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ABSTRACT

Twenty-four severely mentally retarded adolescents (with no uncorrected visual or hearing losses) were trained to use 16 manually signed English signs. Ss were randomly assiged to sign only, or sign plus speech conditions and performances were videotaped. Analysis of results revealed that all Ss learned some signs to criterion and all showed performance gains on most signs. Failure to form given signs correctly appeared to be largely ideosyncratic. Contrary to hypotheses, no learning differences were found between iconic and abstract signs. A substantial part of the document reviews the literature on remedial vocal training and nonspeech communication systems for mentally retarded persons. Animal signing studies are further analyzed, as are implications of signing language training with autistic children. (CL)

Manual Sign Training for Nonverbal Severely Retarded Adolescents

Final Report

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Introduction

One of the most useful of all human adaptive behaviors is the ability to communicate. Successful communication permits interaction between people to gain and provide information as well as accomplish goals. It enables one to formulate ideas about the world in some form that can be shared with others (Bloom & Lahey, 1978; Morehead & Morehead, 1974). Because it is fundamentally involved with social competence and control of one's environment, language descriptions and communication training for the mentally retarded have received much attention.

Historically, communication and language have been associated with speech (Blount, 1968; Jones & Robson, 1979; Lenneberg, 1967; Moores, 1974). Although speech may be the most frequently encountered form of communication, it is important to note that it is not necessarily the sole means of communication. The essence of communication is the effective transmission of information between individuals. This may be accomplished through speech, but other methods are available. Ekman and Friesen (1975) showed that some facial expressions are universally recognized as denoting certain emotions (e.g., smile - happiness, scowl -

anger). Similarily, when one person beats another to the last open spot in a parking lot, the meaning of a clenched fist shaking in the air is likely to be clear. The nature of the information communicated in these two examples is clearly limited, but there are more extended and versatile systems using visual and motoric symbols. The major points to be made here are that communication can be accomplished via means other than speech and that mentally retarded persons must be able to use some sort of communication system if they are going to function competently in a community living environment.

The present research investigated factors that influence the initial acquisition of manual signs by severely mentally retarded adolescents. Before the specifics of this study are explained, literature indicating the limited nature of speech in the severely mentally retarded will be reviewed. Two general training areas will then be described, those providing remedial vocal training and those emphasizing nonvocal communication systems, particularly manual signing. It will be shown that the limited success of vocal training with persons not possessing rudamentary language skills has contributed to the use of nonvocal communication systems. In addition, a variety of nonvocal communication systems will be compared and contrasted. From this review it will be shown that manual sign systems may be a particularly viable initial means of communication for many persons who do not speak and for whom vocal training has not been effective. A more detailed review of the manual signing literature will then reveal that although demonstrations of manual sign learning by mentally retarded persons are increasingly common, the factors influencing the initial acquisition of manual signs have not been well established. The present study drew upon information from three areas of research (verbal learning, motoric learning, and the development of attention) to make predictions about the rate of manual sign acquisition as influenced by sign elements and instructional variables.

Speech Limitations in the Mentally Retarded

Mentally retarded persons are frequently characterized as deficient in language and speech (Blount, 1968; Wehman & Garrett, 1978; Whitman & Scibak, 1979). Speech limitations increase in frequency as the degree of retardation increases (Keane, 1972; Martyn, Sheehan, & Slutz, 1969; Sheehan, Martyn, & Kilborn, 1968) with reports of no functional speech for up to 80% of individuals having IQ scores below 50 (Garcia & Dehaven, 1974). These estimates are based, in large, on assessments of institutionalized individuals. For instance, Sheehan et al. (1968) evaluated the speech of 216 residents in a state institution for the mentally retarded. Each resident was given an individual diagnostic speech evaluation by two speech pathologists. Overall, 38% of the residents had no speech (i.e., did not vocalize at all or only cried and grunted), 14% had delayed speech (i.e., babbled or echoed words), and only 12% had normal speech (i.e., was intelligible, did not interfere with communication, and did not draw attention to itself). The remaining 36% had various problems of articulation and voice. For residents with IQ scores between 25 and 39 (25% of the sample), these figures were 38%, 41%, 0%, and 21% respectively. Finally, for residents with IQ scores below 25 (50% of the sample), the values were 94%, 6%, 0%, and 0%.

A similar study at another institution (Martyn et al., 1969) used identical techniques and measures to assess the speech of 346 residents. Overall, 17% of the residents had no speech, 18% had delayed speech, 21% had normal speech, and 44% had various problems of articulation and voice. For residents with IQ scores between 25 and 39 (33% of the sample), the values were 14%, 19%, 17%, and 50%. For residents with IQ scores below 25 (29% of the sample), the figures were 36%, 33%, 2%, and 29%.

Recently, Reynolds and Reynolds (1979) surveyed staff workers in 57 group homes to obtain ratings of speech handicaps for the 518 residents of the community facilities. The staff workers drew upon client records and observations then used a four point scale to rate each resident's level of impairment using the categories "none," "mild," "moderate," and "severe." The overall prevalence of speech limitations in these noninstitutionalized mentally retarded adults was 51%. For severely and profoundly retarded individuals, however, this figure was 78% and 95% respectively. The prevalence of moderate and severe impairment ratings was also higher for these groups (58% and 83%) respectively, than for the mildly and moderately retarded.

From these studies it is evident that a large percentage of the severely mentally retarded population has significantly limited speech or no speech at all. If current deinstitutionalization practices continue, more severely speech impaired individuals will be placed in community living situations, and as language skills have been shown to be particularly strong predictors of success in community based programs (Schalock, Harper, & Genung, 1981), it is imparative that individuals substantially lacking these abilities receive training to improve their communicative skills.

Remedial Vocal Training

In recent years, training programs have been developed which have succeeded in eliciting and elaborating verbalizations in persons with various degrees of mental retardation. These remedial programs have concentrated on teaching functional language skills selected for their immediate utility in communication. The programs have emphasized remediation through operant models (e.g., Graham, 1976; Guess, Sailor, & Baer, 1974; Jones & Robson, 1979; Whitman & Scibak, 1979).

Skinner (1957) was the first to speculate that language could be described in terms of an operant model. Shortly thereafter, researchers demonstrated that adult speech (Salzinger, 1959) and infant vocalizations (Rheingold, Gewirtz, & Ross, 1959; Weisberg, 1963) could be brought under stimulus control using operant procedures, that is, they were at least partially controlled by their immediate consequences.

This initial work was supported and extended in subsequent studies. For example, Isaacs, Thomas, and Goldiamond (1965) and Sherman (1963, 1965) utilized conditioning principles to reinstate speech in mute psychiatric patients. Salzinger, Feldman, Cowan, and Salzinger (1965) and Lovaas, Berberich, Perloff, and Schaeffer (1966) utilized operant procedures to begin building speech in autistic children. In these studies, vocal models were provided and initially all vocalizations by a child were reinforced (usually with food and praise). Subsequently, only verbalizations that occurred temporally near the model were reinforced.

Finally, reinforcement became contingent upon student vocalizations that were increasingly closer approximations of the trainer's model. Similarly, Risley and Wolf (1967) used operant procedures to shape appropriate speech in four echolalic autistic children.

Following these initial efforts, remedial vocal training studies concentrated on training specific, limited grammatical structures such as noun pluralization (Guess, 1969; Guess & Baer, 1973; Guess, Sailor, Rutherford, & Baer, 1968; Sailor, 1971), past and present verb tenses (Schumaker & Sherman, 1970), comparative and superlative adjectives (Baer & Guess, 1971), prepositions (Sailor & Taman, 1972), questions (Twardosz & Baer, 1973), and noun suffixes such as "er" or "ist" which convert verbs to nouns (Baer & Guess, 1973). The procedures used in these studies were quite similar. For each, correct responses were reinforced with praise and/or food and errors were usually punished by saying "no" and/or by using a brief timeout period followed by a model of the correct response and the initiation of another training trial. Other studies using these same procedures sought to train simple elements of syntax (Garcia, Guess, & Byrnes, 1973; Wheeler & Sulzer, 1970).

In each of these studies, the participants learned the tasks that were set before them. However, the participants already possessed fairly substantial verbal skills prior to training. Although most were classified as severely mentally retarded, all participants had been screened so that only those with established vocabularies were selected for training. Because these studies used verbal participants, the effectiveness of operant technology in remedial speech training with nonvocal individuals remains an open question.

Research and training programs that have been designed to train language to initially nonvocal mentally retarded persons have emphasized imitation training, a skill believed, by some, to be an essential perequisite to speech development (Guess, Sailor, & Baer, 1978; Peterson, 1968; Risley & Baer, 1973). A study by Sloane, Johnson, and Harris (1968) is often cited as an example of successfully training vocal imitation to initially nonimitative children (e.g., Garcia & Dehaven, 1974; Guess et al., 1974; Harris, 1975). Participants took part in several levels of training, according to their initial skills. The initial level focused on gross motor imitation. This was followed by training participants to imitate the placement of vocal musculature needed to produce sounds. At the next level, the students were reinforced for making any sounds, then for imitating sounds, sound chains, and object names. Subsequently, students were expected to answer questions by labeling objects, to develop multiple word chains, and finally, to generalize the use of word chains. Results for three children were presented. The reported IQ scores for these individuals were relatively high (45, 51, 63) compared to other studies. The child with the lowest IQ initially produced only a few vocalizations but began to make "intelligible approximations" to words after two and one-half months of training. The child with the next highest IQ could initially name objects and animals and was only given imitation training to improve articulation. After 22 weeks of training, he began to produce three-word utterances. The child with the highest IQ "had a high verbal rate with a large vocabulary" (p. 98) but had severe articulatory problems. After 10 weeks of training she could produce four accurate vocal imitations.

It is clear that most of the participants had some degree of verbal skill. For these individuals, imitation training served primarily to improve articulation, to refine an existing behavior, rather than establish a totally new response class. As with the participants in the studies on grammatical training, the participants in the study by Sloane et al. (1968) cannot, as a group, be correctly judged as being initially "nonverbal."

One study did use a mute, severely retarded child (Kerr, Meyerson, & Michael, 1965). Initially, any sound made by the child was reinforced and after six sessions the child was producing "grunts" at a rate of seven per minute. Next, the trainer began vocalizing to attempt to establish a discriminative stimulus for the child's vocalizations. After "several" trials, however, the child's rate of vocalizations had fallen to zero. Over the next 40 sessions, the trainer's vocalizations were gradually faded to a rate of one every 15 seconds while maintaining the child's vocalization rate of seven per minute. Finally, the trainer spoke one word per 15 seconds and the child was reinforced only if she vocalized shortly after the trainer said a word. For nine sessions the maximum allowable response lag was 10 seconds and the child's responding was very irregular. For nine additional sessions vocalizations were reinforced only if they occurred within five seconds of the trainer's word. Under this condition the child made steadily more vocalizations across sessions. At the end of training (a total of 58 sessions) the child responded to the trainer's words with vocalizations 60% of the time but still made no verbalizations.

Baer, Peterson, and Sherman (1967) worked with two severely/profoundly retarded children whose vocalizations were initially limited to a few grunting sounds. The students were first trained on motor imitations, using modeling and physical prompts which were subsequently faded. Next, one child was trained on vocal imitations by chaining motor and vocal responses and fading the motor components. The second child was trained by shaping motor imitations successively closer to vocalizations (e.g., positioning the lips and mouth to blow a puff of air, actually blowing air, and finally emitting a "p" sound). For the first child, 10 words were imitated after 20 hours of vocal imitation training. For the second child, seven sounds were imitated after 10 hours of training.

Garcia, Baer, and Firestone (1971) attempted to train vocal and motor imitations to four institutionalized mentally retarded children who had previously learned to imitate selected motor responses. All of the children initially produced sounds and these were shaped through reinforcement of successive approximations to the model sounds. Two sounds were trained concurrently. Training continued until either (a) six successive correct imitations (three of each sound in a training pair) were produced within 10 seconds after the presentation of a model or (b) 15 training sessions of 15 - 30 minutes each were completed without attainment of the six imitation criterion. For one child, 3000 trials were required to train the first pair of imitations to Criterion A. Three other sound pairs were presented for 15 sessions each without being successfully imitated to the criterion level. For a second child, 1200 trials were necessary to establish imitation of the first sound pair. None of the other sound pairs were successfully imitated and training was discontinued after 15 session for each pair. Vocal imitation training was terminated after two months for the two remaining children after no progress had been made.

The slow rate of learning vocal imitations contrasts markedly with the rate of learning motoric imitations. The first child reached Criterion A on the first motor item in 100 trials. Subsequently, the number of trials to criterion per motor item decreased to a low of 15 trials. The second child needed 60 trials to meet the imitation criterion for the first motor item pair and 15 to 30 trials for subsequent pairs. The motor imitation learning rates for each motor pair for the two children who did not progress in vocal training were not as clearly specified but fell within the range of 15 to 100 trials for one child and 15 to 900 trials for the other.

Panyan and Hall (1978) conducted vocal imitation training with two severely retarded women as part of a larger study on task sequencing. Neither woman was previously vocally imitative and training consisted of four cumulative steps: 15 successive imitations of tongue and lip position, the addition of some vocalization for 10 successively correct trials, 10 successive correct productions of the target phoneme, and nine review trials. Training was terminated on any sound that had not been produced to this criterion after 200 trials. After 48 training sessions, one participant mastered all eight sounds presented. The second participant had attained criterion on only four sounds after 78 training sessions. The total number of trials given to the two participants was 2562.

Wehman and Garrett (1978) reported the results of two years of language training with 21 students ranging in age from 6 to 21 and with IQ scores ranging from untestable to 35. Language training was similar to that in Sloane et al. (1968) in that motor imitation was taught initially, followed by sound imitation, word imitation, multi-word strings, etc. Ten of the students possessed at least some verbal skills at the first assessment and subsequently progressed to more advanced training steps after two years of training. Eleven students began the program with only motor imitation [illegible] at the second assessment, two years later, 36% of these children had not progressed at all.

Few would argue that speech was not the optimal goal of language training. Speech is a widely used means of communication in our society and to maximally adapt within a social setting an individual must be able to communicate effectively with other members of the community. For this reason, there have been extensive efforts to teach speech to nonvocal individuals. The guiding principle has often been the belief that remedial training on even a few limited grammatical forms and structures will permit the student to communicate, at least in some limited way. However, the benefits of this training must be considered in light of the costs as well. When students initially possess some vocal and verbal skills, the application of operant technology has at times led to further improvements in these areas. For students lacking these abilities, the results are far less encouraging. Many hours and training sessions have produced, at best, only a f[illegible] sounds and words for these individuals.

Imitation skills seem to be crucial to any subsequent learning of speech. Efforts to train vocal/verbal imitation have simply not been effective. Guess et al. (1978), in reporting outcome data for their elaborate and intensive 60-step language training program, stated that of the children who entered the program without possessing verbal imitation skills, 40% showed no progress even after two years of imitation training. In contrast, children who had well established verbal imitation skills progressed further and more rapidly through training.

Nonvocal communication programs may provide an alternative to speech training for mentally retarded individuals with no vocal imitation skills. These programs use systems originally designed for either deaf persons (manual signing) or physically handicapped persons (Blissymbols, communication boards). They generally emphasize the communicative usefulness of the training contents. These programs will be described in the next section. Generally, it is possible that expressive communication skills may be taught to a nonvocal person more easily via a manual system than by vocalization because arm and hand motions can be guided easily. The difficulty of training the fine motor movements of speech is avoided. In addition, Garcia et al. (1971) has shown that motor imitat[illegible]ed [illegible]kly than vocal/verbal imitations.

<u>Nonspeech Communication Systems</u>

Before reviewing specific sign training studies, a general overview of nonspeech communication systems will be presented. Fristoe and Lloyd (1979) made a useful distinction between unaided and aided nonspeech communication systems that will also be used here. Unaided systems support communication solely by means of movement and positioning of the communicator's body. Aided systems, in contrast, require some devise in addition to the communicator's body.

The principle type of unaided nonspeech

communication system is manual signing. Manual signs are conventionalized symbols formed by various hand configurations and motions. Although there is no single, universal sign language, American Sign Language (ASL) is the sign language used most by deaf adults in the United States. Its origin is a French signing system brought to the United States in the early 1800's. Since then, ASL has become accepted as a true language with its own syntactic and morphological rules. For example, there are rules for handshapes and motion sequences. Also, the rules for word-order are different from those of English. English inflectional mark... (to indicate verb tense, possession, pluralization, etc.) are not used. The signs in ASL may or may not correspond to an English word. The meaning of a sign can be altered by the way it is produced, e.g., by repeating the sign, forming it with demonstrated vigor, or changing the orientation of the sign (Bellugi & Klima, 1978; Fristoe & Lloyd, 1979; Wilbur, 1976).

The sign language used by deaf people at home or otherwise within the deaf community has been ASL. It was within this community that children learned ASL. At school, children traditionally received speech training. In recent decades, signing has gained substantially more acceptibility and several pedagogic manual sign systems have been developed which attempt to parallel English

(Bornstein, 1973, 1974). The developers of these systems recognized that manual signing was widely used by deaf individuals (Wilbur, 1976) but also recognized the importance of knowing the predominant language in a society. It was believed that deaf persons who used a manual system utilizing English word order and inflections would more easily learn English (Fristoe & Lloyd, 1979).

Translating the vocal-visual language of English into a linguistically comparable manual system is a difficult task and the various systems devised to do this vary in their similarity to English. One system, Siglish, simply places ASL signs in approximate English word order. At the other extreme, Seeing Essential English (SEE) uses signs for word roots, prefixes, and suffixes. In addition, affixes are included to describe irregular verb forms. Due to the large number of affixes or markers, SEE signs are frequently quite different from corresponding ASL signs.

Another system, Linguistics of Visual English (LoVE), uses morphemes as basic sign units. A morpheme is the smallest meaningful component of language. The signs in LoVE are also designed to parallel the rhythm of English speech. That is, a three movement sign would be created to correspond to a three syllable word. As with the SEE system, LoVE signs use large numbers of affix markers and are often dissimilar to ASL signs.

The final manual sign system to be discussed, Signed English, is designed to parallel English only in terms of meaning. For example, signs are not created to correspond to English word syllables as in LoVE and the ASL signs used in Signed English (about two-thirds of the vocabulary) are not altered to match the form of English words. This can be seen clearly in the case of compound words. The English word "football" has two morphemes and therefore requires two signs in the morpheme-based LoVE system but only a single natural ASL sign in Signed English. If a single sign does not exist for the compound word, e.g., "dishcloth" then the component morphemes are signed separately. Signed English also uses just a limited number of inflectional markers, again with the emphasis on meaning rather than form. For example, one marker indicates the past tense of an irregular verb without detailing the precise form of the irregularity, e.g., the same marker is used to indicate the past tense of "see" as "saw" and the past tense of "hear" as "heard." Because Signed English uses only a limited number of sign markers which can be ignored in the early stages of sign learning, and because a vocabulary exists which is appropriate for mentally retarded individuals, this system has been recommended for use with mentally retarded persons (Fristoe & Lloyd, 1978, 1979).

Other types of unaided nonspeech communication systems include fingerspelling and gesture systems. Fingerspelling consists of manual representations of alphabet letters. It is usually used in conjunction with other systems, either as an alternative to complex combinations of signs and markers or as a means of communicating information when no appropriate sign is known, e.g., proper names or technical terms. The main advantage of fingerspelling is that only 26 configurations must be learned. Its disadvantages are that it is slower than signing and requires good spelling skills. Fingerspelling is therefore not commonly used with mentally retarded populations.

Gesture systems, however, have been used to train communication skills to mentally retarded persons (Duncan & Silverman, 1977; Levett, 1969, 1971). Gestures can be thought of as non-formalized signs. That is, there are no conventional rules or constraints regarding the formation of gestures as there are with signs. Skelly, Schinsky, Smith, and Fust (1974) developed Amerind, a gesture system based on American Indian Hand Talk. It is comprised of gestures whose meanings can often be readily guessed by persons not trained in Amerind. Fristoe and Lloyd (1979) point out, however, that the vocabulary available in Amerind has few elements of relevance to severely/profoundly mentally retarded persons.

Another form of gestures, mime or pantomime, involves acting out an activity. Bellugi and Klima (1978) describe a pantomime for "egg" as encompassing several steps: (a) picking up an imaginary oval object, (b) acting to strike it against a surface, (c) breaking it open and emptying the contents, and (d) throwing the shell away. There is a wide variety of ways these movements could be performed and the idea of "egg" could be conveyed using more or fewer steps and be equally acceptable mimes whereas the ASL sign EGG requires specific handshapes and motion (The index and middle fingers of both hands are extended with the palms facing the body; the right hand strikes the left, then both hands move downward and apart). Although mime is believed to be easy to teach and easy to comprehend, the number and types of objects and actions that can be represented are quite restricted (Fristoe & Lloyd, 1979). This potentially imposes a limit on communicative effectiveness that may be less than some mentally retarded learners' full abilities.

Just as manual systems provide a means of communication for physically able, nonverbal persons, several mechanical or electronic devises designed to facilitate communication by physically handicapped persons (Harris & Vanderheiden, 1980; Vanderheiden, 1978;

Vanderheiden & Harris-Vanderheiden, 1976). Some of this equipment consists of typewriters or computer displays modified to accept input via a puff of air, for example, or other minimal motor movement. Other simpler devices, like communication boards, have symbols on them and usually require a pointing response. This review will concentrate on the symbol systems used with aided communication systems.

A very simple example of an aided nonspeech communication system is the use of photographs with a communication board. Photographs of people or objects are arranged in a matrix so that the communicator can select, by pointing or other means, the item appropriate to his/her message. As the user's vocabulary increases, additional photographs or pictures can be added to the display (McDonald, 1980). Obvious limitations to this system are the restricted number of concepts that can be depicted by photographs or drawings and the relatively small number of such items that can be placed on a communication board display (Fristoe & Lloyd, 1979).

A less restrictive alternative to photographs is Blissymbolics. This system was designed by Charles Bliss to be an international symbol system based on symbolic logic and semantics (Hollis & Carrier, 1978). The elements of Blissymbols are pictographic (e.g., the outline shape of a chair meaning "chair"), ideographic (e.g., a heart designating emotion), or arbitrary (e.g., a line segment sloping upward </> representing "the") (McNaughton & Kates, 1980). This system's first application by a handicapped population occured in 1971 in Canada where it was used as a means of communication for cerebral palsied individuals. More recently, some preliminary efforts to use Blissymbolics with mentally retarded persons have been attempted according to a survey by Fristoe and Lloyd (1978) but the details of its use with these individuals have not been well documented.

Because Blissymbols are based on meaning, elements can be linked or combined in various ways so as to express an almost limitless number of ideas. This represents a distinct advantage over photographic displays. Unfortunately, much of the vocabulary that has been developed has been directed toward the needs of nonretarded adults. Additionally, meaningful interpretation of the symbols is frequently difficult for children, although the system may still be used in a restricted fashion by both children and mildly mentally retarded persons (McNaughton & Kates, 1980).

The final aided nonspeech communication system to be mentioned is one being developed by Carrier (1980) and Hodges and Deich (1980) based on earlier work by Premack (1970). With this system, abstract plastic shapes representing words are ordered to form sentences. The focus of training is on establishing relationships among word elements, beginning with simple associations between symbols and objets then progressing to multi-symbol strings in which the learner must select appropriate noun and verb symbols to complete sentences. This type of system emphasizes the semantic and syntactic elements of language while reducing the complexity of the responses required. In this case, the appropriate symbol need only be selected and placed on a board, in contrast to the complex constellations of auditory, phonological, and/or motoric skills necessary to respond via speech and/or manual signing. However, this system is limited by the number of symbols that can be easily manipulated. Only very preliminary research has been conducted with this system, so its effectiveness as a means to train communication has not yet been adequately evaluated.

In summary, there are a variety of nonspeech communication systems available for use with handicapped populations. Some emphasize the teaching of syntactic and semantic relationships in order to parallel English, using either manually or manipulable symbols. Most of the aided systems are quite recent innovations, intended to be used primarily by physically handicapped persons. These systems require only very simple motoric input from users but need symbol display arrays or electronic equipment which may limit the user's mobility. In contrast, unaided systems such as manual signing permit communicators to move freely about their environment. Although manual signing has been used by the deaf for many years, its use by the mentally retarded has begun only recently, but is becoming more widespread (Fristoe & Lloyd, 1978; Goodman, Wilson, & Bornstein, 1978). In addition, its use has been extensively reported in the literature, although largely as case studies. For these reasons, and because preliminary evidence to be reviewed suggests that some mentally retarded persons can learn to comprehend and/or produce manual signs, the focus of this study will be on evaluating more specifically the impact of selected sign elements on the acquisition of manual signing skills.

Manual Signing and the Deaf

A logical point to begin a review of the use of manual signing is with the population most closely associated with signing, hearing impaired individuals. Early research on manual signing in the United States concentrated on linguistic descriptors of ASL and were efforts to justify the acceptance of ASL as a legitimate and complete language (Bellugi & Klima, 1978; Wilbur, 1979). The focus of this section will be limited to studies describing the acquisition and use of manual signing by deaf persons insofar as they are related to a variable influencing the initial acquisition of manual signs. Although manual signing has been used in the United States for well over 100 years, studies regarding its initial acquisition and use have been conducted only recently.

The single aspect of training that has been studied with deaf signers concerns the selection of mode or combination of instructional modes to be used when teaching deaf individuals. Historically, language training had centered on maximizing the deaf student's adaptation to a hearing society and emphasized speech skills and lipreading (described in de Villiers & de Villiers, 1978; Moores, 1980). Advocates of this form of training resisted the use of manual signing, claiming that language existed exclusively within the domain of auditory-vocal processing (Battison, 1978). After ASL became generally accepted as a language (see reviews by Moores, 1980; Wilbur, 1976), advocates of exclusively vocal training cited linguistic research findings that ASL was not identical in form to English (e.g., Bellugi & Klima, 1972; Stokoe, 1972) to argue that initial training with manual signs would interfere with the subsequent learning of English (Kates, 1972; also see Moores, 1974). In contrast, others have proposed that language skills and functional communication should be stressed initially, regardless of the transmission modality (Lenneberg, 1967; Moores, 1974). They argued that manual systems could be useful in establishing a first means of communication.

In light of the spirited debate over the role or utility of manual sign training (Graham, 1976; Moores, 1974), it is remarkable that only a few empirical studies on this issue have been published. Quigley (1969) conducted two separate comparisons of training techniques. In the first longitudinal study, 16 matched pairs of 4-year-olds were selected from two preschool training programs. One program emphasized oral training in speechreading and speech production. The second program combined oral training with fingerspelling. When tested after four years of instruction, students who had received the combined instruction performed better on fingerspelling (not surprisingly, since the oral-only group had never before encountered fingerspelling), speechreading, and the majority of measures of reading and written language. In this case, it appeared that exposure to a manual communication system actually facilitated performance and did not impede the acquisition of oral skills as some predicted (Kates, 1972).

The second study reported by Quigley (1969) used over 200 older students (mean CA = 13 years at the start of the study) who had all initially been instructed in oral techniques. Prior to the study they were either being instructed via a combination of oral and fingerspelling techniques or a combination of oral training, fingerspelling, and sign. After five years of instruction, the two groups did not differ in either speech production skills or speechreading ability. The addition of manual signing was not detrimental to oral skills acquisition, relative to the performance of the oral-fingerspelling group. However, the lack of an exclusively oral training control precludes any definitive statement regarding the impact of manual sign training on the learning of oral skills.

A subsequent study by Moores, Weiss, and Goodwin (1973) responded to this need. They located seven preschool programs which represented a variety of training approaches including exclusively oral instruction, oral plus fingerspelling, and oral plus fingerspelling plus signs. A total of 74 students from these programs were equated on CA, intellectual functioning, degree of hearing loss, and age of onset of the hearing loss. They were tested for receptive language ability across five communication modes: (a) sound, (b) writing, (c) speechreading, (d) speechreading plus fingerspelling, and (e) speechreading plus signs. The programs that used combined oral-fingerspelling-sign training produced students whose comprehension of speech and written words were equivalent to that of students taught either orally or any single combination of oral-fingerspelling or oral-sign techniques. Futhermore, students exposed to oral-fingerspelling-sign training elements comprehended speech plus fingerspelling or speech plus signs inputs better than students in the other training groups comprehended spoken or written messages. The inclusion of oral-only programs by Moores et al. (1973) permitted direct evaluation of the interactive effects of manual signing with oral training on oral language comprehension. The findings were consistent with those of Quigley (1969) in that exposure to manual signing and/or fingerspelling did not impair oral skills.

In order to assess the impact of manual sign training on oral production skills, Beckmeyer (1976) presented a paired-associate learning task to 22 hearing impaired adolescents who were familiar with both oral and manual communication training. The items consisted of abstract designs and CVC trigrams. Five lists of items were used and were presented in random order to each participant. The designs were projected onto a screen, one at a time, and the corresponding CVC labeled either orally, through fingerspelling, by a created "sign," through a combination of speech and sign, or by a combination of speech and fingerspelling. Students repeated the label for each trigram three times in succession. To test recall, each visual design on a given list was once again presented and the participant asked for the trigram label. The findings indicated that recall of fingerspelling labels was significantly less than for the other four forms which did not differ from one another.

Although there are few studies, their findings consistently fail to support the contention that manual communication training is detrimental to the learning of oral language skills. Some evidence suggested that combined oral-manual training is more effective than oral training alone (Quigley, 1969) and some suggested that there is no difference (Beckmeyer, 1973), but there is no indication that the use of manual communication hinders the acquisition of oral skills. Further research is necessary to determine precisely what the interactive and independent effects of manual signing and oral skills will yield in terms of language and communication development and what factors influence the acquisition of each.

Observations of deaf children's natural learning of ASL have resulted in the speculation that the iconicity of some manual signs may aid in their acquisition. It has been noted that manual signs are typically first produced at a younger age by hearing impaired children than are words by hearing children (Blanton & Brooks, 1978; Wilbur, 1979). Although direct comparisons must be viewed cautiously, one hypothesis for the earlier use of manual signs is that most of the signs that are meaningful to a young child happen to be relatively iconic, or directly representational in some fashion which decreases the arbitrary nature of the signs. These characteristics presumably make them easier to learn than the corresponding words (de Villiers & de Villiers, 1978; Wilbur, 1979). If this is the case, then training in an instructional setting could begin by using highly iconic manual signs in order to facilitate initial learning and produce early successful communication.

Other dimensions of manual signs which may influence acquisition are the organizational parameters derived from studies of short-term memory for signs conducted by Bellugi and Klima (1978). They asked native users of ASL to recall a list of signs by writing down the English word equivalent for each sign. When the types of errors made by the participants were analysed, it was found that the errors corresponded to visual or structural aspects of the signs. Errors were generally made by intrusions of either handshape, location, hand orientation, or motion. For example, the ASL sign TREE is made by placing the right elbow in the left palm with the right hand pointed upward and twisted back and forth. An error that was commonly reported in this case during recall was the response NOON, a sign identical to TREE except that the twisting motion is not present. Similar intrusions were found for each of the other parameters. If the dimensions along which these intrusion errors occur correspond to the elements of a sign stimulus that are attended to during learning, then they should also suggest potentially fruitful areas of instructional intervention. These elements could be exaggerated and made increasingly salient, or initial groups of signs to be trained could be selected which are substantially different on these factors in order to minimize confusion. These possibilities remain to be investigated.

Efforts have been made to use manual signing as a means of communication for a number of nondeaf and nonvocal populations. The next sections will review the work done with three of these groups. It will be shown that a wide variety of individuals have learned to use at least the rudiments of manual signing and that current research is beginning to focus on the identification of variables influencing the initial acquisition of manual signs.

Animal Signing Studies

Much of the research on sign acquisition in mentally retarded and autistic persons grew out of work done with animals. Gorillas and chimpanzees were the principle subjects of early attempts to train language to animals (Hayes & Hayes, 1964; Kellog & Kellog, 1933). Due to both limitations imposed by the structure of their phonological mechanisms (Bryan, 1963) and the failure of sustained efforts to teach speech to these animals (Hayes, 1951; Kellogg, 1968), trainng efforts shifted to manual systems. The most important knowledge gained from these studies centered on the development of training procedures.

Gardner and Gardner (1969) described the acquisition of signs by their chimp Washoe in an environment engineered to provide many opportunities and inducements for learning. Their emphasis was on demonstrating that a chimp could respond to and use signs in a meaningful fashion. They were primarily interested in the extent of Washoe's sign vocabulary, not in the methods used to establish it. However, the major events in Washoe's day such as eating, bathing, and play were highly structured and ritualized so that signs could be presented predictably and repeatedly to Washoe. After viewing sustained repetitions of the signs, Washoe would imitate them.

Another training technique utilized operant conditioning procedures to reinforce successive approximations of sign forms. This method was used for at least two signs but the Gardners mention briefly that they discovered there was no need to wait for opportunities to shape Washoe's instrumental responses into signs. Instead, they first physically manipulated the chimp's hands into the desired configurations and found that the handshapes and motions were repeated independently, with signs learned more rapidly than with other methods of instruction.

Subsequently, Fouts (1972) systematically compared three instructional techniques; modeling, molding, and "freestyle" (a combination of the first two) on the rate of sign acquisition by a chimpanzee. He found that fewer prompts were required and fewer errors were made when molding rather than imitation was the method of training. Further, the freestyle method was superior to molding alone. Fouts speculated that this was because the trainer could switch from one technique to the other at will, maximizing the benefits from each.

Collectively, these studies demonstrated the viability of manual signing as an initial system of communication. Additionally, instances of animals successfully using manual signs have provided both the impetus for similar training studies with communicatively handicapped humans (e.g., Carr et al., 1978; Hobson & Duncan, 1979; Kahn, 1977; Webster et al., 1973) and guidelines for general training procedures. In these subsequent studies, investigators almost always utilized the modeling and molding procedures described in the animal studies.

Autistic Children and Signing

In this section, the development of manual communication training with autistic children will be reviewed. First, studies illustrating a preference for visual processing and the spontaneous use of gestures by these individuals will be described. Next, studies in which manual signs were taught will be reviewed, begining with case reports and demonstration studies and culminating with current investigations of instructional components.

At roughly the same time that the animal sign training studies were conducted, research done with autistic children had demonstrated that cross-modal visual-auditory paired associates, such as picture-word combinations, were generally quite difficult for these individuals to learn (e.g., Bryson, 1970, 1972). Bryson (1970) presented a series of two-choice, match-to-sample problems to five autistic children ranged in age from 4 years 8 months to 8 years 11 months. She found that the children solved more problems correctly when the stimuli and the responses were in the same modality (i.e., visual to visual matching, auditory to vocal matching) than when they differed (i.e., auditory to visual matching, visual to vocal matching). Bryson (1972) subsequently found similar results when autistic children were required to match four-item visual sequences that had either been presented visually or aurally. For five of the seven autistic children in this second study, visual-visual sequences were learned to criterion in fewer trials than auditory-vocal sequences.

Although autistic children apparently have great difficulty in processing cross-modal information necesary, for example, in learning to associate words and pictures, some clinical reports have suggested that these individuals could possibly use nonverbal means to communicate. Jakab (1972) presented a case report for one autistic child. Initially, it was reported that the child's efforts at expressive communication were limited to tugging at a person's arm, then leading him/her to a desired object. Later, the child reportedly held up his arms when he wished to be picked up by an adult and could use gestures to indicate his desires. Although not the subject of specific training, and recognizing that these observations represented only subjective clinical impressions, the reported use of gestures by an autistic child provided an early suggestion that at least some of these children could use nonverbal behavior in a meaningful way.

In another case study using clinical observations of 14 autistic children over a two year period, Pronovost, Wakstein, and Wakstein (1966) noted that the autistic children seemed particularly attentive and responsive to the nonverbal behavor of the therapists. For example, simple requests such as "Close the window," were complied with only if accompanied be a gesture. Without a gestural cue, the children repeatedly hesitated, looked frequently to the therapist, and made incorrect responses. The authors concluded with a recommendation that communication with autistic children first be established through the use of gestures which can later be paired with words to encourage the development of verbal skills. They qualified this suggestion in recognition of the fact that the facilitative impact of gestures had not been determined experimentally. A similar report was offered by Rutterburg and Wolf (1967) who observed that autistic children "try to communicate with gestures" (p. 322). Largely as a result of these studies and as an outgrowth of procedural knowledge gained from the animal studies, researchers began to train signing skills to autistic children.

Early sign training efforts with autistic children sought primarily to determine if these children could learn and use signs in any fashion and were seemingly included only as an afterthought. That is, early reports of sign training were incidental to the main purpose of the study. In the first such study, Webster, McPherson, Sloman, Evans, and Kuchar (1973) attempted to train an autistic child to follow vocal instructions but after more than nine months of training only limited progress had been made. The authors observed that the child seemed to be attending to visual cues presented by the trainer, so standardized manual signs were introduced. After 12 weeks (24 hrs) of training with signs presented with vocal directions, the child would correctly follow combined signed and spoken one-step instructions (e.g., "Stand up."), signed-only instructions, and spoken-only instructions.

The second study in the area (Miller & Miller, 1973) was an effort to control stereotypic behavior and enhance both the body awareness and the performance of intentional acts of 19 autistic children by teaching them to walk along two parallel boards raised four to six feet off the ground and having various obstacles (e.g., blocks, doors, drawbridges) on them. Although no data are presented, the authors reported immediate changes in the children's behavior as soon as they began to walk on the boards, including "the sudden cessation of autistic mannerisms, the steadiness of eye-contact, and the alternating of searching looks at the worker with careful checking of foot placement and the direction in which the board led" (p. 70). The authors also stated that the autistic children initially required guidance and assistance in performing the intentional acts required to proceed along the boards (e.g., climbing over blocks, opening doors, lowering drawbridges) but "later" were able to successfully act independently.

Pleased with these results, the authors chose to utilize their technique with other "purposeful" behavior and selected 50 functional manual signs, related to daily activities and relevant to the walking task (e.g., OPEN, PUSH, WALK). Here again, the children learned to respond appropriately to sign and word combinations presented by the experimenters and then to words alone. The median number of receptive sign-word pairs learned was 27 (ranging from 7 to 50) and the median number of words understood was 26 (ranging from 9 to 50). Modest gains in sign production were also reported (median of 8, ranging from 1 to 50). The criteria for training were not reported. The median time spent in the overall training program was 13 months.

Bonvillian and Nelson (1976, 1978) and Fulwiler and Fouts (1976) each worked with a single autistic child and used procedures from training studies with apes; namely molding, imitation, prompting, and selective reinforcement (Fouts, 1972; Gardner & Gardner, 1969). In addition, the English word equivalent for each sign was spoken as the sign was presented. After 60 hours of training spread across six months, the child trained in

Bonvillian and Nelson (1976) could produce 56 signs correctly, independent of any prompt, as well as some unspecified number of two- or three-sign strings. The child in Fulwiler and Fouts (1976) reportedly learned 26 signs after 20 hours of training across five months as well as 28 two- or three-sign strings and 25 words. However, no training criteria for mastery of either signs or words were presented in either study.

These studies demonstrate that some autistic children can be taught to produce manual signs. However, these studies did not address the question of what aspects of training were critical to the acquisition of expressive manual signing skills. This remains an important question since only two studies to date have investigated training variables in expressive manual sign learning by autistic children. Carr, Binkoff, Kologinsky, & Eddy (1978) simultaneously presented manual signs and corresponding words with five food items to four autistic children. The investigators sought to determine which training element or group of elements were functional in sign acquisition. Three types of probes were given to each child by an experimenter before any training and again after all signs had been learned. The probes consisted of either visually displaying the actual item, vocally saying the word but blocking the children's view of the experimenter's mouth, or silently mouthing the word. For each condition, 50 trials were given with 10 randomly ordered presentations for each item. Predictably, prior to training, none of the autistic children made any correct sign formations under any condition. However, after training, three of the four children correctly formed the appropriate sign nearly 100% of the time when presented with an object as stimulus but remained at near 0% for the other two conditions. The fourth child also performed at the 100% level for visual stimuli but did so for vocal stimuli as well. Performance in the "lipreading" condition was much lower, approximately 25% correct. This suggests that the visual stimuli controlled sign learning, independent of auditory stimuli. All children had been taught to discriminate between signs as they were trained. Once again, instruction consisted of modeling, prompting, and selective reinforcement. The children learned each sign to a criterion of 10 successive, correct, unprompted formations. The total number of trials to criterion for all five signs ranged from 948 to 7669 with a mean of 4585.

Konstantareas and Webster (1978) conducted a similar assessment of stimulus control for receptive sign lerning by five autistic children. Sign presentation alone was as effective as combined sign and speech and both were superior to speech alone. In addition, iconic signs, defined as those signs with a high degree of similarity to their referents, were learned "more easily" than noniconic signs. These findings must be viewed with caution because neither training criteria nor training duration was reported. The training method was also not explained in sufficient detail to permit replication.

Carr and Dores (1981) did follow-up Carr et al. (1978) using similar procedures and measures and found that for receptive sign learning, four of six autistic children attended to both the visual and auditory cues (manual signs and speech), while the other two children attended only to the visual cues. Despite the limited empirical evidence, little additional work has been done to identify critical elements in manual sign learning. At prese[illegible] t[illegible] researchers in this area generally accept the model, prompt, reinforce training strategy as sufficient for sign learning. They now call for research on issues such as (a) facilitating the maintenance and generalization of sign use, and (b) the potential for various collateral benefits from sign training such as increases in speech production and decreases in the frequ[illegible] of maladaptive behavior ([illegible]rr, 1978; Carr & Dores, 1[illegible]81). However, studies designed to address these interests have yet to be reported.

Sign Training with the Mentally Retarded

During the 1970's there was a dramatic increase in the use of manual signing with mentally retarded individuals (Fristoe & Lloyd, 1978, 1979). Initially, manual communication training was offered to multiply-handicapped persons, usually deaf-mute mentally retarded individuals (Fenn & Rowe, 1975; Hoffmeister & Farmer, 1972; Kopchick, Rombach, & Smilovitz, 1975; Sutherland & Beckett, 1969) or mentally retarded persons with cerebral palsy (Levett, 1969, 1971). In every instance, manual training was given after it was decided that these individuals were unlikely to learn speech. All of these reports were simply general descriptions of programs. If any data were reported they were usually tallies of the number of signs learned after a given period of instruction.

Only a single study at the time had tried to make controlled comparisons between training groups. Hall & Talkington (1970) attempted to compare changes in language development and manual sign comprehension between a group of hearing impaired mentally retarded adolescents and a group of mentally retarded adolescents with normal hearing. The hearing impaired group made significantly greater gains on both measures, as determined by change scores, after six months of training. Meaningful comparison between the groups is impossible, though, because (a) the groups were not equated for initial language ability, (b) only the deaf

group received manual training, and (c) language training
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wespite the interpretive limits of this study, it and the other program reports indicated that some deaf and/or cerebral palsied mentally retarded persons could learn to understand and use at least a few signs. This, along with the finding that the use of manual communication systems did not detract from the acquisition of speech (Beckmeyer, 1973; Moores et al., 1973), led others to investigate the use of manual signing with mentally retarded individuals possessing normal hearing.

Like the studies with hearing impaired mentally retarded and cerebral palsied children, the early published accounts of manual training with normally hearing, mentally retarded individuals consisted of simple clinical demonstrations that these individuals could, at least to some degree, understand and form manual signs (Brookner & Murphy, 1975; Duncan & Silverman, 1977; Grinnell, Detamore, & Lippke, 1976; Linville, 1977; Richardson, 1975; Salisbury, Wambold, & Walter, 1978; Stremel-Campbell, Cantrell, & Halle, 1977; Topper, 1975).

A widely cited case study by Topper (1975) is typical of the studies in this area. She worked with a single subject, a profoundly retarded, institutionalized adult. Initially, one of 13 pictures representing activities of daily living was paired with a gesture. The subject was taught to produce the gesture by means of a series of training steps; physical prompting of the gesture handshape, imitation of the gesture, spontaneous production of the gesture, and spontaneous production of the gesture during a subsequent session. After two months of training, anecdotal reports indicated that 50 gestures had been learned and their use had generalized from the training situation to the living dormitory at large.

Topper concluded that the student had acquired a useful language tool which reach "untapped language potential" (p. 30). Unfortunately, the study failed to demonstrate what had led to the acquisition of that "tool." Details of the training procedure were severely limited as were baseline data regarding language skills. There was no discussion of the possible preexisting use of gesture by the student nor were there criteria for the formation of the gestures. It is possible that some potentially significant behavioral changes occurred but there is insufficient information to evaluate the study or attempt a replication.

All of the case studies cited above had these and other severe shortcomings. Overall, the descriptions of the participants in the studies have been poor.

Information about the intellectual functioning of each individual was frequently vague as were the descriptions of baseline language or communication skills. It is difficult to know what abilities the participants possessed prior to training and therefore it is difficult to know to what population the results of training may be generalized. There are also major problems associated with the nature of the training methods used. In very few cases was there sufficient information to permit more than a rough approximation at replication. Sometimes the specific type of sign system used was not even indicated (e.g., Richardson, 1975; Salisbury et al., 1978; Topper, 1975).

Nevertheless, it had become generally accepted that many initially nonverbal mentally retarded individuals could learn to form manual signs. In addition, researchers were becoming more aware of the successful training efforts with autistic children and also cited animal training studies as support for the feasibility of communicaton instruction in a nonspeech mode. As a result, attention turned to issues such as the generalization of sign comprehension and use, as well as comparisons of sign training with oral training.

An early study of the generalization of signing skills, conducted by Smeets and Striefel (1976), focused on the cross-modal generalization of receptive and expressive signing abilities. One moderately mentally retarded girl was taught to either point to the appropriate picture in an array when a trainer made a sign (measuring receptive learning) or to form the sign corresponding to a picture displayed by the trainer (measuring expressive learning). The stimulus items were two sets of eight pictures consisting of animals, colors, and one number symbol. Receptive training consisted of first imitatively matching (by pointing) a stimulus picture to its duplicate in an array. In the next step, the stimulus picture was paired with an ASL sign. Finally, the sign was presented and the presence of the stimulus card faded by gradually increasing the interval between the trainer's sign demonstration and the presentation of the stimulus card. For expressive training, the girl first imitated the sign alone, then the sign when paired with its stimulus card, and finally formed the sign when shown the picture card, the sign model having been faded through the use of the lengthening delay procedure described in receptive training. The training modality was shifted after every second item.

As each item was learned to criterion (at least nine out of ten correct responses in each of two consecutive ten-trial blocks), it was probed in the modality not trained, i.e., receptively trained items were tested expressively and expressively trained items were tested receptively. All eight of the items which had been learned expressively were responded to 100% correctly during receptive probes. In contrast, only three receptively trained items generalized to the expressive probes. For this single individual, training in sign formation supported a receptive knowledge of that sign as well, but receptive training was not sufficient to support expressive sign formation.

A number of other generalization dimensions were investigated by Kohl, Wilcox, and Karlan (1978). They trained three signs for food items to three moderately mentally retarded children. Training occurred in a group setting using a progression of vocal cuing (e.g., "What is this?") when shown a picture, modeling, and physical guidance. Each student received five minutes of individual instruction within the group each day. The students were also trained individually for 15 minutes twice a week on three other signs in the school's speech training room. After six days, all three students had, in the group setting, reached the training criterion of 80% correct responding to the initial vocal cue for each sign for one day. The students received two more days of training and on the ninth day generalization probes were begun. At this time only one student had reached the 80% criterion in the individual training setting. Over the next four days, the students were tested across: (a) persons (teachers, aides, unfamiliar adults), (b) settings (classroom, speech training room), and (c) type of response cue ("What is this?" "What do you eat for lunch?"). Roughly one-half of the responses to the generalization probes were correct. Signs trained in the classroom were more likely to be produced again in the classroom than in the speech therapy room. Conversely, signs trained in the speech therapy room were more likely to be reproduced again in the speech therapy room than in the classroom. Generalization of sign formation across types of response cues was very limited. When probed by the original training cues, "What is this?" and a food item picture, students produced an appropriate sign 93% of the time. However, when asked "What do you eat for lunch?" in the absence of any food item picture, students formed signs only 19% of the time.

In sum, Kohl et al. (1978) demonstrated that moderately mentally retarded students could quickly learn to produce a limited set of manual signs. In addition, sign use could be readily generalized across persons and to a lesser extent across settings. Generalization of manual sign formation was not as easily accomplished across vocal production cues. It is important to note that students had been exposed to some variety of instuctors and settings during training which would help promote generalization across these dimensions (Stokes & Baer, 1977) whereas only a single form of vocal cue was used during training. Consequently, these generalization findings should be viewed more as an outcome of the training procedures used rather than as characteristics inherent in manual signs.

More recently, other studies of the generalization of manual sign formation have been conducted. Faw, Reid, Schepis, Fitzgerald, and Welty (1981) taught direct care institutional staff techniques for training profoundly retarded residents expressive sign skills. After receiving in-service training, the staff taught expressive sign labels for nine pictures of food and other common items to six residents utilizing a sequence of instructions, modeling, physical guidance, and praise in a small group setting. After 46 training sessions of 15 minutes each, the residents showed a mean increase in percent correct sign formation of 64% (from an initial baseline level of 21%). These gains were maintained across follow-up periods up to 49 weeks long. Generalization of manual sign formation upon request was found across staff (trainers and examiners), and to a lesser extent, across stimuli (training pictures and actual objects). No generalization was apparent across settings (from a structured testing situation to free time or meal time situations on the actual living unit).

In a subsequent study designed to increase the use of manual signing by autistic and profoundly retarded residents in their daily living environment, Schepis, Reid, Fitzgerald, Faw, van den Pol, and Welty (1982) used a number of procedures to facilitate signing. Initially, staff members learned 17 target signs. Then the physical environment was arranged to encourage signing. Items were visible on a shelf but out of residents' reach and were given to a resident only after he/she made the appropriate sign label. Additionally, routine staff-resident interactions incorporated signing. As opportunities arose during the normal course of the day, staff asked questions of the residents that could be answered by using one of the target signs. Finally, short 3 - 5 minute training sessions using one sign at a time were conducted intermittently. In all circumstances, staff used a prompt, physical guidance, reinforcement sequence to elicit sign formation by residents and attempted to model at least one of the target signs during each interaction with a resident. In general, all residents increased and subsequently maintained their use of manual signs in a variety of situations throughout the living unit. However only a limited amount of this signing was produced spontaneously by the residents. For the most, substantial prompting and guidance by staff was necessary to produce sign formation by residents.

Another line of research that was being pursued at the same time as these studies of generalization sought to directly compare the effectiveness of oral and manual training techniques. Although these studies occasionally refered to the oral-manual training controversy found in studies using nonretarded hearing impaired individuals (e.g., Kotkin, Simpson, & Desanto, 1978), none cited any of the subsequent comparativie research. Researchers in the field of mental retardation, therefore, appear to have independently tackled the issue concerning the impact of manual sign training on the acquisition of oral skills.

The earliest effort to experimentally address this issue was that of Bricker (1972). She noted the success of the Gardners (1969) in training signing skills to a chimpanzee and hypothesized that associating manual signs with objects and their word labels might increase the discriminability of the various objects and words. The experimental group of 11 severely mentally retarded children received a series of imitative sign training, sign-word training, and sign-object training. In imitative sign training, students were shaped through physical prompting to independently form a modeled sign on at least seven of 10 training trials. For sign-word training; the spoken word was added to the sign model and the students were required to perform to the previous criterion. Finally, in sign-object training, the training item was shown to the student, who was shown the appropriate sign model and instructed to form the sign.

All students were probed for receptive word knowledge prior to any training, between each component of training, and at the completion of training. Students in the control group were given all probes but received no training. The results indicated that students in the two groups performed at the chance level when tested before training. On the intermediate probes, both groups showed some improvement but there were no reliable differences between groups. At the time of the final probe, the students in the experimental group displayed significantly greater receptive knowledge of the object names than did students who received no instruction.

VanBiervliet (1977) sought to expand upon Bricker's (1972) work by investigating whether manual sign training could facilitate the acquisition of expressive word-object associations. Six moderately or severely mentally retarded adolescents were taught to imitate signs, make the appropriate sign when shown an object, make the appropriate sign when given a word, imitate words, and to say the corresponding word when shown a sign. Responses were established through modeling and shaping procedures. The criterion for progressing from one task to another was two consecutive sessions of at least 14 correct and independent responses out of blocks of 15 trials.

The students' performance was probed at several points. Overall, the students could correctly select an object when shown its sign or given its name on more than 95% of the probe trials. They said the word corresponding to a sign 50% of the time. At the end of training, the students were able to say the name of a displayed object on 90% of the probe trials.

Although these two studies were not direct comparisons of oral and manual training, they are of interest because they are early, methodologically sound demonstrations of manual signs serving to mediate the acquisition of associations between words and objects. Despite the limited nature of the training tasks, simple two-choice discriminations, the potential use of manual signs to facilitate oral skill development is suggested. Consequently, other researchers have investigated the relative contributions or oral and manual approaches to the acquisition of communication.

The first attempt to directly compare oral and combined oral and manual training was by Kahn (1977). Twelve severely mentally retarded children were divided into three training groups, a simultaneous communication group (combined sign and speech training), a speech training group, and a contact-control group instructed in a skill other than communication. Training was essentially parallel between the communication groups. An initial behavior control phase (shaping of attending skills) was followed by practice in the use of the stimulus objects, vocal imitation training (for the speech training group only), and receptive language training. The results of nine months of training were described only in general terms. Three students in the simultaneous communiction group had progressed to the receptive language stage and two of these subsequently produced at least some signs and spoken words. The fourth child was still learning initial attending skills. Two students in the speech training group had completed receptive language training and were beginning to initiate spoken words. Two other children remained in vocal imitation training. The four children in the placebo group showed no changes in ability.

These findings, like those of the early clinical demonstrations of sign acquisitions, are far from conclusive, but are suggestive of the benefits of training. Although limited by a restricted sample size and a lack of both detailed methodology and precise means of analysis, the results indicated that directed instruction improved communication skills more than did training in some other area. In addition, both manual and oral training increased receptive and expressive language performance. Furthermore, the fact that manual training did not impede oral performance was consistent with studies involving nonretarded, hearing impaired participants.

Following Kahn (1977), Kotkin, Simpson, and Desanto (1978) presented a more closely controlled study of this issue. Two moderately mentally retarded girls were first given vocal training and then simultaneous vocal and manual training in a multiple baseline design across three different words. During baseline and test probes, the students were shown pictures depicting each training word and asked, "What's this?" For oral training, the question was replaced by the trainer's vocal labeling of each picture and reinforcement of imitative responses by the students. In manual training, the trainer formed the sign in addition to saying the name of the presented picture. Once again, imitative responses by the students (vocal, sign, or combined) were reinforced.

During the three days of baseline, neither girl verbalized or signed any of the training words. During oral training, one student averaged 7.67 correct responses after three days of training on the first word but made no correct responses for either of the other two training words after six and nine days of instruction respectively. Similarly, the second girl averaged 1.66

correct responses following three days of vocal training on the first word and less than one correct response for each of the other two training words. When manual signs were added, signed responses were acquired quickly, but more central to the study, vocalizations increased in all but one case. The number of vocalizations of the first training word by the first girl decreased to an average of 5.44, but were 7.33 and 4.33 for the second and third words. For the second girl, correct vocalizations increased to 8.44 for the first word, 7.33 for the second word, and 8.67 for the third word. Follow-up probes after one week indicated that both speech and signing had been maintained.

Similar studies have replicated the findings of speech facilitation by manual sign training (Reich, 1978; Wells, 1981) and retention of the signs for up to two months (Hobson & Duncan, 1979). In each of these, as in Kotkin et al. (1978), manual sign training not only did not impede oral development but, quite the contrary, enhanced it.

Each of the studies reviewed in this section has contributed to our knowledge of manual signing. The one consistent finding which emerges is that most of the mentally retarded individuals in training acquired some receptive or expressive knowledge of at least a few signs. Unfortunately, little effort has been made to identify factors that affect the acquisition of manual signs. Many of the training interventions appeared to have been initiated in the absence of any coherent conceptual framework. Lacking the guidance of some general theory of language or signing acquisition, training efforts frequently appeared to be isolated or haphazard (Frisote & Lloyd, 1978; Goodman, Wilson, & Bornstein, 1978). The clinical emphasis of these studies has been on achieving an end product of some type of communicative competence, with little concern directed toward determining the specific methods needed to achieve that competence.

In contrast, the focus of the present study was on assessing the impact of three variables on the initial acquisition of expressive manual signing. These variables concern motoric (touch/nontouch signs) and representational (iconic/abstract signs) aspects of the manual signs and the method by which signs are presented to the student learners (combined oral and manual training/manual only training). They were selected because anecdotal clinical reports suggested that these variables might affect the rate of manual sign acquisition and because empirical work conducted with these variables in other research areas provides some basis for a priori predictions of their influence on manual sign leaning. The discussion of these variables will be followed by a statement of the problem.

<u>Relative Learning Rates for Iconic and Abstract Stimuli</u>

A number of researchers in the field of verbal learning have reported that concrete words are often learned faster and recalled better than abstract words (e.g., Dukes & Bastian, 1966; Paivio, 1965; Stoke, 1929; Winnick & Kressel, 1965). Additionally, Ellis and Porter (1966) demonstrated that students with "low verbal skills" learned a discrimination task more quickly when it incorporated meaningful stimuli (line drawings of real items) than when nonmeaningful stimuli (abstract designs) were used. It is typically argued that this general finding is a result of the relative ease with which most concrete words can elicit images and associated words, as mnemonic aids, compared to most abstract words (e.g., Paivio, 1971).

With manual signs, concreteness and associability can refer to the actual sign configuration as well as the meaning of the sign. Some concrete concepts are represented by easily guessed transparent or iconic signs (e.g., BALL - two cupped hands tracing the outline shape of a ball), while others are described by arbitrary abstract signs (e.g., TRAIN - the index and middle fingers of the right hand rubbing the index and middle fingers of the left hand). Investigators have selected signs that were iconic because they were thought to be easier to learn due to their direct representation of the object being presented (e.g., Bricker, 1972; Topper, 1975). Kohl, Karlan, and Heal (1979) reported that the iconic signs in their sample facilitated instruction-following by providing a model of the desired behavior. They were not concerned with the expressive use of these signs by their students, however, and did not systematically manipulate the iconic-abstract dimension of their stimuli. Carr (1979) also noted anecdotally that autistic children use abstract signs only after lengthy training with iconic signs.

In a recent study, Kohl (1981) found no difference in acquisition rate between iconic and abstract signs for eight severely mentally retarded children. It is likely that an inappropriate selection of training stimuli accounted for this counter-intuitive finding. The sample of manual signs was reviewed by 30 judges who classified each sign as either abstract or iconic. By using this forced choice procedure, Kohl did not maximally separate the sign groups into highly iconic and highly abstract categories. A lack of distinctively different sign groups would have increased the difficulty of detecting differences in learning rate between the groups using statistical procedures.

Griffith and Robinson (1980) avoided this problem by having groups of college students, deaf adults, and first grade children rate the signs in their study for degree of iconicity. All three groups rated the signs similarly and only signs rated as highly iconic or highly abstract were then used in training. This training consisted of instructing moderately retarded children to say the English word corresponding to a presented ASL sign. The children correctly responded to more iconic signs than to abstract signs. This result indicated a facilitative effect of iconicity on the receptive knowledge of manual signs. However, although iconic signs are often included in initial sign training lexicons (Fristoe & Lloyd, 1980), the contribution of iconicity to the acquisition rate of expressive signing remains unclear.

Motoric Features of Signs

The motoric manipulations of the hands are the most salient characteristic of manual signing. Descriptive studies have revealed three basic structural aspects of signing: handshape (Bellugi, Klima, & Siple, 1975; Wilbur, 1979), motion (Supalla & Newport, 1978; Wilbur, 1979), and location (Poizner & Lane, 1978; Wilbur, 1979). The first dimension, the number of handshapes used to form signs, is quite restricted and only for the early learning of sign characteristics by very young children is there any evidence for systematic acquisition of these features (Wilbur, 1979). However, for older individuals who have developed basic motor competencies, there is no evidence to suggest that the handshape of a sign differentially affects the rate at which it is learned.

The second dimension of signing that has been described is the sequences of motion permissible for sign formation. Movement patterns within a sign are constrained in much the same way that letter combinations are constrained in English. By convention, certain letters, such as "b" and "n," are not juxtaposed in English words. Similarly, certain combinations of movement are not permissible within an ASL sign, such as sequentially touching the arm and the head, or pairing a rapid repetition of a verb sign with a rhythmic rocking of the body (Fisher, 1973; Wilbur, 1976). A classification of these configural constraints may be useful in identifying additional sources of linguistic meaning in signs. However, there has been no research to indicate that such information should be a primary consideration when establishing a basic manual communication system.

The body locations at which signs are made are also limited in number and usually inflect the sign in some way. For example, the dimension of time may be conveyed through the placement of the sign: in front of the signer for future tense, to the signer's side for present tense, and behind the signer for past tense (Friedman, 1973). Such inflections add precision to manual signing but are not likely to be important considerations in the teaching of an initial sign lexicon to severely retarded students. In fact, these inflectional markers are typically disregarded during early training (Bornstein et al., 1975; Fristoe & Lloyd, 1979).

The third dimension of location concerns not placement of the sign as a whole, but rather the placement of the hands during the formation of a sign. Specifically, the focus is whether the hands touch each other or come into contact with other parts of the body. On this basis it is easy to dicotomize manual signs into touch and nontouch varieties. The utility of this division is not that it reveals additional meaning in the signs, as do the previously mentioned structural features, but instead concerns its usefulness as a training device. There is some evidence that the touch/nontouch distinction has an impact on manual sign learning rate. Anecdotal reports from studies using animals (Fouts, 1972) and mentally retarded children (Kohl, 1981) suggested that touch signs were learned more quickly than nontouch signs. However, the authors have not attempted to provide any logical explanation for this finding beyond stating that touch signs may provide more feedback to the learner than do nontouch signs. In order to more fully develop such an argument as the basis of making an a priori prediction regarding the effect of the touch/nontouch variable on the rate of manual sign learning, a theory of motor learning which emphasizes the role of feedback will be discussed.

Adams' Closed-Loop Theory of Motor Learning. The closed-loop theory of motor learning of Adams (1971) emphasizes the importance of feedback in detecting and correcting errors made by a subject during learning. According to the theory, a movement produces a "perceptual trace," a sort of motor-memory, that serves as a reference model for subsequent attempts to repeat the motion. During the early trials of a motor learning task, when the learner is making frequent and sizable errors, comparison of performance on a trial with the existing perceptual trace (for an erroneous movement) is not very useful for learning. The person needs to make new responses to correct previous errors rather than repeat them. What is thought to be of central importance is a combination of feedback information describing the just completed motion, called knowledge of results (KR), and hypotheses for corrective movement based upon this knowledge. The theory predicts that the more information provided through KR feedback, the more precise hypotheses for corrective movement can be and the quicker the target motion will be learned.

Once the individual consistently responds correctly, KR becomes less important. Now KR is only reporting that the person is making no errors. At this point, the individual can concentrate fully on matching each performance to the perceptual trace, knowing that it is the correct response. With continued practice the perceptual trace is strengthened and proprioceptive feedback becomes sufficient to correct errors.

Many components of Adams' theory have received empirical support. The motor tasks involved have generally been simple movements, such as drawing a line of a given length, but it has been argued that such a movement must be carefully monitored to achieve accuracy and therefore embodies "the essence of all skills" (Adams, 1976, p. 206). Several studies have manipulated KR. Of central importance for acquisition were the findings that both the type and amount of feedback directly influenced performance. As early as 1932, Trowbridge and Carson demonstrated that quantitative KR (numeric feedback such as "one inch too long") facilitated more rapid acquisition than did qualitative KR (limited feedback of "right" or "wrong"). When no KR was available, no learning occurred. More recently, Adams, Goetz, and Marshall (1972) found that acquisition of a linear positioning task was faster when more feedback was available. This "augmented" feedback condition included visual, auditory, and proprioceptive feedback. In a similar study, Adams and Goetz (1973) found that students who received augmented feedback while learning a positioning task could subsequently better discriminate between the learned and a new motion than students who received minimal feedback. In addition, students who received augmented feedback could better reconstruct the learned motion after making a forced erroneous motion than students who received minimal feedback.

<u>Implications for Sign Learning</u>. Adams' theory and the empirical support described above bear directly on the training of manual signs. The principle of primary importance is that increasing feedback facilitates motor task acquisition. Sign handshapes are varied and will provide different, but not necessarily more or less feedback. The same is true for motion and body location. However, for hand location a distinct quantitative difference is noted between touch and nontouch signs. For both sign types, visual and proprioceptive feedback are available. Touch signs have as well an additional tactual feedback element. Therefore, in accordance with Adams' theory, the movements required to form touch signs, because of the greater amount of associated feedback, should be acquired more rapidly than the movement sequence of nontouch signs of equivalent overall complexity.

Development of Selective Attention and Sign Presentation Techniques

In the sign training studies previously described, when a sign was presented to a student, the instructor typically spoke the English word equivalent for that sign as well. This approach, simultaneous communication, has bearing on the final variable of interest in the present study. Given the extended effort to gain acceptance for the instructional use of manual signing with nonretarded deaf students (Moores, 1980), researchers have consistently included some sort of oral component in training. The argument was that multiple stimulus modality inputs were provided to the student in order to increase the likelihood that the stimuli will cue one another and that at least one channel will become functional for communication (Harris, 1978; Shaeffer, 1980). It has also been asserted that the cue redundancy of simultaneous communication will facilitate the generalization of language use. For example, Grinnell, Detamore, and Lippke (1976) claimed that simultaneous communication would facilitate signing with the mentally retarded because these individuals are exposed to similar combinations of visual, motoric, and auditory cues in other learning situations. Similarily, Hopper and Helmick (1977) described the multi-modality input of simultaneous communication as paralleling the normal speaking exchange (which combines sounds with gestures and facial expressions). They suggested that this combined input might maximize the probability of learning successes with the mentally retarded and support generalization of communication from the training environment to other settings. However, none of these hypotheses have been tested empirically.

Wilbur (1979) has pointed out that simultaneous communication by design divides an individual's attention between the two communication modes of speech and signing. Her suggestion that this would not be as effective as direct speech training for the acquisition of speech (nor presumably as effective as direct sign training for the acquisition of signing) reflects a point of view favoring modality-specific instruction over simultaneous communication.

In sum, there are two main positions regarding manual sign training techniques. One suggests providing a rich stimulus complex of both speech and sign cues and the other advocates presenting only the stimulus of central emphasis. In emphasizing sign learning, the sign cue is central to the task while the vocal cue is incidental. It is important to consider the appropriateness of presenting incidental material to students who have difficulty learning. Research on the development of selective attention bears directly on this issue.

A number of studies have shown that developmentally young and mentally retarded persons demonstrate less selective attending to a central element of a stimulus combination than do older or intellectually normal persons. For instance, Maccoby and Hagen (1965) presented picture cards with varied background coloring to first, third, fifth, and seventh grade children. The students were instructed to remember the background colors in order to match a probe color. Incidental recall was measured by asking the children what picture had appeared on each background. Recall on the central task improved with age. Recall on the incidental task decreased for the oldest group, indicating that these children attended more selectively to the central material than did the younger children. Similar studies were conducted by Zukier and Hagen (1978) and Sexton and Geffen (1979). In each, older children were more likely to voluntarily focus their attention on material relevant to the central task and disregard irrelevant information. For mentally retarded students, Hagen and Huntsman (1971) used cards that each had a central and incidental picture and found that selective attention improved with mental age.

These findings indicate that younger and mentally retarded persons more evenly divide their attention between the relevant, central element of a stimulus and the irrelevant, incidental components. This is a particularly noteworthy problem for mentally retarded persons, who have substantial difficulty initially targeting the relevant dimension controlling a learning task (Zeaman & House, 1963). With simultaneous communication, mentally retarded learners may be distracted by the vocal cue and not concentrate their attention selectively upon the relevant sign cue. If this is the case, then simultaneously presenting vocal and sign cues should result in slower sign learning than presenting sign cues alone.

On the other hand, Zeaman and House (1963, 1979) have demonstrated the importance of salience and novelty in guiding learners' initial selection of a stimulus dimension or cue to be attended to. Mentally retarded persons beginning to learn manual signing have probably been previously exposed to substantial vocal training, meaning manual signs are quite novel by comparison. In addition, as previously noted, the relative salience of the signs is highlighted due to both the fairly gross motions constituting sign formation and the ease with which presentation rate and duration can be altered (Fristoe & Lloyd, 1979). Therefore, learners' attention should be drawn to the sign dimension and the vocal stimulus discounted. If the manual sign dimension is more salient and novel, it will be attended to regardless of the presence or absence of the vocal dimension. Therefore, manual sign training and simultaneous communication should produce equivalent results.

Statement of the Problem

Initially, manual signs used by the deaf were taught to apes in an effort to determine if a nonverbal organism could use such signs to communicate. Early training efforts relied primarily on providing an "enriched" learning environment, i.e., one in which the opportunity and motivation to form manual signs were high and many correct models were provided to be imitated. Instructional methods became more structured and findings indicated that several signs were acquired by the animals and that even multiple sign strings were produced. Subsequently, clinicians and researchers sought to teach manual signs to human nonverbal populations, first autistic children and then the mentally retarded, by using elements of pedagogic systems used with deaf students.

As with the early animal studies, the first studies of sign acquisition by autistic children were general in nature, asking if manual signs could be used in any way by these children. Following early favorable reports, training procedures became more controlled, with rapid sign learning, and in some instances, the spontaneous production of words observed. Subsequent studies sought to determine the generalized effects of sign training on collateral measures, particularly speech production and decreasing maladaptive behavior.

Studies investigating manual sign acquisition by mentally retarded persons also began as case studies. The number of studies reporting receptive and productive manual sign learning is increasing but the factors influencing manual sign acquisition have not been empirically determined. This may in part be due to the fact that no single, comprehensive theory of manual sign acquisition is available; therefore no constellation of control factors has been proposed. Consequently, the present study drew from several areas of research to select three variables that logically should affect the rate of manual sign learning and about which there were sufficient empirical data to predict the nature of those effects.

Three specific hypothese were made:

<u>Hypothesis I</u>. Iconic signs would be learned faster than abstract signs. As a group, stimuli which are concrete, imagible, and have a large number of associates are learned more quickly than items lacking these qualities (Paivio, 1965). Manual signs judged to be iconic are those which have some component of or association to their referent incorporated into their

form, whereas abstract signs appear to be more arbitrary.

Hypothesis II. Touch signs would be learned faster than nontouch signs. Research in the field of motor learning has shown that the nature and amount of feedback available direcly affected learning rate (Adams et al., 1972). For signs of a comparable overall complexity, the presence of a touch component provides an additional element of proprioceptive, tactile feedback to the learner as compared to nontouch signs.

Hypothesis III. Training with manual sign stimuli alone would result in either equivalent or faster sign learning than training with combined manual sign plus speech stimuli. Children and mentally retarded persons generally divide their attention approximately equally between task-relevant elements of a stimulus complex and task-irrelevant elements (Hagen & Huntsman, 1971; Maccoby & Hagen, 1965). If this were the case, the presence of speech cues would draw students' attention away from manual sign cues and impede sign acquisition. However, others have suggested that novelty and salience strongly influence the direction of attention (Zeaman & House, 1963, 1979). If this were the case, the high novelty of manual signs should strongly attract students' attention with the presence or absence of speech cues discounted and not affecting learning rate. Contrary to claims in the literature, simultaneous communication cannot be predicted to produce manual sign learning rates superior to that of manual sign training alone.

Method

Subjects

The participants were 24 severely mentally retarded adolescents drawn from special education classes in secondary public schools in Tuscaloosa and Jefferson counties. The students had no uncorrected visual or hearing losses or motor dysfunctions of a severity that precluded the ability to form manual signs. Students were not initially familiar with any of the training signs. In addition, student participants did not possess vocal imitation skills but were required to demonstrate generalized motoric imitation skills in a pretest.

Materials

Training signs. A sample of 16 signed English signs drawn from a standard source (Bornstein, Hamilton, Saulner, and Roy, 1975) was used. Signs were selected based on ratings of iconicity and motoric difficulty obtained in pilot work described in Appendix A. There were an equal number of iconic, abstract, touch, and nontouch signs (Table 1).

Training objects. Small toys or food items that correspond to the signs being trained were used. In each case, either the actual item (e.g., peanut) or a

Table 1

Signs Used in Training

Sign Group	Iconicity		Motor Difficulty	
Abstract/Nontouch	Mean/S.D.		Mean/S.D.	
CAKE	2.53	1.25	3.20	1.26
MARSHMALLOW	2.73	1.39	3.47	1.41
MOUSE	1.40	0.63	2.80	1.42
PEANUT	2.20	1.32	3.40	1.18
Abstract/Touch				
CANDY	2.60	0.99	2.00	1.14
CRACKER	1.33	0.72	3.20	1.32
FLOWER	1.40	0.83	3.00	1.46
TRAIN	2.00	1.13	2.60	1.24
Iconic/Nontouch				
BROOM	5.67	1.05	3.40	0.99
CAMERA	6.60	0.51	2.07	1.10
HAMMER	7.00	0.00	2.00	1.31
SCISSORS	6.87	0.35	1.27	0.46
Iconic/Touch				
BALL	5.73	1.03	3.13	1.25
RING	6.80	0.56	2.40	1.18
SUN	6.20	0.68	2.00	0.93
TELEPHONE	6.53	0.64	2.87	1.68

Note. Following convention, English glosses for signs are printed in all capital letters.

model (e.g., train) were used.

Video equipment. Training sessions used for reliability assessments were videotaped using a Panasonic television camera, model WV 341P and a Panasonic VHS format videocassette recorder, model NV-8200.

Setting

All testing and training was conducted individually in a quiet room separate from the student's classroom. Student and experimenter were seated at adjacent sides of a table. The training objects and controls for the video equipment were to the experimenter's right, below the level of the tabletop and out of the student's view. The camera was placed in a corner of the room that afforded a clear view of both student and experimenter. Training was conducted 30 minutes per day, 5 days per week.

Pretesting

Motor imitation. Ten movements representing components of the training signs were modeled by the experimenter. For each, the experimenter said: "(Student's name), do this." The tested behaviors were: clap hands, touch nose, touch ear, extend forefinger, make fist, hold hands to side of eyes, touch mouth, make "C" handshape, extend hand palm up, and touch thumbs to fingers. Two students who did not imitate at least 8 of the 10 behaviors within 5 seconds of the model were excluded from the study.

Vocal imitation. Following the motor imitation pretest, the students were asked to repeat the names of the 16 training items. No student imitated more than three words.

Knowledge of manual sign formation. Following the imitation pretest, the experimenter vocally labeled and demonstrated the signs for two sample items. Each training object was then shown to the student and labeled and the student asked to make the sign for the object. No students formed any signs correctly.

Receptive knowledge of object names. After the manual sign formation pretest, the student was tested for knowledge of object names. This phase of pretesting was included to insure that the training stimuli were familiar to the students. First, the necessary pointing response was modeled. Three objects, not training stimuli, were placed on a tabletop in front of the student, spaced in a row approximately 20 cm apart and 35 cm from the student. The experimenter modeled the correct response by saying: "Watch me. I'll touch the pencil." The experimenter then touched the pencil. The objects were rearranged and the appropriate touching response modeled a second time. Next, a set of three training objects were presented and the student asked to touch one particular item. If the student touched the object named, s/he was credited with receptive knowledge of that word and another set of training objects presented. If the student failed to respond within 5 seconds or responded in error, a correction procedure was initiated. First, the correct response was modeled, the objects rearranged while remaining in view and the model again provided. Next, the student practiced the response twice. As before, the objects were reordered in full view between responses. After the student had successfully imitated the experimenter's model, the three objects were removed from the tabletop, reordered, and again presented to the student. The student was then required to touch the correct object upon request. If an error was made at any point during this correction procedure, training reverted back to the last successfully completed step. Finally, each item that required corrective training was probed once more, at the end of the full list of training stimuli being tested. This training procedure was necessary for only two students.

Sign Training

Sign plus speech. For a student in the sign plus speech condition, training began when the student and experimenter were seated together at the table and made eye contact. This was accomplished by using the minimal necessary prompt of this series: (a) saying "(Student's name), look at me," (b) touching the student's chin with fingertips, (c) turning and holding the student's head gently by hand. Compliance at any point was verbally reinforced.

Next, the experimenter showed a training object to the student, i.e., held the object at eye level between himself and the student, placed the object on the table, touched it once and simultaneously labeled it. Then the experimenter made the sign and again provided the vocal label while maintaining eye contact.

At this point, the experimenter said: "(Student's name), make the sign for (object label)." If the student responded correctly within 5 seconds, s/he was praised and the trial was completed. Subsequent trials were identical except that no initial sign model was given. Figure 1 shows a flowchart representation of the sign training sequence. For trials on which the student made no response within 5 seconds, or formed the sign incorectly, a prompting procedure was implemented. If the student initially made no response, the first prompt was a light touch on the student's hands while the request to form the sign was repeated. If after another 5 seconds the student still had not responded, the experimenter physically guided the student's hands into the proper shape for the sign.

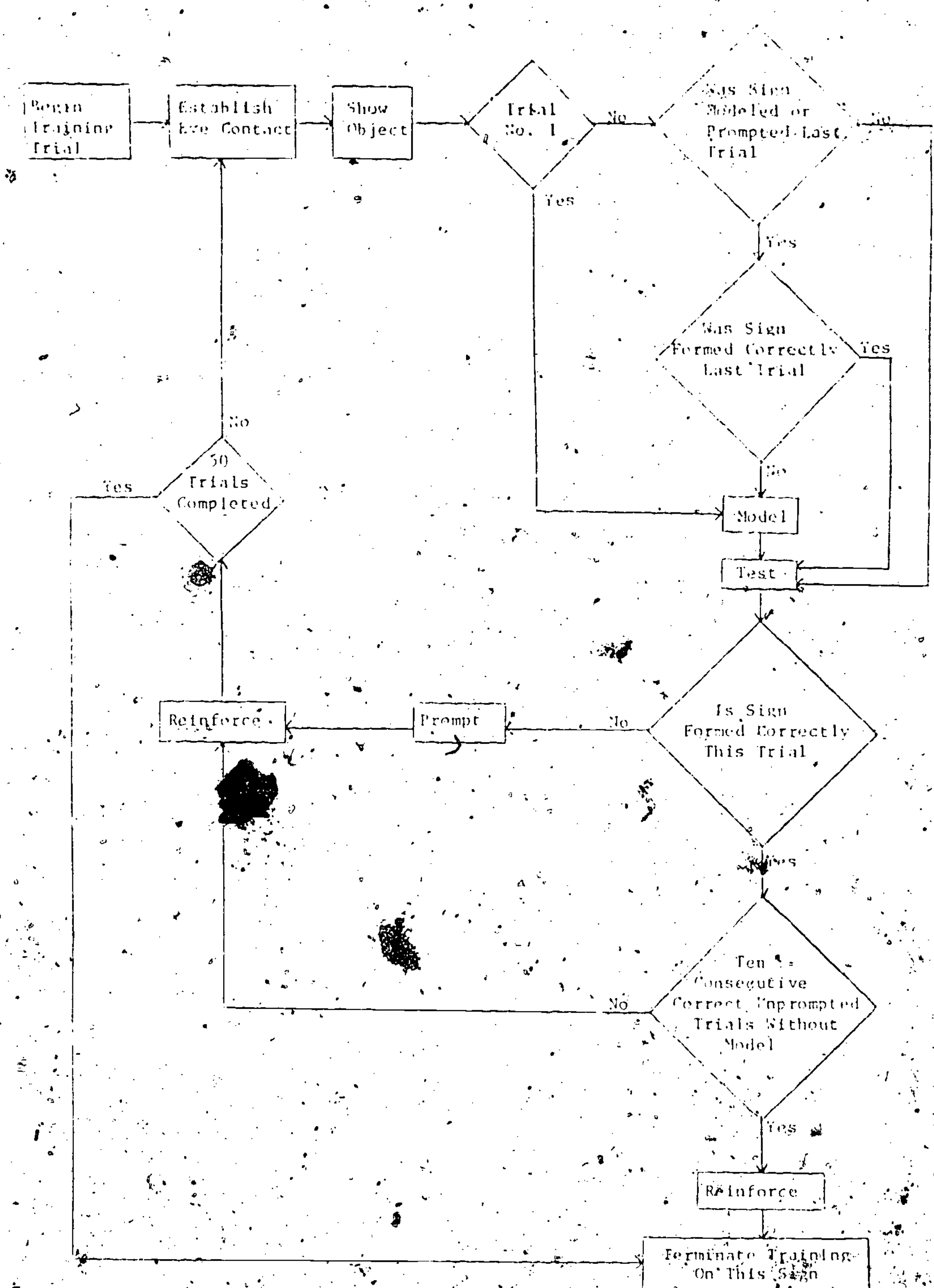

Figure 1. Flowchart of sign training. (Rectangles represent actions to be performed by the experimenter; diamonds represent decision points in the process.)

This physical guidance was administered three times with the experimenter saying the name of the sign each time and with a brief pause between each repetition. On trials subsequent to those on which a prompt was used, the experimenter again provided a model before asking the student to form the sign. For any trial, incorrect responses made be the student were immediately terminated with a "No" from the experimenter and the physical guidance sequence instituted. The training sequence for any given sign was terminated when a student either formed the sign correctly without a model or prompt on 10 consecutive trials or completed 50 trials.

In order to support the students' frequency of responding and to maintain an equal density of reinforcement, students received vocal praise at the end of each trial. Also, on two predesignated trials, randomly selected from each ten-trial block, the student was physically reinforced with a pat on the shoulder or arm.

Sign only. Training procedures in this condition were identical to those in the sign plus speech condition except that the training stimuli were never vocally labeled. As a result, the experimenter's request for the student to form a sign was: "(Student's name), make the sign."

Reliability

Two types of reliability measures were taken. The first was concerned with the experimenter's adherence to the training procedures and the second focused on the consistency with which students' learning data were recorded. For each, videotaped training sessions were viewed by two raters, blind to the hypotheses of the study. Training sessions were sampled at random with the provision that four signs, one from each group, for each of the 24 students were included. This utilized 25% of the total data pool for reliability checks. Raters used a checklist of sequenced training behavior to determine the consistency of modeling, prompting, and reinforcement during training (Appendix C). An overall, mean percent adherence to procedure was calculated and comparisons made across conditions to verify that training was comparable in each case.

Using the same sampling procedures, raters viewed training sessions and independently scored the students' responses using the same type of rating sheet used by the experimenter (Appendix D) and operationalized definitions of correct sign formation (Appendix E). Rater and experimenter records were compared and interobserver reliability calculated to yield a mean percent agreement for the point at which students reached the criterion for sign learning.

Results

Two independent observers viewed videotaped samples of training sessions. These observers rated the trainer's adherence to described training procedures and scored the students' responses as either correct or incorrect. To be correct, the student must have formed the sign without the benefit of any prompt. In each case, interobserver agreement and observer-trainer agreement were calculated by dividing the number of agreements by the total number of observations. All values obtained by this method exceeded .90.

All participants were able to form at least some manual signs to the criterion of 10 successive, correct, unprompted trials. The number ranged from 4 to 16 with a median of 10. Overall, students' ability to correctly form signs increased from an average of 29% in the first trial block to 69% in the fifth trial block.

The mean percent correct sign formation for each sign type and training group are presented in Table 2. Only correct responses on trials without modeling were counted toward the learning criterion. The dependent variable was the number of these correct responses per

Table 2

Mean Percent Correct Responses

for Sign Types and Training Groups

	Sign Training	Sign/Speech Training
Iconic/Touch	.56	.56
Iconic/Nontouch	.41	.48
Abstract/Touch	.63	.73
Abstract/Nontouch	.38	.60

block of 10 trials. This yielded five measures per sign per student to be entered into the analyses. All trials following criterion were scored as correct. A 2 (training group) X 2 (sign representation) X 2 (sign formation) X 5 (trial block) analysis of variance was conducted. A significant effect for trial blocks, F (4, 608) = 114.58, p < .01, indicated that the students were more likely to form signs correctly as training progressed. Also, a significant effect for taction, F (1, 152) = 6.99, p < .01, indicated that touch signs were more likely to be formed correctly than nontouch signs were. A significant trial block X taction interaction was also found, F (4, 608) = 2.53, p < .05, showing that touch signs were learned at a faster rate than nontouch signs.

Discussion

All participants learned some signs to criterion and all showed performance gains on most signs. However, some students made no progress on some signs. These failures to form a given sign correctly, even occasionally, appeared to be largely idiosyncratic in that no individual signs were consistently "failed" across students. But it is of interest to note that most of the signs which were not learned to any appreciable degree were nontouch signs and that a frequent source of error for these signs was the addition of an incorrect touch element by the students. They persisted even when told explicitly not to touch their hands when making a sign. Others have reported a similar pattern of errors (Kohl, 1981). Students seemed to use available touch components of signs primarily to mark the final position of their hands. In other words, once the hands were in motion, they continued to move until they came into contact with some source of physical resistance. The students had difficulty halting their motions short of contact and may have been relying on the additional proprioceptive feedback from that contact to signal the completion of sign formation.

Another finding of interest is the equivalent amount of manual sign acquisition for training that presented a vocal cue in conjunction with a sign model and training with a sign model alone. For the initial acquisition of expressive manual signing skills, a vocal label cue was neither an aid nor a hinderance and need not be a factor in training. However, if manual signing is selected as an augmentatitive rather than an alternative communication system, the impact of a vocal cue during manual training on the subsequent acquisition of speech remains to be determined.

The single outcome which was counter to that hypothesized was the failure to find learning differences between iconic and abstract signs. Although items were selected that the mentally retarded students were familiar with, the initial determination of iconicity values was done by college students who may have more readily made associations between the form of a sign and the form or function of its referent. Also, half of the iconic signs described the form of the referent but the students' experience with the items centered on using them. Therefore, signs that used motions describing a referent's shape, such as moving the hand in a circle for BALL, may have been more novel or seemed more arbitrary than signs which used motions to describe a referent's use, such as the sweeping motion of BROOM.

In conclusion, the present results have a number of implications for training. First, when students are just beginning to form manual signs, associated vocal labels are not necessary. Once the signing response has become well established, vocal cues may possibly be introduced to serve as models and prompts for subsequent speech production by the students. However, the utility of this procedure must still be investigated. Second, touch signs should be selected for an initial training lexicon as they are learned more quickly than nontouch signs and will contribute to early successes in training. Finally, although others have reported more rapid acquisition of receptive knowledge of iconic signs by moderately retarded students (Griffith & Robinson, 1980), the present finding suggests that the representational associations between signs and referents need to be particularly salient to influence the acquisition rate of expressive signing skills by severely mentally retarded students.

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Appendix A

Iconicity and Motoric Difficulty Ratings of Selected Signed English Signs

The purpose of these ratings was to generate two lists of Signed English signs, substantially different in average iconicity but equated on motoric difficulty. Iconicity refers to the extent to which a sign looks like its referent or uses a motion related to that referent. Motoric difficulty focuses on the amount of effort necessary to form the signs, i.e., the number of motions required or the awkwardness of the handshapes. Although others have rated the iconicity of manual signs (Griffith & Robinson, 1980; Luftig, Page, & Lloyd, Note 1), only a few of the signs in this study have been rated. Also, manual signs have not previously been rated for motoric difficulty.

Method

Subjects

The raters were 15 graduate students in psychology who volunteered to participate and who were not familiar with manual signing.

Materials

A sample of 83 signs was drawn from the Signed English Dictionary (Bornstein et al., 1975). Criterion for selection was that the signs represented familiar objects that mentally retarded students were likely to recognize.

Procedure

The sign rating dimensions were explaned to the students by saying:

> In this study you will be shown manual signs, like those used by the deaf. Your task will be to rate each sign on two dimensions. The first will be how closely the form of the sign represents its meaning. For example, some signs are closely related to their meaning, because they describe the shape of an object, like BEARD, or they illustrate the function of an object, like AXE, while others seem more arbitrary, like BUG or CATSUP. The second type of rating will be how difficult the sign is to make. For example, some signs can be formed with just a simple motion, like TOOTHBRUSH or BOWL, while others require several motions or peculiar handshapes, like CLOSET or TRICK.

Next, students were given rating sheets. Each sheet listed the 83 signs to be rated plus 4 artificial "signs" included as validity checks. Under each sign label were two 7-point Likert-type scales. The first scale was for the iconicity rating and was anchored at 1 by "sign not at all like its meaning" and at 7 by "sign very much like its meaning." The second scale was for the rating of motoric difficulty and was anchored at 1 by "sign very simple to make" and at 7 by "sign very difficult to make."

The signs were then presented to the students via a videotape. First, the number on the rating form and the word label for the sign were presented during a 5 sec interval. During the next 5 sec period, the sign was demonstrated twice by a male signer. Finally, there was a 7 sec blank interval during which the students made their ratings. This procedure was repeated for each sign.

Results

Mean ratings of iconicity and motoric difficulty were calculated for each manual sign and are presented in Table 3. Eight of the signs had previously been rated on iconic value in a study by Luftig et al. (Note 1). The correlation between ratings obtained for these signs in the two studies was $r = .94$. Mean iconicity and motoric difficulty ratings for the validity check items were: (a) high iconic/low difficulty, 6.40 (S.D. = 0.91) and 1.53 (S.D. = 1.55), (b) high iconic/high difficulty, 6.60 (S.D. = 0.91) and 2.40 (S.D. = 1.45), (c) low iconic/low difficulty, 1.80 (S.D. = 0.94) and 2.87 (S.D. = 1.30), and (d) low iconic/high difficulty, 2.80 (S.D. = 1.42) and 5.27 (S.D. = 1.33).

Using the present ratings, four groups of signs were created, two high iconic groups (one each of touch and nontouch signs) and two low iconic (abstract) groups (one each of touch and nontouch signs). Signs were selected that significantly separated levels of iconicity (t = 16.05) and minimized motoric difficulty. These signs and their ratings are presented in Table 1 in the Method section of the proposal.

Table 3

Mean Ratings of Iconicity and Motoric Difficulty

for Initial Sign Pool

Sign	Iconicity	Motoric Difficulty	Sign	Iconicity	Motoric Difficulty
REFRIGERATOR	1.80	2.87	GRAPE	2.33	4.27
SPIDER	6.47	2.40	HAMMER	7.00	2.00
STRAWBERRY	2.80	5.27	HAT	5.60	1.73
WATCH	6.40	1.53	HARMONICA	5.47	1.67
AIRPLANE	4.13	3.13	HONEY	1.67	4.67
ALLIGATOR	5.47	2.60	KNIFE	4.47	2.87
APPLE	3.47	2.93	MAGAZINE	2.20	3.13
BABY	6.33	1.60	MARSHMALLOW	2.73	3.47
BALL	5.73	3.13	MASK	5.27	3.53
BALLOON	5.27	3.20	MICROPHONE	6.20	1.13
BANANA	5.20	4.00	MILK	5.93	1.87
BAND AID	4.80	1.87	MOTORCYCLE	6.07	1.33
BASEBALL	5.27	2.60	MOUSE	1.40	2.80
BEAR	3.07	3.13	ORANGE	3.07	2.67
BELT	4.93	2.73	PAPER	3.53	2.40
BIRD	4.87	2.20	PEANUT	2.20	3.40
BOAT	3.13	3.73	PENCIL	2.73	3.70
BOOK	6.47	1.53	PICTURE	3.87	4.60
BOWL	6.27	1.87	POPCORN	3.27	2.87
BROOM	5.67	3.40	PRETZEL	3.80	3.13
BUTTERFLY	6.60	3.46	PUZZLE	3.40	4.53
CAKE	2.53	3.20	RADIO	4.40	2.60

Table 3 (continued)

CAMERA	6.60	2.07	RAISIN	2.33	4.73
CANDLE	2.80	5.67	RATTLE	5.27	2.40
CANDY	2.60	2.00	RECORD	5.53	2.93
CAR	1.47	4.73	RING	6.80	2.40
CARROT	3.73	1.93	SCARF	5.27	3.00
CAT	4.47	3.20	SCISSORS	6.87	1.27
CLAY	4.80	2.27	SNAKE	5.00	3.53
COMB	6.93	1.07	SODA	3.20	4.67
COOKIE	3.67	2.87	SOLDIER	4.87	3.00
CRACKER	1.33	3.20	SPOON	5.33	3.07
CRAYON	3.47	4.27	SQUIRREL	2.40	4.30
CYMBAL	6.47	1.47	STAMP	5.93	3.33
DOG	1.80	3.13	STRAW	4.40	3.93
DOLL	1.27	3.47	STRING	3.40	3.07
DRUM	6.27	1.80	SUNGLASSES	6.20	2.00
DUCK	4.80	2.73	TELEPHONE	6.53	2.87
FISH	5.60	3.80	TRAIN	2.00	2.60
FLAG	5.80	3.73	TURTLE	5.87	4.27
FLOWER	1.40	3.00	WIG	3.00	3.47
FORK	4.73	2.27	YO YO	5.53	3.40
FRISBEE	4.53	3.07	ZIPPER	4.93	2.60
FROG	2.47	3.67			

Note. The first four signs were artificially generated to function as validity checks for the ratings.

Appendix B

Pretesting Data Sheets

Name ______________ School ______________ Date ________

Birthdate ______________ IQ ______________ Time ________

A. Motor Imitation   Instructions and model: "(Name), do this."

Criterion: at least eight correct

1. clap hands ____
2. touch nose ____
3. touch ear ____
4. extend forefinger ____
5. make fists ____
6. hold hands to side of eyes ____
7. touch mouth ____
8. make "C" handshape ____
9. extend hand palm up ____
10. touch thumb to fingers ____

B. Vocal Imitation   Instructions: "(Name), say ____."

Criterion: no more than three correct

1. Marshmallow ____
2. Sunglasses ____
3. Mouse ____
4. Ball ____
5. Peanut ____
6. Ring ____
7. Cake ____
8. Telephone ____
9. Cracker ____
10. Broom ____
11. Train ____
12. Scissors ____
13. Flower ____
14. Hammer ____
15. Candy ____
16. Camera ____

C. Knowledge of Manual Sign Formation. Criterion: zero correct responses

Instructions and model: "(Name), this is a car. This is the sign for car."

"(Name), this is a pencil. This is the sign for pe[ncil]"

"(Name), this is a ____. Make the sign for ____"

1. Telephone ____
2. Cake ____
3. Ring ____
4. Peanut ____
5. Ball ____
6. Mouse ____
7. Sunglasses ____
8. Marshmallow ____
9. Camera ____
10. Candy ____
11. Hammer ____
12. Flower ____
13. Scissors ____
14. Train ____
15. Broom ____
16. Cracker ____

D. Receptive Knowledge of Object Names Criterion: all sixteen correct

Instructions and model: PENCIL bear magazine

"(Name), watch me. I'll touch the pencil."

"(Name), touch the ____."

1. peanut BROOM telephone
2. cracker record BALL
3. HAMMER cake ring
4. bear TRAIN sunglasses
5. PEANUT magazine broom
6. stamp scissors MARSHMALLOW
7. CRACKER record mouse
8. hammer RING candy
9. bear train SUNGLASSES
10. SCISSORS flower marshmallow
11. hammer cake CANDY
12. peanut magazine TELEPHONE
13. stamp FLOWER marshmallow
14. cracker MOUSE ball
15. CAKE ring candy
16. bear CAMERA sunglasses

Checklist of Experimenter Behavior

Student ______________ Sign ______________ [illegible] ______________

Trial Number	Eye Contact (+/-)	Object Displayed (+/-)	Sign Model Required (+/-)	Sign Model Provided (+/-)	Object Labeling Correct (+/-)	Prompt Required (+/-)	5 Sec Delay Before First Prompt (+/-)	Prompt First With Light Touch (+/-)	Repeat Sign Production Request (+/-)	Second 5 Sec Delay (+/-)	Second Prompt With Physical Guidance (+/-)	Repeat Sign Production Request (+/-)	5 Practice Trials Given (+/-)	[illegible]

Appendix D

Sign Training Data Sheet

Name ____________________ School ______________ Date ____________

Training Group ______________ List Number ______ Time ____________

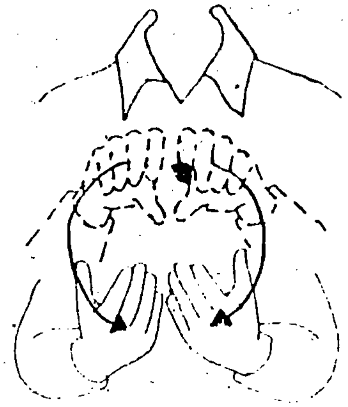
Sign ______________________

Trial #	Response	Type of Prompt	Trial #	Response	Type of Prompt
1			26		
2			27		
3			28		
4			29		
5			30		
6			31		
7			32		
8			33		
9			34		
10			35		
11			36		
12			37		
13			38		
14			39		
15			40		
16			41		
17			42		
18			43		
19			44		
20			45		
21			46		
22			47		
23			48		
24			49		
25			50		

Appendix E

Operationalization of Minimal Acceptables

Criteria for Judging Correct Sign Formation



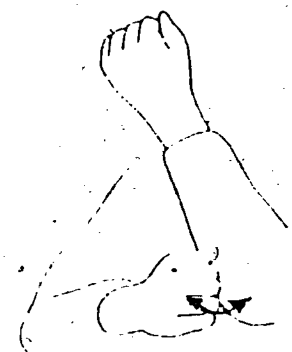
BALL
Curved B shape both hands palms facing. Outline shape of ball ending with palms up. Hands must begin and end side by side touching with no overlap or grasping. Hands must trace a circular path from top to bottom and not merely flip over.

BROOM
S shape both hands. Mime holding broom and sweeping. Hands must move in unison, without touching.

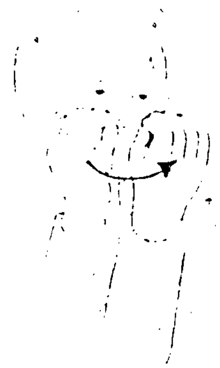
CAKE
Open B LH palm up, tips out. Hold right claw, tips down, over left palm then lift up spreading fingers. Right hand begins in claw shape or with thumb touching fingertips (but not palm).

CAMERA
Mime holding camera in front of face and clicking shutter. Hands are held within 7.5 cm of the face, no further apart than face width with only index fingers and thumbs extended. Either index finger may "click shutter."

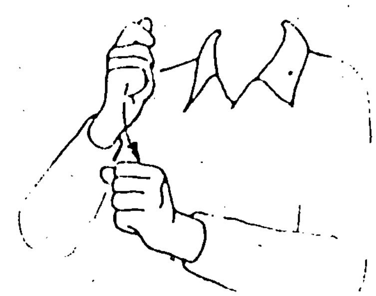
CANDY
Place right index finger within 2.5 cm of right side of mouth (not on cheek or near nose) and twist.



CRACKER
Tap with either side (fingers) or end (thumb) of right A at least half-way down arm (from wrist to elbow).



FLOWER
Thumb and index finger must touch, other fingers are at least bent. Touch tips to right side of nose (not cheek) or upper lip near nostril then move to the left.



HAMMER
S shape left hand. Striking motion is with side (fingers) of right A, not little finger end of hand. Hands do not touch.

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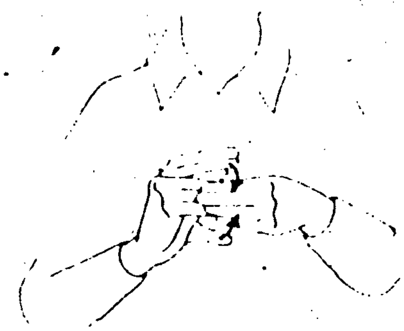
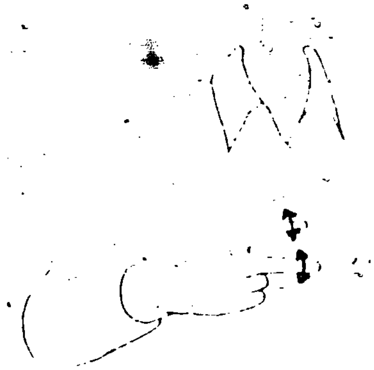


MARSHMALLOW
C shape left hand palm and tips right. Left fingers must be bent and thumb rotated to be in the same plane as index finger. Little finger down. Right hand in same configuration rotated 90° (fingers up and thumb down). Right fingertips must be placed within left C and right thumb must touch at least one other finger when right hand closes.

MOUSE
Right index finger initially in vertical position. Rotation is at wrist only with minimal arm motion. Finger does not touch nose.

PEANUT
Place thumb of right A above (not touching) chin and move away, pivoting at elbow.

RING
Right index finger and thumb must be pla around left fourth finger. Other right fingers may be open or closed. Some slid motion must be demonstrated.



SCISSORS
V shape right hand, palm in, tips left. Open and close fingers like scissors blades.

SUNGLASSES
Circle eyes with index fingers and thumbs. These fingers are bent and touch the face around the eyes. Other fingers are close

TELEPHONE
Y shape right hand. Thumb must be pointed at or touching ear and little finger must be pointed at or touching mouth (not cheek or nose).

TRAIN
H shape both hands, palms down. Rub right H over left. Right fingers must make at least one complete back and forth motion (tips to base to tips or base to tips to base).

Appendix F

Pilot Study

The purposes of this study were to test the practicality of the proposed methodology and to gain a preliminary view of the effects of the independent variable manipulations. Previous studies have not adequately described the sign training procedures or training stimuli so it was necessary to determine whether the proposed techniques and materials could be used in an instructional setting. The rationale for the selection of the particular independent variables was drawn from relevant research literature. However, these variables have generally not been studied empirically or have been investigated only in isolation so questions about their relative importance and combined impact on manual sign learning have not been addressed.

Method

Subjects

The participants in this study were four clients at the McGraw Activity Center of the Tuscaloosa Association for Retarded Citizens in Tuscaloosa, Alabama. The mean CA was 33, ranging from 20 to 44. The mean IQ as assessed by the Arthur Adaptation of the Leiter Internationa Performance Scale was 38, ranging from 31 to

44. Each student was pretested on vocal/motoric imitation, familarity with the training objects, and knowledge of manual signs.

Materials

The training signs, training objects, and video equipment used were identical to those described in the proposal.

Setting

All testing and training was conducted in a quiet conference room at McGraw Activity Center. The arrangement of training materials, videotape equipment, and student-experimenter seating was as previously described in the proposal. Training was conducted 30 min per day, 5 days per week.

Pretesting

All pretesting was identical to that described in the proposal except for motor imitation and receptive knowledge of object names. For motor imitation, the instructions were unchanged but the 10 movements were: clap hands, touch nose, touch ear, touch mouth, raise hands over head, touch head, cross arms, make fists, fold hands, and touch thumb to fingers.

For testing the students' receptive knowledge of object names, no model of the desired touching response was provided. In addition, three distractor items were used on each trial for one student and two distractors

Table 4

Pilot Subject Charactistics

Group	CA	IQ
Sign plus Speech		
CJ	44	44
TW	33	31
Sign		
LW	20	42
TH	34	33

were used for the other three students. If a student made an error, the distractor items were removed and the student practiced touching the correct item three times with the object removed and replaced between each attempt. Then the distractors were replaced and the student again practiced the correct response. If another mistake occured before the student made three successive correct selections, the distractors were removed and the process begun again with only the target item in view. Finally, each missed item was probed two more times in the testing list, once after seven intervening items and again after five additional items.

Sign Training

Training procedures in the two conditions were identical to those described in the proposal with three exceptions. First, the training object was simply placed on the table without first being held at eye level between the student and experimenter. Second, each time students made errors, they were physically guided into the correct response but received no massed repetions of the physical guidance. Finally, the delivery of physical reinforcement was not systematically controlled.

Results and Discussion

The principle reason for this pilot work was to ascertain the feasibility of the proposed training procedures. It was found that students could be located who met the combined criteria of high receptive communication skills and low expressive abilities. Further, all students learned at least some of the 16 signs (mean = 9.75, range 5 - 15) to the criterion of 10 successive correct, unprompted formations within a reasonable period of time (maximum of 16 sessions), even with limited corrective practice following errors.

Reliability

Reliability measures were taken to determine the consistency of the experimenter in following the prescribed training procedures and the accuracy of his scoring of the students' responses. A rater viewed videotapes of 14 training sessions, four for each of two students and three for the other two students. All sign types were sampled.

Training procedure. On each trial, adherence to the training procedure was scored at seven points. The items were: (a) making eye contact, (b) placing the object on the table between the experimenter and the student, (c) labeling the object appropriately (i.e., named in the sign plus speech condition, not named in the sign only condition), (d) providing a model if needed, (e) following the correct prompting sequence when the student made no response, (f) terminating errors and providing a physical prompt, and (g) vocally reinforcing the student on each trial. Reliability was calculated by subtracting the number of experimenter errors from the total number of observations and dividing by the total number of observations. Using this formula, the reliability for adherence to the training procedures was .97.

Student responses. The rater also noted on each trial whether the student correctly formed the manual sign being trained. These ratings were compared with ratings made by the experimenter at the time of training. Reliability was calculated by subtracting the number of disagreements between rater and experimenter from the total number of observations and dividing by the total number of observations. The reliability computed in this fashion for scoring student performance was .98.

Acquisition Data

Due to the limited sample size, the manual sign acquisition data were not analysed statistically. Instead, each main effect and one-way interaction is presented graphically (Figures 3 - 6). In general, the graphs of the main effects across trials blocks (Figure 3) indicate that the sign characteristics selected may influence the rate and extent of sign learning. For each trial block, more iconic signs were acquired than abstract signs (Figure 3b). Difference between touch signs and nontouch signs were also found for each trial block. Across blocks, learning of touch signs was consistently superior to that of nontouch signs (Figure

3c). Only for training technique was there no indication of a main effect due to groups (Figure 3a).

The three interactions, presented in Figures 4 through 6 are also offered as tentative findings. They suggest that manual sign acquisition is influenced by a combination of training technique and sign dimensions. Instruction with signs only led to greater acquisition of touch signs than did instruction with signs plus speech. However, instruction with signs plus speech resulted in greater acquisition of nontouch signs than did instruction with signs alone (Figure 4). Training with signs alone also led to greater acquisition of iconic signs than did training with signs plus speech. Training with signs plus speech led to greater acquisition of abstract signs than did training with signs alone (Figure 5). Finally, iconic and abstract touch signs were both acquired about equally but iconic nontouch signs were acquired better than abstract nontouch signs.

As a means of partially substantiating the general validity of these interactions, data from the individual students are presented. For the group by touch interaction (Figure 4), three of the four students had data isomorphic with the interaction. The same was true for the group by iconicity interaction (Figure 5). The iconicity by touch interaction was supported by five of eight measures (Figure 6).

Again, it is recognized that there is insufficient power to support conventional statistical analyses of the group data presented here and that all findings remain tentative. Nevertheless, the fundamental purpose of the pilot, establishing the practical feasibility of the instructional methodology, has been demonstrated and the findings of consistent group separations, apparent even with the limited sample size, suggest that the proposed study may yield fruitful results.

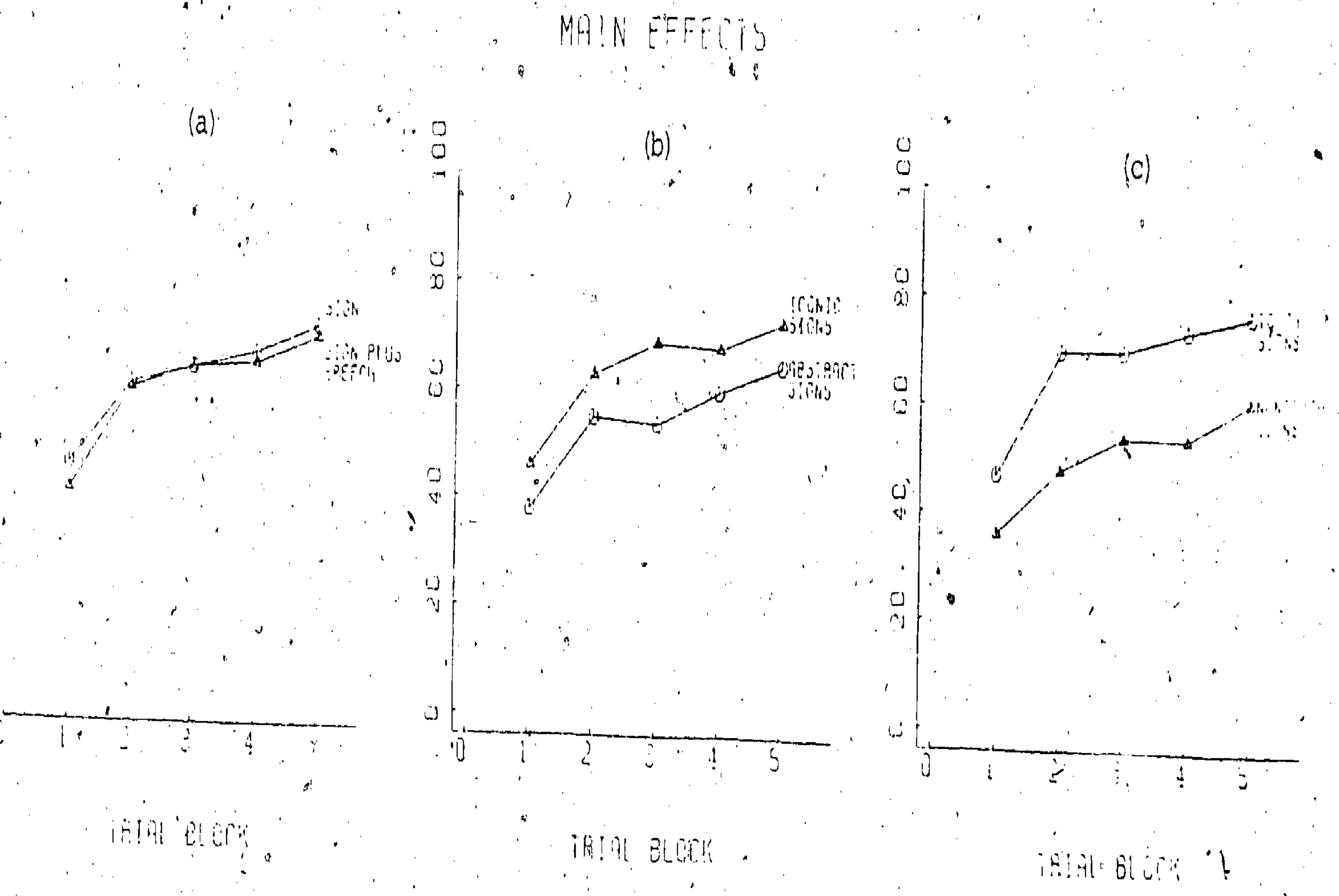


Figure 3. Mean percent correct sign formation per 10-trial block for (a) training groups, (b) levels of iconicity, and (c) type of sign formation

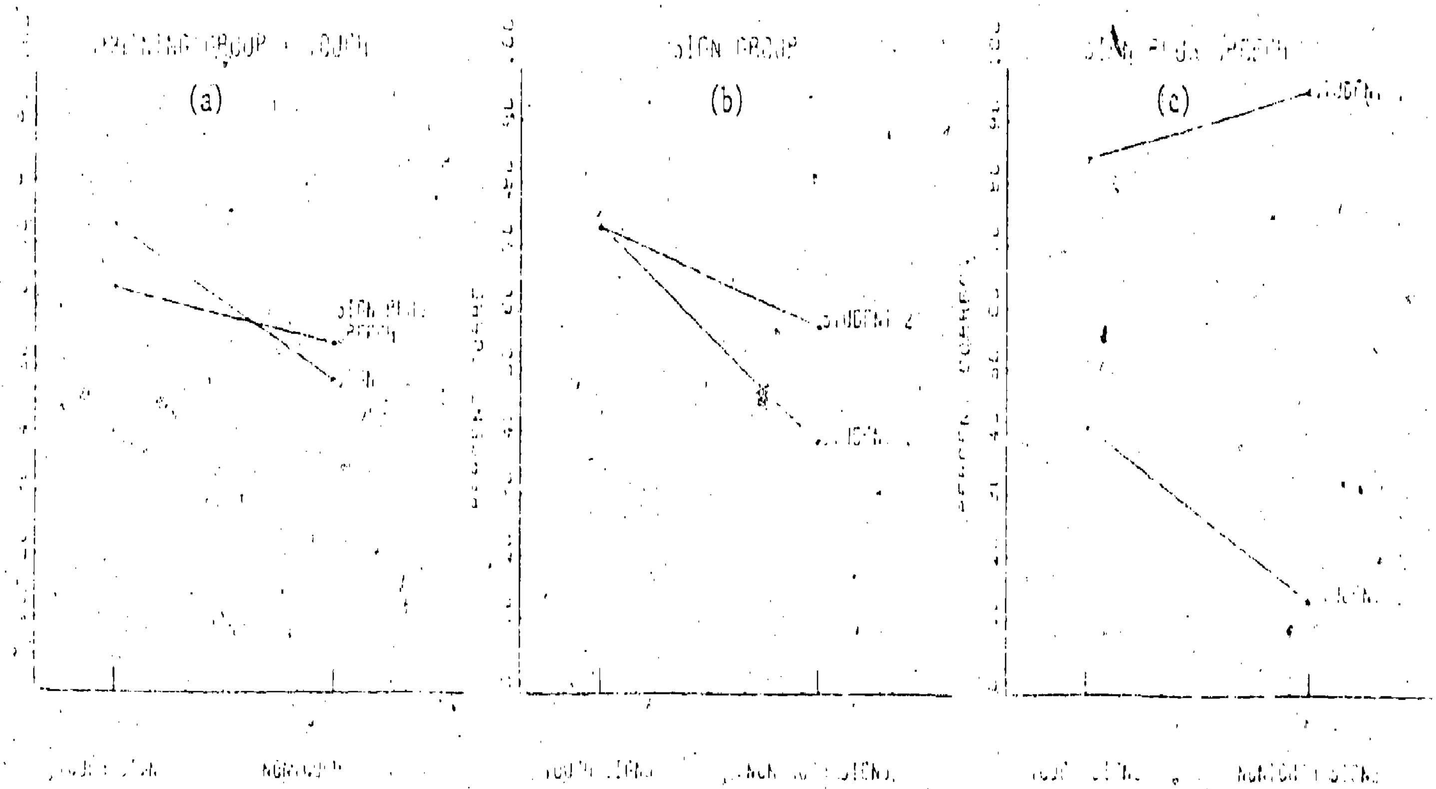


Figure   an percent correct formation of touch and nontouch signs (a) in each training group, (b) by individual students receiving training with signs only, and (c) by individual students receiving training with signs plus speech.

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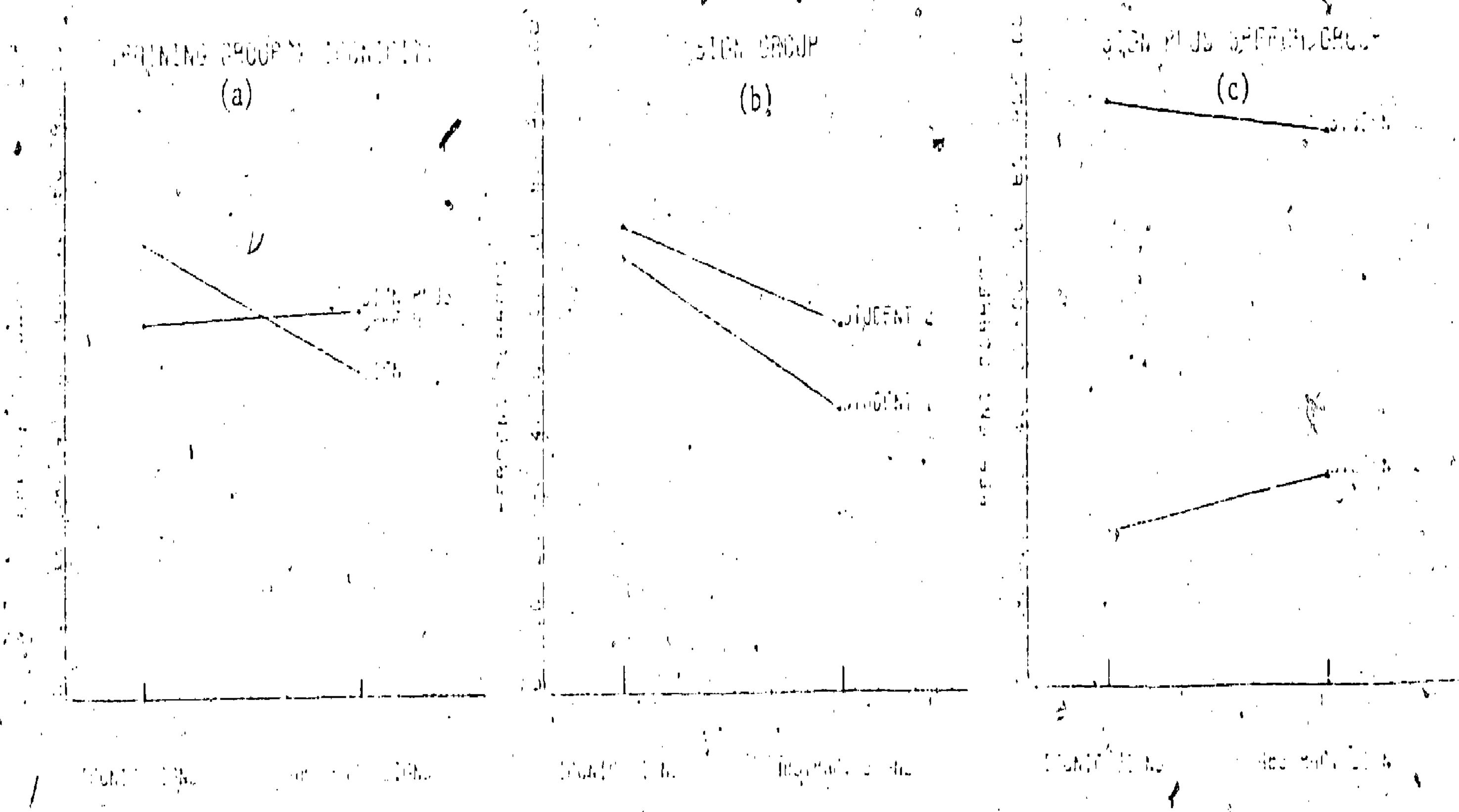

Figure 5. Mean percent correct formation of iconic and abstract signs (a) in each training group, (b) by individual students receiving training with signs only, and (c) by individual students receiving training with signs plus speech.

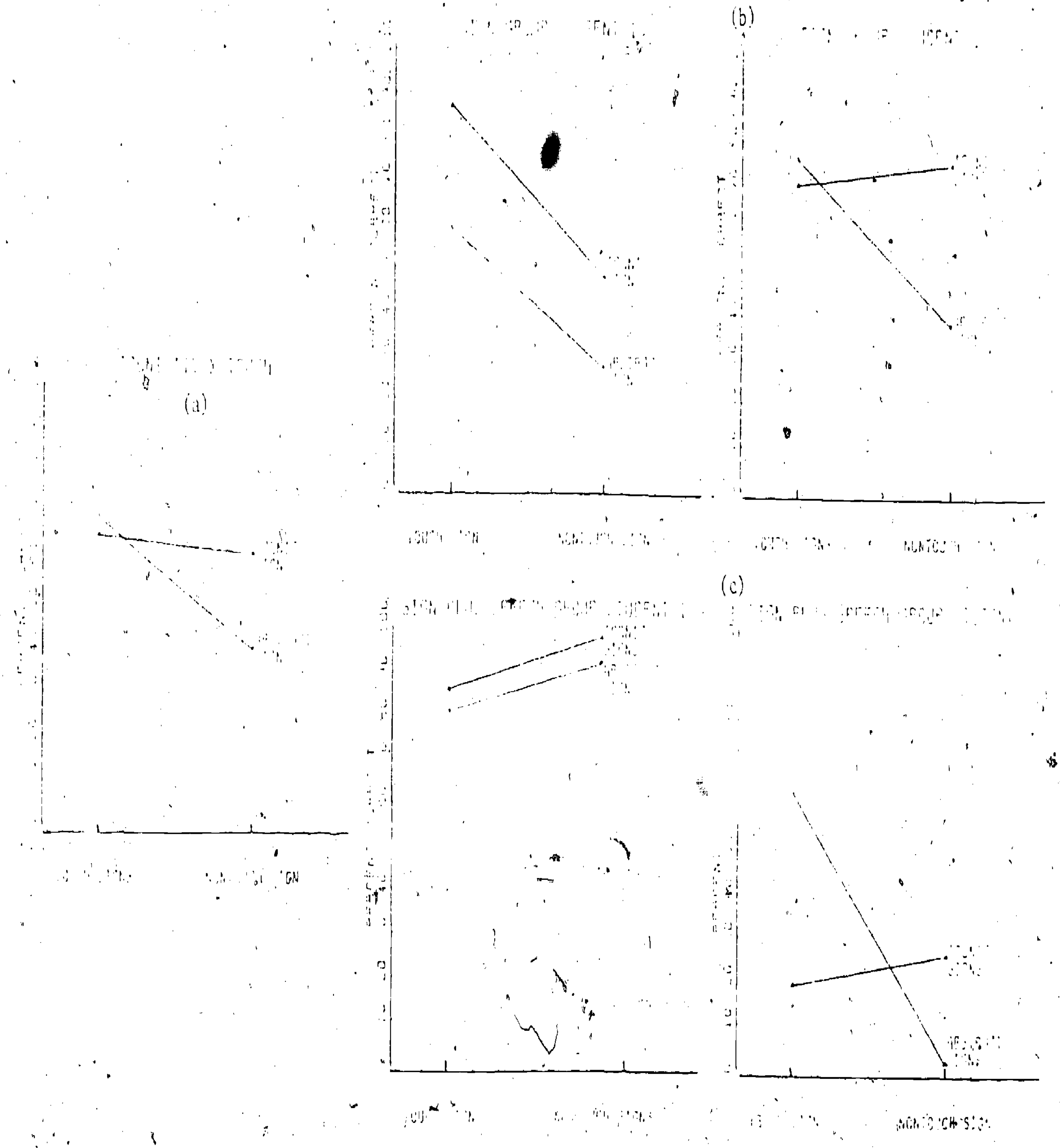

Figure 6. Mean percent correct formation of touch and nontouch signs according to their level of iconicity (a) overall, (b) by individual students receiving training with signs only, and (c) by individual students receiving training with signs plus speech.