SPEECH TEST PROCEDURES
FOR USE WITH HEARING IMPAIRED ABORIGINAL CHILDREN

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ABSTRACT - The development of a speech test for use with Aboriginal children who speak Warlpiri as their first language is described. The test is extremely simple and easy to administer but appears to give reliable results. Possible applications for other Aboriginal languages are considered.

INTRODUCTION

Mild to moderate conductive hearing loss due to chronic otitis media represents a significant problem for many Aboriginal children throughout Australia. Quinn (1983) for example reported a study of the hearing status of children living in communities in Central Australia. Nearly 50% of ears tested had an average hearing loss (at .5,1 & 2kHz) of 30 dB or more. Thirty percent of the children tested had an average loss greater than 30 dB in their better ear. The long term effects of such losses are as yet little understood and much of the published research can be criticized for its poor design. There is, however "an abundance of literature which supports the assumption that otitis-prone children are more susceptible to delays in speech-language, cognition and education" (Bess, 1985; p. 44).

Amplification alternatives available to these children are limited by the nature of the loss. Conventional hearing aids are not suitable as they cannot be used by children with discharging ears. Bone conduction aids represent one possible alternative and have been used with success (Mills, 1988). Another alternative is the use of an FM amplification system where the child wears lightweight non-occluding earphones (Weeks & Callingham, 1984).

In order to adequately assess the suitability of different approaches it is desirable to have speech test materials which measure the child's aided and unaided performance. A modified form of Ross & Lerman's (1971 W.I.P.I. Test has been used with Aboriginal children (Venard et al, 1988). Such a test, however, has one important potential problem: the use of English as the test language. Most Aboriginal children in the Northern Territory do not learn English as their first language. English is introduced only when the child starts school. As a result tests presented in English may not give a reliable measure of the child's speech hearing status but may rather reflect their English language proficiency. This paper describes the development of a speech test in one Aboriginal language - Warlpiri. The procedure adopted, however, may be suitable for use with other language groups.

MATERIALS

The test materials were recorded at Yuendumu an Aboriginal community located approximately 300 km north-west of Alice Springs. Yuendumu has a population of approximately 800 Warlpiri people and 80 non-Aboriginal English-speaking people. Prior to visiting Yuendumu to record the materials, a set of 50 line drawings of items common to the area were prepared by a professional artist. These were placed in a spiral bound booklet with one picture per page. The pictures were shown one-by-one to a Warlpiri as a first language female adult speaker who was asked to name each item in Warlpiri. A high quality audio-cassette recorder was used to record the speaker. The recorded materials were then edited using a computer-based editing system and were equated for intensity using an L_{eq} algorithm (Dermody et al, 1983).

Six lists were then recorded on audio-cassettes. Two lists were randomizations of the 50 items. The remaining four lists each consisted of 5 pseudo random presentations of 5 disyllabic words chosen from the materials recorded. Each of the four lists contained different words. It should be noted that there are no monosyllabic words in Warlpiri. Following field trials with the materials a further list was prepared. This consisted of 10 randomizations of the Warlpiri words: warlu (fire), wati (man), jarlji (frog), parla (leaf) and pingi (ant).

PROCEDURE

The testing was carried out in a classroom at Yuendumu school during two 3 day visits to the community. The materials were presented via a Nakamichi 550 cassette recorder, a Madsen OB 822 audiometer and PA 5010 power amplifier through a B & W speaker. Prior to presentation of the materials, calibration was carried out using a B & K Type 2206 Sound Level Meter at ear level one metre from the loudspeaker measuring the peak dBSPL of the test words.

The two 50 item test lists were presented at 70 dBSPL. Prior to presentations of each of the test words the child was shown a page with pictures of the stimulus and five distractor items. No attempt was made to present distractor items which differed only minimally from the stimulus words. The child was asked to point to the word s/he thought was spoken. The five alternative forced choice (5AFC) lists were presented using a simple up-down adaptive speech test procedure (Mackie and Dermody, 1986). The child was given a sheet showing pictures of the 5 alternatives and was asked to point to the item presented. The first item was presented at 80 dBSPL with the level of the following stimuli decreased by 5 dB until an incorrect response was given. The level was then increased by 5 dB and the step-size was reduced to 2 dB. The stimulus presentation level was decreased until the child gave an incorrect response. At this point the presentation level was increased by 2 dB (the first reversal) until the child again gave a correct response. The level was then decreased by 2 dB (the second reversal). A minimum of 12 reversals was obtained with each child. The child's adaptive speech test (AST) threshold was calculated by averaging the mid-points of the final ten reversals.

PILOT TESTING

Pilot testing was carried out using the materials during a visit to Yuendumu. Two children with hearing within normal limits were presented with the two forms of the 50 item test. The scores obtained were Subject 1 List 1 92% List 2 100% and Subject 2 List 1 98% List 2 96%. The 5AFC lists were also administered to these children. The AST thresholds obtained were Subject 1 40.6 dBSPL and Subject 2 36.3 dBSPL. In testing these children one potential difficulty in using different sets of words for the AST procedure became apparent. When a new list was presented there were initially large excursions. The children appeared to need to hear the new items at a level considerably above the AST threshold in order to verify their identity. Based on this finding it was decided to attempt further testing using the list presenting 10 pseudo-random presentations of the five Warlpiri words. During the pilot phase informal testing using the AST procedure was also attempted with a number of younger children. This revealed that the materials could be successfully used with children as young as five years.

MAIN STUDY

In the main study AST thresholds were obtained using the 5AFC 50 item list. A total of 15 subjects were tested. Fourteen (7 males, 7 females) were children attending Yuendemu school ranging in age from 8 to 12 years. The remaining subject was an adult male. All the subjects spoke Warlpiri as their first language. Pure tone thresholds were obtained for each child by a NAL audiologist. Initial testing involved air conduction thresholds at .5, 1, 2 and 4 kHz. If a hearing loss was detected air conduction thresholds were obtained at 250 kHz and bone conduction thresholds were obtained for the test frequencies. The pure tone average (P.T.Av.) air conduction thresholds at .5,1 and 2kHz. for the better ear was calculated for each child. Four subjects had P.T.Av's of 10 dB or less, 7 ranged from 11-12 dB one subject had a P.T.Av of 22 dB. The remaining subjects had P.T.Av's of 30 dB, 42 dB and 47 dB.

A scattergram showing the relationship between P.T.Av. and the A.S.T. threshold is presented in Figure 1. It may be that the A.S.T. threshold for subjects with P.T.Av's of less than 20 dB are elevated, probably due to the noise level in the room used for testing. Noise level measures taken in the room on a previous visit to Yuendumu (Williams, 1988) revealed an L_{eq} of 50.2 dBA.

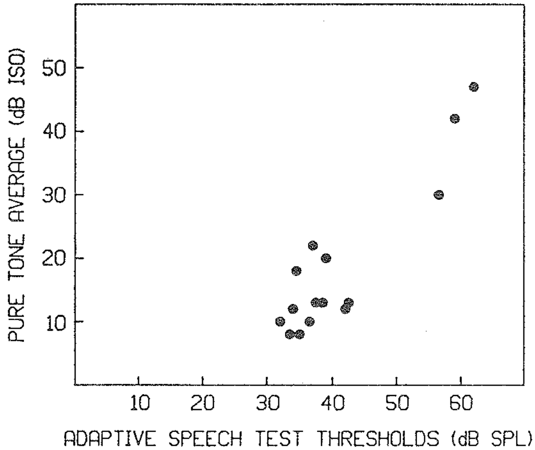

Figure 1. Scattergram showing the relationship between Adaptive Speech Test Thresholds and Pure Tone Average for the subjects in the main study.

A correlation of .9071 (significant at the .001 level) was found between the P.T.Av. and the A.S.T. threshold. Two of the hearing-impaired subjects were also tested using the Selectasonic, a radio-frequency transmitter and receiver system. The system's microphone was placed in front of the loud speaker and the subject wore the receiver with lightweight headphones. The A.S.T. threshold was then calculated and found to be 41.7 dB for Subject 14 and 42.3 dB for Subject 15. This represented improvements in A.S.T. threshold of 17.3 dB and 19.4 dB respectively.

CONCLUSION

The results obtained in the two studies undertaken highlight the potential for developing simple but effective speech tests in Aboriginal languages to ensure the suitability of amplification systems used with hearing-impaired children. The A.S.T. procedure using repeated random presentations of only five words is an extremely simple measure which appears to relate closely to the subject's hearing status. Further research needs to be conducted using these materials with hearing-impaired children in both the aided and unaided condition. This will be carried out in the near future as will pilot studies in other Aboriginal languages.

REFERENCES

Bess, F. (1985) "The minimally hearing-impaired child". Ear and Hearing, 6, 43-47.

Dermody, P., Katsch, R. and Mackie, K. (1983) "Amplitude equalisation techniques for use in word identification speech perception studies". In A.Cohen and M. Broecke (Ed's). Abstracts of the 10th International Conference of Phonetic Sciences, p. 404.

Mackie, K. and Dermody, P. (1986). "Use of a monosyllabic adaptive speech test (MAST) with young children". J. Speech Hear.Res. 29, 275-281.

Mills, C. (1988) "A Queensland programme to provide hearing aids to Aboriginal children". Paper presented at Audiol. Soc. Aust. Conference, Perth.

Quinn, S. (1983). "Aboriginal hearing loss and ear disease in the Australian Northern Territory". Aust.J. Audiol. 4, 41-46.

Ross, M. and Lerman, J. (1971). "Word Intelligibility by Picture Identification". Stanwix House, Inc. Pittsburgh.

Venard, K., Weeks, S. and McCudden, V. (1988.) "A pictorial speech discrimination test modified for Australians". Paper presented at Audiol. Soc. Aust. Conference, Perth.

Weeks, S. and Callingham, L. (1984). "A FM amplification system for Aboriginal children with chronic ear disease". Aust. J.Audiol. 6, 17-22.

Williams, W. (1988.) "Noise level measurements at Yuendumu Community School Northern Territory". NAL Commissioned Report No. 21.

SENSORY-MOTOR INTEGRATION CAPACITY OF STUTTERERS AND NONSTUTTERERS

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ABSTRACT - We review a series of studies concerning the auditory-motor and visual-motor tracking performance of stutterers and nonstutterers. We find no evidence of lateralization differences between the groups and interpret the finding that stutterers perform auditory tracking tasks significantly less well than nonstutterers as evidence of a deficit in ability to form internal auditory-motor models which subserve speech control.

INTRODUCTION

Stuttering is a disorder of speech motor control. Among hypotheses concerning its nature, deficiency in sensory-motor integration processes has been a recurring theme. Some have proposed anomalous lateralization of such processes. Others, noting the similarity between stuttered speech and disfluency induced in nonstutterers by delayed auditory feedback, have argued that a deficit sensory-motor integration leads to control system breakdown. This presentation gives an overview of a series of studies in which we have addressed these issues. For further details see Neilson (1980), Neilson & Neilson (1980, 1987) and Neilson et al. (1985).

TRACKING PERFORMANCE OF STUTTERERS AND NONSTUTTERERS

The auditory-motor skills of 12 stutterers and 12 nonstutterers were tested by means of a dichotic pursuit pitch tracking task. Through one stereo earphone subjects heard a stimulus tone which varied continuously in pitch. Through the opposite earphone a response tone was heard with pitch controlled by the subject. The task was to keep the pitch of the tones matched. Each subject completed a five-minute test in each of four configurations designated RJ, LJ, RH, LH, the R or L indicating the ear receiving the response tone and the J or H indicating whether the tone was controlled by jaw or hand response. Subjects also completed two pursuit visual tracking tests, one using a jaw response (VJ), the other a hand response (VH). While the auditory tests required the pitch of the dichotically presented stimulus and response tones to be matched, the visual tests required the vertical position of stimulus and response display markers to be matched. Otherwise the tracking implementation remained identical for both auditory and visual tracking.

Speed and accuracy of each subject's performance was assessed using cross-correlational and power spectral analysis to compute phase and coherence characteristics for each test. Results were averaged within conditions and compared across groups using analysis of variance. Unlike Sussman and MacNeilage (1975) who used error score analysis, we found no evidence of lateralization differences between stutterers and nonstutterers. However, the systems measures showed the stutterers' auditory-motor tracking performance to be significantly inferior to that of the nonstutterers, whereas the visual-motor performance of the two groups was comparable. Figures 1 and 4 show the averaged characteristics for the auditory tracking performances of stutterers and nonstutterers. The greater phase lag for stutterers in Figure 1 reflects longer time delay between auditory stimulus and correlated motor response. The lower coherence for stutterers in Figure 4 indicates that a lower proportion of response variation was correlated with stimulus variation or, in other words, the stutterers tracked with a higher proportion of inappropriate response or "noise".

The differences observed in the characteristics which describe the auditory-motor tracking performances of stutterers and nonstutterers have parallels to the differences we have seen when comparing other types of tracking performances. Before attempting to interpret the above results we will examine these parallels. Two experiments will be reviewed, both of which examine the visual-motor tracking performance of normal, nonstuttering subjects.

THE EFFECT OF CONTROL-DISPLAY COMPATIBILITY ON TRACKING PERFORMANCE

The effect of differences in control-display (C-D) compatibility was examined in the visual pursuit tracking performance of 24 normal subjects. The task was to superimpose a response marker on a stimulus marker which moved continuously up and down the centre of a graphics display screen. Vertical position of the response marker was controlled either by a light pen (highly compatible C-D relationship) or by a lever (less compatible C-D relationship).

Speed and accuracy of each subject's performance in each condition were assessed by systems analysis measures, as above. Results were averaged within conditions and compared using analysis of variance. Figures 2 and 5 show the averaged characteristics and indicate that tracking performance with the less compatible lever was significantly inferior to that with the highly compatible light pen. The greater phase lag in Figure 2 reflects the longer delay between movement of the stimulus and movement of the response marker when the latter was controlled by the lever. Likewise, the lower coherence in Figure 5 reflects the higher proportion of noise in the response when generated by the lever rather than by the light pen.

THE EFFECT OF PRACTICE ON TRACKING PERFORMANCE

The second parallel with the finding on stutterers and nonstutterers involves extensive practice on a visual pursuit tracking task using a highly incompatible C-D relationship. A single subject's performance was assessed on a task where the response marker on a graphics display screen was required to be superimposed on a continuously vertically moving stimulus marker. Position of the response marker was controlled inversely by a remote light pen. This difficult C-D relationship was practised for a total of 1000 minutes spread over 100 days. Pre- and post-practice assessment used a stimulus signal different from that used in the practice period.

Pre-post performance was compared in terms of speed and accuracy using systems analysis measures, as above. After extensive practice using the incompatible C-D relationship, tracking performance improved significantly as shown in Figures 3 and 6. The decrease in phase lag after practice (Figure 3) reflects a reduction in the average delay between movement of the stimulus and movement of the response marker. Likewise in Figure 6, the higher coherence after practice indicates that the subject reduced the amount of inappropriate movement in his response. These improvements were distinct from stimulus prediction effects.