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To the Graduate Council:

I am submitting herewith a dissertation written by Irving King Jordan, Jr. entitled "The Referential Communication of Facial Characteristics by Deaf and Normal-Hearing Adolescents." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy with a major in Psychology.

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We have read this dissertation and recommend its acceptance:

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Vice Chancellor for
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THE REFERENTIAL COMMUNICATION OF FACIAL CHARACTERISTICS BY DEAF AND NORMAL-HEARING ADOLESCENTS

A Dissertation

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

by

Irving King Jordan, Jr.

August 1973

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ABSTRACT

In order to assess the characteristics of the manual communications of linguistically adult deaf individuals, six pairs of deaf adolescents and 24 pairs of normal hearing adolescents described photographic referents in a referential communication setting. The referents were photographs of people's faces, selected in a preliminary recognizability study to insure a range of difficulty from easily recognizable to almost chance recognition.

Although the design was essentially exploratory and descriptive, there are several noteworthy results: (1) There was no difference between the two subject groups in the accuracy with which they communicated. Both groups scored extremely high. (2) The deaf group had a significantly faster rate of cue presentation. In other words, the deaf subjects managed to include more cues per unit of time than the normal hearing subjects. (3) The uncertainty ratio measures of the deaf subjects were significantly higher than those of the normal hearing subjects. That is, there was less intra-group, inter-subject cue commonality for the deaf subjects. (4) Analysis of the content of the descriptions showed that the deaf and normal hearing subjects included the same features in much the same order in their descriptions. (5) A comparison of the within-group correlations showed a striking difference between groups as far as the overall pattern of these correlations, suggesting a different underlying approach to the task.

It appears, then, that for real-life-like stimuli such as those used in this study, the manual communications of linguistically adult deaf subjects are as efficient and successful as the verbal communications of the normal hearing subjects. While it was found that the two groups "talk about" much the same things, there is less intragroup commonality for the deaf subjects.

Some interesting findings concerning the amount of fingerspelling used and the conserving of motions while signing are presented along with examples showing the difficulty of translating a signed utterance to written English.

It is suggested that a referential communication setting might not be a valid tool for studying the limits of a language without making the setting artificial, and some follow-up studies are outlined.

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CHAPTER I

INTRODUCTION

Linguistic and psycholinguistic researchers have only very recently shown an interest in sign language. There are, however, several examples of sign language studies in the literature relating to the education and rehabilitation of deaf people. Sign language is basically a system of gestures sometimes supplemented by finger-spelling. Contrary to common belief, sign language is not merely gestural English--it is a language in its own right with its own syntax, idioms and lexicon and its own strengths and weaknesses. Educators of the deaf have traditionally been divided sharply as to whether or not sign language should be used in the teaching of deaf children. Regardless of whether a child's formal education is strictly oral or if signing is allowed, however, when he reaches adulthood it is virtually certain that his first language will be sign language.

Several studies (e.g. Stuckless and Birch, 1966; Meadow, 1968; Vernon and Koh, 1970; 1971) were designed to study the effects of early exposure to sign language on later language (English) development, academic achievement, and speech and lipreading proficiency. These studies showed that deaf children from homes where they were signed to (and around) by parents from birth onward showed equal or higher academic and social achievement than children from oral environments. Other studies of sign language have attempted to answer the question of what method of classroom instruction (speech vs. sign language vs. fingerspelling) is most productive. Johnson (1948) concluded that fingerspelling was more understandable than speech, and Klopping (1972) found signing to be the most intelligible communication mode followed by fingerspelling which was better than speech.

Studies of sign language syntax and structure were begun with the now classic "Sign Language Structure," of Stokoe (1960). In this monograph, Stokoe analyzed sign language cherology (chereme is the sign language analogue of phoneme, thus cherology is analogous to phonology) in great detail and introduced methods for analyzing sign morphology and syntax. Stokoe was the first researcher to study the structure of American Sign Language *per se*. He has shown how the elements contrast with each other, can combine with one another in certain ways but not others and that these combinations are governed by an abstract set of rules. In short, he has shown sign language to be a real and complete language worthy of the attention of scientific research. While Stokoe has continued his research (e.g. 1969-70; 1972b; 1972c), different approaches to the study of sign language have also appeared. Schlesinger and his associates at the Hebrew University of Jerusalem (Schlesinger and Peled, 1968; Shunary and Miransky, 1970; Schlesinger, Presser, Cohen and Peled, 1970) have developed a classification system for Israeli signs and have shown how a great many signs are iconic in nature by pointing out the relationship between the sign and its referent. Their work was designed to investigate the potentialities of a manual-visual communication system for use in the rehabilitation of deaf people.

Some interest has also been shown in the acquisition and development of sign language. Tervoort (1961) filmed and decoded early communications between deaf children. He concluded that, for the most part, these communications are made up of natural gestures which are esoteric in nature. The children more or less built their own private communication systems which disappeared when they grew up and went their separate ways. He argues that a visual communication is intrinsically inferior to a verbal one. Bellugi (1972; Bellugi and Klima, 1972) has begun a program in which she plans to observe and record the earliest signing of deaf children of deaf parents much as she did with normal hearing children (Brown and Bellugi, 1964). Hoemann (1972), working with children 11 and younger, has investigated the development of communication skills in deaf children and then compared these skills with the skills of normal hearing children of the same ages. He found that the performance of the 11 year-old deaf children was comparable to the 8 year-old children with normal hearing, i.e. there is a three year lag in communication skills.

Often, when a congenitally deaf child of normal hearing parents enters a state school for the deaf at age five or six, he has virtually no language. It is not surprising then, that at age eight (or eleven) there is still a communication lag. However, by late adolesence, a deaf person has usually become competent in sign language, and, one would expect, more skilled in his communicative abilities. It seems worthwhile to ask if linguistically adult (post adolescent) deaf individuals competent in sign language can communicate with one another with facility comparable to the verbal communications between linguistically adult normal hearing individuals.

In pilot work at the Tennessee School for the Deaf, it was found that linguistically adult deaf adolescents communicated quite well in peer-to-peer settings when the referents to be communicated were photographic exemplars of everyday objects, e.g. cars, trees, houses. This finding seemed to be at odds with Hoemann's conclusion "that deafness constitutes a handicap in peer-to-peer communication even with manual methods (1972, p. 1001)." His work was done within a referential communication setting which introduced more experimental constraint than has usually been the case in studies of sign language.

There are several examples of referential communication-type studies in the psychological literature. A basic experimental procedure, used first by Carroll (cf. Osgood and Sebeok, 1965, p. 200), has been used recently most notably in the work of Krauss, Glucksberg and their associates (e.g. Krauss, 1968; Krauss and Glucksberg, 1969; Glucksberg and Krauss, 1967; Krauss and Rotter, 1968). In their research, communicators work in pairs and describe referents to one another while separated by a screen. Most of their work has been designed to study the <u>development</u> of communication, and their subjects, therefore, have for the most part been children. The basic design has been to provide one subject, the sender, with a wooden block on which there is a printed design. The sender then stacks the block on a wooden peg and describes it to his partner who chooses one of a set of blocks in front of him and puts it on his peg. The sender is given one block at a time until he has described six, and the object of the problem is for the two to end up with an identical order of block-designs. One of the findings reported was that alert, clever kindergarten children are unable to do the task. These children also fail to improve at all with practice. The authors conclude that the children fail not because they are language deficient, but because they have not yet learned to use language in a social way; they use a "private language." Krause, et al. suggest that there is a communicative ability which develops separately from and following general linguistic ability.

Other researchers (e.g. Rosenberg and Cohen, 1966; Cohen and Klein, 1968) have used similar referential communication designs. There are many advantages to a design such as these. For one thing, the task provides an analog to normal language use, and therefore allows generalization to normal language. Perhaps the most important advantage is the ease with which one can decide whether or not the communication is adequate, i.e. whether or not the partners "understand one another." If the referent chosen by the receiver is identical to that described by the sender, one can say that an accurate communication has taken place. In short, communication accuracy can be measured quite precisely.

Mehrabian and Reed (1968) have identified five factors which can be considered as the independent variables in determining communication accuracy. There are attributes of: (1) the communicator, (2) the addressee, (3) the channels, (4) the communication and (5) the referent. Communicator and addressee attributes are any temporary or permanent states or characteristics of the individuals who are communicating.

A channel attribute is a situational setting or modality attribute which can effect the communication. Communication attributes are any qualities of the communication itself, and finally, referent attributes are qualities of the object to be communicated. When comparing the communications of two different groups, referent attributes are eliminated most simply by making them identical for the two groups. The communicator, addressee and channel can then be varied and the resulting communications can be studied.

The investigation reported here was designed to compare the manual-visual communications of linguistically adult deaf individuals with the verbal-auditory referential communications of linguistically adult individuals with normal hearing. The experimental setting was the previously mentioned standard referential communication setting reported often with normal hearing subjects (e.g. Krauss, 1958; Rosenberg and Cohen, 1966) and used by Hoemann (1972) with deaf children. The referents to be communicated were photographic stimuli. The most important reason for using photographic stimuli was to minimize the artificiality of the experimental setting. Pilot work with deaf adolescents showed them to be much more interested in the task and thus more motivated when the stimuli were photographs of real objects or persons rather than more abstract stimuli such as geometric shapes, colored cards or playing cards. By beginning with a great many photographs and sorting on various bases, it is possible to introduce a great deal of variation and control into the stimuli sets.

Pilot work with deaf adolescents made use of some photographic stimuli in a referential communication study. These photographic sets were pictures of parked cars, pictures of people walking and pictures of trees. It was found that when asked to communicate photographs of referents for which there is a common sign or a commonly known label without a sign, the deaf subjects simply signed or spelled the label. A question which presented itself at that time was how much of a handicap, if any, would the absence of conventional labels or ambiguity in a referent impose on deaf persons communicating manually? A codeability experiment using photographs of faces (Fridja and Van De Geer, 1961) showed most facial expressions to be very ambiguous and difficult to label. Some of the stimuli used by Hoemann (1972) in his study were line drawings of faces, but most of these were readily associated with a specific emotion. Photographs of different faces provide both a variety of cues which do have conventional labels, e.g. hair color and length, and a variety of cues without conventional labels, e.g. facial expressions and the shapes of hair contours. For this reason, photographs of faces were used as stimulus materials in the present investigation.

Since the purpose of this study was to compare verbal and manual communications, hearing subjects were restricted to using only the verbal and vocal channels by not allowing them to have visual contact with each other during the session. The deaf subjects were instructed to use whatever means they wanted to communicate. Beyond the physical limitation of being unable to make use of the verbal-vocal channel, then, they were unrestricted.

The presence or absence of receiver-sender feedback has been shown to exert a strong influence on the length and content of a communication (cf. Maclay and Newman, 1960). In order to control for this, hearing subjects were instructed that they were not to ask any questions while acting as receivers. Deaf persons are very sensitive to the slightest visual cues and it was found in pilot work that a quizzical expression, as little as a lifted eyebrow, could add a great deal to a sender's message. Therefore, the deaf subjects were told to remain as expressionless as possible, and were practiced under experiment-like conditions for three one hour sessions each. During the actual test session, the experimenter and both other observers who assisted by filming the session watched carefully for any communication from receiver to sender.

Once the experimental setting and stimulus materials were selected, it was decided to divide the communications into two types: (1) those in which the sender has knowledge of the receiver's alternatives, and (2) those in which he has no knowledge of the receiver's alternatives. Olson (1970), in a paper outlining a communication-based semantic theory, has shown how a message can change drastically depending on whether or not the sender has knowledge of the receiver's set of alternative choices. He demonstrated how a referent is not named, *per se*, but is described in relation to a perceived or an inferred set of alternatives. This variable was introduced to find if any differences in the approach to the problem exist between groups.

In this experiment, an attempt was made to produce a situation in which very natural communication could take place. The subjects worked in pairs, were motivated to communicate and were provided with very real-life-like referents to communicate. The experimental method also avoided the circularity which is always present in a natural communication setting, i.e. the referent can be defined only from the communication itself. Here, the referents are objectively defined before communication takes place. Also, in uncontrolled observation of naturally occurring communication, it is very difficult and often impossible to estimate the adequacy of communication. Here, communication accuracy is determined simply by the success or failure of the receiver to find the correct referent among the alternatives.

The research reported here has been designed as a first attempt at assessing the ability of linguistically adult deaf subjects to communicate effectively in peer-to-peer settings using unrestricted manual communication methods. Because there is no reported research designed to investigate the abilities of adult manual communicators to understand one another, it was not known how deaf subjects would approach the task. Given this lack of basic information, the referential communication paradigm employed has the advantage of allowing the collection of many different types of data (e.g. communication accuracy, communication length [both in time and number of signs] and communication content) which should provide enough information for a preliminary evaluation of what occurs when the communications take place.

CHAPTER II

METHOD

Subjects

Normal hearing subjects were freshmen and sophomores at the University of Tennessee, enrolled in introductory psychology. Participation in the experiment was voluntary. Forty-eight subjects were run in pairs, each subject acting as sender of a message 12 times and as receiver of a message 12 times. Deaf subjects were 12 advanced academic students from the Tennessee School for the Deaf, matched by age with the normal hearing subjects. The 12 represent all of the available advanced students who met the following criteria: (1) were prelingually deaf, i.e., deaf before 18 months of age, (2) had hearing losses of at least 80 dB (ISO), pure tone, in the better ear, and (3) were of average or above average intelligence as measured by the WAIS performance scale. The 12 subjects were run in six pairs.

Stimuli

Stimuli were 3-1/2 X 5 inch black and white photographs of faces taken face on, full frame, from the top of the shoulders to the top of the head. There were 72 male and 72 female photographs, divided into 4 arrays of 36 photographs each. These photographs were part of an original set of 345 photographs collected of student, faculty and staff volunteers, and were selected by the following procedure:

First, a subset of 260 pictures was selected by eliminating all those which, in the opinion of two judges were unique or very different from the others. For example, pictures with outlandish facial expressions and all females wearing glasses were removed. The remaining pictures were then divided into male and female sets and were presented to 74 undergraduate students. Their task was to divide each group into two categories using whatever criterion they chose to make their decisions. Photographs of male faces were regularly divided into two distinct groups. Although these groups were given somewhat different names by the majority of sorters (e.g. hippie vs. straight, liberal vs. conservative, freaky vs. Joe College, dirty vs. clean) the members of the two groups were consistently the same. One group consisted of pictures of long-haired, not well-groomed individuals with beards and mustaches, and the other consisted of pictures of short-haired, well-groomed individuals. Three judges then reduced the two groups of male photographs to arrays of 36 by eliminating those which were least like the others. Several decisions rules used by the judges were based on the characteristics of the picture sample. For example, all those males with very light colored hair were eliminated from both groups because there were very few examples of light-haired males among the photographs. Those males with neat, well-trimmed facial hair which were included in the long-haired group by the sorters were removed for similar reasons. All men wearing dark lensed glasses were removed. In general, those photographs which in the opinions of the judges were highly idiosyncratic or unrepresentative of the array were removed. The array made up of long-haired males was labeled A, and the short-haired male array was labeled B.

The female photographs were regularly divided by the subjects on the basis of hair length, therefore, it was decided that one female array (array C) would consist of 36 photographs of long-haired females. The same three judges responsible for selecting arrays A and B removed all very light-haired female photographs and those photographs which had any outstanding (i.e. both unique and highly salient) features, e.g. obvious false eyelashes, heavy make-up, braces on the teeth, hair ribbons, heavy freckles. gaudy earrings and hair which covered much of the face. For the final array (array D), one female volunteer posed for 72 photographs. In these pictures, her hair was styled in three different ways. From the 72, the three judges chose a final array of 36 such that there were 12 pictures each of the three different hair styles. The judges attempted to match facial expressions such that for most of the 36 photographs, there was one similar facial expression which appeared three times, each time with a different hair style.

The arrays were constructed so that they varied in homogeniety. Graduate student volunteers could more easily identify those males with facial hair and long hair styles after a brief exposure, than they could the short-haired males. Likewise, all male photographs were more easily identified than photographs in the long-haired female array, and these, in turn, were more easily identified than any of the 36 pictures of the same female.

A pilot study using graduate student volunteers was run to determine which of the array photographs would best serve as targets. These volunteers viewed each of the photographs tachistoscopically and then tried to find the correct photograph from among the array. From each of the four arrays, 12 pictures which varied from easily recognizable to very difficult to recognize, were selected as possible targets. These 48 photographs were then used in a tachistoscopic recognition experiment in order to determine which of the photographs were easiest and which were most difficult for subjects to discriminate from other photographs in the arrays. Each photograph was presented to 24 normal hearing subjects tachistoscopically at an exposure time of 250 msc. and a luminosity setting of 1100 on a standard Scientific Prototype two arm tachistoscope with a 100 msc. blank field, luminosity setting 250, immediately following exposure. These duration and intensity values were chosen as optimal exposure parameters on the basis of the pilot study with graduate student volunteers. These values were found to yield a distribution of errors across pictures ranging from nearly perfect recognition to nearly chance recognition. This pattern of errors was necessary to ensure that photographs of varying recognizability could be sampled in the study. After the picture was exposed, the subject remained seated looking at a darkened field for 30 seconds in order to allow any purely visual image or after image to fade completely. After 30 seconds, the experimenter led the subjects from the small tachistoscope room into a larger room where the arrays were arranged on display boards which were placed on tables. Order or presentation of photographs was randomized, as was the order of pictures within arrays. The photographs were presented in the same way to six deaf subjects, and a Pearson product-moment correlation of the percentage of pictures correctly discriminated between the two groups of subjects for the same pictures was .57 (df=46, $p < .01$). Identification of the photographs ranged from 8% correct to 100% correct for the normal hearing subjects and from 17% to 100% correct for the deaf subjects. Dividing the identification percentages into quartiles, it was found that 12 photographs were 100% or 93% correct, 12 were 83% or 75% correct, 12 were 67% or 58% correct, and 12 were correct 50% or less.

In selecting the final set of 24 target pictures, six pictures were taken from each of the four levels of discriminability and six from each of the four arrays. Thus, each array contained three target pictures from one discriminability level and three from another (see Table I).

The tachistoscopic recognition procedure and the other procedures used in selecting the final set of 24 target pictures were designed simply to insure that a representative sample of target photographs would be used in the final communication task. No attempt was made to scale photographs rigorously in terms of recognition difficulty since the main thrust of this study was a comparison between deaf and normal hearing communications rather than a direct assessment of relations between the characteristics of pictures, communications, and communicators.

Procedure

Subjects were run in pairs. When the subjects entered the experimental room, they were asked to take either of two seats at

TABLE I

TARGET PICTURE SELECTION MATRIX

Arrays	Discrimination Level 100% - 93%	83% - 75%	67% - 58%	50% or below
A	3	3		
B	3		3	
C			3	3
D		3		3

opposite ends of a table. The array boards were high enough that they also acted as screens which prevented the hearing subjects from seeing each other during the session in order to prevent any nonverbal communication between subjects. Deaf subjects were seated such that they could see one another and the arrays. The subject who took the seat to the experimenter's left was designated as A and the one to the right as B. Instructions (see Appendix A) were then read aloud to the hearing subjects and read aloud and signed by the experimenter in Signed English to the deaf subjects. After answering any questions that the subjects had, the experimenter presented them with practice arrays of nine photographs each. Subject A was told that subject B's array was identical to his, although the order on the display board was different. It was found that normal hearing pilot subjects while acting as receiver checked the array while listening to the sender's communication. Since deaf subjects cannot do this but must watch the sender, for the hearing subjects, subject B's array was kept covered with a piece of poster board while subject A communicated. Subject B then indicated to the experimenter which of the array he thought was the correct photograph. The experimenter told the subjects only "right" or "wrong," no other feedback was given to them, and they were not permitted to ask any questions of each other or to communicate in any way except when the sender was describing a photograph. Subject B was then asked to describe a practice picture to A, and A indicated to the experimenter which he thought was correct. After this practice session, the experimenter again asked if there were any questions. After answering any questions, or if there were none, the experimenter began the session.

In order to control for any differences between arrays, picture presentation orders for the communication study were varied such that there were six different orders of presentation. Each array appeared in each ordinal position at least once and never more often than twice. The complexity of the task and the limited availability of deaf subjects made it impossible to completely counterbalance orders. The orders of presentation are presented in Table II.

There were two communication conditions, a Knowledge Condition in which the sender would face an array of 36 photographs which contained the target and which was identical to the receiver's array, and a No Knowledge Condition in which the sender was presented with only a target picture and did not know the characteristics of the receiver's array. All photographs were described in both the Knowledge and No Knowledge Conditions across subjects.

The session was divided into eight trials of three photographs each, each subject communicating 12 photographs, three from each array, six in the Knowledge Condition and six in the No Knowledge Condition. In the No Knowledge Condition, the subject was simply handed the target picture by the experimenter before he began his description. In the Knowledge Condition, the subject was handed the target picture, was reminded that the receiver's array was identical to his except for the order of pictures on the display board, and was asked to match the picture with its mate in his array before describing it. This step not only proved to the experimenter that the sender could discriminate the picture before describing it, but prompted him to compare it with

TABLE II

ARRAY PRESENTATION ORDER FOR THE COMMUNICATION STUDY

Presentation Order					
1	2	3	4	5	6
A	D	C	B	B	C
B	C	A	D	C	D
C	B	D	A	A	B
D	A	B	C	D	A

the others in the array. Of the 36 subject pairs, none ever failed to match any photograph correctly. The subjects described the photographs three at a time in the order A, B, B, A, A, B, B, A, alternately No Knowledge and Knowledge. Thus, when describing a photograph in the No Knowledge Condition, the sender had never before seen the entire array. After the eight trials, which were recorded on audio tape for the normal hearing subjects and on video tape for the deaf subjects, the experimenter debriefed the subjects by reading them questions about their communication strategies and their thoughts about the different experimental conditions (see Appendix B).

CHAPTER III

RESULTS

Communication Accuracy

The first analysis made of the communication data was a simple tabulation of the number of errors for each subject and picture, i.e. a measure of communication accuracy. For the deaf subjects, the range of errors per subject pair was 3-10 with a mean of 4.83, and for the normal hearing subjects, the range was 0-8 with a mean of 3.96. The difference between groups was not significant (t=.85, df=28, p>.20). Next, the errors for each picture were summed across subjects and divided by the number of subjects, providing percent correct values for each target picture. This summation was done separately for the Knowledge Condition and the No Knowledge Condition and for the total data. A sign test showed that there was no difference between the two groups for both the total percent correct and for the percent correct in the Knowledge Condition (total, N=22, p=.42; Knowledge, N=16, p=.40). In the No Knowledge Condition there was a difference with a p value of .09 (N=21) in favor of the deaf. Apparently, the deaf subjects did at least as well as the normal hearing subjects in communicating effectively in this task.

The relationship between conditions was then checked for both groups by first calculating a correlated t test within groups on the number of errors made by each subject pair in the two conditions. For the deaf subjects, t=.26 (df=4, p>.20), and for the normal hearing subjects, t=1.28 (df=22, p>.20). Thus, in neither group is there a significant relationship in the number of errors made in the two conditions. Second, the pattern of relationships between the percent correct in the Knowledge Condition and the percent correct in the No Knowledge Condition was looked at by correlating the two. For the normal hearing subjects, the two conditions correlated very highly, $r=.64$ ($df=22$, $p<.01$), but for the deaf subjects, there was virtually no correlation, $r=.03$ ($df=22$, $p>.20$). The errors made by the deaf subjects are apparently distributed more randomly than are those made by the normal hearing subjects.

Cue Analyses

Typed transcripts for each subject pair in both groups were derived in the following manner: For the normal hearing subjects, one transcriber sat and listened to the tape and wrote a verbatim transcription. This was then typed in draft form and another person listened to the tape while reading along with the draft; any changes were noted, and a final transcript was typed. For the video tapes of the deaf subjects, there was a pool of four judges, all competent signers and one of whom was congenitally deaf and a native signer. Three of the four, in various combinations, watched each film together. The meaning of each sign, fingerspelling and gesture was discussed among the group, and the resulting transcripts represent interpretations agreed upon by all three judges.

The next step was to reduce each transcript to lists of cues. This was done by extracting just the informational cues used by each subject in describing each picture. For instance, if a normal hearing subject said, "Well, um, O.K., it's a . . . um . . . girl, a pretty girl, um, with, um, . . . long hair . . . ." The cues extracted would be: (1) girl, (2) girl, pretty and (3) hair, long. Likewise, if a deaf subject signed, "Boy use glasses, black glasses . . ." the cues extracted would be: (1) boy, (2) glasses and (3) glasses, black. This analysis was done by a group of three judges. Before the analysis, the three met and discussed the procedure to be used and had a lengthy practice session. A check on the reliability of the extraction of cues was made by having the judges analyze the same transcripts at the end of the practice session. The procedure was very straightforward and agreement was almost perfect. After the practice session, the three did their analyses independently. Each communication was also timed. For each subject pair, then, there were 24 cards on which were recorded: (1) the cues used in the description, (2) the length of the description in seconds, and (3) the length of the description in number of cues.

From the length notations on the cue cards, for each group, a matrix of the number of cues used, picture by subject was made. Then, by dividing the number of cues by the number of seconds and multiplying by 60, a second matrix was generated for each group, a matrix of cues per minute, picture by subject. Summing across pictures in the cues per picture matrix resulted in a mean number of cues used by each subject pair. These values were correlated with the percent correct values for each subject, obtained by dividing the number of correct pictures by 24. For the normal hearing subjects, $r=.55$, indicating a direct and significant ($df=22$, $\underline{p}<.01$) relationship between the number of cues used and successful communication. For the deaf subjects, $r=.39$, indicating a trend in the same direction, which was not significant ($df=4$, $p>.20$).

Both the cues/picture and cues/minute matrices for both groups were then summed across subjects resulting in the mean number of cues used for each picture, and the mean cues/minute for each picture. Here, again, there were three values for each matrix, a total mean, a Knowledge mean and a No Knowledge mean. The number of cues used to describe each picture was correlated very highly between groups, $r=.75$ ($df=22$, $p<.01$). It seems, then, that the characteristics of the pictures themselves apparently determine for both groups how much is said about them. It was also found that the deaf subjects used significantly fewer cues ($N=24$, $p<.001$ by sign test) to describe the pictures and take much less time to do so than the normal hearing subjects. It follows that the deaf have a significantly faster rate of cue presentation, i.e. cues/minute ($N=24$, $p<.001$ by sign test). For this task, the manual communications of the deaf subjects were very efficient.

Next, from the cue cards, cues were separated into five categories for the descriptions of the pictures of the males. These categories were: (1) facial cues, which included such things as smile, frown, eye color, etc.; (2) hair cues, cues which pertained directly to the hair; (3) facial hair cues, which included beards, mustaches and sideburns; (4) clothing cues and (5) a miscellaneous category which included such things as posture, direction of gaze and gross comparative cues, e.g. "looks like Mrs. Jones." For the descriptions of the female pictures, the categories were the same minus the facial hair category. These categories represented the major clusters of cue content. The miscellaneous category accounted for less than 15% of all cues across pictures and subjects. The total number of cues within each category across subjects was recorded in a picture by category matrix for each condition for both subject groups. These numbers were then converted to percentages and a comparison of conditions within each group was made by correlating the Knowledge and No Knowledge matrices cell by cell. For the normal hearing subjects, the two conditions correlated at the .88 level, and for the deaf subjects, at .85. Clearly there is no difference between conditions as far as these category measures. Because the two conditions correlated so highly for both groups and in order to facilitate a comparison between the groups, the Knowledge and No Knowledge matrices were collapsed into one total matrix and again converted to percentages for both groups. These total matrices are presented in Table III for the normal hearing subjects and Table IV for the deaf subjects. The two matrices were then correlated, and the correlation between groups was r=.88. At least with respect to these general categories, then, the deaf and normal hearing subjects talked about substantially the same things when describing the pictures.

A distributional analysis of the cues used was made by deriving frequency distributions of cues from the categories by simply ordering the cues in terms of their frequency of occurrence. The analysis was

TABLE III

TOTAL PERCENTAGES OF CUES USED PER CATEGORIES
FOR EACH TARGET PICTURE, NORMAL
HEARING SUBJECTS

Target Pictures	Face	Hair	Facial Hair	Misc.	Clothes
A1	29	25	20	10	16
A2	34	32	19	9	5
A4	41	28	6	12	13
A14	31	31	2	18	18
A19	30	34	17	11	9
A31	40	19	15	15	11
B1	39	28	0	13	19
B14	28	37	9	13	12
B24	34	27	12	10	17
B30	31	18	15	15	21
B31	24	25	20	13	17
B32	33	34	3	14	16
C4	48	35		14	3
C7	28	33		14	24
C17	29	36		18	18
C18	41	38		18	3
C23	36	35		17	12
C26	40	27		15	18
D9	35	38		13	13
D14	54	27		15	4
D15	34	32		21	14
D16	41	37		16	6
D30	36	26		19	19
D36	34	26		24	16

TABLE IV

TOTAL PERCENTAGES OF CUES USED PER CATEGORIES FOR EACH TARGET PICTURE, DEAF SUBJECTS

Target Pictures	Face	Hair	Facial Hair	Misc.	Clothes
A1	20	20	30	4	25
A2	28	28	30	6	7
A4	42	19	7	20	12
A14	19	32	2	22	25
A19	24	27	18	18	13
A31	33	23	16	14	13
B1	25	27	0	18	30
B14	17	38	8	11	13
B24	36	23	9	9	22
B30	28	13	15	17	27
B31	16	29	19	9	26
B32	18	34	5	27	15
C4	51	38		9	2
C7	25	32		14	28
C17	20	45		10	25
C18	53	37		8	1
C23	33	32		20	15
C26	29	33		10	28
D9	38	38		8	17
D14	50	32		4	14
D15	32	41		13	14
D16	51	30		14	5
D30	42	27		18	13
D36	30	34		27	10

done by the same three judges who derived the categories. Cues which the judges decided were meaningfully the same were grouped together in the frequency distributions. For example, the cues "guy," "boy," and "man" were all tabulated as "reference to sex," and "black hair," "dark brown hair," and "dark hair," were all tabulated as "hair, dark color." Interrater reliabilities were checked in all three combinations of two. Percent agreement was always 83% or above.

Uncertainty Measures

For each distribution, an uncertainty measure was calculated. Uncertainty is an information theory measure which takes into account both the number of cues given and the variability of those cues. In this case, uncertainty would be at a maximum if there was no commonality across subjects, that is, if each cue was unique, and it would be at a minimum if for a given picture one and the same cue was given by all subjects. Because the Ns differed, especially across subject groups, the uncertainties are expressed in uncertainty ratios, i.e. the obtained uncertainty divided by the maximum possible uncertainty for an N of that size. The higher the uncertainty ratio, the more variability in the distribution. For both the Knowledge and the No Knowledge conditions, the uncertainty ratios of the deaf subjects were significantly higher ($N=24$, $p<.001$ by sign test) than those of the normal hearing subjects. The uncertainty ratios for both subject groups, Knowledge Condition are presented in Table V, and those for the No Knowledge Condition are presented in Table VI. Looking at Table V, it can be seen that of the four times that the uncertainty ratios of the

TABLE V

DEAF AND NORMAL HEARING SUBJECTS' UNCERTAINTY RATIOS
FOR THE KNOWLEDGE CONDITION

Target Pictures	Deaf	Normal Hearing
A1	.7643	.7746
A2	.8100	.8019
A4	.8288	.6621
A14	.8968	.7017
A19	.7807	.6701
A31	.7588	.6975
B1	.7786	.7364
B14	.8045	.7773
B24	.8330	.6873
B30	.7736	.5410
B31	.8814	.7365
B32	.8080	.7673
C4	.8046	.7427
C7	.8781	.7473
C17	.7650	.6842
C18	.8545	.6588
C23	.8440	.8055
C26	.9020	.7493
D9	.7015	.6994
D14	.7827	.7237
D15	.7394	.7777
D16	.6389	.7291
D30	.7270	.7251
D36	.6927	.7344

TABLE VI

DEAF AND NORMAL HEARING SUBJECTS' UNCERTAINTY RATIOS
FOR THE NO KNOWLEDGE CONDITION

Target Pictures	Deaf	Normal Hearing
A1	.8369	.6951
A2	.7906	.7473
A4	.8079	.7775
A14	.8416	.7511
A19	.7859	.6498
A31	.8266	.7185
B1	.7706	.7382
B14	.8516	.7834
B24	.7766	.6951
B30	.7940	.6876
B31	.8010	.7367
B32	.8306	.6730
C4	.7868	.7459
C7	.8056	.7612
C17	.8841	.7389
C18	.8253	.8057
C23	.8998	.7681
C26	.8343	.7161
D9	.8210	.7000
D14	.8664	.7117
D15	.6247	.7411
D16	.7393	.7229
D30	.7513	.8322
D36	.7985	.8161

normal hearing subjects are higher than those of the deaf subjects, three occur in the D array. In the No Knowledge Condition (Table VI) all three of the three higher normal hearing group's uncertainty ratios occur in the D array. In other words, the pattern of uncertainty ratios across groups was different for the other three arrays. It is noteworthy that these uncertainty ratios are high for both groups, indicating a lack of inter-subject commonality.

Cue Overlap

As a further check for similarities or differences between groups in the content of the descriptions, overlap coefficients (OC) for each frequency distribution were calculated. The total number of cues occurring in both groups' distributions were noted, and this value was divided by the smaller N. The higher the OC, the more similarity between distributions. Table VII presents the OCs between the two subject groups for both experimental conditions. Because there was a great difference in Ns, it was decided to look also at the overlap between groups for the cues occurring in only the first five ordinal positions. For this analysis, the first five cues of the normal hearing subjects were noted and compared to the first five of the deaf subjects. If a cue occurred in the first five for both groups, it was given a value of one, if it occurred in only one group's first five, it was given a value of zero. These five values were summed and divided by five. The resulting value, a high frequency commonality value (HFC), could range from 0.0 (no high frequency commonality) to 1.0 (perfect high frequency commonality). The HFC

TABLE VII

OVERLAP COEFFICIENTS BETWEEN THE TWO SUBJECT GROUPS

Target Pictures	Knowledge	No Knowledge
A1	.657	.667
A2	.786	.696
A4	.826	.833
A14	.444	.569
A19	.820	.829
A31	.806	.806
B1	.667	.717
B14	.692	.686
B24	.689	.630
B30	.750	.725
B31	.600	.600
B32	.500	.579
C4	.611	.600
C7	.438	.579
C17	.633	.750
C18	.342	.431
C23	.431	.500
C26	.606	.635
D9	.705	.727
D14	.707	.585
D15	.684	.738
D16	.966	.690
D30	.767	.833
D36	.646	.680

values are presented in Table VIII. Examination of Tables VII and VIII provides evidence that there is a great deal of overlap, thus similarity, in the content of the descriptions given by the two subject groups. In other words, given these referents to describe, the deaf and normal hearing subjects talked about much the same things.

Rate of Communication

Several measures (number of cues, rate of communication, recognizability, communication accuracy and uncertainty ratios) were available for comparisons of the properties of communications between groups. All of the possible combinations of pairs of measures were correlated within each group across the 24 pictures--a total of 28 correlations. Although most of these correlations were not significant and yielded little information, there were several which did show profound differences between the deaf and normal hearing groups.

One difference between the subject groups appeared while examining the relationship between the rate of communication factor and the other measures. It was found that when rate of communication was one factor, quite regularly the two groups correlations differed in direction as well as degree. Those correlations which differed most markedly are presented in Table IX. The first three correlations deal with the relationshp between the number of cues used and the rate of presentation. For the deaf group, there is a strong negative relationship in all three of the correlations, indicating that as the number of cues used increased, the rate decreased. The first correlation for

TABLE VIII

HIGH FREQUENCY COMMONALITY VALUES BETWEEN THE TWO SUBJECT GROUPS

Target Pictures	Knowledge	No Knowledge
A1	.4	.8
A2	.8	.4
A4	1.0	.8
A14	.6	.4
A19	1.0	.6
A31	.6	.6
B1	.8	.6
B14	.4	.8
B24	1.0	.8
B30	.8	.8
B31	.6	.8
B32	.8	.8
C4	.6	.6
C7	.6	.6
C17	1.0	.6
C18	.4	.8
C23	.2	.2
C26	.4	.6
D9	.8	.6
D14	.6	.6
D15	.4	.6
D16	.8	.6
D30	.8	.6
D36	.6	.6

TABLE IX

WITHIN-GROUP CORRELATIONS FOR BOTH SUBJECT GROUPS, RATE OF COMMUNICATION

	Normal Hearing	Deaf
1. No. Cues, Total and Rate of Communication, Total	.46	-.40
2. No. Cues, Knowledge and Rate of Communication, Knowledge	.19	-.62
3. No. Cues, No Knowledge and Rate of Communication, No Knowledge	-.07	-.44
4. Rate of Communication, Knowledge and Percent Correct Recognition	.36	-.17
5. Rate of Communication, Knowledge and Percent Correct, Knowledge	.18	-.37
6. U Ratio Knowledge and Rate of Communication, Knowledge	-.19	-.74

the normal hearing group is in the reverse direction, i.e., as the number of cues increased, the rate also increased, and the second and third are close enough to zero to indicate no relationship.

The fourth correlation shows that for the normal hearing subjects, as the rate of communication increased, so did the percent correct recognition, while for the deaf group, the relationship is in the opposite direction but very low. Similarly, for the fifth correlation for the deaf subjects, as rate of communication in the Knowledge Condition increased, percent correct in the Knowledge Condition decreased; and, while the relationship for the normal hearing subjects is low, again it is in the opposite direction. The sixth correlation shows that for the deaf group, the higher the rate of communication the lower the uncertainty ratios. For the normal hearing subjects, the relationship is in the same direction, but much lower.

Fingerspelling

While viewing the films of the deaf subjects' communications, it became apparent that some of the subjects used a great deal of fingerspelling, much more than others. Therefore, the number of formal (i.e. American Sign Language, as defined by Stokoe, *et al.*, 1965 or Fant, 1964) signs and the number of fingerspelled words were tabulated for each description for each subject. Next, for each subject, the total number of signs was divided by the total number of fingerspellings to yield a signs/fingerspellings (S/F) ratio. The higher the S/F ratio, the fewer the number of fingerspelled words in relation to the number of signs. These ratios were then correlated with measures of reading achievement and language achievement levels from the California Achievement Test. The correlation between S/F ratio and reading level was $r=-.43$, and the correlation between S/F ratio and language level was $r=-.45$. The negative relationships indicate that the higher the language and reading achievement levels, the lower the S/F ratio, i.e. the more fingerspelling used. These language and reading achievement levels are, of course, English language levels. It has been argued very convincingly (Stokoe, 1970) that American Sign Language is a language separate from English. It seems to follow that competent signers with poor English ability would tend to use more signing in relation to fingerspelling. The subjects in this study all use sign language as their primary everyday mode of communication; nevertheless, those who were more proficient in English used a great deal of fingerspelling when describing these referents. Since the subjects were unrestricted and uninfluenced by the experimenter as to whether or not to use any particular communication mode, and since they were all proficient signers and fingerspellers, the question of the ratio of signing to fingerspelling when one wants to communicate accurately seems worth further exploration.

CHAPTER IV

DISCUSSION

The results presented here provide evidence that when describing specific referents in a setting which is very much like a natural language situation, deaf and normal hearing subjects talk about much the same things. There is a great deal of similarity in the content of the descriptions of both subject groups. A comparison of Tables III and IV, pages 25 and 26 shows that with respect to gross categories, there is a great deal of similarity of description content between groups. The overlap coefficients (Table VII, page 31) and the high frequency commonality measures (Table VIII, page 33) provide even finer measures of the content similarities. The greatest amount of overlap between groups occurred in the A array pictures. This makes sense because those photographs of long-haired males with facial hair contain the most salient features of all the picture arrays. It is always these features, the big beard, the shoulder-length hair, etc., which rank highest in the frequency distributions for both groups. The least overlap occurs in the C array. This, too, fits in nicely with the above since the photographs of various females, all of whom have shoulder length hair, have the smallest number of salient, differentiating features. The very high HFC values, none of which is zero, indicate that not only is there a great deal of commonality in the description content, but also in the ordering of cues. Although the two groups used different modalities, then, apparently they described the pictures in much the same way.

Another interesting finding in these results is the very high communication accuracy scores of both groups. There was a very small difference between the two groups' mean communication scores, in fact, if the one abberant deaf subject pair (10 errors) was thrown out, there would be virtually no difference at all. This finding seems to be at odds with Hoemann's (1972) results with deaf children, which showed them to be three years behind their hearing controls in communication skills. There are two possible explanations for the difference between the findings of Hoemann's study and those presented here. First, the stimuli which were used by Hoemann were much more abstract than those employed here. For example, one of his stimulus sets consisted of six circles which began at black and went through four shades of gray to white. Another set was made up of six circles filled with dots of varying density. It would seem that a task such as this is not at all analogous to normal language use, especially for young children, and therefore, not really appropriate for measuring normal peer-to-peer communication. Because the task is very artificial, one would expect a higher error rate such as he found. Second, as mentioned earlier, Hoemann's study dealt with eight and eleven year olds. Because of the great language deficit of most entering students at a residential school for the deaf, it is unlikely that after two or even five years they would have caught up to their normal hearing peers in communication skills. The present study provides evidence that for sign-language competent adolescents in a natural setting, the communication ability gap between deaf and hearing is very much smaller, if it exists at all.

It is also of interest to note that while the communications of the deaf subjects were significantly shorter than those of the normal hearing subjects, they were also much faster, and thus, deaf subjects managed to say more in a short time than did normal hearing subjects. This is in direct contrast with the findings of Bellugi (1972) who has suggested that there is a steady temporal rate for propositioning which would remain the same for manual and verbal languages. She suggests further that since signs take longer to produce than words, this temporal rate of propositioning works to shape the language. She talks about the way deaf signers condense a message by getting rid of any words which are not essential to the information of the message, and says that deaf and normal hearing messages are the same length only because this condensation by the deaf communicators takes place. The results here are in disagreement with such a suggestion. Here, the deaf communicators include more information per unit of time than do the normal hearing communicators. Bellugi based her contention on transcripts of a signer's manual interpretation of a written English story. It seems very acceptable to assume that there would be differences between signed utterances which originated as sign (as with those reported here) and signed utterances which originated as verbal English (as with Bellugi's examples). What is not acceptable is to generalize to all sign language from examples of translated English.

The pattern of uncertainty ratios for the 24 target pictures (see Tables V and VI, pages 28 and 29) also pose interesting problems.

If the A, B, and C arrays are considered apart from the D array, only once in 36 times is the uncertainty ratio of the deaf subjects lower than that of the hearing. (Recall, higher uncertainty ratio means lower response commonality.) While the fact that there were only six subject pairs for the deaf group as compared to 24 pairs for the normal hearing group may partially explain the greater number of idiosyncratic responses of the deaf group, an examination of the transcripts offers a more likely explanation. A very common response among the deaf subjects was to compare some feature of the target picture to someone known to both the communication partners. Cues such as "glasses like Mrs. Randall's," "beard like Mr. Williams'," "hair like yours (or mine)" and "boy built about like you," were used quite often by virtually all the deaf subjects. The normal hearing subjects, on the other hand, used such comparative cues only rarely. This could be due to the fact that the deaf subjects all knew each other very well, and therefore had more common acquaintances than the hearing subjects did. In retrospect, it seems that the normal hearing subjects felt more constrained by the task than the deaf subjects did. As a result, perhaps they worked to keep their descriptions within the confines of "an experimental situation." The fact that for the D array the uncertainty ratios were more equally distributed fits well within this interpretation. When the normal hearing subjects were asked to describe the same girl three times in succession, they seemingly worked at finding new cues to include in their descriptions. As a result, the uncertainty ratios for the D array were among the highest for the normal hearing group. The deaf subjects, however, seemed to use the knowledge that the same girl was to be described more than once to their advantage. Virtually all of the high frequency cues used by the deaf subjects were critical to finding the correct picture, and the descriptions were never superfluous. The uncertainty ratios for the D array for the deaf group were the lowest of all the arrays. The deaf descriptions were pragmatic, the subjects seemed to include what information was necessary to identify the correct picture and not much more. Descriptions produced by the normal hearing subjects, on the other hand, appeared to be more artificial and created for the experimental situation.

Another difference between groups is that indicated by the different pattern of within-group correlations shown in Table IX, page 34. The first three correlations point to the fact that for the deaf group, as the number of cues increased, the rate of communication decreased, while the opposite was true for the normal hearing subjects. By comparing the matrix of cues/picture with the matrix of cues/minute, it becomes apparent that those descriptions which had the highest rate of communication were also the shortest. It has already been noted that the descriptions of the deaf subjects tended to be very pragmatic, and it was the most pragmatic descriptions which were at least partially responsible for the above relationship. Often a signer would look at a target picture, then quickly sign an entire description without pausing. Those descriptions which were longer contained more pauses and added to this effect.

The fourth correlation indicates that as the rate of communication in the Knowledge Condition increased for the normal hearing subjects, so did the percent correct recognition. It seems logical that a picture which was easily encodable and recognizable, would also be quickly encodable and describable. However, this relationship did not hold for the deaf group. In fact, although very low, the relationship is in the opposite direction. Similarly, for the deaf subjects, there is a negative relationship between rate of communication in the Knowledge Condition and percent correct in the Knowledge Condition. That is, as percent correct increased, rate of communication decreased. For the normal hearing subjects, the relationship is in the opposite direction but very low.

The correlation between uncertainty ratio in the Knowledge Condition and rate of communication in the Knowledge Condition is negative for both groups, but very high for the deaf group while very low for the normal hearing group. This indicates that as the rate of communication increased, uncertainty ratio decreased. Recall that for the deaf group those descriptions which were shortest also had the fastest rates of cue presentation. It makes sense that there was more response commonality for those pictures with the shortest descriptions. It was possible to keep the descriptions short because there were a few very salient cues, and it was these cues which led to the high commonality, thus, low uncertainty ratios.

Another measure which lends support to this interpretation is the relationship between the number of cues used and the uncertainty ratios in the Knowledge Condition. For the normal hearing subjects, the correlation was .04, but for the deaf subjects, $r=.52$ ($df=22$, $p<.01$). Here, again, as the descriptions of the deaf subjects increase in length, they decrease in commonality.

The rate of communication factor is different for the two groups. This suggests a different approach to the task by the two groups which is at least partially explained by the large number of very short, rapid descriptions used by the deaf subjects. Perhaps when a short and concise description is sufficient, sign language functions very efficiently. As the descriptions become longer, however, proportionally more and more time is required for each additional piece of information. Another contributing factor could be that the shorter descriptions of the deaf subjects had fewer fingerspellings, and signing is much faster than fingerspelling.

The fact that there was a relationship between amount of fingerspelling and standardized language and reading achievement scores raises some interesting questions. One might ask if those who have more of a command of English fingerspell more as a result, or does the fact that a deaf student fingerspells a great deal lead to a better command of English. It is noteworthy that fingerspelling was unnecessary for success in this task. The one subject pair which had the least number of fingerspellings also tied for the fewest number of errors.

Another interesting finding relating to the fingerspelling came to the author's attention while viewing the films in slow motion. Often times, a word is spelled incompletely. One subject repeatedly spelled only s-h-o for the word short and s-i-l for the word smile.

Viewed at normal speed, the spellings look very natural and complete (the fact that some subjects mouth the word while spelling it adds to this). Viewed frame by frame, however, it can be seen that the remainder of the letters are definitely omitted. Tervoort (1961, p. 469ff) has reported that the fingerspellings of advanced manual communicators is "gestalted." He notes how letters which occur in clusters, such as _th_, and _er_ combine into a total and can hardly be distinguished. More than that, in frame by frame analysis, as noted before, some letters do not occur at all. It might be worthwhile to film a great deal of fingerspellings and study them in an effort to determine whether or not there are regularities in the omissions, and, if so, just what these regularities are. In speech, it is not necessary for the whole word to be spoken for understanding to take place. How a word is pronounced is influenced both by what proceeds it and what follows it. It would be interesting to see what influences how a word is fingerspelled.

While viewing the films of the deaf signers, another thing which became immediately apparent was the way in which motions were economized. One phenomenon, which I call parallel transmission is especially interesting. As an example, the sign "brown" is made by taking the _b_ hand, or, as with Stokoe's system (1960), a _b_ _dez_ and moving it up and down while touching the cheek. Here, the cheek is the _tab_, and in order to be made properly, the _dez_ _b_ must touch the _tab_ cheek. Repeatedly, throughout the films, rules such as this were violated in order to save motion. When describing brown stripes on a shirt, one signer used the dez b to trace vertical stripes from the shoulder downward while mouthing brown. Another signer, describing brown, wavy, shoulder-length hair, simply took the b dez and traced wavy hair contours from the top of the head down to the shoulder. This one sign transmits a wealth of information. Not only does the receiver know that the signer is describing hair, but brown, wavy hair that comes down to the shoulder. The signer has taken two different gestures, a formal sign for brown and a tracing of hair contours, usually signed sequentially, and paralleled them, adding embellishments of hair texture and length. Signs such as these are the rule rather than the exception. Another example which occurred quite regularly was the sign for "like" (i.e. similar to). Ordinarily this sign is made by taking a (usually right handed) g dez and bringing it into contact with a left g which acts as tab. Repeatedly, the tab for "like" was whatever body surface was most convenient. One signer, while describing the color of the eyebrows of a target picture, signed the utterance "eyebrows black like glasses" by tracing the eyebrow with her index finger, signing black across her forehead and then with a g dez, twice struck her forehead by the temple. When viewed in slow motion, the two are slightly different signs--in the first she strikes her temple with the last knuckle of the index finger, and in the second, the finger hits the temple more flatly. The index finger and thumb are separated a little more in the second sign. The first sign was meant to be "like" and the second to be "glasses." (The judges were quite sure of this interpretation because along with signing, she clearly mouthed "black, like glasses.") In this case, it was not only more economical to make the "like" sign where the other signs were to be made, but made in this manner, it meant more than "like," it meant "like glasses."

In addition to paralleling signs in this manner, often a signer will make a sign which is not the intended message. For example, in describing a girl, he may sign "pretty." Now, on top of this message, he often will add a meta-message, a message about the message. By assuming a dour facial expression and perhaps by adding a slight shake of the head, he changes the message to "not too pretty a girl." A quizzical facial expression and side to side motion of the head would change the message to "sort of pretty." The receiver must be able to keep all these separate messages sorted out in order for the communication to be successful, and they apparently do this quite easily. All the deaf subjects paralleled signs and embellished them in this manner very easily and naturally, and it appears to be a very real part of a sign language system.

A very common comment by someone who views manual communication for the first time is that a good many of the gestures are very natural and idiographic, and should therefore, be understandable to someone unfamiliar to manual communication. The films of this study, which included so many informal gestures and imitative expressions, were especially open to such comment. These comments suggested a serious and testable question. Were many of the cues used by the deaf subjects "universal" gestures?

In order to test this question, two experimental follow-ups have been designed and carried out. First, in order to test the "universality" of the gestures used by the deaf subjects, normal hearing adolescents, screened to insure no previous knowledge of manual communication, were asked to describe the target pictures in the same way as the deaf subjects had. In other words, they were instructed to use any gestural means at all, but to refrain from using any verbal-vocal transmission. Surprisingly, these subjects did fairly well at communicating effectively (mean number of errors per session was 7.83, range 5-12). Only a very preliminary comparison of the deaf and normal hearing gestures has been made at this point, but thus far, it appears that imitative facial expressions and such obvious features as beards and glasses are much the same for the two groups. Such important chracteristics as hair or eye color and even the gender of the target picture, are totally lacking from the normal hearing gestures.

In order to test the "understandability" of the deaf subjects' communications, another group of normal hearing subjects, again screened to insure no knowledge of manual communication, were presented with the television tapes of the deaf communications. A normal hearing subject simply acted as receiver seated in front of a TV monitor which acted as sender. The subjects did very poorly at finding the correct targets from the arrays (mean number of errors per session 19.16, range 10-24). The general consensus among the subjects was that while the gestures did "look understandable," they provided very little information which was useful to help in selecting the correct target. Although a careful comparison of the gestures used by both groups has yet to be made, it is apparent that a great deal of what is included in manual communication is not "universal," at least not to normal speakers of English.

One purpose of this study was to look at the workability of a referential communication setting with deaf adult signers as communicators. The subjects seemed to take to the task very well, and as has been noted, communicated very effectively. One possible shortcoming is the great mass of transcription data necessary even for these short descriptions. It is interesting to note that one rationale for using a setting such as this given by Maclay and Newman (1960) was that descriptions were very brief and concise. With artificial stimuli such as they used (geometric shapes) this may be true, but with photographs, the descriptions are quite long and detailed. To add to this problem, there is no standard transcription method for translating a signed utterance into written English. No matter how carefully done, there is always the chance that a good deal will be lost in putting a visual language into a printed form. A good example is an utterance generated by one of the deaf subjects when answering a debriefing question of the experimenter. When asked how long she (an 18 year old female) had known her communication partner (another 18 year old female), she responded by placing her thumb in her mouth as a child would thumb suck and lowering her other hand, palm down and horizontal as when signing "small child," then, with her thumb still in her mouth, she raised the child-like sign all the way to her present height. That brief gestures was overwhelmingly meaningful, and I feel it would be all but impossible to translate into English.

A referential communication setting using photographic stimuli such as those used in this study might not be sufficient for measuring the limits of a language. The small number of errors for both subject groups points to the fact that the task was well within the basal level for all the subjects. It might be possible to introduce even greater control into a photographic stimulus set than has been done here. This would be worthwhile, but, it is the author's opinion that increasing the difficulty of referential communication by introducing time or length of utterance limits or by using more abstract stimuli makes the situation so artificial as to prevent generalization to normal language. Experimental settings other than referential communication may ultimately provide more fruitful avenues for exploring the limits of deaf communication.

A shortcoming of the study is the small number of deaf subjects. Unfortunately, the small population of available and appropriate subjects was virtually exhausted by the research reported here. This research was designed as the first step in what the author hopes to be a series of studies investigating the communicative processes of linguistically adult deaf individuals. The next logical step is to utilize more difficult (but still natural and life-like) situations with a much larger group of deaf subjects.

REFERENCES

REFERENCES

Barakat, R. A. Gesture systems. Keystone Folklore Quarterly, 1969, 14, 105-121.

Bellugi, U. Studies in sign language. In T. J. O'Rourke (Ed.), Psycholinguistics and Total Communication: The State of the Art. Washington, D. C.: American Annals of the Deaf, 1972.

Bellugi, U. and Klima, E. S. The roots of language in the sign talk of the deaf. Psychology Today, 1972, June, 61-64, 76.

Brega, Ilana. Perception of sign language of the deaf. Perceptual and Motor Skills, 1970, 31, 426.

Brown, R. and Bellugi, U. Three processes in the acquisition of syntax. Harvard Educational Review, 1964, 34, 133-151.

Brown, R. W. and Lenneberg, E. H. A study in language and cognition. Journal of Abnormal and Social Psychology, 1954, 49, 454-462.

Cohen, B. and Klein, J. Referent communication in school age children. Child Development, 1968, 39, 597-609.

Danks, J. H. Encoding of novel figures for communication and memory. Cognitive Psychology, 1970, 1, 179-191.

Fant, L. J. Jr., Say It With Hands. Washington, D. C.: Gallaudet College Press, 1964.

Fridja, N. H. and Van De Geer, J. P. Codeability and facial expression: An experiment with facial expressions. Acta Psychologica, 1961, 18, 36-367.

Fusfeld, I. S. How the deaf communicate--manual language. American Annals of the Deaf, 1958, 103, 264-282.

Glucksberg, S. and Krauss, R. M. What do people say after they have learned to talk? Studies of the development of referential communication. Merrill-Palmer Quarterly, 1967, 13, 309-316.

Hoemann, H. W. The development of communication skills in deaf and hearing children. Child Development, 1972, 43, 990-1003.

Johnson, E. H. Ability of pupils in a school for the deaf to understand various methods of communication. American Annals of the Deaf, 1948, 93, 194-213; 258-314.

Klopping, H. W. E. Language Understanding of deaf students under three auditory-visual stimulus conditions. American Annals of the Deaf, 1972, 117, 389-396.

Krauss, R. M. Language as a symbolic process in communication. American Scientist, 1968, 56, 265-278.

Krauss, R. M. and Glucksberg, S. The development of communication: Competence as a function of age. Child Development, 1969, 40, 255-266.

Krauss, R. M. and Glucksberg, S. Socialization of communication skills. In R. A. Hoppe, G. A. Milton and E. C. Simmel (Eds.) Early Experiences and the Processes of Socialization. New York: Academic Press, 1970.

Krauss, R. M. and Rotter, G. S. Communication abilities of children as a function of status and age. Merrill-Palmer Quarterly, 1968, 14, 161-173.

Krauss, R. M. and Weinheimer, S. Effect of referent similarity and communication mode on verbal encoding. Journal of Verbal Learning and Verbal Behavior, 1967, 6, 359-363.

Leavitt, H. J. and Mueller, R. A. H. Some effects of feedback on communication. Human Relations, 1951, 4, 401-410.

Maclay, H. and Newman, S. Two variables effecting the message in communication. In D. K. Wilner, (Ed.) Decisions, Values and Groups. New York: Pergamon, 1960.

Meadow, K. P. Early manual communication in relation to the deaf child's intellectual, social, and communicative functioning. American Annals of the Deaf, 1968, 113, 29-41.

Mehiabrain, A. and Reed, H. Some determinants of communication accuracy. Psychological Bulletin, 1968, 70, 365-381.

Moscovici, Serge. Communication processes and the properties of language. In L. Berkowitz (Ed.) Advances in Experimental Psychology, Volume 3. New York: Academic Press, 1964.

Newcomb, T. M. An approach to the study of communicative acts. Psychological Review, 1953, 60, 393-404.

Olson, D. R. Language and thought: Aspects of a cognitive theory of semantics. Psychological Review, 1970, 77, 257-273.

Osgood, C. A. and Sebeok, T. A. (Eds.) Psycholinguistics: A Survey of Theory and Research Methods Problems. Bloomington: Indiana University Press, 1965.

Rosenberg, S. and Cohen B. D. Referential processes of speakers and listeners. Psychological Review, 1966, 73, 208-231.

Rosenberg, B. G. and Langer, J. A study of postural-gestural communication. Journal of Personality and Social Psychology, 1965, 2, 593-597.

Runkel, P. J. Cognitive similarity in facilitating communication. Sociometry, 1956, 19, 178-191.

Schlesinger, I. M. and Peled, T. A faceted classification of signs and their relation to referents. Working Paper #4, The Hebrew University of Jerusalem, Israel, March, 1968.

Schlesinger, I. M., and Presser, B., Cohen, E. and Peled, T. Transfer of meaning in sign language. Working Paper #12, The Hebrew University of Jerusalem, Israel, February, 1970.

Sebeok, T. A. Coding in the evolution of signalling behavior. Behavioral Science, 1962, 7, 430-442.

Shunary, J. and Miransky, L. A. A comparison of adults' and children's signs. Working Paper #13, The Hebrew University of Jerusalem, Israel, January, 1970.

Stokoe, W. C., Jr. Sign language structure: An outline of the visual communication systems of the American deaf. Studies in Linguistics, Occasional Papers #8, University of Buffalo, 1960.

Stokoe, W. C., Jr. Sign language diglossia. Studies in Linguistics, 1969-70, 21, 27-41.

Stokoe, W. C., Jr. The Study of Sign Language. Washington, D. C.: Educational Resources Information Center, Clearinghouse for Linguistics, 1970.

Stokoe, W. C., Jr. A classroom experiment in two languages. MS, Linguistics Research Laboratory, Gallaudet College, 1972. (a)

Stokoe, W. C., Jr. Linguistics, sign language and total communication. MS, Linguistic Research Laboratory, Gallaudet College, 1972. (b)

Stokoe, W. C., Jr. Motor signs as the first form of language. Paper read at AAA, Toronto, Symposium on Language Origins, December, 1972. (c)

Stokoe, W. C., Jr., Casterline, D. C. and Croneberg, C. G. A Dictionary of American Sign Language. Washington, D. C.: Gallaudet College Press, 1965.

Stuckless, E. R. and Birch, J. W. The influence of early manual communication on the linguistic development of deaf children. American Annals of the Deaf, 1966, 111, 452-460, 499-504.

Tervoort, B. T. M. Esoteric symbolism in the communication behavior of young deaf children. American Annals of the Deaf, 1961, 106, 436-480.

Triandis, H. C. Cognitive similarity and communication in a dyad. Human Relations, 1960, 13, 175-183.

Triandis, H. C. Some determinates of interpersonal communication. Human Relations, 1960, 13, 279-287.

Vernon, M. and Koh, S. D. Early manual communication and deaf children's achievement. American Annals of the Deaf, 1970, 115, 527-536.

Vernon, M. and Koh, S. D. Effects of oral preschool compared to early manual communication on education and communication in deaf children. American Annals of the Deaf, 1971, 116, 569-574.

APPENDICES

APPENDIX A

INSTRUCTIONS

The experiment you are about to participate in is designed to explore some of the ways in which people communicate information to each other. The task is not designed to be a test of your personality or communication ability. We are interested most in what you say when you describe something.

In this experiment you will be asked to serve in each of two roles, that of sender of a message and that of receiver of a message. As a sender, you will be shown a photograph of a face, either by itself or as part of a set of 36 photographs of faces. Your task will be to describe the face in such a way that your partner can pick the photograph out of a set of 36. You will be asked to describe 12 photographs to your partner, 6 as part of a set and 6 in isolation. You will also be asked to find 12 photographs that your partner describes.

As a receiver, you will be seated where you cannot see your partner, and after listening to his description, you should try and find the correct photo in the array of 36. You may <u>not</u> ask your partner for any more information or to clarify what he has said. You should say nothing, just listen to the description and try and find the photograph in the array.

In attempting to describe the faces you are given, you may use any information or strategy you want to as long as the information is appropriate to the person in the photograph. Disregard such things as darkness/lightness of the photo or spots and imperfections in the paper. Your partner's photo will very likely not have the same degree of darkness and may not have the same imperfections, so this information would be of no help to him. If by some chance you know the person in the photo, do not identify him, just describe the photo as you would any other. Other than the above restrictions, you may describe the photograph in any way which would help your partner identify it. You may use objective characteristics of the person (e.g. she wears glasses) or subjective impressions (e.g. he is ugly).

As receiver, the photographs will be covered until the sender indicates that he has completed his description. When he finishes, we will remove the cover and you try and find the correct picture.

Before we begin the experiment we will let you practice with a sample so that you can get an idea of what we would like you to do.

We will record your descriptions on this tape recorder so that we can study what you said later. We identify you on the tape only by number, so you will remain anonomyous.

Do you have any questions at all?

O.K., then, we'll start.

APPENDIX B

DEBRIEFING

Subject pair no. _______

Sex of _S_s A______________ B________________

Pair familiarity

As senders: What kind of strategy or strategies did you use in describing the photos? That is, what characteristics or features did you attend to first? Do you feel that you improved as you went along?

A.

B.

How would you compare the conditions in which you had knowledge of your receiver's array with those in which you had no knowledge in terms of what you did, how hard it was, etc.

A.

B.

As receivers: What characteristics or features did you find most helpful in identifying the target pictures?

A.

B.

What kind of strategy did you use? That is, did you attempt to eliminate certain photos systematically? Did you form a mental image of the face from the description? What did you do to find the picture?

A.

B.

Any other comments at all:

VITA

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