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An experiment in voice identification

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AN EXPERIMENT
IN
VOICE IDENTIFICATION

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Most deaf children have some residual hearing in the lower frequencies, but can they use this hearing with amplification to identify talkers? Can children with severe hearing losses identify talkers more easily than children with profound losses? What influence does long-term familiarity with speakers have on speaker identification by deaf children? And as a minimum, can deaf children identify a male talker versus a female talker? Unable to find answers to these questions in the literature, a study was designed that would hopefully provide some helpful insight into the area of voice identification by deaf children.

It has already been determined in the literature (e.g., Erber, 1982 and Ling, 1978), that deaf children benefit from the use of hearing aids, but the degree of this benefit varies from each child. For example, the child who suffers from a moderate-to-severe hearing loss that cuts straight across the frequencies can be expected, given appropriate amplification, to detect all sounds of speech, since hearing is present over the complete speech frequency range (80 - 8000 Hz). The child whose audiogram shows a moderate-to-severe loss that drops off after 1000 Hz can be expected to detect all speech sounds, but to miss some of the components of the fricatives and the high frequency bursts of plosives. They will also be able to recognize all prosodic features of speech (intonation, duration, stress, etc.) as well as all vowels, all voiced consonants and most variant cues of manner, place and voicing. Children with hearing losses in the severe range should be able to detect all prosodic features of speech, and the low-frequency components of all vowels and some consonants. Generally, cues of manner of consonant production and the presence of voicing can be de-

tected with such residual hearing. Children with hearing losses representing the profound level will be able to detect the first formants of most vowels and thus, most of the prosodic patterns of speech should also be audible.

There would be few to dispute the information just cited on the benefits of wearing hearing aids to enhance residual hearing of deaf children. But what role do hearing aids play in connection with the task of voice identification by deaf children? And furthermore, what degree does hearing loss play in the task along with everyday exposure to a voice over a six-month period of time?

SUBJECTS

Twelve students in the Middle School division of Central Institute for the Deaf were chosen for the study. The twelve children were selected from four different homeroom classes; three children per homeroom. Each child was a first-year student in their particular homeroom and with their particular homeroom teacher. (Homeroom is defined as the room where the children spend most of their day. Homeroom teacher is defined as the teacher who teaches them the most subjects throughout the day.)

The twelve children chosen for the sample were between the ages of six and eight years. Their hearing losses ranged between moderate-to-severe(56 - 70dB) down to profound (95+dB). Since schools for the deaf have an over representation of severe and profound hearing classes, the sample does not reflect the hearing losses of the total hearing aid population. The sample selected was as follows: 2 moderate-to-severe (58 - 65dB), 3 severe (80 - 94dB) and 7 profound (101 - 120dB). The aided speech frequency averages of the sample were all above their hearing thresholds.

PROCEDURE

To carryout this study in voice identification, there needed to be a variety of voices for the listeners to descriminate between and identify. These voices also had to be considered familiar to the listeners.

Five talkers were selected to be recorded on tape for this study. Four of the talkers were females in their twenties and homeroom teachers in the Middle School division of Central Institute for the Deaf. Each of these four teachers had exactly three children from their homeroom in the sample of listeners. They also had contact with the remaining children in the sample during the day, thus their voices were considered to be familiar to the listeners. The fifth talker was a male in his middle thirties and a teacher in a different division of Central Institute for the Deaf, C.I.D. This male teacher had taught in the Middle School division of C.I.D. in the previous year (1981-1982) and had contact with approximately 50% of the children in the sample in a teaching capacity. The remaining 50% of the children in the sample were new students to the Middle School division and had not been exposed to his voice prior to this study. However, the principal task in this case of the male talker was to distinguish it from female voices and not to recongnize it among other male voices.

In this study, all elements of the recording situation were maintained as similar as possible. Voice recordings were obtained for each of the 5 teachers on the same afternoon in late September. The voice samples were recorded on a AKAI model GXKC-760D cassette recorder. All recordings were done in a quiet environment within an audiometric booth at C.I.D. The voices were all recordered at 65 dB S.P.L. Each teacher was recorded three times per cassette tape with 5 second intervals between samples. This procedure was carried out so that subjective selection of the most natural and fluent sounding of the samples per tape could be played during the experiment.

The passage selected to be read for all recordings was entitled, "Arthur the Shirker" and ranged in length, when read outloud, between 25 and 30 seconds. This passage was selected for its length, large amount of direct discourse and interrogative statements. According to Pollack, Pickett and Sumby (1954) the duration of the sample of a speaker's voice is an important variable in voice identification of speakers. Long samples of speech are optimum versus single monosyllabic words when normal hearing listeners are identifing speakers. Thus, deaf listeners should also be exposed to longer speech samples in a similar task. It was also believed that the large amounts of direct discourse and interrogative statements would make this passage sound similar to a teacher-child discussion in a classroom situation and consequently, aid the children in the voice selections. The passage is as follows:

> Once there was a young rat named Arthur, who could never make up his mind. Whenever the other rats asked him if he would like to go out with them, he would answer, "I don't know." And when they said, "Would you like to stay at home?", he wouldn't say yes or no either. He would alsways shirk at making a choice.
>
> One day his aunt said to him, "Now, look here. No one will ever care for you if you carry on like this; you have no more mind than a blade of grass!" The young rat coughed and looked wise as usual, but said nothing.

Each teacher had been given several days to practice reading the passage outloud so that they would have some degree of familiarity with it before the recording session.

A 35 mm. picture of each teacher was taken prior to the recording session. All 5 pictures were developed and then mounted and numbered one through 5 randomly on cardboard. The children had only to point to the teachers picture to identify the talkers' voice after they had listened to the entire passage. This procedure was carried out to simplify the listeners' task.

The study was designed to include two separate testing periods with a six-month interval between them. The first testing was to take place within

the first two months of the school year when the children in the sample had one begun to become familiar with the teacher's voices in the Middle School. The second and final testing was to be held within the last two months of school, after the children had been exposed to their teacher's voice for the entire school year.

Early in October the first testing was carried out on two consecutive Wednesday mornings. Six children were tested per session taking approximately 1 hour at a time. The children were brought into the audiometric booth individually. Each wore their normal acoustic amplification, and in the case of the sample listerners, their hearing aid(s), during the testing session. They were seated at a small tabel approximately two and one-half feet from the loudspeaker that would present the voice stimuli. They were instructed that they would hear some teachers that they knew talking from the loudspeaker. They had to listen to the entire tape and then point to the picture of the teacher they thought was speaking. The pictures were on the small table infront of the children. All children indicated that they understood the task before starting the tapes.

The cassette tapes were played at 65dB S.P.L., one at a time, randomly but in predetermined order by the examiner. The examiner kept track of the listener's selections after each tape was played. The entire testing session, per child, took approximately 10 minutes in length.

The exact same procedure was carrier out again in April of the same school year. The order the tapes were played was again in random, predetermined order but different from the order presented to the listeners in October. The same sample of listeners was used again except that one child no longer was a student at C.I.D. and another child was sick on the final day of testing. Thus, the sample size was cut to ten children during the second testing period.

To establish whether this task in voice identification was possible for hearing people as listeners, the examiner tested five teachers from C.I.D. who were familiar with the teachers that were recorded in the study. The same procedure, as described earlier for the hearing-impaired listeners, was carried out with the normal hearing listeners. All the listeners correctly identified the taped voices with 100% accuracy.

RESULTS

The results of this study will be presented in four parts so as to answer each of four questions that were presented in the introduction of this paper.

The first question of whether deaf children can identify speakers by hearing their speech through acoustic amplifiers will be addressed in the following graphs.

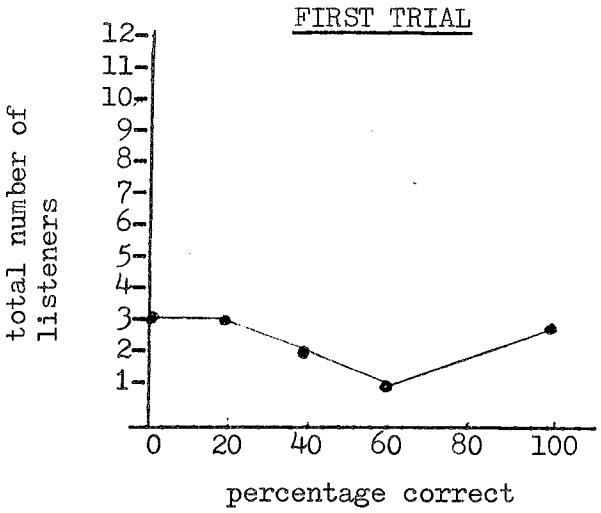

Figure 1:

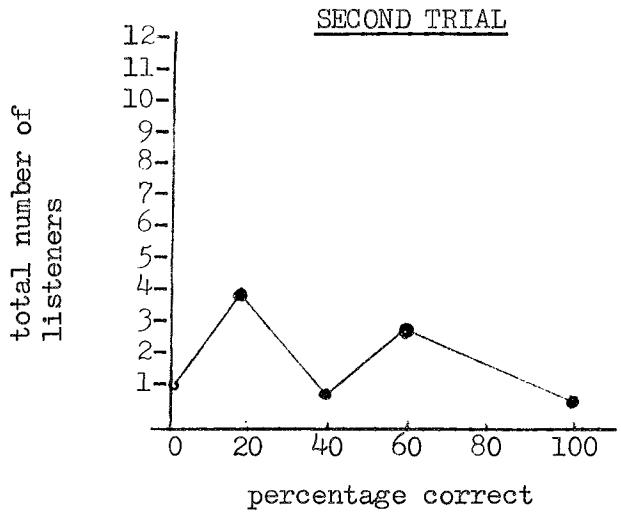

Figure 2:

Figures 1 and 2 present the total number of listeners in the sample on the horizontal axis and the percentage of correct scores on the vertical axis for the first and second testing period. The maximum percentage correct that any child could score in the study was 100% and three children received this score in the first trial and one child received this in the second trial.

Conversly, there were three listeners who received 0% on their first trial and one listener on the second trial. The rest of the listeners fell between the highest and lowests percentiles.

	First Trial		Second Trial	
HEARING LOSS: Listeners	RAW SCORE CORRECT	% CORRECT	RAW SCORE CORRECT	% CORRECT
Mod-Severe:				
Nicky	** 5	100	3	60
Christen	2	40	1	20
Severe:				
Kevin	** 5	100	** 5	100
Christoper	** 2	40	1	20
Robyn	3	60	1	20
Profound:				
Paige	** 5	100	3	60
Shannon K.	1	20	2	40
Gavin	0	0	1	20
Shannon B	0	0	0	0
Kyle	0	0	** 3	60
* Michelle	1	20		
* Josie	1	20		

TABLE 1: * only tested in first trial
** includes homeroom teacher

Table 1 supplements graphs 1 and 2 by listing the listeners' raw scores along with their percentage correct for trial 1 and 2. The listeners' raw scores ranged between 5 out of 5 correct to 0 out of 5 correct.

The wide range of raw scores and percentiles demonstrates that some deaf children are capable of identifing voices when using their hearing aids and other deaf children are not capable of doing this.

The second question to be explored from the results of this study was regarding whether children with severe hearing losses could identify talkers more easily than children with profound losses. To answer this question, the correct raw scores and percentages of each listener within the three hearing loss categories were analyzed. See Table 1

What is apparent, in the findings in Table 1, is that there is absolutely no consistency in correct responses by the listeners and their degree of hearing impairment. It was expected that the findings would show a converse relationship between hearing loss and percentage correct. The smaller the hearing loss, the higher the correct raw score and vice versa, the larger the hearing loss, the smaller the correct score. For example, listeners with moderate-to-severe hearing losses should score the highest percentage correct. Profound listeners, on the other hand, were expected to score lower percentiles because of their degree of hearing impairment.

It is true, from the results, that within the moderate-to-severe category of hearing loss, that Nicky received a 100% correct in the first trial, as expected. But Christen, also falling within this hearing category, only scored a 40% correct on her first trial. The same is true for the other two categories of hearing loss. Each category has a wide range of scores anywhere from 100% down to 20%.

To group listeners according to their hearing loss so as to predict their percentage of correct scores is not a feasible result from this study. Each child is an individual and perceives various auditory cues in different manners, thus the inconsistent results in this area.

What influence does long-term familiarity with speakers have on speaker identification? The postulated answer to this third question was that the longer the exposure to a voice or voices, the easier it is to identify it or them. However, this was not the conclusion that was drawn after examining the results of this study. The conslusion that can be drawn is that exposure alone to a voice or voices is not enough to improve a deaf childs ability to identify it or them at a later date.

To take this one step further, what if any improvement was made in correctly identifing homeroom teachers soley by the listeners in their homeroom. The

homeromm teacher's voice is the one voice they are exposed to the most throughout the day and naturally should be the most recognizeable.

However, the results do not support the obvious in this case, refer to Table 1. The double asterisk next to the raw score indicates that the listener correctly identified his/her homeroom teacher in his selections. Only one child showed improvement in this area from the first trial to the second trial. The rest of the children either stayed the same or decreased in their correct responses. Thus, even daily exposure to a voice over a 6 month period has little or no effect on the deaf childs ability to identify it from a closed set of voices.

The final question presented in the introduction was of lesser importance to the examiner and this experiment in voice identification, but none the less of interest. The question was stated as follows: Can deaf children identify a male talker versus a female talker? As mentioned previously, this was not a task related to exposure or familiarity with the male voice. It was, instead, a task of discriminating a male voice from female voices. In analyzing the results to find the answer to this fourth question, the examiner was only interested in determining whether the listeners correctly identified the male voice when the male voice was played. Here are the results of this analysis:

	CORRECTLY DISCRIMINATED MALE VOICE	
Listeners:	First Trial	Second Trial
Nicky	Yes	Yes
Christen	Yes	Yes
Kevin	Yes	Yes
Christopher	Yes	Yes
Robyn	Yes	Yes
Paige	Yes	Yes
Shannon K.	Yes	Yes
Gavin	No	No
Shannon B.	No	No
Kyle	No	No

TABLE 2:

More than 50% of the listeners were able to correctly identify the voice of the male as just that, the voice of a male. The listeners were also consistent in their ability to identify a male's voice for both testing sessions. They either were able to distinguish it from among female voices or they were not able to do this. In either case, they were consistent in their responses in both trials.

The conclusion of the examiner is that the ability to discriminate a male voice from among female voices is related to hearing loss. The lesser the severity of the hearing loss, the more easily it is to identify a male voice, while the greater the severity of loss, the harder the task becomes. This is apparent in Table 2. The listeners are listed in increasing levels of hearing loss with their corresponding trial results. The farther down the list, the more severe the hearing impairment and the change from a correct response to an incorrect response. Without having an exact measure of this male's fundamental frequency, it is safe to assume that it is within the normal limits for a male of his age (approximately 100 Hz). Because a correct response for the male voice was often the only correct response made be the listeners, the examiner will assume that a lower F^{o} is much easier to discriminate from higher fundamental frequencies (approximately 250 Hz) of the female voices for the deaf child. The fact that most deaf children have some residual hearing in the lower frequencies might be the reason for the increase in correct responses in this portion of the study.

DISCUSSION

Deaf children are trained to use their residual hearing, with acoustic amplification, to correctly identify and produce intelligible speech. There has not been the emphasis put forth in the past to train deaf children to use their residual hearing to identify speakers. That might be the reason for the

lower than expected correct responses in this study. Maybe if more effort was exercised in training deaf children to utilize their hearing to identify voices, especially of their teachers and family, than a different set of results would be feasible.

What can be concluded from this study, is that some deaf children can identify voices they are familiar with, but exposure to these voices over a school year and without specific training in voice identification is insufficient for increasing correct identification scores. However, no relationship was established between degree of hearing loss and percentage correct.

REFRENCES

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3. Pollack, I., Pickett, J.M., and Sumby, W.H., "On the Identification of Speakers by Voice", Journal of the Acoustical Society of America, Volume 26, #3; May 1954.