Acquisition and Generalization of Cued Speech by a Chronically Aphasic Adult

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We know from past research that techniques employing the visual modality may facilitate the speech or language performance of aphasic or apraxic individuals. Visual techniques used with aphasic persons include the use of phonetic clinician cues, printed words, gestures, pictures, novel symbols, and visual action imagery (Rosenbek, Lemme, Ahern, Harris, and Wertz, 1973; Rosenbek, Green, Flynn, Wertz and Collins, 1977; Rosenbek, 1978; Dabul and Boller, 1976; Skelly, Schinsky, Smith and Fust, 1974; Gardner, Zurif, Berry and Baker, 1976; Rahber, 1980; Helm-Estabrooks, Fitzpatrick and Barresi, 1982; and others).

PURPOSE

The efficacy of Cued Speech as a restorative or compensatory approach to treatment of severe auditory comprehension deficits in acquired aphasia has not been studied. Cued Speech as originally developed by Cornett (1967), "...employs a set of hand cues which, together with the speechread form, permit visual identification of a phoneme" (Nicholls and Ling, 1982, p. 262). Cued Speech has been shown to be an effective means of clarifying spoken language for severely hearing-impaired children (Ling and Clarke 1975; Clarke and Ling, 1976).

Cued Speech is a system of 12 hand signals, or cues, which facilitate speechreading skills by differentiating phonemes that look similar (Figure 1). In Cued Speech, four static hand positions are used to identify four separate groups of vowels. These four positions are shown at the top of Figure 1--"side," "throat," "chin," and "mouth." Diphthongs are identified by combinations of hand positions, shown in the middle of Figure 1. For example, the diphthong in "my" involves movement of the hand from the "side" to the "throat" positions. Eight hand configurations are used to identify eight separate groups of consonants, shown at the bottom of Figure 1. Thus, 12 hand signals comprise the Cued Speech system. Hand positions identify vowels, and hand configurations identify consonants. For consonants, hand configurations provide voice and manner information, while natural lip and tongue postures provide place information. When Cued Speech hand signals are presented concurrently with the lipread form (i.e., orofacial movements), all English phonemes became visually distinctive.

The goal of this treatment program was to teach Cues from the Cued Speech system for each consonant phoneme to a 43-year-old male with chronic aphasia. Our primary question was: Do Cues improve auditory discrimination or comprehension of spoken words?

Treatment Conditions. Three conditions for presenting spoken words were defined. Condition I was AV_1 + Cue--that is, auditory plus visual--watch clinician plus the accompanying hand Cues for the phonemes comprising

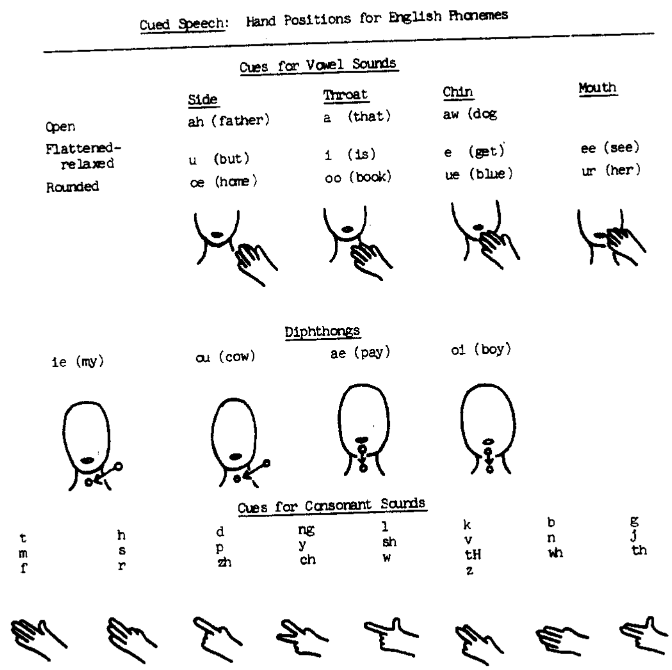

Figure 1. Cued Speech hand positions for English phonemes.

the word. Condition II was AV_1--that is, auditory plus visual--watch clinician--a presentation mode corresponding to natural conversational speech. Condition III was A-alone--that is, auditory alone, wherein both visual--watch clinician and visual--hand Cues were withheld.

Hypotheses. The purposes of this study were to address three null hypotheses. Hypothesis 1. Treatment of consonants in single words in Condition AV_1 + Cue will have no effect on recognition of corresponding consonants in untreated (generalization) stimuli in Condition AV_1 + Cue. Hypotheses 2. Treatment of consonants in single words in Condition AV_1 + Cue will have no effect on recognition of corresponding consonants in either the treated or untreated (generalization) stimuli in Condition AV_1. Hypothesis 3. Treatment of consonants in single words in Condition AV_1 + Cue will have no effect on recognition of corresponding consonants in either the treated or untreated (generalization) stimuli in Condition A-alone.

CASE HISTORY

Our case was a 43 year old right-handed male who sustained a stroke in May, 1977. A CT scan performed at 30 months post-onset showed a large infarct in the left middle cerebral artery distribution, and a small infarct in the right posterior temporal region.

The Porch Index of Communicative Ability (Porch, 1967) was used as the primary measure of language ability during the first 4 years of speech and language treatment at the Veterans Administration Medical Center in Durham, North Carolina. In this period, he improved from the 40th percentile to the 61st percentile overall. Improvement in the

Gestural modality was from the 42nd to the 77th percentile, and in the verbal modality from the 65th to the 81st modality. An early score on the Token Test (DeRenzi and Falgioni, 1978)--10 of 36 correct--did not change significantly during the course of treatment. Several months before this study began, at 5 years post onset of aphasia, he achieved an Aphasia Quotient of 35.8 (of 100.0) on the Western Aphasia Battery (Kertesz, 1982). Our patient's speech was "borderline fluent," with phonemic paraphasias, neologisms, and intelligible words mixed. Semantic paraphasias and anomic hesitations were present. He also had abnormal vocal quality and prosody. In other performance areas, confrontation naming and repetition were markedly impaired and auditory comprehension was severely impaired.

In contrast to auditory-verbal language, reading and writing were relatively preserved at 5 years post onset. On the Western Aphasia Battery, he achieved a combined reading and writing score of 63.0 (of 100.0). Figure 2 shows his written description of the "Cookie Theft" picture (Boston Diagnostic Aphasia Exam, Goodglass and Kaplan, 1972). Other findings included a mild oral-nonspeech apraxia, with intact limb praxis. Nonverbal reasoning ability as measured by Raven's Coloured Progressive Matrices (1956) was within normal limits. Visual memory was intact. Auditory and visual acuity were intact. Of importance to the present study was the general finding that visual processing was superior to auditory processing.

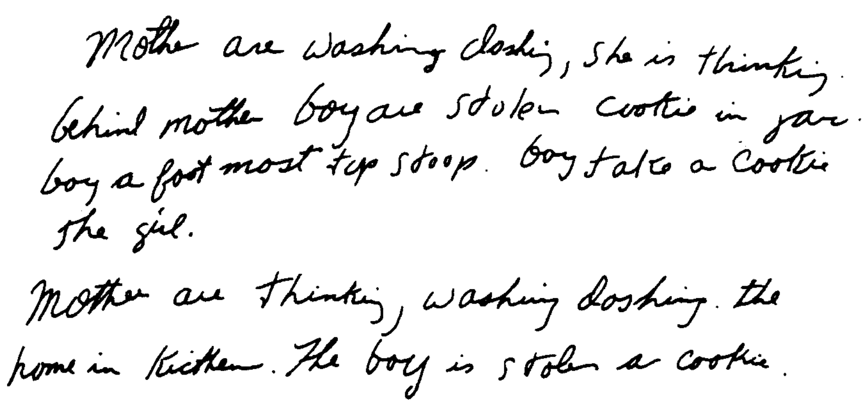

Figure 2. A sample of our patient's writing at 5 years post-onset.

In summary, at the time of the treatment study, our patient presented a moderate chronic aphasia, characterized by paraphasic and paragrammatic spontaneous speech, a marked oral naming deficit, a marked repetition deficit, a severe auditory comprehension deficit, moderate alexia and agraphia, intact visual abstract reasoning, intact visual memory and intact auditory and visual acuity.

Our rationale for using a visual signal system such as Cued Speech to augment spoken language was based on our patient's profile of an auditory comprehension deficit associated with chronic aphasia and relatively spared abilities in the visual modality. In addition, pretesting of auditory discrimination showed that our patient was able to discriminate minimal word pairs distinguished by visually distinct place features, but was unable to discriminate word pairs distinguished solely by features of manner or voice. In preparation for the treatment program, the patient, his wife, and the first author attended a Cued Speech workshop. The wife subsequently observed all treatment sessions.

METHOD

An A-B-A time series design, with concurrent generalization measures, was employed to study our hypotheses regarding learning and generalization of Cued Speech. We identified three Conditions of stimulus presentation, as described earlier; AV_1 + Cue, AV_1, and A-alone. We identified two sets of stimuli for each Condition— a Treatment Stimulus Subset, and a Generalization Stimulus Subset. Each stimulus subset consisted of 15 minimal pairs, or 30 single-syllable words representing all consonant phonemes contrasted by manner or voice (Table 1). We then obtained baseline measures of performance under three Conditions of presentation for both Treatment and Generalization Stimulus Subsets until a pre-established stability criterion of plus-or-minus 10 percent was achieved. A single clinician (JBR) then administered the treatment in Condition AV_1 + Cue.

Table 1. Two Stimulus Subsets for Teaching Cued Speech.

Treatment Stimuli		Generalization Stimuli	
mob	mop	wash	watch
curl	girl	dip	deep
peg	peck	path	bath
bull	wool	save	safe
race	raise	joke	yoke
choose	shoes	let	led
down	town	boys	poise
fine	vine	lawn	long
toys	noise	rule	rude
road	roll	hurt	herd
have	half	gum	come
y'all	yawn	that	than
chug	jug	rise	rise
then	thin	pout	bout
scene	sing	push	bush

<u>Proficiency Probes</u>. At the beginning of each session, proficiency measures were obtained for all stimuli. Conditions of presentation were counterbalanced. Stimuli were randomized within stimulus subsets (30 stimuli each). During pre- and post-treatment baselines, both Treatment and Generalization Stimulus Subsets were presented. Proficiency probes involved a single presentation of a target word in Condition AV_1 +

Cue, or AV_1, or A-alone. The response display was comprised of 2 printed words--the target word and its corresponding minimal pair. The patient responded by pointing. This response was recorded as correct or incorrect. Neither corrective feedback nor practice was provided during proficiency probes.

Treatment Steps. Following administration of proficiency probes in each session during the Treatment (B) phase, training involved presentation in the AV_1 + Cue condition with systematic feedback and practice. Each treatment trial consisted of 5 steps. Figure 3 illustrates the 5 steps for the minimal pair "have" versus "half." In Step 1, the clinician presented AV_1 + Cue for the target word; in this example, "half." In Step 2, the patient responded by pointing to the printed word from a choice of 2. In Step 3, the clinician immediately gave corrective feedback; either "yes" or "no." In Step 4, the clinician presented the AV_1 + Cue sequence for the target word; in effect, repeating Step 1. In Step 5, the patient gestured the Cue sequence after the clinician's model given at Step 4.

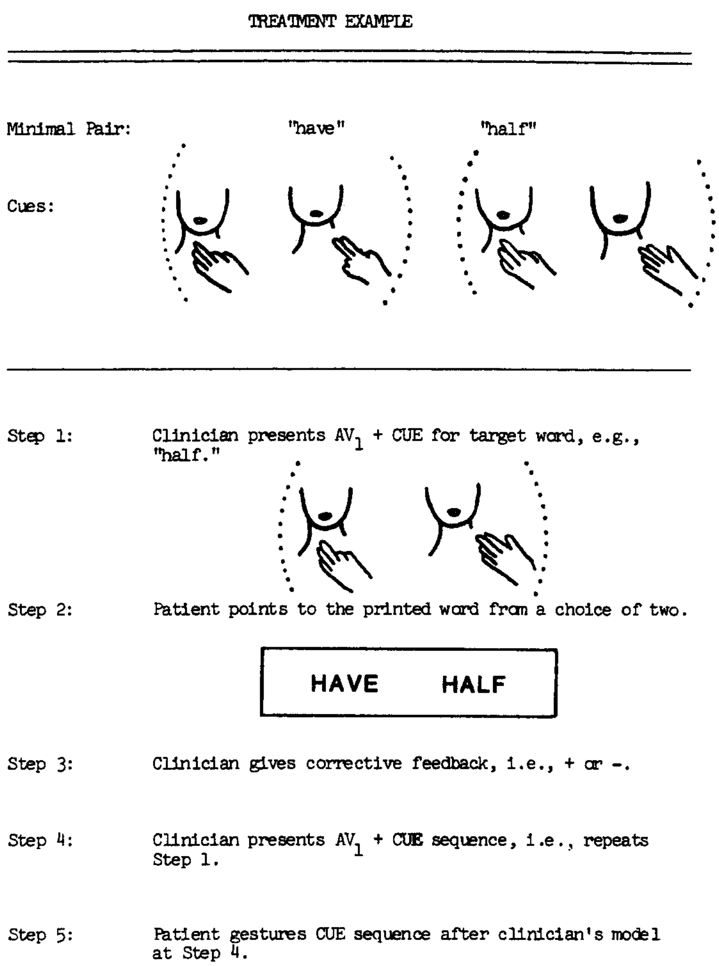

Figure 3. Five-step treatment administered in Condition AV_1 + Cue for stimuli from the Treatment Subset.

Figure 4 (top) shows the results of our patient's performance in the AV_1 + Cue Treatment Condition (auditory plus visual--watch clinician plus the accompanying hand Cues for the phonemes comprising the word). In the A Phase (6 sessions), a stable baseline for both the Treatment and Generalization Stimulus Subsets was obtained. In the B Phase (16 sessions), treatment was rendered for the Treatment Stimulus Subset only, and our patient improved to the criterion of 90 percent or better over 4 consecutive sesions. In the second A Phase (4 sessions), our patient showed stable performance on treated stimuli as well as generalization to similar, but untreated stimuli. Stable proficiency data in the second A Phase -- in which treatment was withdrawn -- provide evidence for intramodality generalization.

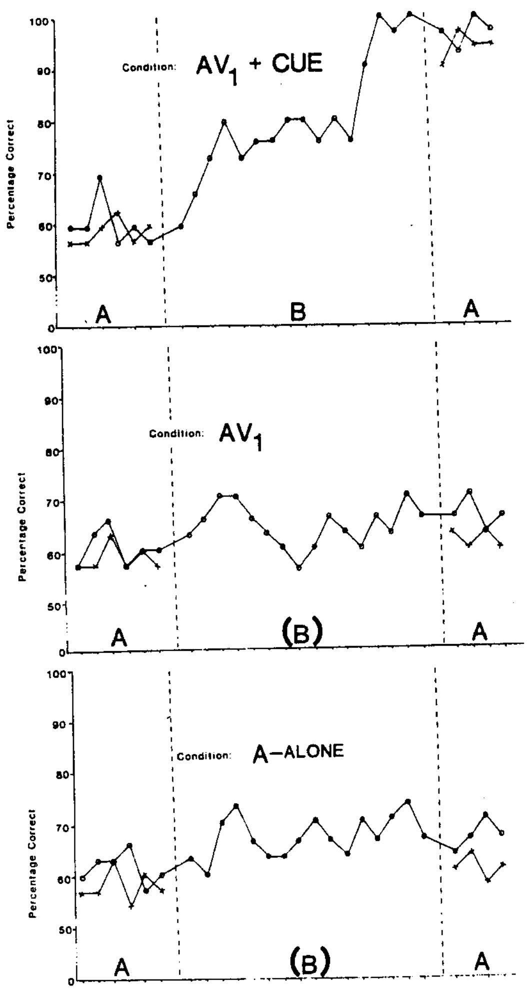

Figure 4. Performance under three conditions of stimulus presentation for the Treatment Subset (o) and the Generalization Subset (x). Treatment was given in Condition AV_1 + Cue only (top, B phase), with concurrent generalization measures shown for Conditions AV_1 (middle) and A alone (bottom).

Figure 4 (middle) shows time series data for Condition II, AV_1 (auditory plus visual -- watch clinician). Essentially stable performance was observed during the pretreatment baseline phase, through the phase corresponding to the AV_1 + Cue treatment just described, and finally through the posttreatment probes.

Figure 4 (bottom) shows the time series data for Condition III, A-alone (auditory input without the benefit of either visual--watch clinician or visual--hand Cue information). Again, essentially stable performance was observed during the pretreatment baseline phase, through the phase corresponding to the AV_1 + Cue treatment, and finally, through the posttreatment probes. Figure 4 is a composite of the data reflecting our patient's discrimination performance under three Conditions of stimulus presentation. Treatment was rendered in Condition AV_1 + Cue only. Concurrent generalization measures in Conditions AV_1 and A-alone were conducted. That is, these Conditions were concurrently measured, but not treated, as shown on the middle and bottom graphs.

The null hypotheses now can be addressed.

Hypothesis 1. Treatment of consonants in single words in Condition AV_1 + Cue will have no effect on recognition of corresponding consonants in untreated (generalization) stimuli in Condition AV_1 + Cue. Hypothesis 1 was rejected. Treatment of single words in Condition AV_1 + Cue generalized to corresponding untreated stimuli. Intramodality generalization was shown.

Hypothesis 2. Treatment of consonants in single words in Condition AV_1 + Cue will have no effect on recognition of corresponding consonants in either the treated or untreated (generalization) stimuli in Condition AV_1. Hypothesis 2 was accepted. Treatment of AV_1 + Cue had no significant effect on discrimination performance in Condition AV_1. Intermodality generalization was not shown.

Hypothesis 3. Treatment of consonants in single words in Condition AV_1 + Cue will have no effect on recognition of corresponding consonants in either the treated or untreated (generalization) stimuli in Condition A-alone. Hypothesis 3 was accepted. Treatment of AV_1 + Cue had no significant effect on discrimination performance in Condition A-alone. Intermodality generalization was not shown.

Results showed that our patient was able to learn the discriminating value of Cues. Improvement and generalization within the experimental Condition AV_1 + Cue was clinically significant. However, there was a lack of clinically significant generalization from the treated Condition to those Conditions corresponding to more natural spoken language--AV_1 and A-alone. These data suggest that learning of Cued Speech by our patient did not facilitate auditory comprehension *per se*. Rather, Cued Speech was used by him as an additional input to discriminate the voice and manner features of English consonants in single words.

Intramodality generalization data showed that our patients was able to learn the discriminating value of Cues. Intermodality generalization data showed, in contrast, that learning of Cues did not clinically benefit discrimination in the more natural conditions -- namely, auditory plus visual, or auditory-alone.

We condlude that Cued Speech was, for this chronic aphasic individual with a persistent severe auditory comprehension deficit, a compensatory visual input for discrimination of English phonemes.

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Cornett's permission to publish an illustration of the Cued Speech hand signals obtained by the first author at a recent Cued Speech workshop. This research project was completed during the first author's participation in the Speech Pathology-Audiology Residency (SPAR) Program, co-sponsored by the Duke University and Veterans Administration Medical Centers, Durham, North Carolina.

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DISCUSSION

Q: I understand that for each consonant-vowel-consonant word, a different hand signal represents each of the 3 phonemes. Was your patient confused by this? How long did it take him to learn the Cued Speech hand signals?

A: No, he was not confused. Our patient attended a Cued Speech workshop so that he would get the idea that Cued Speech was a meaningful system; i.e., that the purpose of Cued Speech was to enhance spoken messages. The patient was scheduled for hourly sessions twice a week. Treatment extended for 4 months due to several unanticipated absences. The total number of hourly treatment sessions was 26.

Q: What is the patient doing with Cued Speech now? What is the patient's wife doing with it?

A: We were dependent on the wife for carryover; it was for this reason that she attended the Cued Speech workshop and all the treatment sessions. Unfortunately, she has not carried through with the use of Cues at home after the Cued Speech treatment period. The patient is presently communicating by reading and writing as he was prior to the study.

Q: I'd like to get an idea of how much distance was travelled in terms of generalization. How similar were the untreated stimuli from the treated stimuli?

A: They were very similar. Each subset contained each consonant phoneme so that our patient could learn the Cues for each one. In addition, each subset was comprised of all CVC's differentiated by either the manner or voicing feature so thay (treated and untreated stimulus subsets) were matched accordingly.

Q: I'm having trouble understanding the treatment example that you gave. That example was for one item on a treatment task, is that right?

A: Yes.

Q: To succeed on a given item, did the subject have to pass through all five steps successfully, so failure at any step would represent failure on that given item?

A: No. The only step in the sequence that was evaluated was the patient's pointing response; i.e., his selection of the target word from the printed minimal pair. Success or failure was determined at Step 2. The remaining steps in the sequence involved corrective feedback and practice performing the Cues. Specifically, the patient's ability to gesturally imitate the Cue sequence (Steps 4 and 5) was evidence for his ability to attend to and recognize the hand movements comprising Cue sequences.

Q: I would like to make two comments. First your data obviously show [intramodality] generalization. On the other hand, you can't really be sure why the behavior changed because you didn't "reverse the second A." I think that you could rectify this with replication.

Some of the procedures that [Rusch and Kazdin, 1981] talk about in terms of looking at generalization such as partial and/or sequential withdrawal might further answer your questions about generalization by systematically removing parts of the treatment package rather than withdrawing the whole treatment package.

Q: Could you tell us why you did not look at just Cued Speech alone since you were interested in intramodality generalization? Should we assume that the acquisition curve was just based on the acquisition of the Cues?

A: The Cues gave him the additional visual information that he needed to differentiate the consonants distinguished [only] by voice [or] manner.

Q: I would suggest that you could have made that a stronger argument if you had looked at just A-only, AV_1 only, and just Cues only. I suspect you would have had a stronger case for that acquisition curve.

C: I understand the discussant's point but I do not agree that this would have been an appropriate design for the questions of interest to us in the study. First, we were interested in our patient's ability to learn Cued Speech, not Cues alone. We chose to teach AV_1 + Cue because this is the manner in which it is currently being used to teach understanding of spoken language to hearing impaired individuals. Second, we chose to use AV_1 and A-alone as our generalization modalities because they represent the "natural" conditions of communication among non-brain-damaged individuals. Our third and most important reason for not teaching Cues alone was because Cues for consonants represent only voice and manner distinctions. Cues without the benefit of at least V_1 (watch clinician) would contain no place information. It is unlikely that our aphasic patient could have inferred the communicative value of Cues presented in this way.

Q: I'd like to go back to the question regarding lack of "sag" in the second A phase. I think we need to get into this in this group. I can understand if we were giving a drug and it is demonstrated to be efficacious during the treatment phase and you withdraw the drug one might expect a "post treatment sag." But I'm not sure that should be a criterion in behavioral treatment, especially of aphasia, in order to demonstrate the efficacy of your treatment that you need the "post treatment sag." When we fix them we'd like them to stay fixed.

A: We agree.

Q: I think it is an issue whether or not you can withdraw certain behaviors. You should use either a combined design or an alternate procedure. There are two possible explanations: One is, you chose the wrong design for the behavior, or, second, you didn't have control.

C: I understand the idea that something like a partial withdrawal design would help us understand -- in Condition AV_1 + Cue -- whether the Cues _per se_ were making the difference in the acquisition curve or whether the patient needed the combination of AV_1 plus Cues. The experimenter, in fact, withdraws the treatment, (s)he does not withdraw the behavior. Once the individual acquires the behavior, and treatment is withdrawn, the experimenter has no control over whether the behavior is sustained at a high level or whether the behavior reverses. We understand that additional treatments may be rendered -- [B], C, C. . . -- to further refine one's interpretation of why the behavior changed during treatment, but once a desired proficiency level is attained, why would the researcher/clinician want to do this?