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The influence of sentence length and complexity on the speechreading performance of profoundly deaf children

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PRELIMINARY DEVELOPMENT OF A CONNECTED-DISCOURSE SPEECHREADING TEST

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INTRODUCTION

The teaching of speechreading as a skill for hearing-impaired persons rests upon the premise that the ability to receive spoken messages through the sense of vision is trainable. The design and evaluation of methodology for such training would be much easier for the teacher were there a standardized measure of the relative skill of individuals at the complex task known as speechreading. A number of tests have been developed which are intended to help the teacher on evaluation of speechreading skill and in diagnosis of areas which need particular work (Barley, 1964; Butt and Chreist, 1968; Cavender, 1949; Craig, 1964; Taafe, 1957; Utley, 1946). These tests generally are based upon the assumption that the ability to speechread sentences, single words, and in some instances individual speech movements, are predictive of one's ability to receive normally spoken messages through speechreading.

This premise appears to be the root of one of the major problems in testing speechreading skill. A score on a speechreading test tells one only how well a given person could understand a particular set of sentences (or words) under a particular set of conditions. To generalize this score to everyday communication skills is a large step. The typical hearing-impaired person must attempt to understand what is being said in a number of situations under a variety of conditions each day. Seldom is he spoken to in single words or even in single sentences without any contextual clues.

Tests Using Single Word Stimuli

Nitchie (1930) estimated that ordinary speech averages about 13 sounds per second and that the eye was capable of perceiving only 8 to 10 movements per second. Miller (1960) estimates the maximum rate of speech to be 12.5 sounds per second. Whichever estimate we accept, it is quite probable that many speech sounds are not seen by the speechreader during running conversation. A spoken sentence might seem quite different to the speechreader than the same words spoken separately. The physical characteristics and individual speech idiosyncrasies of individual speakers also tend to obscure the movements associated with certain speech sounds.

There is also a large amount of variability in the way certain speech sounds may be formed by different speakers. For example, there are a large number of tongue positions that will produce a quite acceptable /t/, but which look quite different. On the other hand, there are many homophenous sounds which appear identical for a given speaker, but which sound very different (e.g., /p/,/b/, and /m/).

A final problem in predicting speechreading ability from performance on single-word tests is the transition effect caused by the blends and co-articulations which occur where words are joined in normal running speech. Certain sounds are normally dropped or changed in some way when they appear adjacent to certain other sounds (e.g., with many speakers, "What's your name?" becomes "Wha chur name?").

Tests Using Sentence or Phrase Stimuli

Many of the objections to single word stimuli presented above also apply to sentence and phrase stimuli. The addition of other related sentences in normal conversation tends to increase the number of adjacent and interacting sounds and in many cases also increases the rate of speech beyond that used in speaking a single sentence.

One of the most important objections to the use of any type of unrelated material as stimuli is that this type of test bears little resemblance to the actual situations in which the hearing-impaired person routinely uses his speechreading ability. People normally speak in groups of several sentences of widely varying lengths and complexity, all of which are concerned with the same topic. It is a well-known point that speechreading is much easier if the topic is known before the speaker begins.

One of the major factors in most theoretical constructs of speechreading ability is the ability to synthesize the fragmented information received by the eye into a meaningful message. A second important factor is the ability to rapidly shift previous perceptual or cognitive associations to make the received message appear meaningful in the light of new incoming information (Jeffers and Barley, 1971).

Neither of these abilities may be adequately tested with single word stimuli, nor by unrelated sentences which do not allow for the additional input on which changes in perceptual or cognitive associations may be made. In synthesis social and physical contextual

cues may also be important and these are notably lacking from single sentence and single word stimuli, as is the clue afforded by a general grasp of the topic. For example, if you are discussing the new book your brother is working on, "He's writing." is an easy phrase to understand, whereas in isolation it appears identical on the lips to "It's raining."

As an example of flexibility, or the ability to shift previous associations, the one given by Jeffers and Barley (1971) is especially amusing:

> In viewing a production of "South Pacific" a hearing-impaired person saw, "Her skin is tender as imagined love.", instead of the correct, "Her skin is tender as Di Maggio's glove."

The two versions appear identical on the lips and if given only a single sentence, even a very good speechreader might well have accepted the former. However, when the other lines of the song are known, the speechreader discards the former version as absurd and accepts the latter, for he realizes that the song is about Bloody Mary.

This author has reached the conclusion that a truly predictive test of general speechreading ability must consist of groups of related sentences of varying length and complexity within a range set by the linguistic level of the population with which it is to be used.

The present study was designed as a preliminary step in the development of such a test, intended primarily to demonstrate that relatively young children of superior speechreading ability (as indicated by teacher ratings) could perform well on such a task.

In order to provide topically related sentences on the approximate language level of the children to be tested, seven stories were created of the type found in the Croker, Jones, and Pratt (1966) series. Responses were indicated on multiple-choice sentences to minimize scoring difficulties such as those involved in scoring hearing-impaired children's expressive language. On one story the children were also asked to "write the story" in order to provide a basis for comparison of the results with the children's ability to retain and express the salient points of the story.

METHOD

Subjects

Four hearing-impaired children from the primary department of Central Institute for the Deaf served as subjects. The ranged in age from 9 years, 3 months to 9 years, 8 months, with a mean age of 9 years, 6 months. The average hearing threshold level for the better ear for the frequencies 500, 1000, and 2000 Hz. ranged from 80 dB to 103 dB ISO with a mean HTL of 93 dB*. All the subjects had attended classes at C.I.D. since infancy and normally used speech and speechreading as their primary means of communication. All were considered to be excellent speechreaders by their teachers, and all were of normal intelligence (mean performance IQ=117).

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*One subject, A.D., had two widely varient audiograms (one year apart) for her better ear. The better (and latter) score is given above. Were the poorer audiogram for her better ear considered instead, the range would be 93 dB to 103 dB ISO with a mean of 98 dB.

Speaker

A female teacher of the deaf recorded all the stimuli in a quiet, normally reverberant room with special lighting to illuminate her mouth and face. She spoke in a normal voice without exaggeration and at her normal rate for story-telling. This teacher had not taught the children used as subjects and at the time of recording did not know who the subjects would be.

Stimuli

As explained above, seven stories of varying length (from 68 to 141 words) were developed (see Appendix I). The stories were designed to contain vocabulary and sentence structures generally within the receptive abilities of the subjects, although unfamiliar words were not arbitrarily excluded if they seemed important to the story.

Equipment

The stimuli were recorded on ½ inch videotape, using a Sony videotape recorder, microphone, and 21-inch TV receiver/monitor, and an Ampex video camera. The recording was done in a quiet, normally reverberant room under high illumination conditions with the speaker facing the lights and camera. The wall behind the speaker was painted a non-reflective dark color. Stimuli were separated by a 20 second blank space on the tape, during which the machine was turned off during playback to allow for responses. Just prior to each story, the speaker said, "Story number ___." The titles of the stories were not recorded on the videotape.

Test Procedure

The visual stimuli were presented on a 21-inch monitor placed 5 feet in front of the center subject and approximately 2 feet above his eye level. The testing room was dimly lit to provide minimal visual distraction. Acoustic cues were provided by amplifying

the acoustic output of the videorecorder by passing it through a Grason-Stadler hard-wire type group hearing aid with individual attenuators mounted on each child's desk. Under the aided condition the children listened to this amplified signal through TDH-49 earphones mounted in MX 41/AR cushions. Half the children were given acoustic cues for each story, in a counterbalanced manner to offset the effect of learning. All stories were seen twice by each subject, once with and once without acoustic aid.

Following each story, the videotape was stopped and the subjects were given response sheets on which they were instructed to underline the ending which made each statement true. A sample response sheet was completed by each child before testing began.

Each child was allowed to set the acoustic signal attenuator at his own preferred listening level after it was ascertained that all the children prefered levels well above their thresholds, i.e., the settings allowed for either 0 or 3 dB attenuation from a 130 dB output.

Scoring

Each subject's responses were scored as correct or incorrect. There were ten responses for each story so the per cent correct score for any individual story was obtained by multiplying the raw score by a factor of ten.

RESULTS AND DISCUSSSION

The subjects in this study were part of an experimental classroom with one full-time and one part-time teacher of the deaf. Both these teachers were asked to rate the receptive communication abilities of all four children on the Receptive Oral Language Scale presently being developed at CID (Cramer, 1974).

All four of the subjects received ratings of A or B for general communication ability on the ROLS (see Appendix II), which correspond to correct reception of spoken language at least 90% and at least 75% of the time, respectively. On the section of the ROLS which deals with one-way reception of information (section 1, Appendix II), all four subjects received the A or 90% or better rating.

As predicted by the ROLS ratings, all the subjects performed reasonably well on the speechreading test, with a mean score of 75.9% and a range from 44.3% to 89.3% (Table I). The one subject (A.D.) who seemed to lag behind her predicted ability (A rating on ROLS, 44.3% on speechreading test), was observed several times to be disinterested in the task and easily distracted.

She exhibited such behavior as dropping her pencil midway through a story, playing with the group hearing aid, attempting to talk to the examiner, etc. Motivation probably plays a highly relevant role in the design of a speechreading test for children of this age. However, it is also worthy of note that on the previous year's achievement test (present year's data not yet available), this subject was approximately one year behind the other children for whom scores were available, in average grade equivelent, in sentence and word meaning, and in paragraph meaning. Her educational age was approximately one year behind her chronological age, whereas the educational ages of the two other children for whom data was available were three to five months ahead of their chronological ages (Table II). This leads the examiner to suspect either that a minimum third grade reading and vocabulary level may be necessary for the successful completion of this test, or that teachers may misjudge a child's oral speech reception abilities in the classroom situation.

Neither of the hypotheses formulated above may be accepted on the basis of this study alone. This test, or s similar one, should be administered to a much larger group of children of more widely variant abilities.

Only a slight (3.3%) increment was noted for the audio-visual condition over the visual-alone condition. This is somewhat lower than the increments shown by such researchers as Numbers and Hudgins (1948), Hudgins (1954), Evans (1960), Van Uden (1960, 1970), and Erber (1972). The results of some of these studies is summarized in figure 1. Further study is necessary to determine if this difference is due to the relatively good speechreading abilities of these subjects or to the difference in stimulus material. On hypothesis is that the time-intensity pattern perceived by profoundly deaf children from an acoustic signal may be of greater help when applied to a short segment of speech (with a smaller set of logical alternatives for each visual-acoustic pattern) than when applied to normal running speech.

Although the population and stimulus set of this preliminary study were much too limited to allow sweeping generalizations about the potential uses of such a test for classifying speechreaders, it does offer some promise. Further study is indicated with a more variable population and with stories more critically selected for levels of language difficulty. The performance of this group of children does tend to show that a story-test of speechreading is feasible for relatively young (9-10 years old) deaf children if the language of the stories and the requirements of the response action are carefully controlled to be within the children's capabilities.

TABLE I

SPEECHREADING TEST SCORES

SUBJECT	SPEECHREADING SCORE IN %	AIDED SPEECH-READING SCORE	AVERAGE SCORE
E.G.	82.8	90.0	86.4
C.G.	88.6	90.0	89.3
A.D.	42.8	45.7	44.3
K.K.	82.8	84.2	83.5
AVERAGE	74.2	77.5	75.9

TABLE II

AMERICAN SCHOOL ACHIEVEMENT TEST SCORES

TEST DATE: MARCH, 1973

SUB.	CA ON TEST DATE	EA ON TEST DATE	AVERAGE GRADE EQUIV.	SENT. & WORD MEAN. GRADE LEV.	PARA. MEAN. GRADE	LANG. GRADE LEVEL
*E.G.	NO ACHIEVEMENT TEST SCORES AVAILABLE					
C.G.	8.6	9.1	3.9	3.9	4.6	2.9
A.D.	8.5	7.5	2.2	2.4	1.8	3.2
K.K.	8.3	8.6	3.3	3.3	3.6	3.6

* Although there were no achievement test scores available for this subject at the time of tabulation, a verbal score was obtained on the WISC, with a verbal IQ of 91, which indicates near-normal ability with verbal material.

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APPENDIX I

STORIES FOR SPEECH READING TEST

I

One cold windy day in winter, a very dignified lady was walking along an icy sidewalk. Suddenly, her feet flew out from under her and she fell down so hard that she saw stars.

A man who was on the other side of the street ran over to her and exclaimed, "Oh, Miss, did you fall?"

"No," she replied, with great dignity, "I was tired and sat down to rest."

II

One day a bee fell into a river. It did not know how to swim and it almost drowned.

A bird sat beside the river in a tree. She looked down and saw the poor bee in the water. She felt sorry for it and wanted to help it. So she dropped a leaf into the water. The bee climbed up on it and was safe.

Not long after that, the bird was in a tree near her nest. She did not see a man with a gun hiding in the bushes. He lifted his gun to shoot the bird. The bee saw its friend's danger and flew to help her. It stung the man and he dropped his gun. The bird flew away and was safe.

III

There once lived in England a brave man named Walter Raleigh. He was very kind and polite, too.

One day Walter was walking down the street in London. He was all dressed up in a beautiful velvet suit. The streets were very wet and muddy and he had to be careful to keep his shoes clean.

Then Walter looked up and saw the Queen coming down the street. She came to a big mud puddle and stopped because she didn't knwo how she could get across. Walter quickly pulled off his coat and spread it over the puddle. The Queen walked across the water without getting any on her shoes.

The Queen was so pleased that she sent for Walter Raleigh to come to the palace. She made him a knight and from then on he was called Sir Walter Raleigh.

IV

Mrs. Wheeler was a rich woman who lived in Boston. One day, while she was shopping, she lost a beautiful diamond pin. When she discovered her loss, she put an advertisement in the Lost and Found column of the lnewspaper.

A boy, who was skating on the sidewalk, found the pin near the curb. The next day he saw the advertisement in the paper. He took the pin to Mrs. Wheeler's house. She was very glad to get it back and wanted to give him a reward, but he refused to take it. She thanked him for returning the pin and asked for his name and address. When Christmas came, Mrs. Wheeler sent the honest boy twenty dollars.

V

The people who live in the far north are called Eskimos. Their summer is very short, but the sun shines allday and all night. In the winter the sun does not shine at all.

The Eskimos live in small snow houses, called igloos, which have no doors nor windows. When they go into their houses, they have to creep on their hands and knees through low tunnels.

VI

Lipsu was an Eskimo boy. One day he took his dog team far out on the ice. Suddenly he stopped and looked around. The part of the ice that he was on had broken off and was floating away. It grew calder and the wind started to blow. Lipsu made a little snow house and crawled into it. He was warm in the house, but was too scared to sleep.

After several hours the wind changed and the piece of ice drifted back to the shore. Lipsu was very lucky to get back on land alive.

VII

One morning Mrs. Bear went to look for something to eat. She left Teddy Bear and Johnny Bear at home. She told them to be good.

For a little while they played in the den. Then Johnny Bear ran outside. He smelled something sweet. The smell was coming from a big tree. Johnny climbed the tree and reached his paw in a hole near the top. There was honey in the tree, but there were bees too. The bees were very angry with the little bear. They stung him on the nose, and on his ears, and even on his eyes. The little bear lay on the ground and rolled over and over until finally the bees gave up and flew back to their tree.

APPENDIX II

To the Teacher:

In this questionnaire we would like for you to determine the receptive communication abilities of individual children enrolled at CID. Your judgments should be based on how well you think a child understands what is communicated to him orally.

There are five situations for which you are asked to make a decision about a child's receptive skill. For each of these five situations, you will rate the child's understanding on a five-point scale which ranges from 'nearly always understands' to 'rarely understands'. In addition, you will also be asked to estimate an individual's comprehension in these five situations under two conditions: 1) prior set established for communication, i.e., child is introduced to the nature and topic of conversation, and 2) no prior set established for communication.

When you assign a rating to a child, please assume that the child is motivated to participate in the situation described, that he is attending carefully, and that you have his cooperation. Also, assume that the language construction and vocabulary used for communication are familiar to the child, and that no exaggerated articulation or extreme gestural or written cues accompany the communication.

Please answer each of the items. If you encounter a question that seems ambiguous, rate the child to the best of your ability. You may indicate your uncertain ratings by listing them in the space provided labeled "Comments". An explanation of your uncertainty will be appreciated.

Thank you for your time and your cooperation. Please return the completed questionnaires to your supervisor.

Kathy Cramer

Kathy Cramer
Research Department

Receptive Oral Language Scale

Nearly always understands (at least 90% of the time)	Frequently understands (at least 75% of the time)	Usually understands (at least 50% of the time)	Sometimes understands (at least 30% of the time)	Rarely understands (less than 30% of the time)
A	B	C	D	E

1. When you are giving instructions (e.g., homework assignment, classroom exercise, going for testing, etc.), this student:

   A B C D E when you establish a prior set as to what will be communicated

   A B C D E when no prior set has been established as to what will be communicated

2. When you are leading a classroom discussion which involves communicating more than two consecutive ideas, this student:

   A B C D E when you establish a prior set as to what will be communicated

   A B C D E when no prior set has been established as to what will be communicated

3. When you are having a conversation with this student outside of the classroom (e.g., in the hallway, on the playground, in the library, etc.) he:

   A B C D E when you establish a prior set as to what will be communicated

   A B C D E when no prior set has been established as to what will be communicated

4. When this student is communicating with his hearing-impaired peers in a classroom situation, he

A B C D E when you establish a prior set as to what will be communicated

A B C D E when no prior set has been estsblished as to what will be communicated

5. When hearing adults, who are not experienced in communicating with deaf children (e.g., visitors to the school, employees in stores, movies, restaurants, etc.) talk to this child, he

A B C D E when a prior set has been estsblished as to what will be communicated

A B C D E when no prior set has been estsblished as to what will be communicated

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COMMENTS:

Teacher's Name: _____

Thanks again.