Computer-Based Auditory Training: It's Convenient and Affordable – But Does It Work?

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Disclosures

Financial

- Consultant
  - Starkey Hearing Technologies
  - Hearing Industries Association

Nonfinancial

- No nonfinancial relationships to the content of this presentation

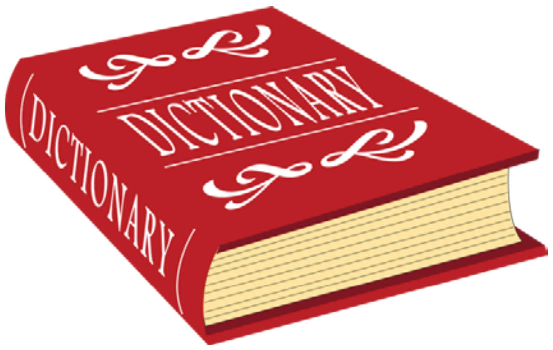
Learning Objectives

- At the conclusion of this presentation, participants will be able to:
  - Describe two commercially available remote auditory training products;
  - Discuss the results of a recently published systematic review of computer-based auditory training programs;
  - Describe the evidence supporting the association between auditory training and brain plasticity.

Does computer-based auditory training work? Why we want to know

- Hearing aids don’t always meet patients’ expectations
  - Particularly problematic in the demographic who purchase hearing aids
    - Speech-in-noise
    - Working memory
    - Speed of processing
- Decades of research have demonstrated that AT can improve auditory processing
  - But clinicians don’t want to provide these services in the clinic
    - Resource constraints
    - Lack of reimbursement
  - CBAT programs completed at home may be the answer

First… Some definitions



- Auditory training
  - Formal listening activities whose goal is to optimize the activity of speech perception (A. Boothroyd)
- Computer-Based Auditory Training
  - Software-controlled AT
- Gamification
  - The application of game-design elements and game principles in non-game contexts (e.g. health & wellness)
    - https://en.wikipedia.org/wiki/Gamification

An Historical Perspective…

- Levitt H, Oden C, Simon H, Noack C, Lotze A. (2012). Computer-Based Training Methods for Age-Related APD: Past, Present, and Future. in "Auditory Processing Disorders: Assessment, Management and Treatment.” 2nd Edition, D Geffner and D Swain, (Eds.) San Diego:Plural Press
    - https://pluralpublishing.com/publication_apd2e.htm

Auditory Training in Context

Process \ Goal	Function	Activity	Partici-pation	Quality of life
Sensory management	√	√	√?	√?
Instruction	√	√	?	?
Perceptual training	X	√?	?	?
Counseling	X	X	√	√
Holistic	√	√	√	√

Figure 2. The evidence of effectiveness for 4 aspects of intervention argues in favor of a holistic approach to adult aural rehabilitation.

Boothroyd A. (2007). Adult Aural Rehabilitation: What Is It and Does It Work? Trends in Amplification, 11(2):63-71

Systematic Reviews in AR

- Sweetow, R. & Palmer, C.V. (2005). Efficacy of individual auditory training in adults: A systematic review of the evidence. *Journal of the American Academy of Audiology*, *16(7)*, 494-504
- Henshaw H, Ferguson MA. (2013). Efficacy of individual computer-based auditory training for people with hearing loss: a systematic review of the evidence. *PLoS ONE 8*(5): e62836. doi:10.1371/journal.pone.0062836

Sweetow & Palmer (2005)

- *Does evidence exist supporting improvement in communication skills through individual auditory training in an adult hearing-impaired population?*

Sweetow & Palmer, 2005

Table 1. Review of the Auditory Training Investigations That Met the Systematic Review Inclusion Criteria

Reference	Design	Intervention	Outcomes	Results	Comments
Bode and Oyer (1970)	Before/After with control group	Training in two listening conditions with two response formats	CID W-22 M-Rhyme Test Semi-diagnostic test	Impaired listeners should receive training similar to the outcome measure	Small N, not randomized, not blinded, no follow-up, same day training because subjects would not come back
Walden et al (1981)	RCT	AR training alone AR + visual training AR + auditory training	Auditory consonant recognition Visual consonant recognition A-V sentence recognition	All groups improved with training, AR + visual and AR + auditory groups improved more than the AR alone group	Not blinded; cannot generalize beyond the male, VA population; no follow up
Kricos et al (1992)	RCT with pre- and posttest outcome measures	Training 4 weeks, 2 x per week, 1 hour or no training	HHIE Speech recognition test at various SNRs (signal-to-noise ratios)	Significant reduction in self-perceived hearing handicap and improvement in speech recognition in all subjects (control and experimental)	Not blinded, no feedback with training, no follow-up testing
Montgomery et al (1984)	RCT with pre- and posttest outcome measures	Training (50 hours) Control Group with AR but no A-V Normal hearing group	A-V sentence test	Experimental group improved more on the audiovisual sentence task than the control group	Deals primarily with A-V training, not just auditory, not blinded, no follow-up, difficult to generalize due to all male, veteran population
Rubenstein and Boothroyd (1987)	Before/After with no control group	Synthetic training Synthetic plus analytic training (8 1-hr private sessions over 4 weeks)	NST SPIN	Effect of training method was not significant. The gains achieved by both groups were not lost in the month following the end of training.	Not blind, small N, no control group, no feedback with training
Kricos and Holmes (1996)	Before/After with control group	Analytic training Active listening training (1 hour, 2 x per week over 4 weeks) No training	CST HHIE CPHI	Only significant finding was for three subscales of the CPHI—active listening group was better than the control group	Subject variability impacted the ability to analyze the data, not blind, total of 8 hours of training over 30 days, no follow-up

Note: AR = aural rehabilitation; A-V = auditory-visual; CID W-22 = Central Institute for the Deaf Word List 22 (Hirsh et al, 1952); CPHI = Communication Profile for the Hearing Impaired (Demorest and Erdman, 1987); CST = Connected Speech Test (Cox et al, 1987); HHIE = Hearing Handicap Inventory for the Elderly (Ventry and Weinstein, 1982); M-Rhyme Test = Modified Rhyme Test (Fairbanks, 1958); NST = nonsense syllable test (Resnick et al, 1975); RCT = randomized controlled trial; SPIN = Speech in Noise Test (Bilger, 1984); VA = Veterans Administration.

Study Quality (Sweetow & Palmer, 2005)

Table 2. Summary of Study Quality

Study	Blinding	Randomized to Groups	Control Group	Power Calculation	Validated Outcome Measures	Finding
Analytic						
Bode and Oyer (1970)	x	x	x	x	C/T	A+
Walden et al (1981)	x	*	*	x	C/T	A+
Synthetic						
Kricos et al (1992)	x	*	*	x	C/T	S-
Montgomery et al (1984)	x	*	*	x	C/T	S+
Synthetic and Analytic						
Rubinstein and Boothroyd (1987)	x	x	x	x	*	S+ S/A+
Kricos and Holmes (1996)	x	x	*	x	*	S+ A-

Sweetow & Palmer (2005)

Study Quality

Study quality parameters are reported in Table 2. Randomized controlled trials offer the highest level of evidence and, as can be seen in Table 2, three of the identified investigations followed this design. Unfortunately, none of the investigations provided any information related to the blinding of the subject or the investigator. Without a control group, it is very difficult to attribute change to a particular auditory training method exclusively. Four of the six studies included a control group. None of the studies provided a power calculation that would indicate the number of subjects needed to identify a clinically interesting difference at a particular power level. All but one of the studies included small N's per group (8 to 13 subjects), and several studies identified large variability between subjects as a limiting factor to identifying significant change post–

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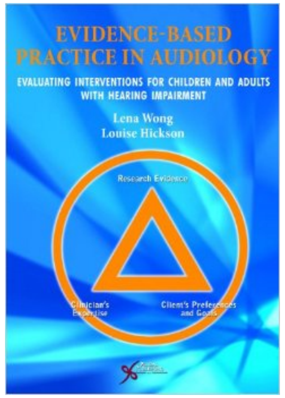
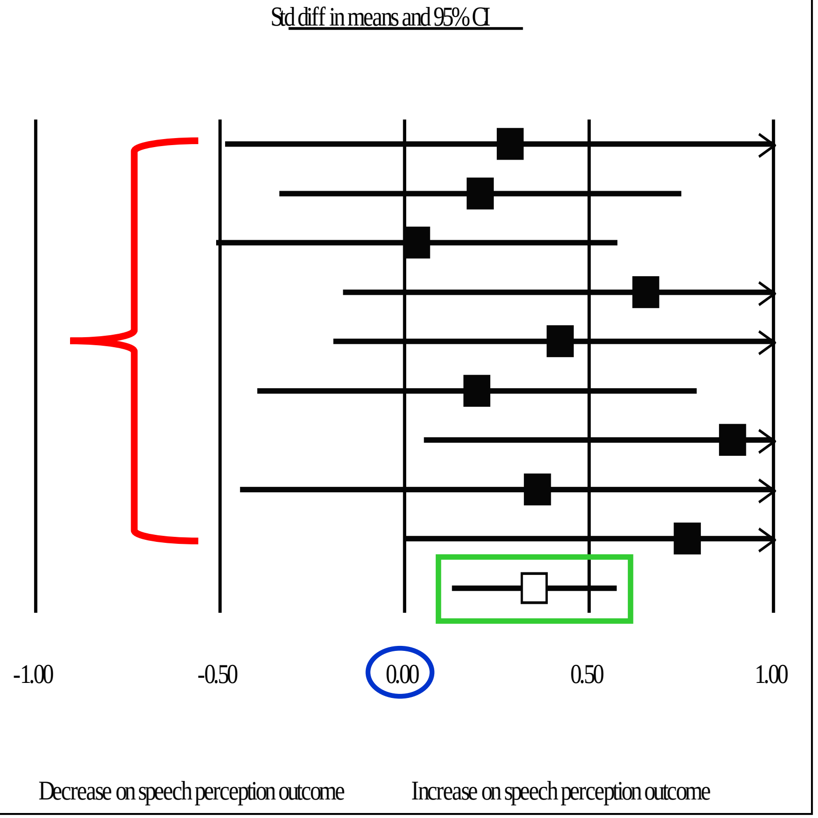
Synthetic						
Kricos et al (1992)	x	*	*	x	C/T	S-
Montgomery et al (1984)	x	*	*	x	C/T	S+
Synthetic and Analytic						
Rubinstein and Boothroyd (1987)	x	x	x	x	*	S+ S/A+
Kricos and Holmes (1996)	x	x	*	x	*	S+ A-

Auditory training meta-analysis (Forest) plot



Study name	Subgroup within study	Outcome	Statistics for each study: Std diff in means	Lower limit	Upper limit
Kricos et al. 1992	AT (Synthetic) vs. NT	Combined	0.287	-0.487	1.060
Kricos & Holmes 1996	AT (Analytic) vs. NT	Combined	0.205	-0.340	0.750
Kricos & Holmes 1996	AT (Synthetic) vs. NT	Combined	0.033	-0.511	0.577
Montgomery et al. 1984	AT vs. HA	AV Sentences	0.654	-0.167	1.475
Rubenstein & Boothroyd 1987	AT (Analytic)	Combined	0.422	-0.193	1.037
Rubenstein & Boothroyd 1987	AT (Synthetic)	Combined	0.196	-0.399	0.792
Walden et al. 1981	AT Auditory vs. NT	AV Sentences	0.889	0.052	1.727
Walden et al. 1981	AT Visual vs. NT	AV Sentences	0.360	-0.446	1.167
Humes et al. 2009	AT vs. NT	CID Sentences	0.767	0.000	1.533
TOTAL			0.352	0.128	0.575
Sweetow&Sabes, 2006		HINT	0.16		
Sweetow&Sabes, 2006		QuickSIN@45dB	0.31		
Sweetow&Sabes, 2006		QuickSIN@70dB	0.23		



Note: AT=Auditory training; AV=Auditory+Visual; CID=Central Institute for the Deaf; HA=Hearing aid; NT=No treatment; HINT=Hearing in Noise Test; QuickSIN= Quick Speech in Noise Test

From Chisolm & Arnold, 2012

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PLOS ONE

Efficacy of Individual Computer-Based Auditory Training for People with Hearing Loss: A Systematic Review of the Evidence

Helen Henshaw*, Melanie A. Ferguson

NIHR Nottingham Hearing Biomedical Research Unit, Nottingham, United Kingdom

Abstract

Background: Auditory training involves active listening to auditory stimuli and aims to improve performance in auditory tasks. As such, auditory training is a potential intervention for the management of people with hearing loss.

Objective: This systematic review (PROSPERO 2011: CRD42011001406) evaluated the published evidence-base for the efficacy of individual computer-based auditory training to improve speech intelligibility, cognition and communication abilities in adults with hearing loss, with or without hearing aids or cochlear implants.

Methods: A systematic search of eight databases and key journals identified 229 articles published since 1996, 13 of which met the inclusion criteria. Data were independently extracted and reviewed by the two authors. Study quality was assessed using ten pre-defined scientific and intervention-specific measures.

Results: Auditory training resulted in improved performance for trained tasks in 9/10 articles that reported on-task outcomes. Although significant generalisation of learning was shown to untrained measures of speech intelligibility (11/13 articles), cognition (1/1 articles) and self-reported hearing abilities (1/2 articles), improvements were small and not robust. Where reported, compliance with computer-based auditory training was high, and retention of learning was shown at post-training follow-ups. Published evidence was of very-low to moderate study quality.

Conclusions: Our findings demonstrate that published evidence for the efficacy of individual computer-based auditory training for adults with hearing loss is not robust and therefore cannot be reliably used to guide intervention at this time. We identify a need for high-quality evidence to further examine the efficacy of computer-based auditory training for people with hearing loss.

Citation: Henshaw H, Ferguson MA (2013) Efficacy of Individual Computer-Based Auditory Training for People with Hearing Loss: A Systematic Review of the Evidence. PLoS ONE 8(5): e62836. doi:10.1371/journal.pone.0062836

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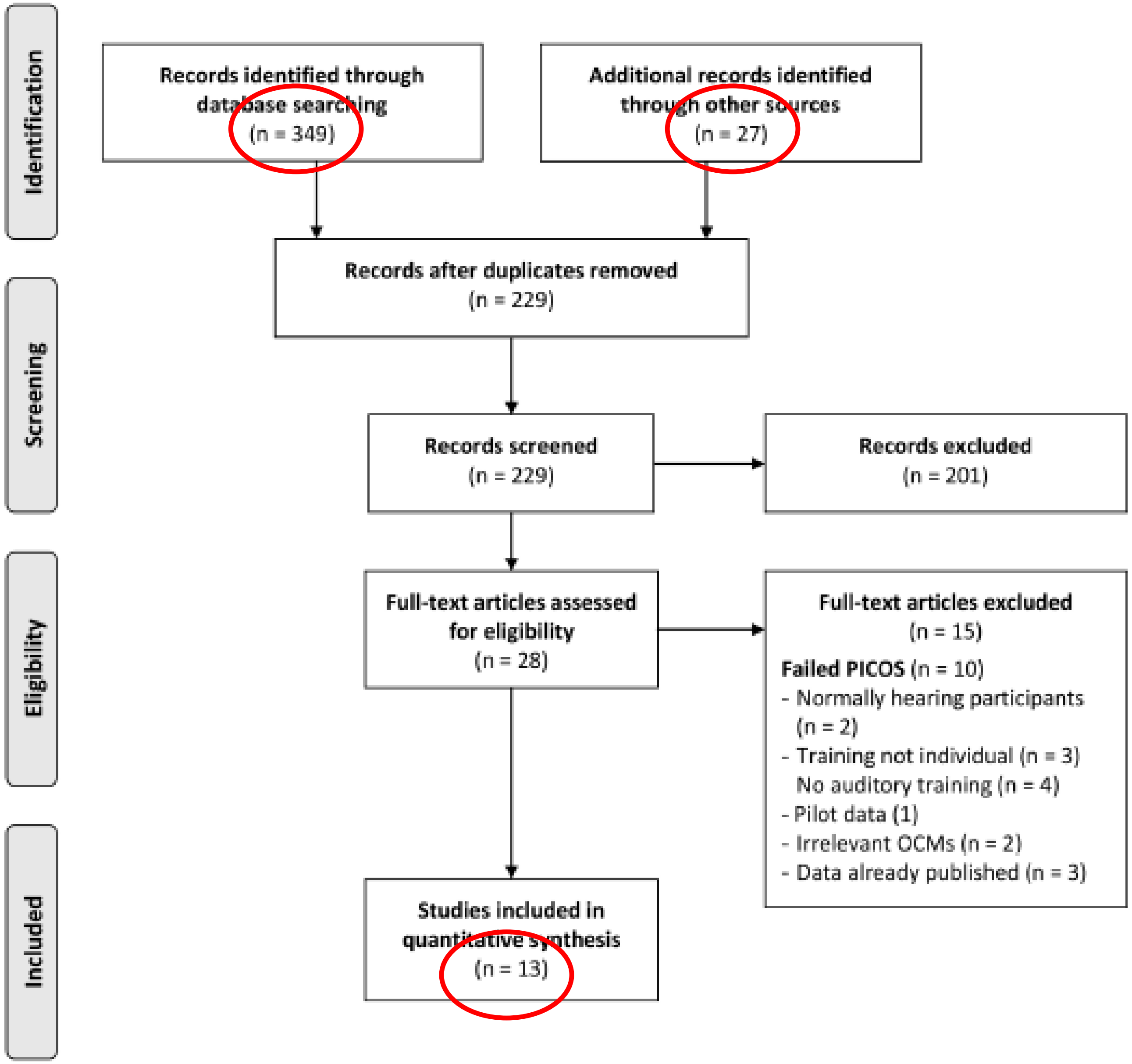


Figure 1. Flow diagram of the study identification, eligibility, and inclusion process.
doi:10.1371/journal.pone.0062836.g001

Major Findings

- Auditory training resulted in improved performance for trained tasks in 9/10 articles that reported on-task outcomes
- Although significant generalization of learning was shown in measures of speech intelligibility, cognition, and self-reported hearing abilities, improvements tended to be small
- Where reported, compliance with computer-based auditory training was high, and retention of learning was shown at post-training follow-ups
- Published evidence was of <u>very-low to moderate study quality</u>

Henshaw H, Ferguson MA. (2013). Efficacy of Individual Computer-Based Auditory Training for People with Hearing Loss: A Systematic Review of the Evidence. PLoS ONE 8(5): e62836. doi:10.1371/journal.pone.0062836

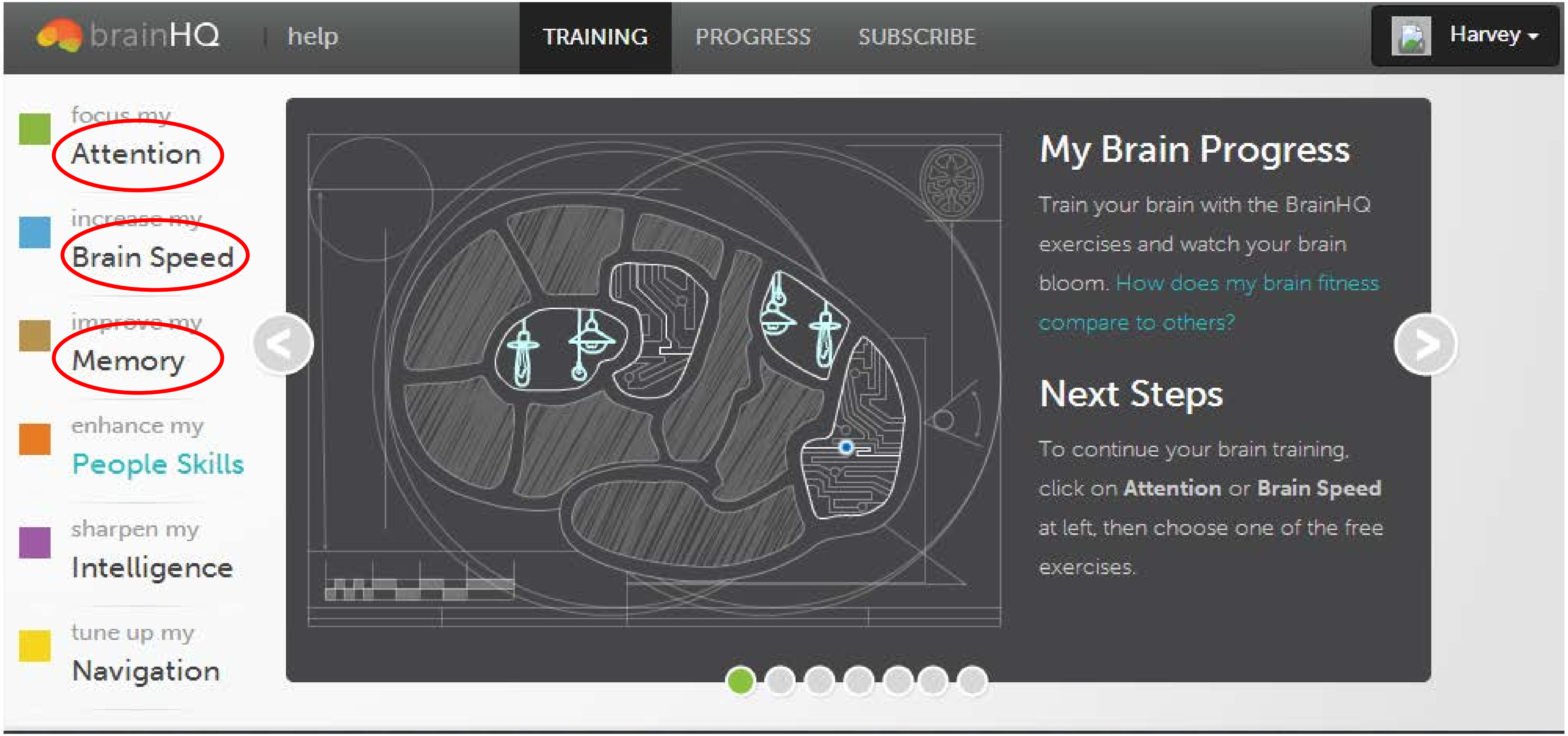
What's available commercially?

- Brain HQ
- Lumosity
- LACE
- ReadMyQuips

Gamification

- *The concept of applying game mechanics and game design techniques to engage and motivate people to achieve their goals*
- *Gamification taps into the basic desires and needs of the users impulses which revolve around the idea of Status and Achievement*

https://badgeville.com/wiki/Gamification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SUBSCRIBE
Harvey
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increase my
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enhance my
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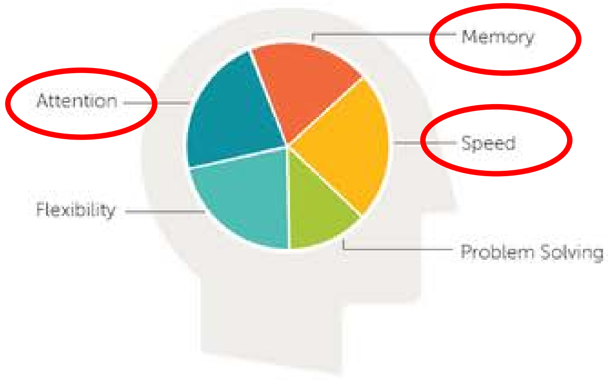

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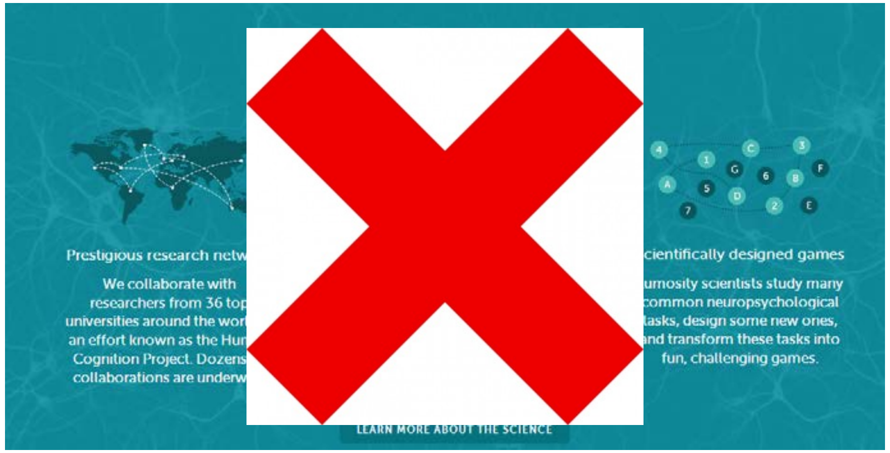

http://www.nytimes.com/2016/01/19/health/ftcs-lumosity-penalty-doesnt-end-brain-training-debate.html

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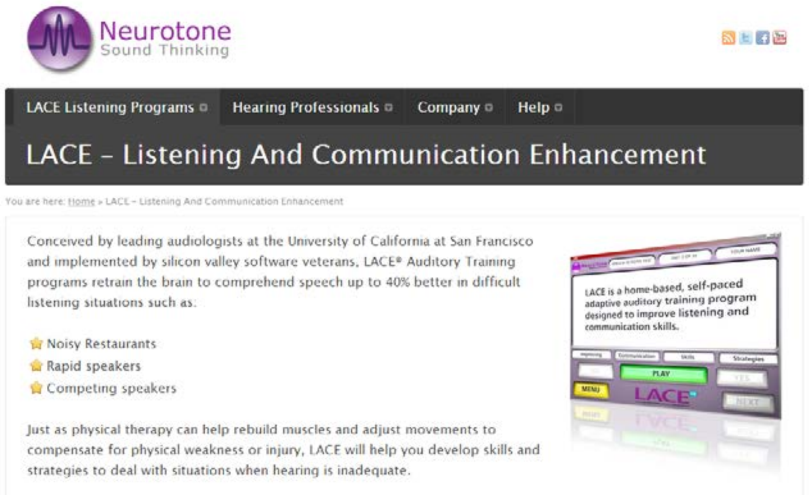
The evidence

- LACE



- ReadMyQuips

LACE (Sweetow & Henderson-Sabes, 2007)

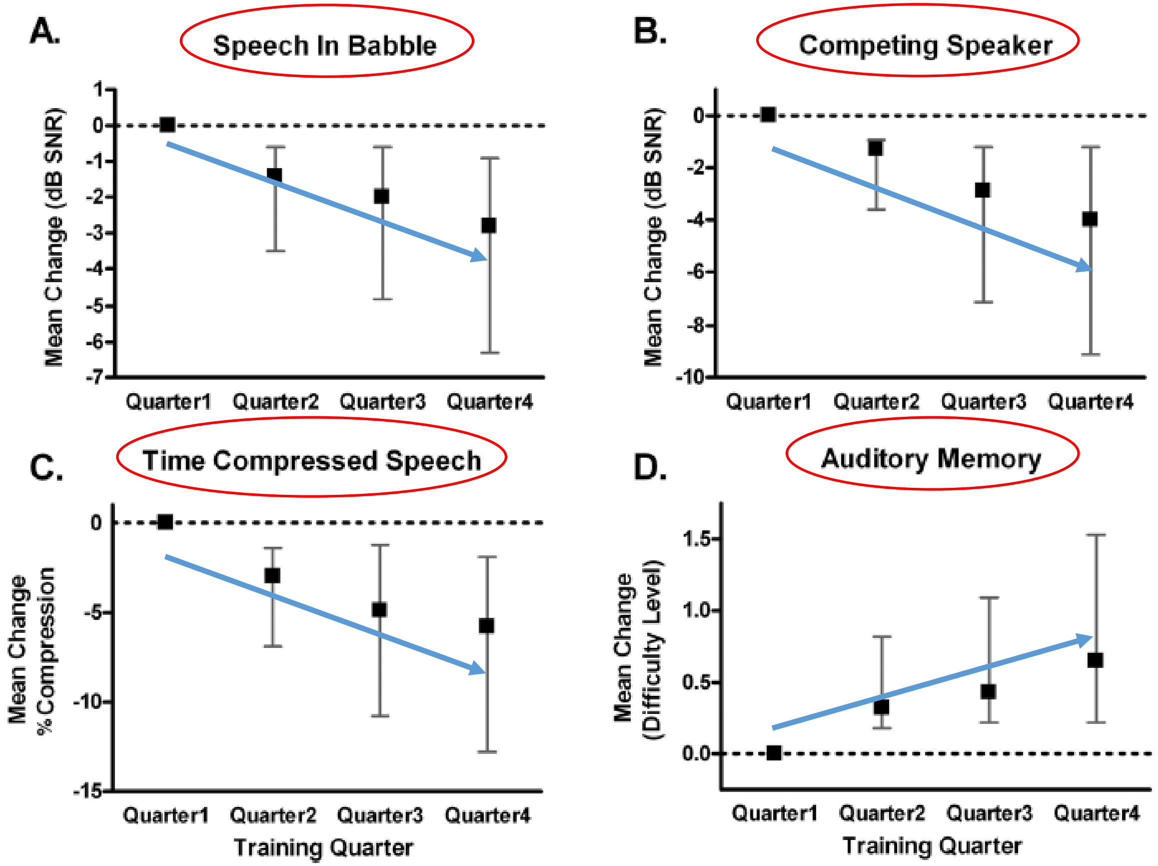


Figure 2. Mean improvement on training task scores for each quarter of the training relative to the first quarter of training, for all subjects completing Listening and Communication Enhancement (LACE) training. (A) Group mean change on speech in babble performance. A decrease in decibels of signal-to-noise ratio (dB SNR) score indicates improvement. (B) Group mean improvement on speech with a competing speaker performance. A decrease in dB SNR score indicates improvement. (C) Group mean improvement on time-compressed speech performance. A decrease in score indicates improvement. (D) Group mean improvement on auditory memory performance. An increase in score indicates improvement. Error bars indicate 95% confidence interval of the mean.

J Am Acad Audiol 24:214–230 (2013)

The Effect of LACE DVD Training in New and Experienced Hearing Aid Users

DOI: 10.3766/jaaa.24.3.7

Anne D. Olson*
Jill E. Preminger†
Jennifer B. Shinn‡

Abstract

Background: Numerous studies have demonstrated that improving the ability to understand speech in noise can be a difficult task for adults with hearing aids (HAs). If HA users want to improve their speech understanding ability, specific training may be needed. Auditory training (AT) is one type of intervention that may enhance speech recognition abilities for adult HA users.

Purpose: The purpose of this study was to examine the behavioral effects of an AT program called Listening and Communication Enhancement (LACE) in the DVD format in new and experienced HA users. While some research has been conducted using the computer version of this program, no research to date has been conducted on the efficacy of the DVD version of the LACE training program in both new and experienced HA users.

Research Design: An experimental, prospective repeated measures group design, with random assignment.

Study Sample: Twenty-nine adults with hearing loss were assigned to one of three groups: new HA plus training, experienced HA plus training, or control (new HA users with no training during the study but provided with training afterward). New HA aid users were randomly assigned to either the training or control group.

Intervention: Participants in the training groups completed twenty 30 min training lessons from the LACE DVD program at home over a period of 4 wk.

Data Collection: Participants in both training groups were evaluated at baseline, after 2 wk of training and again after 4 wk of training. Participants in the control group were evaluated at baseline and after 4 wk of HA use. Several objective listening measures were administered including speech in noise, rapid speech, and competing sentences tasks. Subjective measures included evaluating the participants' perception of the intervention as well as their perceptions of functional listening abilities.

Results: Findings indicate that both new and experienced users improved their understanding of speech in noise, understanding of competing sentences, and communication function after training in comparison to a control group. Effect size calculations suggested that a larger training effect was observed for new HA users compared to experienced HA users. New HA users also reported greater benefit from training compared to experienced users. AT with the LACE DVD format should be encouraged, particularly among new HA users, to improve understanding in difficult listening conditions.

Key Words: Auditory training, hearing aids, home training, older adult, speech in noise

Abbreviations: AT = auditory training; HA = hearing aid; IOI-AI = International Outcome Inventory-Alternative Intervention; IOI-HA = International Outcome Inventory-Hearing Aid; LACE = Listening and Communication Enhancement; MCR = message to competition ratio; NAL-NL1 = National Acoustic Laboratories—Non-linear 1; QuickSIN = Quick Speech in Noise; SSI = Synthetic Sentence Identification; SSQ = Speech, Spatial and Qualities of Hearing Scale

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Portions of this article were presented at the Academy of Rehabilitative Audiology Annual Meeting, September 2010, San Francisco, CA, AudiologyNOW!, April 2011, Chicago, IL.

LACE (Olson, Preminger & Shinn, 2013)

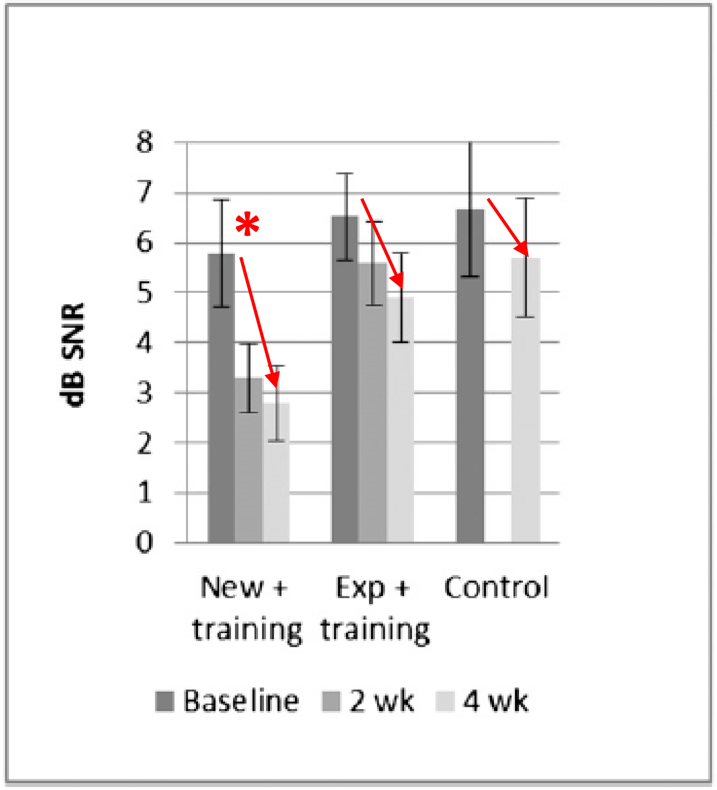

Figure 1. Mean scores for QuickSIN (dB SNR) (error bars – 95% CI) at baseline, after 2 wk, and after 4 wk of training for training and control groups. Lower scores represent better ability to understand speech in noise.

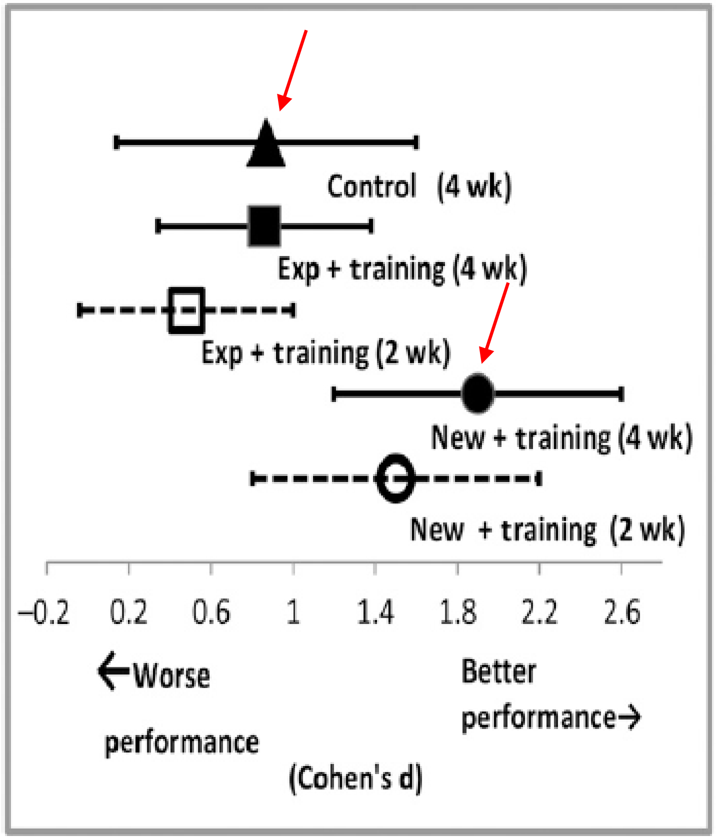

Figure 2. Within group effect sizes (Cohen's d) over time based on QuickSIN test. Larger training effects are seen for new HA users.

A Randomized Control Trial: Supplementing Hearing Aid Use with Listening and Communication Enhancement (LACE) Auditory Training

Gabrielle H. Saunders,[1,2] Sherri L. Smith,[3,4] Theresa H. Chisolm,[5] Melissa T. Frederick,[1]
Rachel A. McArdle,[6] and Richard H. Wilson[3,4]

Objective: To examine the effectiveness of the Listening and Communication Enhancement (LACE) program as a supplement to standard-of-care hearing aid intervention in a Veteran population.

Design: A multisite randomized controlled trial was conducted to compare outcomes following standard-of-care hearing aid intervention supplemented with (1) LACE training using the 10-session DVD format, (2) LACE training using the 20-session computer-based format, (3) placebo auditory training (AT) consisting of actively listening to 10 hr of digitized books on a computer, and (4) educational counseling—the control group. The study involved 3 VA sites and enrolled 279 veterans. Both new and experienced hearing aid users participated to determine if outcomes differed as a function of hearing aid user status. Data for five behavioral and two self-report measures were collected during three research visits: baseline, immediately following the intervention period, and at 6 months postintervention. The five behavioral measures were selected to determine whether the perceptual and cognitive skills targeted in LACE training generalized to untrained tasks that required similar underlying skills. The two self-report measures were completed to determine whether the training resulted in a lessening of activity limitations and participation restrictions. Outcomes were obtained from 263 participants immediately following the intervention period and from 243 participants 6 months postintervention. Analyses of covariance comparing performance on each outcome measure separately were conducted using intervention and hearing aid user status as between-subject factors, visit as a within-subject factor, and baseline performance as a covariate.

Results: No statistically significant main effects or interactions were found for the use of LACE on any outcome measure.

Conclusions: Findings from this randomized controlled trial show that LACE training does not result in improved outcomes over standard-of-care hearing aid intervention alone. Potential benefits of AT may be different than those assessed by the performance and self-report measures utilized here. Individual differences not assessed in this study should be examined to evaluate whether AT with LACE has any benefits for particular individuals. Clinically, these findings suggest that audiologists may want to temper the expectations of their patients who embark on LACE training.

Key words: Auditory perception, Auditory training, Hearing, Hearing aids, Hearing rehabilitation, Neuroplasticity.

(Ear & Hearing 2016;37;381–396)

INTRODUCTION

Despite significant advances in hearing aid technology, only about 14% of individuals >50 years old who might benefit from hearing aids use them (Chien & Lin 2012). Furthermore, there is wide individual variation in treatment outcome among those using amplification (Humes 2013). One approach to improving hearing aid outcomes is the provision of auditory training (AT), or systematic listening practice, aimed at maximizing the use of an individual's residual hearing. AT relies on the assumption that neurons in the brain can reorganize and restructure following, for example, training or changes in sensory input (Kraus et al. 1995; Ramachandran 2005; Reuter-Lorenz & Lustig 2005). The possibility that an adult with hearing loss could be "trained" or "retrained" to use bottom-up and top-down auditory processing skills is rooted in the recognition that (1) hearing aids cannot restore the auditory system to normal, (2) hearing aid processed signals differ acoustically from unprocessed signals, and (3) the auditory system of a patient acquiring hearing aids likely has been deprived of normal auditory input for several years.

Although there are data demonstrating that AT can result in improvements in the understanding of speech-in-noise (see Sweetow & Palmer 2005; Chisolm & Arnold 2012 for reviews), AT is not commonly recommended to adults with hearing loss. This may in part be due to limited reimbursement for adult audiologic rehabilitation as well as the concomitant time-, resource-, and cost-constraints associated with clinician-driven intervention models. One approach to addressing these limitations is the use of computer-based AT. A number of computer-based training programs exist, such as CasperSent (Boothroyd 2008), the Frequent-Word auditory training protocol (Humes et al. 2009), Listening and Communication Enhancement (LACE; Sweetow & Sabes 2006), and Speech Perception Assessment and Training System (Miller et al. 2007). Although these programs differ in the specific skills trained, they are similar in terms of the underlying training principles, which include adaptive algorithms that maintain training difficulty at a level near the upper limits of the user's auditory ability, the provision of feedback to promote learning, "rewards" to increase motivation, and the expectation that the user will train almost daily over several weeks. A fundamental assumption of any AT program is that the skills learned within the program will "generalize" or "transfer" to untrained stimuli and/or to everyday listening situations.

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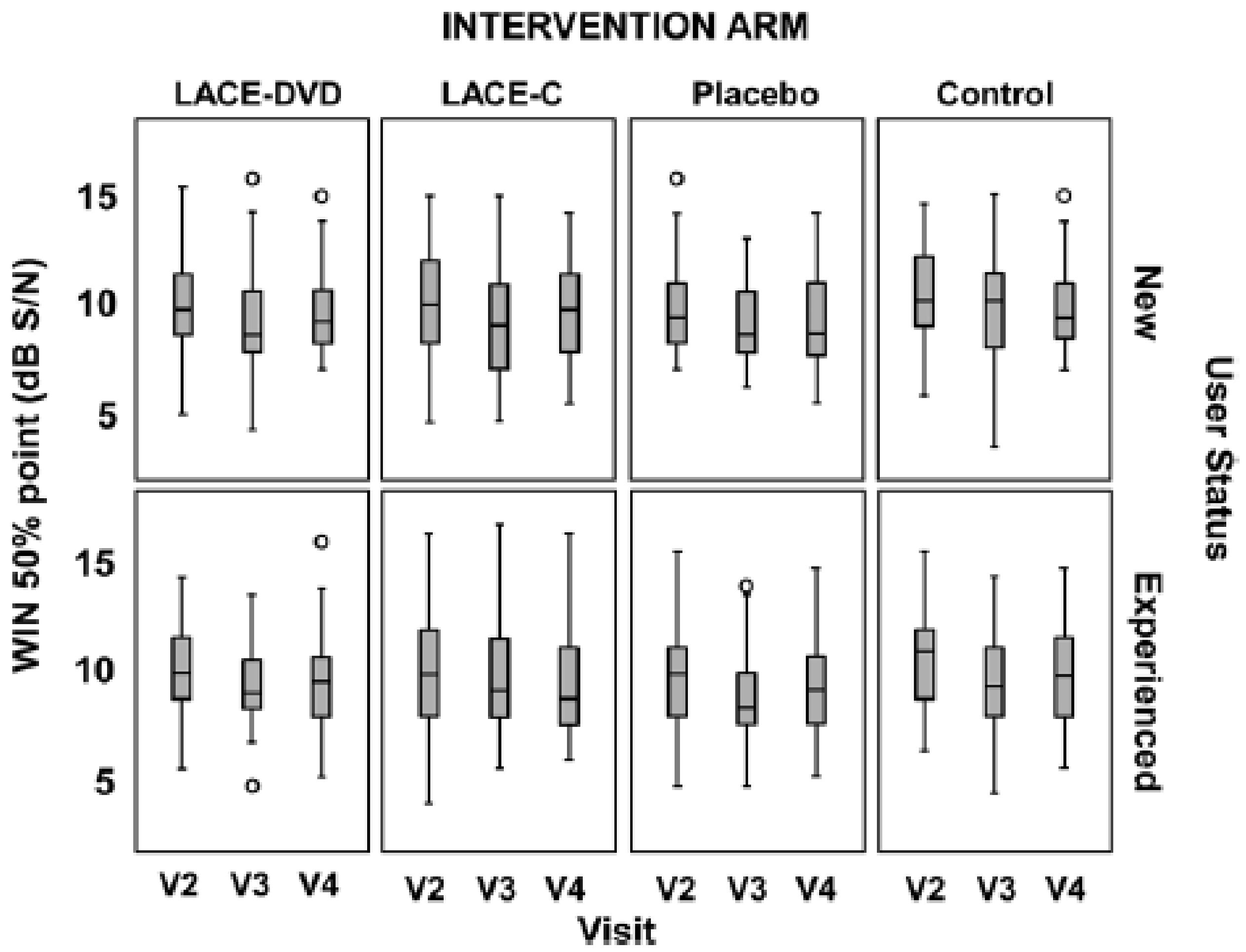

Fig. 2. Boxplot for WIN scores by visit for each intervention user group separately. The median value is shown by the *solid horizontal line* with the lower and upper ends of the box showing the 25th and 75th percentiles, respectively, and the upper and lower ends of the whisker indicating the range of values within 1.5 times the interquartile range. *Circles* depict outliers that are >2 whisker lengths above or below the 75th or 25th percentiles, respectively. WIN indicates Words-in-Noise test.

AJA

Research Forum

Learning to Listen Again: The Role of Compliance in Auditory Training for Adults With Hearing Loss

Theresa Hnath Chisolm,[a,b] Gabrielle H. Saunders,[c] Melissa T. Frederick,[c] Rachel A. McArdle,[b,a] Sherri L. Smith,[d,e] and Richard H. Wilson[d,e]

Purpose: To examine the role of compliance in the outcomes of computer-based auditory training with the Listening and Communication Enhancement (LACE) program in Veterans using hearing aids.

Method: The authors examined available LACE training data for 5 tasks (i.e., speech-in-babble, time compression, competing speaker, auditory memory, missing word) from 50 hearing-aid users who participated in a larger, randomized controlled trial designed to examine the efficacy of LACE training. The goals were to determine: (a) whether there were changes in performance over 20 training sessions on trained tasks (i.e., on-task outcomes); and (b) whether compliance, defined as completing all 20 sessions, vs. noncompliance, defined as completing less than 20 sessions, influenced performance on parallel untrained tasks (i.e., off-task outcomes).

Results: The majority, 84% of participants, completed 20 sessions, with maximum outcome occurring with at least 10 sessions of training for some tasks and up to 20 sessions of training for others. Comparison of baseline to posttest performance revealed statistically significant improvements for 4 of 7 off-task outcome measures for the compliant group, with at least small ($0.2 < d < 0.3$) Cohen's d effect sizes for 3 of the 4. There were no statistically significant improvements observed for the noncompliant group.

Conclusion: The high level of compliance in the present study may be attributable to use of systematized verbal and written instructions with telephone follow-up. Compliance, as expected, appears important for optimizing the outcomes of auditory training. Methods to improve compliance in clinical populations need to be developed, and compliance data are important to report in future studies of auditory training.

Key Words: auditory training, adults, LACE, hearing loss, compliance

The goal of auditory training (AT) is to increase the listener's ability to compensate for degradation in the auditory signal due to internal (e.g., hearing loss) or external (e.g., noise) factors (Sweetow & Palmer, 2005). The recent development of several computer-based AT programs for at-home use provides potential to increase opportunities for adults with hearing loss to engage in perceptual learning, which in turn may lead to better speech understanding and improved communication ability (Boothroyd, 2007; Sweetow & Sabes, 2007). Systematic reviews of the literature provide evidence that AT can lead to improvements, albeit modest, in speech understanding (Chisolm & Arnold, 2012; Sweetow & Palmer, 2005).

An important question regarding AT outcomes relates to compliance, or adherence, to the treatment regimen. For example, the commercially available Listening and Communication Enhancement (LACE) program consists of 20 sessions that are completed over 4 weeks. A review of the clinical records of 3000 patients using LACE revealed that only 30% completed 10 or more of the 20 training sessions (Sweetow & Sabes, 2010). The question arises as to whether individuals who complete LACE's 20-sesssion training protocol (i.e., compliers) have better outcomes than those who do not (i.e., noncompliers). Lack of compliance with nonmedication interventions in other areas of healthcare is strongly related to outcomes (e.g., DiMatteo, Giordani, Lepper, & Croghan, 2002). It is logical, therefore, to assume that this positive relation exists for LACE use. The present report examines the potential influence of compliance on outcomes of LACE training for adult hearing-aid users. The

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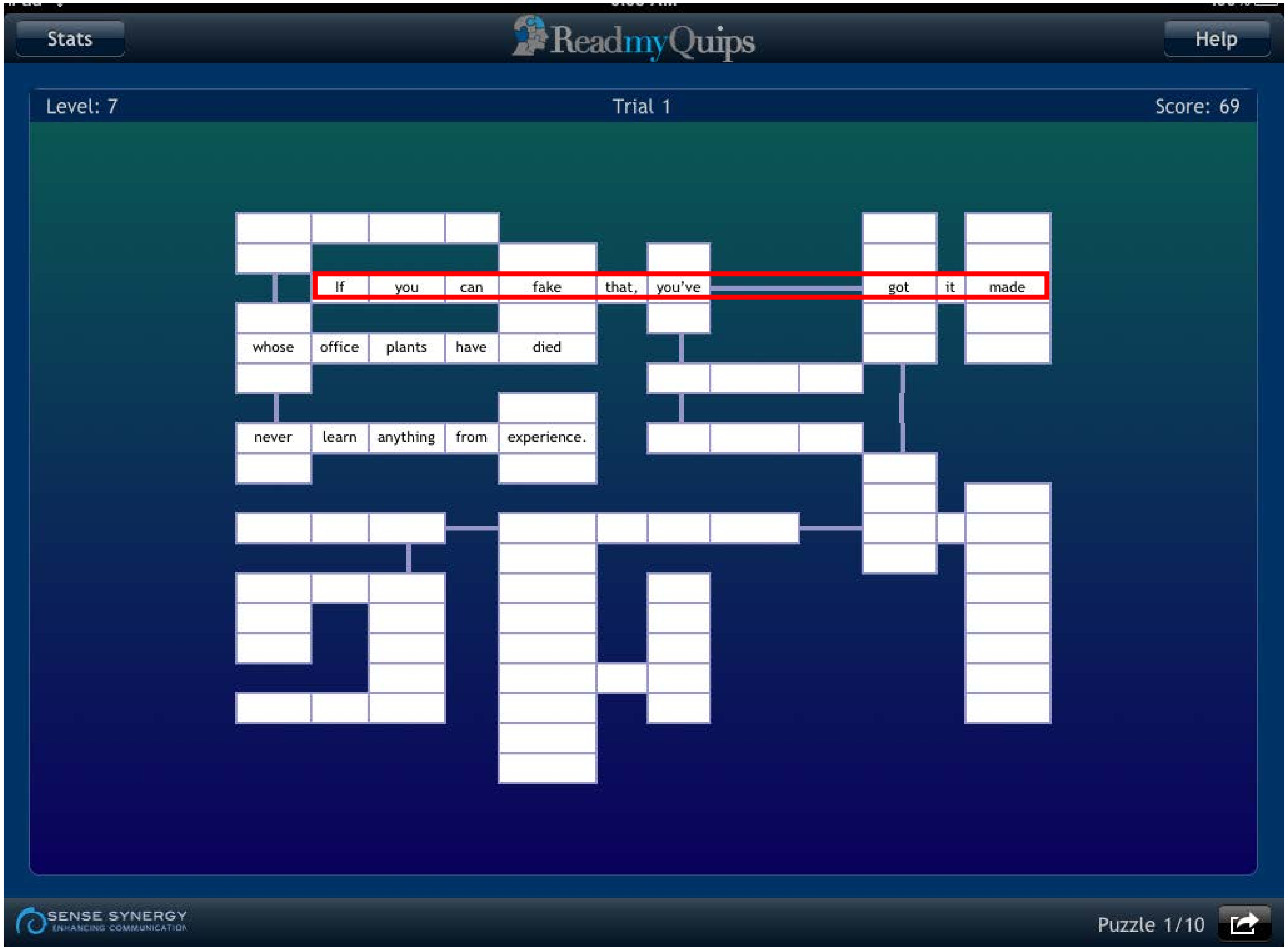
Acting is all about honesty. _____ _____ _____ _____ _____ _____ _____ _____ _____ (George Burns)

Acting is all about honesty.

(George Burns)


Stats
ReadmyQuips
Help
Level: 7
Trial 1
Score: 69
If you can fake that, you've got it made
whose office plants have died
never learn anything from experience.
SENSE SYNERGY
ENHANCING COMMUNICATION
Puzzle 1/10

AJA

Research Forum

Can a Remotely Delivered Auditory Training Program Improve Speech-in-Noise Understanding?

Harvey B. Abrams,[a,b] Kirsten Bock,[c] and Ryan L. Irey[a]

Purpose: The aims of this study were to determine if a remotely delivered, Internet-based auditory training (AT) program improved speech-in-noise understanding and if the number of hours spent engaged in the program influenced postintervention speech-in-noise understanding.
Method: Twenty-nine first-time hearing aid users were randomized into an AT group (hearing aids + 3 week remotely delivered, Internet-based auditory training program) or a control group (hearing aids alone). The Hearing in Noise Test (Nilsson, Soli, & Sullivan, 1994) and the Words-in-Noise test (Wilson, 2003) were administered to both groups at baseline + 1 week and immediately at the completion of the 3 weeks of auditory training.
Results: Speech-in-noise understanding improved for both groups at the completion of the study; however, there was not a statistically significant difference in postintervention improvement between the AT and control groups. Although the number of hours the participants engaged in the AT program was far fewer than prescribed, time on task influenced the postintervention Words-in-Noise but not Hearing in Noise Test scores.
Conclusion: Although remotely delivered, Internet-based AT programs represent an attractive alternative to resource-intensive, clinic-based interventions, their demonstrated efficacy continues to remain a challenge due in part to issues associated with compliance.

Untreated hearing loss has been found to have negative overall functioning and quality of life effects, such as cognitive and functional decline, social isolation, higher risk of falls, decreased social and emotional function, and communication decline (Kramer, Kapteyn, Kuik, & Deeg, 2002; Lin et al., 2011; Tun, McCoy, & Wingfield, 2009; Uhlmann, Larson, Rees, Koepsell, & Duckert, 1989). Hearing aids are the primary intervention strategy for hearing loss, and despite impressive technological advancements and evidence of their effectiveness, only 74% of hearing aid users reported being satisfied, with the remaining 26% reporting either dissatisfaction or having neutral feelings toward their hearing aids. One of the top reasons for dissatisfaction is a perceived lack of benefit, particularly in background noise (Kochkin, 2007). In order to overcome this dissatisfaction, patients may require additional postfitting audiologic rehabilitation (AR) services, including auditory training (AT) designed to improve speech understanding in challenging listening situations (Sweetow & Henderson Sabes, 2006). Research has supported the benefits of AT on speech perception (Chisolm & Arnold, 2012; Henshaw & Ferguson, 2013; Kricos & Holmes, 1996; Olson, Preminger, & Shinn, 2013; Walden, Erdman, Montgomery, Schwartz, Prosek, 1981).

Despite the potential benefit of AR, only 16% of audiologists report providing such services to their patients (Schow, Balsara, Smedley, & Whitcomb, 1993). Reasons for the small percentage of professionals offering these services include a perceived lack of adequate time or financial resources (Northern & Beyer, 1999). Another barrier to the implementation of AR is lack of patient acceptance and compliance (Sweetow & Sabes, 2010); this could be addressed by providing AT remotely. The goal of remotely delivered computerized AT is to provide postfitting care that is effective, convenient, and accessible. One currently available program that appears to meet these criteria is ReadmyQuips (RMQ; http://www.sensesynergy.com/readmyquips). RMQ is an audiovisual (A/V) adaptive training program delivered through the use of games, puzzles, and videos. There is no published research, however, that has examined the efficacy of RMQ for improving

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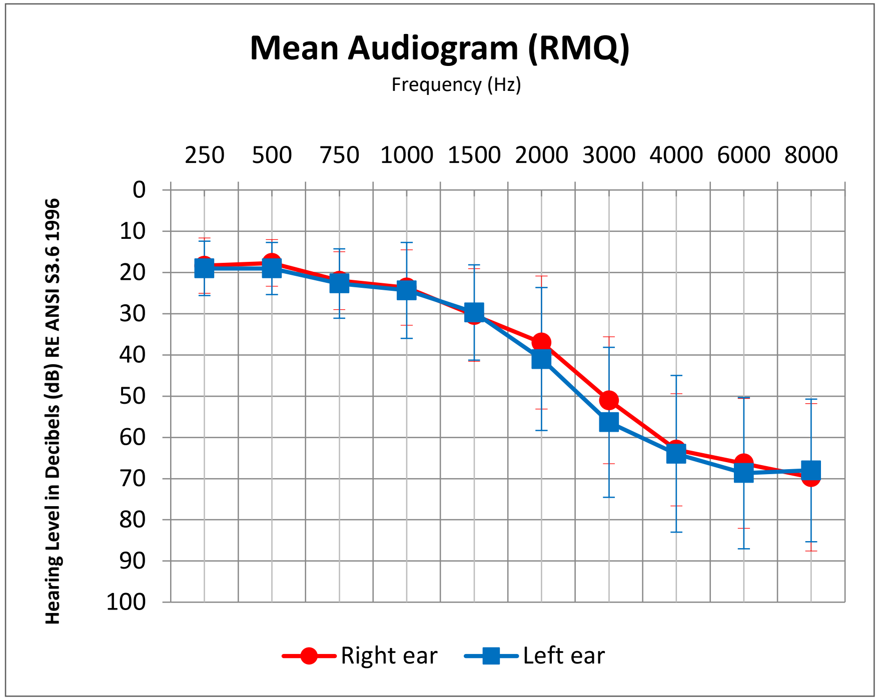
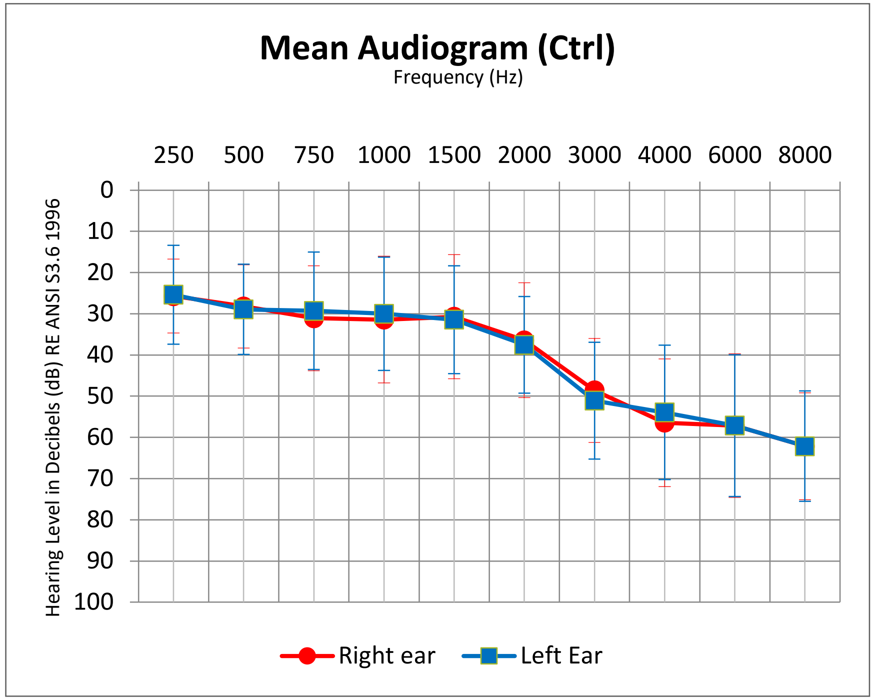
Disclosure: The authors have declared that no competing interests existed at the time of publication.

Participants



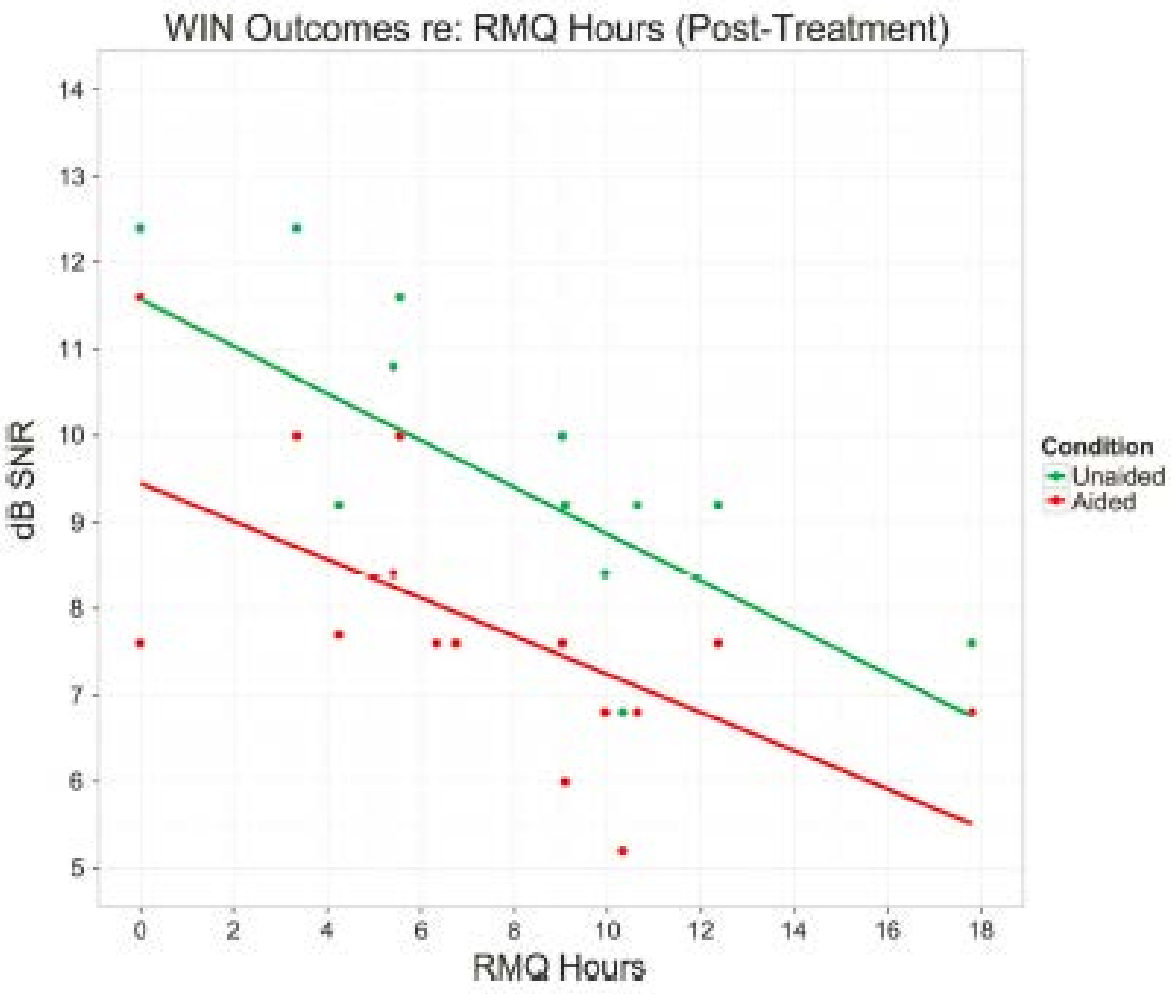


Age	Gender	PTA
65.6	M= 11 F=4	R: 32.33 L= 35.16

Age	Gender	PTA
61.8	M= 6 F=8	36.16 36.87

Test Measures

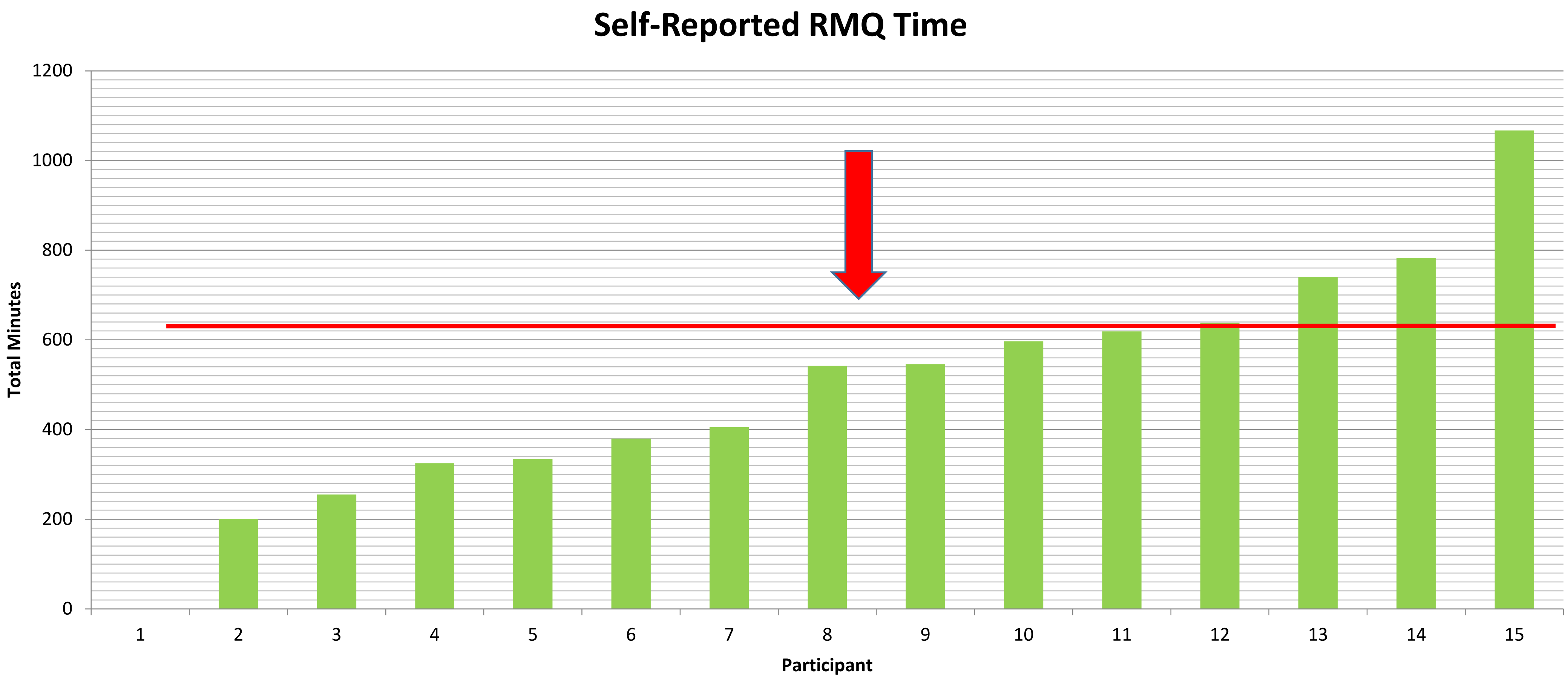
- **Abbreviated Profile of Hearing Aid Benefit (APHAB)**
  - Questionnaire design to measure amount of trouble the patient is having with communication or noises in various everyday situations
- **Device-Oriented Subjective Outcome (DOSO)**
  - Questionnaire designed to measure hearing aid outcomes in a way that is relatively independent of wearer personality
- **Hearing-in-Noise Test (HINT)**
  - 25 ten sentence lists presented in speech-shaped noise presented in an eight speaker array
- **Words-in-Noise Test (WIN)**
  - 35 monosyllabic word lists presented at 0, 2, 4, 8, 12, 16, 20 and 24 dB SNR based on PTA
- **The System Usability Scale (SUS)**
  - Ten-item Likert scale of subjective assessments of program usability
- **Overall satisfaction/Likelihood to Recommend Questionnaire**


WIN Outcomes re: RMQ Hours (Post-Treatment)
dB SNR
RMQ Hours
14
13
12
11
10
9
8
7
6
5
0
2
4
6
8
10
12
14
16
18
Condition
Unaided
Aided

Wear Time

	Daily Use	% Directional	% Noise	%Speech in Noise
RMQ	9.6 hours	19.16%	1.4 %	41.3%
CTRL	8.4 hours	17.6 %	1.2 %	41.2%

Time on task



Self-Reported RMQ Time
Total Minutes
0
200
400
600
800
1000
1200
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Participant

Observations

- Though remotely delivered AR is convenient, compliance to a program schedule may be problematic
  - “Internet user” has a wide range of meaning
  - Patients may need technological support
- Large variability in performance within groups
  - Suggests some individuals benefit much more than others

Neural Correlates of Selective Attention With Hearing Aid Use Followed by ReadMyQuips Auditory Training Program

Aparna Rao,[1] Dania Rishiq,[2] Luodi Yu,[3] Yang Zhang,[3,4] and Harvey Abrams[5]

Objectives: The objectives of this study were to investigate the effects of hearing aid use and the effectiveness of ReadMyQuips (RMQ), an auditory training program, on speech perception performance and auditory selective attention using electrophysiological measures. RMQ is an audiovisual training program designed to improve speech perception in everyday noisy listening environments.

Design: Participants were adults with mild to moderate hearing loss who were first-time hearing aid users. After 4 weeks of hearing aid use, the experimental group completed RMQ training in 4 weeks, and the control group received listening practice on audiobooks during the same period. Cortical late event-related potentials (ERPs) and the Hearing in Noise Test (HINT) were administered at prefitting, pretraining, and post-training to assess effects of hearing aid use and RMQ training. An oddball paradigm allowed tracking of changes in P3a and P3b ERPs to distractors and targets, respectively. Behavioral measures were also obtained while ERPs were recorded from participants.

Results: After 4 weeks of hearing aid use but before auditory training, HINT results did not show a statistically significant change, but there was a significant P3a reduction. This reduction in P3a was correlated with improvement in d prime (d') in the selective attention task. Increased P3b amplitudes were also correlated with improvement in d' in the selective attention task. After training, this correlation between P3b and d' remained in the experimental group, but not in the control group. Similarly, HINT testing showed improved speech perception post training only in the experimental group. The criterion calculated in the auditory selective attention task showed a reduction only in the experimental group after training. ERP measures in the auditory selective attention task did not show any changes related to training.

Conclusions: Hearing aid use was associated with a decrement in involuntary attention switch to distractors in the auditory selective attention task. RMQ training led to gains in speech perception in noise and improved listener confidence in the auditory selective attention task.

Key words: Amplification, Auditory selective attention, Auditory training, HINT, P3a, P3b, ReadMyQuips, Speech perception testing

(Ear & Hearing 2017;38;28–41)

INTRODUCTION

A fundamental issue in cognitive neuroscience research is to understand neural plasticity associated with age, experience, and pathological conditions. Individuals with hearing loss present an interesting population to study because they commonly suffer compromised speech perception, particularly in noisy group environments (Harkins & Tucker 2007), leading to significant problems in verbal communication. Interventions designed to enhance speech perception in adults have included the design of hearing aids with advanced digital signal processing algorithms and the development of novel auditory training programs (Pichora-Fuller & Singh 2006; Sweetow & Sabes 2006, 2007; see review in Pichora-Fuller & Levitt 2012). Hearing aids primarily amplify sounds to compensate for loss of audibility, although new signal-processing algorithms also aim at extracting speech cues from background noise. Auditory training programs for adults harness the plasticity of the neural system to enhance function in response to training (Buonomano & Merzenich 1998; Anderson et al. 2013).

Traditional hearing aids compensate for loss of audibility by amplifying signals, causing new hearing aid users to report immediate improvement in communication function and reduced perception of handicap (Chisolm et al. 2007). Continued use over a period of couple of months leads to even further improvements in signal detection because wearers use new sensory cues over time, a process called "acclimatization" (Gatehouse 1992; Arlinger et al. 1996). Despite gains through advanced signal-processing technology, hearing aids users report persistent problems in speech perception in the presence of noise relative to premorbid experience (Kochkin 2007, 2010). Because amplification alone cannot compensate for listening difficulties, training has been proposed to enhance this skill in adults with hearing aids and cochlear implants (Boothroyd 2007; Moore & Amitay 2007). This is possible because the adult brain retains the positive feature of plasticity, which refers to the ability to change in response to experience. Structural and physiological changes are induced in the brain as a consequence of stimulation, training, and learning (Condon & Weinberger 1991; Recanzone et al. 1993). In addition to behavioral approaches, imaging and electrophysiological techniques have been used to document these changes (Jäncke et al. 2001; see review in Tremblay & Kraus 2002).

Mechanisms of speech perception recruit both peripheral and central auditory functions (Pichora-Fuller & Singh 2006; Boothroyd 2010). Perceptual factors include audibility and processing of the acoustic elements of speech, such as temporal cues, gap detection, and frequency discrimination. Cognitive abilities of attention, memory, and comprehension also play a crucial role in difficult listening situations. Thus, successful perception of speech signals involves a combination of bottom-up (sensory) and top-down (cognitive) processes (Sweetow & Sabes, 2006; Fu & Galvin 2007; Woods & Yund 2007). Analytic or "bottom-up" training emphasizes accessing stimulus-based cues, while synthetic or "top-down" training involves improving cognitive skills. The analytic approach targets the building blocks of speech and may involve discrimination or identification of phonemes or words. In contrast, the synthetic approach

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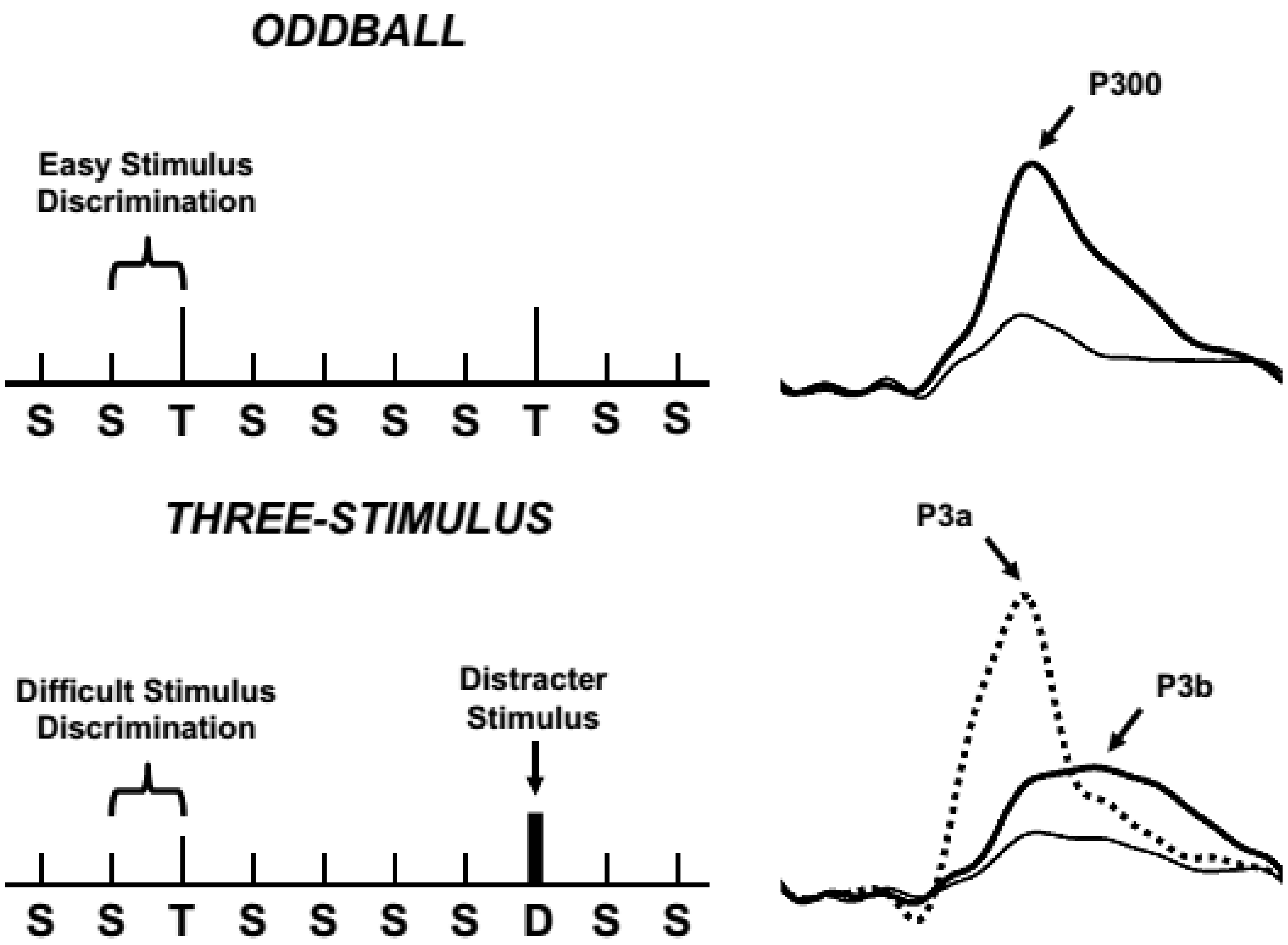
Selective Attention

- The ability to suppress irrelevant information and focus on relevant signals in the environment
- A cognitive skill of tremendous importance for everyday living and learning
- We hypothesized that participants trained with RMQ will show enhanced auditory selective attention measured using ERP components (P3b and P3a) and behavioral measures

Auditory ERP in Selective Attention



Polich, J.(2007)

P3b

- **Voluntary**
- **Task relevant**
- **Increases with cognitive effort & performance**

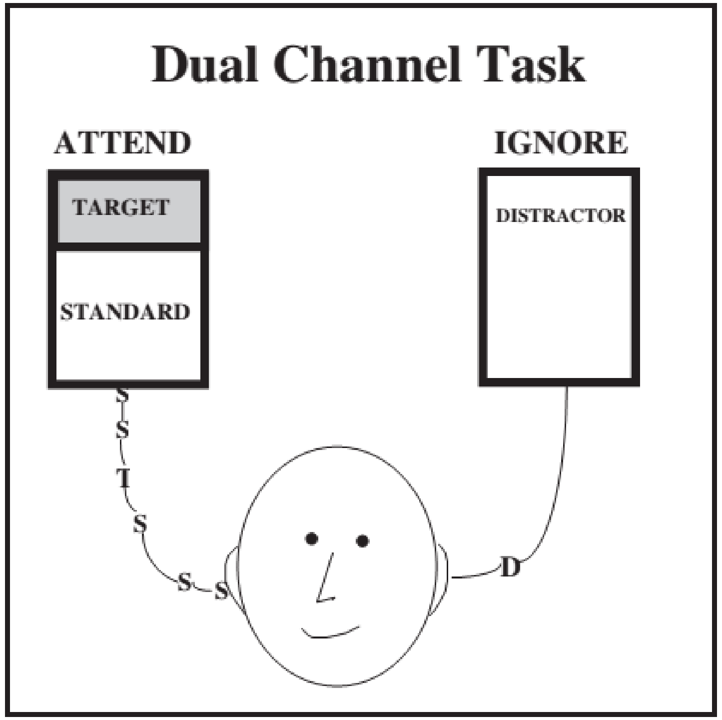
P3a

- **Involuntary**
- **Task irrelevant**
- **Increases with distractor salience**

Methodology

- Before HA fitting
- Four weeks after HA fitting

Session 1: Pretest → HA fitting → Session 2: HA posttest → Training (4 weeks) → Session 3: Training posttest

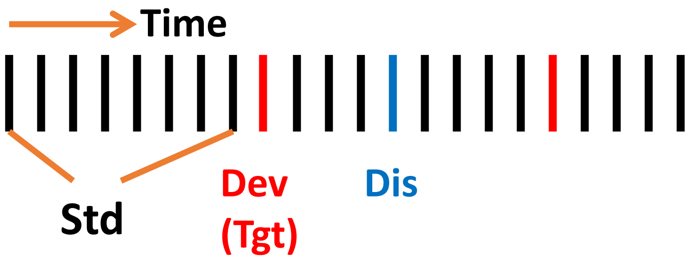


Melara, R. D., Tong, Y., & Rao, A. (2012)

Control group: Audiobooks

Experimental group: RMQ

Oddball paradigm



Training + amplification

- Reduced P3a from pretest to training posttest found in both groups, indicating reduced distractor salience after hearing aid use (and training)
- Link between changes in d' and in P3b were found only in the experimental group, indicating relationship between listening performance and task-relevant attentional allocation strengthened by RMQ training

Behavioral-ERP Correlation

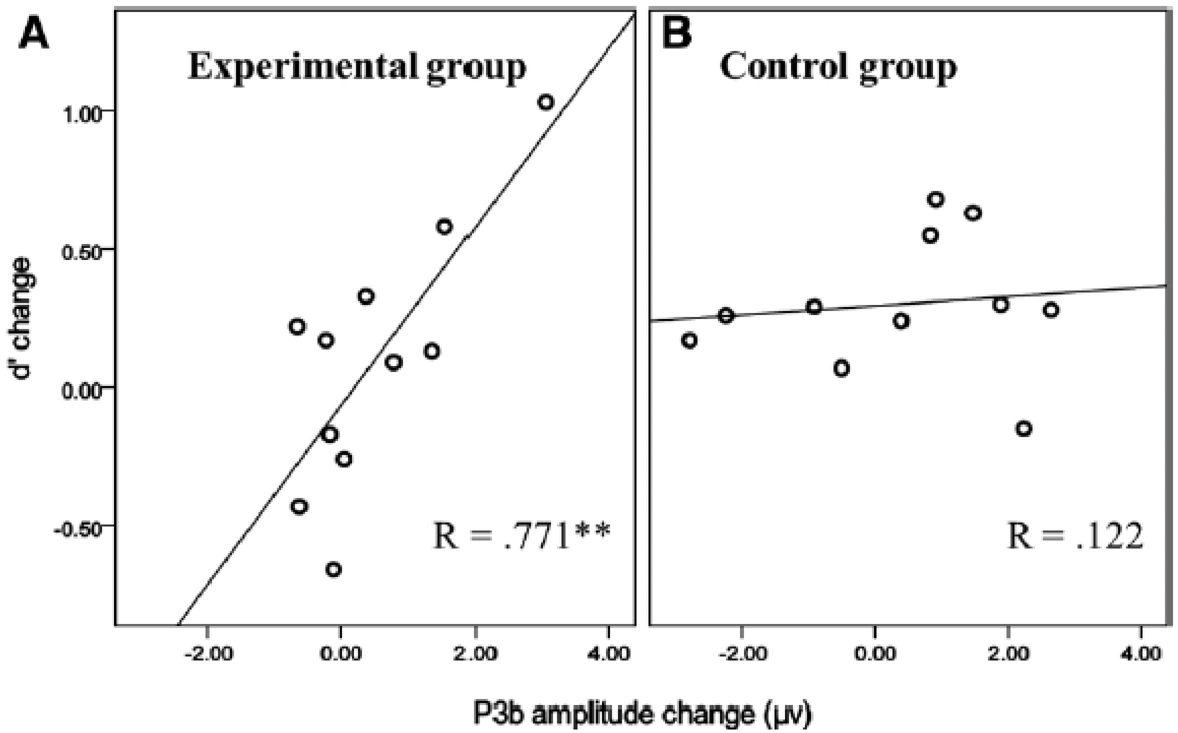


Fig 6. Correlations between change in *d′* and mean amplitude of P3b at Pz for the experimental (A) and control groups (B) are shown here. Change was measured from before training to after training. Asterisks denote statistically significant values (**p* < 0.05; ***p* < 0.01; ****p* < 0.001).

Research Note

Can a Commercially Available Auditory Training Program Improve Audiovisual Speech Performance?

Dania Rishiq,[a] Apama Rao,[b] Tess Koemer,[c] and Harvey Abrams[d,e]

Purpose: The goal of this study was to determine whether hearing aids in combination with computer-based auditory training improve audiovisual (AV) performance compared with the use of hearing aids alone.
Method: Twenty-four participants were randomized into an experimental group (hearing aids plus ReadMyQuips [RMQ] training) and a control group (hearing aids only). The Multimodal Lexical Sentence Test for Adults (Kirk et al., 2012) was used to measure auditory-only (AO) and AV speech perception performance at three signal-to-noise ratios (SNRs). Participants were tested at the time of hearing aid fitting (pretest), after 4 weeks of hearing aid use (posttest I), and again after 4 weeks of RMQ training (posttest II).
Results: Results did not reveal an effect of training. As expected, interactions were found between (a) modality (AO vs. AV) and SNR and (b) test (pretest vs. posttests) and SNR.
Conclusion: Data do not show a significant effect of RMQ training on AO or AV performance as measured using the Multimodal Lexical Sentence Test for Adults.

Audiovisual (AV) speech perception is the process by which auditory and visual stimuli are combined to perceive speech (Dey & Sommers, 2015). Seeing the articulatory gestures of the talker enhances speech perception in both listeners with typical hearing and those with hearing impairment, especially in compromised listening conditions (Erber, 1975; Sumby & Pollack, 1954). For all but listeners who are most profoundly hearing impaired, AV speech perception has been consistently superior to perception through either hearing or vision alone (Grant, Walden, & Seitz, 1998). The benefits from combining auditory and visual cues are particularly important for adults with moderate high-frequency hearing loss who often confuse high-frequency consonants auditorily. The visibility of these speech sounds combined with the partially received auditory message can help the listener with hearing impairment perceive the auditorily missing sounds (Montgomery, Walden, Schwartz, & Prosek, 1984).

Given that speech perception is a multisensory process, maximizing the ability of listeners with hearing impairment to use the combined auditory and visual information in their message perception may improve their overall speech perception and face-to-face communication. Researchers have attempted to enhance AV speech perception in adults with hearing impairment using a variety of approaches, such as AV training (Richie & Kewley-Port, 2008). There is compelling evidence that training with AV materials can improve speech-in-noise performance and enhance perceptual learning in listeners with typical hearing and those with hearing impairment, demonstrating superior effects for AV training relative to auditory-only (AO) training (e.g., Bernstein, Auer, Eberhardt, & Jiang, 2013; Kawase et al., 2009; Montgomery et al., 1984; Moradi, Lidestam, & Ronnberg, 2013; Zilber, Ciuciu, Gramfort, Azizi, & van Wassenhove, 2014). For example, Montgomery et al. (1984) provided laboratory-based AV training to adults with moderate hearing loss and assessed AV speech recognition using an AV sentence test (Walden, Erdman, Montgomery, Schwam, & Rosek, 1981). They found that patients who received concentrated exposure to AV training showed significantly greater improvements in AV sentence recognition compared with controls who received a traditional aural rehabilitation program.

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Disclosure: Harvey Abrams is employed with Starkey Hearing Technologies, which provided grant funding for this project. Starkey Hearing Technologies also distributes ReadMyQuips, a computer-based training program used in this study.

Design

- Randomized between-group, within-subjects design
- Experimental and control groups
- 12 participants in each group:
  - <u>Experimental group (HA +RMQ)</u>
    - 8 males.
    - Average age = 68 years (range 51 years to 84 years).
  - <u>Control group (HA only)</u>
    - 10 males.
    - Average age = 69 years (range 62 to 81 years).

Training protocol

- Read My Quips
  - 30 minutes per day
  - 5 days per week
  - 4 consecutive weeks
- All participants completed a written log
  - Tracked start time and end time
  - Difficulty level
- Control group participants did not receive any structured treatment

Outcomes measured using Multimodal Lexical Sentence Test for Adults (MLST- A)

- Developed by Dr. Karen Kirk and colleagues
- 12 equivalent lists
    - 24 sentences per list
- Seven to nine words per sentence
- Three key words per sentence
    - Scores could range from 0 to 3 per sentence

MLST-A

- Words controlled for lexical characteristics of frequency (how often words occur in a language) and density (number of phonemically similar words or lexical neighbors to target)

The Multimodal Lexical Sentence Test for Adults: Performance of Listeners with Hearing Loss

Karen Iler Kirk[1], Lindsay Prusick[1], Amanda Silberer[1], Laurie Eisenberg[2], Nancy Young[3], Brian French[4], Nicholas Giuliani[1], Amy Martinez[2], Dianne Ganguly[2], Chad Gotch[4], Lisa Weber[3] & Susan Stentz[3]
[1]The University of Iowa, Iowa City, IA; [2]House Ear Institute, Los Angeles, CA; [3]Children's Memorial Hospital, Chicago, IL; [4]Washington State University, Pullman, WA

Introduction

This investigation is one in a series of studies to develop the Multimodal Lexical Sentence Test for Adults (MLST-A).

Rationale
- Listeners use both auditory and visual cues to extract meaning from highly variable speech signals (e.g., different talkers, dialects, speaking rates and background noise). The addition of visual cues yields substantial gains in speech intelligibility (Sumby & Pollack, 1954). Traditional clinical tests of spoken word recognition routinely employ auditory-only presentation of words or sentences produced by a single talker using carefully articulated speech. Such constrained tests may not adequately characterize the performance of adults with hearing loss.
- The long-term goal of this project is to develop multi-talker, multimodal sentence lists, controlling for the lexical characteristics of word frequency (i.e., how often words occur in language) and lexical density (i.e., the number of phonemically similar words, or lexical neighbors to the target).

Purpose
- To examine the performance of adults with hearing loss on the MLST-A sentence lists.
- To evaluate inter-list equivalency, test re-test reliability, and validity of the MLST-A.

Test Development

Stimuli
320 sentences created by Bell & Wilson (2001)
- semantically neutral
- 7-9 words in length
- 3 key words per sentence drawn from one of four lexical categories

Table 1. Example sentences from each lexical category with key words in red

Lexical Category	Example Sentence
High-Sparse (HS)	You could use the switch near the lamp.
High-Dense (HD)	She sat against the back of the seat.
Low-Sparse (LS)	Browse through the junk to find the spool.
Low-Dense (LD)	The canned fruit made a stain on his cuff.

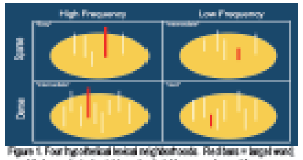

Figure 1. Four hypothetical lexical neighborhoods. Red bars = target word; white bars = lexical neighbors; bar height represents word frequency

Talker Selection
- 10 talkers (5 males and 5 females)
- selected to maximize F0 range within gender
- Standard American English dialect

Recording and Editing
- recorded in High Definition audiovisual digital format
- sentences edited and stored as separate files
- RMS amplitude equalized across sentences and talkers

Evaluating Sentence Intelligibility

Procedures
- normal hearing adults (N = 182) were randomly assigned to one talker in one presentation format (Visual [V], Auditory [A] or Auditory+Visual [AV])
- speech presented at 60 dB SPL in speech shaped noise at a SNR of 0 dB
- responses scored as %-key words correct

Results
A repeated measures analysis of variance (RMANOVA) was performed with talker and presentation format as between-subject factors and word frequency and lexical density as within-subject factors. Visual-only scores were omitted from the analysis due to floor effects.

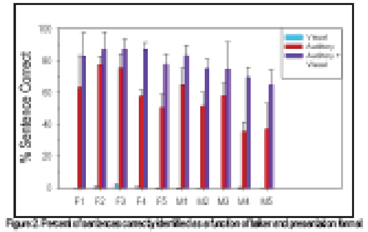

Figure 2. Percent of sentences correctly identified as a function of talker and presentation format

- presentation format ($F(1, 106) = 142.43$, $p<0.01$)
  - AV > A
- talker ($F(9, 106) = 13.08$, $p<0.01$)

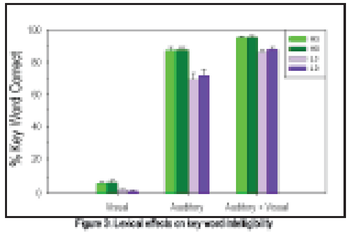

Figure 3. Lexical effects on key word intelligibility

- high frequency words > low frequency words ($F(1, 103) = 1415.03$, $p<0.01$)
- dense words > sparse words ($F(1,103) = 33.36$, $p<0.01$)

Creating Equivalent Lists
- sentences inspected across talkers within each lexical category and presentation format
  - mean key word correct was used to estimate the level of difficulty for a sentence produced by an individual talker
  - sentences with mean values outside a small range were eliminated
- remaining sentences were used to generate 30 lists
  - minimum of 2 male and 2 female talkers per list
  - 3 sentences per lexical category (12 sentences per list)
  - similar mean key word intelligibility scores within each presentation format

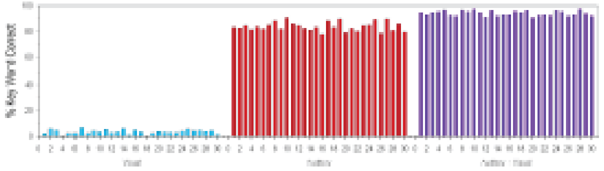

Figure 4. Mean key word correct score for equivalent lists in each presentation format (based on data from adults with normal hearing)

Methods

Participant Inclusion Criteria (N = 182)
- 18-85 years of age
- normal or corrected-to-normal vision
- oral English as the primary language
- bilateral sensorineural hearing loss
- use of sensory aid(s)
  - ≥ 6 months of current sensory aid use

Procedures
- all 30 sentence lists administered twice over 2 sessions
  - 10 lists per presentation format (V, A, AV)
  - lists assigned to each presentation format and format order were counterbalanced across participants
- 2 lists of Hearing in Noise Test were administered at one test session
- speech was presented at 60 dBA SPL in quiet
- verbal responses were scored as % key word correct

Table 2. Demographic characteristics of participants with hearing loss

	CI Users (n = 30)	HA Users (n = 32)	CI + HA Users (n = 7)
Mean Age at Test	[illegible]	[illegible]	[illegible]
Mean Age at Diagnosis	[illegible]	[illegible]	[illegible]
Duration of Hearing Loss	[illegible]	[illegible]	[illegible]
Hearing Loss Classification	[illegible]	[illegible]	[illegible]
Mean Age Fit (current device)	[illegible]	[illegible]	[illegible]
Duration of Use (current device)	[illegible]	[illegible]	[illegible]
Gender	12 males 18 females	11 males 21 females	4 males 3 females

Results

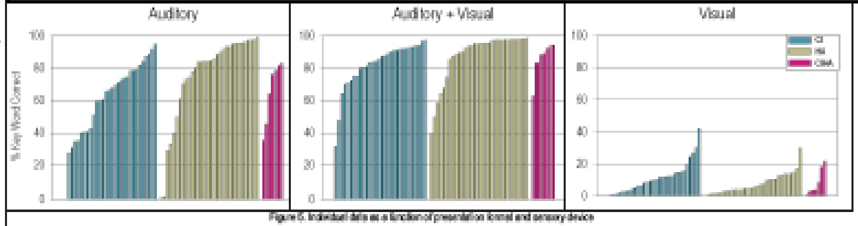

Figure 5. Individual data as a function of presentation format and sensory device

RMANOVA was computed to examine presentation format and lexical density effects. Visual-only scores were omitted from the analysis due to floor effects.

Presentation Format
- significantly influenced recognition of key words in sentences ($F(1, 67) = 120.38$, $p<0.01$)
  - AV > A

Sensory Aid Type
- trend for HA users to demonstrate better key word recognition, but this difference was not significant ($F(1, 67) = 3.89$, $p>0.01$)
- significant interaction between presentation format and sensory aid type ($F(1, 67) = 7.43$, $p<0.01$)
  - CI users showed greater increases in mean scores from the A to AV presentation (62% vs. 82%, respectively) than did the HA users (75% vs. 88%, respectively)

Lexical Effects as a Function of Presentation Format
- significant main effects
  - word frequency
    - high frequency words (M = 88%) > low frequency words (M = 69%) ($F(1, 67) = 264.05$, $p<0.01$)
  - lexical density
    - dense words (M = 78.40) > sparse words (M = 76.13) ($F(1, 67) = 28.36$, $p<0.01$)
- significant interaction between word frequency and presentation format ($F(1, 94) = 24.87$, $p<0.01$)
  - The difference between scores for low frequency vs. high frequency words was greater in the A presentation format (61% vs. 80%, respectively) than in the AV presentation format (77% vs. 91%, respectively).

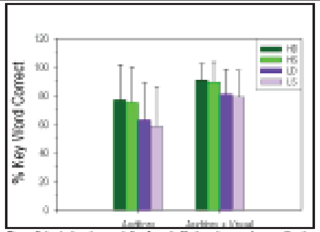

Figure 6. Lexical and presentation format effects on key word recognition by adults with hearing loss

Inter-List Equivalency
- An effect size measure (Cohen's d) was used as a measure of difference between lists within a given presentation format.
  - d was computed for all pairwise comparisons
  - 30 lists X 29 comparisons = 870 comparisons per presentation format
  - Each list yielding d > 0.50 for 50% or more comparisons (~17 lists) were flagged for further inspection.

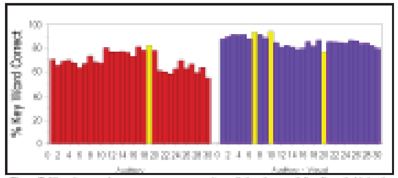

Figure 7. Mean key word accuracy scores per sentence list and presentation format obtained by adults with hearing loss (yellow bars represent lists needing further inspection)

Test-Retest Reliability and Validity
- MLST-A score stability was assessed by correlating scores from test session 1 and 2.
- Validity of the MLST-A was assessed by correlating scores in the A presentation format with scores on the HINT.

Table 3. Correlational coefficients

Presentation Format	Test-Retest Reliability	Validity
Visual	r = 0.87*	N/A
Auditory	r = 0.95*	r = 0.79*
Auditory + Visual	r = 0.94*	N/A

*p<0.01

Discussion and Future Directions

Strengths of the MLST-A
- based on strong psychometric principles
- incorporates "real-world" stimulus variability
  - multiple talkers
  - different presentation formats
- reliable and valid in adults with hearing loss
- multiple lists are equivalent in all 3 presentation formats

Future Directions
- establish normative data
  - degree of hearing loss
  - sensory aid type
- evaluate performance in noise

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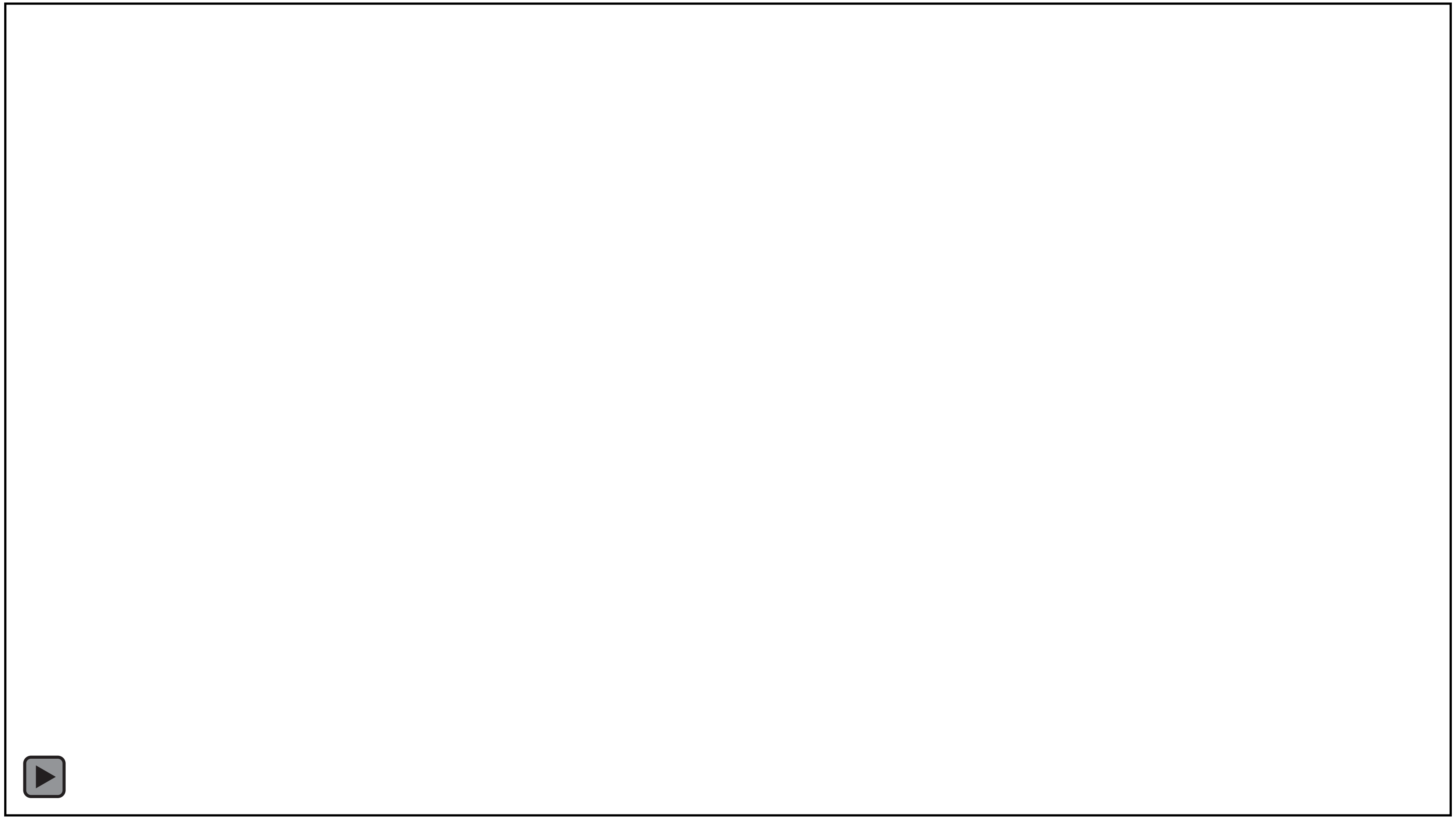
MLST – A

- Five male and five female talkers
- For this study, administered in AO and AV modes

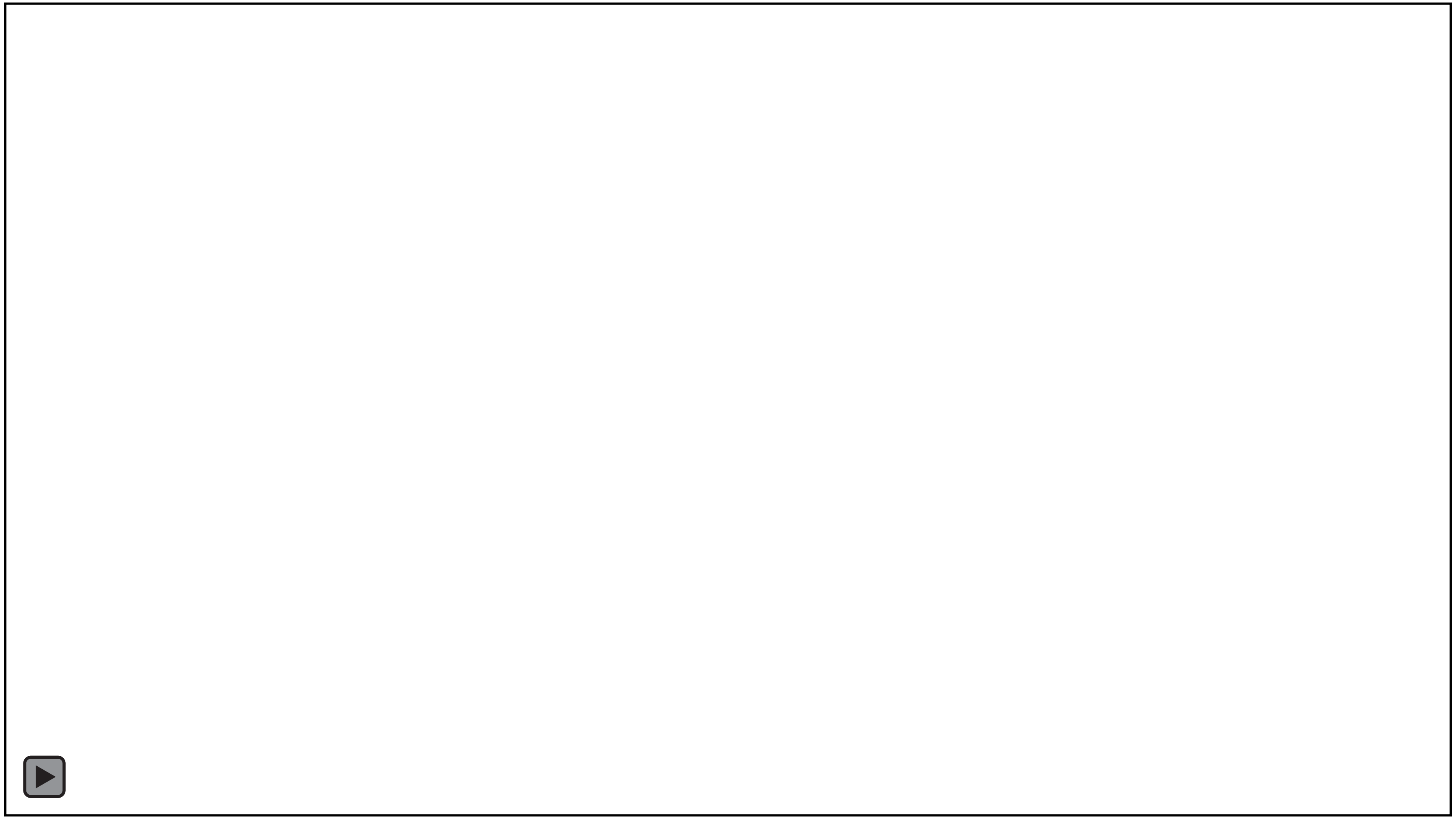
- Presentation Level
  - 60 dB SPL
- Three signal-to-noise ratios (SNRs)
  - +5 dN
  - 0 dB
  - - 5 dB
- Mode of presentation (AO vs AV) and SNR randomized for testing

Total of 6 Test Conditions		
AO (-5 dB SNR)	AO (0 dB SNR)	AO (5 dB SNR)
AV (-5 dB SNR)	AV (0 dB SNR)	AV (5 dB SNR)

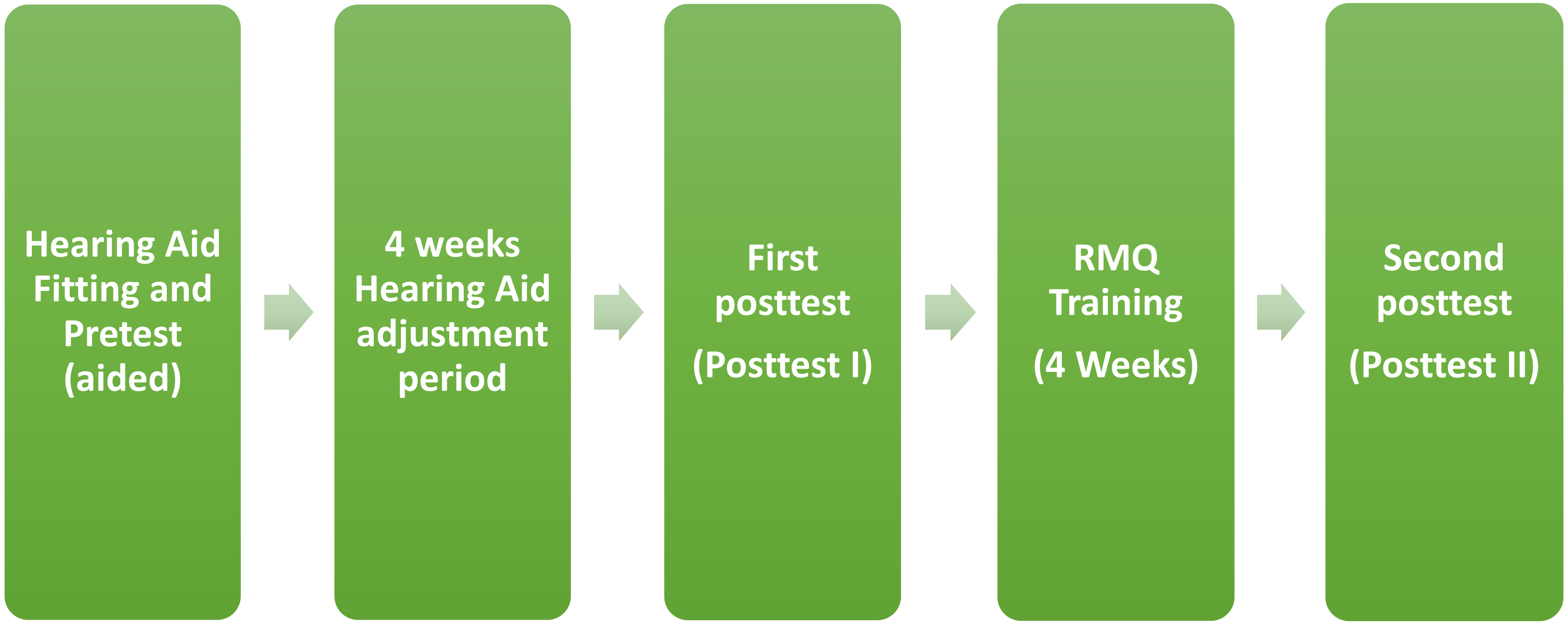
MLST – A



MLST – A



Study Timeline



Participants were tested at the time of hearing aid fitting, after four weeks of hearing aid use, and after four weeks of RMQ training.

Results

Randomized between-group, within-subjects repeated measures ANOVA
Main effects

Main Effects	**F-values**
Test: 3 levels Pretest vs. posttest 1 vs. posttest 2	$F\ (2, 44) = 2.3,\ p = .12$
Mode: 2 levels AO vs. AV	$\mathbf{F\ (1, 22) = 205,\ p < .01}$
SNR: 3 levels + 5 dB, 0 dB, -5 dB	$\mathbf{F\ (2, 44) = 520,\ p < .01}$

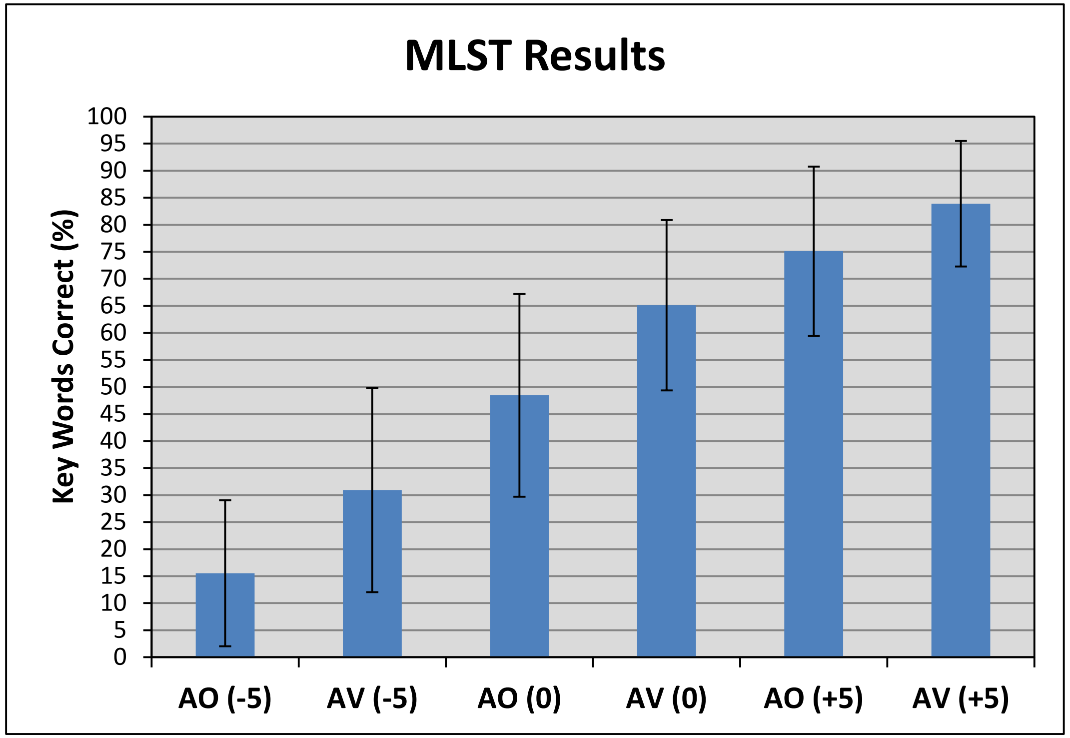
Interactions

Interactions	F values
Test × SNR	$F(4, 88) = 3.9$, $p < .01$
Mode × SNR	$F(2, 44) = 8.2$, $p < .01$

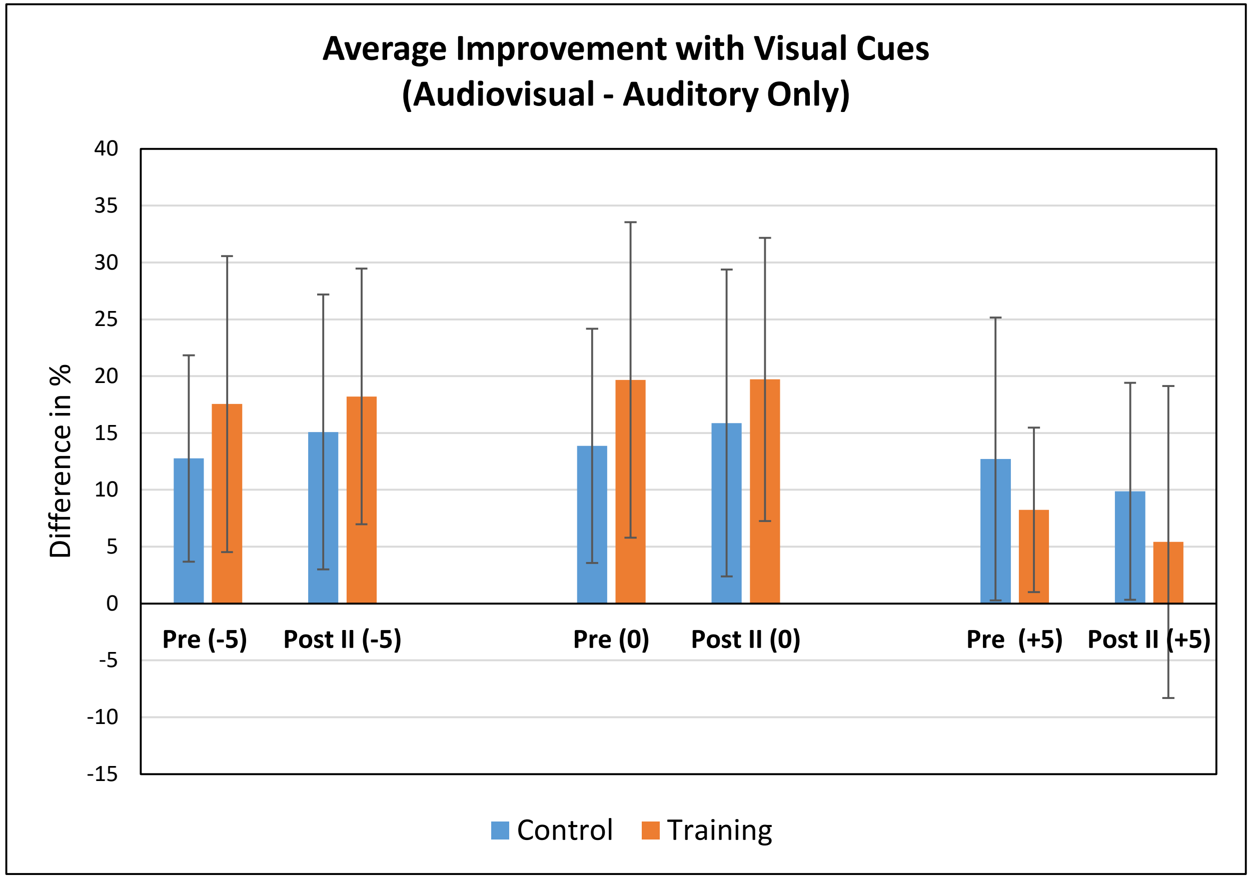
** None of the interactions involving Group significant

Results

- <u>Interactions</u>
- Mode × SNR
  - AV scores always greater than AO scores
  - Scores at +5 dB SNR > scores at 0 dB SNR > scores at -5 dB SNR



Results



Average Improvement with Visual Cues
(Audiovisual - Auditory Only)
Difference in %
40
35
30
25
20
15
10
5
0
-5
-10
-15
Pre (-5)
Post II (-5)
Pre (0)
Post II (0)
Pre (+5)
Post II (+5)
Control
Training

Summary

- The availability of visual speech cues improved speech perception (consistent with the literature)
- RMQ training did not improve audiovisual speech perception as measured using the MLST-A
  - Regardless of SNR and mode, changes were not seen
- Enhancement from visual cues varied significantly across subjects
  - One individual showed a difference of 45% with addition of visual cues at 0 dB SNR at posttest I

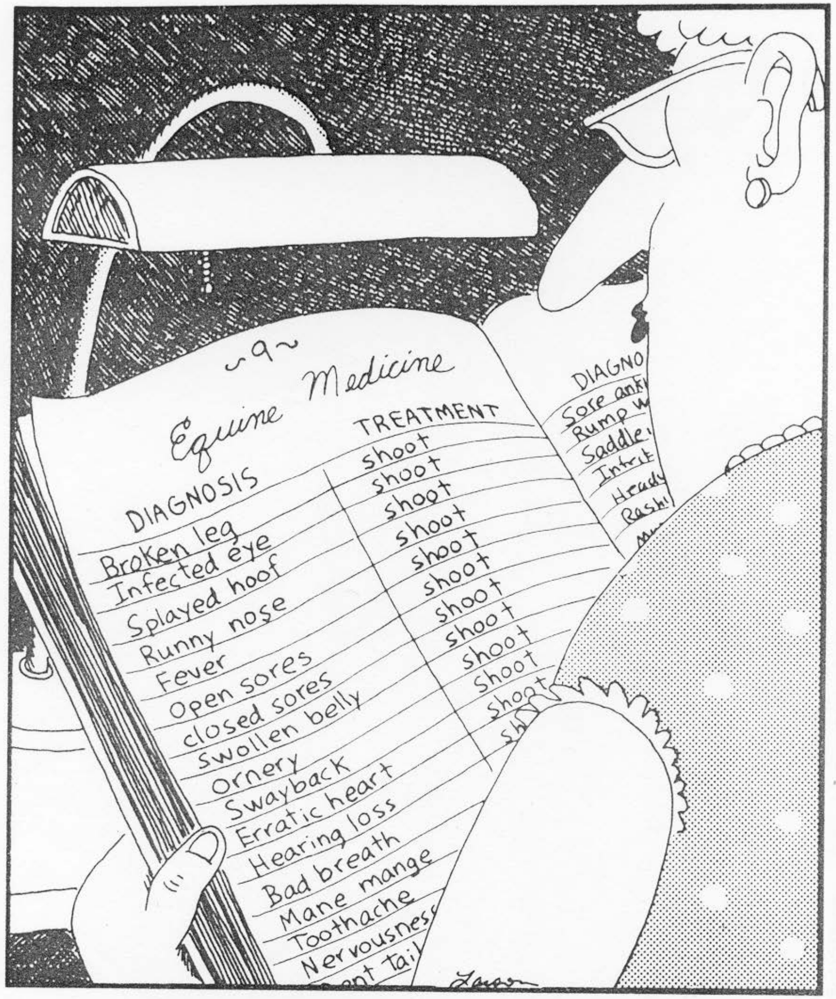
Discussion

- Possible explanations for lack of AV benefit:
  - Training exposure was insufficient
  - Training not designed to achieve criterion level at various difficulty levels
  - Participants were advised to challenge themselves, but varied in their ability to do so
  - Participants were individuals with acquired hearing loss in the mild to severe range
    - They did not have to rely on visual cues and speechreading as much as individuals with congenital severe profound hearing loss

Overall Summary

- Several studies since Henshaw & Ferguson (2013) have added to the literature
  - equivocal support for the benefits of computerized AT in its present form
- Compliance matters
  - Even in closely controlled research protocols, compliance was a challenge
  - Clinicians must carefully monitor patient compliance
  - AT must be engaging for the patients
    - Create meaningful reward incentives

Lessons Learned



Like most veterinary students, Doreen breezes through chapter 9.

Thank You

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