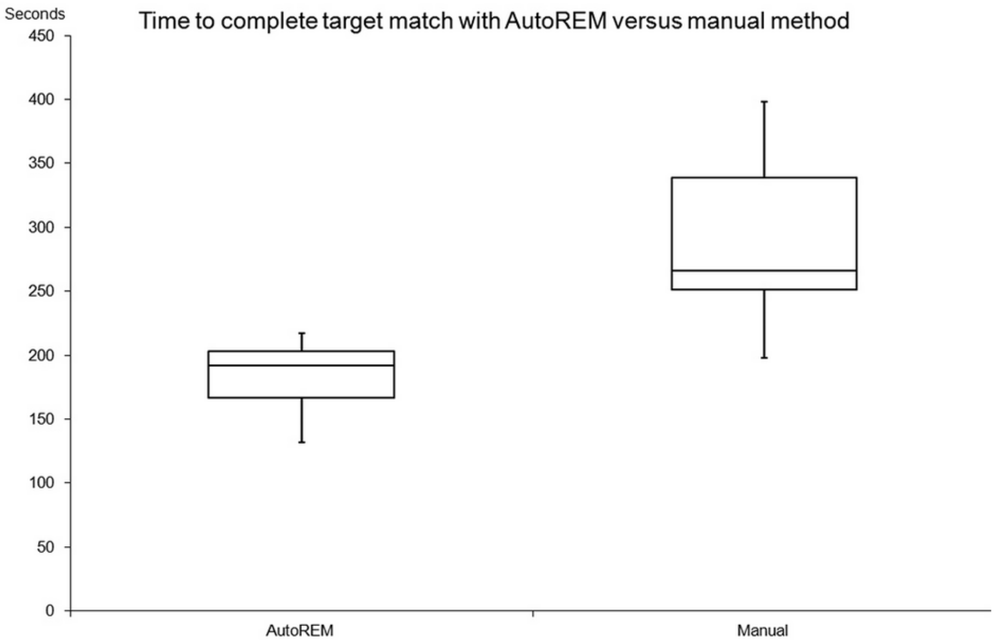
The "Speech, Spatial, and Qualities of Hearing" (SSQ) questionnaire was developed by Stuart Gatehouse and William Noble. It is designed to measure self-reported auditory disability across a wide variety of domains, reflecting the reality of hearing in the everyday world. It covers:

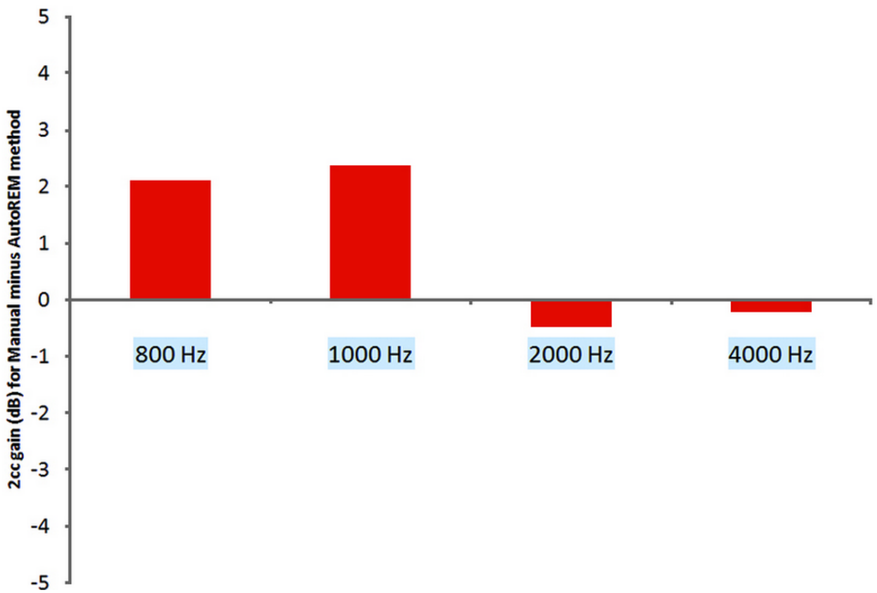
- hearing speech in a variety of competing contexts;
- the directional, distance and movement components of spatial hearing
- segregation of sounds and attending to simultaneous speech streams;
- ease of listening;
- the naturalness, clarity and identifiability of different speakers, different musical pieces and instruments, and different everyday sounds.

http://www.ihr.mrc.ac.uk/products/display/ssq

Background – Objective

- Auto Fit – no similar studies done





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http://www.hearingreview.com/2014/09/fast-easy-fitting-verification-integrated-real-ear-measurement/

Literature Review

Original Article

International Journal of Audiology 2005; 44:293–301

Manufacturer predicted and measured REAR values in adult hearing aid fitting: Accuracy and clinical usefulness

Discussion

Overall, the results of this study indicate that for the hearing aid model, hearing loss configurations, and input levels used here, the real-ear aided responses predicted by the manufacturer's fitting software were inaccurate for almost all subjects. The difference between actual and predicted REAR values was greater for males than females (see Tables 3, 4 and 5). This

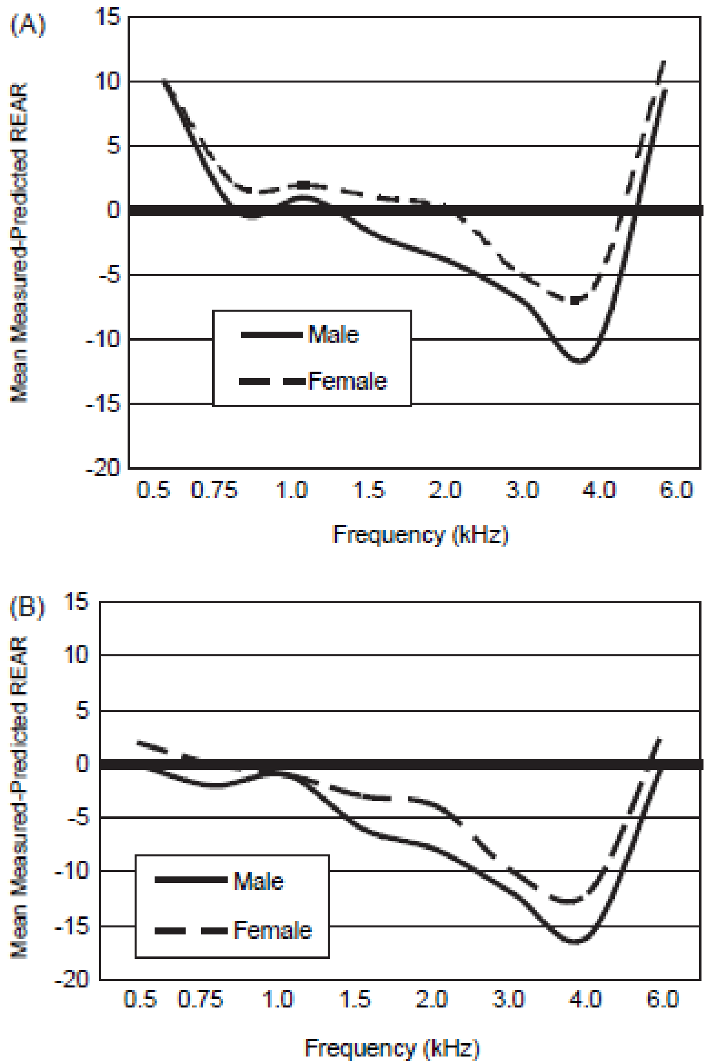

Figure 1. Mean difference between measured real-ear aided response (REAR) values and predicted REAR values for male (N = 17 subjects, N = 31 ears) and female (N = 24 subjects, N = 47 ears) subjects for a flat mild hearing loss using a 50 dB SPL FFT speech weighted input (A) and a 90 dB SPL FFT speech weighted input (B). Positive values indicate that the measured value exceeded the predicted value while negative values indicate that the predicted value exceeded the measured. Values of 0 indicate no difference between measured and predicted REAR.

Aarts, N.L., & Caffee, C.S. (2005). Manufacturer predicted and measured REAR values in adult hearing aid fitting: accuracy and clinical usefulness. *International Journal of Audiology, 44*(5), 293-301. doi: 10.1080/14992020500057830

Literature Review

Research Article

The Accuracy of Matching Target Insertion Gains With Open-Fit Hearing Aids

Table 1. Total number of ears for each frequency (cases for which NAL–NL1 recommended a target real ear insertion gain), number of cases that failed at each audiometric frequency, and percentage of cases that failed, both before and after adjustment.

Variable	Value						
Frequency in kHz	0.25	0.5	1	1.5	2	3	4
Number of ears	51	51	51	51	51	51	50
Number of fails, before	0	3	19	16	5	8	16
Percentage of fails, before	0	6	37	31	10	16	32
Number of fails, after	0	0	0	1	0	2	8
Percentage of fails, after	0	0	0	2	0	4	16

Results: Of the 51 initial fittings, 36 (71%) failed to achieve a match within ±10 dB of the NAL–NL1 insertion gain target at 1 or more frequencies between 0.25 and 4 kHz. After the authors adjusted the frequency-gain response of the hearing aids, only 9 fittings (18%) failed to achieve a match. **Conclusion:** These outcomes suggest that target insertion gains for the open-fit hearing aids used here are rarely achieved with a first fitting but can usually be achieved through adjustments based on REIG measurements.

Aazh, H., Moore, B.C.J., & Prasher, D. (2012). The accuracy of matching target insertion gains with open-fit hearing aids. *American Journal of Audiology, 21*(2), 175-180. doi: 10.1044/1059-0889(2012/11-0008)

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Table 2. For Each Frequency, the Number of Cases (cases for which NAL-NL1 recommended a target REIG), Maximum Mismatch, Mean and SD of the Initial and Final Mismatches, and Mean and SD of the Absolute Values (abs) of the Initial and Final Mismatches

Frequency (kHz)	Number of cases	Fitting	Max (dB)	Mean (dB)	SD (dB)	Mean of abs (dB)	SD of abs (dB)
0.25	36	Initial	-20	-3.9	6	3.9	6
		Final	-20	-2.9	5	3.5	5
0.5	40	Initial	-14	-2.7	5	3.5	4
		Final	-10	-0.7	3	1.9	3
				-1.4	6	4.3	4
				0.1	3	2.2	2
				-4.0	7	7.7	5
				-2.2	3	2.6	3
				-6.0	8	7.8	6
				-2.6	4	3.1	4
				-4.0	7	6.5	4
				-0.8	3	1.9	2
				-10.2	7	10.5	7
				-5.4	6	5.8	6
4	26	Initial	-16	-8.2	5	8.2	5
		Final	-10	-3.0	4	4.0	3

Note: A negative number indicates that the REIG was below the target. For the initial fitting at 2 kHz there were two mismatches that were equally large, but opposite in sign, so the maximum is shown as ±16.

CONCLUSIONS

For a representative sample of digital hearing aids fitted using the manufacturers' first fit or quick fit program, 64% of fittings failed to come within ±10 dB of the NAL-NL1 insertion gain target at one or more of the audiometric frequencies between 0.25 and 4 kHz. The

Aazh, H., & Moore, B.C.J. (2007). The value of routine real ear measurement of the gain of digital hearing aids. *Journal of the American Academy of Audiology, 18*(8), 653-664.

Literature Review

Short-Term and Long-Term Hearing Aid Benefit and User Satisfaction: A Comparison between Two Fitting Protocols

comments. Protocol B included all of Protocol A and a speech-in-noise test, loudness discomfort levels, and aided loudness. Thirty-two participants completed the Abbreviated Profile of Hearing Aid Benefit (APHAB) and the Satisfaction with Amplification in Daily Life (SADL) at 45 days and three months post–initial fitting.

Interestingly, as in our study, Cunningham et al (2001) found no statistically significant differences on any of the benefit and satisfaction measures. Hence, small amounts of change in gain do not lead to measurable increases in perceived benefit and satisfaction in hearing aid users.

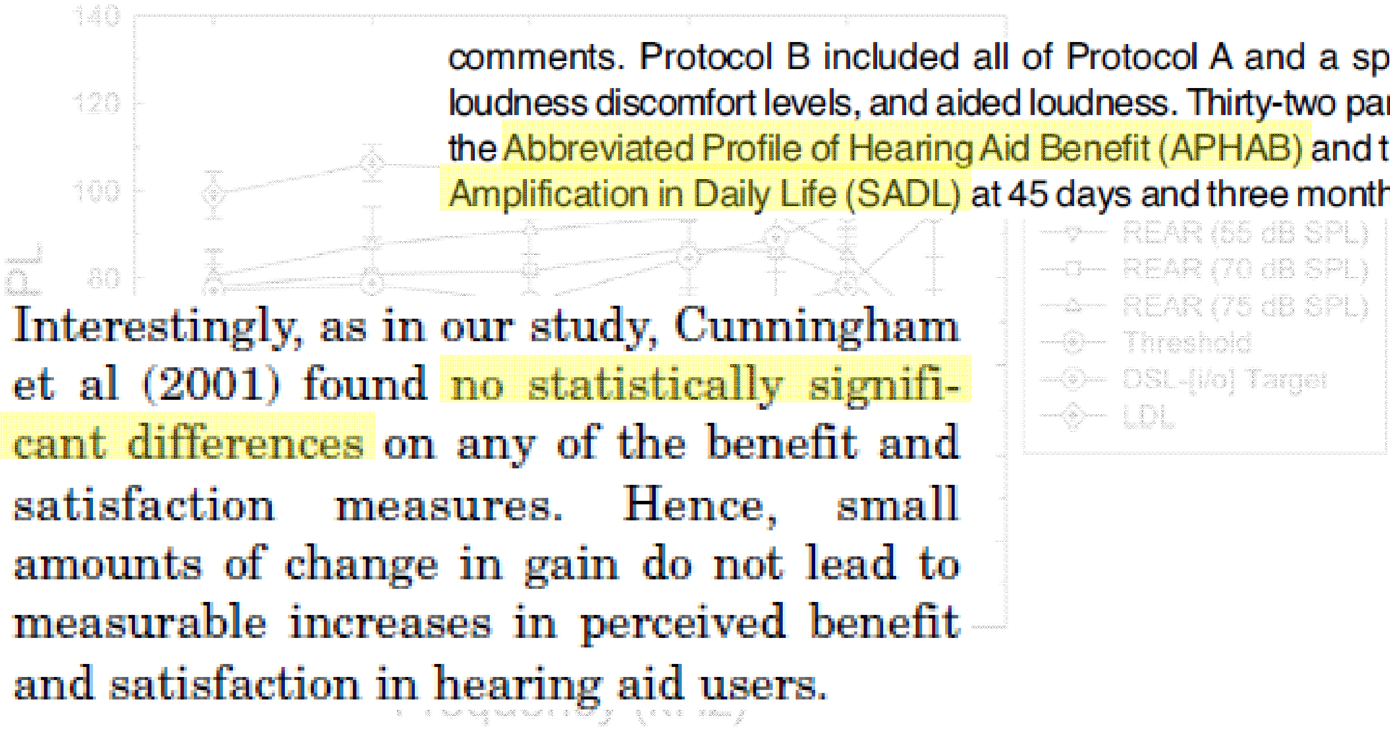


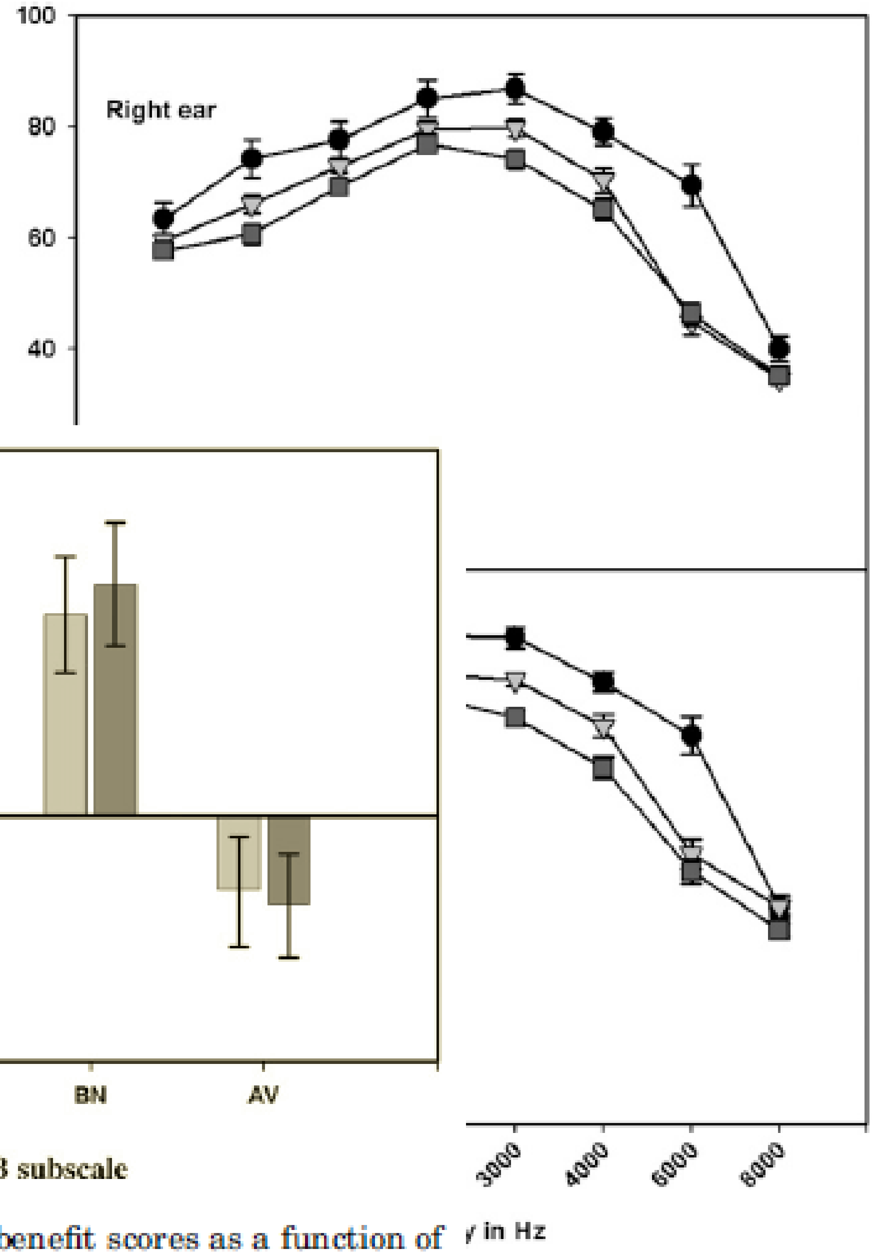
Figure 2. Real-ear measure results for Group A participants. REARs were obtained for speech inputs at 55 (triangles down), 70 (squares), and 75 (triangles up) dB SPL. Also shown are the DSL[i/o] target (pluses in circles) and predicted LDL (pluses in diamonds). LDL was predicted by the Verifit system. The error bars represent one standard deviation.

Shi, L. F., Doherty, K. A., Kordas, T. M., & Pellegrino, J. T. (2007). Short-term and long-term hearing aid benefit and user satisfaction: A comparison between two fitting protocols. *Journal of the American Academy of Audiology, 18*(6), 482-495.

Literature Review

Initial-Fit Approach Versus V
Comparing Self-Perceived He

DOI: 10.3766/jaaa.23.10.



target data (circles), verified prescription REAR (triangles), and initial-fit approach REAR (squares) for the right ear *(top panel)* and left ear *(bottom panel)*.

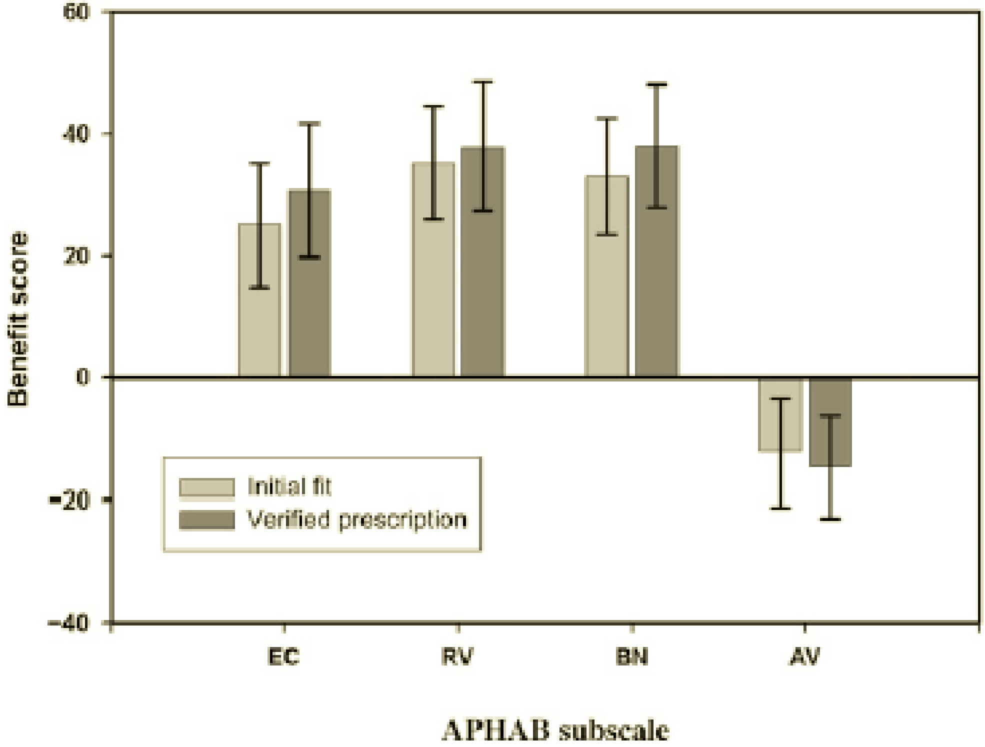


Figure 2. Mean (±2 SE) APHAB benefit scores as a function of type of fitting.

Abrams, H.B., Chisolm, T.H., McManus, M., & McArdle, R. (2012). Initial-fit approach versus verified prescription: comparing self-perceived hearing aid benefit. *Journal of the American Academy of Audiology, 23*(10), 768-778. doi: 10.3766/jaaa.23.10.3

Literature Review

Fast and Easy Fitting and Verification with Integrated Real-ear Measurement

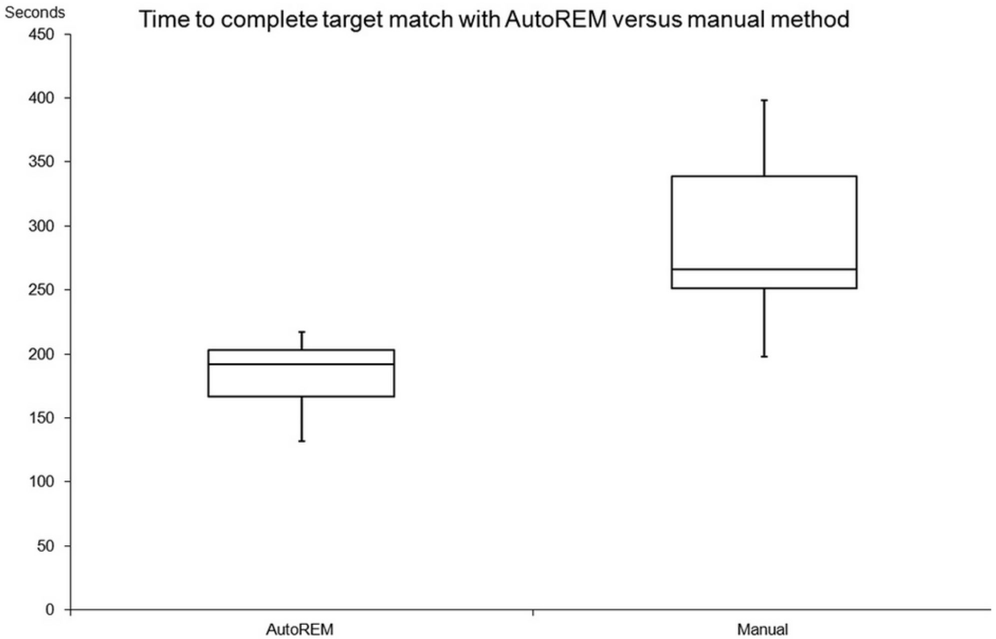


Figure 3. Fitters' average time with manual fitting was over 4.5 minutes with greater variability. Time with AutoREM averaged about 3 minutes with less variability.

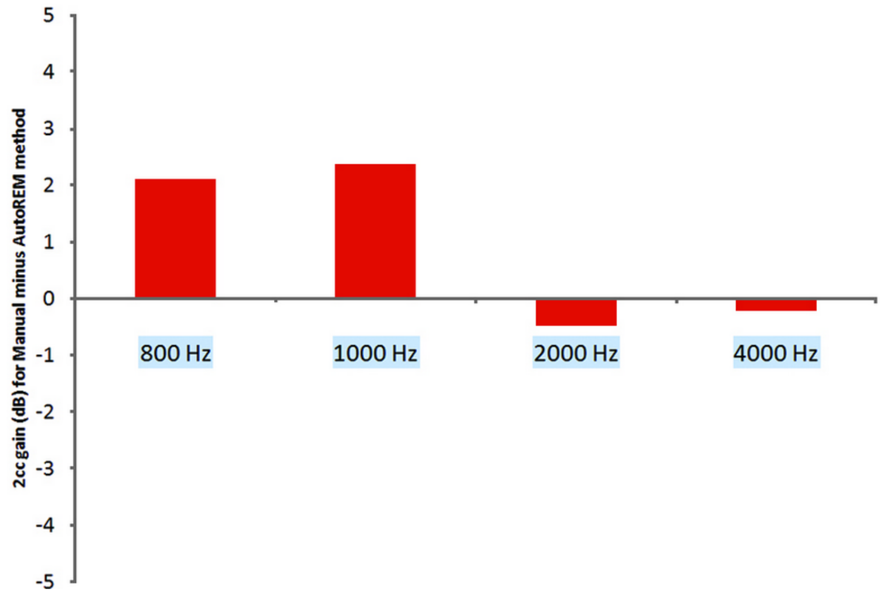


Figure 5. Average differences in fine-tuned gains between the manual and AutoREM procedures. Positive values mean that gains were adjusted higher with the manual method than with AutoREM.

Koehler, E.D., & Kulkarni, S. (2014). Fast and easy fitting and verification with integrated real-ear measurement. *Hearing Review,* (21 (10)), 36-40.
http://www.hearingreview.com/2014/09/fast-easy-fitting-verification-integrated-real-ear-measurement/

Critical Background

Author	Findings
Aazh & Caffee (2005)	Up to 88% discrepancy in ±4dB between manufacturer's fitting software and REAR
Aazh, Moore, & Prasher (2012)	71% failed to achieve a match within ±10dB of NAL-NL1 insertion gain at one or more frequencies
Aazh & Moore (2007)	65% of fittings failed to achieve ±10dB of NAL-NL1 insertion gain at one or more frequencies
Shi, Doherty, Kordas, & Pellegrino (2007)	- Varied deviations of REAR from target response - APHAB & SADL as outcome measures (hearing aid benefit and user satisfaction), no significant differences across time (45 days and 3 months post-fitting)
Abrams, Chisolm, McManus, & McArdle (2012)	- Initial-fit approach is significantly different than verified prescriptions in meeting targets (RMS deviation from target) - APHAB as outcome measure (scores for First Fit lower than score for manual adjustment with REM)

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NHG DSRB Ref: 2014/00475

07 August 2014

Mr Balakuthalingam Perumal
Department of Otolaryngology - Head and Neck Surgery
National University Hospital

Dear Mr Perumal

NHG DOMAIN SPECIFIC REVIEW BOARD (DSRB) APPROVAL

STUDY TITLE: Three hearing aids fitting approaches for adults: Comparing outcome measures of speech intelligibility and subjective rating

We are pleased to inform you that the NHG Domain Specific Review Board has approved the application as titled above to be conducted in **National University Hospital**.

The approval period is from **07 August 2014** to **06 August 2015**. The NHG DSRB reference number for this study is **2014/00475**. Please use this reference number for all future correspondence.