AUDITORY INTEGRATION TRAINING: ITS EFFECT ON NATIVE JAPANESE SPEAKERS' PERCEPTION OF ENGLISH

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This study proposes an investigation of the effects of Auditory Integration Training (AIT) on the ability of native Japanese speakers to perceive English using four tests: speech perception in noise (SPIN), /r/-/l/ phoneme discrimination test, /r/-/l/ synthetic continuum, and /e/-/e/ vowel discrimination. AIT is an auditory training method that uses music for perceptual training for individuals with auditory processing problems. Most frequently it is used to reduce hypersensitivity to noise. It has, however, been used successfully for individuals without hypersensitive hearing. Reports from those studies reveal a variety of improvements in both perception and production of speech. It has not yet been studied for its effect on normal-hearing speakers of English, native or non-native. A pilot study was conducted on a native and nonnative speaker of English to see if AIT offered any benefit for normal hearing adults. It revealed significant improvements in the perception of speech in noise following AIT for both subjects (10%). Based on these promising results, the goal of the proposed study is to examine AIT efficacy for native Japanese learners of English with respect to specific changes in perception of English.

INTRODUCTION

Nonnative speakers' often-limited ability to acquire new phonemic categories has challenged researchers for many years. Many highly proficient second and foreign language (L2) speakers continue to speak with an accent, demonstrating difficulties in perception and production of some nonnative contrasts (Flege, 1988; Goto, 1971). Linguistic experience produces major changes in the perception of some speech sounds. One consequence of language-specific distinctions is that adults who learn a second language often have particular difficulty with the perception and production of sounds that are distinct in the second language but not in their native language (Jamieson & Morosan, 1986). In English, for example, /r/ and /l/ are sounds of the language called phonemes which distinguish one word from another, like 'rake' vs. 'lake.' Japanese, however, has an /r/, but not an /l/. Because /r/-/l/ are phonemic in English, but not in Japanese, adult Japanese speakers of English commonly struggle in both the perception and production of this contrast.

In English, /r/ and /l/ are voiced liquids, with differences and similarities in acoustic characteristics and in articulation. Liquids are characterized by changes in vibration in the vocal tract called formant transitions. Formant transitions serve as critical acoustic cues to the identification of /r/ and /l/ in English. Three formants are usually required for the perception of /r/ and /l/, and the third formant, which is responsive to front versus back construction of the oral cavity, distinguishes them from each other. As for articulation, differences in tongue tip configuration and position create the distinctions between the two

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sounds.

These two phonemes differ from the sound referred to as a Japanese /r/. To American listeners, the Japanese [r] often sounds like [d] (Miyawaki, Strange, Verbrugge, Liberman, Jenkins, & Fujimura, 1975). Because of the differences in their phonetic realization, it difficult for the adult Japanese learner of English to perceive and produce the /r/ and /l/ contrast which is common in American English. In addition, native speakers of English frequently find it difficult to understand which phoneme the Japanese speaker intends to produce: /r/ or /l/.

Difficulty in production and perception of speech is not unique to L2 learners, and many techniques for improving perception have been developed throughout the years. Attempts to remediate perceptual deficiencies have varied, depending on the specific goal of remediation. Methods of auditory training for perceptual improvement were initially developed in the mid 1900s for individuals with hearing loss and distortions, and the techniques used for hearing remediation have evolved over the last 60 years. In order to understand how perceptual training evolved, a brief overview of its history follows, highlighting different methods of auditory training currently in use, their uses and identification of those who might benefit from such training.

Background: Auditory Training

Initially the goal of auditory training was to improve auditory communication skills under difficult, yet commonly encountered, listening conditions for WWII veterans with hearing loss, by making use of their residual hearing. Listening tasks that incorporated the use of relatively intense, non-speech, competing noise were developed. Twenty-five years later, Sanders (1971) suggested that listening exercises should be organized and presented under conditions of decreasing redundancy of information, with linguistic and situational cue variables ordered and controlled through the introduction of various types of competing noise. Finally, Garstecki (1981) developed an auditory-visual training paradigm for hearing-impaired adults that included four message parameters, systematically varied to either increase or decrease the redundancy of information provided. These methods demonstrate the complexity of remediating speech perception for monolingual speakers of any language. In addition, no training technique was originally intended for non-native language learners, although second and foreign language learners can also benefit from auditory training.

Today, auditory training is generally defined as the use of instruction, drill, or practice to increase the amount of information received when processing speech. Current auditory training practices typically fall into the following four categories: *analytic*, *synthetic*, *pragmatic*, and *eclectic*. *Analytic* training involves breaking speech into smaller components which are trained separately, like syllables, phonemes, or segments of speech which share particular segmental or supra segmental features. *Synthetic* training focuses on more global aspects such as meaning and context, where the emphasis is on understanding. Its focus is top-down, which makes use of previous 'higher-level' knowledge in analyzing and processing information. *Pragmatic* training includes changing the conditions under which interaction takes place by adjusting the distance between speaker and listener, for example, asking for the speaker to speak more loudly. Finally, *eclectic* training programs typically combine elements of all three auditory training methods (Blamey & Alcántara, 1994). Of the four methods mentioned, both analytic and synthetic are commonly used for L2 learners. Neither, however, has been shown to consistently change the ability of L2 learners to discriminate non-native L2 phonemes equal to the native speaker. Although native-speaker discrimination abilities are not necessary for communication, the ability to discriminate the sounds of a language is critical to understanding the language itself. Clearly, the greater the discrimination difficulty, the greater the communication difficulty. This study focuses on perceptual abilities below the word level; therefore, only analytic methods of auditory training will be discussed. The following is an analysis of several perceptual training methods, analytic in nature, used to remediate the perceptual abilities of two different subject groups: Japanese learners of English, and native-speaking children with articulation disorders.

Perceptual Training: Adults

Perceptual training studies of the discrimination abilities of Japanese learners of English reveal an evolution of techniques for improving their ability to hear the /r/-/l/ contrast. Strange and Dittman (1984) used a fix-standard AX discrimination task for adult intermediate-level ESL students. Subjects were asked if two words were the same or different and given immediate feedback as to their response. Using computer-generated speech, the researchers developed a continuum of 10 tokens that began with the word 'rock' and ended with 'lock.' Along this continuum of synthetic speech, the word gradually changed from sounding like 'rock' to sounding like 'lock'. Subjects improved for the 'rock-lock' synthetic speech continuum, but had no ability to generalize the contrast in other phonetic environments with natural human speech. Using natural speech in their studies, Logan, Lively, and Pisoni (1991) trained monolingual speakers of Japanese to discriminate the /r/-/l/ phoneme contrast. Logan, et al. used a two-alternative forced-choice task with five speakers and five phonetic environments.[1] Unlike the previous study, subjects where subjects were asked if two words were same or different, this study required them to decide which of two words they heard. Subjects were asked if they heard 'miller' or 'mirror,' for example, and were then given immediate feedback on their choices. This 'high-variability' of both speakers and phonetic environment resulted in consistent improvement in minimal pair identification, where words are alike in sound except for a single phonetic feature. Following training, performance for the two phonetic environments in word-final position was close to ceiling, while performance in the remaining three environments ranged from 70-80% correct. Interaction between talker and phonetic environment was also significant, with some talkers' productions, however, poorly perceived in word-initial and intervocalic environments.

Examining the role of phonetic environment and speaker, Lively, Logan, and Pisoni (1993) modified their previous study, this time training Japanese listeners of English who had only been in the US for two months. In the first experiment (with the same task as their previous study), researchers used only the three most-difficult phonetic environments as training stimuli: initial singleton (room-loom), initial consonant cluster (grass-glass), and intervocalic (correct-collect). Moderate improvements (80% pre-test to 86% post-test) were observed with generalization to new words produced by both a familiar and unfamiliar talker. In the second experiment, a new group of subjects was trained with tokens from a single talker who produced words from five phonetic environments, all containing the /r/-/l/ contrast. Although subjects improved from pre-test to post-test, they failed to generalize to tokens produced by a new talker.

Evaluating long-term retention of new phonetic categories, Lively, Pisoni, Yamada, Tohkura, and Yamada (1994) trained monolingual speakers of Japanese, using the same two-alternative forced-choice identification task with feedback, five different speakers, and five phonetic environments to discriminate the /r/-/l/ contrast. Training lasted three weeks, and retention was assessed three and six months after training. Pre-test to post-test results were 65% to 77% accuracy in identifying the /r/ and /l/. Three months later, subjects accuracy was at least 8% above pre-test level, and six months later, still 4.5% above the pre-test level.

Manguson, Yamada, Tohkura, Pisoni, Lively, and Bradlow (1995) used five groups of subjects, each group trained with a different talker. Two of their groups showed robust perceptual learning that generalized to novel tokens and talkers, while the remaining three failed to show significant perceptual learning. This study reinforces the findings of a previous study showing that some talkers are more poorly perceived than others (Logan, et al., 1991).

Together these studies support the idea that variability of both speakers and phonetic environments in training elicits the greatest improvement in identifying the /r/-/l/ contrast. What they fail to answer is why some talkers are well perceived and others are not. Concerning phonetic environments, work by Sheldon and Strange (1982) suggests that, in the context of initial clusters, acoustic information differentiating the /r/ and /l/ may be reduced, while in final position, acoustic information may actually be enhanced. Perhaps the answer is simpler than that. The Japanese /r/ does not occur in either word-final or syllable-final position and this is the environment where the most improvement occurs, the one which does not compete with the native language /r/.

Recently, Bradlow, Pisoni, Akahane-Yamada, and Tohkura (1997) investigated the effects of training the /r/-/l/ contrast on speech production by monolingual adult Japanese speakers living in Japan. Results of perceptual training showed a 16% gain in identification accuracy, from 65% to 81%. Improvement of the Japanese speakers /r/-/l/ spoken utterances as a consequence of perceptual training was evaluated by native English speakers using two separate tests. First, a direct comparison of the pre- and post-test tokens showed improvement in the perceived rating by native English speakers of /r/ and /l/ productions as a consequence of perceptual learning. Second, the post-test productions were more accurately identified by the English listeners than the pre-test productions in a two-alternative minimal-pair identification procedure. These results indicate that perceptual improvement of /r/ and /l/ transferred to production.

The studies cited above report various degrees of success in training adult L2 learners to discriminate non-native phoneme contrasts. The focus of these studies is perceptual improvements of these contrasts. Bradlow, et al. (1997), however, demonstrates transfer of perceptual training to production. The following studies with monolingual children also show a transfer of perceptual training to production.

Perceptual Training: Children

Like Bradlow, et al. (1997), Rvachew and Jamieson (1989) and Rvachew (1994) examine the relationship between speech perception and production errors. The subjects in one of their experiments were 12 monolingual children with normal hearing with an articulation disorder. These children were, at the time of the study, receiving speech services for phonemes other than /s/ and /ĭ/, the [sh] sound. A two-alternative forced choice task was used to assess their ability to identify the /s/-/ĭ/ stimuli, first using a synthetic continuum of *seat-sheet*. A second stimulus set was included in order to assess the effect of increased amplitude (loudness) or duration of 's' frication on the identification of these phonemes. Children identified the stimuli by pointing to pictures. Adult and normal children accurately identified all stimuli. Seven of the articulation-disordered children, those who mispronounced the /s/ and /ʃ/, misidentified them.

Experiment 2 was conducted to examine /s/ and /θ/ [th]. Like the first experiment, stimuli were presented on a synthetic continuum (*sick-thick*). Both adults and normal speaking children responded appropriately to the words *sick* and *thick*, while none of the articulation-disordered children were able to identify to these words accurately. Rvachew and Jamieson (1989) concluded that for at least some children who have a functional articulation disorder production errors might reflect speech perception errors.

Rvachew (1994) examined the role of speech perception training in the correction of production errors. Twenty-seven preschoolers who misarticulated /ʃ/, were randomly assigned to three groups. Production errors included stop substitutions [d] or [t], fricative substitutions [s], affricate substitutions [dʒ], and distortions of the /ʃ/. Six sets of stimuli were developed. The training word pairs were: *shoe-Xshoe* where *Xshoe* refers to misarticulated versions of the word *shoe* for Group 1, *shoe-moo for* Group 2, and *cat-Pete* for Group 3. Group 1 and Group 2 children demonstrated a superior ability to articulate the target sound in comparison to Group 3 children, as measured by pre-post improvement.

This study and those of cross-language speech perceptual training demonstrate the importance of training with stimuli that contrast the target sound with its substitution (Rvachew, 1994). The *shoe-Xshoe* training procedure administered to Group 1 also supports this hypothesis, as every child was exposed to contrasts related to his or her error. However, as no child in this study substituted /m/ for /ʃ/, the equivalent success of the *shoe-moo* training procedure does not support the importance of exposing the child to a contrast between error sound and the substituted sound. Perhaps both training techniques help phoneme discrimination: training which contrasts one phoneme with its substitution and intense training of a single phoneme.

Bradlow, et al. (1997), Rvachew and Jamieson (1989), and Rvachew (1994) reveal similarities between perception and production for monolingual adult Japanese hearing English and monolingual children; both have problems with production where they have perceptual problems. The perceptual training techniques used for these studies showed similar results for both groups: improved perception leads to improved production.

No study, however, has demonstrated either 100% improvement or improvement to native-like performance when training phoneme contrasts. It is therefore reasonable to examine a new method of auditory training. Based on the understanding that similar perceptual difficulties appear to exist between adult L2 learners and children with articulation disorders, I propose using a new technique for adult L2 learners which is currently being applied to children with several types of auditory disorders: Auditory Integration Training. The following is a brief explanation of AIT and a summary of the disorders that appear to be positively affected by AIT.

Auditory Integration Training

Auditory Integration Training was developed by Guy Bérard to remediate auditory processing problems with the intention of rehabilitating disorders of the auditory system, like hearing loss or hearing distortions, where one is either hyper or hyposensitive to specific sound frequencies. Bérard claims that his method of auditory integration training has successfully helped individuals with several conditions, including autism, central auditory processing disorder (CAPD), attention deficit hyperactive disorder (ADHD), mental retardation (MR), and learning disability (LD) (Bérard, 1993). According to AIT researchers, inconsistencies or distortions in hearing cause difficulties in comprehension (Rimland & Edelson, 1994).

During AIT, subjects listen to 10 hours of music through headphones over a two-week period. The music is 'filtered' by a machine called an 'Audio Effects Generator,' which randomly modulates the volume level of the frequencies of the music. The frequencies are either increased or decreased by 20 dB, or there is no volume change at all. Faster tempos have more modulation than slower ones. Due to the randomness of the modulation, subjects are unable to become accustomed to the rhythm.

The studies reported in the literature thus far have varying results. Initially, the goal of researchers in the United States was to improve hearing and sound sensitivity in individuals with autism. In fact, a significant reduction in sound sensitivity has been reported in several studies with autistic subjects (Bettison, 1996; Madell & Rose, 1994; Monville & Nelson, 1994; Rimland & Edelson, 1994; Veale, 1993; Woodward, 1994). Madell and Rose (1994) also report improvement in sound sensitivity in non-autistic children, in addition to an improvement in word recognition in noise by a child with learning disabilities. Yencer (1996), however, reports no improvement following AIT for 36 CAPD subjects, while Rudy, Morgan, and Shephard (1994) report several significant changes for 13 subjects with ADHD and CAPD. Finally, Highfill and Cimorelli (1995) report significant changes in language and cognitive measures of an eight-year old with severe mental retardation and autism. Although a reduction in sound sensitivity was the goal of AIT for these studies, other communicative improvements have been reported. Following is a summary of those studies.

AIT Studies

Currently, AIT as a therapeutic method has both supporters and opponents. Exactly what it accomplishes, for whom it is an appropriate auditory therapy, and how to measure the resulting improvements are questions not yet answered. The assessment tools reported in the literature to determine the efficacy of AIT cover four general categories: 1) language comprehension and processing, 2) hearing acuity, 3) social behaviors, and 4) intelligence. These instruments are all commonly used in identifying disorders for which AIT has been administered. Many AIT studies report changes in communication and hearing.

A significant reduction in sound sensitivity following AIT has been reported by the following studies: Bettison (1996) reported improvement for 80 subjects; Rimland and Edelson (1994) for 445 subjects; Woodward (1994) for 60 subjects. Madell and Rose (1994) also report improvement in sound sensitivity in a single autistic subject.

These studies reveal improvements in sound sensitivity through audiometric exam post-AIT. Other studies report functional improvements through questionnaires answered by professionals and parents of subjects. Both Veale (1993) and Monville and Nelson (1994) sent surveys to parents of 68 and 42 autistic children who received AIT. Improvements reported in Veale's study related to verbal communication were: more appropriate speech ('I'm thirsty' versus 'want cup'), more focused attention, improved speech-language skills (initiates and follows simple conversations), and improved attention to auditory direction (multi-step directions, for example). Monville and Nelson reported an increase in the amount of language used, increases in vocabulary or spontaneous speech, more asking and answering of questions, and better conversational skills. They also reported an increase of clarity of speech. Parents in both studies also reported a reduction of sound sensitivity.

Other studies included non-autistic subjects. For example, Rudy, Morgan, and Shephard's (1994) 13 subjects with ADHD and/or CAPD were assessed in several ways prior to, immediately following, and three months post-AIT. Immediately following AIT, there were significant improvements in central auditory processing (Staggered Spondaic Word Test[2] and Screening Test for Auditory Processing Disorders[3]), and language function (Clinical Evaluation of Language Fundamentals – Revised[4]), but no change in intelligence (Test of Non-verbal Intelligence[5]). Three months post-AIT, there were additional improvements in language function, and intelligence. No significant changes in acuity were detected.

Madell and Rose (1994) also report improvements in sound sensitivity in non-autistic children. In addition, they report changes in a child with learning disabilities auditory processing difficulties and very limited hypersensitivity. More important for the purpose of the current study being proposed, is a change in word recognition in noise by the LD subject, which improved from 72% to 100% post-treatment, because recognition of speech in noise is also problematic for L2 learners (Mayo, Florentine, & Buus, 1997).

Based on the results reported in the literature which demonstrate the potential value of AIT for a variety of auditory needs, AIT warrants further investigation. There is, however, no evidence thus far to support any systemic benefit to AIT. Nor is it known how AIT affects processing of the speech signal or at what level the effect occurs. The improvements reported thus far from AIT vary from study to study. The goal of the proposed study is to examine the efficacy of AIT for a subject group which may be able to answer more specifically the effect of AIT on speech perception: normal monolingual and bilingual speakers. A pilot study was conducted for that purpose, using the SPIN (speech perception in noise) test because it had previously reported in the AIT literature.

Pilot Study

The following pilot study was run to see if AIT has *any* effect on speech perception in noise for normal adult subjects. Two bilingual female Ph.D. students at the University of Arizona volunteered for this study in the spring of 1998, a native (S1) and non-native speaker of English (S2).

Prior to AIT, both subjects took the revised SPIN test (Kalikow, Stevens, & Elliott, 1977). As previously noted, non-native speakers do not recognize speech in noise as efficiently as native speakers. The SPIN test, a standard for speech perception, measures speech discrimination using sentences that simulate a range of contextual situations encountered in everyday speech communication. Subjects listen to sentences spoken simultaneously with babble in the background. With sentences generally five to eight words in length, the last word in the sentence, always a monosyllabic noun, is the stimulus item. The SPIN test requires subjects to identify the final word in a sentence. This test has two forms: sentences where the final word is highly predictable because of contextual cues, and sentences where the final word is of low predictability because of no contextual cues.

Subjects in the pilot study took the low predictability form only, as the point of the pilot was to examine any affect AIT may have on processing of acoustic input.

As previously noted, non-native speakers do not recognize speech in noise as efficiently as native speakers. Subject 1 and 2 correctly identified the target word 88% and 68% of the time, respectively. Subject 2's results are very close to those reported by Mayo, et al. (1997) for bilinguals who learned the L2 post-puberty, whose SPIN scores for low-predictability words was 65%.

Mayo, et al. (1997) Study			Pilot study		
MON	BSI	BPP	NE PRE	88%	98%
85%	76%	65%	NNE POST	68%	78%

Table 1. Comparison of SPIN test results. This table compares the results of Mayo, et al. (1997) with the results of the pilot study. Pre-AIT both pilot subjects % correct fall near those reported by Mayo, et al. However, post-AIT, both pilot subjects % correct is improved. The % correct of the NNE speaker in the pilot study, who learned English post-puberty, now falls within the 'bilingual since infancy' range.

The subjects were then administered AIT with commonly produced frequencies in human speech filtered: 750, 1500, 3000 Hz. Post-AIT, Subject 1 correctly identified 98% of the target words in the SPIN test, and Subject 2 correctly identified 78% of the target words, both improving 10% (see Table 1). Subject 2's results now fell *between the correct percentages for monolingual English speakers and bilingual since infancy* for no context sentences.

Although results of this study are promising, there are questions that it failed to answer and limitations that need to be addressed. First is the impact of the filters, second, is the issue of test-retest advantages. The subjects in the pilot may have improved in the retest condition for several reasons: acclimation to the setting, remembering the words, or even from being less nervous. Third, data from two subjects is not enough to provide convincing evidence for AIT efficacy no matter how it is evaluated. Finally, one measurement of efficacy is not enough. Several measurements are necessary in order to understand not only 'if AIT works,' but 'what it does' concerning speech perception. The goal of the proposed studies is to answer the following research questions:

1. Does AIT help Japanese learners of English better discriminate speech in noise?
2. Does AIT help Japanese learners of English better discriminate the non-native /r/-/l/ phoneme contrasts?
3. Does AIT influence how Japanese learners categorize the non-native /r/-/l/ phonemes on a synthetic continuum?
4. Does AIT influence how Japanese learners of English discriminate English vowels?

PROPOSED STUDIES

The proposed research will examine the efficacy of AIT on native Japanese learners' of English by testing their abilities compared to native English speakers with respect to speech perception in noise, and /r/-/l/ and /e/-/ɛ/ perception. In addition to difficulties in discriminating the non-native phoneme contrasts, recent research demonstrates that non-native speakers do not recognize speech in the presence of noise as well as native speakers (Mayo, et al., 1997). Although the ability to understand speech in noise improved as their exposure to the L2 (American English) increased, they did not perform as well as natives even after extensive exposure. Also, highly proficient non-native speakers did not benefit as much from contextual cues as native listeners. The studies reported in the literature reveal two specific auditory processing difficulties faced by L2 learners: perception in noise and perception of non-native phoneme contrasts. The focus of this study is remediation of those difficulties.

Prior to AIT, most subjects are given audiometric exams to identify the specific frequencies to which they are hypersensitive. However, since remediation of hypersensitivity is not the goal of this study, no audiometric measures will be taken, but subjects will not be accepted if they have any known hearing problems.

EXPERIMENT 1: ROLE OF THE FILTERS

The purpose of the first experiment will be to investigate the questions and limitations of pilot study. In order to examine the efficacy of AIT on non-native learners of English, baseline norms must first be established for adult native monolingual speakers of English. Therefore, *Experiment 1* will address the following research issues:

1. What is normal on the SPIN test for low predictability sentences where there is no contextual cue as to the last word?
2. Is filtering necessary for Auditory Integration Training?
3. What is the best way to measure improvements from AIT?
4. Is there a learning curve in the test-retest situation?

Subjects

Twenty-four native English speakers, students at the University of Arizona will participate in this study. As one purpose of the first experiment is to examine the efficacy of filters during AIT, subjects will be divided into four groups:

Group	Condition of Filters	No. subjects
NF	No filters activated during AIT	8
HF	Filters beyond speech frequencies activated: 6000, 8000, 12000 Hz	4
PF	Commonly produced frequencies in speech filtered: 750, 1500, 3000 Hz	4
C	Control group receiving no AIT; taking pre-and post-tests	8

Subjects will be randomly assigned to all four groups. The Control Group will serve to determine if there are test-retest advantages.

Procedure

All subjects will be administered the following tests pre- and post-AIT:

1. *Revised Speech Perception in Noise Test (SPIN).*
2. *Word identification test (/r-l/),* from Strange & Dittman (1984) which includes words which contrast the /r/-/l/ phonemes in four phonetic environments: initial singleton, initial cluster, intervocalic, and final singleton (see Appendix).

3. *Categorization of /r/-/l/* along a synthetic continuum. The continuum consists of tokens of synthetic speech ranging from /ra/ to /la/. This it to determine the category boundaries (/r/-/l/) for native speakers.
4. Goodness rating of vowels /e/ and /ɛ/. These are two phoneme categories in English, but only one in Japanese. The /e/ region is within a phoneme category for English, but may be outside the bounds of the Japanese /e/ (Maye, 1998).

AIT will then be administered for 10 hours over a three-week period for Group NF, Group PF and Group HF. The musical selections to be used, approved by the maker of the Audio Effects Generator:[6] 1) Bob Dylan's *Greatest Hits*, 2) Genesis *Invisible Touch*, 3) Natalie Cole *Everlasting*, 4) Trevor Pinnock *J.S. Bach*, 5) Magic Moods *Ocean Surf*, 6) John Mellencamp *Human Wheels*, 7) Michael Jackson *Dangerous*, 8) Paula Abdul *Spellbound*, 9) Bruce Springsteen *Human Touch*, and 10) Paul McCartney *Off The Ground*. According to the Society for Auditory Integration Training,[7] the music used for AIT should cover a wide range of frequencies and have a fast tempo. The approved selections were analyzed for such criteria.

EXPERIMENT 2: EFFECT OF AIT ON JAPANESE LISTENERS

The purpose of this experiment is to examine the same questions concerning AIT efficacy with respect to adult Japanese learners of English. In doing so, a comparison can be made to the results from the native English speakers in the first experiment.

Subjects

Sixteen native speakers of Japanese, students at the University of Arizona will participate in this study. The results of the first experiment with native speakers of English will determine which filtering, if any is necessary.

Procedures

The results of the first experiment will determine if the native speakers of Japanese will be filtered during AIT. The procedures from the first experiment will be repeated in the second.

Predictions

Significant perceptual changes (10% improvement) are expected resulting from AIT in both experiments (native and nonnative speakers of English) for the SPIN test, based on the results of the pilot study. It is possible that there will be no differences between Group NF and Group HF, but I am reluctant to predict. At this time, it is difficult to tell whether or not there will be changes in identification of the words containing the /r/ and /l/ contrast, categorization along the /r/-/l/ continuum, or goodness ratings of /e/ and /ɛ/ for either the native English speakers or native Japanese speakers, although it is reasonable to assume there might be based on the pilot. It is important to evaluate both vowel and consonant contrasts, because AIT may affect one and not the other. Hopefully changes will occur beyond the SPIN test that will reveal what is occurring perceptually that leads to improvement of perceiving speech in noise. For there to be improvement in discriminating speech in noise, acoustic changes must be occurring. What functional change that causes is yet unknown.

CONCLUSION

Treatment methodologies from a variety of fields which currently address the remediation of auditory problems are potentially beneficial to second language learners. Unless such methods are tested under controlled circumstances where specific changes are identified, like phoneme discrimination, speech to noise ratios, and perceptual categorization, for example, we will not know the truth about their efficacy in this particular domain. The AIT studies presented in this proposal demonstrate its efficacy for individuals with several disorders known to have problems with auditory processing. Thus far, it is most effective in reducing hypersensitivity to noise. However, the pilot study demonstrates its value to individuals with no apparent medical condition, at least for perception of speech in noise. Clearly it is not yet known if or how effective AIT will be in helping L2 learners create new phonemic categories. If such results are obtained by this study, there is the possibility of direct application to the classroom for L2 learners, particularly for Japanese learners of English.

NOTES

1. Five phonetic environments were: initial singleton (room-loom), initial cluster (grass-glass), intervocalic (mirror-miller), final singleton (war-wall), and final cluster (farce-false).
2. The SSW test is composed of 4 items in a dichotic listening task. Each item consists of two spondaic words (words of two syllables which when pronounced have equal stress on both syllables, like 'cowboy,' 'doorway,' etc.) with each word presented to a different ear. The latter half of the word presented to the first ear overlaps the first half of the word presented to the second ear.
3. The SCAN is used to detect dysfunction of the central nervous system in processing information. It is comprised of three subtests: monosyllabic low-pass filtered words, monosyllabic words with multi-talker and babble background, and competing words presented to right and left ear simultaneously.
4. The CELF-R identifies language function in several areas: phonology, syntax, semantics, memory, word finding and retrieval. Part of the exam is production and the other is processing.
5. The TONI is a language-free measure of cognitive ability.
6. From "Audio Effects Generator User's Guide," 1993, BGC Enterprises, Inc.
7. Founded in January, 1992 by practitioners, researchers, and parents to study the efficacy of AIT for individuals with special needs.

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APPENDIX

Initial singleton		**Initial cluster**		**Intervocalic**		**Final singleton**	
read	lead	breed	bleed	mirror	miller	dear	deal
room	loom	broom	bloom	berry	belly	core	coal
road	load	grow	glow	correct	collect	war	wall
right	light	grass	glass	arrive	alive	tire	tile

Filler words			
deep	keep	swimming	swinging
hope	soap	defend	descend
boat	boot	him	hip
get	got	mad	man