TRAINING ASSISTANCE FOR NEW AUDITORY PERCEPTS

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INTRODUCTION

There are many new hearing aid features on the market today that emphasize high frequency information; such as, instruments with an extended bandwidth or instruments with a frequency lowering algorithm. With these new features, audibility training may be helpful with adaptation to the new auditory percepts that the patient may be experiencing. The available home based training programs may not provide specific phoneme focus. Therefore, we developed a listening program to help facilitate adaptation particularly for unvoiced consonants.

OBJECTIVE

To develop a computerized home listening program that is phoneme based to assist hearing aid wearers with adaptation to new auditory percepts [Audibility Training CD: Training on Vowels and Voiceless Consonants].

DEVELOPMENT

Considerations for choosing activities:

1. need to be conducted via a computer
2. need interaction to maintain interest
3. need to direct focus on a particular phoneme
4. need more than one speaker to present materials

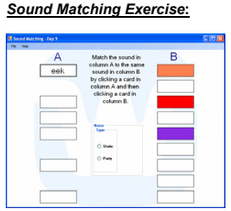
The training was divided into two main sections. The first section focused on vowel differentiation. Those with more severe hearing losses may have difficulty with vowels as well as consonants. The second section focused on voiceless consonants /p, t, k, s, f, ʃ, θ/ to emphasize high frequency content. Each section consisted of ten days of training for a total of twenty days.
Activities increased in complexity from determining if a target sound/word was the same or different from the comparison sound/word to identification of the target word. The materials were spoken by three different speakers: one male and two female. There were three to four activities within a session. Each session takes 15-20 minutes to complete.
To increase the challenge of these exercises, background noise can be added: either a party noise of multiple talkers or a continuous speech-shaped noise.

Minimal Computer Requirements:

- Windows XP/2000 (program will NOT work with Windows 98 or Mac)
- PC with 300 megahertz (MHz) or higher processor
- 128 megabytes (MB) of RAM or higher
- 300 MB free hard disk space
- Super VGA (800x600) or higher resolution video adapter and monitor
- CD-ROM or DVD drive
- Keyboard and mouse
- Sound card and speakers

TRAINING EXERCISES AND INSTRUCTIONS

Sound Matching Exercise:



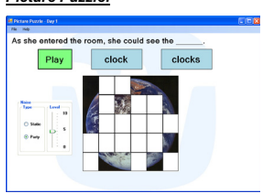
The purpose of this exercise is to give the patient practice hearing a particular vowel or consonant. The patient should click on a button in Column A and listen to the sound or word and try to find a match in Column B.
If both of the sounds/words match, the button in Column A will disappear and the button in Column B will change colors. If there is not a match, both buttons will remain the same. When the exercise is complete, you will see a picture appear and you may click on "end exercise" to exit.

DEVELOPMENT (cont.)

Sound Matrix

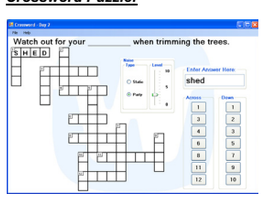
Some patients have difficulty differentiating different vowels. The purpose of this exercise was to give the listener practice in comparing vowel sounds. By pressing any button in the display matrix, the patient will hear two "target" words. It is not an identification task; only to see if the patient can hear a difference. If the patient is able to hear a difference, they would press the "YES" button. If the patient does not hear a difference, they would press the "NO" button and choose a new set of "target" words. When all word pairs in the matrix have been heard, the patient would press the "Finished" button. The percentage of word pairs that the patient was able to hear a difference will be displayed.

Picture Puzzle:



This is a minimal pair activity. The words will differ either by a vowel for the vowel training or a high frequency consonant for the consonant training. The patient will press the "Play" button to hear a sentence. A sentence with one word missing and two options for that missing word will be displayed. The patient should click on the word which they think was said. If the word was correct, a piece of the picture puzzle will appear. If the word was incorrect, a puzzle piece will not appear. Once a word has been chosen, the sentence and word options will disappear. Press the "Play" button to hear the next sentence and see the next word options. At the end of the exercise a picture is revealed.

Crossword Puzzle:



The goal of this exercise is to reinforce attention to a particular "target" sound in a discourse context. It is an auditory attention and discrimination task. In this exercise the patient presses the number of a "clue" for Across or Down. A sentence will be displayed with a missing word. The goal is to hear and understand this word. The patient will type the word in the [Enter Answer Here] text box. If the word is correct, it will be displayed in the crossword puzzle. If it is incorrect, it will not be displayed and the patient should try again.

Count the Number:

This activity was designed to increase auditory attention by focusing the subject's attention on a selected phoneme in running speech. There are a total of ten sentences to listen to. The patient will press the green "Play" button to hear that sentence. The goal is to count the number of a specific sound. Once the patient has counted those sounds, they should click on the corresponding number. If the number is incorrect, the number will turn red. If the number is correct, the sentence will be displayed with the sounds highlighted.

RESULTS

The training was used during research at the Office of Research in Clinical Amplification. The test participants were included in a study with a frequency transposition algorithm, the Audibility Extender [AE]. To assist with their adaptation to transposed information, they were given the Audibility Training CD. They were encouraged to participate in the training for five days; take two days off; and then continue training.

For the following data, 14 participants with high frequency hearing loss [normal to mild-mod loss through 1k precipitously sloping to severe-profound loss at 4k Hz and above] were evaluated at the fitting of the instrument with and without frequency transposition and then one month after training. The results shown in Figure 1 were for the consonants in the Nonsense Syllable Test [NST] at a 50 dB SPL presentation level. The average results show an improvement of 8% for the transposition after training.

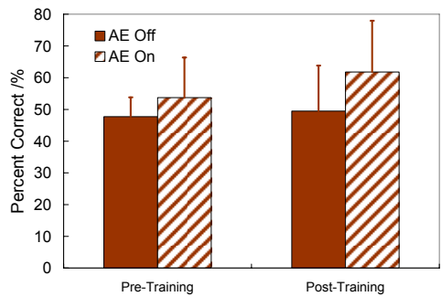


Figure 1: Results for all consonants on NST; 50 dB SPL presentation level

Scatter plots of consonant performance were shown in Figures 2a and 2b. The consonant results for pre-training were shown in Figure 2a. A few of the subjects obtained better results with AE off; whereas, others performed better with AE on at the initial visit. After training, Figure 2b, there was only one test subject who obtained slightly better results with AE off. All other subjects performed better with AE on. Several subjects improved as much as 14-34% with the AE while others did not improve as much (4-8%).

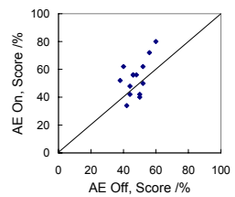


Figure 2a: Pre-training AE off vs AE on/consonants

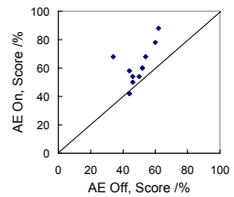


Figure 2b: Post-Training AE off vs. AE on/consonants

Two participants, with a more severe loss than those in the previous study, were seen for a similar study. The study was to examine the effect of frequency transposition for participants with a more severe loss. The same testing was performed. In addition, they were given more training time than in the first study. They were seen for the initial fitting; one month after training; and after two months of training. It was noted that the training seemed to be more effective for some participants than others. In addition, time also seemed to be a factor. There was more improvement noted after two months of training than after only one month of training.
In Figure 3, the results for this participant show improvement in identification of the consonants in the NST with the AE program from 46% at the initial fitting, to 60% after one month of training. With the additional month of training, the participant improved to 74%. This was a 28% improvement from the initial fitting.

RESULTS (cont.)

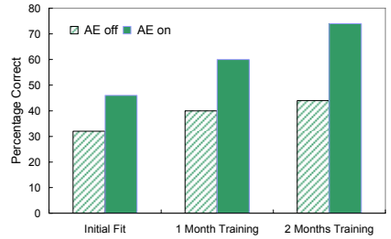


Figure 3: Participant A results for all consonants on NST; 50 dB SPL

For the participant in Figure 4, the effect of training was not as significant after the first month of training. The identification of consonants on the NST was 32% at the initial fitting and 36% after one month of training. For this participant, an additional month of training was more effective with an improvement to 48% after two months of training.

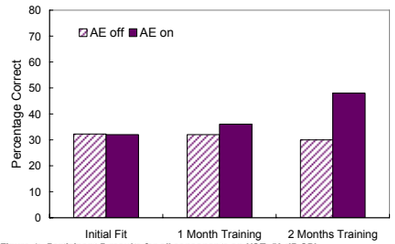


Figure 4: Participant B results for all consonants on NST; 50 dB SPL

APPLICATIONS

There are several potential applications for the use of this training in the clinic:
1. Counseling tool: can the patient hear the target sounds? These activities may help a reluctant hearing impaired patient realize the need for amplification.
2. Adaptation tool:
   a. For new hearing aid wearers to adjust to amplification in general.
   b. For experienced hearing aid wearers who may be adjusting to a new algorithm such as expanded bandwidth or frequency transposition.
3. Comparison tool:
   a. Patient can compare listening to activities with one program or settings to another to determine preference.
   b. Patient can compare performance of new hearing aid to their old hearing aids and recognize improvement.

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