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Assessing Auditory Discrimination Skill of Malay Children Using Computer-based Method

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Abstract—**The purpose of this paper is to investigate the auditory discrimination skill of Malay children using computer-based method. Currently, most of the auditory discrimination assessments are conducted manually by Speech-Language Pathologist. These conventional tests are actually general tests of sound discrimination, which do not reflect the client's specific speech sound errors. Thus, we propose computer-based Malay auditory discrimination test to automate the whole process of assessment as well as to customize the test according to the specific speech error sounds of the client. The ability in discriminating voiced and unvoiced Malay speech sounds was studied for the Malay children aged between 7 and 10 years old. The study showed no major difficulty for the children in discriminating the Malay speech sounds except differentiating /g/-/k/ sounds. Averagely the children of 7 years old failed to discriminate /g/-/k/ sounds.**

I. Introduction

Auditory discrimination refers to the ability to distinguish between speech sounds [1]. It simply evaluates the speech perceptual skill of an individual. It is different from the pure tone audiometer, which tests the hearing sensitivity of an individual at different audible frequencies and sound levels.

There are a few popular auditory discrimination tests available in English language such as Wepman Auditory Discrimination Test [2], Templin Test of Auditory Discrimination [3], Goldman-Fristoe-Woodcock Test of Auditory Discrimination [4] and Washington Speech Sound Discrimination Test [5]. These tests are conducted in either one of the levels: discrimination and identification. The Wepman Auditory Discrimination Test and Templin Test of Auditory Discrimination are tests at discrimination level. At this level, an individual is presented with pair of speech sounds and the individual is asked to determine whether the pair is same or different. At identification level, the individual is presented with a speech sound at one time and the individual is asked to determine which word is presented. Examples of the test are Goldman-Fristoe-Woodcock Test of Auditory Discrimination and Washington Speech Sound Discrimination Test.

The testing time for these auditory discrimination tests ranges from five minutes to 20 minutes. A variety of stimuli are used, from nonsense syllables to words. These tests are conducted manually by SLP. Repetitious jobs are involved to manage the test such as word naming, sheet recording, scoring and result summarizing.

Bankson and Bernthal pointed out that most widely used auditory discrimination tests were general tests of sound discrimination, which did not reflect a client's specific speech sound errors [6]. The tests typically used a paired comparison task of minimal pairs (e.g. cup-tup) produced by the Speech-Language Pathologist (SLP) or presented via audiotape.

Currently there is no standard Malay auditory discrimination test to be used in clinics and hospitals. The clinician-derived test varies from one to another in different clinics and hospitals. The test may have the same problem of generalness as discussed by Bankson and Bernthal.

Though most of the auditory discrimination tests are still conducted manually by SLP, we are looking into the use of computer in automating the whole process of assessment. We propose a computer-based Malay auditory discrimination test to overcome the generalness of the test as well as developing a standard Malay auditory discrimination test, which to be used in Malaysian clinics and hospitals. The beauty of the proposed system is that the SLP can customize the stimuli of the test according to the specific speech sound errors of the client.

The features of the computer-based Malay auditory discrimination test and the assessment procedure are discussed in the Section II. The results and discussions of the auditory discrimination test among the Malay children are explained in the Section III. The paper is concluded in Section IV.

II. Methodology

The proposed computer-based Malay auditory discrimination test was shown in Figure 1. The system was able to conduct the auditory test at both discrimination and identification level, but only discrimination level was discussed here.

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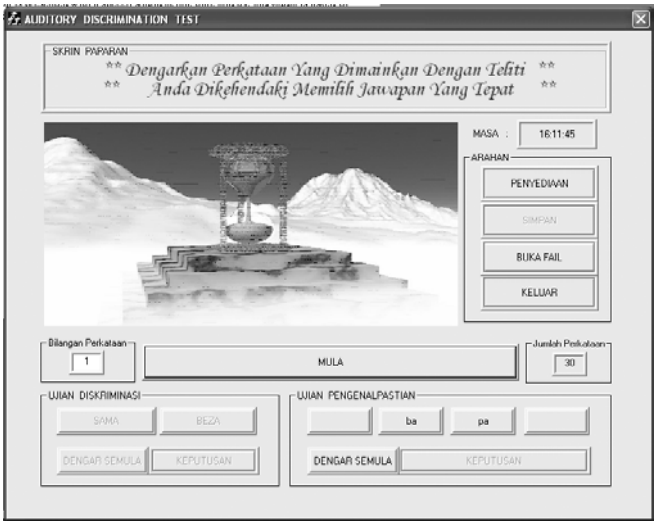

Fig. 1. Computer-based Malay Auditory Discrimination Test

Prior to the auditory discrimination test, the system needed to be pre-set first, as shown in Figure 2. The system was able to test the auditory discrimination at all three positions of word: initial, middle and final. The middle position of the word was further classified into two groups: Syllable-Final-Word-Within (SFWW) and Syllable-Initial-Word-Within (SIWW). Initial and final word positions were also referred to Syllable-Initial-Word-Initial (SIWI) and Syllable-Final-Word-Final (SFWF) respectively. All word positions were checked for the test.

The second step in the setup was to determine the target consonants and its associated error consonants. The system allowed a maximum of three error consonants to be compared with the target consonant. The beauty of the computer-based system was that it was able to customize the auditory discrimination test based on the specific error sounds of the client. Next step was to indicate a consonant, which the client did not have difficulty in producing it. This correct consonant was used to form the stimuli at SFWW position. Once the button "SEMAK" was clicked, the system generated the relevant stimuli to be used in the test. Then, button "DISKRIMINASI" was clicked to select the discrimination test and with that it completed the experiment setup.

Once the button "MULA" was clicked, the auditory discrimination test started by presenting first pair of sounds. The client needed to determine whether the pair of sounds was same or different simply by just clicking the button "SAMA" to indicate the same sounds or button "BEZA" to indicate the different sounds. The system continued to the next pair of sounds once the client provided the input of answer. The auditory discrimination test completed when all the pairs of sounds were presented. The system allowed to playback the pair of sounds for the second time if the client could not catch up with the sounds or missed the sounds. The result of the test was viewed by just clicking the button "KEPUTUSAN". In order to save the test result, the button "SIMPAN" was clicked. A name of file needed to be provided in order to save the result. The button "BUKA FAIL" was clicked to view the previous saved file or result.

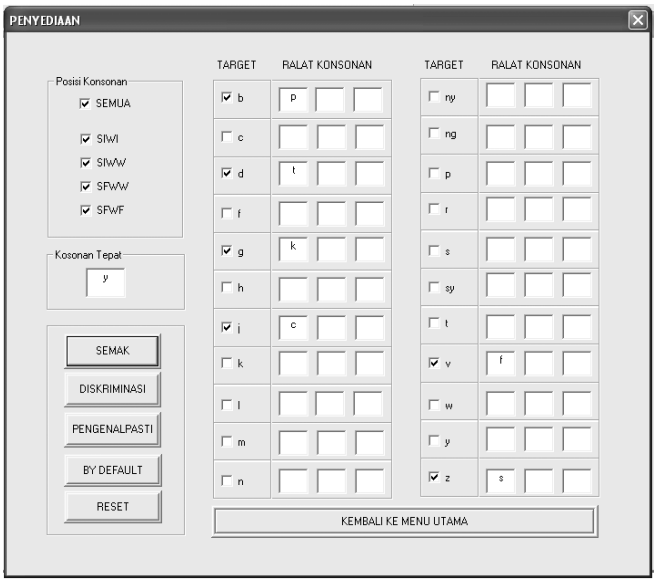

Fig. 2. Setting up the discrimination test

The administration time for the test was around 10 minutes for each client. The computer-based system was able to do scoring and summarize the result for the SLP, thus SLP no longer needed to do the jobs of calculation and recording during and after the auditory discrimination test. The system was able to save the result of the test into a file in the computer as well as to read the result from the file.

The ability to discriminate between voiced and unvoiced consonantal sounds among Malay children was studied. The children aged between 7 and 10 years old were selected for the study. A total of 28 children were selected randomly for the auditory discrimination test. The number of clients according to the age group was shown in Table I. The test was done at a primary religious school at the University of Technology Malaysia, Skudai, Johor, Malaysia. Six groups of sounds were selected for the auditory discrimination test: /b/-/p/, /d/-/t/, /g/-/k/, /j/-/c/, /v/-/f/, and /z/-/s/. The pair of voiced and unvoiced sounds came from the same manner and place of articulation. A total of 30 stimuli were generated by the system and used in the test. The stimuli were shown in Table II. The generated stimuli were available at SIWI, SIWW and SFWF positions and none of SFWW position was tested.

TABLE I
NUMBER OF CLIENT ACCORDING TO AGE GROUP

No	Age Group (Years Old)	No of Client
1	7	5
2	8	7
3	9	6
4	10	10
	Total	28

TABLE II
COMPUTER-GENERATED STIMULI

No	Target And Error Consonants	Generated Stimuli	No Stimuli
1	/b/-/p/	/ba/-/ba/, /pa/-/ba/, /aba/-/aba/, /apa/-/aba/, /ab/-/ab/, /ap/-/ab/	6
2	/d/-/t/	/da/-/da/, /ta/-/da/, /ada/-/ada/, /ata/-/ada/, /ad/-/ad/, /at/-/ad/	4
3	/g/-/k/	/ga/-/ga/, /ka/-/ga/, /aga/-/aga/, /aka/-/aga/	6
4	/j/-/c/	/ca/-/ca/, /ja/-/ca/, /aca/-/aca/, /aja/-/aca/	4
5	/v/-/f/	/fa/-/fa/, /va/-/fa/, /afa/-/afa/, /ava/-/afa/	4
6	/z/-/s/	/za/-/za/, /za/-/sa/, /aza/-/aza/, /asa/-/aza/, /az/-/az/, /as/-/az/	6
		Total No Stimuli	30

III. RESULTS AND DISCUSSIONS

The test result was shown in Table III. From the result, it was found that Malay children of 7 years old showed the poorest performance, with an average of 80.7%. The significant factor was contributed by their poor ability to discriminate between /g/ and /k/ sounds. The performance generally improved with the increment of the age of the children. The children of 9 years old outperformed other age groups, with an average of 93.9%. More clients needed to be tested in order to get a more representative performance of children at each age group.

The overall performance of these 28 Malay children was at 90.0%. Among the pairs of the sounds, /c/-/j/ was the pair of the sounds that was highest to be discriminated by the children, with an average of 94.6%. The pair sounds of /g/-/k/ was the poorest to be discriminated by the children, with an average of 71.4%. Averagely, the children of 7 years old failed to recognize the difference between /g/ and /k/ sounds. Two out of the children regarded both of the sounds to be the same. However, children of 9 and 10 years old seemed to have no problems in discriminating the pair of the sounds. The performances of children in discriminating other pairs of sounds were in between 86.9% to 89.3%.

From the result, generally the children did not have problem in discriminating the pairs of same voiced sounds. The error rates were recorded in between 1.8% and 10.7%. However, if high error rate was recorded, the children might have problem in recognizing the sound. The discrimination of pairs of same voiced sounds was averagely better than the discrimination of the pairs of different sounds except for the pair of /j/-/c/ sounds.

TABLE III
TEST RESULT OF AUDITORY DISCRIMINATTION ACCORDING TO AGE GROUP

No	Target Consonants		Age (Years Old)				Avg (%)
			7	8	9	10	
1	/b/	/b/	100.0	95.2	94.4	93.3	95.2
		/p/	73.3	90.5	94.4	86.7	86.9
	Average		86.7	92.9	94.4	90.0	91.1
2	/d/	/d/	100.0	95.2	94.4	96.7	96.4
		/t/	73.3	85.7	100.0	86.7	86.9
	Average		86.7	90.5	97.2	91.7	91.7
3	/g/	/g/	100.0	100.0	100.0	95.0	98.2
		/k/	30.0	64.3	91.7	85.0	71.4
	Average		65.0	82.1	95.8	90.0	84.8
4	/j/	/j/	90.0	92.9	91.7	95.0	92.9
		/c/	90.0	92.9	100.0	95.0	94.6
	Average		90.0	92.9	95.8	95.0	93.8
5	/v/	/v/	90.0	85.7	83.3	95.0	89.3
		/f/	60.0	92.9	91.7	95.0	87.5
	Average		75.0	89.3	87.5	95.0	88.4
6	/z/	/z/	86.7	85.7	88.9	96.7	90.5
		/s/	66.7	90.5	94.4	93.3	88.1
	Average		76.7	88.1	91.7	95.0	89.3
	Average		**80.7**	**89.50**	**93.9**	**92.7**	**90.0**

The performance of each child of 7 years old was in between 73.3% and 90.0%. The pair of /g/-/k/ sounds was the lowest to be correctly discriminated by them, with an average of 30%. It was then followed by /v/-/f/ sounds. The /j/-/c/ sounds were the highest to be discriminated with an error of 10.0%.

A major improvement had been found in the group of eight years old if compared to the group of seven years old. The performance of each child was in between 70.0% and 100.0%. Only one of the children managed to scored 100% for the test. The /g/-/k/ sounds were the lowest to be discriminated by this age group, with an average of 64.3%. The /j/-/c/ and /v/-/f/ sounds were discriminated at the highest rate, with an average of 92.9%.

As for the group of nine years old, the performance of each child was in between 80.0% and 100.0%. Four children achieved 100% in discriminating the sounds. Instead of having the most difficulty in discriminating /g/-k/ sounds, the children were found to have most problems in discriminating /v/-/f/ sounds. The sounds /d/-/t/ were the highest to be recognized by them, at an average of 97.2%.

Lastly, the performance of each child was recorded in between 80.0% and 100.0% for the ten years old. Two of the children scored 100%. The /b/-/p/ and /g/-/k/ are sounds to be least discriminated whereas /j/-/c/, /v/-/f/ and /z/-/s/ were discriminated correctly with the highest rate.

IV. Conclusion

The auditory discrimination skill of Malay children was investigated using computer-based method. The proposed computer-based Malay auditory discrimination test was able to automate the whole process of assessment as well as to customize the test according to the specific speech error sounds of the client. The ability in differentiating voiced and unvoiced Malay speech sounds was studied for the Malay children aged between 7 and 10 years old. The overall performance of these children was recorded at 90.00%, which showed that no major difficulty for the children in discriminating the Malay speech sounds. Averagely the /g/-/k/ sounds was the most difficult to be discriminated by the children and averagely the children of 7 years old failed to discriminate the sounds.

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