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Tailoring Auditory Training to Patient Needs with Single and Multiple Talkers: Transfer-Appropriate Gains on a Four-Choice Discrimination Test

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Abstract

OBJECTIVE—Our long-term objective is to develop an auditory training program that will enhance speech recognition in those situations where patients most want improvement. As a first step, the current investigation trained participants using either a single talker or multiple talkers to determine if auditory training leads to transfer-appropriate gains.

DESIGN—The experiment implemented a 2 × 2 × 2 mixed design, with training condition as a between-participants variable and testing interval and test version as repeated-measures variables. Participants completed a computerized six-week auditory training program wherein they heard either the speech of a single talker or the speech of six talkers. Training gains were assessed with single-talker and multi-talker versions of the *Four-Choice Discrimination Test*. Participants in both groups were tested on both versions.

STUDY SAMPLE—Sixty-nine adult hearing-aid users were randomly assigned to either single-talker or multi-talker auditory training.

RESULTS—Both groups showed significant gains on both test versions. Participants who trained with multiple talkers showed greater improvement on the multi-talker version whereas participants who trained with a single talker showed greater improvement on the single-talker version.

CONCLUSION—Transfer-appropriate gains occurred following auditory training, suggesting that auditory training can be designed to target specific patient needs.

Keywords

auditory training; second language acquisition; hearing loss; hearing aids

Introduction

To our knowledge, no group of researchers has published a report describing the reasons that adults with impaired hearing seek auditory training. We do know that only a minority of adults receive auditory or listening training; for instance, Schow et al. (1993) reported that only 15.6% of the audiologists they surveyed provide auditory training to their patients. We

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also know that many adults who enroll in a training regimen fail to comply with the procedures. Sweetow and Sabes (2010) recently reported that out of over 3,000 patients who enrolled in the *Listening and Communication Enhancement (LACE)* computerized-based auditory training program, less than 30% of them completed ten lessons or more.

In our clinical experience providing auditory and speechreading training to adults who use either hearing aids or cochlear implants (cf., Tye-Murray et al., 1988), we have noted two prevalent reasons that motivate patients to seek training. One reason is that they want to better understand spoken language as they interact with persons in their community and in their workplace. For instance, they hope to better recognize the speech of store clerks, medical personnel, casual acquaintances, and fellow employees. In response to this need, our early work with developing computerized speechreading training programs provided situation-specific training, and training exercises included vocabulary that one might encounter in, say, a shoe store, a restaurant, an office, or a physician's office. Training items were spoken by a variety of talkers (Tye-Murray, 1992, Tye-Murray, 2002). The goal was to enhance patients' abilities to understand utterances spoken by everyday communication partners (ECPs) across a range of listening situations that they might typically encounter on a daily basis.

The second reason that patients often seek speech perception training in our facilities is to enhance their ability to understand the speech of a particular communication partner (PCP). A patient might want to better understand the speech of his or her domestic partner or might want to better understand the speech of an adult child, a grandchild, or a direct supervisor (boss) in the workplace. Indeed, it is not uncommon for the PCP to be the instigator of the training experience, imploring and encouraging the patient to seek assistance from our audiological staff beyond just acquiring a listening device.

The possibility that patients may enroll in auditory training for one of these two reasons motivated the present investigation. We sought to determine whether we might tailor training in response to a particular motivation, and whether by so doing, we would enhance the abilities of patients to better recognize the speech of a relatively large number of talkers (i.e., six) or to better recognize the speech of a PCP. Our overriding objective is to develop auditory training programs that will meet with patients' expectations of benefit and that will also provide benefit in the specific situations that individuals most want to improve their understanding of spoken communications. As a first step towards meeting this objective, we determined whether training patients to recognize a single talker would lead them to recognize the speech of that talker better than would a group of patients who had received training in recognizing the speech of a group of talkers, and conversely, whether training patients to recognize multiple talkers would lead them to recognize the speech of those talkers better than would a group of patients who had received training in recognizing the speech of a single talker.

Our approach to tailoring auditory training to the specific goals of individual patients is derived from the Health Behavior Model of Medical Compliance in which one of the principal determinants of adherence is the value placed by an individual on a particular goal. A critical first step in applying this model is to establish whether specific training protocols--in this case single-talker versus multi-talker auditory training--provide differential benefit when patients are asked to listen to the speech of either a single talker or of multiple talkers. Recent findings from cognitive training (Edwards et al., 2002, McArdle & Prindle, 2008) indicate that near transfer – in which training and testing exercises target similar abilities (e.g., training on working memory to improve working memory abilities) – is far more effective than far transfer – in which training on general abilities (e.g., executive functions) is used to improve specific cognitive functions (e.g., working memory). Applying these results to auditory training led us to predict that near transfer (training and testing with single talkers; training and testing with multiple talkers) would lead to greater improvements than far transfer (training on single talkers, but testing on multiple talkers; training on multiple talkers, but testing on single talkers).

Existing evidence suggests that both multi-talker and single-talker auditory training approaches can be effective. In terms of multi-talker training, a series of second language (L2) learning studies (Bradlow et al., 1997, Hardison, 2003, Lively et al., 1993, Lively et al., 1994, Logan et al., 1991) have demonstrated that acoustically varied presentation formats can be used to train learners on challenging L2 phonemic contrasts, such as the contrast between liquid consonants /r/ and /l/ in English for many native Japanese speakers of English. Another series of experiments (Barcroft & Sommers, 2005, Sommers & Barcroft, 2007) revealed that L2 vocabulary learning substantially improves in an additive matter when target words in the input are presented in acoustically varied formats based on phonetically relevant sources of variability, such as talker characteristics, speaking style, and speaking rate. More recently, Sommers, Barcroft, and Mulqueeny (2008) demonstrated the positive effects of talker variability on first language vocabulary learning among adults learning low-frequency vocabulary. For instance, a student will more effectively learn a new word if he or she hears it spoken by more than one talker, in a contrasting fashion, than if it is spoken by only one talker. Based on these earlier investigations, the first working hypothesis for the current study was that individuals trained with multiple talkers will exhibit improved word discrimination, especially when test items are spoken by multiple talkers.

Support for using single-talker auditory training to enhance recognition of a PCP’s speech comes from the literature pertaining to talker normalization and talker familiarity. Listeners may gradually acquire information about the properties of a talker’s productions based on accurate encoding and perception of linguistic content and use this information to map highly variable acoustic productions onto individual representations (Nygaard & Pisoni, 1998, Remez et al., 2007, Remez et al., 1997, Sheffert et al., 2002). In addition, the findings from these studies demonstrate that prior exposure to a given talker’s voice substantially improves subsequent speech recognition for items spoken by that talker compared to an unfamiliar talker. Through auditory training, listeners may learn pertinent information about the idiolect (the “dialect” of an individual) of a given talker. When asked to identify utterances by this same talker, individuals can use memory for the ideolectic information as an additional basis for making perceptual decisions. Thus, the second working hypothesis for the current investigation was that training with single talkers will be most beneficial when testing is also restricted to that same single talker.

The effectiveness of auditory training programs that incorporate either a single talker or multiple talkers has not been well studied, in part, because of the paucity of quality research available about auditory training in general. Sweetow and Palmer (2005) identified 213 peer-reviewed studies with a primary emphasis on auditory training. Of those, six (about 3%) provided data adequate for evaluating training efficacy, and one (Montgomery et al., 1984) concerned auditory-visual (speechreading) training. The five auditory training programs utilized single-talker rather than multi-talker training (Bode & Oyer, 1970, Kricos et al., 1992, Kricos & Holmes, 1996, Rubinstein & Boothroyd, 1987, Walden et al., 1981). No direct comparison has been made between single- and multi-talker approaches.

Two recent investigations, one of which involved multi-talker auditory training and one of which involved single-talker training, suggest that both kinds of approaches are beneficial, although they too, do not permit a direct comparison of the differential efficacy of single-versus multi-talker training. In a multi-talker study, Burk and Humes (2008) trained eight older listeners with hearing loss to recognize a set of 150 words spoken by six different talkers throughout training. Following training, participants improved in their abilities to recognize the 150 words spoken by the now familiar six talkers, as well as the same set of words spoken by an unfamiliar talker (i.e., someone not used in training). Improvements did not generalize to new and untrained words or keywords in sentences, either when spoken by a familiar or an unfamiliar talker. In another study, Burk, Humes, Amos and Stauser (2006) provided single-talker training to seven older adults who had hearing loss, again using a limited set of words (n=75). The participants improved dramatically on the trained words but improved only marginally on a list of untrained words. There was no advantage associated with the words spoken by the talker used in training versus the two unfamiliar talkers. This last finding is contradictory to the investigations described previously in which single-talker training was found to be talker specific and suggests that further investigation are needed to establish whether auditory training can be designed to improve speech recognition for a PCP.

At least one previous study examined the differential effectiveness of two distinct auditory training methods. Bode and Oyer (1970) provided auditory training to two separate groups of participants, which included open-set versus closed-set response formats. They found that participants trained with the closed-set response formats showed more improvement on a closed-set post-training test whereas participants trained with an open-set response format improved more on an open-set test (W-22), although the trends were not significant. They suggested that open-set and closed-set training most affect the corresponding types of speech discrimination tasks.

These results support our presumption that auditory training can be tailored to meet specific patient demands and serve as evidence for the applicability of transfer appropriate processing (TAP; Morris et al., 1977) within the field of auditory training. According to TAP theory, human memory/learning depends upon the degree of compatibility between the tasks that one performs at the times of study and testing. The more similar tasks are at these two times, the better the memory/learning. Much of the research support for TAP has involved semantic versus structural tasks. Morris, Bransford, and Franks (1977), for example, found that participants who answered semantically oriented questions about words at study performed better on a standard recognition test than those who had completed a structurally oriented rhyming task at study; however, those who had performed the rhyming task at study performed better on a test that was structurally oriented (one that required making judgments about the sounds of words). Barcroft (2002) also demonstrated TAP effects in L2 vocabulary learning. In that study, English-speaking L2 Spanish learners made pleasantness ratings about word meanings (a semantic task) and counted the number of letters in words (a structural task) while attempting to learn a set of novel Spanish words. During subsequent free recall tasks, the participants recalled more words in the pleasantness-ratings condition when free recall was in English, that is, when participants attempted to recall the English counterparts of the target words (a classic levels-of-processing effect; see Craik & Lockhart, 1972), but more words in the letter-counting condition when free recall was in Spanish (an inverse levels-of-processing effect that is consistent with TAP). In other words, the structural letter-counting task was more *transfer appropriate* for learning new word forms as compared to the semantic pleasantness-ratings task, and the semantic task was more transfer appropriate for recalling word forms that already knows (in this case, L1 English words acquired well before the study). We believe that the relative transfer appropriateness of different tasks is an important issue in the area of auditory training as well. When patients come in with specific listening complaints, such as an inability to understand a particular family member’s speech, a TAP perspective would suggest that it is possible to tailor training to address this exact problem.

In the present investigation, we presented multi-talker auditory training to one group of adults who have hearing loss and single-talker auditory training to another group. In the first phase of what is to be a longitudinal study of the benefits of multi- and single-talker auditory training, we asked whether single-talker training resulted in greater gains for a single-talker four-choice speech discrimination task than for a multi-talker speech discrimination task, and whether multi-talker training resulted in greater gains for a four-choice multi-talker speech discrimination task than for a single-talker task. If the predictions of TAP are applicable in this area of auditory training, we would expect any gains observed for training to be more pronounced in the single-talker condition when testing was based on the single talker in question and more pronounced in the multi-talker condition when testing was based on the multiple talkers.

Methods

Participants

Participants consisted of 69 adults aged 18 to 89 years (M=66 years, SD= 16 years) who wore at least one hearing aid. They were randomly assigned to either the multi-talker auditory training group (MTG) or the single-talker auditory training group (STG). If assigned to the STG, they were then randomly assigned one of the six talkers for training (these were the six talkers used in the multi-talker training condition). To control for possible intelligibility differences in our six talkers, each of the talkers were assigned to approximately equal number of participants from the STG. The MTG consisted of 18 males aged 18 to 87 years (M= 67 years, SD= 17 years) and 17 females aged 23 to 89 years (M=62 years, SD=20 years). The STG consisted of 21 males aged 46 to 89 years (M=70 years, SD= 10 years) and 13 females aged 22 to 87 years (M=64 years, SD= 18 years). Table 1 displays means and standard deviations for pure-tone averages (PTAs), duration of hearing loss, NU-6 word identification, and age for participants in the STG and MTG. As shown in the far right column, none of the differences between participants in the two groups reached statistical significance, indicating that participants were well-matched on these measures.

Description of the Auditory Training Program and Procedures

The program, entitled *I Hear What You Mean*, so called because of its emphasis on meaning-based training, included 12 lessons, with five activities in each lesson. Activities were always completed in order from Activity 1 to Activity 5. Lessons took approximately one hour to complete and each one focused on a particular theme, such as *family*. Activity 1 focused on sound identification in a manner that introduced the theme of the lesson; Activity 2 was a meaning-oriented picture-based four-choice discrimination task; Activity 3 involved completing sentences; Activity 4 required meaning-oriented contextualized sentence-identification; and Activity 5 entailed listening comprehension. Each lesson focused on one of the three principal types of phonetic contrasts – manner, place, or voicing – that are well established as being important for understanding English words. Participants completed two lessons per week for six weeks for a total of 12 training sessions. A lesson required approximately one hour to complete.

Training occurred in our laboratory, a setting that resembles an audiological clinical testing area. All training stimuli were presented in an auditory-only condition in four-talker babble while participants were seated in a single-walled sound-attenuating booth. Within and across training sessions signal-to-babble ratios (SBR) were set adaptively so as to maintain approximately 80% items correct during the training activity. The participants used an ELO 17-inch touch screen monitor to select responses. Participants completed the training at their own pace. An audiologist was available to greet participants and to answer questions, but was not involved directly in the training activities. Participants who completed the multi-talker training listened to six different talkers, three men and three women, throughout the entire program. The six talkers were culled from a pool of 14 candidate actors who auditioned for inclusion. To ensure that talkers in the multiple talker condition were clearly discriminable, the six talkers were selected to have a wide range of fundamental frequencies so as to provide variability across the speech spectrum. For the vowel /u/, for example, the three female speakers' fundamental frequencies ranged from 191 to 220 Hz and the three male speakers' ranged from 108 to 206 Hz.

Test Measure and Procedures

Participants underwent a thorough assessment battery pre- and post-training, that included such tests at the *Iowa Consonant Test* (Tyler et al., 1986) and the *Build-A-Sentence Test* (Tye-Murray et al., 2008). We present results from the *Four-Choice Discrimination Tes*t because it represents one of the earliest stages of auditory skill development (e.g., Erber, 1982) and because it was the sole test that allowed us to compare directly the effects of training with the six talkers from our auditory training program versus training with only one of the six talkers. The test consisted of 144 two-word combinations presented in an auditory-only condition. For the test, the two-word combinations were presented in four-talker babble at +2 SBR so that a percent correct score could be obtained as opposed to the adaptive procedure used during training. Participants heard two words (e.g., "bat" -"mat") followed by four pictures representing each of the possible combinations of these two words (e.g., one picture would show a bat then a mat, another would show a mat followed by a bat, another would show two mats, and the final one would show two bats). The first six word combinations were practice items followed by 46 word combinations in each of three different test conditions (single, multi, filler). Filler items, which were not analyzed, were spoken by a talker who was not part of the training program. In the single-talker test, individuals who were trained using only a single talker heard that same talker produce all of the test items, whereas for individuals trained with multiple talkers, the talker was one of the six (selected pseudo-randomly) whom they heard during training. For the multi-talker test version, all six talkers spoke items. For each trial in the multi-talker test version, the two words were spoken by different talkers (selected pseudo-randomly on each trial). Presentations were blocked by condition (single, multi, filler) with order of condition counterbalanced such that approximately equal numbers of participants in the STG and MTG heard each test version (single, multi, filler) first, second and third about 1/3 of the time.

Participants sat in a sound-treated booth in front of an ELO 17-inch touch screen monitor. Written instructions for the test were printed on the screen and were verbally reviewed by the experimenter. The participants were instructed to touch the box that had pictures of the words they heard in the sequential order that they were presented. The test words were presented at 62 dB SPL at a +2 SBR through 2 loudspeakers placed at 45 degree angles on either side of the participant.

Results

In order to assess the gains accrued from auditory training as a whole, we combined the results for both test versions (i.e., single-talker and multi-talker) and both training groups (i.e., STG and MTG) and compared the mean percent correct scores obtained prior to and after auditory training. Figure 1 shows that on average, participants improved by 13.7 percentage points on the single-talker and multi-talker versions of the *Four-Choice Discrimination Test*.

Of particular importance for the current investigation is the extent to which training benefits were specific to the type of training received. Figure 2 displays percent correct identification as a function of testing interval (pre- versus post-training) for four conditions resulting from the orthogonal combination of single-/multi-talker training and single-/multi-talker testing. For the multi-talker test version (closed symbols), participants in the MTG scored slightly poorer (M=54%, SD=15.01) on average than those in the STG (M=55%, SD=16.43) prior to engaging in auditory training, but outscored the STG following completion of training (MTG: M=69%, SD=14.55 and STG: M=65%, SD=15.87). For the single-talker test (open symbols), participants in the MTG scored better (M=65%, SD=20.51) on average at the pre-training test interval than participants in the STG (M=61%, SD=20.64), but scored worse than the STG following auditory training (MTG: M=76%, SD=14.95 and STG: M=79%, SD=13.84). This type of double dissociation between training condition and testing condition provides evidence for transfer appropriate training effects.

To further examine the findings in Figure 2, a three-way mixed design analysis of variance (ANOVA) was conducted. Percent correct scores from the pre- and post-training test intervals and two versions of the *Four-Choice Discrimination Test* (multi-talker and single-talker) were entered as repeated-measures variables whereas training group was entered as a between-subjects variable. Results of the three-way ANOVA indicated a main effect for the test interval, with the post-training test interval average 13.7 percentage points higher than the pre-training test interval ($F(1, 67) = 173.8$; $p <.0001$; $\eta^2_p = .722$), and a main effect for test version, with scores on the single-talker test version higher than scores on the multi-talker version ($F(1, 67) = 75.0$; $p <.0001$; $\eta^2_p = .582$). Results from the between-subjects comparisons did not indicate an effect for training group ($F(1, 67) =$; $p =.851$). Although no two-way interactions were found, results must be interpreted in light of a three-way interaction between test interval, training group, and test version ($F(1, 67) = 12.5$; $p <.01$; $\eta^2_p = .157$).

To determine the source of the three-way interaction, separate mixed-design two-way ANOVAs, one with only the MTG and the other with only the STG, were conducted. For both analyses the pre- and post-training scores along with test version were entered as repeated-measures variables. Results for the MTG revealed a main effect for test interval ($F(1, 34) = 79.8$; $p <.0001$; $\eta^2_p = .701$), indicating that participants improved significantly from pre- to post-training, and also indicated a main effect for test version ($F(1, 34) = 5.3$; $p <.0001$ $\eta^2_p = .447$), indicating that the MTG's performance on the multi-talker post-training *Four-Choice Discrimination Test* was significantly better than that on the single-talker post-training *Four-Choice Discrimination Test*. Although it failed to reach significance, the interaction between test version and test interval approached statistical reliability ($F(1, 34) = 3.2$; $p = .084$ $\eta^2_p = .085$). Parallel analyses for the STG also indicated significant improvement from pre- to post-training ($F(1, 33) = 94.7$; $p <.0001$; $\eta^2_p = .742$), and revealed a main effect for test version ($F(1, 33) = 53.4$; $p <.0001$; $\eta^2_p = .618$). In contrast to the MTG, the percent correct scores for the STG showed a significant interaction between test version and test interval ($F(1, 33) = 10.0$; $p <.01$; $\eta^2_p = .233$). To investigate the interaction, Bonferroni corrected post-hoc tests comparing the STGs pre- and post-training scores for both versions of the test were conducted. The results revealed that scores from both versions showed improvement following training ($p < .001$ for both comparisons). Results of the post-hoc testing, along with the findings shown by Figure 2, suggest that the two-way interaction for the STG was due to the larger improvement in pre- to post-training scores on the single-talker *Four-Choice Discrimination Test* relative to the scores for the multi-talker test version (improvement = 17.7 and 10.5 respectively).

In summary, the results indicated significant changes in the percent correct scores for both types of training and on both versions of the *Four-Choice Discrimination Test*. Also, results from the subsequent two-way ANOVAs indicated that the likely cause of the three-way interaction in the three-way ANOVA was the result of the relatively disproportionate gains from pre- to post-test made by the STG on the single-talker test. The results of the three-way interaction, along with an inspection of Figure 2, suggest that the STG improved more on the single-talker test version than the MTG.

To investigate the possibility that one or both groups contained potential outliers that may be influencing the amount of gains, scatter plots comparing pre- and post-training scores for both versions of the *Four-Choice Discrimination Test* were created. Figure 3 shows that most data points are above the equality line, indicating that nearly all participants, regardless of group, showed some degree of improvement after training. The scatter plots also suggest transfer-specific training effects because the only two data points below the unity line in the multi-talker testing condition were collected from participants in the STG and three of the four data points below the unity line in the single-talker testing condition were collected from participants in the MTG.

Discussion

The goal of the present investigation was to determine whether auditory training can be tailored to affect patients' ability to discriminate speech spoken by a PCP or by ECPs. The results indicated that patients who received auditory training that features the speech of only one talker, or a PCP, improved their discrimination of the talker's speech more so than patients who received auditory training that features the speech of several talkers. Although less compelling, the results also indicated that patients who receive auditory training that features the speech of several talkers, or ECPs, will likely improve their discrimination of multiple talkers' speech more so than patients who receive auditory training that features the speech of a single talker. Taken together, these results suggest that it is possible to tailor auditory training to meet specific patient needs and that transfer-appropriate gains can be realized. From a clinical perspective, these findings suggest that a patient who wants to improve communication with a PCP (such as a domestic partner) might engage in single-talker auditory training, with the individual's PCP speaking the training items. Conversely, a patient who desires to improve communication with the community at large might instead engage in multi-talker auditory training.

From a larger theoretical perspective, the present findings of transfer-appropriate gains, wherein single-talker auditory training led to greater gains on the single-talker *Four-Choice Discrimination Test* and multi-talker auditory training led to greater gains on the multi-talker *Four-Choice Discrimination Test*, suggest that TAP (Morris et al., 1977), a theory originally designed to make predictions about the relationship between task type and learning outcomes in the area of human memory, is applicable to auditory training as well. We interpret the results as a call for additional consideration of how TAP may be applied to other issues in auditory training. For example, is auditory training that involves attention to meaning more transfer appropriate for communicative situations that involve meaning in the real world when compared to auditory training that focuses on form only (e.g., a same-different task for a series of syllables)? From a TAP perspective, the answer to this question would be "yes." Applying the TAP perspective to auditory training in this manner may offer a fruitful and exciting new approach to addressing a variety of issues and challenges in auditory training.

More globally, the present results suggest that auditory training is beneficial, as both the MTG and STG realized significant gains following training. Scores on the two versions of the *Four-Choice Discrimination Test* improved by between 10 percentage points (the STG for the multi-talker test) and 17 percentage points (for the STG for the single-talker test). This finding is encouraging given that previous investigators have reported modest or no gains (see Sweetow & Palmer, 2005, for a review). We have recently reported evidence that auditory training can lead to qualitative improvements in listening as well as to measurable improvements in speech identification. We analyzed participants' responses to a questionnaire that queried them about their subjective assessment of the *I Hear What You Mean* auditory training program. Participants indicated that their participation in auditory training was beneficial in terms of enhancing their listening performance in everyday communication situations and in bolstering their self-confidence in their listening abilities (Tye-Murray et al., submitted).

Conclusions

The experimental results, which showed impressive gains following auditory training on two Four-Choice Discrimination Tests, speak to the long-term potential of designing programs that aim to achieve transfer-appropriate gains and speak to the potential of designing auditory training programs that are responsive to the needs of patients.

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ACRONYMS/ABBREVIATIONS

ECP	everyday communication partner
L2	second language
MT	Multi-talker
MTG	Multi-talker training group
PCP	particular communication partner
SBR	signal-to-babble ratio
SLA	second language acquisition
ST	Single-talker
STG	Single-talker training group
TAP	transfer appropriate processing

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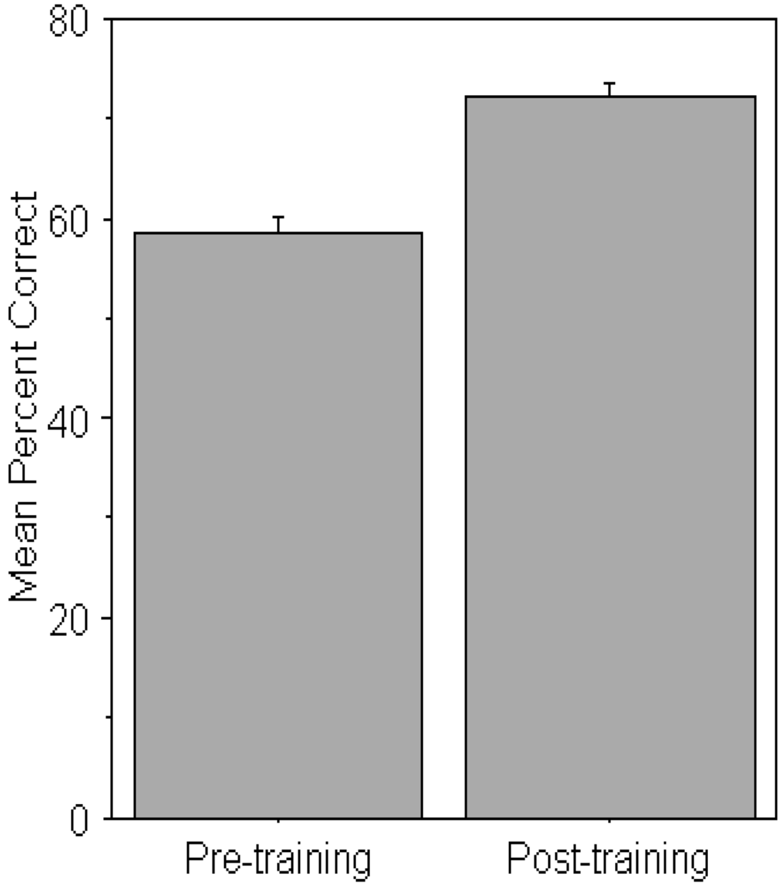

Figure 1.
Pre- and post-training scores for the *Four-Choice Discrimination Test*. Scores are combined for both the MTG and the STG, and for both the single-talker and the multi-talker versions of the test. Error bars indicate standard error.

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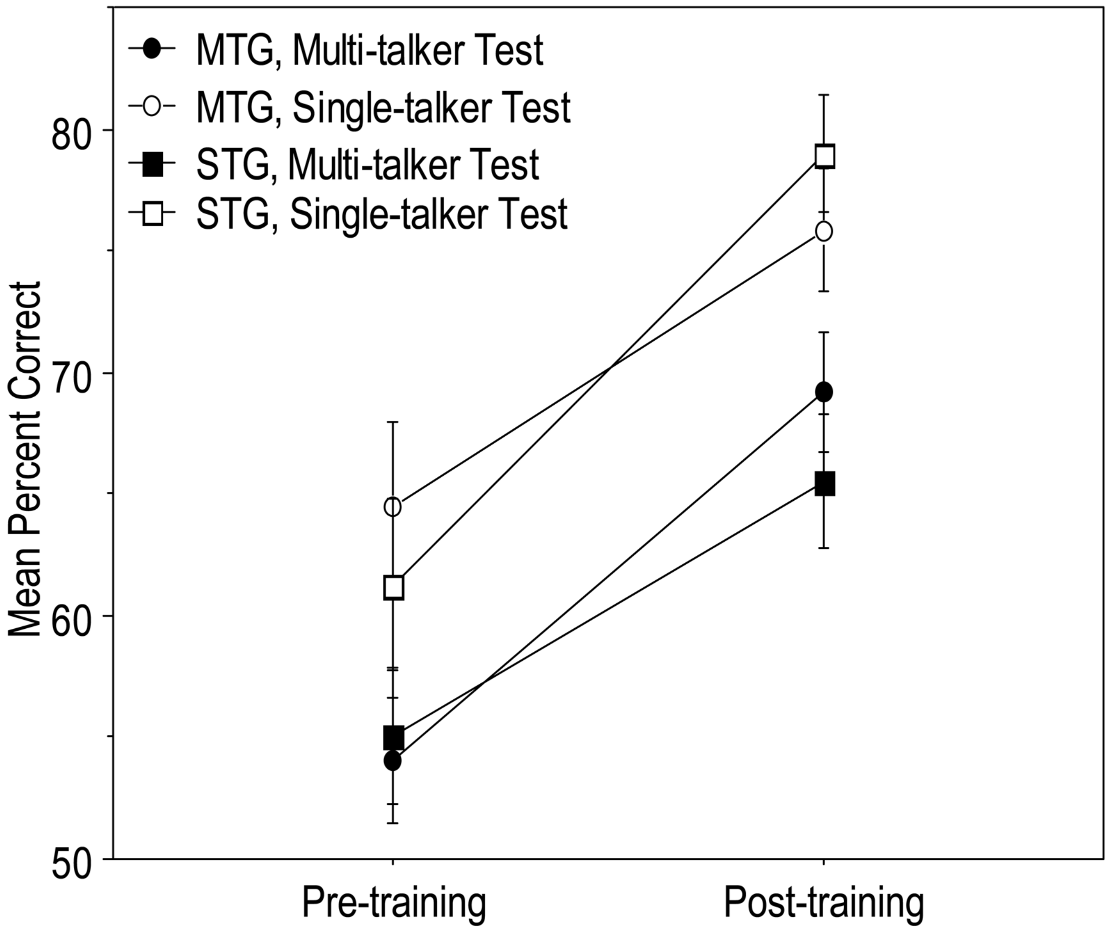

Figure 2.
Scores from the multi-talker and single-talker versions of the *Four-Choice Discrimination Test* for the pre- and post-training test sessions for the two training groups, MTG and STG. Error bars indicate standard error.

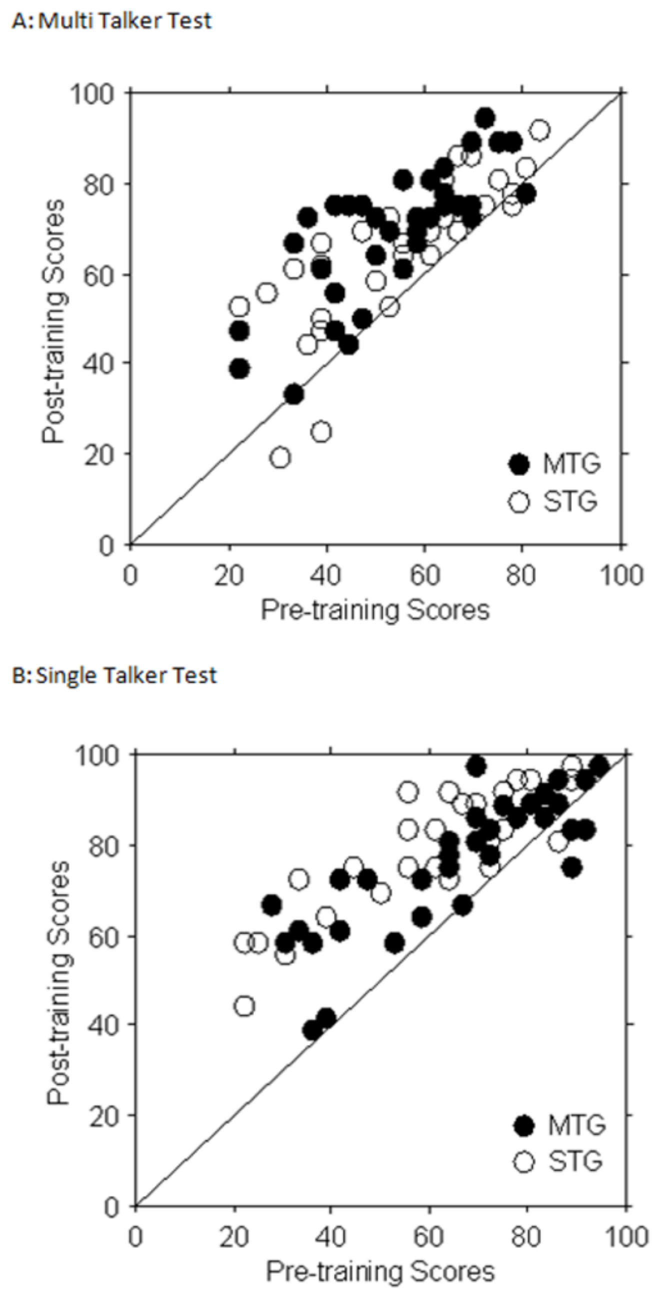

Figure 3.
Scatter plots showing pre- vs. post-training scores on the *Four-Choice Discrimination Test* for the multi talker version (top panel) and the single talker version (bottom panel). Open circles are the sores from the MTG and closed circles are from the STG. Scores above the unity line indicate improvement after training.

Table 1

Demographic Characteristics of Participants in STG (single-talker auditory training group) and MTG (multi-talker auditory training group).

Measure	STG: Mean (SD)	MTG: Mean (SD)	p-value
PTA	47.1 (15.6)	49.6 (13.9)	p> .3
Duration of hearing loss (years)	16.1 (10.7)	20.2 (18.2)	p > .2
NU-6 word identification	77.7 (17.7)	70.4 (21.3)	p > .1
Age (years)	67.2 (13.7)	64.2 (18.7)	p > .3