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AN EVALUATION OF CUED SPEECH TRAINING ON LIPREADING
PERFORMANCE IN DEAF PERSONS

by

Nancy A. Neef

A Dissertation
Submitted to the
Faculty of The Graduate College
in partial fulfillment
of the
Degree of Doctor of Philosophy

Western Michigan University
Kalamazoo, Michigan
August 1979

ACKNOWLEDGEMENTS

The author extends her gratitude to Galen Alessi, R. Orin Cornett, Brian Iwata, Jack Michael, and Paul Wiener for their many helpful suggestions in the writing of this manuscript; to Ken Buelow, Richard Haas, Wayne Hazel, Robert McAllister, Gerald Shook, and Kathy Woods for their cooperation in conducting this study; and to Steve Braam, Genae Hall, Peg Iwata, Gary Legg, and Jean Meyer for their assistance with reliability checks.

Nancy A. Neef

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One of the most obvious and pervasive problems facing many of the estimated 14 million hearing impaired persons in the United States involves communication difficulties and their profound effects on social, psychological, educational, and vocational functioning (Myklebust, 1964; Schein & Delk, 1974; Schiller, 1974; Vernon, 1970). While speech and speechreading are important skills for any deaf individual, it has been well established that most deaf persons never acquire proficiency in these areas (Moores, 1978; Schein & Delk, 1974; Scouten, 1969). This may at first seem surprising since the oral philosophy of communication, emphasizing exclusive use of amplification, lipreading, and speech, has dominated deaf education in the United States. Proponents of the oral philosophy assert that speech and speechreading skills are essential if deaf persons are to function effectively in a "hearing world" and that the use of manual communication (i.e., sign language and fingerspelling) interferes with the acquisition of these skills. However, research outcomes have suggested that deaf children trained via oral methods of instruction perform no better with respect to speech and speechreading than children trained using manual methods of communication (Chasen & Zuckerman, 1976; Corson, 1973; Meadow, 1968; Stuckless & Birch, 1966; Vernon & Koh, 1970, 1971). There are several reasons for the apparent lack of success in teaching speech and speechreading skills to deaf persons. First with respect to speech, the deaf person cannot react as a listener to his/her own vocal behavior and, therefore, cannot compare the sounds (s)he makes to those produced by the teacher or speaker. Thus, the deaf person must depend on

indirect, imprecise, and delayed feedback based on the reactions of the listener as to the accuracy of his/her vocal responses. With respect to speechreading, performance may be impeded since visual stimuli change rapidly and only 33% of the phonemes are visibly discriminable to begin with. For example, the phonemes "b," "m," and "p" are all visually identical on the lips, and the phonemes "h," "k," "ng," and "g" are produced in the back of the throat rendering visual detection on the basis of lip movements difficult, if not impossible. As a result of this ambiguity, the most skilled speechreaders miss about 75%, and the average deaf child at least 95%, of what is said (Vernon, 1972). Furthermore, speechreaders describe the process as fatiguing, possibly due to muscle tension or negative emotional behaviors resulting from the inability to respond successfully to spoken stimuli. A second reason for the disappointing results of efforts to teach speech and speechreading to deaf persons may be found in the approaches which traditionally have been used. Most of these methods were developed for hard-of-hearing or deafened adults, whose repertoire is much different from the prelingually deaf child who has never acquired mastery over a spoken language. In spite of the magnitude of the problem, there has been very little innovation in teaching speech and speechreading to the deaf in 50 years (Moore, 1978). Furthermore, very little experimental research has been conducted in these areas (Bennett, 1974; Farwell, 1976; Miller, Ransey, & Goetzinger, 1958; Moore, 1978). Thus, methods utilized for teaching speech, speechreading, and language to deaf persons tend to be based on theory and anecdotal experience rather than on scientific evidence (Myklebust, 1964).

Cued speech has recently been proposed as an attractive alternative to pure oral training methods in facilitating the development of speech, speechreading, and language in deaf persons (Cornett, 1967). Manual cues consisting of eight handshapes in four positions near the face serve as supplementary stimuli which are added to existing sources of strength (information from the lips). Thus, sounds that are visually identical on the lips such as "t," "d," "n," and "l" are distinguished by differential handshapes, whereas visually dissimilar sounds such as "t," "m," and "f" are represented by the same handshape. Figure 1 illustrates the eight handshapes and four positions used in cued speech corresponding to the phonemes. The word "cap," for example, would be cued by placing the index and middle finger ("k") on the throat ("a") and then moving the hand with index finger extended ("p") to the side, in synchrony with the lip movements. This method of communication is based on the rationale that if all sounds in spoken language were visibly discriminable and differentiated on the lips, the deaf child would learn language in a similar manner to a hearing child through a visible approximate analogue to spoken language.¹

 Insert Figure 1 about here

Cued speech was designed to combine certain elements of the oral and manual methods of communication. Success with cued speech has been reported in the form of increased accuracy in lipreading, a vocabulary comparable to those of hearing children, greater relaxation among children, shortening of delay time between receptive learning and

expressive production, increased communication among children, and increased speech intelligibility (Rupert, 1969; Schiller, 1974). Several features of cued speech appear attractive. First, the combined spoken and cued words present a less ambiguous stimulus to the deaf person. Ling and Clarke (1975) conducted an experiment in which cued and noncued phrases and sentences were presented to 12 severely deaf subjects. Their written responses were then analyzed in terms of the number of complete phrases, sentences, and words correct and the type of phoneme errors made. Results showed that more cued than noncued material was correctly identified, suggesting that cued speech facilitates accuracy in speechreading. Furthermore, the number correct on noncued material increased over successive years, suggesting that the use of cued speech may facilitate speechreading of noncued material (Clarke & Ling, 1976). On the other hand, Borriild (1972) reported that a mouth-hand system as a supplement to speechreading has been in use in most Danish schools for nearly 70 years and that most pupils who were trained in this manner were "helpless" when they were forced to confront pure lipreading. However, differences between the cued speech method developed by Cornett and other mouth-hand systems may account for these discrepant findings.

Another potential advantage of cued speech is the suggestion that it requires a person who has already acquired a language as few as 12-15 hours to learn (Cornett, 1975) and obviates the necessity of taking lessons over a long period of time as would be required with sign language.

Third, it has been hypothesized that cued speech should decrease

the tendency to exaggerate lip movements on the part of the speaker, permitting the deaf "listener" to obtain more practice in observing normal lip movements (Cornett, 1975).

Fourth, acquisition of cued speech by a deaf person would be effective with respect to learning pronunciation of a vocabulary and would render further speech correction unnecessary or much easier. If a deaf child cues what (s)he says, the listener who knows cued speech knows the stimulus controlling the child's response and can thus detect and correct errors in pronunciation.

Although much success has been reported with cued speech (Cornett, 1975), relatively little research has been conducted in an attempt to verify these assumptions. The purpose of the present research was to address some of these issues through examining the effects of cued speech training on: (1) speechreading accuracy with cued material; (2) speechreading accuracy with noncued material; (3) speech production (articulation) responses; and (4) the amount of time required for cued speech acquisition.

Method

Subjects and Setting

Three profoundly deaf males served as subjects. Student 1 was 22 years old, congenitally deaf, and his IQ score was 96 as measured by the WAIS. Most of his early education took place in a public school program which emphasized lipreading as the method of communication. At the time of the study, he had recently been transferred to a different educational program sponsored by the local school district. He possessed minimal language and communication skills. He was able to

respond to simple instructions in sign language and to give the sign for various objects when requested. However, he exhibited virtually no spontaneous expressive sign language; and, in spite of his early and extensive oral training, he neither vocalized nor lipread.

Student 2 was 23 years old (IQ 103, source unavailable), diagnosed as having a congenital bilateral sensory neural hearing loss, etiology unknown. Until the 12th grade, he was enrolled in a special education classroom in a public school which emphasized the oral method of instruction. Two years prior to the beginning of the study, he began attending a residential rehabilitation center where he received trade instruction with the occasional use of interpreter (sign language) services. He also received periodic speech therapy, primarily to remediate his "harsh vocal quality" through "breathing relaxation and strength without phonation." The student was brought to the experimenter's attention by the trade instructors, who complained that they were having difficulty communicating with him and that his speech was unintelligible.

Student 3 was 26 years old (IQ 106 as measured by the Revised Beta Examination and 97 on subtests of the WAIS) and diagnosed as having a congenital bilateral sensory neural hearing loss due to genetic factors (Usher's syndrome). He had virtually no usable hearing. Until the 12th grade, he attended a public school which emphasized the oral method of instruction. Speech therapy attempts were abandoned after the sixth grade. Shortly before the beginning of the study, he was enrolled in the same rehabilitation center as Student 2, where he was also brought to the experimenter's attention by the trade instructors,

who were having difficulty communicating with him.

The nature and purpose of the study was explained both in sign language and in writing to all three students, and they were accepted as subjects on the basis of their willingness to participate and the granting of informed consent. All training was conducted by the experimenter during individual sessions in a classroom setting.

Stimulus Selection

Sets of training stimuli for each student were divided into groups of phonemes, as shown in Table 1. For Student 1, two sets of training stimuli (Sets A and B) were developed consisting of 14 phonemes each. Each set of 14 phonemes was divided into five groups of at least one vowel and one consonant. The two consonant phonemes in three of the five groups for Set A and in all four groups containing two consonants in Set B were visually identical on the lips/tongue (e.g., "f" and "v"). For Students 2 and 3, 35 phonemes (Set C) were divided into seven groups. The four consonants contained in each of the first groups were both visually identical on the lips with another phoneme in that group (e.g., "t" and "n," "m" and "b" for Group 1) and were also visually identical on the hands with another phoneme in that group in that they were represented by the same cue stimulus (e.g., "t" and "m," "n" and "b" for Group 1). The purpose of organizing the first three phoneme groups on this basis was to decrease the probability that the student could make a correct response by attending to either the lip/tongue stimulus or hand (cue) stimulus alone. Since cued speech was designed such that accurate differentiation of phonemes requires attending to both sources of stimuli, it was thought desirable

to arrange early training in a manner that would facilitate this. All remaining groups were arranged on this basis as closely as possible.

 Insert Table 1 about here

Procedure

Training sessions. Each group of phonemes within a set was trained sequentially. Each phoneme within a group was first trained individually (e.g., "t," "n," "m," "b," "ah" for Group 1 of Set C). The experimenter presented one of the stimulus cues while simultaneously articulating the corresponding phoneme. The subject was then instructed to write the phoneme on a piece of paper which had been provided. The stimulus presentation was repeated either if the subject requested it prior to making a response or indicated in some other way that he was having difficulty, such as attempting to imitate the experimenter's response. A correct response was recorded if the subject wrote the phoneme which the experimenter had presented. Following a correct response, social reinforcement was delivered in the form of descriptive praise (e.g., signing, "Good job. That's right."). The next trial was then initiated with another of the phonemes within the group. Following an incorrect response, a remedial trial was initiated in which the experimenter wrote the correct phoneme(s) and repeated the trial until a correct response occurred. After five consecutive correct responses occurred for each of the individual phonemes in the group, training was begun on two-phoneme consonant vowel combinations with the group (e.g., "tah," "nah," "mah," "bah" for Group 1 of Set C) in the same

manner. When mastery criterion was met on two-phoneme combinations within a group, training was begun on all possible three-phoneme combinations within a group (e.g., "Mahb," "bahm," "naht," "tahn," etc., for Group 1 and Set C). Since Group 5 of Set A and Group 2 of Set B contained only two phonemes, these latter two training phases were not conducted for these groups. After mastery criterion was achieved, training was begun on three-phoneme combinations between (previously) trained groups (e.g., "dun," "mul," "shahd," "buch," etc., for Group 1 and 2 of Set B). This training phase was not conducted for Group 1 alone since no phonemes were previously trained with this group. All groups of phonemes in each set were trained in this manner with two exceptions for Set A. First, instead of writing the response, the subject pointed to the appropriate flashcard from among those containing a different phoneme (combination) within the particular group. This aspect of the procedure was changed for subsequent sets (B and C) to the written response described originally in an attempt to increase the strength of the response and decrease the probability of making a correct response by chance alone. Second, the mastery criterion for each training phase consisted of 10 consecutive correct responses for each phoneme (combination) as opposed to five. The mastery criterion was reduced for subsequent sets since it seemed to be unnecessary and the subject appeared to become restless.

Individual phoneme probes. Probes were conducted over all the individual phonemes in a set as shown in Table 1 prior to training and whenever the subject met criterion on the last training phase (e.g., three-phoneme combinations between groups) of a group. The purpose of

these probes was to assess pre-post acquisition of lipreading skills with a cued stimulus, generalization of lipreading skills in the absence of a cued stimulus, and generalization to expressive articulation responses. For the receptive cued part of the probe, the experimenter randomly presented the cue and articulatory stimulus for each of the phonemes in the set and instructed the subject to write the corresponding letter(s) (Sets B and C) or touch the corresponding flashcard (Set A). A correct response was recorded if the subject wrote (touched) the stimulus which the experimenter had cued. With Sets B and C and the final probe of Set A, if an incorrect response was made, the experimenter scored whether it was a substitution error. A substitution error was defined as a response to a stimulus that was visually identical on the lips to the stimulus presented. For example, if the stimulus presented was "m" and the subject wrote (touched) either "p" or "b," a substitution error was scored.

The procedure for the receptive noncued portion of the probe was identical to that of the receptive cued portion with the exception that the experimenter merely pointed to her lips and then articulated the phoneme, without presenting the cue stimulus. Following the receptive portions of the probe, subjects were tested on expressive skills (articulation responses). The experimenter presented flashcards on which the phonemes were printed and, in sign language, instructed the subject to "voice" (articulate) the sound. A correct response was recorded if the subject accurately pronounced the individual phoneme such that it could be clearly distinguished and differentiated by the listener. Reinforcement, remediation, and corrective feedback were not

in effect during any portion of the probes.

If a correct response was not recorded on the receptive cued part of the probe for each of the phonemes trained immediately prior to the probe session, a review session was held. The review session was identical to the individual phoneme training procedure and was followed by another probe.

Novel phoneme combination probes. Prior to training and following individual phoneme probes, novel phoneme combination probes were conducted. The purpose of these probes was to assess generalization of training to novel, untrained phoneme combinations with both a cued and noncued stimulus. Items on these probes consisted of 24 three-phoneme nonsense words. These were divided into four groups of six words for Set A and six groups of four words for Sets B and C. Each group consisted of words comprised of two phonemes from a training group and one phoneme from a previously trained group. The first two training groups were combined for this purpose since novel combinations could not be generated from the first group alone (i.e., since the first group did not contain previously trained phonemes from which novel combinations could be formed).

During each trial for the cued portion of the probe, the experimenter cued and articulated the stimulus word. A correct response consisted of the subject writing the word the experimenter presented. The experimenter repeated the stimulus presentation once upon the subject's request if the subject had not yet begun to make a writing response. No reinforcement, feedback, or remediation were in effect. For the non-cued portion of the probe, the experimenter articulated the same stimuli

without cues. All other aspects of the procedure were the same.

On one occasion, a probe (Set C) was simultaneously administered to one of the subjects and a deaf staff member at the rehabilitation center. The latter was a highly skilled lipreader who had never received training in cued speech. The purpose of this probe was to socially validate the effectiveness of cued speech training by comparing subjects' lipreading performance with that of an untreated deaf peer who was skilled with respect to the target behavior.

Data collection and reliability. The following data were collected by the experimenter and an independent observer (either a speech therapist or a graduate student naive to the experimental conditions): (1) correct responses during training; (2) correct responses on individual phoneme and novel phoneme combination probes for receptive cued, receptive noncued, and expressive (articulation) trials; and (3) substitution errors on individual and novel phoneme combination probes for receptive cued and receptive noncued trials. For Sets A and B, independent observations were also made on training time (number of minutes from the experimenter's presentation of the stimulus during the first trial of a session to the subject's response during the last trial of a session) and on whether the experimenter exaggerated her lip movements during presentation of stimuli. For Set C, independent observations were made by a second observer based on the subjects' written responses during training and probe sessions. The experimenter provided the observer with a numbered list of the stimuli in the order in which they were presented and the subject's original written responses which were numbered correspondingly. The observer

then compared the two to determine the correctness of the responses. For reliability of articulation portions of individual phoneme probe sessions for Set C, the observer scored from tape recordings of each stimulus presentation articulated by the experimenter, followed by the subject's response. (When the experimenter presented the printed phoneme stimulus to the subject, she covered her face with a piece of paper to avoid observation by the subject while she pronounced the phonemes for the benefit of the observer who could not see the printed stimulus.)

Following data collection, experimenter and observer records were compared and interobserver reliabilities calculated by dividing the number of agreements by agreements plus disagreements and multiplying by 100. This formula was used to compute agreement percentages of subjects' correct responses during training and correct responses and substitution errors on individual phoneme and novel phoneme combination probes for: (1) occurrences; (2) nonoccurrences; and (3) occurrences plus nonoccurrences. Agreements averaged across the three subjects are presented in Table 2 and ranged between 89.7 and 100%.

 Insert Table 2 about here

Interobserver reliabilities were calculated for length (time) of training sessions with Sets A and B by dividing the lesser time (number of minutes) by the larger time and multiplying by 100. Reliability checks made on 37% of all training sessions yielded a score of 99.7%.

On no occasions did observers indicate that the experimenter had

exaggerated her lip movements while presenting stimuli during training or probe sessions.

Experimental Design

This study utilized a multiple baseline design across groups of phonemes. Baseline data in the form of individual and novel phoneme combination probes were taken prior to training. Training was begun on the first group of phonemes and proceeded sequentially through the other groups. Baseline probes continued for all phoneme groups not yet trained.

Results

Shown in Figure 2 is Student 1's performance on receptive cued (closed circles), receptive noncued (open circles), and expressive articulation (open squares) portions of individual phoneme probe sessions with two sets of training stimuli (A and B). The number of correct responses of a possible 14 is shown for individual phoneme probes conducted during baseline and training conditions. As can be seen from this figure, the subject's scores on both receptive cued and noncued and expressive (articulation) improved as he was exposed to sequential cued speech training on the five groups of phonemes in each Set A and B. Scores on the receptive cued part of the probe following training on the final phoneme group for both sets of training stimuli were 14 or 14 correct. Although the subject did not perform as well on the receptive noncued and expressive (articulation) parts of the probe, generalization as a result of cued speech training did occur as demonstrated by the improvement over baseline levels. Increases in receptive performance with noncued stimuli occurred from means of 2 and .33 responses correct

during baseline to 9 and 4 correct responses after training on the last group for Sets A and B, respectively. Similarly, there was an increase in the number of correct expressive (articulation) responses from means of .4 and 0 responses during baseline to 6 and 4 responses correct following completion of training for Sets A and B, respectively.

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Insert Figure 2 about here

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Shown in Figure 3 is performance on individual phoneme probes for Students 2 and 3, respectively, with Set C. These data are similar to those of Student 1, in that subjects' scores on receptive cued, receptive noncued, and expressive (articulation) improved as they were exposed to sequential cued speech training on each group. Scores on the receptive cued part of the probe following training on the final phoneme group were 34 (35) of 35 correct for Student 2 (3). Although Students 2 and 3 performed better on the receptive noncued and expressive (articulation) parts of the probe than did Student 1, data are similar; performance in these areas did not equal the high scores obtained on the receptive cued part of the probe, yet generalization as a result of cued speech training did occur. Receptive noncued scores for Student 2 (3) increased from a mean of 4.8 (8.2) correct of a possible 35 during baseline before training on Group 1, to 26 (23) correct on the probe following training on the final group. Expressive (articulation) scores increased from a mean of 6.8 (12.5) correct during baseline before training on Group 1 to 31 (32) correct on the final probe after completion of training.

 Insert Figure 3 about here

An analysis of the type of errors made during individual phoneme probes for Students 1-3 can be seen in Table 3. This table shows the total number of incorrect responses and the number of substitution errors (i.e., an incorrect phoneme which was visually identical on the lips to the phoneme stimulus presented) with cued and noncued stimuli. (The number of nonsubstitution errors can be determined by subtracting the latter from the former.) As can be seen from this table, the number of substitution errors with cued stimuli decreased (Student 1, Set A; Students 2 and 3, Set C) or remained low (Student 1, Set B) as the total number of errors decreased. Most of these substitution errors occurred with phonemes which had not yet been trained. The number of substitution errors with noncued stimuli, however, either increased (Student 1, Set B), remained stable (Student 1, Set A; Student 2), or decreased only slightly (Student 3).

 Insert Table 3 about here

Shown in Figures 4 and 5 is performance on cued (closed circles) and noncued (open circles) trials on novel phoneme combination probe sessions for Students 1 and Students 2 and 3, respectively. The number of correct responses of a possible 24 is shown for novel phoneme combination probes conducted during baseline and training conditions. As can be seen from these figures, subjects' scores on both cued and

noncued trials improved as they were exposed to sequential cued speech training on the groups of phonemes within each set, indicating generalization to novel combinations of the phonemes trained. For Student 1, the number of correct responses increased from 0 during baseline to 21 and 22 correct of the 24 possible on the final probe session after completion of training, for Sets A and B, respectively. For Students 2 and 3, the number of correct responses increased from 0 (0) during baseline to 16 and 23 correct, respectively, of the 24 possible on the final probe session following training. Consistent with the data on individual phoneme probe sessions, generalization occurred to noncued stimuli for all three subjects, although scores were generally lower than with cued stimuli. On the final probe session following training, scores with noncued stimuli were 6, 6, 4, and 10 correct of a possible 24, for Students 1 (Sets A and B), 2, and 3, respectively.

 Insert Figures 4 and 5 about here

The number of incorrect responses and substitution errors on novel phoneme combination probe sessions with cued and noncued stimuli is shown in Table 4 for Students 1-3. (These data were not collected for Set A except for a final review session, during which 0 of 8 incorrect responses and 10 of 18 incorrect responses were substitution errors on cued and noncued trials, respectively.) Consistent with the data on individual probe sessions, the proportion of substitution errors to nonsubstitution errors (total number of errors - substitution errors) was less with cued stimuli than with noncued stimuli. For Student 1,

the number of substitution errors with cued stimuli remained low (0-1), while the number of substitution errors with noncued stimuli increased (0-11). For Students 2 and 3, the number of substitution errors with cued stimuli generally decreased as the total number of incorrect responses decreased and most substitution errors were made to untrained phonemes. For Student 2, substitution errors decreased from 9 of 24 incorrect responses during baseline to 2 of 8 incorrect responses on the final probe following completion of training. For Student 3, substitution errors decreased from 8 of 24 incorrect responses during baseline to 1 on the final probe. The number of substitution errors with noncued stimuli for Students 2 and 3, however, remained stable, even though the total number of errors decreased.

 Insert Table 4 about here

Results of the novel phoneme combination probe administered to an acknowledged skilled lipreader with no cued speech training yielded the following scores: With both cued and noncued stimuli, 1 of 24 responses were correct; and 18 of the 23 incorrect responses were substitution errors.

Total training time for Students 1-3 was 10.9, 9.07, and 2.90 hours, respectively.

Discussion

Results of this study indicate that cued speech is effective in teaching lipreading skills to deaf persons. All three subjects demonstrated increased accuracy in lipreading with cued stimuli, and to a

lesser extent with noncued stimuli, as a function of cued speech training. In addition, cued speech training appeared to facilitate articulation. The effectiveness of the training procedure was demonstrated by a multiple baseline design across groups of phonemes. Very few correct responses were made during baseline, and probe scores increased only after training conditions were introduced for each successive group.

Subjects' performance on novel phoneme combination probes demonstrated that cued speech training was effective with respect to generalization of lipreading skills to untrained combinations of phonemes. Results of a multiple baseline design across groups of three-phoneme combinations indicated that correct responses to cued, and to a lesser extent, noncued stimuli increased only after the phonemes comprising each successive group were mastered during training. Although research with hearing impaired students has shown that operant procedures can facilitate generalization of articulation to phonemes in untrained words, few other studies have examined generalization of lipreading skills to phonemes in novel words (Bennett, 1974).

The present findings appear to substantiate several proposed advantages of cued speech over other methods of communication. First, the results of this study suggest that combined spoken and cued words do, in fact, present a less ambiguous stimulus to the deaf person than spoken words alone. For all three subjects, responses to cued stimuli were more often accurate than responses to the same stimuli presented without cues. The substitution error data suggests that incorrect responses to spoken stimuli alone occurred largely as a function of the

visual similarity of many of the phonemes on the lips; without the benefit of cues to differentiate these phonemes, subjects often incorrectly identified a phoneme as one that was visually identical to that which was presented. This is consistent with the performance of a skilled lipreader on a novel phoneme combination probe, whose incorrect responses primarily consisted of substitution errors.

In support of the finding of Clarke and Ling (1976), however, lip-reading skills in the presence of a cued stimulus did generalize to some extent to lipreading skills in the absence of cues. The failure of mouth-hand systems to generalize to pure lipreading in Danish schools (Borrild, 1972) may be attributed to differences in the systems used; cued speech is the only mouth-hand system which requires the "listener" to attend to stimuli from the lips as well as the hands of the speaker in order to respond appropriately (e.g., some systems signal only the occurrence of vowels, and others contain different cues for each sound which may be presented for the first phoneme of a word only; these latter systems more closely approximate an incomplete phonemic fingerspelling method) (Cornett, personal communication). This unique feature of cued speech may facilitate transfer of stimulus control to spoken stimuli in the absence of cues, where other methods have been less successful. Assuming that the deaf person attends to the lip movements before attending to the cues (which is likely since the former provides more information than the latter), (s)he may receive instantaneous feedback or confirmation as to the correctness of his/her initial lipreading response by observing the cues; therefore, (s)he may become more adept at discriminating subtle differences between phonemes

when cues are not provided. This may also be more likely to occur if the deaf person obtains practice in observing normal lip movements. The hypothesis that cued speech decreases the tendency to exaggerate lip movements received some support in the present study; at no time did observers note abnormal lip movements on the part of the experimenter during stimulus presentations. (Of course, it is not entirely clear that such lip movements would not occur with persons who had less experience interacting with deaf persons.) Finally, since the stimuli in cued speech are unambiguous, the deaf person may be more likely to attend to visual stimuli involved in lip movements and, therefore, receive more practice in lipreading. Craig and Holland (1970) noted that deaf children frequently do not attend to stimuli necessary for lipreading, which the authors attribute to the possibility that these stimuli are "confusing" rather than providing informational reinforcement. Thus, attempts to maintain attending behaviors necessary for lipreading have often relied upon tangible, external reinforcement such as tokens and edibles (Craig & Holland, 1970; Holland, 1967; Johnson & Kaye, 1974). Preferably, behaviors required for effective lipreading would instead be maintained by the natural reinforcers inherent in the target behavior (lipreading). In this respect, cued speech seems a more desirable alternative.

A second proposed advantage of cued speech supported in the present study is the short amount of time required to learn it. Cued speech has the potential to be learned quickly because it involves a closed (complete) set of a minimum number of skills that can be used to generate maximum skill competence in other areas. The average amount of

training time per subject in the present study was 7.6 hours, and all three subjects acquired the cues in less than the 12-15 hours generally predicted. Although the subjects were not taught cues for four diphthongs and one to seven remaining phonemes due to convenience of grouping, these were later taught outside the experimental situation in less than one hour. The relative ease with which cued speech can be learned may be attractive to hearing persons involved with deaf individuals (e.g., parents) who might otherwise be discouraged by long and frequent lessons as are required with sign language.

Third, the results of this study support the hypothesis that cued speech facilitates speech production. All three subjects demonstrated improvements in articulation of individual phonemes as a function of cued speech training. Possibly the subjects' spontaneous use of hand movements as they attempted to vocalize resulted in better control of articulation responses. It cannot be determined to what extent subjects' previous oral instruction contributed to this. However, after the subjects had completed training, their acquisition of cued speech proved to be effective with respect to speech correction. Student 1 was taught to vocalize his name, the names of several of his friends and fellow students, and some basic survival words (e.g., "Help me."). In spite of previous extensive oral instruction, this subject had never before been observed by the staff to vocalize any words. Students 2 and 3 were subsequently taught to pronounce a list of words their instructors had suggested were basic to their trade area, such that others in the department were able to understand them. Although speech teachers generally report that they spend an average of one

week teaching deaf children to pronounce a single complex word with traditional oral methods of instruction (Schiller, 1974), the students in the present study were taught via cued speech to effectively articulate a list of 6-10 words in less than 1.5 hours. One reason for the effectiveness of cued speech in facilitating speech production is that the effectiveness of the listener who knows cued speech is improved. Traditionally, a critical effect of reduced auditory input in deaf persons is that they miss most of the feedback information that reinforces the responses of the hearing individual and any feedback they might receive is usually ambiguous and long delayed (Craig & Holland, 1970). The deaf individual's vocal responses are not likely to be automatically reinforced as are the hearing individuals when the product generated from his/her vocal response has formal similarity to (i.e., matches) the auditory stimulus from the vocal response of the original speaker. Even so, the listener may detect and correct articulation errors more easily, quickly, and precisely if both the speaker and the listener know cued speech. However, it should be noted that although cued speech appeared to facilitate the subjects' articulation, it did not affect voice quality which contributed to the unintelligibility of their speech.

Even though the findings discussed indicate that cued speech is effective with respect to acquisition of lipreading and speech skills, it has been suggested that treatment interventions need to be evaluated according to therapeutic as well as experimental criteria (Kazdin, 1977; Risley, 1970). Therefore, several social validation measures were applied to determine the efficacy of the procedure. First, an attempt

was made to determine the importance of the behavior change effected by cued speech training by providing a basis of social comparison (Kazdin, 1977); the novel phoneme combination probe given to Students 2 and 3 was on one occasion simultaneously administered to a deaf individual who had not received cued speech training, identified by his co-workers as a skilled lipreader. Results showed that after an average of less than six hours of training, both subjects (2 and 3) accurately lipread considerably more of the stimulus words than their "non-deviant peer." It is not meant to imply that this expert lipreader was not indeed skilled; lipreaders often rely on contextual or situational "clues" in ordinary conversation, the use of which was precluded in this situation since individual nonsense words served as stimuli.

Second, a measure of subjective evaluation for articulation was obtained with Student 1's speech therapist and Student 2 and 3's trade instructor who rated the respective subjects' vocal behavior as greatly improved with respect to intelligibility. (On the basis of Student 2's performance, his trade instructor subsequently referred Student 3 for cued speech training.)

Third, an attempt was made to assess the acceptability and appropriateness of the procedure in terms of practicality. Wolf (1978) has indicated that this is related to the likelihood that the program will be adopted and supported by others. Cued speech training was not continued with two of the three subjects due to the fact that they were subsequently able to locate employment and leave the program. However, the speech therapist at the institute was learning cued speech upon

termination of the study in order to initiate training with other deaf students who might benefit from it.

Although cued speech appears to be an attractive alternative method of communication, it is unlikely, nor is it recommended, that it replace ASL (American Sign Language) as the preferred mode in the deaf community. Cornett (1975) has suggested that deaf individuals must be bilingual; he has proposed that deaf persons acquire cued speech from hearing individuals for the purpose of learning English (or a spoken language) and that they learn ASL from deaf persons who are native users of that language.

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Footnote

This analogue cannot be considered exact. First, the deaf speaker cannot respond as an effective listener to his own vocal behavior due to interference with the echoic stimulus generated by an echoic response; thus, the deaf child does not receive the same automatic reinforcement as a hearing child from the close correspondence between the response product generated by the vocal response of the child and the auditory stimulus generated by the vocal response of the speaker. (It may be possible for some type of automatic reinforcement to occur, however, through the establishment of functionally equivalent stimulus classes involving kinesthetic feedback; if the deaf child matches the lip movements of a speaker with his/her own lip movements in a mirror and pairs the latter with the kinesthetic stimuli arising from the movement of facial muscles, then correspondence between the visual stimuli of a speaker's lip movements and kinesthetic stimuli as a product of the deaf child's echoic response may be automatically reinforcing.) Second, more passive learning occurs with the hearing child than with the deaf child since the hearing child can simultaneously attend to visual and auditory stimuli (e.g., read while listening to television or a conversation); the deaf child, however, is limited to attending to visual sources of stimuli only.

Table 1
Groups of Phonemes Comprising Sets of Training Stimuli

Group	Set A (Student 1)	Set B (Student 1)	Set C (Students 2 and 3)
1	t, n, u	ch, sh, i	t, n, m, b, ah
2	f, v, a	j, e	d, l, sh, ch, u
3	h, th, ee	k, g, ur	g, k, th, tH, e
4	m, p, ue	d, l, aw	s, h, z, p, ue
5	b, ah	s, z, oo	y, j, zh, ur, oo
6			w, r, wh, aw, ee
7			f, v, a, i, oe

Table 2
Interobserver Agreement Scores

Average	Training	Novel Comb. Phoneme Probes (correct Rs)		Novel Comb. Phoneme Probes (sub. errors)		Individual Phoneme Probes (correct Rs)			Individual Phoneme Probes (sub. errors)	
		Cued	Noncued	Cued	Noncued	Cued	Noncued	Art.	Cued	Noncued
Sessions observed	46.4	62.6	68.6	68.6	68.6	81.3	81.3	81.3	81.3	81.3
Occurrence	100.0	98.0	98.8	98.4	99.3	100.0	98.4	95.7	100.0	100.0
Nonoccurrence	99.5	99.5	100.0	100.0	95.1	99.2	99.8	89.7	100.0	98.9
Occurrence & nonoccurrence	99.8	98.9	99.8	99.4	98.7	99.4	99.6	92.2	100.0	99.1

Table 3

Number of Substitution Errors over Total Number of Errors on Cued and Noncued Trials during Individual Phoneme Probe Sessions for Students 1-3

Student	Set	Probe Sessions	Cued Trials										
			1	2	3	4	5	6	7	8	9	10	11
1	A	# sub. errors/ total # errors	2/14	0/11	0/10	1/14	1/13	1/08	1/08	1/08	3/05	0/02	0/00
1	B	# sub. errors/ total # errors	0/13	0/14	0/14	0/11	0/06	0/04	0/00				
2	C	# sub. errors/ total # errors	6/26	8/29	14/31	8/28	9/21	12/20	7/15	4/12	4/09	2/05	0/01
3	C	# sub. errors/ total # errors	10/25	11/25	13/26	12/26	10/21	7/14	7/12	7/09	3/06	4/05	0/00
			Noncued Trials										
1	A	# sub. errors/ total # errors	13/01	9/02	13/03	12/04	13/05	11/06	11/07	12/08	5/09	6/10	5/11
1	B	# sub. errors/ total # errors	0/12	0/14	0/14	2/13	1/07	2/09	5/10				
2	C	# sub. errors/ total # errors	5/30	8/31	12/29	13/28	10/25	12/28	6/18	7/18	9/17	12/16	4/04
3	C	# sub. errors/ total # errors	17/30	11/25	14/25	16/27	16/18	10/19	9/19	5/12	12/13	5/11	10/12

Table 4

Number of Incorrect Responses and Substitution Errors on Cued and Noncued Trials during Novel Phoneme Combination Probe Sessions for Students 1-3

Student	Set	Probe Sessions	Cued Trials								Noncued Trials							
			1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
1	B	Total # errors	24	18	17	14	10	8	2		24	23	24	24	23	22	18	
		# sub. errors	0	0	1	1	0	0	0		0	3	5	5	9	11	8	
2	C	Total # errors	24	20	19	17	12	17	10	8	24	22	23	20	20		17	19
		# sub. errors	9	3	1	5	6	4	7	2	9	9	8	11	12		10	10
3	C	Total # errors	24	20	17	14	14	10	6	1	24	21	24	22	21	14	17	13
		# sub. errors	8	0	1	1	3	5	2	1	9	6	13	5	6	10	12	9

Figure Captions

Figure 1. The eight hand configurations which are superimposed on the four hand positions corresponding to the consonant and vowel phonemes, respectively, in cued speech. (The four diphthong hand positions which are included in cued speech but which were not taught to the subjects in this study are not shown.)

Figure 2. The number of correct responses on cued, noncued, and articulation portions of individual phoneme probes for sets A and B with Student 1.

Figure 3. The number of correct responses across groups of phonemes on cued, noncued, and articulation portions of individual phoneme probes for Set C with Students 2 and 3.

Figure 4. The number of correct responses across groups of phonemes with cued and noncued stimuli on novel phoneme combination probes for Sets A and B with Student 1.

Figure 5. The number of correct responses across groups of phonemes with cued and noncued stimuli on novel phoneme combination probes for Set C with Students 2 and 3.

Cued Speech Hand Positions for Vowel Sounds

<u>Side</u>	<u>Throat</u>	<u>Chin</u>	<u>Mouth</u>
ah (father) (not)	a (cat)	aw (dog)	
u (mother)	i (sit)	e (get)	ee (she)
oe (home)	oo (look)	ue (new)	ur (her)



Cued Speech Hand Configurations for Consonant Sounds

t	h	d	ng	l	k	b	F
m	s	p	y	sh	v	n	J
f	r	zh	ch	w	tH	wh	th
					z		









