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A FACTOR ANALYTIC STUDY OF THE RELATION BE-
TWEEN THE SPEED OF VISUAL PERCEPTION AND THE
LANGUAGE ABILITIES OF DEAF ADOLESCENTS.**

**The Ohio State University, Ph.D., 1966
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A FACTOR ANALYTIC STUDY OF THE RELATION BETWEEN
THE SPEED OF VISUAL PERCEPTION AND THE LANGUAGE ABILITIES
OF DEAF ADOLESCENTS

DISSERTATION

Presented in Partial Fulfillment of the Requirement for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By

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* * * * *

The Ohio State University
1966

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CONTENTS

	Page
VITA	ii
ACKNOWLEDGMENTS	iii
TABLES	vi
FIGURES	vii
CHAPTER	
I. INTRODUCTION	1
Definition of terms	6
Summary	8
II. REVIEW OF THE LITERATURE	9
Receptive Language	
Skills of Deaf Children	9
Expressive Language of the Deaf ...	17
Prediction of	
Language Achievement	27
Visual Memory	29
Visual Perception	31
Summary	38
III. PROCEDURES	39
Subjects	39
Measures of Language Abilities	40
Measures of Visual Perception	41
Experimental Method	49
Equipment and Calibration	54
Summary	56
IV. RESULTS AND DISCUSSION	57
Hypotheses and	
Description of Analysis	57
Visual Perception and Language	59

	Page
CHAPTER	
Inter correlations of Visual Perceptual Measures	64
Inter correlations of Language Measures.....	67
Factor Analysis	69
Discussion	87
Summary	92
V. SUMMARY AND CONCLUSIONS	94
Summary	94
Conclusions	96
APPENDIXES	
A. Subject Description	98
B. Stimulus Lists and Answer Keys	101
C. Raw Scores	107
D. Mean, Standard Deviation, and Correlation Matrix	112
LITERATURE CITED	115

TABLES

	Page
TABLE	
1. Pearson Product-Moment Correlation Coefficients ($\bar{r}$) Relating Measures of Visual Perception to Those of Language	62
2. Pearson Product-Moment Correlation Coefficients ($\bar{r}$) to Indicate Interrelationships Between the Measures of Visual Perception	65
3. Pearson Product-Moment Correlation Coefficients ($\bar{r}$) to Indicate Interrelationships Between the Measures of Language	68
4. Rotated Factors	71

FIGURES

FIGURE		Page
1.	A Theoretical Model of Receptive and Expressive Language Acquisition in the Deaf	91

CHAPTER I

INTRODUCTION

Receptive language as a means of mental, emotional, and social growth in the severely aurally handicapped child has long been a focus of interest and research for educators. In general, attempts have been made to give such children every possible habilitative advantage since their educational and vocational success seems to depend upon this skill. More specifically, teachers of these children have been searching for more appropriate means of teaching them language. Their search for a method, whether it be orally, manually, or graphically oriented, appeared to have the same basic goal: that of giving the child with a severe hearing loss a more adequate mastery of language.

The present exploratory investigation dealt primarily with relating one aspect of the receptive language skills of deaf children (speed of visual perception) to that of general language ability (speechreading, reading, and writing). The following discussion was divided into several parts to facilitate a rationale for the study. Prediction of language achievement was a major concern and has been discussed at the outset.

Educators of the deaf have been, for the most part, unsuccessful in predicting language ability of deaf children. At the same time they generally have been unable to account for those children with the same type of sensory deprivation who are somehow able to achieve comparatively high levels of language. In most cases efforts to use intelligence as a determining factor were proven unsatisfactory. Concerning this, Myklebust (1964a) stated:

...Educators became concerned about children who have average or above average mental ability (on performance tests), but who often did not show corresponding ability to learn and to achieve academically -- the question of what was measured by performance tests as compared to verbal tests became critical...

Most of the intelligence tests in current use for children with severe hearing losses appeared to have most of the following characteristics: (1) no timing is done; (2) instructions are simple or pantomimed; and (3) non-verbal, or performance, items predominate. Examples of tests in which the above three criteria predominated were the Leiter International Performance Scale (1940) and the Nebraska Test of Learning Aptitude (Hiskey, 1955).

Secondly, there seemed to be four visual modes whereby language symbols could be transmitted to a child with a severe hearing loss. These could include speechreading, fingerspelling, manual signs, or the printed word. These modes have been used with varying degrees of success for

an adequate command of various language skills over the past century in schools for the deaf in the United States and abroad. The first three of the above means of conveying language information involved the relatively rapid movements of the lips, fingers, or hands. Depending upon any particular theory of education, any one of the above approaches may be employed in isolation or simultaneously with other methods to teach language to the deaf child. It appeared that each mode involved the perception of form, whether it was the configurational movement of the lips, fingers, hands, or printed-word-configuration. More specifically, all of the modes except reading involved the apparent visual perception of patterned form movement. It has been emphasized by such investigators as Winebrenner (1951) and McQuarrie (1957) that the visual perception of form in the normal hearing child was fundamental in learning how to read. For the deaf child, however, the visual perception of form seemed more crucial for all language learning in that practically every language clue must be taken from the lips, fingers, hands, or the printed symbol. For the normal child, it seemed that hearing constituted the primary basis for the learning and later decoding of a symbol system.

Finally, because form and relatively rapid movement appeared to be basic elements in the early language environment of deaf children, it was surmised that certain

important knowledge could be obtained by a scientific investigation of these parameters of language acquisition. It was hypothesized cautiously that if such a relationship was shown, then speed of visual perception could be of value as a predictive and research tool for those interested in habilitating children with severe hearing losses.

The idea that perception and movement were important to thought or receptive language processes was not necessarily unique or new. Spearman (1923) spoke of certain basal cognitive faculties to include perception (which includes a movement factor), intellect, memory, and imagination. He described the perceptual process as supplying the "soil out of which cognition originally springs." According to him, great speed was involved in the perceptual process from the time certain afferent nerves were thrown into excitation until the time the impulses reached the brain. He stated: "The passage from the earlier to the later phase appears to happen most quickly and inevitably in the case of vision."

It seemed plausible that among a group of deaf children, there would be some whose visual perceptual abilities would be superior due to perhaps some innate perceptual abilities or to yet unknown factors, thus permitting a more rapid intake of patterned language movement. Therefore, it seemed desirable that this visual perceptual process be tested or related to language. The available studies dealing with the visual perception of the deaf, have, however, dealt

primarily with finding specific strengths and weaknesses of the deaf when comparing them to hearing persons. Little or no work seemed to have been devoted to correlating visual perception of the severely aurally handicapped child to language abilities. Few if any studies have attempted to correlate speed of visual perception with language abilities in the deaf.

The importance of the present study was that a new approach to measuring visual perception in the deaf was tested. The basic variable investigated was speed of visual perception, including several measures, which was related to a battery of language tasks. The general hypothesis of the study was: the faster a deaf child can visually perceive and process meaningful movements, geometric shapes, pseudo-symbolic shapes, and letter shapes, the more rapidly he can visually assimilate information, including language.

Definition of terms

Perception. As used in this study, perception referred to the attachment of meaning to patterned movement utilizing the visual sense.

Imagery. Imagery referred to the mental internalization of pictographic experience.

Symbolism. A symbol was something that represented an object, action, feeling, or idea.

Conceptualization. Conceptualization referred to the classification of experience into categories according to common elements.

Abstraction. Abstraction was the ability to think imaginatively in non-concrete terms.

Speechreading. Speechreading referred to the process of comprehending the words of the speaker by associating meaning with the movements of the lips and face.

Form. As used in this experiment, form referred to configurations of letters, figures, lips, hands, or finger positions.

The deaf. The deaf are those individuals for whom the sense of hearing is nonfunctional. This general group can be subdivided into two distinct classes based on the

time the hearing loss occurred. The congenitally deaf are those who were born deaf, while the adventitiously deaf are those who were born with normal hearing but through later illness or trauma lost it. According to Huizing (1953) a 60-90 dB loss for pure-tone audiometry characterized a severe hearing impairment with the 60 dB level constituting a critical borderline for the natural development of speech in young acoustically impaired children. Most authorities agree, however, that a 75 dB (ASA system) or greater loss before the age of three years in the better ear as measured by pure-tone audiometry constitutes a severe loss and will define a child as being deaf.

The hard of hearing. The hard of hearing, according to the above criteria, will probably have a loss of 60 dB or less for pure-tone audiometry. Their hearing, while defective, should still be functional.

Summary

The receptive language functions of deaf children were discussed according to (1) prediction of language achievement, (2) modes used to channel the language information, and (3) relationship to the present study.

The inadequacy of any present method for predicting language achievement in the deaf was the main reason for this investigation. It was surmised that there were various unexplored areas in the field of language development of deaf children which needed to be analyzed more critically. One area which seemed to warrant such an investigation was the relation that speed of visual perception might have to that of language abilities.

CHAPTER II

REVIEW OF THE LITERATURE

This section will cover the research in five areas related to the deaf: (1) receptive language skills of deaf children, (2) expressive language of the deaf, (3) prediction of language achievement, (4) visual memory, and (5) visual perception.

Receptive Language Skills of Deaf Children

Speechreading

When a hearing loss occurs, speechreading, or the act of associating meaning with movements of the lips and other facial cues, may be used as a primary means of language reception. The individual who suffers a gradual loss of hearing may become an expert speechreader without conscious effort, while the congenitally deaf child or the adult who experiences a sudden loss will probably need special help to become skillful in this form of receptive communication.

The task of learning to speechread can be very difficult. Spoken language is composed of numerous phonemes, many of which are not visible on the lips. In order to gain skill in speechreading, it seemed logical to assume that an individual had to be able to retain mentally the lip movements while receiving them, organize these movements into some kind of order and associate the lip movements with experience. The speechreader will gain additional clues from watching the

expression on the face of the speaker and the interplay of his facial muscles. Various investigations have been conducted in an attempt to isolate the parameters of the speechreading process. These studies seemed to fall into several major areas: the relationship of speechreading skill to other factors, the difficulty of various speechreading materials, and tests of speechreading.

Kitson (1915) conducted an experimental study in which he related speechreading skill to certain tachistoscopic, reading, and completion tests. His results indicated that subjects with better visual skills, larger visual spans, and those who had good synthetic ability were also the better speechreaders. Gault (1927) explored the ability of deaf subjects to recognize words by vision and also by vision plus the tactual sense. He found that twice as many words were recognized by vision and touch than were recognized by vision alone. Other researchers, such as Pintner (1929a), Heider and Heider (1940a), and Reid (1946) conducted studies using deaf subjects and found no significant relationship between the ability to speechread and certain intelligence and achievement tests. In general, work done with normals by Cavender (1949), O'Neill (1951), and O'Neill and Davidson (1956) supported the above conclusions. However, the results of studies by Costello (1957) and Simmons (1959) with deaf subjects showed this language function to be significantly correlated with various types of intellectual abilities. For instance, Costello found that the Visual Digit Span Test

(Blair, 1957), correlated significantly with the ability to speechread as did scores on the Wechsler Picture Arrangement Test (Wechsler, 1944). Myklebust (1964a), in his National Study, found that intelligence as measured by teacher ratings and the Draw-a-Man Test (Goodenough, 1926) related to speechreading ability. Therefore, memory for a sequence of symbols and the ability to perceive and understand social situations seemed to be positively related to speechreading success. One other study by Worthington (1956) showed no significant relationship between speechreading skill and certain personality factors among deaf high school students.

Little or no work seemed to have been accomplished with deaf subjects concerning the difficulty of speechreading materials; rather, treatment of this area had primarily been done with hearing subjects. In one such study, Morris (1944) found that longer sentences were more difficult to speechread than were shorter ones and that a word was harder to understand when placed in a long sentence than when placed in a shorter sentence. The position of a sentence within a group of sentences was not found to be an important variable; neither did the position of groups of sentences negatively effect speechreading performance. O'Neill (1954) investigated the visibility of certain sounds of speech. He found that the vowels (o) and (u) appeared to be most visible, while (p) and (f) were the most visible consonants. Another study of the difficulty of speechreading materials was com-

pleted by Brannon and Kodman (1959), who found no difference between skilled and unskilled speechreaders in their ability to speechread isolated words; skilled subjects, however, scored higher on the Utley Sentence Test and visual identification of words was found to be directly related to the place of articulation. The relationship of four speeds of speaking and speechreading difficulty has been investigated by Byers and Lieberman (1959) who found that a decrease in speaking rate did not significantly improve speechreading performance.

Speechreading tests which have been successfully used with the deaf include those created by Conklin (1917), Day and Fusfeld (1929), Heider and Heider (1940a), Mason (1942), Lowell (1957), and Craig (1965). Of these, the Craig Lip-reading Inventory has recently gained popularity as a research tool in the field of Education of the Deaf. A 16-millimeter color film is used with a pictorial and graphic multiple-choice answer sheet. Subjects are tested for both sentence and word identification ability.

The Utley Test (1946), which has been used extensively in research for both the deaf and the hearing, has for the most part proven to be too difficult for the deaf. Heider (1947) and DiCarlo and Kataja (1951) have found many items in this test to be nonfunctional.

Research carried out in other countries has not greatly increased the knowledge of speechreading here in the United States. According to Quigley (1966), these studies revealed

that angle and distance from the speaker, facial expression, practice, and the presence of sound influenced speechreading performance.

It seemed clear that much still remained to be investigated concerning the parameters of speechreading, especially as a receptive communicative tool for the deaf.

Reading

Reading seems to be vital to the education of the deaf child because it constitutes a primary means for the acquisition of knowledge. Deaf children lack the auditory counterparts of visual symbols, however, and are therefore at an extreme disadvantage in learning to read. For instance, Smith (1926) found that hearing children recognize 272 spoken words at the age of two, 1540 at the age of four, and 2562 at age six. The deaf child, on the other hand, may be unfamiliar with a single spoken word when he enters school at the age of three or older.

There are two major theories concerning the teaching of reading to the deaf. One school of thought contends that the deaf child must develop oral language before he can benefit from reading instruction. Strickland (1958) indicated that a deaf child will read no better than he speaks. That is, if he speaks in fragmentary sentences he will have difficulty comprehending words in a complex or compound sentence.

The other philosophy supports the idea that it is not necessary to restrict every deaf child's expression to his

slowly acquired speech, and that it is possible and beneficial for him to begin reading before speaking.

There seemed to be very few experimental studies involving reading instruction with deaf children. Gates (1926a) hypothesized that the visual modality was developed to a higher degree than other senses for the hearing impaired and found this to be true when their ability to recognize correct from incorrect word spelling was examined. He concluded that vision should be put to maximum use in teaching reading. Enlisting the help of others, he attempted to teach deaf children how to read at an earlier age with a new method based on self study material presented in small units.

Several other authorities should be mentioned concerning silent reading techniques. Pintner (1927) upheld this method and concluded that earlier teaching of reading would give the deaf child a basic tool for learning. Pugh (1945) suggested that the deaf child would get much more precise understanding from language that was presented in the written form. Only two other investigators, Lauritson (1928) and Newlee (1930), reported minor studies on silent reading methods. They concluded that silent reading methods, when started before oral procedures, strengthened other aspects of language.

Material for the techniques of teaching reading to the deaf can be found in manuals written by Hart (1963) and Streng (1964). The relationship between language development and reading is covered in articles by Scott (1962), Pauls (1958),

and Strickland (1958).

A method which seems to hold great promise for teaching reading is programmed instruction. Falconer (1960, 1961, and 1962), a pioneer in this field, used a memory drum to expose individually presented card-frames to teach 15 nouns to eight deaf children between the ages of six and seven. The children spent five minutes a day for ten days learning the nouns. Results of a post-test disclosed a mean of 13.75 correct words as compared with a pretest mean of 4.12. The mean retention score after two weeks was 13.63. Stuckless and Birch (1962) taught language and vocabulary constructions to 99 deaf children, ten years of age, by means of a simple hand-operated machine and found that the deaf children learned the same amount of material as the normal hearing children, but in less than half the time. Others who have used the programmed learning technique to teach certain language concepts included Fehr (1962), Rush (1964), and Beckmeyer (1963).

Various studies are being conducted to explore the possibilities of using programmed instruction as a supplementary tool in the teaching of language to deaf children. Black (1965) discussed a series of long-range programs aimed at correcting some of the common errors of language usage by the deaf. Stuckless (1964) used ten 60-frame programs designed to help correct areas of difficulty in written compositions of the deaf. He reported a significantly positive effect on syntax, especially for subjects who had high initial error

rates.

Others who are conducting research in this field include Karlsen (1965), Frisina (1964), and Withrow (1965). The largest project being developed in programmed instruction is Project LIFE (Language Improvement to Facilitate Education of Hearing Impaired Children). It is sponsored by the U.S. Office of Education, Captioned Films for the Deaf, and administered by the National Education Association. According to Wooden (1964), the project utilizes the services of curriculum writers, programmers, consultants, and other specialists and is designed to supplement and reinforce existing language programs for the deaf. A specially designed teaching machine incorporates 8-millimeter movies, filmstrips, and tapes for auditory training, and makes either multiple-choice or constructed responses possible. Books, picture dictionaries and other materials will be produced and used as part of the program.

These new methods are primarily visual in their approach to the teaching of reading. Evidence from studies done by Triggs (1959) and Goins (1958) suggested that there is a positive relationship between visual discrimination, perception, and reading progress. One of the hypotheses of this study was that such a relationship existed.

Most of the other reading research done with the deaf has been directed toward determining reading ability and degree of retardation. La Grone (1936) found the reading scores of her fifth-grade deaf children were at the 2.9 to

3.0 grade level and those in the tenth grade were at the 4.7 to 6.6 grade level. The investigations of Pintner (1918), Reamer (1921), Upshall (1929), and Pugh (1946), as well as that of Myklebust (1964a) in his National Study ascertained the reading vocabulary ability of deaf and hearing children. Results of these studies revealed that the severely aurally handicapped child was retarded as much as five years or more in reading achievement.

Expressive Language Skills of the Deaf

Writing

Information concerning the expressive language of the deaf has been collected in two ways. Both methods involve either collecting tape recordings of speech or samples of writing. When using the first method, investigators do not attempt to control the subjects' responses. In the second method responses are controlled by keeping certain variables constant. The data collected can be analyzed either quantitatively through such procedures as counting the number of words and sentences or linguistically, which yields grammatical or structural data. Most of the studies published in this area have been of the quantitative type. The written language of deaf children has been studied under various categories: quantity of language, complexity, style, correctness, and parts of speech. Each of these will be dealt with separately in a review of the literature.

Quantity of language

Heider and Heider (1940c) compared the written compositions of 301 deaf children aged 11 to 17 to those written by 817 hearing children aged 8 to 14. They found the compositions written by the 17-year-old deaf children resembled those of the eight-year-old hearing children. Both groups used the same number of words, but the deaf used more sentences. Subsequent studies by Templin (1950), Myklebust (1964a), and Simmons (1962) supported the Heiders' conclusions of use of short sentences.

Style

The Heiders (1940c) reported that the deaf used "more fixed phrases that could be learned and used as units." Myklebust (1964a) compared the written language of 706 deaf children, aged seven to 15, to those of 270 hearing students of the same age range and found that the deaf subjects used a greater percentage of carrier phrases at each age level than did the hearing subjects. Simmons (1962) compared the type-token ratios found in the compositions of 54 deaf children, aged nine to 15, with those of 112 hearing children, aged eight to 13. She found the deaf were below the hearing at all age levels in average type-token ratios. The deaf were also found to be redundant in their use of phrases and their compositions displayed little variation in syntactic patterning.

Parts of speech

Both Myklebust (1964a) and Simmons (1962) have compared the parts of speech used by deaf and hearing children. However, the results of their studies cannot be directly compared because they did not use the same classification categories. Myklebust, using the traditional categories of nouns, verbs, articles, pronouns, prepositions, adjectives, adverbs, conjunctions, and interjections, analyzed compositions written in response to a picture by 200 deaf and 200 hearing children, matched according to sex, chronological age, and non-verbal intelligence. He found that ratios of the parts-of-speech held the same rank order in both groups, but that the deaf subjects' use of pronouns, prepositions, adjectives, and conjunctions was significantly less frequent than the hearing subjects' of the same chronological age. The deaf rarely used adverbs but used relatively more nouns and articles than the hearing group.

Simmons used Fries (1952) analysis of English grammar in assigning words to eight categories. She reported that her deaf subjects used a greater number of determiners (words such as the and a), Class I (corresponding approximately to the traditional noun classification), and Class II (transitive and intransitive verbs), than did the hearing subjects. The deaf used a smaller proportion of Class IV words (corresponding approximately to the traditional adverb classification), auxiliaries, and conjunctions than did the hearing children. Both

groups used a similar proportion of Class III words (corresponding approximately to the traditional adjective classification) and prepositions.

Others who have investigated the language of the deaf include Wells (1942), who used a semantic classification in comparing parts of speech ratios in four compositions written by each of 160 hearing and 252 deaf subjects in grades three through six. He studied groups in reference to their use of abstract nouns (nouns not referring to a particular thing) and relational words (conjunctions, prepositions, and relative pronouns). He found that the hearing excelled the deaf at all grade levels in the use of abstract nouns, and also in the use of relational words except at the third grade level. The deaf were from three and one-half to five years retarded in their use of these parts of speech. He also found that the differences between the deaf and hearing increased as the level of abstraction increased.

A study by MacGinities (1964) showed the deaf to be remarkably similar to the hearing in the ability to restore omitted words from sentences selected from second grade readers. He used 30 deaf girls with a mean age of 12.7 and 30 hearing girls with a mean age of 9.5 and concluded that although the deaf may use certain parts of speech less frequently than the hearing, their ability to use such grammatical categories in simple constructions may be no more impaired than their ability to use language in general.

Correctness

The numerous errors of the written language of the deaf have been noted in several studies. Thompson (1936) analyzed 16,000 compositions written by 800 deaf children. Although this study has been criticized due to poor description of methodology, the findings are of interest. The average number of errors per 1,000 words was counted in each of four major classifications: syntax and case, clauses, words and vocabulary, and punctuation. Results showed that about half of the errors were in the "words and vocabulary" classification and that the majority of the errors fell into three subclassifications: the omission of necessary words, the use of wrong words, and the addition of excessive words. The greatest number of errors was found in the "omission" classification. The results of Myklebust's (1964a) study were consistent with Thompson's findings in that the omission of essential words by the deaf constituted the greatest number of errors of written language at all age levels.

Fusfeld (1955) noted the misuse of definite articles, incorrect use of verb forms, substitution of wrong words, lack of agreement between subject and verb, and garbled sequences of words in the written compositions of deaf college-preparatory high school graduates. Few other studies have been reported concerning the language errors of deaf children. Simmons (1962) found the deaf to use extraneous words, while Cohen (1964) reported that the partially deleted stories of deaf children were more difficult for hearing children to

restore than were stories done by other hearing children.

Methods for teaching written language to the deaf range from the strictly analytical to the natural. For example, the Fitzgerald Key (Fitzgerald, 1926) was designed to develop the child's power of reasoning and discrimination about language. Groht (1958), advocated the Natural Method whereby the teacher creates situations which provide numerous contacts with the principles of language. More recently, Craig, Carr, and Latham (1964) have developed a phrase-unit approach based on Groht's Natural Method. For the most part, however, no one method has been found which even gives the deaf child a functional use of the language. From all indications, the influence of research findings in the field of linguistics may hold promise for the development of future methods for teaching written language to the deaf.

Speaking

Although this exploratory investigation does not specifically deal with the speech of deaf children, the secondary language skills of reading and writing are thought by many authorities to be dependent upon the primary skills of the comprehension and use of speech. Therefore, research in speech must be necessarily included in a review of the literature.

The speech of deaf children has been studied under two major subdivisions: spoken language (units larger than the

phoneme) and speech production (one speech sound or a set of sounds). These categories will be dealt with separately.

Spoken language

Eberhardt (1940) investigated the spoken language of deaf and hearing children and found that (a) the sentences of the deaf were shorter in the number of words and in number of clauses than the sentences for the children with normal hearing; (b) the deaf children used more simple sentences; and (c) they used fewer verbs in subordinate clauses than the children with normal hearing.

Goda (1959) used pictures as stimuli to elicit 50 spoken responses from deaf adolescents. He analyzed the average sentence length and sentence quality and concluded that since all language skills are closely related, it might be predicted that a deaf child who is superior in one skill will be superior in all skills. He also felt that the quantitative and qualitative aspects of expressive language were similarly related. Those children who used larger numbers of words in speaking and writing generally expressed themselves in relatively longer and more complex sentences.

In his National Study of language development in deaf children, Myklebust (1964a) found that teacher ratings of spoken language were related to three measures of written language: sentence length, syntax, and degree of abstraction. The results also showed that more females than males were rated as having good proficiency in spoken language. Brown

and Mecham (1961) also used teacher ratings to analyze the development of the language of deaf children. Intelligence, age, and degree of hearing loss were found to correlate significantly with the ratings.

Few other studies have been carried out which have focused on the spoken language of deaf children. Simmons (1962) found that the written and spoken type-token ratios of hearing children were higher than those of deaf children. Waldon (1963) studied the spoken and written language of 30 hearing and 30 hearing impaired children. Hearing losses in the experimental group ranged from 40 to 70 dB. Results showed the two groups did not significantly differ in the length of spoken and written responses. The normals, however, used a larger number of simple sentences, more complete sentences, and a larger number of words in sentences than the children with impaired hearing. The hearing impaired children also used a significantly larger number of one-word responses than the normals. Significant differences were found between the two groups in written sentence structure but not in the spoken sentence structure.

Champagne (1965) determined the relationship between the spoken language and articulatory abilities of deaf and hard of hearing adolescent children. She also analyzed articulation as influenced by the position of the phoneme within the stimulus word and by the place of articulation. She found that the hard of hearing subjects resembled the hearing subjects in productivity and quality. Syntactical errors of the hard of hearing group resembled those of the deaf group, but were fewer

in number. The deaf group was highly deficient in both structural accuracy and productivity of spoken language. When compared to the normal subjects, the deaf showed significant differences in all measures of language. The results of articulatory measures showed that the hard of hearing group misarticulated many phonemes but fewer than the deaf subjects.

Murry (1965) studied the relation between hearing loss and spoken language of deaf and hard of hearing children. He found that the hard of hearing group resembled the hearing group in their productivity capacity, but not in grammatical accuracy. The hard of hearing group showed syntactical errors similar to those of the deaf, but fewer in number. In productivity and structural accuracy, the deaf were found to be highly deficient relative to normal hearing children; when compared to the hard of hearing group, they showed significant differences in all measures of total output and output accuracy.

Speech production

Hudgins (1934) investigated the breathing patterns of deaf and hearing subjects. The deaf displayed such difficulties as slow rate, abnormal rhythm, excessive breath, and nasality. Other abnormalities such as prolongation of vowels and extra syllables were sometimes added after abutting consonants. Voelker (1938) found that the deaf speak nearly 150 per cent slower than the hearing. Hughson et al. (1942), studied the vocal and phonetic characteristics of

367 deaf children in a residential school. The ability to produce intelligible speech by the deaf was found to be related to the amount of auditory training.

A study by Hudgins and Numbers (1942) involving 192 deaf children, revealed that the most frequent errors of articulation were the surd-sonant distinction, compound consonants, the failure of releasing consonants, vowel substitution, and malarticulation of diphthongs. Speech intelligibility was lowered the most by faulty rhythm and misarticulation of consonants.

Other investigators who have studied the articulation process of deaf children include Sykes (1940), who found that voiced consonants, labials, and the indefinite vowel /ə/ occurred most frequently in their speech, while the vowels /a/, /ʌ/, and /ɛ/ were used more frequently. Hudgins (1953 and 1958), in further research, found that the deaf tended to utter single words on one breath and ignore the timing relationship between articulation and breathing. The deaf could produce motor movements of the jaw and tongue as rapidly as normals but were deficient in performing rapid movements with speech phonemes.

Several spectrographic studies of the speech of the deaf have also been reported. Calvert (1961) found that the deaf usually extended vowel and consonant duration about four to five times that of the hearing. Angelocci (1962) investigated the formants of vowels as produced by deaf and normal hearing males from 11 to 14 years of age. In general he found that

the deaf displayed a higher fundamental frequency, more scattered formant frequency positions, and a more distorted formant one/formant two relationship of one vowel to the next.

The tongue movements of deaf and hearing children were recorded by means of a glossal transducer by Brannon (1964). The deaf, in comparison to the hearing, displayed slower and more labored tongue movements and also showed an increase in unnecessary glossal movements as the length of their utterances were increased. No correlation was found between intelligence and success in producing intelligible speech.

Prediction of Language Achievement

The problem of language achievement prediction in deaf children has long confronted educators. Such prediction is desirable for grouping and teaching purposes. If a deaf child's capabilities for acquiring the language of his culture could be determined at an early age, teachers might be able to develop individualized programs of instruction. Most of the efforts to find linguistic predictors have been based upon non-verbal or performance type tests. One of the first group tests that was used was developed by Pintner (1929b) and called the Pintner Non-Language Mental Test. Individual tests, such as the Draw-a-Man (Goodenough, 1929), the Leiter International Performance Scale (1940), and the Grace Arthur Point Scale of Intelligence (1943) were developed. Other tests, such as the Wechsler-Bellevue (1944) and the Chicago Non-Verbal Examination (Brown, 1947), were also commonly used. More recently the Grace Arthur Point

Scale of Intelligence Tests, Revised Form II (1947), the Wechsler Intelligence Scale for Children (1949), the Wechsler Adult Intelligence Scale (1955), and the Nebraska Test of Learning Aptitude in Young Deaf Children (Hiskey, 1955), have come into use.

Investigators have compared these tests with one another in terms of their capacity to sort out good and poor learners in schools for the deaf. It has been shown, however, that the various tests give significantly different intelligence scores. For example, MacKane (1933) found that intelligence scores of the deaf varied with the test given. Birch and Birch (1951) reported that some children could be classified as mentally retarded by some tests and as superior or gifted by others. They concluded:

So far as can be determined from the literature, there is no strong evidence that the Leiter, the Hiskey, the Goodenough or the Wechsler Performance Tests are very useful in the prediction of success in academic learning tasks.

It appeared that non-verbal or performance type intelligence tests, while useful to the psychologist for general screening purposes and to the researcher for indication of group trends, were not, for the most part, an effective means of predicting academic achievement in deaf children.

The fact that it takes a severe degree of mental retardation to completely preclude functional language development seemed to lend support to the above conclusions. It has also been observed that the acquisition of foreign languages was not substantially related to measures of intelligence (Car-

roll, 1962).

Visual Memory

Memory tasks are included in most of the previously mentioned non-verbal and performance type intelligence tests. A review of the literature did not reveal many studies aimed at finding a relationship between certain memory tasks and language achievement in deaf children. Various studies have been conducted, however, to discover how well deaf children perform on memory tasks in relation to hearing children.

For instance, Myklebust (1964a) reported that seven types of memory have been studied: memory for design, tactual motor memory, memory for movement, object location, dot patterns, picture span, and digit span. The general conclusion seemed to be that the deaf, when compared with hearing children, were superior on some memory functions (memory for designs), equal on others, and inferior on others (particularly span tests). Myklebust inferred that these differences might have existed because of differences in the alerting mechanisms and perceptual organization of those deprived of hearing.

Hiskey (1955) concluded that the deaf were inferior to the hearing on memory abilities in regard to colors and numbers because they could not verbalize mentally. Frisina (1955), Blair (1957), and Costello (1957) found, however, that the deaf performed well on the Knox Cube Test which is primarily a visuo-motor-kinesthetic memory task and does not require verbalization. Both the Blair and Costello study showed the

deaf to be significantly superior to the hearing on this particular memory task. The Blair study, in addition, revealed the deaf to be superior to the hearing on memory for designs. The deaf did not attempt to generalize (at least visually) from past experiences, but rather, simply observed and reproduced what they saw. This, according to Myklebust (1964a), may have given them an advantage over the hearing who were observed to make verbal comparisons.

Goetzinger and Rousey (1957) found results contrary to the three previously mentioned studies (Frisina, Blair, and Costello), in that deaf adolescents were retarded in visual memory when tested by the Knox Cube Test.

Others who have investigated different aspects of memory in the deaf include Morsh (1936) who found the deaf comparable to the hearing in their ability to remember the position of objects in space. The results of a study by Brill (1953) showed that deaf children could not remember sentences which were longer than four or five words in length (this being the equivalent of the memory of hearing children for sentences). He concluded that lack of memory for sentences is part of the over-all handicap of deaf children. Blair (1957) found the deaf to be inferior to the hearing on three span tests: Picture Memory Span, Domino Span, and Digit Span. The results of a study by Fuller (1959) were in close agreement with the results of Blair. It is interesting to note that, in both studies, the deaf did almost as well on digits reversed as they did on digits forward, while the hearing individual usually

displayed better scores on digits forward than digits backward.

Nonverbal memory has been investigated by Furth (1961) who found no difference between deaf and hearing subjects in the age range from 7 to 10 years, but at 11 and 12 years, the hearing subjects out performed the deaf.

The results of these studies indicated that the deaf were superior to the hearing on some memory tasks and inferior to them on others. The deaf have been found to perform highest on memory for design tasks and lowest on digit span tasks.

Visual Perception

General

Experimental work done in the area of perception of visual movement seems to have been performed primarily with hearing normals. These studies, however, have helped establish terms applicable to any study of visual movement perception. For instance, two types of thresholds have been of primary concern in this area: (a) the rate of threshold (defined as the lower limit of speed awareness); and (b) the displacement threshold (defined as the lower limit of awareness of position change). Rate thresholds for both moving and static forms of the various visual perceptual tests given in this investigation could not be obtained due to the limitations of the equipment used. Ideally, thresholds of this type would seem to be the most applicable means of establishing a relationship between such factors as language ability and visual perception.

Aubert (1886) determined the perception of moving objects by fixation on the moving object in the presence of a visible-stationary reference point. Crook (1937) determined that there were three principal determinants of real visual perception of motion: (a) as the illumination is increased, the movement is more easily perceived until the illumination saturates the foveae: (b) the faster the rate of movement, the lower the displacement discrimination ability; and (c) the larger the object in motion, the greater the displacement and rate of discrimination ability. Hunter and Sigler (1940) suggested that the "span" of visual discrimination, or attention span, should be included as a fourth determinant. According to them, this span could be affected by various factors, such as intensity and duration of the stimulus, instructional stimuli, class of objects, age of subjects, and previous amount of practice. These four determinants of visual perception were all taken into consideration in this investigation.

Wertheimer (1912) studied the temporal interval between stimuli, and reported that with intervals up to about 30 milliseconds the two stimuli appeared to occur simultaneously. Intervals of near 60 milliseconds gave the appearance of "optimal movement." Stimulus succession appeared at about 200 milliseconds.

Graham (1951) concluded his chapter on perception of movement with a consideration of important variables. Some of these variables which are unquestioned and some which are

the foci of disagreement are (1) length of pause between stimuli; (2) duration of stimulus exposure; (3) distance between stimuli; (4) form; (5) relative difference in intensity; (6) wavelength distributions; and (7) conditions of the subjects. He also stated that research in perception "...has suffered from too much generalization and too little experimentation and analysis."

Visual perception of the deaf

Braly (1937) and Stockwell (1952) have been concerned with surveys of visual difficulties in deaf children. They suggested a higher incidence of visual defects among the deaf, which referred to peripheral sensory acuity and not perceptual abilities; nevertheless, visual defects would have influenced a study of visual perception.

A review of the literature did not disclose any studies in which speed of visual perception had been used as a basic factor in relation to language achievement of the deaf. However, a few investigations have been designed to compare the deaf with the hearing in various visual perceptual tasks. For instance, Heider (1940b) studied the color sorting behavior of deaf children at the Clark School for the Deaf. The perceptual task was to select, from a group of variants, those colors which belonged with the basic hues. Results showed that deaf children selected colors over a wider range than hearing children their own age.

Oléron (1950) found that the deaf were not superior to

normal hearing children in tachistoscopic perception. They did, however, perceive complex material more accurately than simple materials, within limits. Oleron (1953) has also studied the visual discrimination of paired objects by deaf subjects in the age range of 4 to 7 years and found that the deaf were only somewhat inferior to their hearing counterparts.

Myklebust and Bratten (1953) employed various perceptual tasks, originally designed to help discover behavioral disturbances in the brain damaged child, and investigated the effect that sensory deprivation had on visual perception in the deaf. They employed marble board, figure-ground, pattern reproduction and perseveration tasks. The results of their study showed the deaf to be significantly inferior to hearing controls on a number of tasks, notably in that more errors were made in reproducing marble patterns and more exposure time was needed in the production of dot patterns. A greater number of deaf subjects gave background rather than foreground responses in one out of five items in the object series and three out of five items in the design series. The deaf and hearing groups performed similarly on reproduction of line patterns and on the perseveration tasks. The results of other studies did not support the conclusion that the deaf were inferior to the hearing on tasks of visual perception. Using some of the same perceptual tasks as those used in the above study, Larr (1956) paired two independent groups of 25 deaf children each from the lower grades of two different schools for the deaf with a normal and subnormal control group. The results of his study

were contrary to the findings of Myklebust and Bratten in that the deaf subjects performed equally well on marble board reproduction. On the figure-ground task they gave more background references than either control group. Studies by Hayes (1955) and McKay (1952) were also not in agreement with the findings of Myklebust and Bratten.

Other researchers who have investigated the area of visual perception in the deaf include Furth and Mendez (1963) who compared deaf and hearing subjects at two age levels (nine and 16 years) in their ability to visually perceive figures illustrating some of the major principles of gestalt. Both the experimental and control groups generally performed alike, except that the younger deaf children were inferior to the hearing subjects on two tasks which involved discriminatory as opposed to a global approach.

Thompson (1964) used the Howard-Dolman Binocular and Monocular Depth Perception Test, the Letter-Like Form Discrimination Test, and the Muller-Lyer Illusion Size Discrimination Test on 30 congenitally deaf, 30 adventitiously deaf, and 30 normal children. He found no statistically significant differences in perceptual performance on any of the three visual tasks between the three groups. The results did not confirm the hypothesis that developmental retardation of visual functioning within the adventitious group decreased with age of onset of deafness. He suggested that "...the development of visual perception from birth may be

relatively autonomous of auditory deafects."

The inconsistencies reported in the findings of these few investigations pointed out a definite need for replicational studies and in general a thorough analysis of visual perception in relation to the behavior and achievement of the deaf within their own population.

Visual perception and reading
achievement in hearing
children

Several studies should be mentioned concerning perception and reading ability done with normal hearing children. For example, Winebrenner (1951) in an extensive investigation of 1,510 children, found a significantly positive relationship between perception for form outline and school achievement. He insisted that a child must be able to perceive and reproduce form before successfully learning how to read. Coleman (1953) determined that skill in visual form perception is necessary for successful achievement in reading. The results of a study by Goins (1958) showed that poor readers often had not learned to notice the details of objects.

The above studies suggested the necessity for the establishment of visual perceptual skill prior to early reading instruction. The implications seemed to apply to deaf children, in that the perception of form, whether it be on the lips, the fingers, or the printed page, must precede the teaching of language.

Visual perception and speech-
reading abilities

Attempts to find a relationship between visual perception and speechreading abilities have been concerned primarily with hearing normals, and the results of such studies, while interesting, cannot be directly applied to the field of education of the deaf.

Kitson (1915) compared fifteen adults at the Chicago School of Lipreading on a completion test (which measured the subjects' "synthetic" ability), a speechreading test, and a tachistoscopic test. A positive correlation of .80 was found between the sum of the ranks in the two tests and rank in speechreading. Using hearing subjects, O'Neill and Davidson (1956) revealed a nonsignificant correlation between speechreading ability and the recognition of tachistoscopically projected digits. Bennett (1961) found a non-significant correlation between speechreading ability as measured by the Utley test and visual perceptual ability as measured by the Gottschaldt test (a timed visual perceptual test where the task is to find a simple geometric figure within a more complex figure). Cutting (1961) in a correlational study, used Form A of the Utley film and the Gottschaldt test and found only one of the four independent variables, Part A of the Gottschaldt, correlated significantly with the dependent variables. When multiple correlations were computed, however, a significant correlation of .36 was found between the Utley

film and Part A and B of the Gottschaldt test.

Perhaps one of the explanations for the above non significant correlations was that static movement (as found in tachistoscopic exposures) or non movement perceptual tasks were used. It seemed plausible that since real movement was involved in speechreading, the perceptual tasks used might have proven to be more predictive if this parameter of speechreading had been taken into consideration.

Summary

A review of the literature surveyed five areas of research relevant to this investigation. These areas were (1) receptive language skills of deaf children; (2) expressive language of the deaf; (3) prediction of language achievement; (4) visual memory; and (5) visual perception.

A review of the literature revealed that the deaf were severely retarded in expressive language when compared to their hearing counterparts. Secondly, performance-type intelligence tests to predict language abilities in deaf children, for the most part, have proven to be ineffective. Thirdly, the measures of the deaf on a number of memory tasks, were found to be superior to those of the hearing control group on some tasks. However, on other tasks, their scores were equal to or inferior to those of the control group. Finally, studies of the visual perceptual abilities of deaf children primarily have been concerned with comparing the deaf to the hearing, while few if any investigations have correlated speed of visual perception with language abilities.

CHAPTER III

PROCEDURES

The primary purpose of this investigation was to determine the relationships between various measures of speed of visual perception and scores representing the language abilities of deaf children. The measures of visual perception were for both moving and static forms. The measures of language abilities were related to speechreading, reading, and writing. A secondary purpose was to perform a factor analysis to search for common factors in these data. In order to achieve these purposes, the following procedures were adopted.

Subjects

An experimental group of 39 deaf children of ages 12-16 years (mean chronological age of 14.2 years) were selected for this investigation. Twenty subjects were chosen from the Ohio School for the Deaf, Columbus, Ohio and 19 from the Indiana State School for the Deaf, Indianapolis, Indiana (out of the original group of twenty students, one female subject could not complete the test battery due to illness). The total group thus consisted of 19 females and 20 males and included no child with brain damage, visual defects, or other compounding handicap according to school records. The mean intelligence quotient of the group was 86.5 with a range of 67 to 127 based upon the Leiter International Performance Scale. All subjects had an average loss of 85 dB (re International Standard Reference Zero) or greater in their better ear for the four frequencies of 500,

1,000, 2,000, and 4,000 Hz and had acquired their deafness at birth or before the age of three.

Measures of Language Abilities

Three different examinations were used to obtain measures of language: (1) the Craig Lipreading Inventory, (2) the Gates Reading Survey Test, and (3) the Picture Story Language Test. A full description of each one follows.

Speechreading test

The Craig Lipreading Inventory for words and for sentences was selected. It is designed to differentiate levels of speechreading skill among deaf children between the end of the first grade through the tenth grade. A restricted but phonemically representative vocabulary is used. A trained teacher of the deaf spoke the words in a close-up view of her face on colored motion picture film. For each item there were four choices on a prepared answer sheet; the subject marked his choices after viewing each item. The children had ample time to make their choice between items. In the Craig movie there were a total of 33 stimulus words and 24 stimulus sentences. A practice item preceded the test.

Reading ability

To determine reading skill, either Form 1 or Form 2 of the Gates Reading Survey Test was administered to all subjects simultaneously (one group at each school). This examination was divided into three different parts. The first section

measures Speed and Accuracy, for which the children were given 6 minutes to complete as many of the 36 multiple choice items as possible. The second part, Reading Vocabulary, contained 65 multiple-choice items, for which there was no time limit. The last section, Level of Comprehension, consisted of 21 multiple-choice sequences and was also untimed.

Writing ability

The Picture Story Language Test, a recently published test of written language (Myklebust, 1964b), was a means of evaluating a story written by a child in response to a standard picture. The story was scored in terms of Productivity, Syntax Quotient, and Abstract-Concrete levels of language. There were three scores of productivity: Total Words, Total Sentences, and Words per Sentence. The Syntax Quotient was a measure of grammatical accuracy, while the Abstract-Concrete Scale examined the child's ability to detach himself from the stimulus and use imagination in writing. Norms for this test have been established for both the hearing and the deaf.

Measures of Visual Perception

The five tests of visual perception constructed for this investigation utilized static as well as moving forms in an effort to differentiate good from poor perceivers. In order to investigate the possibility that speed of visual perception of form might be an important and basic variable in the acquisition of language in deaf children, these tests were planned so that they would test important visual parameters of their

receptive language: form, symbols (both real and pseudo), and the two types of movement. For example, form is present in the configuration of the written alphabet, on the lips of the speaker, and on the configuration of the hand or finger positions. Two and sometimes all four of these modes of receptive language can be used by deaf children to learn language. While these modes may be very different when it comes to the sending of a message, the perception of form seemed to be basic to their successful reception by a receiver. Fingerspelling and speechreading appeared to involve the visual perception of moving form. Hence it seemed desirable to measure the perception of movement. Test A, Speed of Perception of Digital Movements was therefore constructed. The perception of static symbols, such as is needed in learning how to read, requires the ability to notice details of objects as well as the ability to find differences among similar objects.

The results of certain studies suggested that the ability to perceive and reproduce form is a necessary requirement for learning how to read. The two tachistoscopic tests that presented letter sequences and real words were prepared with this purpose in mind. On these measures the subjects needed to perceive the tachistoscopically projected stimuli and record what they perceived on appropriate score sheets.

All five tests of the visual perceptual battery used various speeds to obtain several scores. Four different exposure durations (15, 55, 90, and 130 milliseconds) were used

in the tachistoscopic tests, while the movie was given at four discrete projection speeds (12, 16, 20, and 24 frames per second). The distance of the tachistoscope and the movie projector from the screen was always kept constant at twenty feet.

Movie test

Test A, Speed of Perception of Digital Movements consisted of twenty sequences of fingerspelled consonants, such as "LTGX." The purpose of this test was to determine the speed with which the deaf child accustomed to fingerspelling can perceive and record (write) a sequence of four letters shown by means of a variable high-speed projector. The test was constructed so that a range of difficulty was presented; the configuration of finger and hand movements at the beginning of the test was a relatively easy discriminatory task, but became increasingly difficult for later trials. It seemed to the investigator that the letter sequence "PDME" would be comparatively easy to discriminate because of the upward and downward movement of the hand, while the sequence "LVTS" might present a more difficult task because only the fingers move. At high speeds this could be an important visual perceptual factor because of the fewer movement clues. This assumption was, however, only a speculation on the part of the investigator, and was not quantified.

The film was silent and photographed in Black and white by the Motion Picture Studios, The Ohio State University, at

8 frames per second. An experienced teacher of the deaf from the Rochester School for the Deaf served as the subject by fingerspelling the letter sequences. Her hand was photographed as white against a black background. The rate of fingerspelling was kept constant by calling out a letter every one-half second and by appropriate pauses in between each sequence of letters. Editing disclosed that all four letter sequences took up 21-24 frames of film. Sufficient leader film was inserted between sequences so that the projector could be stopped for recording purposes.

The procedure was as follows: The child saw the first twenty sequences projected at 24 frames per second. He recorded his responses to each sequence on the appropriate space of the answer sheet. On the second presentation of the twenty letter sequences, the speed of the Analyst Projector was slowed to twenty frames per second and the subject responded as before. Scores were thus obtained on all four presentations. Each group of twenty sequences was four frames per second slower than the previous twenty sequences, until the last group, at 12 frames per second, was slightly faster than the speed at which the subject's hand was originally photographed. See Appendix B for a list of the letters used.

Tachistoscopic tests

Test B. Speed of Perception of Pseudo-Symbolic Forms.

The twenty sequences of forms for this test were chosen by the investigator because it was believed they would represent

an unknown symbol system. Actually, the forms closely resembled letters from the various alphabets other than English. By using such a system, it was surmised that a deaf child's ability to perceive and discriminate small differences in form would be tested.

The forms were drawn in black and white and photographed on black and white 35-millimeter film for mounting in slides. By placing yellow cellophane with the to-be-mounted negative, the figures appeared as yellow against a black background when projected on the screen. Smith (1940) demonstrated that the color yellow when paired with black was 80% visible when compared to other color combinations. McCormick (1957) in a study of the relative legibilities of various combinations of colors found that yellow when paired with black ranked two in a series of eleven color combinations. For these reasons, the stimuli for the Pseudo-Symbolic Test, as well as the stimuli for the other tachistoscopic tests, appeared as yellow against a black background on the screen. Illumination of the screen was kept to the absolute minimum by closing down the diaphragm of the tachistoscope to its smallest aperture. The illumination was kept constant for all the tachistoscopic tests.

The test was constructed so that the first five items were relatively easy in that only one simple figure was used for the discriminatory task. The second group of five sequences incorporated two figures; the third group three figures, and the last group, four figures. Thus an attempt was made to increase

the difficulty as the test progressed. Examples of the pseudo-symbols appear in Appendix B.

Test C, Speed of Perception of Geometric Figures. The twenty stimulus figures used in this measure were taken by permission from the Chicago Non-Verbal Examination¹ and the Metropolitan Reading Readiness Test². The items were chosen because it was thought that they represented a discriminatory task that would be different from the previously described Pseudo-Symbolic Test. The figures in this test were constructed in variations of the more traditional circles, square, and triangles. Items were arranged from easy to very difficult. The subjects were tested in groups of ten. The conditions of the previous test were duplicated in reference to illumination, exposure durations, figure color, and distance of the projector from the screen (twenty feet).

Test D, Speed of Perception of Familiar Words. Nineteen, 4-letter PB words and 61, 4-letter PBK words were chosen and used as a group for this test because of their relative familiarity. No attempt was made to control the configuration of any of the words. Familiarity was judged to be a more important

¹Acknowledgement is given to the Psychological Corporation, New York, for the use of seven items from Test Five of the Chicago Non-Verbal Examination.

²Acknowledgement is given to Harcourt, Brace, & World, Incorporated, New York, for the permission to use 13 items from the Metropolitan Reading Readiness Test, Test Form R.

variable to control due to the language difficulty of most deaf children (see Appendix B for a list of these words).

A pilot study revealed that the words were too easy when presented even at the fastest speed of the tachistoscope. In order to make the test more difficult, one more of the parameters of visual perception was altered. In addition to keeping the illumination to a low minimum (the same level as used in the previous two tests) different parts of the letters were cut away by laying pieces of varying width white cardboard over the letters when they were photographed. According to Huey (1908) "ascenders" yield better cues than "descenders," and the upper segments of words are easier to read than the lower segments. In another study, Paterson and Tinker (1946) found that the upper half of the word furnished better cues for word perception when the word appeared in small rather than capital letters.

In order to make the test difficult, but still comprehensible at high tachistoscopic speeds, it was decided to use upper case letters and to cut out larger sections of the middle of the letters as the test progressed. These letters were $1\frac{1}{4}$ " when photographed and appeared as yellow against a black background on the screen. The first five words of each twenty-word sequence had $\frac{2}{8}$ inch removed from their mid section; the next five had $\frac{3}{8}$ removed; the next five, $\frac{4}{8}$ removed; and the last five had $\frac{5}{8}$ inch removed. No more than one-half of any word was removed. This was judged by the investigator to be of maximum difficulty. The words crab, grab, bath, cost, cook,

beef, bead, grew, page, darn, cost, cage, and frog were excluded from the original list because of their confusibility with other words when their mid-section had been removed. A list of these eighty words appears in Appendix B. The section on photography under equipment gives a fuller description of how the stimuli were prepared.

Test E, Speed of Perception of Letter Sequences. Four presentations of eight, four-letter sequences such as "LCBX" were presented tachistoscopically at the same four exposure durations as were used in the previous three tachistoscopic measures. Thus, twenty, four-letter sequences were given at each speed. The sequences were chosen randomly from the alphabet, with no two like letters ever appearing in the same sequence. The letters were upper case $1\frac{1}{2}$ ' when photographed as in Test D. No vowels were included in the sequences. All of the consonants were included except in the following instances: the letter B was not used beyond the first five sequences due to its confusability with D when the center of the letter was removed; and G was not used at all because of its confusability with C.

In order to make this test relatively difficult, the middle section of each four-letter sequence was cut away. However, smaller sections were cut out than were cut out in the test of Familiar Words, since the letter sequences were not meaningful and it was assumed they would be more difficult to perceive than words. The first five sequences had $1/8$ inch cut away from their mid-section, the second five had $2/8$ inch, the third

five had 5/16 inch, and the last five sequences had 3/8 inch cut away. Illumination, letter coloring, and screen distance were kept constant as in the preceding examinations. A listing of these letter sequences appears in Appendix B.

Experimental Method

Language battery

The Craig Lipreading Inventory. This test was administered to ten children simultaneously in a semi-darkened room. Multiple-choice answer forms were used. The directions for this measure (as for all of the instructions in the test battery) were given by means of the manual sign language in conjunction with fingerspelling and speech. The directions were as follows:

You will be seeing a colored movie of a young lady speaking. She will be saying one of the words that you see on your answer sheet (this was repeated for the second section of the test, with the word sentences inserted for word). Mark an X on the word (or sentence) which you think she said. There will be one practice trial. Do you understand? Are there any questions? Watch the screen now for the practice Word.

One point was given for each correct item for a total possible score of 33 for the section on words, and 24 for the sentences.

The Gates Reading Survey Test. All of the subjects were examined at one time (one group at each school). The following directions were given for the different sections:

(1) Speed and Accuracy Test

Look at the first page for the practice item. Go ahead and read the paragraph and then draw a line under the word which best answers the question or completes the sentence. Draw a line under one word only. Work as quickly as you can without making errors. Are there any questions? Now, turn the page and begin with number one. Stop when I turn the lights off.

(2) Reading Vocabulary Test

Look at the first word in each line. Then find another word in the same line that means the same or nearly the same as the first word. Note the number of this word and write its number in the blank space at the right. Do the practice items A, B, and C. Let me check your answers before you begin the test. Are there any questions?

(3) Level of Comprehension Test

Read each paragraph. Note the space marked A. Note the line of words marked A. Find the word in Line A that makes the best sense in space A and draw a line under it. Do the same for the space marked B, and for C when there is a C. If you cannot do one of the paragraphs, do not spend too much time on it. Go on to the next item. Do you understand? Are there any questions?

Raw scores were obtained for each section and these were converted to grade scores and age scores from norms which extend from Grade 2 to Grade 12. Mean grade and age scores were also determined.

The Picture Story Language Test. Students were examined either in their classroom or in a special test room for this measure. A large picture of a small boy sitting at a table playing with various toys was placed before the examinee. The instructions were simply, "Write the best story you can about

the picture." No time limit was set.

The three productivity scores were obtained as follows: (1) the Total Number of Words in the story were counted; (2) the Total Number of Sentences were noted; and (3) the Total Number of Words was divided by the the Total Number of Sentences for a Words per Sentence score. The Syntax Quotient was determined by scoring the number of grammatical errors, assigning penalties according to different error categories (additions, omissions, substitutions, and word order), and finally by dividing the Total Correct by the Total Unit (number of words plus the total omissions).

The Abstract-Concrete score was determined by comparing the child's written composition with scaled examples in the handbook. The composition was thus put on one of the following levels: (1) Level I, Meaningless-Language, (2) Level II, Concrete-Descriptive, (3) Level III, Concrete-Imaginative, (4) Level IV, Abstract-Descriptive, or (5) Level V, Abstract-Imaginative. Abstract-Concrete scores may range from 1 to 25 within these levels.

Battery of visual perceptual tests

Test A, Speed of Perception of Digital Movements. Subjects were tested in varying sized groups that never exceeded ten. The following instructions were communicated to them:

You will see a group of four letters, such as "LVMT" flashed on the screen. These letters do not make real words. Your job is to write what you see, on your answer sheet. There will be eighty groups of letters flashed on the screen. The middle part of the letters has been cut away

to make the test more difficult. Watch the screen now for the practice items. Write down as many letters as you see in the practice space on your answer sheet. (demonstrate practice items # 1 and # 2) To help you keep your place I will hold up a card for each item with the number on it. If you cannot get any letters, draw a line beside that item. You will get credit for every letter you see. Are there any questions? We will go through the test four times. Be sure to print neatly.

The students were given credit for every letter they recognized for a possible score of eighty at each of the four speeds used. A fifth score was obtained by counting the number of responses in which all four of the letters were correctly identified for a single exposure.

Test C, Speed of Perception of Familiar Words. This examination was given to groups of ten students. The usual means to communicate the directions was used.

You will see a familiar word such as "stop" flashed on the screen. Your job is to write down this word on your answer sheet. There will be eighty words flashed on the screen. The middle part of the letters has been cut away to make the test more difficult. Watch the screen now for the practice words. Write what you see in the practice space on your answer sheet. (demonstrate practice words # 1 and # 2) You will receive credit for every word you see and write down. To help you keep your place I will hold up a card with a number on it every time I flash an item on the screen. Are there any questions? We will go through the test four times. Be sure to print neatly.

A score of twenty was possible at each of the four different speeds.

Test D, Speed of Perception of Pseudo-Symbolic Forms. Two different answer forms were used in this examination in an attempt to control the variable of order effects in learning.

The twenty stimuli were presented at each of the following exposure durations: 15, 55, 90, and 130 milliseconds. The examination was administered to ten subjects at a time who had been instructed to keep the answer form covered with a large white $8\frac{1}{4}$ X 8 inch card prior to each exposure. After the stimulus form had been flashed on the screen, the subjects immediately slid the card down until the four multiple-choice answers appeared. An X was placed on one of the four figures which they believed matched the one flashed on the screen. Thus, the subjects were not allowed to study the pseudo-symbols prior to the tachistoscopic exposure, because it was surmised that prior knowledge of the possible choices would influence the outcomes. A card with the appropriate number of the stimulus was held up prior to each exposure so that the subjects would be able to keep their place on the score sheet (this was done for all the visual perceptual tests). The number of correct responses, out of a possible twenty, was tallied at each of the four speeds. Instructions were as follows:

You will be seeing some figures flashed on the screen that may look like some kind of alphabet letters. Your job is to watch the screen and then put a large X on the same figure that appears on the answer sheet. There are four choices every time the figure is flashed. Look at the practice figures. Now cover them with the white card. It is important that you keep the figures covered with the card until after the figure is flashed on the screen. (demonstrate) Now pull the card down and make a large X on your choice. Watch the screen now for the second practice figure. Pull the card down. Make your choice. To help you keep your place I will hold up a card with a number on it like this. (holds up card) Are there any questions? We will go through the test four times.

Equipment and Calibration

Photographic equipment

Slides. All figures, symbols, letter sequences and familiar words were photographed with a 35-millimeter camera (Exa I, single reflex) on fine grain black-and-white-film (Panatomic X). The high contrast negatives were inserted in ready-mounts and sealed with yellow cellophane. The finished slides gave excellent yellow on black contrast for maximum discrimination. A total of 208 slides was made.

Motion Picture. The motion picture sequences were filmed at 8 frames per second by the Motion Picture Division, Department of Photography, The Ohio State University. The hand of the skilled teacher of the deaf appeared as white against a black background.

All unnecessary movements and distractions were eliminated in the final film. Editing disclosed that all sequences took 21 to 24 frames, the majority falling within a 22-frame length. This was made possible by using stopwatch timing and by calling out the letters of each sequence every one-half second as they were simultaneously being produced by the skilled teacher of the deaf in front of the camera. Ample leader film was spliced in between each four-letter sequence to allow the investigator time to stop the projector for recording purposes during the actual testing situation. This also allowed sufficient footage for the projector to gain maximum speed after being turned on prior to each fingerspelled sequence.

Instruments

Movie projector. A Kodak Analyst II Movie Projector, 16-millimeter, with a variable speed rheostat (5-24 frames per second) was used.

The top speed was determined by turning the variable dial to the maximum speed position. The slowest speed was determined by noting that spot on the dial where the film was just above the flickering point. The middle two speeds were determined by finding what constituted reasonable steps in between the other two speeds. Four speeds were therefore determined: 12, 16, 20, and 24 frames per second.

A method was devised to calibrate the four speeds used. A section of film 318 frames in length was counted. Sufficient leader film was spliced in before this section to give ample time for the projector motor to gain maximum speed prior to the appearance of the fingerspelling sequence on the screen. The sequence was timed by means of a stopwatch for each of the four different settings on the continuously variable dial. Thus the stopwatch was started when the fingerspelling commenced and stopped when it disappeared from the screen. This was done five times at each speed and an average was taken.

The variable of reaction time of the experimenter in timing was not considered to be critical in establishing these four speeds for this particular study. It was difficult to control small variations of speed due to (1) limitations of the projector, (2) possible inaccuracy of the dial setting changes, (3) variation in line voltage, and (3) film

drag changes.

Tachistoscope. An Alphax Tachistoscope, Wollensak Company, with four exposure durations was determined to be correctly calibrated by the following procedure. The signal from a photo-electric cell (attached to the shutter of the tachistoscope) was fed into a Hewlett-Packard, 450-A Laboratory Amplifier; the Amplifier was in turn hooked into a Textronix, 565 Dual-Beam Oscilloscope for monitoring purposes. The oscilloscope presented a concise visual display of the amount of time the shutter had remained open.

The following exposure durations were determined in milliseconds (an average of ten trials) at the four dial settings: at 1/100 second, 15 ms; at 1/50 second, 55 ms; at 1/25 second, 90 ms, and at 1/10 second, 130 ms.

Screen. A 5' X 5' white beaded screen was used for all the visual perceptual tests and for the Craig movie. Since the groups of subjects never exceeded ten, it was possible to seat them directly in front of the screen for maximum visibility.

Summary

A description of the procedures used in this investigation was given according to (1) subjects, (2) measures of language abilities, (3) measures of visual perception, (4) experimental method, and (5) equipment and calibration. A full description of how the tests were created and the directions for administering them was reported.

CHAPTER IV

RESULTS AND DISCUSSION

The major purpose of this research was to make an exploratory investigation of the relationship between speed of visual perception and language abilities in deaf children. A secondary purpose was to perform a factor analysis to see if common factor loadings existed among the various tests. The outcomes of the statistical analyses and discussion of the outcomes are presented in this chapter.

Hypotheses and Description of Analysis

The general null hypothesis tested in this study was there is no relationship between speed of visual perception and language abilities in deaf children. The study was designed to test the following specific null hypotheses:

1. There are no correlations between the various tests of visual perception and those of language.
2. There are no factors extractable from the test data according to the FACANA program.

The hypotheses concerning these relationships were tested by computing Pearson product-moment correlations for all possible pairs of scores. These scores were indicated by abbreviated headings in Appendix D, which contains the general correlation matrix. The scores of the perceptual test battery were arranged in the order of the speed used (fast to slow) or exposure duration. Four speeds or exposure durations were

used in each of the visual perceptual tests and so four scores were obtained. The fifth score, present in Test A, Speed of Perception of Digital Movements (M5), and Test B, Speed of Perception of Letter Sequences (L5), was computed from the number of responses in which all four stimuli of any particular response were identified.

The abbreviations used in the correlation matrix found in Appendix D represent the perceptual test battery as follows: (1) Test A, Speed of Perception of Digital Movements (M1, M2, M3, M4, and M5); (2) Test B, Speed of Perception of Letter Sequences (L1, L2, L3, L4, and L5); (3) Test C, Speed of Perception of Familiar Words (W1, W2, W3, and W4); (4) Test D, Speed of Perception of Pseudo-Symbolic Forms (P1, P2, P3, and P4); and Test E, Speed of Perception of Geometric Figures (F1, F2, F3, and F4).

The measures of language and their abbreviated subdivisions appear as follows: (1) The Craig Lipreading Inventory - words (LR1), and sentences (LR2); (2) The Picture Story Language Test - total number of words (Words), total number of sentences (Sent.), words per sentence (WPS), syntax (Syn.), and abstract concrete (AC); and (3) The Gates Reading Test - speed and accuracy (RS), vocabulary (RV), and level of comprehension (RC).

In addition to the above measures of visual perception and language, the chronological age (CA), and the intelligence quotient (IQ) of each subject were also included in the correlation analysis.

Visual Perception and Language

The correlations between measures of visual perception and those of language were the major concern of the study, since it was designed to determine if any measures of speed of visual perception might be predictive of language learning in the deaf. These correlation coefficients can be found in Table 1 and have been discussed below.

For 38 degrees of freedom a coefficient of .325 or greater was significantly different from zero at the .05 level; one of .418 was significant at the .01 level. Out of the 220 coefficients in Table 1, 112 lacked significance. The majority of these non-significant correlations have been shown in the right portion of the table and were related to Tests D (pseudo-symbolic forms) and E (geometric figures). In other words, the language measures generally were not related to the perception of non-meaningful or non-symbolic stimuli. When Tests D and E were related to the language measures, they were usually related to speechreading scores or the two productivity measures of writing. Now the relationships depicted in Table 1 will be discussed in terms of each type of language skill.

Visual perception and speechreading

The coefficients relating the two speechreading scores (LR1 and LR2) of the Craig film and all the measures of visual perception have been shown in rows 1 and 2 of Table 1. Generally speaking the generalization to be drawn was that speech-

reading was more related to the measures of Test A (M1 through M5) than to the other measures of visual perception (B, C, D, or E). Among the five scores of Test B (letter sequences) there were only two significant coefficients. None of the scores of Test C were correlated to speechreading. There were three instances of significant correlations for Test D, but only one for Test E.

The conclusion was formulated that for those deaf children accustomed to the manual language, the filmed test of fingerspelling was moderately related to speechreading ability, but the tachistoscopic measures were generally not related to speechreading. Perhaps the interpretation of moving forms was common to both fingerspelling and speechreading and therefore accounts for this outcome. The recognition of briefly exposed static forms did not relate as well to speechreading.

Visual perception and writing

These coefficients, between the measures of visual perception and the five scores of written language, have been shown in rows 3-7 of the table. Again it is noted that the scores for Test A were all significantly correlated with every written language measure (mostly r 's of .50 to .60), whereas the scores for the remaining visual perceptual tests were not related in every case. For Tests D and E involving non-symbolic forms there was no correlation with visual perception in many instances.

Thus it was concluded that Test A had a moderate association with written language skill in this group of deaf children. Those children who were able to recognize more letters presented by fingerspelling at high speeds tended to have better written language in terms of productivity, syntax, and use of abstraction. The motion picture test of fingerspelling seemed to hold promise as a predictor of language abilities in those deaf children who rely upon the manual method for social or educational purposes.

Visual perception and reading

Correlations between the three reading scores and those of visual perception have been shown in rows 8, 9, and 10 of Table 1. In this case Test A revealed high correlations (.60's) in many instances with reading ability. The relationship was closer for reading than for speechreading or writing. For Tests B and C the coefficients were not so high and many were non-significant. In no case were Tests D and E related to the reading scores.

The outcomes suggested that the ability to perceive rapid fingerspelling was correlated rather highly with reading in the children used for this study. The relationship was close enough to be predictive. Among the deaf children who relied upon manual communication, those who could identify symbols rapidly on the fingers were also more proficient in reading. It may be that a test of fingerspelling at high speeds would be a good predictor of language achievement.

TABLE 1
Pearson Product-Moment Correlation Coefficients (r)
Relating Measures of Visual Perception
to Those of Language (df = 38).

		Measures of Visual Perception									
		Test A					Test B				
		M1	M2	M3	M4	M5	L1	L2	L3	L4	L5
Measures of Language	1. LR1	.54**	.50**	.53**	.52**	.56**	.32*	.18	.20	.27	.33*
	2. LR2	.46**	.46**	.40*	.36*	.41*	.15	-.13	.02	.04	.08
	3. Words	.60**	.53**	.54**	.46**	.44**	.49**	.37*	.34*	.31	.30
	4. Sent.	.48**	.45**	.44**	.34*	.37*	.42**	.30	.24	.21	.21
	5. WPS	.42**	.44**	.46**	.43**	.32*	.32*	.14	.32*	.22	.23
	6. Syn.	.45**	.36*	.45**	.38*	.40*	.31	.12	.36*	.41*	.24
	7. AC	.50**	.44**	.46**	.47**	.44**	.44**	.27	.45**	.43**	.35*
	8. RS	.68**	.64**	.65**	.53**	.61**	.48**	.38**	.44**	.23	.41*
	9. RV	.69**	.64**	.65**	.64**	.63**	.29	.23	.40*	.31	.44**
	10. RC	.52**	.50**	.47**	.46**	.57**	.36*	.41*	.42**	.40*	.52**

*Significant at .05 level, r of .325.

**Significant at .01 level, r of .418.

TABLE I (continued)

Pearson Product-Moment Correlation Coefficients (r)
 Relating Measures of Visual Perception
 To Those of Language (df = 38).

		Measures of Visual Perception											
		Test C				Test D				Test E			
		W1	W2	W3	W4	P1	P2	P3	P4	F1	F2	F3	F4
Measures of Language	1. LR1	.23	.31	.18	.12	.27	.19	.46**	.42**	-.10	.10	.16	.35*
	2. LR2	.07	.18	.03	-.00	.22	-.02	.33*	.15	-.17	-.05	-.00	.22
	3. Words	.37*	.41*	.22	.15	.26	.31	.60**	.50**	.25	.22	.43**	.36*
	4. Sent.	.14	.16	.03	.07	.26	.27	.51**	.43**	.20	.17	.36*	.16
	5. WPS	.31	.51**	.35*	.37*	.02	-.04	-.04	-.05	.04	.30	.17	.23
	6. Syn.	.32*	.37*	.25	.32*	.04	-.11	.26	-.04	.06	.29	.19	.37*
	7. AC	.42**	.46**	.40*	.32*	-.00	.06	.16	.18	.08	.37*	.28	.30
	8. RS	.28	.30	.19	.13	.08	-.12	.30	.19	.03	.11	.14	.14
	9. RV	.34*	.48**	.43**	.32*	-.08	-.02	.31	.16	.04	.07	.22	.23
	10. RC	.38*	.48*	.38*	.29	-.03	-.04	.13	.17	-.06	.19	.16	.10

*Significant at .05 level, r of .325.

**Significant at .01 level, r of .418.

Intercorrelations of Visual
Perceptual Measures

In general, Tests A, B, and C correlated highly with each other. Only nine of the 91 possible combinations failed to be significantly correlated. Tests D and E, however, correlated non-significantly with the other visual perceptual measures, except for F4 (the slowest exposure speed of Test E) with which 17 of the other visual perceptual test measures correlated. It appeared that of all the measures of Tests D and E, this single element (F4) contributed most. Besides this measure, only 26 of the other 119 possible correlation combinations of Tests D and E correlated significantly. Of these, F2 correlated fairly high with L1 (.48), L3 (.55), and L4 (.54). This seemed to suggest that these two perceptual tests were related in a manner not found in any of the other visual perceptual tasks. Because all of the visual perceptual tests were designed to test speed of visual perception, it did not seem unusual for many of the measures to show relationships.

TABLE 2

Pearson Product-Moment Correlation Coefficients (r) to Indicate
Interrelationships Between the Measures
of Visual Perception (df = 38).

	Test A				Test B					Test C			
	M2	M3	M4	M5	L1	L2	L3	L4	L5	W1	W2	W3	W4
M1	.91**	.94**	.86**	.86**	.52**	.44**	.57**	.45**	.57**	.42**	.59**	.36*	.39*
M2		.94**	.86**	.83**	.51**	.38*	.51**	.41*	.52**	.30	.51**	.28	.29
M3			.92**	.85**	.54**	.44**	.59**	.46**	.57**	.34*	.57**	.37*	.34*
M4				.81**	.47**	.41*	.65**	.55**	.58**	.40*	.60**	.44**	.42**
M5					.41*	.47**	.51**	.45**	.63**	.26	.40*	.19	.33*
L1						.76**	.69**	.54**	.58**	.38*	.49*	.27	.24
L2							.66**	.56**	.62**	.41*	.41*	.31	.29
L3								.86**	.78**	.63**	.66**	.56**	.53**
L4									.78**	.68**	.66**	.60**	.61**
L5										.53**	.60**	.48**	.42**
W1											.72**	.72**	.71**
W2												.75**	.65**
W3													.72**

*Significant at .05 level, r of .325.

**Significant at .01 level, r of .418.

Table 2 (continued)

	Test D				Test E			
	P1	P2	P3	P4	F1	F2	F3	F4
M1	.26	.18	.43**	.30	.04	.28	.34*	.55**
M2	.17	.08	.39*	.27	.16	.27	.30	.43**
M3	.18	.11	.40*	.33*	.11	.33*	.29	.51**
M4	.16	.11	.40*	.35*	.11	.42**	.32	.58**
M5	.31	.09	.36*	.30	.02	.26	.21	.49**
L1	.10	.23	.13	.23	.28	.48**	.32	.34*
L2	-.04	.21	.09	.20	.23	.36*	.29	.28
L3	.09	.16	.23	.15	.22	.55**	.33*	.58**
L4	.02	.14	.30	.20	.18	.54**	.36*	.58**
L5	.13	.29	.25	.32	.18	.35*	.18	.45**
W1	-.00	.18	.38*	.14	.10	.30	.34*	.52**
W2	-.09	.26	.18	.23	.08	.30	.18	.47**
W3	-.29	.10	.16	.19	.04	.17	.15	.43**
W4	.05	.03	.07	-.01	.12	.29	.21	.50**
P1		.34*	.32	.19	-.02	.32	.21	.39*
P2			.14	.34*	.03	.24	.28	.30
P3				.54**	.15	.22	.40*	.40**
P4					.16	.22	.38*	.30
F1						.44**	.51**	.18
F2							.67**	.52**
F3								.49**

*Significant at .05 level, r of 3.25.**Significant at .01 level, r of 4.18.

Intercorrelations of Language
Measures

Due to the established interrelatedness of the various aspects of language (Goda, 1959), it did not seem surprising that the eight language scores (three tests) showed a high degree of relationship. Out of 45 possible correlational combinations, 35 were significantly related. Out of these 35 combinations, 24 were significant at the .01 level of confidence. The following correlations were the highest: (1) LRL/LR2 - .80, (2) Words/Sent. - .88, and (3) RS/RV - .71. Such high relationships might be expected, since the above three combinations were each from their own specific testing area (speechreading, writing, and reading).

TABLE 3

Pearson Product-Moment Correlation Coefficients (r) to indicate
Interrelationships Between the Measures of
Language ($df = 38$).

<u>Lipreading</u>		<u>Writing</u>					<u>Reading</u>		
	LR2	Words	Sent.	WPS	Syn.	AC	RS	RV	RC
LR1	.80**	.43**	.25	.38*	.46**	.35*	.44**	.42**	.44**
LR2		.32*	.19	.40*	.45**	.35*	.40*	.37*	.38*
<u>Writing</u>									
Words			.88**	.13	-.25	.52**	.45**	.42**	.18
Sent.				.13	.14	.51**	.41*	.38*	.13
WPS					.50**	.33*	.41*	.43**	.45**
Syn.						.54**	.42**	.44**	.32*
AC							.56**	.64**	.50**
<u>Reading</u>									
RS								.71**	.62**
RV									.62**

*Significant at .05 level, r of .325.

**Significant at .01 level, r of .418.

Factor Analysis

Description

According to Cronbach (1960),

Factor analysis is a systematic method for examining the meaning of a test by studying its correlations with other variables. The investigator gives a large collection of tests to the same persons. The analysis tries to determine how many distinct abilities are being measured reliably, to detect additional 'trace' abilities which could be measured reliably by modifying the tests, and to reduce the confusion which results when the same ability is given different names in different tests. Factor analysis gives information about the nature and organization of individual characteristics and clarifies what any given test measures. It is used in studies of interests, attitudes, and personality as well as in studies of ability.

A factor analysis may be designed so that there is a relatively large number of loadings (weighted summations of common-factor scores) on some tasks, and small or zero loadings on others. Those tests which load on the same factor might be said to have elements in common. On the other hand, tests which do not load on a factor may be examining abilities which are unique, and may not be related to any of the other tests in a test battery. Such a zero loading, according to Cronbach (1960), may be thought of in terms of a "pure measure." Hence, by critically examining the test loadings on a factor, it is possible for the investigator to make generalizations concerning the abilities being tested. If in seeking a relationship between visual perception and language abilities in deaf children, the tests constructed to measure these abilities

loaded on the same factor, then, there might be reason to believe that these abilities (speed of visual perception and language) were related. Since this investigation was primarily concerned with finding such a relationship, the purpose of the factor analysis was to determine if the tests used (five visual perceptual tasks and three language tasks) were measuring common elements between the variables of speed of visual perception and language abilities, or whether they were measuring unique skills.

The factor analysis was performed according to the FACANA program, using the IBM 7094 Computer. Twenty factors were extracted and rotated to orthogonal simple structure according to the Kaiser varimax method. Only those factors which had two or more loadings on two different measures of .30 or greater were considered, and only loadings of .57 or greater were used to name a factor. Thus, ten of the original twenty factors were considered in the following discussion of the components shared by the entire test battery. The ten rotated factors appear with their respective loadings on the following page.

Factors

Factor I: Symbol recognition and memory

Because 16 test scores loaded on Factor I, the discussion to follow will be organized according to: (1) loadings which defined the factor; (2) the common elements of visual perceptual tests which loaded on the factor; (3) elements

TABLE 4
Rotated Factors

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
1.	.85**	.25	.22	.12	.12	.18	.15	.13	.10	-.05	.01
2.	.89**	.14	.19	-.01	.11	.21	.11	.06	-.02	.04	.07
3.	.90**	.18	.17	.02	.04	.11	.18	.06	.11	.08	.05
4.	.84**	.28	.07	.03	.05	.09	.13	.08	.06	.24	.09
5.	.82**	.10	.07	.21	.07	.15	.22	.23	.14	-.08	.14
6.	.27	.20	.26	.04	.07	.13	.75**	.01	.07	.18	.13
7.	.25	.24	.10	-.06	.13	-.09	.88**	.09	-.03	-.04	.06
8.	.36*	.52*	.06	.07	.10	-.08	.45*	.10	.10	.20	.42*
9.	.22	.60**	.06	.00	.21	.02	.32	.02	.19	.16	.56*
10.	.39*	.42*	-.04	.12	-.04	.04	.39	.20	.02	-.05	.57**
11.	.08	.86**	.12	.04	.18	.07	.17	.12	.04	-.03	.04
12.	.35*	.78**	.14	-.11	-.03	.12	.12	.03	.03	.14	.10
13.	.16	.83**	.01	-.24	-.06	-.03	.06	.18	-.01	.06	.06
14.	.22	.84**	-.08	.11	.09	-.09	.05	.03	.15	-.08	-.03
15.	.13	-.13	.12	.91**	.12	.12	-.02	-.05	-.02	.05	.02
16.	.01	.09	.13	.17	.12	.02	.11	-.06	-.05	.03	.05
17.	.25	.14	.35*	.16	.16	.20	-.07	.00	.08	.01	.05
18.	.16	.06	.25	.04	.14	.12	.06	.03	-.09	.03	.05
19.	.00	.03	.12	-.04	.25	-.10	.13	-.03	.01	.06	.04
20.	.13	.17	-.01	.26	.55*	-.10	.26	.00	.17	.58**	.14

** Loadings used to name the factors.

* Other loadings.

TABLE 4 (continued)

Rotated Factors

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
21.	.14	.11	.21	.08	.85**	-.03	.10	.07	.04	.04	.02
22.	.35*	.43*	.01	.32*	.26	.08	.10	-.09	.18	.06	.07
23.	.35*	.06	.06	.11	-.01	.74**	.16	.12	.20	-.03	.01
24.	.31*	-.04	.13	.08	-.05	.88**	-.12	.11	.12	.02	-.02
25.	.30*	.17	.83**	.10	.09	.15	.18	.04	.05	-.04	-.05
26.	.27	-.08	.88**	.01	.08	.01	.14	.14	.01	.06	.07
27.	.30*	.26	-.12	.00	.11	.23	.04	.14	.19	.05	-.04
28.	.25	.21	.07	-.02	.10	.28	.03	.13	.83**	.05	.06
29.	.23	.29	.43*	-.03	.08	.16	.09	.57**	.33*	.33*	.02
30.	.51*	.03	.19	.02	-.03	.15	.26	.53*	.14	-.07	-.04
31.	.58**	.20	-.21	-.12	-.03	.08	-.03	.66**	.12	-.07	.09
32.	.33*	.28	-.07	-.11	.20	.35*	.20	.60**	-.09	.01	.10
33.	-.11	.09	-.04	-.11	.10	.12	-.12	-.06	-.02	-.00	-.04
34.	.19	.37*	.15	.12	.05	.16	-.00	.05	.01	.04	.05

** Loadings used to name the factors.

* Other loadings.

common to the language tests which loaded on the factor; and (4) elements common to both visual perceptual and language tests which loaded significantly on Factor I.

Loadings which defined the factor. Factor I was defined by Test A, Speed of Perception of Digital Movements, in that all five subdivisions of this test were heavily loaded (M1 - .85, M2 - .89, M3 - .90, M4 - .84, and M5 - .82) and the vocabulary subtest (RV - .58) of the Gates Reading Survey Test. The first of these tests, Test A, was unique from the other visual perceptual tasks in that it required the perception of fingerspelled consonant sequences (four letters per sequence) at real speeds from very fast to slow, controlled by means of a variable speed movie projector. The fifth score (M5) was compiled from the number of responses in which all four of the letter sequences were correctly identified. Vocabulary (RV) measures the range of the pupil's ability to work out the recognition and meaning of words. On this basis, identification of Factor I seemed to be dependent upon (1) the real aspect of speed; (2) the visual perception of form (in this case, form refers to the configuration of the hand and finger positions); (3) the ability to perceive, remember (immediate recall), and record all four letters of any particular response correctly; and (4) the capacity to understand the meaning of words. The mental process that was basic to these tasks seemed to be Symbol Recognition and Memory, the

arbitrary name given to Factor I.

The common elements of the visual perceptual test battery. In addition to the components found in Test A, Speed of Perception of Digital Movements, several other visual perceptual tasks of the test battery were significantly loaded. These measures included (1) two scores of Test B, Speed of Perception of Letter Sequences (L3 - .36, and L5 - .39); (2) one score of Test C, Speed of Perception of Familiar Words (W2 -.35); and (3) one score of Test E, Speed of Perception of Geometric Forms (F4 - .35).

It seemed to be obvious that these tests had the element of speed of perception in common. Test A was based upon the perception of real movement while Tests B, C, and E depended upon speed of recognition of non-moving stimuli. The basic ingredient, however, found in all four of the perceptual tasks of Factor I, appeared to be that of form perception. Test A utilized form in the configuration of the fingers and hand; Test B in the configuration of letters; Test C in the configuration of words and Test E employed form in geometrical configurations. It will be remembered that M5 tested the child's ability to immediately recall all four letters of any particular fingerspelled sequence. L5 tested this same ability, the only difference was that static forms were presented rather than real movement forms.

Elements common to the language tasks. Language test scores which contributed to Factor I were loaded from .30 to .58. They included (1) both divisions of the Craig Lipreading Inventory (LR1 - .35, and LR2 - .31); (2) two divisions of the Picture Story Language Test (Words - .30, and WPS - .30); and (3) all three scores of the Gates Reading Survey (RS - .52, RV - .58, and RC - .33).

LR1 (words) and LR2 (sentences) measured an individual's ability to recognize meaningful movements of a speaker's lips. LR1 required that the subject retain lip movements and associate these movements with meaningful past experiences. In the case of LR2, the recognition of sentences involved in addition to the above, the skill to properly group and sequentialize the movements. LR2 made more demands upon the use of context than LR1.

RS (speed and accuracy test) represented the speed at which a child can comprehend 36 paragraphs of substantially equal difficulty, while RV (vocabulary test) measured the range and difficulty level of the pupil's ability to work out the recognition and meaning of words. The last reading test, RC (level of comprehension test), examined the subject's capacity to comprehend 21 given passages with reasonable thoroughness.

It seemed that since the examinations were designed to test various aspects of language, an underlying element of general language ability probably accounted for the seven significant loadings. Language ability might be further

delineated into receptive and expressive language skills, so that speechreading and reading could be related as expressive skills. The productivity scores may have tested an overall language ability. It has been shown by such investigators as Goda (1959) that if a deaf child is superior in one language task he will most likely be superior in all aspects of language. This may have explained the interrelatedness of the three language tests on Factor I.

Elements common to both visual perceptual and language tasks. Common elements found in those tasks which loaded significantly on Factor I are discussed according to (1) form perception, (2) speed, (3) immediate memory, (4) language, (5) memory-span, and (6) open-set skill.

All of the visual perceptual tests which loaded on this factor (Tests A, B, C, and E) were constructed with detailed form as one of the basic and important components. Form detail as found in the positions of the fingers and the hand (Test A), letters, and letters in words (Test B and C), as well as geometric figures (Test E) helped define this element. The perception of form was also essential for satisfactory participation on the language measures used in this investigation. Such form was found in the shape of the lips (LR1 and LR2) as well as in the letter configurations of words found in the remaining language tasks (Words, RS, RV, and RC) which loaded on Factor I. All of the above mentioned tasks required the individual to visually discriminate or match small form details.

All of the visual perceptual tests which loaded on Factor I included speed of perception at either four different exposure times (Test B, C, D, and E) or at four different projection speeds (Test A). This element was also present in both of the lipreading tests (LR1 and LR2), as well as in the speed and accuracy test (RS) of the reading tests.

The element of immediate memory was required on all of the visual perceptual tests which loaded on Factor I as well as both of the speechreading tests. For example, after each presentation of either the movie or the tachistoscopic stimuli, the subjects were required to record or pick the appropriate response within five seconds after the stimulus had been presented. It was evident that there had to be an immediate response in lipreading or the memory trace would be lost.

Language symbols were present in a non-meaningful way in Test A of the visual perceptual test battery. Consonantal letter sequences of this examination were fingerspelled at four projector speeds. Test B also used language symbols (consonantal sequences) in a basically non-meaningful manner. Test C incorporated four-letter familiar words. It might be argued that those visual perceptual tasks which included meaningful language symbols would be related to the standardized language measures because of this aspect rather than the visual perceptual and speed factor. This was more true, though, for Test C which included familiar

words, than it was for Tests A and B which incorporated language symbols without much meaning.

Memory-span is a term which has been used to describe the amount of information that can be internalized through the visual channel at any given instant. Two of the perceptual test measures (M5 and L5) as well as two of the language measures (LR1 and LR2) were dependent upon this element. It will be remembered that M5 and L5 represented those responses in which a subject could correctly internalize all four stimuli during any one particular movie or tachistoscopic response sequence (in the case of the movie, the four consonantal stimuli were fingerspelled in sequence, while in the tachistoscopic presentations, all four letters of a sequence were exposed simultaneously). The task of speechreading single words as well as sentences necessarily involved a similar ability. Even a short word, such as "pencil" as used in the Craig Lipreading Inventory, involved a number of rapid sequential lip movements which had to be internalized or memory coded for processing purposes. The numerous lip movements present when a sentence is spoken make greater demands upon memory.

Open-set skill, the final component of Factor I, was present in many of the tests (both visual perceptual and language) of this investigation. In order to possess this skill, the subject had to be capable of providing his own comparison stimuli against which to match the perceived

stimulus or the required task. This could be more easily understood by examining Tests A, B, and C. No multiple-choice answer form was provided for these tasks: the subject recorded what he saw without the aid of a visual reference. In essence, he had to rely upon past learning in order to accomplish this task satisfactorily. For example in Test A, Four-letter sequences were fingerspelled at various speeds and had to be perceived and recorded without the aid of a visual reference system. In Tests B and C, the same type of skill was required. The student was required to use a previously learned reference system in order to recognize and record the letter sequences or familiar words.

Both of the speechreading measures (LR1 and LR2) as well as all of the productivity scores in writing also required this capacity. For instance, when an individual was receiving information by means of lips movements, he had to refer to past experiences or memory traces which no one other immediate source could supply. In the same sense, when a child was asked to write an original composition, he had to accomplish the task without outside assistance. Again, he had to rely upon an open reservoir of words and language patterns to accomplish such an assignment.

The general null-hypothesis which was to be tested in this study was there is no relationship between speed of visual perception and language abilities in deaf children.

This hypothesis was rejected at the .01 level of confidence on the basis of the evidence compiled from the correlation matrix and more specifically from the information indicated in the loadings of Factor I. Nine of the visual perceptual tasks loaded as did seven of the language scores. The second hypothesis formulated at the outset, that there were no factors extractable from the test data, was also rejected on the basis of the results of the factor analysis.

Factor II: Rapid recognition of reduced symbols

Eight test scores loaded on Factor II. Those tasks which loaded significantly enough to define the factor included (1) all four scores of Test C, Speed of Perception of Familiar Words (W1 - .86, W2 - .78, W3 - .83, and W4 - .84); and (2) the slowest exposure time of Test B, Speed of Perception of Letter Sequences (L4 - .60). According to these loadings, Factor II included mainly the rapid identification of letter sequences and familiar words. An arbitrary name given to Factor II was Rapid Recognition of Reduced Symbols. The concept "reduced" was included because the stimuli of these tests were partially deleted.

The other test measures which contributed to Factor II included (1) one other exposure time of Test B (L3 - .52); (2) the memory-span element of Test B (L5 - .42); and (3) intelligence (IQ - .37). It was interesting to note that intelligence (IQ) loaded with the seven visual perceptual scores. From the results of testing hundreds of thousands

of men in the armed forces, Davis (1947) also determined by means of a factor analysis that perceptual speed and basic mental ability were related. Spearman (1923) also suggested that perception involved great speed (especially visual perception) and contributed to cognition.

It is apparent that a relationship existed between Factor I and Factor II because both of these factors loaded on some of the same test measures. The biggest difference between the two factors in this respect, however, was that Factor II loaded on four more tachistoscopic test measures (L3, L4, L5, W1, W2, W3, and W4) than did Factor I (L3, L5, and W2).

The rapid perception of static forms was the common element found in Test B and C. Speed of the visual perception of form, memory-span, and intelligence were therefore the interrelated elements of this factor.

Factor III: Language productivity

Factor III was named Language Productivity since both total number of words (Words - .83) and total number of sentences (Sent. - .88) of the Picture Story Language Test were heavily loaded. Two other measures, Test B, Speed of Perception of Letter Sequences (L2 - .35) and the abstract-concrete score (AC - .43) of the Picture Story Language Test helped to further define the factor.

According to these loadings, the ability to perceive,

remember, and record letter configurations was somehow related to productivity in written language. It seemed most likely that the deaf child who was better equipped to perform on language productivity tasks, was able to do so because he had a larger reservoir of useable words at his command. One could only speculate that the superior visual perceptual ability (as evidenced in L2) had permitted this more profitable and quantified use of language because the visual channel could more readily take in and retain needed information (in this case letter configurations). That was, if visual input was increased, language output could be advanced.

It has been previously stated that the abstract-concrete scale (AC) measured the child's ability to use imagination in writing. Imagination, productivity, and speed of visual perception of form configurations, then, were the basic ingredients of Factor III. It seemed credible that imagination in a deaf child's written language was only made possible because he had at his command the needed words; hence, the relationship of imagination to productivity. So it seemed that the elements of imagination and speed of visual perception of form were more closely tied to the productivity measure than they were to each other.

Factor IV: Recognition of non-symbolic forms

Since two measures, Test D, Speed of Perception of Pseudo-Symbolic Forms (P1 - .91) and Test E, Speed of Perception of Geometric Forms (F4 - .32) loaded on Factor IV, it was

appropriately named Recognition of Non-Symbolic Forms.

Speed and the perception of form (either geometric configurations, or form configurations which resemble alphabets other than English) appeared to be components inherent to this factor.

Factor V: Speechreading

Factor V was named Speechreading since both tests (LR1 - .74, and LR2 - .88) of the Craig Lipreading Inventory loaded heavily on it. Level of comprehension (RC - .35) helped to further define the factor.

The three test measures seemed to be related in that they all required the individual to perceive form configurations (shape of the lips and word form) and to perform at a high level of comprehension. Also, all three measures seemed to require that the individual give his full attention (both visually and mentally) if essential information was to be satisfactory received. The ability to "fill in" for those elements not fully comprehended or visually related (from the context provided) may have also been a factor common to the three measures. For instance, it was not always possible to match every lip movement with the correct word it represented; too many sounds were hidden from the receiver for a continually positive identification. Due to the language handicap that sensory deprivation imposes upon deaf children, a difficulty in supplying context will probably occur in reading as well as in speechreading.

Factor VI: Speed of perception of letters

Three exposure times of Test B (L1 - .75, L2 - .88, and L3 - .45) and the memory-span measure of the same test (L5 - .39) loaded on Factor VI. Since the two fastest exposure times (L1 and L2) defined the factor, it was named Speed of Perception of Letters. It was evident that Factor VI was related to Factors I and II in that some of the same loading combinations occurred among them. The elements of speed, letter form perception, and memory-span were therefore commonly shared by the measures of this factor. Factors I and II were general factors, whereas Factor VI was specific to letter recognition.

Factor VII: Abstraction and language-decoding

Factor VII was named the Abstraction and Language-Decoding factor because the abstract-concrete score (AC - .57), vocabulary (RV - .66), and level of comprehension score (RC - .60) were loaded above the .57 level. Speed and accuracy (RS - .53) provided additional factor information.

The elements of this factor seemed to be dependent upon a child's ability to decode a symbol system (the three measures of reading) and imaginatively use a variety of word symbols in a connected manner as an expression of written language. It seemed to represent inner language, or the child's capacity to think and to associate meaning with symbols.

Factor VIII: Syntax

Factor VIII was named by the syntax score (Syn. - .83) of the Picture Story Language Test. Such a measure examined an individual's skill to use grammatically correct language. This particular factor was further defined by the abstract-concrete score (AC - .33) of the Picture Story Language Test, which tested a child's imaginative skill in creative writing.

Factor VIII was different from all of the other factors in that it was the only one upon which the syntax measure loaded significantly; thus it was named Syntax.

The ability to use syntax or the grammar of the language correctly necessarily required well founded language habits. Due to the interrelatedness of language, it was not surprising that another language measure, the abstract-concrete score, loaded with it. Certainly the highest levels of thinking requires a good command of connected language if the individual is to think with "words."

Factor IX: Speed of perception of geometric forms

The name Speed of Perception of Geometric Forms was given to Factor IX, since Test E, Speed of Perception of Geometric Forms was more heavily loaded (F2 - .58) than the other test measure (AC - .33). Factor IX seemed to be unique in that the elements of speed of perception of geometric form and the imaginal aspect of producing written language had not previously loaded together.

The skill needed to perform well on these two measures might have been tied in with yet another capacity: the ability to think in an unstructured manner. To illustrate this, a deaf child who performs well on Test E, may have been able to do so because in making his choice, he did not need to rely upon past experience. This unstructured manner of perceiving or thinking, may well be closely related to the imaginative production of written language.

Factor X: Memory-span

Memory-Span was the name given to Factor X because of test measures loading on it, only L5 of Test B, Speed of Perception of Letter Sequences loaded high enough to be a naming measure (.57). Memory-span in this investigation, as previously discussed, involved the ability to correctly perceive all four stimuli (letter sequences) as they were simultaneously exposed at various exposure times. The difference between Factor X (L3 - .42, L4 - .56, and L5 - .57) and Factor VI, Speed of Perception of Letters (L1, L2, L3, and L5) was that in the latter factor, more and faster speeds loaded. Factor X was also more dependent upon memory-span than was Factor VI. Factor X seemed to be unique in that it was the only factor upon which L5 loaded high enough to be used as a naming variable.

Discussion

The data from the correlation matrix and the ten factors from this matrix show the visual perceptual and language elements of the test battery to be positively related. Very few of the visual perceptual measures failed to load significantly with the language measures or outside visual perceptual scores. To clarify this point, most tests loaded with completely different outside measures (i.e., M1 and RS) and did not always load within the scores of the same measure (i.e., L1, L2, and L3). This permitted a base upon which to build the elements of the particular factor being considered. For instance, Factor I loaded on at least one score of every test in the test battery except chronological age (CA) and intelligence quotient (IQ), and Test D, Speed of Perception of Pseudo-Symbolic Forms. Factors which loaded only within a single measure include Factor VI (L3, L4, and L5), Factor VIII (Syntax and AC), and Factor X (L3, L4, and L5). However, even these scores did not measure the same ability within a particular test. For example, L1, L2, and L3 measured something slightly different (speed of perception of letter forms) from L5 (memory-span). The same analysis holds true for Factor X. Syntax and the abstract-concrete score of the Picture Story Language Test, although they were both language measures from the same test, measured completely different aspects of written language.

It seemed worthwhile to examine those measures which did not significantly load with any outside test scores. These measures included: (1) P2, P3, and P4 of Test D, Speed of Perception of Pseudo-Symbolic Forms; (2) F1 and F3 of Test E, Speed of Perception of Geometric Forms; and (3) chronological age (CA).

Chronological age represented the only single score that did not significantly load with any other measure. Even the two visual perceptual tests mentioned above had at least one score which significantly loaded with other test measures (P1 and F2). It may be credible that the range of ages represented by the subjects (12 to 17 years) was not wide enough to create a correlation with any of the other variables. Or it may be explained by the fact that the deaf child reaches a plateau in language development, and in some aspects of language shows practically no progress beyond 11 years of age (Myklebust, 1964a). Therefore age did not make any difference with respect to language; the same seemed to hold true for speed of visual perception.

The five scores of the two visual perceptual examinations that did not load with any of the other measures, presented a more difficult problem for discussion. The exposure rates of these tests may not have been fast enough (due to the limitations of the tachistoscope) or the tests themselves may have been too difficult. It was possible

that they simply were not satisfactorily measuring what had been originally intended. Since this investigation represented only an exploratory effort, none of the visual perceptual tasks were standardized.

It is apparent that there were elements which were partially shared by the ten factors. For instance, Factors I, II, VI, and X all share L5 or the element of memory-span for letter sequences. See Table 4 for other factor relationships.

The five visual perceptual tasks constructed for the investigation were based on the perception of real movements or static forms (finger movements, letters, words, pseudo-symbolic, and geometric). For the most part, the three factors (I, II, and III) which loaded on both visual perceptual and language elements, loaded on the higher speeds of the visual perceptual tests. For instance, Factor I loaded on all speeds (M1, M2, M3, and M4); Factor III on the second fastest speed (L2); and Factor IX on the second fastest speed of that measure (F2). These loadings suggested that language ability in general (as determined by the tests used in the investigation) was positively related to the perception of the faster, rather than the slower, real movements and briefly exposed forms of the visual perceptual test battery. These results seemed to give credance to the hypothesis that the ability to visually perceive rapid movement or to recognize forms quickly was .

somehow linked to the overall pattern of language acquisition. The initial language intake systems of the deaf (speechreading, fingerspelling, or manual signs) seemed to be based upon rapidity of visual perception. It seemed logical that those deaf children who were more attentive to visual cues or who quickly synthesize visual information from the world, would be more likely to develop language at a faster rate. This hypothesis did not seem to be too distant from thoughts expressed by Spearman (1923) who concluded that perception (he theorized that speed is inherent in perception) was a basic element of the cognitive process.

The relationship which appeared to exist between speed of visual perception and the acquisition of language in the deaf was illustrated by the model which appears on the following page. According to this model receptive language could be learned either through the avenue of form movement or form non-movement (the former usually is the preferred method in early language instruction). Both of these avenues were tested in the visual perceptual test battery of this investigation (both static and real movement form as found in the movie and tachistoscopic tests, and non-movement form as found in the graphic symbol or word). The results of the data analysis suggested that these two avenues might well be important variables to consider in the language acquisition of deaf children, especially the form movement avenue.

Early language environment for the deaf child, while

Figure 1

A Theoretical
Model of Receptive and Expressive
Language Acquisition
In The Deaf

soundless, is usually composed of the sensation of the movements of people and things. As he grows older, he learns to visually perceive the image form of these movements (lips, fingers, or hands) and connect them with meaningful experience.

The model also brought together receptive and expressive language (only writing was used as an expressive measure in this study) to an important juncture; for it is only after the deaf child has reached the point where he can internalize and remember experiences in a meaningful manner that expression is possible (Myklebust, 1964a). Ideally this point may have come on the receptive side of the model at the point of conceptualization (where experience is classified into categories). It also could be possible that the child may have been ready at an earlier stage (symbolization).

Summary

The outcomes of the statistical analyses and a discussion of the outcomes were presented in this chapter. A high correlation was shown to exist between fingerspelling and the reading measures. This correlation seemed to be high enough to support a theory that Test A, Speed of Perception of Digital Movement might be valuable as a predictor of language abilities in deaf children. The following ten factors were extracted and named from the test data:

(1) Factor I: Symbol Recognition and Memory; (2) Factor II: Rapid Recognition of Reduced Symbols; (3) Factor III;

Language Productivity; (4) Factor IV: Recognition of Non-Symbolic Forms; (5) Factor V: Speechreading; (6) Factor VI: Speed of Perception of Letters; (7) Factor VII: Abstraction and Language-Decoding; (8) Factor VIII: Syntax; (9) Factor IX: Speed of Perception of Geometric Forms; and (10) Factor X: Memory-Span. In general the data from the correlation matrix and the ten factors from this matrix showed that the measures of visual perception and language were positively related.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

The basic aim of the present investigation was to explore the relationship between speed of visual perception of form and certain language abilities of deaf adolescents. Thirty-nine deaf children, ages 12 - 17 years, from two state residential schools for the deaf served as subjects. Only subjects with an average hearing loss of 75 dB (or greater) in the better ear for the frequencies of 500, 1,000, 2,000, and 4,000 Hz were used.

A battery of five visual perceptual tests and three tasks of language were administered for a total of 32 different scores. Chronological age and the intelligence quotient were also included for a total of 34 measures.

Results of Pearson product-moment correlations revealed many of the tests of the visual perceptual battery to be related to the language tests at the .01 level of significance. The most predictive relationship was between the motion picture (Test A) and measures of speechreading, writing, or reading. Test A seemed to offer promise as a predictive device for language achievement in deaf children accustomed to the manual method.

In order to secure additional relationships and to determine whether or not common elements were present among

the various tests, the correlation matrix was converted to a factor matrix by means of a factor analysis. The following ten factors were extracted:

Factor I. Factor I was named the Symbol Recognition and Memory factor. Sixteen different measures were related in terms of speed, immediate memory, language, memory-span, or open-set skill.

Factor II. Eight test scores loaded on Factor II which was termed the Rapid Recognition of Reduced Symbols factor.

Factor III. Factor III, the Language Productivity factor, was so named because of the loadings on that part of the Picture Story Language Test. It related to number of words produced and sentence length in writing.

Factor IV. Factor IV was named the Recognition of Non-Symbolic Forms factor due to the heavy loadings on tests of perception of pseudo-symbolic and geometric forms.

Factor V. Both scores of the Craig Lipreading Inventory loaded heavily on Factor V and thus the factor was called the Speechreading factor.

Factor VI. The name Speed of Perception of Letters was given to Factor VI. Factor VI was related to Factors I and II due to similar loading combinations.

Factor VII. Factor VII was named the Abstraction and Language-Decoding factor. It contained elements of use of abstraction in writing, richness of vocabulary, and compre-

hension and speed in reading.

Factor VIII. The name Syntax factor was given to Factor VIII because of the heavy loading of that element on the Picture Story Language Test.

Factor IX. The elements of speed of perception of geometric form and the imaginational aspect of writing loaded on Factor IX. The name, Speed of Perception of Geometric Forms was attached to it because the heavier loading was in the first element.

Factor X. Finally, Factor X was given the name Memory-Span since L5 of Test B, Speed of Perception of Letter Sequences was the defining element.

Conclusions

The results of this investigation suggested that there was a relationship between speed of visual perception of form and language abilities in deaf children. The correlation coefficients obtained showed such a relationship as did the common element loadings on the different factors. As has been previously discussed in the introduction, it was hypothesized cautiously that those deaf children who were better equipped at an early age to take in the rapidly moving language stimuli presented by means of the lips, hands, and fingers were in a better position to learn the complexities of the language. This could be directly observed in those children who had the ability to

do well on both measures.

Since this investigation represented only an exploratory effort, the results should be viewed in terms of future research. Immediate consideration might be given to using speed of visual perception as a predictive factor in the acquisition of language in the deaf. In order to obtain a more complete picture of these possibilities, a similar battery of tests might be given, but equipment capable of threshold determination should be used.

Recommendations for further study

1. A replication of the study using the same number of test measures, but with a larger and younger age group (7-11 years), as well as with the age group used (12-17 years). Equipment capable of variable speeds high enough to obtain thresholds would be desirable.
2. Standardization of a movie of fingerspelled letter sequences to be used for predictive and research purposes.
3. A study of the differences between the speed of visual perception and language abilities among deaf children from hearing homes and those from homes whose parents are deaf.
4. A longitudinal study to determine the effects of training in speed of visual perception of form on language abilities in the deaf.

APPENDIX A

SUBJECT DESCRIPTION

Subject Description

Subject Number	Sex	Race	Hearing Loss in Frequency (Hz)					Etiology	Parents	
			500	1,000	2,000	4,000	Average		Hearing	Deaf
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1.	F	C	55	70	80	95	75	Endogenous	X	
2.	M	C	70	80	90	95	84	Endogeneous	X	
3.	F	C	NR	NR	NR	NR	NR	Exogenous, 1 year	X	
4.	M	N	80	100	NR	NR	90	Endogenous	X	
5.	M	C	NR	NR	NR	NR	NR	Exogenous, 14 months	X	
6.	M	C	NR	NR	NR	NR	NR	Undetermined	X	
7.	F	C	80	80	NR	NR	80	Endogenous		X
8.	F	C	75	90	NR	100	88	Endogenous	X	
9.	F	C	NR	90	NR	NR	90	Exogenous, 1 month	X	
10.	F	C	90	100	100	100	98	Exogenous, 3 years		
11.	F	C	75	95	100	100	92	Endogenous		X
12.	M	C	80	95	NR	NR	88	Endogenous		
13.	M	C	70	90	95	NR	85	Endogenous		
14.	F	C	85	100	NR	NR	92	Endogenous	X	
15.	F	C	100	95	100	NR	98	Exogenous, 8 months		X
16.	M	C	80	95	NR	NR	88	Exogenous, 1 year		
17.	M	C	80	100	100	100	95	Endogenous		X
18.	M	C	80	100	100	100	95	Endogenous		X
19.	M	C	75	95	95	NR	82	Exogenous, 13 months	X	
20.	M	C	75	100	NR	NR	88	Endogenous		

Subject Description

Subject Number	Sex	Race	Hearing Loss in Frequency (Hz)					Etiology	Parents	
			500	1,000	2,000	4,000	Average		Hearing	Deaf
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
21.	F	C	65	80	95	90	82	Endogenous	X	
22.	F	C	95	NR	NR	NR	95	Endogenous	X	
23.	M	C	90	100	100	100	98	Endogenous		X
24.	M	C	75	75	85	65	75	Endogenous	X	
25.	M	C	75	80	NR	100	85	Undetermined	X	
26.	F	C	95	NR	NR	NR	95	Endogenous	X	
27.	F	N	55	95	NR	NR	75	Endogenous	X	
28.	M	C	80	90	NR	NR	85	Undetermined	X	
29.	F	C	85	110	110	110	104	Exogenous, 7 months	X	
30.	M	C	90	95	90	95	92	Endogenous	X	
31.	M	C	65	85	95	NR	82	Undetermined	X	
32.	F	C	80	95	100	100	94	Exogenous, 2 years	X	
33.	M	C	80	100	100	NR	95	Undetermined	X	
34.	M	C	90	100	NR	NR	95	Undetermined	X	
35.	M	C	75	95	NR	NR	85	Endogenous	X	
36.	F	C	75	95	NR	NR	85	Endogenous	X	
37.	F	C	70	90	95	100	88	Endogenous	X	
38.	F	C	75	80	80	75	78	Endogenous		X
39.	F	C	80	80	85	85	82	Endogenous		X

* NR's were not averaged.

APPENDIX B
STIMULUS LISTS
AND
ANSWER KEYS

TEST A, SPEED OF PERCEPTION
OF DIGITAL MOVEMENTS

Answer Key

1. lcsf	11. pskc
2. dtyc	12. ltgd
3. bfkx	13. wnxh
4. tmbn	14. gsyv
5. lsbc	15. ydkv
6. plnx	16. pvls
7. hkcl	17. rnzh
8. wshv	18. gwpz
9. fpbt	19. fdkt
10. yxsn	20. dflc

TEST B, SPEED OF PERCEPTION OF LETTER SEQUENCES

Answer Key

1. nxys	21. yxsn	41. xsny	61. sxyn
2. klch	22. hckl	42. khlc	62. lkch
3. mtnb	23. tmnb	43. tnbm	63. btnm
4. wpzq	24. wqpz	44. wpqz	64. qwzp
5. ctyd	25. yctd	45. ytdc	65. tydc
6. vpls	26. plsv	46. pslv	66. lvps
7. ykvd	27. dvyk	47. vykd	67. yvkd
8. pcks	28. psck	48. sckp	68. pkcs
9. svyc	29. yscv	49. ysvc	69. svcy
10. slcf	30. scfl	50. clsf	70. sclf
11. zhnr	31. znrh	51. znhr	71. zrhn
12. wtnx	32. nwtx	52. nwxt	72. wntx
13. dtfk	33. dkft	53. dftk	73. dfkt
14. wskf	34. fwsk	54. fswk	74. fskw
15. jsle	35. jscl	55. sclj	75. sjlc
16. swvh	36. svwh	56. swhv	76. shvw
17. tdcl	37. tlcd	57. tcld	77. tedl
18. fpty	38. ftpy	58. ftyp	78. fytp
19. pnlx	39. plxn	59. pxln	79. pxnl
20. dcfl	40. dlcf	60. dfcl	80. dclf

TEST C, SPEED OF PERCEPTION OF FAMILIAR WORDS

Answer Key

1. tire	21. else	41. live	61. seed
2. nest	22. bush	42. them	62. room
3. true	23. hurt	43. pass	63. that
4. thin	24. sell	44. vase	64. ship
5. shoe	25. case	45. drop	65. rich
6. nuts	26. ache	46. east	66. most
7. with	27. neck	47. slip	67. hand
8. sled	28. ride	48. fold	68. hunt
9. pink	29. take	49. pond	69. such
10. cart	30. scab	50. need	70. near
11. ways	31. star	51. shop	71. five
12. tree	32. cars	52. turn	72. feed
13. chew	33. skin	53. next	73. nest
14. rose	34. knee	54. plow	74. poor
15. king	35. tray	55. weed	75. move
16. park	36. sing	56. race	76. camp
17. wait	37. find	57. year	77. knit
18. suit	38. fair	58. loud	78. send
19. sack	39. path	59. yard	79. wide
20. dish	40. jump	60. gray	80. west

TEST D, SPEED OF PERCEPTION
OF PSEUDO-SYMBOLIC FORMS

TEST E, SPEED OF PERCEPTION
OF GEOMETRIC FIGURES

APPENDIX C

RAW SCORES

RAW SCORES FOR THE ENTIRE GROUP OF SUBJECTS (N = 39)

Subjects	M1	M2	M3	M4	M5	L1	L2	L3	L4	L5	W1	W2	W3	W4	P1	P2	P3	P4
1.	68	70	68	71	45	56	61	60	68	22	16	14	16	20	12	11	16	15
2.	42	46	49	51	0	42	47	40	41	5	6	10	13	7	9	12	13	16
3.	12	7	28	47	3	35	57	51	58	12	9	8	16	15	8	11	10	11
4.	7	16	18	33	0	17	53	38	43	10	8	8	13	15	7	9	6	12
5.	22	33	32	32	0	38	40	39	45	1	4	2	6	11	14	9	9	7
6.	12	33	30	35	0	26	36	42	40	0	1	2	6	8	5	6	8	10
7.	70	72	73	72	50	36	55	51	53	17	7	10	11	15	13	12	14	12
8.	62	65	66	70	40	63	70	70	74	45	10	11	11	11	12	9	12	14
9.	42	40	42	42	13	34	43	43	46	11	12	14	14	12	10	12	13	12
10.	41	45	47	52	7	45	56	55	56	9	9	10	15	15	4	13	8	10
11.	60	42	57	45	25	45	68	55	59	23	14	13	17	18	7	9	10	10
12.	44	39	49	57	8	29	47	56	55	15	12	12	17	16	6	8	10	9
13.	36	38	43	53	4	10	0	50	63	15	13	13	17	19	12	10	13	12
14.	65	61	66	69	30	42	58	51	45	16	11	11	12	16	11	9	12	12
15.	47	47	56	59	9	48	53	60	60	16	14	14	17	19	4	6	10	11
16.	39	39	37	51	2	48	47	52	60	11	12	15	15	18	6	10	10	11
17.	49	61	60	61	20	52	64	60	63	26	16	14	16	19	11	13	9	10
18.	41	51	53	57	17	61	67	72	72	47	14	17	18	18	6	11	12	12
19.	32	36	43	50	2	51	53	52	59	18	13	14	18	18	7	6	11	12
20.	45	49	54	58	18	40	50	56	63	18	9	14	18	18	10	10	8	14

RAW SCORES FOR THE ENTIRE GROUP OF SUBJECTS (N = 39)

Subjects	M1	M2	M3	M4	M5	L1	L2	L3	L4	L5	W1	W2	W3	W4	P1	P2	P3	P4
21.	64	62	65	67	32	63	60	63	63	21	6	14	12	13	11	11	10	11
22.	32	53	53	56	9	32	37	38	48	1	6	8	15	11	4	3	11	9
23.	50	61	65	66	21	53	62	58	63	18	8	12	19	20	5	9	11	14
24.	66	71	68	67	41	53	60	61	61	28	10	14	17	16	5	6	7	10
25.	61	64	63	64	31	48	54	62	51	13	15	11	16	18	11	6	14	12
26.	53	46	45	59	24	35	48	52	59	11	12	9	14	18	9	7	11	11
27.	62	59	66	68	32	62	67	69	71	39	15	17	20	18	11	13	10	14
28.	56	57	63	67	23	41	37	34	33	2	4	9	8	10	10	11	11	14
29.	14	19	22	16	0	32	33	19	28	1	1	4	7	13	9	7	7	11
30.	17	24	29	36	0	29	38	37	47	1	9	7	11	12	8	8	11	10
31.	37	42	42	42	0	34	31	33	28	4	6	9	16	11	7	13	7	11
32.	47	51	60	69	22	46	44	54	46	7	8	15	15	19	10	7	6	10
33.	50	51	49	52	9	37	43	50	46	7	8	10	17	18	10	7	10	8
34.	54	54	52	61	17	58	64	60	65	28	16	14	19	19	10	12	12	12
35.	41	47	47	48	2	46	53	46	57	8	16	12	17	17	6	9	13	14
36.	43	54	51	52	7	41	53	50	54	7	13	17	15	15	6	10	10	9
37.	34	37	38	43	1	51	53	54	57	5	12	13	13	18	8	9	5	7
38.	61	67	65	71	40	40	46	48	58	28	14	14	17	20	6	9	10	10
39.	65	68	65	70	40	28	51	47	64	22	10	16	18	20	6	8	11	12

RAW SCORES FOR THE ENTIRE GROUP OF SUBJECTS (N = 39)

Subjects	F1	F2	F3	F4	LR1	LR2	Words	Sent.	WPS	Syntax	AC	RS	RV	RC	CA	IQ
1.	11	13	15	15	24	27	144	18	80	95	18	25	30	17	180	127
2.	10	9	11	9	19	25	81	14	58	64	8	17	18	14	159	92
3.	7	10	10	11	13	9	20	4	50	87	8	8	15	7	164	76
4.	6	6	7	7	6	8	0	0	0	0	0	0	0	11	166	75
5.	7	9	9	8	8	14	30	10	30	60	1	8	0	0	167	83
6.	10	6	9	7	10	19	36	6	60	83	6	15	11	3	146	74
7.	6	10	10	12	21	23	66	11	60	85	7	19	21	12	165	115
8.	10	12	12	14	18	22	52	8	65	73	7	23	14	11	166	79
9.	6	6	8	10	13	22	72	10	72	89	8	9	15	3	166	71
10.	8	9	11	11	20	26	25	4	62	83	7	12	11	4	193	78
11.	5	6	8	10	19	21	65	7	93	98	7	26	21	14	163	75
12.	10	12	12	12	4	11	17	3	57	90	7	12	19	11	185	76
13.	7	10	10	12	17	26	25	3	83	91	8	11	15	7	169	105
14.	10	10	12	10	21	21	73	7	100	86	8	27	20	7	167	81
15.	8	8	9	10	7	12	78	11	70	79	8	14	14	3	168	85
16.	7	10	11	9	15	19	55	6	92	73	8	15	21	8	195	73
17.	9	13	12	12	15	18	34	2	170	86	8	13	15	14	151	106
18.	10	10	7	10	16	17	39	5	78	82	8	18	21	16	151	102
19.	7	9	9	12	22	27	46	4	115	93	8	19	13	12	193	112
20.	7	9	11	12	17	14	36	5	72	88	7	8	17	6	195	83

RAW SCORES FOR THE ENTIRE GROUP OF SUBJECTS (N = 39)

Subjects	F1	F2	F3	F4	LR1	LR2	Words	Sent.	WPS	Syntax	AC	RS	RV	RC	CA	IQ
21.	6	12	11	12	21	28	55	6	92	96	7	12	13	18	149	71
22.	6	6	5	7	20	26	27	4	67	88	8	16	15	8	197	72
23.	11	13	12	11	7	11	58	10	58	73	8	13	14	3	178	90
24.	7	10	11	7	17	24	40	10	140	98	19	36	43	37	160	81
25.	7	9	10	12	18	24	34	4	85	88	7	32	21	21	161	81
26.	4	9	9	11	16	28	40	7	57	96	13	17	17	15	181	71
27.	7	11	9	12	23	26	94	14	67	95	18	23	16	17	164	100
28.	7	8	9	9	20	23	57	10	57	72	8	18	20	4	162	67
29.	9	7	8	7	13	22	10	2	50	87	4	10	5	8	172	73
30.	8	12	11	10	18	24	29	4	72	81	8	4	8	5	203	73
31.	5	6	8	10	12	20	36	4	90	55	7	17	15	7	172	87
32.	8	11	8	11	18	28	34	2	170	90	8	14	14	12	163	101
33.	10	7	10	12	12	23	56	8	70	66	8	12	23	3	195	71
34.	11	10	12	10	23	25	80	10	80	88	8	17	18	18	162	104
35.	9	10	15	11	17	19	54	7	77	82	8	9	10	12	196	87
36.	8	8	10	9	11	20	65	9	72	78	8	17	16	15	144	88
37.	10	11	9	11	7	12	23	4	57	92	13	12	8	5	149	87
38.	7	5	8	12	22	29	35	5	70	88	8	13	29	15	186	106
39.	9	9	10	12	22	24	47	4	118	99	7	16	19	21	162	95

APPENDIX D
MEAN, STANDARD DEVIATION,
AND CORRELATION MATRIX

Item No.	Mean	Std. Deviation
1	44.69	16.80
2	48.13	15.34
3	50.74	13.89
4	54.85	13.05
5	16.51	15.06
6	42.23	12.10
7	50.23	12.92
8	50.97	10.86
9	54.41	11.10
10	14.82	11.61
11	10.23	4.02
12	11.56	3.68
13	14.67	3.51
14	15.74	3.52
15	8.36	2.69
16	9.26	2.38
17	10.28	2.38
18	11.31	2.04
19	7.95	1.81
20	9.26	2.17
21	9.95	2.00
22	10.49	1.89
23	15.95	5.32
24	20.95	5.72
25	47.90	26.09
26	6.72	3.79
27	77.33	31.71
28	81.97	16.92
29	8.26	3.62
30	15.56	7.07
31	16.28	7.53
32	10.87	6.94
33	170.90	15.84
34	86.49	14.54

Correlation Matrix

	M1	M2	M3	M4	M5	L1	L2	L3	L4	L5	W1	W2	W3	W4	P1	P2	P3	P4	F1	F2	F3	F4	LR1	LR2	WORDS	SENT.	WFS	SYN	AC	RS	RV	RC	CA	IQ
M1		.91**	.94**	.86**	.86**	.52**	.66**	.57**	.60**	.87**	.42**	.59**	.36*	.39*	.26	.18	.43**	.30	.04	.28	.34*	.55**	.54**	.46**	.60	.48**	.42*	.45**	.50**	.68**	.69**	.52**	-.12	.33
M2			.94**	.86**	.83**	.81**	.38*	.51**	.41*	.68**	.30	.51**	.28	.29	.17	.08	.39**	.27	.16	.27	.30	.43**	.50**	.46**	.53**	.45**	.44**	.36*	.44**	.64**	.64**	.50**	-.14	.41
M3				.92**	.85**	.84**	.44**	.59**	.46**	.57**	.34*	.57**	.37*	.34*	.18	.11	.40*	.35*	.11	.33*	.29	.51**	.53**	.40*	.54**	.44**	.46**	.45**	.46**	.55**	.65**	.47**	-.14	.40
M4					.81**	.47**	.41*	.65**	.55**	.58**	.40*	.60**	.44**	.42**	.16	.11	.40*	.35*	.11	.42**	.32	.58**	.52**	.36*	.46**	.36*	.43**	.38*	.47**	.65**	.64**	.46**	-.07	.42
M5						.41*	.47*	.51**	.45**	.63**	.26	.40*	.19	.33*	.31	.09	.36*	.30	.02	.26	.21	.43**	.56**	.41*	.44**	.37*	.32	.40*	.44**	.61**	.63**	.57**	-.18	.36
L1							.76**	.69**	.54**	.58**	.38*	.49**	.27	.24	.10	.23	.13	.23	.28	.48**	.32	.34*	.32	.15	.49**	.42**	.32	.31	.44**	.48**	.29	.36*	-.19	.26
L2								.66**	.56**	.62**	.41*	.41*	.31	.29	-.04	.21	.09	.20	.23	.36**	.29	.28	.18	-.13	.37*	.30	.14	.12	.27	.38*	.23	.41*	-.21	.16
L3									.56**	.78**	.63**	.66**	.56**	.53**	.09	.16	.23	.15	.22	.55**	.33*	.58**	.20	.02	.34**	.24	.32	.36*	.45**	.44**	.40**	.42*	-.20	.34
L4										.78**	.68**	.66**	.60**	.61**	.02	.14	.30	.20	.18	.54**	.36*	.58**	.27	.04	.31	.21	.22	.41*	.43**	.23	.31	.43*	-.02	.42
L5										.53**	.60**	.48**	.47**	.13	.29	.25	.32	.18	.35*	.18	.45**	.33*	.08	.30	.21	.23	.24	.35*	.41	.44**	.52**	-.24	.39	
W1											.72**	.72**	.71**	-.03	.13	.38*	.14	.10	.30	.34*	.52**	.23	.07	.37*	.14	.31	.32	.42**	.28	.34*	.36*	.05	.46	
W2											.75**	.65**	-.09	.26	.18	.23	.08	.30	.18	.47**	.31	.18	.41*	.16	.51**	.37*	.46**	.30	.48**	.48**	-.12	.45		
W3											.72**	-.29	.10	.16	.19	.04	.17	.15	.43**	.18	.03	.22	.03	.35*	.25	.40*	.19	.43**	.18*	.22	.38	.14	.48	
W4											.05	.03	.07	-.01	.12	.29	.21	.53**	.12	-.01	.15	.37	.37*	.32	.32	.13	.32	.29	.14	.24	.24	.24	.24	
P1											.34*	.32	.19	-.02	.32	.21	.39	.27	.22	.26	.26	.02	.04	-.00	.08	-.08	-.03	-.21	.24	.24	.24	.24	.24	
P2												.14	.34*	.03	.24	.28	.30	.19	-.02	.31	.27	-.04	-.11	.06	-.12	-.02	-.04	-.24	.29	.29	.29	.29	.29	
P3												.54**	.15	.22	.43*	.43**	.46**	.33*	.60**	.51**	-.04	.26	.16	.	.	.	.	.	.	.	.	.	.	
P4																.16	.22	.38*	.30	.42**	.15	.50**	.43**	-.05	-.04	.18	.19	.16	.17	.03	.28	.28	.28	
F1																				.44**	.51**	.19	-.13	-.17	.25	.20	.04	.06	.08	.03	.04	-.06	-.10	.27
F2																					.87**	.52**	.10	-.05	.22	.17	.30	.29	.37*	.11	.07	.19	-.06	.33
F3																						.49**	.16	-.00	.43**	.35*	.17	.19	.28	.14	.22	.16	.15	.24
F4																						.35*	.22	.36*	.16	.23	.37*	.30	.14	.23	.10	.15	.49	
LR1																								.80**	.43**	.25	.38*	.46**	.35*	.44**	.42**	.44**	.12	.39
LR2																									.32	.19	.43*	.45**	.35*	.40*	.37*	.38*	.12	.24
WORDS																										.88**	.13	.25	.52**	.45**	.42**	.19	-.08	.41
SENT.																											-.13	.14	.51**	.41*	.38*	.13	-.11	.26
WFS																												.50**	.33*	.41*	.43**	.45**	-.12	.34
SYN.																													.54**	.42**	.44**	.32	-.02	.22
AC																														.56**	.64**	.50**	-.02	.30
RS																															.71**	.62**	-.26	.21
RV																																.62**	-.00	.26
RC																																	-.28	.31
CA																																		-.11
IQ																																		

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