

PRIMARY MENTAL ABILITIES OF DEAF CHILDREN

By

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ABSTRACT

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The Problem.

The purpose of this study is to compare the primary mental abilities of deaf and hearing children, in order to determine whether, potentially, the deaf and the hearing show the same degree and pattern of abilities. The hypothesis which this study attempts to support is that, when the abstract intelligence of the deaf, apart from their ability to verbalize, is measured by an adequate measuring instrument, the deaf closely approximate the hearing in potential capacity. By adequate measuring instrument is meant one which requires no language either in directions or response, yet which correlates highly with verbal measures of intelligence.

In addition to the main hypothesis, several other aspects of the problem are considered. These related studies include: (1) the relationships between type of deafness and test performance, between age of onset and test performance and between degree of loss and test performance; (2) the correlation between scores made by the deaf on the Wechsler-Bellevue Intelligence Test and the Chicago Tests

of Primary Mental Abilities, and (3) the relationship between teacher's estimate of the deaf individual's ability and the individual's performance on these tests.

Major Findings Summarized.

The comparison between the deaf and the hearing on the Wechsler and Thurstone Tests, suggested that the deaf do possess the capacity to develop abstract intelligence, at least those aspects of abstract intelligence which do not depend upon ability to verbalize. Specifically, they show the same ability as the hearing in numerical ability, space perception and memory. When critical ratios of the differences to the standard error of the differences between the deaf and the hearing groups on the six Thurstone factors were computed, no significant differences were found on the three factors mentioned above. The hearing were superior to the deaf in verbal ability, word fluency and reasoning, as measured by this study. Statistical evidence for this conclusion is found in Table IX. The deaf also show the same ability as the hearing in those aspects of intelligence measured by the performance section of the Wechsler. The mean intelligence quotient for the Kendall and Indiana students on the performance section was 106.5; standard deviation, 14.43; standard error, 1.32; which is significantly higher than Wechsler's mean of 100 for hearing individuals.

The mean intelligence quotient for the New Jersey School was 101.8; standard deviation, 14.25; standard error, 1.50; which is not significantly different from Wechsler's norms.

No significant relationships were found between type of deafness and test performance or between degree of deafness and test performance. The relationship between age of onset and test performance was not examined because of insufficient data.

Teachers' estimates of academic ability showed a fairly strong relationship to the appraisal of ability furnished by these tests.

In addition to the answers to these questions, correlations between the Wechsler and Thurstone Tests were computed to determine whether these tests were measuring what is measured by individual tests of intelligence. They were, therefore conclusions can be drawn.

Further Research Suggested.

This investigation was limited to a study of the potential abstract intelligence of the deaf individual. Further studies in which an attempt is made to present instructional materials to the deaf from a visual standpoint, not neglecting training in speech and lipreading as a necessary means of communication, will demonstrate whether, through an emphasis on reading and educational films and other visual aids, the deaf individual could more nearly approach the hearing in educational achievement.

TABLE OF CONTENTS

Chapter	Page
I INTRODUCTION.....	1
Statement of the Problem.....	1
Definitions of Terminology.....	3
Justification for the Study.....	12
II SOURCES OF DATA AND PROCEDURE.....	20
Subjects Tested.....	20
Measuring Instruments.....	21
Procedure.....	27
III SURVEY OF RELATED STUDIES.....	31
Research in Mental Measurements with the Deaf.....	31
Research on Primary Mental Abilities.....	73
IV ANALYSIS OF DATA.....	99
The Criterion for Combining Scores from Different Schools.....	99
Comparison of the Deaf and the Hearing on the Chicago Tests.....	100
Comparison of the Deaf and the Hearing on the Wechsler-Bellevue.....	104
Correlation between the Wechsler-Bellevue and the Chicago Tests of Primary Mental Abilities.....	107
Relationship Between Type of Deafness and Test Performance.....	114
Relationship Between Degree of Loss and Test Performance.....	115
Relationship Between Age of Onset and Test Performance.....	116
Relationship Between Teacher's Estimate and Test Performance.....	117
V SUMMARY AND CONCLUSIONS.....	121
Sources of Data and Procedure Summarized.....	121
Major Findings Summarized.....	124
Implications in this Study.....	126
Further Research Suggested.....	128
BIBLIOGRAPHY.....	129
APPENDIX.....	

LIST OF TABLES

Table		Page
I	THE THURSTONE TEST BATTERY.....	26
II	RELIABILITIES FOR COMPOSITES AS GIVEN BY THURSTONE.....	27
III	EDUCATIONAL QUOTIENTS OF DEAF AND HEARING.....	39
IV	HEARING MENTAL AGES OF FOUR DEAF GROUPS.....	40
V	I.Q.'s REPORTED BY ZECKEL AND VAN DER KOLK.....	58
VI	TESTS OF DRAWING ABILITY.....	62
VII	A COMPARISON OF THE INTELLIGENCE OF THE HEARING, DEAF AND SPEECH DEFECTIVE.....	65
VIII	CHI SQUARE TESTS OF ASSOCIATION.....	100
IX	COMPARISON OF SCORES FOR THE DEAF WITH THE MEAN SCORES FOR THE HEARING ON THE THURSTONE TESTS.	101
X	WECHSLER I.Q. RANGE FOR STUDENTS IN THE THREE SCHOOLS FOR THE DEAF.....	104
XI	PERFORMANCE OF THE DEAF IN THE THREE SCHOOLS ON THE WECHSLER.....	105
XII	CORRELATIONS BETWEEN THE WECHSLER AND CERTAIN OTHER TESTS.....	108
XIII	COEFFICIENTS OF CORRELATION BETWEEN WECHSLER AND THURSTONE SCORES, WITH RELATED CRITICAL RATIOS AND THEIR SIGNIFICANCE.....	109
XIV	CORRELATIONS BETWEEN WECHSLER AND THURSTONE.....	111
XV	RELATIONSHIP BETWEEN TYPE OF DEAFNESS AND TEST PERFORMANCE.....	115
XVI	RELATIONSHIP BETWEEN DEGREE OF LOSS AND TEST PERFORMANCE.....	116
XVII	RELATIONSHIP BETWEEN TEACHER'S ESTIMATE OF ABILITY AND TEST PERFORMANCE.....	119

CHAPTER I

INTRODUCTION

Educators of the deaf find themselves faced with the question whether the handicap of deafness carries with it the incapacity to develop abstract intelligence.¹ Research in the field of mental measurements with the deaf has established that (1) the deaf are from three to four years retarded educationally,² and (2) all verbal tests of intelligence become for them educational achievement tests in language and therefore show similar retardation.³ Even on non-language tests, the best estimate so far is that the average I.Q. of the deaf does not quite reach 90.⁴

Statement of the Problem.

Additional study is needed to show whether the potential capacity of the deaf is below that of the hearing.

The purpose of this study is to compare the primary mental abilities of deaf and hearing children in order to determine whether, potentially, the deaf show the same degree and pattern of abilities. The hypothesis which this study attempts to support is that, when the abstract intelligence

1. Rudolph Pintner, Jon Eisenson and Mildred Stanton. The Psychology of the Physically Handicapped. New York. F. S. Crofts and Co. 1941. p. 129.

2. Ibid. p. 149.

3. Rudolph Pintner. "Contributions of Psychological Testing to the Problems of the Deaf." Proceedings of the International Congress on the Education of the Deaf. Trenton, N. J. 1933. p. 214.

4. Pintner, Eisenson and Stanton. op. cit. p. 127.

of the deaf, apart from their ability to verbalize, is measured by an adequate measuring instrument, the deaf closely approximate the hearing in potential capacity. By adequate measuring instrument is meant one which requires no language either in directions or response, yet one which correlates highly with verbal measures of intelligence.

In addition to the main hypothesis, several other aspects of the problem are considered. These related studies include: (1) the relationships between (a) type of deafness and test performance, (b) age of onset and test performance and (c) degree of loss and test performance; (2) the correlation between scores made by the deaf on the Wechsler-Bellevue Intelligence Test and the Chicago Tests of Primary Mental Abilities, the two tests used in this study; and (3) the relationship between teacher's estimate of the deaf individual's ability and his performance on these tests.

Data on the relationships between type of deafness, age of onset and degree of loss and test performance are included in the hope that they will add to the understanding of the main problem. Do the congenitally deaf possess more abstract ability than do the adventitious? Are those deaf individuals who lose their hearing before entering school more handicapped with regard to academic ability than those who become deaf later in life? Does the amount of hearing loss have any relationship to amount of intelligence? The answers to these questions will not only indicate possible reasons for academic retardation, but may aid the educator in planning an educational program for the deaf.

The correlations between the Wechsler and Thurstone Tests are considered in this study because no similar study on normal individuals was found, and it was felt that some knowledge of the relationship between the performance and verbals sections of these two tests was essential to the understanding of the problem of the abstract intelligence of the deaf.

Definitions of Terminology.

Intelligence. A brief discussion on the nature of intelligence is presented in order to clarify "intelligence" as used in this study and to justify the selection of the two measuring instruments employed.

Binet and Simon, who used a single dimension of mind in differentiating between the bright and the dull,¹ wrote:

It seems to us that in intelligence there is a fundamental faculty, the alteration or the lack of which is of the utmost importance for practical life. This faculty is judgement, otherwise called good sense, practical sense, initiative, the faculty of adapting one's self to circumstances. To judge well, to comprehend well, to reason well, these are the essential activities of intelligence.²

After Binet the dispute over what the term intelligence means began. Certain psychologists decided one must distinguish a Binet I.Q., a Pintner-Paterston I.Q. and any other I.Q. as representing somewhat different kinds of intelligence.³

1. J. P. Guilford. "Human Abilities." Psychological Review. 47. 1940. p. 370.

2. Alfred Binet and Th. Simon. The Development of Intelligence in Children. Translated by Elizabeth S. Kite. Baltimore. The Williams and Wilkins Co. 1916. p. 336.

3. Guilford. op. cit. p. 370.

At the beginning of the century the purpose which was back of the development of the single tests was the measurement of specific mental capacities. There is evidence that the early psychologists did not have in mind, primarily, the measurement of general mental capacity.¹ The development of tests which would measure general capacity, or general intelligence, grew out of the age-scale movement (Binet and his successors) and the correlation movement (Spearman and his successors) both of which directed attention toward general intelligence rather than toward particular mental functions.²

Spearman insisted that the Binet scale, the model for all intelligence tests, was constructed on the basis of his g-factor theory. Others labelled Spearman's "g" factor intelligence.³

Binet appeared to think of intelligence as a kind of composite of a considerable number of types of performance or of the ability to carry on a number of types of performance. At the same time he seemed to regard the ability to carry on these various types of performance as an indication of an underlying characteristic which was not to be identified with any of them. The successors of Binet have likewise refrained from attempting to formulate any exact definition of intelligence. They have been content with a general

1. Frank N. Freeman. Mental Tests. New York. Houghton Mifflin Co. 1939. p. 169.

2. Ibid.

3. Guilford. op. cit. p. 371.

description of the sorts of things that intelligence enables one to do.¹

Spearman, on the other hand, favored factor analysis to distinguish sharply between various abilities, to define them, and ultimately to develop tests to measure them. The factor analysts have criticized the Binet school because their procedure is vague and undefined, empirical rather than psychological.²

Terman, in 1916, called intelligence "the ability to do abstract thinking."³ His 1937 edition of the Binet Scale contains no discussion of the nature of intelligence, but seems to be based upon the same principle.

Thorndike, in 1927, defined intelligence in terms of the difficulty of the tasks a person could do, the number of tasks, and the speed with which he could do them.⁴ He felt that every stimulus-response unit would constitute an ability and the element of the situation to which the response is made would be part of the definition of the ability. If there is such a thing as general ability, he believed it to be merely the sum of all the particular abilities.⁵

1. Freeman. op. cit. p. 432.

2. Ibid.

3. Lewis M. Terman. The Measurement of Intelligence. Boston. Houghton Mifflin Co. 1916. p. 344.

4. Edward L. Thorndike, E. O. Bregman, M. V. Cobb, et al. The Measurement of Intelligence. New York. Teachers College, Columbia. 1927. p. 22-24.

5. Freeman. op. cit. p. 435.

The present theories of primary abilities, as expressed by such men as Kelley and Thurstone, state that correlations between tests can be accounted for by assuming the influence of a limited number of abilities, called primary mental abilities.¹ These abilities are similar to the old faculties except that they are based on an attempt to account for the correlations which are found between tests instead of being based on ordinary observation or common sense.²

Freeman defines intelligence as "the ability to learn acts or to perform new acts that are functionally useful."³ He adds:

This definition leads to a distinction between types or forms of intelligence to fit the diversity of kinds of functionally useful acts... Some would object to making the concept as broad as this. They would confine it to what we ordinarily call the intellectual, that is, to abstract thinking. This, however, seems to be an arbitrary restriction of the term... We would include, then, such diverse types of learning as are involved in manipulation, performing an act of skill, identifying an object, learning names of objects, forming concepts, and solving puzzles or problems of all sorts. These all are evidently means of functional adaptation.

Different types of measures of intelligence may be used to measure the ability to make various types of adaptation.

The form of adaptation that has been most thoroughly explored is success in school... In the meantime, success in vocational pursuits has

1. Ibid. p. 437.

2. Ibid.

3. Frank S. Freeman. "The Meaning of Intelligence." 39th Yearbook. National Society for the Study of Education. 1940. p. 18.

also been used and there has been some attempt to measure 'social intelligence.'¹

Stoddard defines intelligence as "the ability to undertake activities that are characterized by (1) difficulty, (2) complexity, (3) abstractness, (4) economy, (5) adaptiveness to a goal, (6) social value, and (7) the emergence of originals, and to maintain such activities under conditions that demand a concentration of energy and a resistance to emotional forces."²

In summary, then psychologists first spoke of the faculties of the mind. Then a single dimension of mind was referred to and named intelligence. Out of the dispute over the exact nature of intelligence emerged the studies of the factors of the mind, differing from the faculties mainly in that they are analyzed statistically rather than theoretically.

Our present tests are most successful as measures of the composite of mental abilities, which is sometimes called intelligence.³

Thus, it is not merely a facetious statement to say that intelligence is what is measured by intelligence tests. Whether the term intelligence is used, or, to avoid dispute, primary mental abilities, the tests are useful because they enable educators to predict performance in school and in some other situations.

1. Ibid. p. 19.

2. George D. Stoddard. The Meaning of Intelligence. New York. The MacMillan Co. 1943. p. 4.

3. Freeman. Mental Tests. p. 16.

Another comment on intelligence tests by Freeman is significant:

We sometimes speak of tests as though they measured intellectual capacity directly. This, of course, is not true. What they measure is the manifestation of capacity in action or in behavior. Intellectual capacity is not something which can be seen, felt, heard, or measured in any direct fashion. We assume in mental tests that the behavior of the individual expresses or represents the maximum of which he is capable.¹

No attempt has been made to discuss or evaluate all the theories of independent unit or group tests. Rather, a brief overview of the nature of intelligence and some present day theories have been presented. It is the purpose of this investigation to use those measures which have been refined and established through careful research and analysis to compare the mental abilities of the deaf with those of the hearing. In the selection of the Chicago Tests of Primary Mental Abilities, developed by Thurstone, and the Wechsler-Bellevue Intelligence Test, the findings of recognized research are being utilized.

Traxler is expressing the feeling of many present day psychologists when he says that "the use of factor analysis may now be listed as one of the major techniques of personality measurement."²

1. Ibid. p. 20.

2. Arthur E. Traxler. "Brief Overview of the Period. Psychological Tests and Their Uses." Review of Educational Research. 11:1. 1941. p. 7.

And of the Wechsler-Bellevue, Stuit wrote that the method of standardization employed was worthy of special note, and that the test results have agreed remarkably well with clinical judgement.¹

Thurstone and Wechsler concur in their views regarding the nature of intelligence. According to Thurstone,

There is nothing wrong about using a mental age or an intelligence quotient if it is understood as an average of several tests. The error that is frequently made is interpreting it as measuring some basic functional unity when it is known to be nothing more than a composite of many functional unities.²

Wechsler, in defining intelligence for users of his scale, makes a similar statement:

Intelligence is the aggregate or global capacity of the individual to act purposefully, to think rationally and to deal effectively with his environment. It is global because it characterizes the individual's behavior as a whole, it is an aggregate because it is composed of elements or abilities which, though not entirely independent, are qualitatively differentiable. By measurement of these abilities, we ultimately evaluate intelligence. But intelligence is not identical with the mere sum of these abilities, however inclusive. There are three important reasons for this: (1) The ultimate products of intelligent behavior are not only a function of the number of abilities or their quality but also of the way in which they are combined, that is, upon their configuration. (2) Factors other than intellectual ability, for example, those of drive and incentive, enter into intelligent behavior. (3) An excess of any given ability may add relatively little to the effectiveness of the behavior as a whole.

* * * * *

1. Dewey B. Stuit. "Current Construction and Evaluation of Intelligence Tests." Review of Educational Research. 11:1. 1941. p. 9.

2. Thelma Thurstone. "Primary Mental Abilities of Children." Educational and Psychological Measurement. 1. 1941. p. 105.

Although intelligence is no mere sum of intellectual abilities, the only way we can evaluate it quantitatively is by the measurement of the various aspects of these abilities.¹

Both Wechsler and Thurstone use the electricity simile. Wechsler says, "We do not, for example, identify electricity with our modes of measuring it."² We know intelligence by what it enables us to do.

Of his own tests he claims:

We think that they measure general intelligence in the sense defined above. We shall not, however, claim that they measure all that goes to make up general intelligence, because no tests at present are capable of doing it. The only thing we can ask of an intelligence scale is that it measures sufficient portions of intelligence to enable us to use it as a fairly reliable index of the individual's global capacity.³

Thurstone expresses the same feeling in his Vectors of Mind: "Admittedly we are studying but a part of human personality, but that makes the study no less valid."⁴

Thus, various theories as to the nature of the native ability called intelligence have been presented, and the reasons for choosing the measuring instruments designed by Wechsler and Thurstone have been given. In this study, intelligence will be regarded as the aggregate or global capacity of an individual, as the composite of mental abilities.

1. David Wechsler. The Measurement of Adult Intelligence. Baltimore. The Williams and Wilkins Co. 1944. p. 4.

2. Ibid.

3. Ibid. p. 11.

4. L. L. Thurstone. The Vectors of Mind. Chicago. University of Chicago Press. 1935. p. 46.

The Deaf and the Hard of Hearing. A committee on nomenclature, appointed by the Conference of Executives of American Schools for the Deaf, reporting in 1937, recommended that the use of the terms "deaf-mute," "deaf and dumb," "semi-mute," "semideaf" and "mute" be discontinued by educators.¹ The committee defined "deaf" and "hard-of-hearing" as follows:²

The deaf: Those in whom the sense of hearing is non-functional for the ordinary purposes of life. This general group is made up of two distinct classes, based entirely on the time of the loss of hearing:
 (a) the congenitally deaf--those who were born deaf;
 (b) the adventitiously deaf--those who were born with normal hearing but in whom the sense of hearing has become nonfunctional through illness or accident.

The hard-of-hearing: Those in whom the sense of hearing, although defective, is functional with or without a hearing aid.

Methods of Instruction. Deaf children in their schools, being without the sense of hearing, and to a greater or less extent without normal speech, must have some means provided for their education other than through the ear. In the imparting of knowledge to the deaf, or in securing communication with them in the class room, the eye constitutes the most important means to be resorted to.

Out of the two basic means of communication, the oral and manual, have grown the three principal methods of instruction:

A. The oral method. Speech and lipreading are the means of communication, the medium through which all instruction is given.

1. Merle E. Frampton and Hugh Grant Rowell. Education of the Handicapped. Volume Two. Problems. New York. World Book Co. 1940. p. 195.

2. Ibid. p. 196.

B. The manual method. Finger spelling and the sign language are used as the means of communication as well as for instructional purposes.

C. The combined method. All deaf students are given an opportunity, in the first years of their school training, to learn speech and lipreading. Those who seem incapable of profiting from instruction under the oral method are then taught in manual classes.

Justification for the Study.

The question of the type and amount of native ability of the deaf child has not yet been adequately answered. Studies in which the intelligence of the deaf was measured by performance tests are about equally divided in finding the deaf equal to or slightly inferior to the hearing. (For complete details see section on related studies.) At least five such tests--the Kohs Block Designs, the Goodenough Draw-a-Man, the Porteus Maze, the Symbol-Digit and the Drever-Collins--show no statistically significant differences between the deaf and the hearing. Performance tests have been assumed to be inadequate for measuring general intelligence, partly because of the various types of intelligence and partly because such performance tests do not seem to measure all aspects of intelligence.¹ And yet, the correlation between the Kohs Block Designs and the Stanford-Binet

1. Edwin G. Peterson. "Testing Deaf Children with Kohs Block Designs." American Annals of the Deaf. 81. 1936. p. 242.

is .84;¹ between the Goodenough and the Binet, .76;² between the Porteus Maze and the Binet, .77;³ and between the verbal and performance halves of the Wechsler-Bellevue, as follows:

Verbal I.Q. x Full Scale I.Q., $r = .90 \pm .007$
 Performance I.Q. x Full Scale I.Q., $r = .88 \pm .008$
 Verbal I.Q. x Performance I.Q., $r = .71 \pm .018$

When corrected for attenuation the correlations between performance and verbal sections increase significantly, thus:

Verbal I.Q. x Performance I.Q., $r = .83.$ ⁴

Thus, to a large extent, performance tests do appear to measure the same aspects of intelligence as do the verbal tests.

In testing hard of hearing children on a verbal intelligence test and on a non-language test, Pintner found a significant difference between the hard of hearing and the normal child on the first test but not on the second and concluded that the verbal factor in intelligence is what caused the difference.⁵ Goldstein feels that "if effective measurements and accurate tests were devised to record the intelligence quotient of the deaf child, his I.Q. registration would not differ from that of the normal child."⁶

1. Florence L. Goodenough. Measurement of Intelligence by Drawings. New York. World Book Co. 1926. p. x.

2. S. C. Kohs. Intelligence Measurement. New York. MacMillan Co. 1927. p. 157.

3. S. D. Porteus. "The Measurement of Intelligence." Journal of Educational Psychology. 9. 1918. p. 19.

4. Wechsler. op. cit. p. 124.

5. Rudolph Pintner and Joseph Lev. "The Intelligence of the Hard of Hearing School Child." Journal of Genetic Psychology. 55. 1939. p. 44.

6. Max A. Goldstein. Problems of the Deaf. St. Louis. Laryngoscope Press. 1933. p. 251.

The difference between the educational quotient of the deaf and hearing child is easily explained. The deaf child lacks the language to compete academically with the hearing. The difference in intelligence quotients on verbal tests of intelligence may be explained in the same way. The differences found by at least half the investigators on performance tests is not so readily understandable. Supposedly there is no language problem. The criticism has been made that, since most of these tests were standardized on hearing children, they are not fair to the deaf child.¹ Yet, the deaf child is living in a hearing world, competing with hearing persons. If there is to be any basis for comparison, any attempt to predict his success, his abilities cannot be judged by a separate scale. What he does on a test designed for hearing children is exactly what the educator of the deaf needs to know.

If one assumes that there is actually a significant difference between the native ability of the deaf and hearing child, (which has not been conclusively demonstrated), what may be the reasons for the difference? Several theories have been advanced to explain this. Pintner feels that auditory images and possibly kinaesthetic imagery play a part in the development of intelligence.² He also speculates on whether a deficient nervous system caused either by poor heredity or

1. Pintner, Eisenson and Stanton. op. cit. p. 73, 83.

2. Rudolph Pintner and Donald Paterson. "A Comparison of Deaf and Hearing Children in Visual Memory for Digits." Journal of Experimental Psychology. 2. 1917. p. 83.

the ravaging diseases which often cause deafness may account for much of the backwardness of the deaf, even when compared on performance tests.¹ He feels that the former explanation is the more important one, according to his own studies (reviewed in detail in the following section.)²

Burt was asked whether atrophy of the acoustic center and the partial atrophy of the motor center permanently affected general intelligence in the case of the deaf child. His reply was in the negative; since, as he pointed out, localization of atrophy to that extent has not been proved.³

Zeckel feels that there is a physiological basis for the retardation for at least a portion of the deaf population in cerebral lesions. He writes:

If the deafness is accompanied by cerebral lesions, as in hereditary degenerative forms and in some acquired traumatic and infectious cases, we may expect an occasional occurrence of dementia debility or decrease in intelligence. In those cases of deaf-mutism where the internal ear or the auditory nerve has been injured and there is no brain lesion, there are the following problems with respect to the intelligence. In the first place it might be possible that in hereditary genuine deaf-mutism there is already 'a priori' a greater frequency of an inferior mental disposition. In the second place the disposition might be quite normal, but the deafness the cause of an impaired intellectual development. The influence of the loss of hearing and speech with the consequent dearth in verbal engrammata must lead to a more concrete form of thought. The habitual exercise of transposing abstract notions into speech symbols in the spoken

1. Ibid.

2. Ibid. p. 84.

3. C. Burt. "Deafness and General Intelligence." American Annals of the Deaf. 72. 1927. p. 364.

language is reduced and this may probably lead to a deterioration of intellectual development. Although the deaf person in digital speech has at his disposition other symbols which play the same part as the symbols of speech, this compensation of the specific functions required by oral speech remains nevertheless insufficient. The heard and the spoken language is always very much richer in abstractions than the language of gestures. The spoken word with its accent, intonation, sound and personal enunciation is rich in shades, brings great multiplicity of elements of consciousness, stimulates the process of thinking and provides much greater exercise of the whole intellectual sphere than the visualized image or the simple gesture, or finger word. The lack of hearing and speech may on these grounds impede the development of the psychic intellectual life of the deaf child or at best retard it in comparison with other people.¹

Stroud states a similar belief, that "it is difficult to see how any high order of intellection can go on in the absence of language."²

The results of Eberhardt's and other experiments at the Clarke School for the Deaf seem to contradict Pintner's findings and the theories of Zeckel and Stroud. She found that "in general the results indicated that for the deaf the loss of acoustic memory images of language is compensated for by visual images of movements of the lips or by somesthetic images of the word patterns in the speech organs."³ She feels that, in many cases, "thinking in meanings" is of greater significance to the deaf than "thinking in words."⁴

1. Adolf Zeckel. "Research Possibilities with the Deaf." American Annals of the Deaf. 87. 1942. p. 178.

2. J. B. Stroud. "Applications of Intelligence Tests." Review of Education Research. 11:1. 1941. p. 35.

3. Margarete Eberhardt. "A Summary of Some Preliminary Investigations of the Deaf." Psychological Monographs. 52. 1940. p. 3.

4. Ibid. p. 4.

She adds:

Probably the most significant of this material (i.e., her studies) is that dealing with the development of concepts in young deaf children without language. The experiments show that the world of the young deaf child is already organized beyond the perceptual level and that this organization closely follows that of speaking people. They show clearly that language is not essential for organized, conceptual thought at least during its first stages.¹

Eberhardt's and Heider's studies at the Clarke School were done with young deaf children, which may account for the discrepancy in view.

All studies on the mechanical and motor ability of the deaf seem to find no significant differences between them and the hearing. (See section on related studies.) Pintner and his followers recommend, therefore, that these assets of the deaf be emphasized, rather than their liabilities.² He feels that educators of the deaf should experiment with a curriculum which makes these abilities the central point around which all the rest revolve. The core of such a curriculum would be mechanical and motor; linguistic studies would be supplementary,--auxiliary to the main purpose of education. He believes that if so used, they might have more meaning for the deaf child, and he would be better motivated than he is at present.³

Fusfeld, in a criticism of the findings of Pintner and Stanton and the recommendations expressed above, notes that

1. Ibid. p. 5.

2. Pintner. "Contributions of Psychological Testing to the Problems of the Deaf." p. 219.

3. Ibid.

the range of mechanical ability as revealed by the tests is a wide one for deaf children as well as for the hearing, indicating that not all of them would be favorably inclined toward that sort of training which would be best suited to mechanical aptitude, that is, shopwork.¹

Bjorlee is also convinced that the tendency of concentrating on vocational training to the extent of curtailing academic work is a serious problem.² Vocational training in America had its start in the schools for the deaf,³ mainly because it was felt that the deaf, because of their handicap, were unable to develop a symbolic structure which seems to underlie abstract intelligence. It was believed that these handicapped students needed to be given manual training if they were to become self-supporting, self-sufficient members of society. In the face of all the work which has been done in the past few years on individual differences in interests and aptitudes, it would seem a retrogression if the core of the curriculum for all deaf students were centered in mechanical and motor training simply because that was the one field in which they had been proved equal to the hearing.

Thus far, all the results of testing the deaf are based on what have been classes by Pintner as tests of concrete rather than abstract intelligence. He uses "concrete" to refer to those abilities measured by performance tests,

1. Irving S. Fusfeld. "The Mechanical Ability of Deaf Children." American Annals of the Deaf. 83. 1938. p. 381.

2. Ignatius Bjorlee. "The Status of Vocational Training in our Schools." American Annals of the Deaf. 85. 1940. p. 257.

3. Ibid. p. 252.

abilities which may be tested without the use of language.¹
All of the tests of abstract intelligence used with the deaf have been based upon language and the results are, therefore, useless.²

Therefore, if an appraisal of the abstract intelligence of the deaf is desired, it would seem that a non-language test which correlated highly with those verbal tests used to measure abstract intelligence should be used. According to the correlations given by Wechsler and quoted earlier in this paper, the Wechsler-Bellevue Performance Examination meets these requirements. It requires no language in presentation or response. It has a correlation of $.88 \pm .007$ with the Wechsler full scale I.Q. For this reason it was felt that results with the Wechsler Intelligence Test would be significant in determining the capacity of the deaf to develop abstract intelligence.

1. Pintner, Eisenson and Stanton. op. cit. p. 128.

2. Ibid.

CHAPTER II

SOURCES OF DATA AND PROCEDURE

The group of deaf subjects used in this study, as well as the measuring instruments chosen to appraise their mental abilities, will be described in this chapter.

Subjects Tested.

The Wechsler-Bellevue Individual Intelligence Test and the Chicago Tests of Primary Mental Abilities were given to 210 deaf children. All students between the ages 11-17, inclusive, having no other handicap but deafness, in the intermediate and advanced grades of the academic departments of the following schools for the deaf were tested for this study: Kendall School, Washington, D.C., New Jersey State School, West Trenton, and the Indiana State School, Indianapolis. The number at each age level is not large, but it is the total sample in these three residential schools for the deaf.

These schools seem to be typical of residential schools for the deaf in the United States. At least there is no evidence that they are dissimilar. Kendall School, in Washington, D.C., is attended by the deaf residents of the district. The two state schools serve the hypacusic from all parts of the state. Feeble-minded children are excluded from all three schools, although some individuals with physical handicaps other than deafness are admitted. The latter were not included in the present study.

Measuring Instruments.

The Wechsler-Bellevue. The third edition, 1944, of the Wechsler-Bellevue Individual Intelligence Test for Adults and Adolescents, a point scale, and Chicago Tests of Primary Mental Abilities, 1941 edition, a group-administered test, were used in this study. The Chicago Tests were made available through the American Council on Education and are the result of the most recent experiment by Thurstone and Thurstone, described in the section on related studies.

The complete Wechsler-Bellevue Scale includes the following subjects:

1. Information: This test contains twenty-five questions designed to measure the range of the individual's knowledge, and through this means, to indicate his intellectual capacity.¹ The subject is asked the height of the average American woman, the distance from Paris to New York, and similar questions of general information.

2. Comprehension: This test is a test of common sense, success depending upon the possession of a certain amount of practical information and a general ability to evaluate past experience.² There are ten questions. For example, the subject is asked what he would do if he were sitting in a theatre and were the first person to discover a fire.

1. Wechsler. op. cit. p. 78.

2. Ibid. p. 81.

3. Arithmetic Reasoning: This subtest, containing ten problems, is an indicator of the degree of mental alertness. All the questions touch upon common-place situations or involve practical calculations and have been so devised as to avoid verbalization or reading difficulties.¹

4. Memory Span for Digits: Digit span is an indication of retentiveness and attention.² Since this test involves reading a series of numbers aloud which the subject must repeat, it cannot be used with the deaf. The vocabulary test was used as an alternate in this study.

5. Similarities: These twelve questions test degree of maturity and level of thinking. The test contains a great amount of "g".³ The subject is asked to tell in what way a poem and a statue, and similar pairs of objects and concepts are alike.

6. Picture Arrangement: This test effectively measures a subject's ability to comprehend and size up a total situation. The understanding of these six situations corresponds to what other writers have referred to as "social intelligence."⁴ The subject is given a series of pictures, which when put in the proper order, tell a story.

7. Picture Completion: This test is designed to measure the individual's basic perceptual and conceptual

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1. Ibid. p. 82.
 2. Ibid. p. 83, 84.
 3. Ibid. p. 86.
 4. Ibid. p. 88.

abilities in so far as these are involved in the visual recognition and identification of familiar objects and forms.¹ In a broad way the test measures the ability of the individual to differentiate essential from unessential details.² One essential detail is missing from each of a series of pictures. The subject must name this feature rather than an unessential feature which may also be missing.

8. Block Design: This is the best single performance item, and is one of the few performance tests that seemingly does measure very much the same sort of thing that verbal tests measure.³ It involves both synthetic and analytical ability; it involves the ability to perceive forms and to analyze these forms.⁴ The subject is asked to reproduce with blocks a pattern which is on a card before him.

9. Digit Symbol: This subtest involves associative flexibility, attention and concentration.⁵ The subject must copy from the sample the proper symbol for each of sixty-seven digits.

10. Object Assembly: These three tasks give information about the thinking and working habits of the subject. They are an indication of his mode of perception.⁶ The subject must assemble a manikin, a profile, and a hand.

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1. Ibid. p. 90.
 2. Ibid. p. 91.
 3. Ibid. p. 92.
 4. Ibid. p. 93.
 5. Ibid. p. 95.
 6. Ibid. p. 98.

Alternate: Vocabulary: The number of words a man knows is at once a measure of his learning ability, his fund of verbal information and of the general range of his ideas.¹

The first five of these subtests give the verbal score and verbal I.Q.; the second five give the performance score and I.Q. The total weighted score on all the subtests gives the I.Q. for the full scale.

The Thurstone Tests. The second examination used in this study, the Chicago Tests of Primary Mental Abilities, by Thurstone and Thurstone, differs from the Wechsler in that, instead of assigning each individual a composite score such as the intelligence quotient, it gives scores for each of six mental abilities which statistical analyses have shown to be relatively independent.

The battery provides tests for the following abilities:

1. The Verbal factor V: represented in tests involving verbal comprehension; for example, tests of vocabulary, opposites and synonyms, completion tests, and various reading comprehension tests.

2. The Word Fluency factor W: involved whenever the subject is asked to think of isolated words at a rapid rate. It is for this reason it has been called a Word Fluency factor. It can be expected in such tests as anagrams, rhyming, and producing words with a given initial letter, prefix or suffix.

1. Ibid. p. 99.

3. The Space factor S: involved in any task in which the subject manipulates an object imaginally in two or three dimensions. The ability is involved in many mechanical tasks and in the understanding of mechanical drawings. Such material cannot be used conveniently in testing situations, so Thurstone used a large number of tasks which are psychologically similar, such as Flags, Cards, and Figures.

4. The Number factor N: involved in the ability to do numerical calculations rapidly and accurately. It is not dependent upon the reasoning factors in problem-solving, but seems to be restricted to the simpler processes, such as addition and multiplication.

5. The Memory factor M: All test batteries have a high factor loading in memory. The tests for memory which are now being used depend upon the ability to memorize quickly.

6. The Reasoning factor R: involved in tasks that require the subject to discover a rule or principle covering the material of the test. The Letter Series and Letter Grouping tests are good examples of the task. In all these experimental studies two separate reasoning factors have been indicated. They are perhaps Induction and Deduction, but Thurstone has not succeeded in constructing pure tests of either factor. The tests which are now being used are more heavily saturated with the Inductive factor, but for the present, Thurstone simply calls the ability R - Reasoning.¹

1. Thelma Thurstone. "Primary Mental Abilities of Children." p. 111, 112.

These tests were standardized on samples of approximately 1,000 children at each half-year grade level from grade 5B through the senior year in high school. They were standardized during the school year 1940-1941. Separate age norms are available for each of the six primary abilities.¹

The battery contains the following tests:

TABLE I
THE THURSTONE TEST BATTERY²

Factor	Tests	Time Limits	
		Practice	Test
N Number	Addition	3	6
	Multiplication	3	5
	Three-higher	5	6
V Verbal Meaning	Sentences	3	5
	Vocabulary	3	4
	Completion	3	6
S Space	Flags	10	5
	Figures	6	5
	Cards	6	5
W Word Fluency	First Letters	3	5
	Four-letter words	3	4
	Suffixes	3	4
R Reasoning	Letter Series	6	6
	Letter Grouping	7	4
	Pedigrees	5	6
M Memory	First Names	1-2*	5-8*
	Word-Number	1-2*	4-8*

*The first number is the time for presentation of the memory material. The second is the time for recall.

1. L. L. Thurstone and T. G. Thurstone. Manual. The Chicago Tests of Primary Mental Abilities. Washington, D. C. American Council on Education. 1941. p. 7.

2. Ibid. p. 8.

The split half reliabilities of the six composites in the test battery as reported by Thurstone are given in Table II.

TABLE II
RELIABILITIES FOR COMPOSITES AS GIVEN BY THURSTONE¹

	N	V	S	R	M
6th Grade	.97	.95	.96	.96	.63
8th Grade	.97	.96	.97	.97	.67
10th Grade	.97	.96	.98	.97	.74
12th Grade	.98	.96	.98	.97	.82

Procedure.

Administration of the Tests. Each individual examination on the Wechsler-Bellevue required approximately one hour to complete. All tests were administered and scored by the writer. About a month and a half was spent at each of the three schools, eight hours each day, to complete the tests. The testing at the New Jersey School was done in December, 1945 and April, 1946; at the Kendall School in February and March, 1946; and at the Indiana School in April and May, 1946. The directions as outlined by Wechsler were carefully followed, with the exception of certain modifications made necessary by the deafness of the subjects. For the performance half of the examination, all directions were given in pantomime. No difficulties were encountered in demonstrating what the subject was to do; even the youngest subjects readily understood what was required of them. Wechsler's time limits and the help allowed on certain items were strictly followed. The deaf

1. Ibid. p. 29.

were neither aided nor penalized by the method of administration in this part of the test. Language was not involved either in the administration or the responses on this part of the test. This is similar to the procedure used by Pintner and others when testing the deaf. These tests could not be administered to the deaf by anyone not familiar with the deaf and their sign language.

Giving the verbal half of the test presented some difficulties, however. The directions had been typed on cards, one card for each question or situation. The older and brighter students simply read the cards and gave the answers verbally if they could talk, or in finger spelling if their speech was unintelligible. If a child could not read, the question was presented to him in sign language, the administrator being careful at all times to give no help beyond setting up the question or the situation requiring response. Wechsler stressed the fact that, in designing the tests he kept the language as simple as possible, so that tests such as Information and Comprehension would actually test these factors and not be vocabulary tests. The only verbal test requiring timing was arithmetic, where the timing should begin when the examiner finishes reading the question. In this test, therefore, no signs were used. The subject read the problem aloud from the card; timing began when he finished reading. The writer is convinced that the deaf were neither helped nor penalized by her method of giving this half of the test.

The total testing time for the seventeen tests involved in the measurement of Thurstone's six factors was approximately 176 minutes. Of this time, approximately 75 minutes were devoted to fore-tests or practice exercises and exactly 101 minutes to the tests proper. The complete series was administered in two sessions in order to avoid fatigue. It was administered to groups of about twenty-five, with teachers at the three schools assisting as proctors.

The tests were all administered by the writer, and the directions for each test were carefully followed.

These directions and the demonstrations were all done in pantomime. No difficulty was experienced in explaining to the subjects exactly what was required of them. The younger subjects took a little more time on the practice exercises, but the time limits for the tests proper were strictly kept. Students were seated in alternate seats, and additional proctors were utilized for the distribution of materials and for general supervision. All tests were scored by hand by the writer. The scoring for both tests required a month to complete.

Treatment of Data. The scores for the deaf on the Thurstone tests were compared with the norms for hearing children published by Thurstone and Thurstone to determine whether the abilities of the deaf follow the same pattern as those of the normally hearing. As an added investigation of the effect on mental abilities of the loss of one means of perception, the mean scores for the deaf on the verbal and

and performance sections of the Wechsler-Bellevue as well as on the full scale were compared with Wechsler's norms for the hearing.

In addition the ten Wechsler subtests were correlated with each of the six Thurstone primary mental abilities to determine the extent to which they are measuring the same factors. The Wechsler performance section, the verbal section and the total Wechsler were each correlated with the total Thurstone score.

The effect of age of onset, type and degree of deafness were also studied to determine their effect on the primary mental abilities.

Finally, a rating scale which includes the teacher's estimate of ability was devised and used to compare that estimate with test performance.

CHAPTER III

SURVEY OF RELATED STUDIES

In order to indicate why further study on the mental abilities of the deaf was necessary, two types of studies related to the problem considered in this thesis will be discussed here. First, mental measurements of the deaf will be reviewed. All the published results of research will be considered. Second, the research which has been done in the past few years on primary mental abilities will be summarized.

Research in Mental Measurements with the Deaf.

The Earliest Studies. The first attempt at estimating the mental abilities of the deaf was made in 1889 by Greenberger.¹ He developed an informal classification of deaf students by a simple developmental scale, using information obtained from the parents, and from simple tasks which the deaf child was required to perform. Compared to the Binet Scale, this was a crude, unstandardized interview.

The next published study of the intelligence of the deaf was made by Mott in 1900.² She compared deaf and hearing children on tests in observation and memory and found the deaf unquestionably superior. These results were not borne out by

1. D. Greenberger. "Doubtful Cases." American Annals of the Deaf. April, 1889. p. 56.

2. Alice J. Mott. "A Comparison of Deaf and Hearing Children." American Annals of the Deaf. January, 1900. p. 36.

later investigations.

The First Standardized Test Developed for the Deaf.

Pintner and Paterson, who have done more in the field of intelligence testing with the deaf than any other investigators, began as early as 1914 to devise a scale of their own, when they found the Binet Scale impractical for use with the deaf.¹ Testing twenty-two deaf children with the Coddard Revision of the Binet, they found the average retardation to be four and a half years.² They reported the difficulties which make the Binet inadequate for testing the deaf: (1) lack of comprehension, (2) lack of environmental experience, (3) difficulties due to the peculiar psychology of the deaf.³

Before completing their own test, Pintner and Paterson tried out several non-language tests on groups of deaf children. During 1914-1915, in an attempt to measure the deaf child's immediate memory, 481 deaf children at the Ohio School for the Deaf were tested individually in a study made by these two men.⁴ The age range was seven to twenty-six. The smallest number tested at any one age was fifteen at age seven; the largest number was fifty-one at age sixteen. All pupils nineteen years of age and older were grouped together and called adults.⁵

1. Rudolph Pintner and Donald G. Paterson. "Psychological Tests of Deaf Children." The Volta Review. 19. 1917. p. 665.

2. Pintner. "Contributions of Psychological Testing to the Problems of the Deaf." p. 215.

3. Pintner and Paterson. "The Binet Scale and the Deaf Child." American Annals of the Deaf. 1915. p. 301.

4. Pintner and Paterson. "A Comparison of Deaf and Hearing Children in Visual Memory for Digits." p. 76.

5. Ibid.

The test was a standard series of digits test, including series of from two to seven digits, two exposures of each length of digits being given.¹ The results for the deaf child were very low. The authors found it "rather startling to find that the average deaf child at any age never equals the average ability of seven-year-old hearing children."² Only five deaf children had a memory span of seven digits.³

Pintner and Paterson compared their results with those reported by MacMillan and Bruner, who gave the Symbol-Digit Test to Chicago Day School pupils and found scores for the latter group superior at every age to the Ohio School Group.⁴ They presented adequate reasons for this discrepancy, the most important being that the day school attracts a select group of deaf children.

In general, they summarize their findings as follows:

1. The oral group are superior to the manual on the average.
2. Deaf children as a group have an abnormally poor memory span due to the lack of auditory experience.
3. The adventitious deaf are superior to the congenital on the average.
4. Auditory experience plays an important part in the efficiency of both hearing and deaf individuals

1. Ibid. p. 77.
 2. Ibid. p. 82.
 3. Ibid. p. 80.
 4. Ibid. p. 81.

in visual memory for digits.

5. There are no sex differences among the deaf in this test.¹

The authors theorized at great length on the cause of the disparity between the two groups (deaf and hearing):

It (i.e., this disparity) is revealed by an analysis of the mental processes involved in this test. The hearing individual (in most cases probably) uses auditory images (consisting of the sound of the digits) plus inner tactual sensations aroused by the innervation of the muscles controlling the vocal cords, tongue and larynx. There may also be involved kinaesthetic imagery related to the hand movements necessary to write the digits. For the most part the auditory factor is eliminated for the deaf subject. This leaves the deaf child dependent for his memorization and recall mainly upon the visual percept, which becomes a visual image after the withdrawal of the stimulus. Many of the deaf children used their hands during the perceptual process, spelling out the digits as they were exposed. Many of them also used inner speech as indicated by lip movements. Hence memorization visually was in many cases aided by secondary sensory processes. Of course, a deficient nervous system caused either by poor heredity or the ravaging diseases which often cause deafness, probably accounts for much of the backwardness of the deaf in this test. But the results obtained in the Symbol-Digit Test lead us to emphasize what is more probable, namely, the importance of audition in aiding the visual memory.²

Fintner and Paterson's own study gave two pieces of supporting evidence to the above theory. First, the greater the previous auditory experience of the group, the greater was the efficiency in immediate memory for digits. The two deaf children in this study who did not become deaf until thirteen years of age had normal visual memory ability.³

1. Ibid. p. 88.

2. Ibid. p. 83.

3. Ibid. p. 84.

Second, the adventitious deaf were superior to the congenital at every age except nine. This was not true when the test involved learning, as in the Symbol-Digit Test. Therefore, in immediate memory, previous auditory experience was of considerable importance as contrasted with another type of tests that involved the same materials, i.e., digits.¹

In 1916, Pintner and Paterson administered the Digit-Symbol Test to 325 pupils as a class test. The scores for the deaf were always below those for the hearing. A retardation of three years was shown.²

Also in 1916, they reported the results of an investigation made of twenty deaf and twenty hearing children, using the Seguin Form Board. They found that the average entering class of deaf children were apt to be about a year backward in form board ability and that this backwardness was not made up during the first year in school.³ (Eighteen of the deaf and fourteen of the hearing children were available for the retest a year after the first testing.)

That same year, using the Trabue Language Scale, Pintner and Paterson found just 6.4% of the deaf children in a large residential school exceeding the fourth grade ability of hearing children.⁴ On the Woolworth and Wells Directions

1. Ibid. p. 85.

2. Pintner and Paterson. "A Class Test with Deaf Children." American Annals of the Deaf. 61. 1916. p. 272.

3. Pintner and Paterson. "The Form Board Ability of Young Deaf and Hearing Children." American Annals of the Deaf. 61. 1916. p. 188.

4. Pintner. "Contributions of Psychological Testing to the Problems of the Deaf." p. 215.

Tests, the deaf child was much retarded.¹

Research up to 1917 Summarized. One year later, Pintner and Paterson wrote a summary of psychological tests of deaf children, mentioning Greenberger's work and Mott's study. They were highly critical of the latter investigation, questioning the conclusion which she had drawn from so vague an experiment.² They reviewed in some detail a study made by MacMillan and Bruner who found the deaf uniformly poorer than the hearing in a cancellation of A's test. These two men reported 82% of the deaf inferior to the average for hearing children in both motor time and perception time. In perception of size by the sense of touch, the deaf were less accurate than the hearing; while in sensitivity for lifted weights, the two groups were about equal. The 184 deaf children used were a somewhat selected group since there were only seven slightly retarded or subnormal included.³

In 1918 Porteus worked out the correlation between his maze test and Terman's first revision of the Binet. Based on 263 cases, the correlation was .77⁴ He then gave his test to twenty-four deaf children in Melbourne to prove that the test was applicable to the deaf where the Binet was not. The deaf "seemed equal to the hearing."⁵

1. Ibid.

2. Pintner and Paterson. "Psychological Tests for Deaf Children." p. 664.

3. Ibid.

4. Porteus. op. cit. p. 19.

5. Ibid. p. 30.

That same year, Pintner and Paterson again summarized their own findings from psychological tests administered to the deaf. They reported:

1. The Binet-Simon Scale was impractical for the deaf.
2. The average orally-taught pupils were superior in all the tests to the average manually-taught, due to the fact that brighter pupils were selected for oral instruction.
3. In all mental tests not involving the functioning of audition, the average deaf child was from two to three years retarded compared to the average hearing child of the same age.
4. In all tests involving auditory processes (such as visual memory for digits and the language tests) the average deaf child, regardless of age, is only equal to the average hearing child of seven, eight or nine years of age.
5. There is no sex difference among the deaf in any mental tests.¹
6. There seems to be no difference between the adventitious and congenital deaf in mental tests; although in tests involving auditory processes, those who become deaf after four or five seem to have benefited from having possessed hearing.

Newlee also used the Digit-Symbol Test, as well as the

1. Pintner and Paterson. "Conclusions from Psychological Tests." The Volta Review. 20. 1918. p. 13.

Symbol-Digit form, with eighty-five deaf children six to eighteen years of age in the Chicago Day School in 1918. These were also administered as class tests.¹ The deaf children tested equal to hearing children (She used W. H. Pyle's norms for hearing children.) on this particular learning ability. There was little difference between the sexes.²

By this time Pintner had completed two group tests especially designed for the deaf: the Pintner Non-Language Mental Test, composed of six separate tests; and the Pintner Educational Survey Test, eight separate tests of subject matter. Reamer administered these two tests to 2500 deaf children for the purposes of standardization.³ She found the manual group lower than the oral in average mental ability and educational index.⁴ The congenital group were slightly below the adventitious in both ratings, while there was little difference between the partially and totally deaf. Among the adventitious, the age of becoming deaf influenced the educational index. There were no sex differences in either rating. The average difference in mental ability between the deaf and the hearing was two years; the average educational retardation was five years.⁵

1. Clara E. Newlee. "A Report of Learning Tests With Deaf Children." The Volta Review. 21. 1919. p. 216.

2. Ibid. p. 223.

3. Jeannette Chase Reamer. "Mental and Educational Measurements of the Deaf." Psychological Monographs. 29: 3. 1921. p. 127.

4. Reamer. op. cit. p. 129.

5. Ibid. p. 130.

McManaway, in 1923, using the Educational Survey Test, reported his thirteen-year-old deaf equal to eight-year-old hearing children.¹

The 1927 Survey. Using the same two tests used by Reamer, Pintner made a survey of schools for the deaf six years later, in which 4432 children twelve years of age or older, from thirteen day and twenty-eight residential schools were tested.² He reported that the age at which deafness occurs has little influence on the mental rating, but a decided influence on the educational rating. Each year of hearing after age four seems to give an increased facility in language as measured by the educational test.³ Comparing the deaf with hearing children, ages twelve to fifteen inclusive, he found a distinct superiority for the hearing. Educational ratings showed more superiority for the hearing than did mental ability.⁴

TABLE III
EDUCATIONAL QUOTIENTS OF DEAF AND HEARING

Deaf	Hearing Norm.	Approx. Educ. Quot.
Age 12	Age 7-9	65
13	8-10	62
14	8-9	63
15	9-10	60

1. Pintner. "Contributions of Psychological Testing to the Problems of the Deaf." p. 215.

2. Rudolph Pintner. "The Survey of Schools for the Deaf." American Annals of the Deaf. 72. 1927. p. 412.

3. Ibid. p. 413.

4. Ibid.

Tables III and IV show the comparison between the deaf and the hearing in educational quotient¹ and the approximate hearing mental ages of the four deaf groups in the study.² They indicate that these deaf students were four to six years behind the hearing, with a maximum E.Q. of 65 and a probable mean I.Q. of about 84.

TABLE IV
HEARING MENTAL AGES OF FOUR DEAF GROUPS

Deaf Age	Approx. Hearing M.A.	Probable I.Q.
12-6	10-8	85
13-6	11-2	83
14-6	11-8	83
15-6	12-1	86

In 1928, Drever and Collins, in Edinburgh, published their Performance Tests of Intelligence, designed for use with the deaf. These tests were standardized on 400 subjects.³ Of these children, 200 were deaf and 200 hearing, ages four and a half to six.⁴ The material of the Drever and Collins Tests combines a block design test (after Kohs), a cube test (devised by Knox), a domino test (new), a size and weight test (suggested by the cube test), a manikin and profile test (patterned after Pintner-Paterson), a form-board test (using Pintner's Two-Figure Board and Healy's Puzzle A), cube

1. Pintner. "Contributions of Psychological Testing to the Problems of the Deaf" p. 217.

2. Ibid.

3. James Drever and Mary Collins. Performance Tests of Intelligence. Edinburgh. Oliver and Boyd. 1928. p. 5.

4. Irving S. Fushfeld. "The Drever and Collins Tests." American Annals of the Deaf. 81. 1936. p. 181.

construction (after Gaw), picture completion (Healy's Picture #1 and elaboration.)¹

Of this study Drever and Collins wrote: "As far as we have been able to determine, no significant retardation as yet has been indicated."²

One year later the same tests were administered to 1474 children, ages five to sixteen, and the deaf again proved equal to the hearing norms on that scale.³ Their findings, contradicting as they did most of the work done in this country, were severely criticized. Pintner wrote of the 1929 report: "This does not agree with our findings in the U. S. and we have reason to believe that Drever's norms are too easy."⁴

Psychologists from the Institute for Juvenile Research conducted a survey at the Jacksonville School for the Deaf in Illinois about this time, to determine the correlations of non-language tests with each other, with school achievement, and with teachers' judgments of the intelligence of children.⁵ The entire school population, 390 children, were given individual and group non-verbal mental tests and a battery of educational tests. For correlations between

1. Ibid. p. 183.

2. Drever and Collins. op. cit. p. 18.

3. Pintner. "Contributions of Psychological Testing to the Problems of the Deaf." p. 217.

4. Ibid. p. 218.

5. Andrew W. Brown. "The Correlations of Non-Language Tests With Each Other, With School Achievement, and With Teachers' Judgements of the Intelligence of Children in a School for the Deaf." Journal of Applied Psychology. 14. 1930. p. 371.

different non-language tests the scores of the entire group were used. For the correlations of non-language tests with school grades and scores on educational tests only children above Grade V were used. There were about one hundred children in these upper grades. Chronological ages ranged from fourteen to twenty-five, the average being about sixteen years of age.¹

The children were given the following tests:

- (1) Pintner Non-Language Mental Tests,
- (2) Series of performance tests from Pintner-Paterson group,
- (3) Stanford Achievement Arithmetic Tests (computation and reasoning),
- (4) Stanford Achievement Reading Tests.

The performance tests were given individually, the others in groups of about twenty-five each. The sign language was used for the directions for the educational tests.

School marks in language and arithmetic were averaged over a four year period to give a Teachers' Rating in each subject. There was also an average of teachers' estimate of intelligence with the principal's and supervisor's estimates on a rating scale of one to twenty.²

The resulting correlations were as follows:³

1. Correlation between Pintner Non-Language and Point Performance Scale = $.80 \pm .01$ (N = 333)
2. Correlation between Pintner Non-Language and CA = $.66 \pm .02$ (N = 337)
3. Correlation between Point Performance Scale and CA = $.74 \pm .01$ (N = 390)

1. Ibid. p. 372.
 2. Ibid.
 3. Ibid. p. 375.

Thus there was a close correlation between the non-verbal tests. They measured the same thing to a fairly close degree. The high correlation with CA shows that the tests did differentiate one age level from another and therefore measured some kind of maturity, physical, mental, or a combination. With the exception of arithmetic, these tests did not predict educational achievement.¹

The correlation between raw scores on the Pintner Non-Language and the average of Teachers' Ratings was $.12 \pm .07$ ($N = 98$). The correlation between total weighted scores on performance tests and Teachers' Judgment was $.18 \pm .07$ ($N = 98$). These are negligible correlations. They are much lower than the correlation of teachers' estimates of intelligence with the scores on verbal intelligence tests. The latter correlation is usually around $.50$.² It is evident from these results that teachers do not base their judgments of intelligence on the type of performance required in the non-verbal tests. If teachers' judgments of intelligence can be taken as a fair sample of judgments in general, Brown felt that these non-verbal tests do not measure what is usually considered as general intelligence. The fact that teachers' judgments of ability have a closer correspondence with verbal than non-verbal tests, he pointed out, indicated that what is usually considered as general intelligence is the type of response associated with the use of language concepts.³

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1. Ibid.
 2. Ibid.
 3. Ibid.

Among the tests designed for normal hearing children and used with the deaf, was the Goodenough "Draw a Man" Test. Peterson and Williams, in 1930, tested 466 pupils, ages four to twenty-one, in five schools.¹ They found that the curve of distribution was not normal, that a greater number clustered at the lower portion of the curve. The average retardation of the deaf was one year ten months, and it increased proportionately according to the advancing age of the children.²

Two years later the same test was administered to 406 deaf children, ages five to twenty, along with the Pintner Non-Language Test. The median I.Q. for the Goodenough was 87.7; for the Pintner Non-Language, 98.4.³

The lectometer, a device designed by Dr. Max Meyer for testing the deaf, was used in 1932 with 132 deaf and 1251 hearing children between the ages of five and twenty. Very little difference in ability was discovered.⁴

MacKane took the Drever-Collins Performance Test, the Pintner-Paterson Performance Test and the Grace-Arthur Performance Test and arranged them into a single battery, since many of the subtests were found in more than one of the three

1. Edwin G. Peterson and James M. Williams. "Intelligence of Deaf Children as Measured by Drawings." American Annals of the Deaf. 75. 1930. p. 275.

2. Ibid. p. 290.

3. Florence L. Goodenough and Mary Shirley. "A Survey of Intelligence of Deaf Children in Minnesota Schools." American Annals of the Deaf. 77. 1932. p. 247.

4. Max F. Meyer and H. F. Lane Schick. "The Use of the Lectometer in the Testing of the Hearing and the Deaf." American Annals of the Deaf. 77. 1932. p. 304.

scales.¹ This battery and the Pintner Non-Language Test were administered to 130 deaf children and a matched hearing group.² MacKane concluded that his results in giving the Drever-Collins Performance Scale to deaf and hearing children supported the original conclusion of Drever that at no age-level were the deaf as much as one year retarded, although all three performance scales did show the hearing group superior.³ The Pintner Non-Language Test showed a marked superiority for the hearing group.⁴ He added: "It seems evident from this study that the performance scale and the non-language test measure different abilities."⁵

Research up to 1933 Summarized. In a paper read before the International Congress on the Education of the Deaf in 1933, Pintner summarized the psychological testing with the deaf to that date. The individual studies have already been mentioned in their chronological order, but Pintner's summaries and comments will be discussed at this point.

He stated that the "standard verbal intelligence test becomes in effect an educational achievement test in language when given to deaf children. Therefore, adequate intelligence tests for the deaf must be of the non-language type. This

1. Keith MacKane. A Comparison of the Intelligence of Deaf and Hearing Children. Teachers College, Columbia University, Contributions to Education No. 585. New York City. Bureau of Publications. Teachers College, Columbia University. p. 41.

2. Ibid. p. 42.

3. Ibid. p. 43.

4. Ibid.

5. Ibid. p. 44.

means that the tests must be given without the aid of language instructions, and also no verbal material must appear in the context of the test itself."¹

The following tests, according to Pintner, have been constructed on these principles and have proved their usefulness in the testing of the deaf child:

I. Individual Intelligence Tests:

1. The Pintner-Paterson Performance Scale. Ages 9-16.
2. A Performance Scale for Young Deaf Children - Pintner.

II. Group Intelligence Tests:

1. Pintner Non-Language Mental Test for ages 9-16.
2. Pintner Primary Non-Language Test for ages 5-9.
3. Goodenough Drawing Test for ages 5-14.
4. Porteus Maze Tests for ages 5-14.²

Summarizing the results of tests involving language, Pintner stated that the deaf are three to six years behind the hearing.

If our educational quotient of 65 is a fair measure for deaf school children in general, we may say that the average deaf child during his school life achieves only 65 percent of those knowledges and skills which depend on language, as compared with the average hearing child.³ . . .

.
If he is an average deaf child and not an exceptional one, he must, therefore, be severely handicapped during his whole life wherever and whenever he comes into contact with positions in which language is an essential or important part. The question for the educators of the deaf is whether this language handicap can be

1. Pintner. "Contributions of Psychological Testing to the Problems of the Deaf." p. 214.

2. Ibid.

3. Ibid. p. 215.

surmounted or not. Can we by more ingenious methods of instruction, by better techniques of teaching wipe out this very severe retardation in language? The answer to this will partially depend upon whether we have in all deaf the same amount of basic intelligence as we have in the hearing.¹

In all situations involving words and in thinking by means of verbal symbols he (the deaf) is very markedly handicapped, and, in spite of a long and painstaking education, he seems unable to catch up with his hearing brother. In dealing with non-verbal symbols he is much nearer the hearing. Here his I.Q. is about 85.....In dealing with actual things - concrete intelligence - his I.Q. is higher still, perhaps about 90.²

In mechanical ability he may be on a level with the hearing. In general motor ability he is equal to the hearing except in those motor functions directly conditioned by the semi-circular canals.³

He recommended, therefore, emphasizing the assets of the deaf rather than liabilities.

These assets seem to be the mechanical and motor abilities of the deaf. Would it not then be wise to experiment with a curriculum which makes these abilities the central point around which all the rest would revolve? The core of the curriculum would be mechanical and motor; linguistic studies would be supplementary. They would be used as auxiliary to the main purpose of education. And if so used, they might have more meaning for the deaf child. He would be better motivated than he is at present.⁴

Pintner did, however, mention individual differences, saying that "some have high abstract or verbal intelligence."⁵

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1. Ibid. p. 216.
 2. Ibid. p. 218.
 3. Ibid.
 4. Ibid. p. 219.
 5. Ibid.

The same year that Pintner made his report, Max Goldstein published the most comprehensive book to date on the problems of the deaf. In it he supported Drever and MacKane in the view that the deaf have a basic ability equal to that of the hearing. He wrote: "If effective measurements and accurate tests were devised to record the intelligence quotient of the deaf child, his I.Q. registration would not differ from that of the normal child."¹

Research from 1935 to 1940. In 1936 reports were published on two tests designed for hearing children and administered to the deaf, and a new test developed especially for the deaf. Two of these studies were made in Canada. The first was carried out by Peterson in the Saskatchewan School for the Deaf. He used the Kohs Block Designs. Peterson's study, an investigation of 100 deaf pupils, ages five years seven months to seven years, showed a retardation of the deaf as compared with hearing public school children. The range of I.Q.'s was 54-156, mean 92.5, median, 95.² Teachers' estimates showed "an expected low correlation with I.Q."³ Peterson felt the results indicated that the Kohs Block Design Test was worthy of further study by investigators studying the intelligence of deaf children.⁴

1. Goldstein. op. cit. p. 251.

2. Peterson. op. cit. p. 253.

3. Ibid. p. 254.

4. Ibid.

The second report on an established test applied to the deaf concerned the Arthur Performance Scale which was given to ninety children admitted to special classes for the deaf and hard of hearing in St. Paul between January, 1929 and May, 1936.¹ The age range was five years seven months to sixteen years eleven months. The findings were as follows:²

Arthur I.Q.'s	68-152
Interquartile Range	84-106
Median I.Q.	97
Mode	97
Mean	97.16
Stand. Dev. of Distribution	15.92
P.E. of Stand. Dev.	.80
Av. Dev. of Distribution	12.736
Med. Dev.	10.738
P.E. Mean Dist.	1.13

Bishop concluded: "In so far as one can draw conclusions from ninety cases, the findings indicate a normal distribution with as nearly an unselected group of deaf children as one can find in the general school population."³

With reference to the entire deaf population this was a selected group, however, since day school and special class pupils have more hearing and a higher I.Q., because deaf children with less hearing loss and higher ability tend to go to day schools and remain there.

The new test for the deaf published in 1936 was the Ontario School Ability Examination, Canada's second contribution to the field in that year. The test is a composite

1. Helen M. Bishop. "Performance Scale Tests Applied to Deaf and Hard of Hearing Children." The Volta Review. 38. 1936. p. 447.

2. Ibid. p. 484.

3. Ibid. p. 485.

of the Gesell Block Building, Drever-Collins Block Design, Drever-Collins Domino, Knox Cube, Healy Fernald Puzzle, Stanford Revised Drawing, Design and Weight Tests.¹ A median I.Q. of 94 was established for 288 deaf children ages five to twenty-two.²

Morsh studied a different aspect of the handicap of deafness--the question of the precise effect of destruction or impairment of one sense upon the other senses and upon motor performance. These questions have "long been of interest to both the psychologist and the teacher of the deaf--to the former because scientifically the problem has bearing on the relation of motor development to the development of perception and ideation, and to the latter because of its practical application in such spheres as vocational guidance, aptitude determination, and social and occupational adjustment."³

Morsh investigated, at Gallaudet College and Kendall School in Washington, D. C., the effects of deafness upon visual and motor performance. He drew his controls from the public schools in Washington, D. C., and from American University.⁴ He found:

1. There was no significant difference in tapping.
2. The deaf were superior to the hearing on the steadiness test.

1. Harry Amoss. Ontario School Ability Examination. Toronto. The Ryerson Press. 1936. p. 7.

2. Ibid. p. 9.

3. Joseph Eugene Morsh. "A Comparative Study of Deaf and Hearing Students." American Annals of the Deaf. 82. 1937. p. 223.

4. Ibid.

3. The deaf excelled the hearing for the first day's balancing performance at all three limits and at the three minute limit for the average of thirty trials.
4. Deaf boys excelled hearing girls in balancing performance except blindfolded.
5. When blindfolded, the deaf subjects showed inferior balancing performance to blindfolded hearing subjects.
6. On the Locator - Memory Tests, deaf girls excelled over deaf and hearing boys and hearing girls.
7. In speed of eye movement the performance of the deaf was inferior to that of the hearing.¹

For the Locator-Memory Tests, twenty small common objects such as a pin, a screw, a cork, a match, etc., are placed one in each of twenty square compartments on a white board. The subject observes for one minute. The objects are then removed and placed with twenty objects previously unseen, each related to a test object by association. The subject must replace the original objects.²

In 1937 Lane published the results of a testing program which had been carried out at Central Institute for the Deaf, St. Louis, over a period of years. She wrote:

By the selection of individual performance tests, which are non-verbal in directions and response, deaf children ranging in age from two to nineteen years tested at Central Institute for the Deaf show intelligence equal to that of hearing children measured on the same tests and their intelligence quotients follow a normal distribution curve.³

Her results on tests of educational achievement were likewise more favorable for the deaf than the studies of

1. Ibid. p. 232.

2. Ibid.

3. Helen Schick Lane. "Measurement of the Mental and Educational Ability of the Deaf Child." NEA Proceedings. 75. 1937. p. 442.

Pintner and others; for she found, at the end of a seven-year testing program using the Stanford Achievement Test, that the deaf were just two years retarded.¹ She admitted that this retardation was not as great as that reported by other investigators, and states: "it is believed it can be further reduced by (1) starting the education of the deaf child at an earlier age; (2) increasing the amount of reading; (3) presenting more problems requiring rationalization and less guidance in solving them; (4) utilizing residual hearing and preserving language acquired before the onset of deafness."²

The tests upon which Lane based her conclusions regarding the mental ability of the deaf child were:

1. Randall's Island Performance Series - ages 2-5 - 250 scores - Median I.Q. 97.6.
2. Lectometer - ages 5-19 - 200 scores - compared to norms for hearing, showed equal ability.
3. A new performance series - not standardized on enough hearing children - given to 100 deaf children, indicated normal intelligence for the deaf.³

Lane wrote: "From all these tests it seems safe to conclude that the deaf as a group are not mentally retarded."⁴

It will be noted that "all these tests" include three, the last not standardized. Recognizing that her results are contradictory, Lane states that this is due to the use of tests not strictly non-verbal, to testing in large groups, by examiners not familiar with the deaf child.⁵

1. Ibid. p. 443.

2. Ibid.

3. Helen Schick Lane. "Measurement of the Mental and Educational Ability of Deaf Children." Journal of Exceptional Children. 4:8. 1938. p. 171.

4. Ibid.

5. Ibid.

A more comprehensive study which seems to support Lane's findings was reported in 1938 by Springer.¹ The purpose of the study was to discover whether "deaf and hearing children differ in mental ability when the language factor is eliminated and intelligence is measured by means of a non-language test."²

The Goodenough Draw-a-Man Intelligence Test was used since it requires no verbal responses and is a non-language test. Teachers' ratings on seven intellectual traits were also obtained by the use of Division I, Intellectual Traits of the Haggerty-Olson-Wickman Behavior Rating Schedules.³

Springer tested 330 deaf and 330 hearing children in the spring of 1935. All subjects were between six and twelve years of age, in New York City schools. Chronological age, sex, nationality and general social status were very carefully matched.⁴

An analysis of the results, by age and sex, revealed that on the Goodenough point score, at no age level did the deaf and the hearing children differ significantly. There was a slight tendency for the hearing children, especially the hearing girls, to receive slightly better scores than the deaf, but the differences between the means of the deaf and hearing groups were statistically insignificant.⁵

1. N. Norton Springer. "A Comparative Study of the Intelligence of a Group of Deaf and Hearing Children." American Annals of the Deaf. 83. 1938. p. 138.

2. Ibid.

3. Ibid. p. 139.

4. Ibid. p. 140.

5. Ibid.

When the Goodenough point scores were converted into intelligence quotients, with the exception of the eleven-year-old deaf boys whose mean I.Q. was significantly higher than that of the hearing boys of this age level, the difference between the deaf and the hearing boys, when all the ages were combined, was found to be very small and statistically insignificant.¹ The hearing girls tended to receive higher I.Q.'s than the deaf girls at each age level. Although these I.Q. differences were statistically insignificant at any particular age, when all the ages were combined, the mean I.Q. for the hearing girls was significantly superior to that of the deaf girls.

When the sexes were combined, the hearing children's mean I.Q. was significantly superior to that of the deaf children. This superiority was mainly due to the high I.Q.'s received by the hearing girls. The overlapping of the individual I.Q.'s of deaf and hearing children was found to be very large and of much more importance than the differences between deaf and hearing. Although the deaf children tended to receive slightly lower I.Q.'s than the hearing children, the mean I.Q. of 96.24 indicated that the deaf children were of normal, or average, intelligence.²

Low negative correlations ranging from $-.114 \pm .055$ to $-.268 \pm .053$ were found between the intelligence test

1. Ibid. p. 141.
 2. Ibid. p. 151.

scores and the teachers' ratings on Division I, Intellectual Traits of the Haggerty-Olson-Wickman Behavior Rating Schedule.¹

An item analysis indicated that the deaf and the hearing children were equally successful on the individual items of the Goodenough Test.²

As part of a study of the social competence of deaf and hard of hearing children, ninety-seven deaf children were tested with the Arthur Performance Scale and the Chicago Non-Verbal Test.³ A median I.Q. of 100.9 was found for the Arthur; 95.5 for the Chicago. Again, this was a day school group and somewhat selected.

In a study conducted at Teachers College under the sponsorship of Pintner by Dr. Mildred B. Stanton, the performance of equated groups of deaf and hearing children was compared to obtain an evaluation of the mechanical ability of deaf children.⁴ Stanton matched 121 deaf boys and 36 deaf girls with a similar number of hearing children, the groups being matched for sex, age, nationality of parents and occupational level of the father. The age range was twelve to almost fifteen.

She used the Minnesota Test of Mechanical Ability, with a modified testing technique worked out so that it could be

1. Ibid.

2. Ibid. p. 152.

3. Alice Streng and Samuel A. Kirk. "The Social Competence of Deaf and HOH Children in a Public Day School." American Annals of the Deaf. 83. 1938. p. 253.

4. Mildred B. Stanton. Mechanical Ability of Deaf Children. Teachers College, Columbia University, Contributions to Education. #751. New York. Bureau of Publications. Teachers College, Columbia University. 1938. p. 5.

used with deaf children. The Pintner Non-Language Mental Test was also used.

The battery included the Minnesota Paper Form Boards A and B; Spacial Relations Boards A, B, C, and D; and the long form of the Minnesota Assembly Boxes A, B, and C.¹

Stanton found that the deaf boys were at least the equal of the hearing boys in mechanical ability, as judged by the above test, when age, nationality and parental occupational level were the same. The deaf girls tended to be inferior to hearing girls when the same factors operated. The deaf boys were superior to the deaf girls in mechanical ability. Both the deaf group and the control group were inferior in mechanical ability to the hearing group on which the Minnesota Tests were standardized.²

In intelligence, as determined by the Pintner Non-Language Mental Test, the deaf group indicated a slightly higher score level, although the difference was not statistically reliable. A higher relationship was found between the Minnesota Test scores and intelligence when measured by a non-language test than when the intelligence test was a verbal one.³

Stanton concluded:

Other studies have shown that the deaf are markedly handicapped in relation to the hearing wherever verbal intelligence plays a part. This study seems to

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1. Ibid. p. 30.
 2. Ibid. p. 51.
 3. Ibid. p. 53.

indicate that they are very similar to the hearing in mechanical ability. This aspect of their education should, therefore, be emphasized in order to compensate for their handicaps in other directions, and in order to allow them to compete more nearly on equal terms in later life. At the same time it must not be imagined that the deaf are specially endowed with mechanical ability. If the Minnesota norms are valid for the hearing in general, the deaf are handicapped even in this respect. At least they come nearer to the hearing in this area, but their potentialities have not been realized.¹

Stanton seems to be assuming that the hearing group in her study was not representative. One might as easily assume, since both the deaf and hearing samples were low and equal, that it was not a representative sample for either group.

The Porteus Maze Test was used by Zeckel and Van der Kolk in Rotterdam and other schools to compare the intelligence of children born deaf and those of good hearing.² They tested 100 deaf and 100 hearing children, seven to fourteen years of age, an equal number of deaf and hearing children being selected at each age from a similar environment. An attempt was made to secure a random sample.³

Since there were some difficulties with the very young children in giving directions, some verbal element was added. The investigators felt it was principally a test of insight.⁴

1. Ibid. p. 54.

2. Adolf Zeckel and J. J. Van der Kolk. "A Comparative Intelligence Test of Groups of Children Born Deaf and of Good Hearing, by Means of the Porteus Test." American Annals of the Deaf. 84. 1939. p. 116.

3. Ibid. p. 117.

4. Ibid. p. 118.

The results were as follows:

The deaf children from 7-11 years inclusive are always below the line of the I.Q. 100, rising only at 12 years to this line, which is established by Porteus as 100 according to the greatest frequency of a very large group.¹

The following table shows the I.Q.'s:

TABLE V

I.Q.'s REPORTED BY ZECKEL AND VAN DER KOLK

Group	N	I.Q.
Younger Group, Hearing	47	88.64
Younger Group, Deaf	47	78.66
Older Group, Hearing	53	108.11
Older Group, Deaf	53	95.77 ²

The authors concluded from this that the deaf child at an early age is far behind, but that this backwardness is later made up and the I.Q. of 100 almost attained.³ On that basis one would also have to conclude the intelligence of the hearing child follows the same pattern, a tendency which is contrary to the theory of the I.Q.

Zeckel and Van der Kolk found the average I.Q. of the hearing children 99.36, of the deaf 86.09, and they agreed with Pintner and Paterson that the deaf child, without the verbal element playing an important role, shows a backwardness of intelligence as compared with the hearing.⁴ This

1. Ibid. p. 119.

2. Ibid. p. 120.

3. Ibid.

4. Ibid. p. 122.

seems to contradict two of their previous statements. If they had trouble in giving directions, the verbal element did play an important role. Second, if the deaf make up their backwardness as they grow older, these findings do not agree with those of Pintner and Paterson.

In an attempt to discover the value of non-verbal tests in predicting school success, Bridgeman made a study of ninety children at the California School for the Deaf.¹ She failed to find one deaf child who, having failed badly on a scale of non-verbal tests, was able to make even fair progress in his school work. On the other hand, a considerable proportion of the group tested, who showed normal and at times very superior ability on the non-verbal scales, were no more successful in school subjects than the frankly mentally deficient children.²

Of the ninety children tested, eighty-three were either educational failures or had serious disturbances of conduct. The other seven were selected by the school as being normal or superior in intelligence, successful in their school progress, and socially normal in their attitudes toward other children and the school situation.

The following tests were used: The Arthur Point Scale of Intelligence, Ontario School Ability Examination, Stanford

1. Olga Bridgeman. "The Estimation of Mental Ability in Deaf Children." American Annals of the Deaf. 84. 1939. p. 337.

2. Ibid.

Revision of the Binet Scale (in cases where the child was only hard of hearing), Healy Scaled Information Test (for children who could hear or who could read at the fourth grade level or above), and the Randall's Island Tests for Younger Children.¹

The children varied in age from six to twenty-one years, with a range in MA from two to eighteen years. Median age was about fourteen years, median MA nine years, median I.Q. about 70.²

Bridgeman concluded that in spite of the failure of the non-verbal tests to indicate educational success or failure in some instances, they do serve, apparently, to rule out really mentally inferior cases.³

On the basis of seventeen failures with I.Q.'s of 90 or more she said, "It is very unlikely that so large a number of school failures should have specific educational disabilities. It is far more probable that these deaf children with high I.Q.'s are suffering from the results of actual brain disease in some cases, and in others from a combination of the many social and educational factors which act in a much smaller degree to retard the school progress of hearing children."⁴

These seem to be rather far-reaching conclusions to make since there were only seven subjects in the comparison group,

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1. Ibid. p. 338.
 2. Ibid. p. 339.
 3. Ibid. p. 338.
 4. Ibid. p. 346.

and five uncorrelated tests were used.

A Study of Deaf College Students. The results of five years of testing with the American Council on Education Psychological Examination at Gallaudet College were published in 1940 by Fusfeld. He reported no wide difference revealed between the general native caliber of the freshmen who enroll at Gallaudet College and that of freshmen in general in American colleges and universities.¹ He added: "This examination also revealed the deaf group with a particular advantage in arithmetical ability and in the ability needed for dealing with set grammatical rules to be used in an imaginary language."²

These results may indicate only that Gallaudet has high standards as far as admission is concerned. One would need to know what percentage of the total deaf population the freshmen at Gallaudet represented before any far-reaching comparisons with the hearing in general could be made.

Research from 1940 to the Present. A series of tests was administered in the West Virginia School for the Deaf under Pintner as part of an investigation in several schools to determine whether or not the deaf, with their loss of hearing, were being compensated in any way so as to give them better art ability or art appreciation. Pintner concluded that there was no evidence of any distinct ability

1. Irving S. Fusfeld. "Research and Testing at Gallaudet College." American Annals of the Deaf. 85. 1940. p. 183.
 2. Ibid.

peculiar to the deaf.¹

The Kline-Carey Measuring Scale for Free Hand Drawing, the Goodenough Test and the McAdory Art Test were given. Table VI presents the results.

TABLE VI
TESTS OF DRAWING ABILITY²

Test	Group	Boys	Girls	Both
Kline-Carey Boys = 99 Girls = 97	Percent above normal	22	20	21
	Normal	18	17	17
	Slightly below	38	28	33
	Below norm level for CA 10 years	22	35	29
Goodenough Boys = 92 Girls = 72	Percent above normal	11	3	7
	Normal	30	27	29
	Slightly below	42	47	44
	Below norm level for CA 10 years	17	23	20
McAdory Boys = 83 Girls = 76	Percent above normal	14	22	18
	Normal	14	20	17
	Slightly below	44	28	36
	Below norm level for CA 10 years	28	30	29

The three tests consisted of the following items:

1. Kline-Carey Measuring Scale for Free Hand Drawing, by L. W. Kline and G. L. Carey, designed as a means of measuring the quality of free-hand drawing with respect to representation. The children were asked to draw a house, a tree, a rabbit and a figure in action.

1. Irving S. Fushfeld. "Tests of the Drawing Ability of Deaf Children." American Annals of the Deaf. 85. 104. p. 102.
2. Ibid. p. 103.

2. The Goodenough Test, by Florence L. Goodenough, designed for the purpose of measuring intelligence by drawings. The children were asked to make a picture of a man.

3. McAdory Art Test, by Margaret McAdory, a test of artistic judgement as based on the preference order of four pictures in a series of plates bearing four pictures each. Each plate consists of four variations of the same picture involving differences in shape and line arrangement, value of dark and light and in color schemes.

Each test was graded at Columbia University in such a way that it was determined only if a pupil was above, equal to, or below the normal. Some of the pupils tested were below the normal levels for a CA of ten years, indicating a very low score.¹

Boys were better than girls on the first two tests which are mainly drawing tests. Girls were better on the third test, an art appreciation or color value test. A few showed exceptional ability. Of the fifteen boys, 73 percent were art students. Of the 14 girls, 43 percent were art students.²

Lane, this time in collaboration with Schneider, made another study similar to the one she did in 1938. This time the investigators assembled a scale including: (1) Kohs Block Design, (2) Knox Cube, (3) Seguin Board, (4) Manikin and Feature Profile, (5) Form Boards (Two-Figure Board,

1. Ibid. p. 102.

2. Ibid. p. 103.

Healy A and Casuist Board), (6) Healy Picture Completion I, (7) Drawing (for children of mental age of seven years or less.)¹

These tests were given to a total of 239 children; 133 deaf or speech defective, 106 with normal speech and hearing. The deaf and speech defective children were pupils of Central Institute for the Deaf or attended Corrective Speech Clinic. The children in the hearing group were from the public schools of St. Louis and a Jewish Sunday School.² The authors of this report did not say how the samples were chosen.

Mental ages were obtained directly from the norms for the tests. Standard procedures were followed in administering the tests.

This time some correlations were done. The validity coefficients were computed between scores on this scale and scores on other accepted measures of intelligence as follows:³

Performance:	Cor. with Lectometer Tests	=	.78 ± .03	(N=68)
	Cor. with Randall's Island	=	.65 ± .04	(N=65)
Verbal:	Cor. with Binet	=	.65 ± .08	(N=26)
	Cor. with Henmon-Nelson	=	.68 ± .08	(N=21)
	Cor. with Kuhlman-Anderson	=	.19 ± .14	(N=21)
	Cor. with Detroit	=	.56 ± .12	(N=15)
	Cor. with Total	=	.63 ± .04	(N=106)

1. Helen Schick Lane and Jenny Louise Schneider. "A Performance Test for School-Age Deaf Children" American Annals of the Deaf. 86. 1941. p. 441.

2. Ibid. p. 442.

3. Ibid. p. 443.

There were not sufficient scores on the Haggerty, Otis or Pintner-Cunningham to warrant computation of validity coefficients, but these cases were included in the total.

Table VII shows the comparison of the hearing, deaf and speech defective on the Advanced Performance Scale:¹

TABLE VII
A COMPARISON OF THE INTELLIGENCE OF THE HEARING, DEAF
AND SPEECH DEFECTIVE

Group	Range of CA	Mean I.Q.	Median I.Q.	Range I.Q.
Hearing	7-0 to 13-7	112.75	113.33	81-163
Deaf	7-0 to 21-4	103.57	104.07	60-141
Speech	6-0 to 12-0	97.12	99.0	40-140

Lane and Schneider stated that the high average I.Q. of the hearing group was probably due to selection. The choice of pupils to be tested was left to the teachers, and selection of superior children was made. The Binet test had been given only to those children who were maladjusted.²

They also added that in both the deaf and speech groups, some spastics were included; although they admitted, "A performance test score cannot be considered an accurate measurement of intelligence for these children with impaired motor ability."³ Therefore the first group tested really had

1. Ibid.

2. Ibid. p. 444.

3. Ibid.

three variables: deafness, speech defect, cerebral palsy.

They added still another variable for they wrote: "The lowest score made by a deaf child is that of a totally deaf boy who is losing his vision progressively and who is poorly coordinated muscularly due to rickets and other childhood diseases."¹ It would seem that the authors were comparing a group with several handicaps with a normal group, and that no true conclusions can be drawn as to the effect of deafness on mental ability.

The authors continued: "To compare the ability of the deaf and hearing, the scores of the speech defectives have been included with those of the hearing group as all of these children have normal hearing. The combining of these two groups probably yields a more normal distribution as both the selected superior children in the public schools and a few mentally defective from the Speech Clinic are included."² This seems a rather precarious way to get a representative sample.

The comparison of these two groups showed greater variability for the hearing group (as might be expected) and a slightly higher average I.Q. for the deaf.

The following figures show the comparison of distribution curves of intelligence for the deaf and hearing groups.³

1. Ibid.

2. Ibid.

3. Ibid. p. 445.

<u>Group</u>	<u>Mean I.Q.</u>	<u>Median I.Q.</u>	<u>S. D.</u>	<u>Skewness</u>
Hearing	101.96	104.83	21.84	- .394
Deaf	103.57	104.07	16.85	- .092

The median 2.87 points above the mean for hearing indicates the influence of extremely low scores on the mean, obviously the feebleminded speech defectives.

In a comparison of the difficulty of each test, Kohs Block Design, Manikin-Profile and Healy Picture I, the deaf show scores above average. Lane and Schneider felt that perhaps the training in speech and lip reading had developed superior ability in visual perception, analysis and synthesis, which these specific tests are designed to measure. "Form boards are also measures of visual perception, but are more abstract, lack meaning, and scores are greatly influenced by speed of performance. In the education of the deaf, perfection in the execution of each task is urged at the expense of speed. Consequently the deaf child is deliberate in performance."¹

They also brought out the fact that some of the deaf children had poor muscular coordination because of the loss of function of the static labyrinth in addition to the hearing loss. They mentioned again the spastic deaf children included in the group, pointing out, "These children have poorer scores due to slower performance and for them the test is not a reliable index of mental ability."²

1. Ibid. p. 446.

2. Ibid.

The majority of investigators, discovering that the deaf score somewhat lower on most scales, try to analyze the reasons for the discrepancy. Lane and Schneider's analyses seem to be more in the nature of excuses for the tests; if the score is low for the deaf, they conclude that the test is unreliable. They appear to be more anxious to juggle the groups until they get a favorable score for deaf; than to secure an accurate diagnostic picture of the mental abilities of the deaf.

Finally, Lane and Schneider concluded with the following analysis:

At present this series may be criticized for giving too much weight to visual perception, but until further studies of the nature of intelligence and an accurate analysis of what the various tests measure can be made, this series may be considered a fair measure to determine the intelligence of a child with a language handicap. To remove tests of visual perception because they favor the deaf would be as reasonable as removing verbal tests because they favor the hearing. Perhaps the intelligence of the deaf is manifested in his ability to improve his visual perception.¹

The small number of subjects tested, the irregular sampling and juggling of groups, the very high means for hearing and deaf make it doubtful that this is "a fair measure" for determining the intelligence of the deaf. In addition, verbal tests are not withheld from the deaf because they favor the hearing, but because they give no score for the deaf child who cannot read the directions nor understand the printed subject matter nor give an adequate answer in good language.

1. Ibid. p. 447.

Two additional studies complete the research on the intelligence of the deaf up to the present time:

In 1941, "A Performance Scale for the Measurement of 'Intelligence'" was published by T. P. Alexander in England.¹ The quotation marks are his, probably indicating that he, like so many other investigators, had some doubt as to what he was measuring. His scale includes the Passalong Test, Block Design Test and Cube Construction Test used at Margate School. He gave scoring and norms, but no comparison with hearing groups.

The last study to be reviewed was part of a larger study made of several aspects of deafness by Burchard and Myklebust in 1942.² The Grace Arthur Performance Scale was administered to 189 deaf children at the New Jersey School, 121 of which were congenitally deaf and 68 adventitious cases.

There were 100 male and 89 female students. The age range was seven to nineteen. The mean for the congenitally deaf was 102.5, standard deviation 20.2; for the adventitious group the mean was 101.3, standard deviation 20.5. The difference between the means was 1.19 in favor of the congenital group; the standard error of the difference 3.19; the critical ratio .37. Both groups were found to be of

1. W. P. Alexander. "A Performance Scale for the Measurement of 'Intelligence'." The Teacher of the Deaf. 39-238. 1941. p. 119.

2. E. M. L. Burchard and H. R. Myklebust. "A Comparison of Congenital and Adventitious Deafness with Respect to its Effect on Intelligence, Personality, and Social Maturity." Part 1: Intelligence. American Annals of the Deaf. 87. 1942. p. 140.

average intelligence, and the difference between the groups was not statistically significant.¹ These results do not agree with Day, Fusfeld and Pintner, Peterson and Williams, Reamer. They agree with Brever and Collins, Schick, and Streng and Kirk. Thus, the results of this study agree with those of experimenters who used performance tests and the Chicago Non-Verbal Test. They do not agree with those who used the Pintner Non-Language.²

Summary of Research on Mental Abilities of the Deaf.

Of the studies just reviewed, all which were concerned with the educational achievement of the deaf showed a retardation. The average was about five years. All but one of the investigators who measured the intelligence of the deaf with a verbal examination likewise found the deaf behind the hearing, usually from three to six years. The exception was the freshman group at Gallaudet College which tested equal to freshmen at a hearing university.

As far as mechanical and motor skills are concerned, the investigators were unanimous in asserting that the deaf are as good as the hearing.

It is in the field where most of the testing has been done, that is, with non-language and performance tests, that there is the real disagreement. It is obvious that the deaf

1. E. M. L. Burchard and H. R. Myklebust. "Comparison of Congenital and Adventitious Deafness." Journal of Educational Psychology. 36. 1945. p. 322.

2. Ibid.

cannot keep up with the hearing educationally. It is equally easy to discover that one cannot secure an adequate measure of native ability using an instrument which the deaf cannot comprehend, that is, language. However, when an attempt is made to devise a measuring instrument which will truly measure native mental ability and which will measure the deaf as accurately as the hearing, many difficulties are encountered.

Thirteen studies in which non-language or performance tests were used showed the deaf inferior to the hearing; thirteen proved that he is equal; two indicate that he is superior. Both these last studies have been questioned because of vagueness of procedure or failure to use standardized tests, but the split between the group which finds the deaf equal to the hearing and the group which finds them inferior cannot be explained away. To make the problem more difficult, the differences are seldom very great. Does a mean I. Q. of 98 for a large group of deaf students prove they are equal to or inferior to the hearing? On which side does a mean I. Q. of 96 or 94 belong? The mean I. Q. for the hearing is supposed, theoretically, to be 100, yet few standardizations for intelligence tests come out neatly and exactly at 100, nor do the investigators always give the standard deviation and probable error of their distribution.

At best, one can conclude that the deaf are greatly retarded educationally; that verbal measures of mental

abilities are inadequate, and that when non-verbal measures are used, there is evidence that the deaf are still somewhat inferior to the hearing in intelligence. Various logical reasons have been offered to explain this difference, if it actually exists; the most frequent being that the same factors which cause the deafness also cause a mental retardation.

Although most of the studies here reviewed were concerned with comparing the native ability of the deaf with that of the hearing, some at least endeavored to analyze what they were measuring in these comparisons. It is generally agreed that the performance tests tend to measure the same factor; but that that factor is not "general intelligence," nor will it predict educational success. It seems to be just a part of what educators mean when they refer to school ability.

The important questions still unanswered are: What factor or factors do the performance tests measure? What implications are there for the educators of the deaf? This study will attempt to answer these questions. Those investigators who discovered that the deaf were uniformly equal to the hearing in mechanical and motor skills advocate that those be the core of their curriculum. That solution ignores individual differences and interests and aptitudes, and is a hasty conclusion at best. It is hoped that a study of the pattern of the intelligence of the deaf, as seen in an analysis of their various mental abilities, will shed new light on the subject.

Research on Primary Mental Abilities.

The researches on the primary mental abilities which have been in progress for several years have had as their first purpose the identification and definition of the independent factors of mind. As the nature of the abilities became more clearly indicated by successive studies, a second purpose of a more practical nature has been involved in some of these studies. This has been to prepare a set of tests of psychological significance and practicable adaptability to the school testing and guidance program.¹

Guilford wrote in 1936: "Thus far in the development of the factor methods the interest has been in the theoretical questions, which is quite as it should be. Before we attempt to measure the degree to which an individual possesses any primary ability, we must know with some assurance that such an ability exists."² In the years since that time numerous studies, by Thurstone and others, have given indication that these primary abilities exist and can be measured.

Cain, in 1939, wrote: "The greater number of investigations, however, have centered upon the improvement of methods in factor analysis, the identification of factors, and the stability and reliability of factors. Little has been done to determine the actual relationships of the

1. Thelma Thurstone. "Primary Mental Abilities of Children." p. 106.

2. J. P. Guilford. Psychometric Methods. New York. McGraw-Hill Book Co., Inc. 1936. p. 509.

statistically determined factors to success."¹ To a large extent that is still true today. This chapter will review recent studies concerned with primary mental abilities, in particular those related to educational guidance. No published studies of primary mental abilities of the deaf were found.

The Development of the Factor Theories. First the history of the analysis of human abilities as summarized by Guilford in 1940 will be reviewed briefly. He wrote:² "The psychologist's story of human abilities might well be given the subtitle 'from faculties to factors.'" He uses the word "ability" as referring to "the constitutional conditions of individuals for performing in some specified manner."³

Guilford began his history with Galton, who regarded abilities as specific, and tested them as such.⁴ Whipple, who wrote on mental measurements in 1915, spoke of them as separate mental functions. It was Binet, however, who gave the language of measurement the turn it was to take for many years until the researches of Spearman, Thomson and Thurstone brought it back to that begun by Galton. In distinguishing between brightness and dullness, and calling

1. Leo Cain. The Relation of Primary Mental Abilities Factors to the Academic Achievement of College Students. Doctoral Dissertation. Stanford University. 1939. p. 2.

2. Guilford. "Human Abilities." p. 368.

3. Ibid. p. 367.

4. Ibid. p. 369.

that distinction "intelligence," Binet suggested a single dimension of mind, thus initiating the dispute over what intelligence means.¹

Spearman, about 1904, began those studies out of which grew the various factor theories.² He and his followers held the view that all intellectual activities have in common an important factor which is the essential element of intelligence and that this factor is supplemented by numerous specialized abilities of narrower range.

Spearman found that diverse tests of mental abilities usually gave intercorrelations which could be wholly accounted for (within the limits of their errors of sampling) by a single general factor plus specific factors. The generalized factor he symbolized by the letter "g," the specific factors by the letters "s1, s2, s3," etc.³ Spearman's own favorite explanation of "g" was that it represented general mental energy, while the "s" factors were the engines of the mind.⁴

Later, he grudgingly recognized as group factors: verbal ability, numerical ability, mechanical ability and a possible factor of mental speed.⁵

1. Ibid. p. 370.

2. L. L. Thurstone. "A New Conception of Intelligence." Educational Record. 17. 1936. p. 442.

3. Philip Ewart Vernon. The Measurement of Abilities. London. University of London Press. 1940. p. 164.

4. Charles Spearman. The Abilities of Man. New York. The MacMillan Co. 1927. p. 135.

5. E. Palinsky. "An Analysis of the Mental Factors of Various Age Groups from 9-60." Genetic Psychology Monograph. 23. 1941. p. 197.

Spearman insisted that the Binet scale, the model for all intelligence tests, was constructed on the basis of his g-factor theory. Others labelled his "g" factor intelligence.¹

Thomson developed the group factor theory, which offered an explanation for the fact of low intercorrelations among parts of a test battery and which was more suited to serve as a theoretical basis for vocational testing. He assumed that there were many elementary abilities and that each test samples a certain range of these.²

Since Spearman formulated the two-factor theory and devised the method of tetrad differences for discovering the factors, other procedures have been invented. These allowed for the extraction of more than one factor, as Spearman himself admitted the possibility of several factors in test batteries. Kelley, Thurstone and Hotelling each developed techniques of factor analysis.³

Thurstone's first major application of the theory of factor analysis is described in his Vectors of Mind. He explained that the factorial methods have been developed primarily for the purpose of analyzing the relations of human traits. A trait he defined as "any attribute of an individual." An ability is "a trait which is defined by

1. Guilford. Human Abilities. p. 371.

2. W. Brown and G. F. Thomson. The Essentials of Mental Measurement. London. Cambridge University Press. 1925. p. 36.

3. Salinsky. op. cit. p. 197.

what an individual can do."¹ This definition implies that there are as many abilities as there are innumerable things that individuals can do. Each ability is therefore objectively defined in terms of a special task and of a specified method of appraising it. "The task, together with the method of appraising it, which defines an ability" is called a test. "The linear evaluation of a test performance is called a score. It is implied in these definitions that an index of ability is co-variant with the score in the test which defines the ability, and that a true index of ability is co-variant with the true score in the test."²

Thurstone's method of analysis allows for the extraction of many factors, which are called weighted group factors in order to differentiate them from the group factors of Thomson's sampling theory. Thomson postulated innumerable elementary abilities; Thurstone postulated a limited number, not yet fixed.³ The Thurstone multi-factor theory, like Thomson's sampling theory, served as an explanation for low inter-test correlations as well as high test correlations with the entire battery. The Thurstone method has been most widely used.⁴

In 1936, summing up the work he had done so far with multiple factor analysis, Thurstone wrote: "While a single total index of mental endowment such as mental age is very

1. Ibid. p. 48.

2. Ibid.

3. Ibid.

4. Balinsky. op. cit. p. 198.

useful in differentiating those who are generally bright from those less endowed, it is of great practical and scientific importance to isolate those elements of intelligence which are in some fundamental sense primary."¹ He had isolated seven primary abilities at that time: number facility, word fluency, visualizing, memory, perceptual speed, induction, verbal reasoning.²

In support of his theory, Thurstone wrote:

For many years psychologists have been accustomed to the problems of special abilities and disabilities. These are, in fact, the principle concern of the school psychologists who deal with children who cannot read, have a blind spot for numbers, or do one thing remarkably well and other things poorly. It seems strange with all this experience in differential psychology that we have clung so long to the practice of summarizing a child's mental endowment by a single index, such as the mental age, the intelligence quotient, the percentile rank in general intelligence, and other single average measures. An average index of mental endowment should be useful for many educational purposes, but it should not be regarded as more than the average of several tests....There is nothing wrong about using a mental age or an intelligence quotient if it is understood as an average of several tests. The error that is frequently made is interpreting it as measuring some basic functional unity when it is known to be nothing more than a composite of many functional unities.³

The Refinement of the Tests Measuring Factors.

Thurstone's next major investigation was made with a battery of fifty-six psychological tests given to a group of 240 college students who volunteered for the study.⁴ This

1. L. L. Thurstone. "A New Conception of Intelligence." p. 443.

2. Ibid. p. 446.

3. Thelma Thurstone. "Primary Mental Abilities of Children." p. 105.

4. L. L. Thurstone. Primary Mental Abilities. Chicago. University of Chicago Press. 1938. p. 10.

study revealed a number of primary abilities, some of which were clearly defined by the configuration of test vectors while others were indicated but less clearly defined.

At the conclusion of this study, Thurstone wrote:

Further experimental studies of the factors will be much more refined and crucial in character in that the experimental tests can be constructed more precisely to test specific psychological questions....The tests that have been constructed for the subsequent studies are more nearly pure in that some of them could be designed so as to feature one factor with little admixture of the others. This process will continue for some time until we shall be able to prepare psychological tests that involve only one or two factors instead of three, four, or five, as is the case with most of the tests in common use.¹

As was mentioned previously in this chapter, the studies of primary mental abilities have concerned themselves first with defining the abilities and second with determining their relationship to success. Since many of the studies involve both aspects of the problem, they will simply be considered in chronological order.

Shanner, Stalnaker and Cain each reported an investigation in 1939.

Shanner analyzed the statistics published by Thurstone for the experimental edition of the Primary Mental Abilities Tests. He found that a comparison of the profiles obtained on these tests suggested that groups selected upon the basis of academic achievement may differ significantly with respect to their primary mental abilities. In so far as they "are capable of accurately defining these abilities,

1. L. L. Thurstone. Primary Mental Abilities. p. VI.

we may use the tests for guidance purposes and for predicting performance on various achievement tests. The battery of tests is satisfactorily reliable and the inter-correlations for the ability scores are sufficiently low to indicate considerable independence of mental factors measured, even though they are not so low as one should desire."¹ He suggested additional refinement and improvement of the tests, which has, of course, been done since his report.

In a criticism of Shanner's article, Crawford disagreed with each of his conclusions in turn. He agreed that it was altogether likely that "groups selected upon the basis of academic achievement" do really "differ significantly with respect to their mental abilities," but stated that "such difference is not revealed by this particular trial of the tests in question." Second, he asserted that "inter-correlations as reported in this study are not 'sufficiently low to indicate considerable independence of mental factors measured,' although they certainly are 'not so low as one should desire.'" He concluded:

That 'the tests in their present form unquestionably constitute a valuable addition to the field of aptitude testing I sincerely hope and believe, but this demonstration of their diagnostic powers is unconvincing. The results thus reported appear, at least to the present writer, distinctly less encouraging than had been hoped for, when the long awaited primary ability measures became generally available.

1. William M. Shanner. "A Report on the Thurstone Tests for Primary Mental Abilities." Educational Records Bulletin. 27. 1939. p. 60.

I still maintain faith in their ultimate importance as significant contributions not only to psychological theory, but to practical guidance needs as well.¹

Stalnaker also analyzed Thurstone's work. Using the same 1938 experimental edition of Thurstone's Primary Mental Abilities Tests, he felt that speed was a factor, though not recognized as such.² He believed that a different factor pattern would emerge if the same tests were given with a more generous time limit, but he did not prove it.

He likewise disagreed with Thurstone's seven factors, maintaining that seven are not required to account for the correlations found with the populations concerned, a conclusion he reached after applying other methods of factor analysis to the data.³

With regard to the value of this particular set of tests for individual diagnosis and guidance, Stalnaker felt that, in spite of the enormous amount of research which directly or indirectly has gone into the preparation of the present set of tests and the careful editing to which they have been subjected, the results obtained with one group of candidates do not support in full the theory of the seven

1. A. B. Crawford. "Some Observations on the Primary Mental Abilities Patterns in Action." School and Society. 51. 1940. p. 592.

2. John M. Stalnaker. "Primary Mental Abilities." School and Society. 50. 1305. December 30, 1939. p. 870.

3. Ibid. p. 871.

primary abilities.¹ The time allowed for each test is brief, and the resulting individual scores, therefore, are not as dependable as if longer tests had been used. Stalnaker felt that the tests could be materially improved by the elimination of items of low validity, by arranging the items in order of difficulty and by adjusting the time limits.²

Since this experiment was done with the older edition of the tests, and since many of Stalnaker's recommendations have been incorporated into the newer edition, no further comment seems necessary.

Recent Studies on the Relations of Mental Abilities to Achievement. In a different type of study, an attempt to compare results on the Thurstone Tests of Primary Mental Abilities with academic achievement, Cain raised the following questions:

1. What relationships do the primary mental abilities of Perception, Number, Verbal relations, Spatial relationships, Memory and Induction, as measured by the Thurstone Primary Mental Abilities Tests yield with measures of academic achievement?³
2. What is the relationship between the Thurstone measures and an adaptation of the Thorndike Intelligence Examination for High School Graduates, the scholastic aptitude test used at Stanford University?⁴
3. Do the measures of primary mental abilities reveal anything regarding the nature of the basic mental ability or abilities that enter into academic achievement, to what extent do they contribute to the variance in

1. Ibid. p. 872.

2. Ibid.

3. Cain. op. cit. p. 6.

4. Ibid. p. 7.

performance?¹

4. What is the practical value of these measures as diagnostic instruments in the guidance of students in selection of courses?

5. What are the limitations of these measures?²

The major findings of Cain's investigation are as follows: The Thurstone Primary Mental Abilities Tests are not highly related to any of the academic variables,³ although there was adequate consistency of relationship from group to group to indicate that a verbal factor was contributing to the variance in the English, history, French, biology and psychology variables and that an inductive factor was contributing to the chemistry and mathematics variables.⁴ He concluded, therefore, that the only measures of definite value for purposes of educational guidance determined by his study are the tests of a verbal and inductive nature.⁵

That same year, Spearman showed that a pattern of general group factors would fit the same results (as Thurstone had reached with his independent factors) as well or better.⁶

The following year, Guilford summarized the research to date. In answer to the question: "What factors have been discovered?" he wrote: (1) There seems to be sufficient

1. Cain. op. cit. p. 7.

2. Ibid.

3. Ibid. p. 138.

4. Ibid. p. 140.

5. Ibid.

6. Charles Spearman. "Thurstone's Work Re-worked." Journal of Educational Psychology. 30. 1939. p. 15.

evidence for "g".¹ (2) The three most frequently verified factors are verbal, numerical and spacial.² (3) The memory factor has been verified more than once.³ (4) Speed of perception, induction, deduction, verbal fluency, attention, alertness have also been recognized.⁴ (5) Speed and learning ability have not as yet been isolated.⁵

A report by Schaefer in 1940 simply gave "increasing evidence for the reliability of the functional unities" determined by factorial studies in the cognitive field of human ability.⁶

That same year Moffie constructed five non-verbal tests to measure five of the seven Thurstone primary mental abilities; (P) Perceptual Speed, (S) Space, (I) Induction, (D) Deduction and (M) Memory. The purpose of the study was to find if these newly constructed performance tests really measured what they were arbitrarily named.⁷

These tests, in addition to the Witmer Cylinder, Porteus Maze, Profile, Lepley, Healy P. C. II, Five Figure, and the

1. Guilford. Human Abilities. p. 377.

2. Ibid. p. 378.

3. Ibid. p. 379.

4. Ibid. p. 380.

5. Ibid. p. 381.

6. Willis C. Schaefer. "The Relation of Test Difficulty and Factorial Composition Determined from Individual and Group Forms of Primary Mental Abilities." Psychological Bulletin. 37:7. 1940. p. 457.

7. D. J. Moffie. "A Nonverbal Approach to the Thurstone Primary Mental Abilities." Psychological Bulletin. 37:7. 1940. p. 446.

complete Thurstone Primary Abilities Battery (Experimental Edition) were given to 110 freshmen boys at Penn. State.

Pearson product - moment correlations were obtained. The body of the data comprising nineteen variables was treated by the Thurstone centroid method of factor analysis. The Thurstone tests were used as the criterion to aid in the identification of the factors.

Moffie found that the following three group factors were needed to explain the data: (1) Space, (2) Induction, and (3) Perceptual Speed. No general factor was disclosed.

The results indicated, according to the investigator, that the newly constructed performance tests, arbitrarily named tests of Perception and Deduction, in reality measure Space. The newly constructed space test had a high loading on this axis. Induction, as located by the criterion, seemed to be measured by the newly constructed performance test of induction.¹

Three studies of the predictive value of primary mental abilities were also reported in 1940.

Adkins analyzed the relation of primary mental abilities to preference scales and to vocational choice. Her paper was a report of two studies, the first of which was conducted jointly by Dr. G. F. Kuder and herself and questioned the extent to which one's abilities are related to the types of

1. Ibid. p. 447.

activities which one prefers.¹ She used the experimental edition of Thurstone's Primary Mental Abilities tests with scores on seven primary abilities composites, given to 512 University of Chicago freshmen in 1938. The same students filled out an experimental edition of Kuder's Preference Record, which yields scores for nine types of activities.

Adkins reported relatively little overlapping between the measure of ability and the preference measures. She concluded that if measures in each of these domains have prognostic value for certain criteria of success, a combination of the two sorts of measures ought to prove more effective than measures in either field alone.²

In the second study, she investigated the relations of primary mental abilities to vocational choice. She demonstrated that the ability profiles of the various vocational groups differ and that the differences are reasonable.³

The second investigation of this type for 1940 was made by Ball. He took the first semester averages and semester grades in nine subject matter fields for 147 freshmen girls and 159 freshmen boys at Penn. State and correlated them with the Thurstone Primary Mental Abilities

1. Dorothy C. Adkins. "The Relation of Primary Mental Abilities to Preference Scales and to Vocational Choice." Psychological Bulletin, 37. 7. 1940. p. 456.

2. Ibid.

3. Ibid. p. 457.

Tests.¹

He found that the Thurstone scores correlated low with grades in subject matter fields. The verbal (V) was the best single prognostic factor, with correlations varying from + .20 with mathematics to + .40 with English composition. M(Memory) and N(Numerical) were next best, followed by I(Induction) and D(Deduction); P(Perception) and S(Space) had little prognostic value.²

The third study of the predictive type was also done at Pennsylvania State College. Tredick used 113 freshmen women in the Department of Home Economics as her subjects. She found that the multiple regression equation made up of the four most promising Thurstone Tests, (N, V, I and D), predicted academic success with an efficiency represented by a multiple R of .61. She also found that the Thurstone tests measured far from independent abilities, since half the inter-correlations were above + .20.³

Further Refinement of the Thurstone Tests. That same year, Thurstone summarized the latest work on the Primary Mental Abilities Tests themselves.⁴ She mentioned several

1. Fred J. Ball. "A Study of the Predictive Values of the Thurstone Primary Mental Abilities Tests as Applied to Lower Division Freshmen." Master's Thesis. 1940. Penn. State College Studies in Education. 24. 1942. p. 51.

2. Ibid.

3. Virginia D. Tredick. "The Thurstone Primary Mental Abilities Tests and a Battery of Vocational Guidance Tests as Predictors of Academic Success." Master's Thesis, 1940. Penn. State College Studies in Education. 24. 1942. p. 58.

4. Thelma Thurstone. "Primary Mental Abilities of Children." Psychological Bulletin. 37:7. 1940. p. 446.

previous studies with students of high school age in which the same primary abilities had been isolated as had previously been found among a group of superior college students. This latest investigation aimed at isolating the primary mental abilities of children.

Sixty psychological tests were given to 1100 eighth grade children in the Chicago public schools. The correlation matrix was analyzed by the centroid method, and the factor matrix rotated into a simple structure. Six of the factors previously described were found: Number, Space, Verbal meaning, Word fluency, Memory and Reasoning. A second-order general factor was also indicated. The seventeen tests which were assembled for a practical program in the schools were also described in this paper.¹

The Thurstones did not find in these data a general factor distinct from the primary factors, but felt that the second-order general factor should be of as much psychological interest as the more frequently postulated, independent general factor of Spearman, and that it is probably the same factor as Spearman's.²

Thurstone summed up the investigation as follows:

It should not be assumed that there is anything final about six primary factors. No one knows how many primary mental abilities there may be. It is hoped that future factorial studies will reveal many

1. Ibid. p. 447.

2. Thelma Thurstone. "Primary Mental Abilities of Children." Educational and Psychological Measurement. 1. 1941. p. 109.

other important primary abilities so that the mental profiles of students may eventually be adequate for appraising educational and vocational potentialities. In such a program the present studies are only a starting point in substituting for the description of mental endowment by a single index the description of mental endowment by a profile of fundamental traits.¹

Research Since 1941. In 1941, several investigators studied both the nature of independent abilities and their application. An extensive study of the first type was done by Morrow.

The purpose of Morrow's study was to determine whether human abilities as measured by special tests are independent or interdependent and the extent of such relationship. More specifically, he set out to find by means of correlational analysis and the factorial analysis technique the degrees of relationship among certain tests of intelligence, musical ability, artistic judgement, clerical ability, mechanical ability and manipulative ability.²

He used the following tests with eighty subjects:

1. American Council on Education Psychological Test.
2. Seashore Measures of Musical Talent.
3. Meier-Seashore Art Judgement Test.
4. Minnesota Vocational Test for Clerical Workers.
5. Likert and Quasha Revised Minnesota Paper Form Board.
6. Minnesota Spacial Relations Test.
7. Minnesota Mechanical Assembly Box.
8. O'Connor Finger and Tweezer Dexterity Tests.³

The correlations found as a result of this study were mainly positive, although rather low, thereby indicating

1. Ibid. p. 112.

2. Robert S. Morrow. "An Experimental Analysis of the Theory of Independent Abilities." Journal of Educational Psychology. XXXII. 7. October, 1941. p. 495.

3. Ibid. p. 496.

slight degrees of interrelationships among the abilities tested.¹ Morrow also found a general factor.²

Morrow concluded that the Spearman two-factor theory represents a static system and is apparently incomplete for explaining the results obtained here.³ He disagreed also with Thurstone's conclusions, feeling that abilities are by no means absolutely specific and diverse due to the existence of considerable overlapping of function.⁴ He claimed, in all, that by virtue of his findings, the Spearman and Thurstone theories are inadequate for explaining the relationships expressed in his study. Rather he concluded with the hypothesis that the abilities he tested are not disparate and static abilities, but that they are, instead, functional and dynamic relationships within the total personality.⁵

Balinsky undertook to study mental factors and to note any changes in these factors and their organization. He selected various age samplings from 9-60; including samplings at 9, 12, 15, 25-29, 35-44, 50-59.⁶ All were given the Wechsler-Bellevue Examination. The independent mental factors found in this study are the following:

1. For age nine, a G factor and verbal factor.
2. For age 12, a verbal factor, a performance factor, and one called seeing relationships in social situations.

1. Morrow. op. cit. p. 499.

2. Ibid. p. 510.

3. Ibid. p. 508.

4. Ibid.

5. Ibid. p. 511.

6. Balinsky. op. cit. p. 229.

3. For age 15, a verbal factor, a performance factor and one that could not be clearly indicated.
4. For age 25-29, a verbal factor, a performance factor, a memory factor and a factor called restriction in solution.
5. For age 35-44, a verbal factor, a performance factor, and a memory factor.
6. For 50-59, a G factor, a performance factor, and a factor involving some sort of reasoning.

It will be observed that except at the lowest and highest levels, a performance factor and a verbal factor are present for each age sampling. Balinsky concluded that "the above factors are the ones existent in the Wechsler-Bellevue Scale and are sufficient to describe all the test variables at each level."¹

Ellison and Edgerton came to similar conclusions to those found by Cain in 1939, in their study published in 1941.² They found a correlation of above 0.40 between Factor V and grades in each of the four subject fields they considered, the highest being with English grades.³

They set out to answer the following questions by their investigation:

1. What relationships are there between the factor scores and academic grades?
2. What relationships are there between the Ohio State University Psychological Test score and the factor scores?
3. How well can academic grades be predicted on the basis of the primary factor scores?

1. Ibid. p. 230.

2. Mary Lou Ellison and Harold Edgerton. "The Thurstone Primary Mental Abilities Tests and College Marks." Educational and Psychological Measurement. 1. 1941. p. 399.

3. Ibid. p. 406.

4. Are the factor scores related to grades in specific college subjects?¹

Thurstone's Primary Mental Ability Tests were used.

The subjects consisted of forty-nine students in the College of Arts and Sciences at Ohio State University. This was not a random sample; it included forty-one freshmen, six sophomores and two juniors. Thirty-nine per cent of them ranked at the 90th percentile or above in intelligence on the Ohio State University Psychological Test; fifty-four per cent ranked at the eightieth percentile or above.²

The following were the results of the study: Computing the relationships between the factor scores and point-hour ratio (PHR), the correlation between factor V and PHR was found to be highest (0.44). The correlation between factor M and PHR was 0.31; the others ranged from 0.24 to 0.19.³ (For a more complete explanation of the nature of the various factors as isolated by Thurstone, see the first section of this paper.)

The multiple correlation between PHR and the weighted scores of the seven factors is 0.640. Such a correlation, the authors of this study asserted, suggests that there may be some justification for the use of the Primary Mental Abilities Tests for the prediction of academic success in college.⁴

1. Ibid. p. 399.

2. Ibid. p. 401.

3. Ibid. p. 402.

4. Ibid.

Computing the relationship between the Ohio State University Psychological Test score and the factor scores, factor V was again found to be highest (0.52). Factor M was 0.28. The correlation of factors P, I and D with intelligence were positive, but very low.¹

In answer to the third question of how well PHR can be predicted on the basis of primary factor scores, Ellison and Edgerton stated that the correlation of scores with PHR is increased slightly when the intelligence test rating is used, from 0.640 to 0.648. In a random sample of freshman they felt this difference would probably be greater.²

Studying the relation of factor scores to grades in specific college subjects, Ellison and Edgerton found:

1. English grades correlate highest with factor V (0.75).
2. Factors, S, M and D also show correlations above 0.40 with English grades.³
3. The only factor showing a correlation above 0.40 with science grades is factor V.⁴
4. All the factors are apparently important in determining foreign language grades, since all factors except P correlate above 0.40 with foreign language. The most significant is factor I with a correlation of 0.78.
5. The highest correlation among the factors with psychology grades is factor D (0.63). V is also high (0.59).
6. The correlations between factor I and the school subjects are low with the exception of foreign language grades (0.78).
7. Factor P shows very low correlation with all four school grades.
8. There is little differentiation between the corre-

1. Ibid. p. 403.
 2. Ibid. p. 404.
 3. Ibid. p. 405.
 4. Ibid. p. 406.

lation of the school grades and factor N, the only correlation higher than 0.40 being with foreign language grades. Factors S and N both have correlations over 0.40 with English and foreign language grades, and factor D has a significant correlation with English, foreign languages and psychology grades.¹

Ellison and Edgerton felt that, with such observations as are reported in their study, with more experience the Thurstone Primary Mental Abilities Tests will become a useful instrument in the academic counseling program of colleges. They also asserted, however, that it will be important to have some knowledge of methods of instruction in the several courses so as to judge whether the relationship observed is a function of the abilities of the student and the subject matter being studied, or of the methods of instruction.²

One criticism which might be made of this study is aroused by the fact that the authors correlate PHR and grades, which seems rather like correlating age and date of birth.

Yum found similar results to those found by Cain and Ellison and Edgerton in his study of the relation between the Thurstone tests for primary mental abilities and academic success.³ His investigation revealed both sex and divisional differences. The verbal, inductive reasoning, and deductive reasoning factors were found to be more closely

1. Ibid.

2. Ibid.

3. E. S. Yum. "Primary Mental Abilities and Scholastic Achievements in the Divisional Studies at the University of Chicago." Journal of Applied Psychology. 25. 1941. p.712.

related to scholarship than the remaining factors.¹

Two additional studies were reported which dealt with the application of primary mental abilities tests to specific subject matter fields.

Harrell and Faubion reported their conclusion, based on several studies, that there was no one separate factor for a mechanical ability.² Rather they found several factors which are more or less prominent in mechanical work, their pattern depending upon its type and complexity and on the point reached in the learning curve.³

Goodman found results which substantiate Thurstone's findings.⁴ Intercorrelational coefficients among Thurstone's seven primary mental abilities scores were obtained from scores of 170 freshmen engineering students of Penn. State College on the experimental edition of the primary mental abilities tests. Four factors were isolated, G, R, V, M. This finding of a general factor, G, for a college population corroborates Thurstone's finding of a general factor for eighth-grade children.⁵

Additional conclusions from this same study were

1. Ibid. p. 720.

2. Willard Harrell and Richard Faubion. "Primary Mental Abilities and Aviation Maintenance Courses." Educational and Psychological Measurement. 1. 1941. p.63.

3. Ibid.

4. C. H. Goodman. "Factorial Analysis of Thurstone's Seven Primary Abilities." Psychometrika. 8. 1943. p. 121.

5. Ibid. p. 129.

published by Bernreuter and Goodman:¹

1. The tests show sufficient reliability to justify their use in making comparisons of individuals on the college level.
2. The freshman engineering students are superior to Thurstone's High School Seniors in deductive reasoning and space, possibly superior in verbal, possibly inferior in inductive.
3. The low but positive intercorrelations indicate that the tests are not entirely pure measures of the primary abilities, but, despite the impurities, they are sufficiently independent for them to possess significant different values in predicting scholastic success.
4. At least four of the primary abilities - number, verbal, induction, reasoning do correlate sufficiently with success to justify their use.

Swineford and Holzinger, in 1942, reported the verbal factor to be more highly correlated with school grades than the others, except the general factor,² conclusions which agree with several previous studies. In their investigation, using ninth-grade children, the major factors located were the general, spatial, verbal, speed and memory. Regression equations based on the factors yielded a multiple correlation of .720 with scholastic success as compared to a correlation of .573 between I.Q. and scholastic success. This increase in predictive value was statistically significant.³

Readministration of some of the tests to a majority of the original pupils one year later disclosed a factor pattern

1. Robert G. Bernreuter and Charles H. Goodman. "A Study of the Thurstone Primary Mental Abilities Tests Applied to Freshmen Engineering Students." Journal of Educational Psychology. 32. 1941. p. 60.

2. F. Swineford and K. J. Holzinger. "A Study in Factor Analysis." Supplement Educational Monograph. 53. 1942. p. 99.

3. Ibid. p. 99 ff.

essentially the same.¹ Some evidence was found for the pupils to prefer occupations which corresponded to their abilities.²

Stuit and Hudson, the following year, administered Thurstone's tests to students in engineering, medicine and journalism.³ Characteristic profiles for the various professional groups were revealed. The authors came to the conclusion reached in the studies reported above, that these tests have definite value in educational and vocational counseling.

Summary of Studies on Primary Mental Abilities. Thus, the history of research on primary mental abilities has been traced, and studies which attempted to define these abilities as well as those which used them to predict academic and vocational trends have been discussed. The controversy among the supporters of the two-factor theory and the various theories of group and independent factors has not as yet been resolved, yet there seems to be sufficient evidence that primary mental abilities do exist and can be measured. The Thurstone method of factor analysis seems to be the most widely accepted, perhaps because it is the easiest to master. Certainly there has been more application of his method to the practical field of testing.

1. Ibid.

2. Ibid.

3. Dewey B. Stuit and H. H. Hudson. "The Relation of Primary Mental Abilities to Scholastic Success in Professional Schools." Journal of Experimental Education. 10. 1942. p. 179.

Those factors most frequently mentioned in studies dealing with factor analysis itself are: verbal, memory, space, numerical, speed of perception, and induction. When educational application is attempted, the verbal factor shows the highest correlation with academic success in practically every study, with memory a close second. Induction, deduction, numerical and perception show fairly high correlations.

As was pointed out in the summary at the end of the first part of this section, dealing with mental measurements in the field of the deaf, no single index of intelligence has been adequate to describe the ability of the deaf child. A profile, as provided by the Thurstone Primary Mental Abilities Tests, may give a more adequate picture of the abilities of these physically handicapped children. Since the Thurstone Primary Mental Abilities Tests have never been administered to deaf children, it was decided to use them in this study and to compare the patterns of abilities shown by the deaf with those shown by hearing children, in the hope that some insight will be given into the cause of the deaf child's educational lag.

CHAPTER IV

ANALYSIS OF DATA

The primary purpose of this study was to compare the deaf and hearing with regard to primary mental abilities. In addition, the following related problems were investigated: (1) the relationships between (a) type of deafness and test performance, (b) age of onset of deafness and test performance and (c) degree of hearing loss and test performance; (2) the correlation between scores made by the deaf on the Wechsler-Bellevue Intelligence Test and the Chicago Tests of Primary Mental Abilities; and (3) the relationship between teacher's estimate of the deaf individual's ability and the individual's performance on these tests. Data on these problems are presented and analyzed in this chapter.

The Criterion for Combining Scores from Different Schools.

Since three schools were used, one of the first problems was to determine whether the distributions of the scores for the three schools were significantly divergent or whether they could be combined for the analysis of the data. The Chi Square Test was used for this purpose.

For both the Thurstone Tests and the Wechsler the distributions for the Indiana School and the Kendall School were similar. The Chi Square of 5.39 and p greater than .05 presented in Table VIII indicate that there is no significant difference between the two distributions. When the distribution for the New Jersey School is compared with that for either the

Kendall School or the Indiana School, the probability is less than five in one hundred that differences are due to chance fluctuations in sampling.¹

TABLE VIII
CHI SQUARE TEST OF ASSOCIATION

TESTS	SAMPLES COMPARED	χ^2	df	p
Wechsler	Kendall - Indiana	5.39	4	.05
	Kendall - New Jersey	12.00	4	.05
	New Jersey - Indiana	20.30	4	.01
Thurstone	Kendall - Indiana	2.17	4	.05
	Kendall - New Jersey	9.15	4	.05
	New Jersey - Indiana	34.80	4	.01

We did not combine the scores for the New Jersey School with those for the other two schools. The distribution curve of the New Jersey School scores was positively skewed. This may be accounted for by the fact that sixteen of the older students at this school were unavailable for testing. The scores for the Indiana School and the Kendall School were combined for some of the calculations, while separate analyses were made for the New Jersey School.

Comparison of the Deaf and the Hearing on the Chicago Tests.

In order to answer the question which forms the basis for this study, i.e., whether the handicap of deafness is

1. Throughout the remainder of this chapter, a probability level of .05, i.e., the probability of obtaining a statistic as large or larger than the one obtained, through random errors of sampling, is taken to indicate significance. A probability of a statistic occurring once in one hundred times is taken to indicate a high level of significance.

TABLE IX

COMPARISON OF SCORES FOR THE DEAF WITH THE MEAN
SCORES FOR THE HEARING ON THE THURSTONE TESTS

Factor	School	Num. of Cases	Num. above Mean	Num. below Mean	Critical Ratio	P
N	Indiana	93	50	43	.80	>.05
	Kendall	27	4	23	5.15	<.01
	Ind. & Kend.	120	54	66	1.20	>.05
	New Jersey	90	11	79	10.86	<.01
V	Indiana	93	0	93	*	—
	Kendall	27	1	26	*	—
	Ind. & Kend.	120	1	119	*	—
	New Jersey	90	1	89	*	—
S	Indiana	93	51	42	1.00	>.05
	Kendall	27	14	13	.00	—
	Ind. & Kend.	120	65	55	.80	>.05
	New Jersey	90	45	45	.00	—
W	Indiana	93	9	84	13.33	<.01
	Kendall	27	10	17	1.00	>.05
	Ind. & Kend.	120	19	101	11.33	<.01
	New Jersey	90	5	85	18.75	<.01
R	Indiana	93	14	79	8.75	<.01
	Kendall	27	7	20	2.85	<.01
	Ind. & Kend.	120	21	99	*	—
	New Jersey	90	8	82	14.80	<.01
M	Indiana	93	62	31	3.40	<.01
	Kendall	27	13	14	.00	—
	Ind. & Kend.	120	75	45	3.00	<.01
	New Jersey	90	18	72	6.82	<.01

*These differences were obviously significant, therefore no critical ratios were computed.

associated with the incapacity to develop abstract intelligence, scores made by the deaf and hearing on the Wechsler and Thurstone Tests were analyzed.

For the Chicago Tests, each deaf individual was compared with the appropriate age norm for hearing students, as computed by Thurstone. The number of deaf students whose scores fell above and below the mean score for the hearing on each of the six primary mental abilities was determined. Differences between the deaf and hearing groups were computed for each of the three schools and for the Kendall School and the Indiana School combined. Critical ratios of the differences to the standard error of the differences between the deaf and hearing groups were computed.¹ The results of these computations are presented in Table IX.

When the five per cent level of significance is used, indicating that the chances are less than five in one hundred that differences between the deaf and the hearing on the Thurstone Tests are actual and not due to chance fluctuations of sampling, no significant differences were found for the Indiana School nor the Indiana and Kendall Schools combined on the numerical and space factors and for the Kendall School on word fluency as revealed by p greater than .05 in Table IX. (For the number of cases above and below the mean for the hearing for each factor, the critical ratio and the probability that the differences are significant, see Table IX.) Highly significant differences in favor of the hearing over the Indiana School students were

1. Formulae used: $CR = \frac{p1 - .50}{\sigma p}$ ($p1$ = per cent of cases below the mean)

$$\sigma p = \sqrt{\frac{pq}{N}} \quad (q = 1 - p)$$

found on the verbal, word fluency, and reasoning factors. The hearing group showed a highly significant superiority over the Kendall School students on the numerical, verbal and reasoning factors. When scores for the Kendall and Indiana Schools were combined, the deaf students were below the hearing, to a highly significant degree, on the verbal, word fluency and reasoning factors. The New Jersey School students were significantly lower than the hearing, at the .01 level, on the numerical, verbal, word fluency, reasoning and memory factors. The scores for the Indiana and Kendall Schools combined and for the Indiana School alone are superior to a highly significant degree to those for the hearing on the memory factor. On just two factors, the verbal and reasoning factors, do the deaf in all three schools score below the hearing to a highly significant degree.

To summarize, the deaf, as measured in this study, are below the average hearing individual in verbal ability, word fluency and reasoning. They show about the same ability on the numerical, spacial relations and memory factors.

Since the tests for the verbal, word fluency and reasoning factors all involve language, differences in favor of the hearing might have been expected. The tests for spacial relations and numerical ability, on the other hand, require no language in administration or response; the memory tasks require simply an immediate recall of simple names and numbers. This would suggest that there is no inability on the part of

the deaf individual to develop abstract intelligence demanded by tasks not requiring verbalization. Further implications of these results will be discussed under the general summary and conclusions in the final section.

Comparison of the Deaf and The Hearing on The Wechsler-Bellevue.

For this analysis the Indiana and Kendall scores were combined, while those for the New Jersey School were treated independently. (For justification of this procedure see page 99.)

The range in I.Q. for the three schools is as follows:

TABLE X

WECHSLER I.Q. RANGE FOR STUDENTS IN THE
THREE SCHOOLS FOR THE DEAF

Schools	verbal I.Q.	Performance I.Q.	Full Scale I.Q.
Kendall	50-109	65-134	51-123
Indiana	53-116	60-132	62-123
New Jersey	47-103	62-143	56-116

The mean intelligence quotient, standard deviation and standard error of the mean were calculated for both the performance and verbal sections of the Wechsler as well as for the full scale. A table giving these data follows:

TABLE XI
PERFORMANCE OF THE DEAF IN THE THREE
SCHOOLS ON THE WECHSLER

Test Sections:	Scores of children in the three schools					
	Kendall plus Indiana :			New Jersey		
	: Stand.:	: Stand.:		: Stand.:	: Stand.:	
	Mean :	Dev. :	error :	Mean :	Dev. :	error
	:	:	of the:	:	:	of the
	:	:	mean :	:	:	mean
Performance Section	106.5	14.43	1.32	101.6	14.25	1.50
Verbal Section	76.6	14.53	.32	66.3	14.21	1.50
Full Scale	90.0	13.68	1.25	82.3	14.11	1.49

The data in Table XI may be compared with Wechsler's norms for hearing individuals. The mean full scale intelligence quotients for individuals at various age levels as given by Wechsler,¹ based on a population, 1621 normal individuals, vary between 98.75 and 100.89. The standard deviations range from 13.20 to 16.85. For the verbal intelligence quotients the range for 1621 cases is 98.00 to 102.09; standard deviations from 13.22 to 16.65. For the performance intelligence quotients the range for 1411 cases is 99.00 to 102.50; standard deviations from 12.60 to 16.21.

The mean intelligence quotient of 106.5 (see Table XI), for the Kendall and Indiana schools combined, on the

1. Wechsler. op. cit. p. 122.

performance section of the Wechsler-Bellevue is significantly higher¹ than the mean intelligence quotient for the hearing which is set at 100 by Wechsler's standardization. For the New Jersey School, the mean intelligence quotient of 101.6 for the performance section is not significantly different from the mean intelligence quotient of the normally hearing.²

For all three schools, the mean verbal intelligence quotients are considerably below the mean for the general population,³ being 76.6 for the Kendall and Indiana Schools and 66.3 for the New Jersey School. These results are to be expected on that section of the examination requiring ability to verbalize.

The mean intelligence quotient for the deaf subjects in the Kendall and Indiana Schools on the full scale is 90.0 as presented in Table XI. The mean intelligence quotient for the New Jersey School is 82.3. These are significantly lower than the mean intelligence quotient of 100.11⁴ for the hearing.⁵

1. The probability is less than .01 that this difference was due to sampling variability.

2. The probability is greater than .05 than any difference was due to chance fluctuations of sampling.

3. The mean for the Indiana and Kendall Schools is between 75.64 and 77.56, and that for the New Jersey School is between 61.80 and 70.80 (taking $\pm 3\sigma$ mean as the probable range).

4. Wechsler gives the mean intelligence quotient for a normal population of 1508 as 100.11; standard deviation, 14.69. (Wechsler. op. cit. p. 127.)

5. The 99.77 confidence limits for the mean intelligence quotient for the Kendall and Indiana Schools are 86.25 to 93.75; for the New Jersey School, 77.87 to 86.81.

Thus, on the verbal section of the Wechsler Test of intelligence, these 210 deaf students score far below the hearing. These results bear out the findings of previous investigations. On that section of the test which involves no language in administration or response, the deaf score as high or higher than the hearing. These findings support the conclusions of about half the investigators in the field.

Since the performance half of the Wechsler correlates highly with the full scale, and therefore measures some of the same aspects of intelligence, it would seem that the deaf have the potential ability to compete successfully with the hearing on tests of abstract intelligence such as these. The fact that the subtests in the performance section measure spacial relations, visual perception and memory seems to bear out the findings already discussed in connection with the Thurstone Tests, i.e., that in these three abilities at least the deaf are not inferior to the hearing.

Further relationships between the two tests used in this study will be discussed in the section under correlations. The educational implications will be discussed in the section devoted to general summary and conclusions.

Correlation between the Wechsler-Bellevue and the Chicago Tests of Primary Mental Abilities.

No study was found in which scores made by normal individuals on both the Wechsler and Thurstone Tests were correlated. It seemed profitable, however, to compare these

deaf groups on the two scales, on the verbal and performance sections of the two scales, and on each of the subtests of each scale. Other correlations on similar performance and verbal tests, as reported by Wechsler, are presented in Table XII.

TABLE XII
CORRELATIONS BETWEEN THE WECHSLER AND CERTAIN OTHER TESTS¹

Test correlated with Wechsler	N	r	
Stanford-Binet 1916 Rev.	75	.82	±.03
Stanford-Binet 1937 Rev.	227	.89	±.01
Army Alpha	92	.74	±.03
A.C.E. Tests	112	.53	±.05
Morgan Mental Ability	125	.62	±.04
Hennon-Nelson	50	.81	±.04
C.A.V.D.	108	.69	±.03
Otis S.A.	108	.73	±.03

Table XIII is concerned with a statistical comparison between Wechsler and Thurstone scores. All correlations in this table were computed from raw scores.² The standard error and critical ratio for each correlation coefficient, as well as the probability of an r as large or larger than the one observed, were computed and appear in Table XIII.

1. Wechsler. op. cit. p. 134.

2.
$$r = \frac{N\sum XY - \sum X \cdot \sum Y}{\sqrt{[N\sum X^2 - (\sum X)^2][N\sum Y^2 - (\sum Y)^2]}}$$

TABLE XIII

COEFFICIENTS OF CORRELATION BETWEEN WECHSLER AND THURSTONE
SCORES, WITH RELATED CRITICAL RATIOS AND THEIR SIGNIFICANCE

Sections correlated		Kendall plus Indiana scores				New Jersey scores			
		r	Cr	CR	p	r	Cr	CR	p
N x	Information	.67	.05	13.40	<.01	.65	.06	10.83	<.01
	x Comprehension	.53	.07	8.15	<.01	.64	.06	13.22	<.01
	x Arithmetic	.76	.04	20.00	<.01	.77	.04	18.33	<.01
	x Similarities	.49	.07	7.10	<.01	.49	.08	6.12	<.01
	x Vocabulary	.61	.06	10.70	<.01	.44	.08	5.17	<.01
	x Picture Comp.	.34	.08	4.25	<.01	.19	.10	1.88	>.05
	x Picture Arrang.	.31	.08	3.78	<.01	.31	.10	3.26	<.01
	x Object Assembly	.31	.08	3.78	<.01	.09	.10	.87	>.05
	x Block Design	.44	.07	6.02	<.01	.43	.08	5.06	<.01
	x Digit Symbol	.48	.07	6.85	<.01	.60	.07	8.95	<.01
V x	Information	.41	.07	5.46	<.01	-.02	.10	-.19	>.50
	x Comprehension	.40	.07	5.26	<.01	.05	.10	.45	>.50
	x Arithmetic	.42	.07	5.60	<.01	.07	.10	.67	>.50
	x Similarities	.36	.08	4.56	<.01	.14	.10	1.36	>.05
	x Vocabulary	.57	.06	9.34	<.01	.22	.10	2.20	>.05
	x Picture Comp.	.13	.09	1.46	>.05	.04	.10	.38	>.05
	x Picture Arrang.	.04	.09	.44	>.05	-.04	.10	-.38	>.05
	x Object Assembly	.03	.09	.33	>.05	-.05	.10	-.48	>.05
	x Block Design	.19	.09	2.18	<.05	-.17	.10	-1.66	>.05
	x Digit Symbol	.27	.08	3.21	<.01	-.25	.10	-2.55	>.05
S x	Information	.34	.08	4.25	<.01	.45	.08	5.35	<.01
	x Comprehension	.28	.08	3.33	<.01	.45	.08	5.35	<.01
	x Arithmetic	.39	.08	5.06	<.01	.51	.08	6.62	<.01
	x Similarities	.29	.08	3.49	<.01	.36	.09	3.95	<.01
	x Vocabulary	.31	.08	3.78	<.01	.42	.09	4.88	<.01
	x Picture Comp.	.40	.07	5.26	<.01	.39	.09	4.38	<.01
	x Picture Arrang.	.37	.08	4.74	<.01	.40	.09	4.54	<.01
	x Object Assembly	.47	.07	6.62	<.01	.33	.09	3.54	<.01
	x Block Design	.69	.05	14.68	<.01	.64	.06	10.32	<.01
	x Digit Symbol	.35	.08	4.37	<.01	.52	.08	6.84	<.01
W x	Information	.52	.07	7.87	<.01	.47	.08	5.73	<.01
	x Comprehension	.46	.07	6.47	<.01	.48	.08	5.92	<.01
	x Arithmetic	.32	.08	3.95	<.01	.47	.08	5.73	<.01
	x Similarities	.40	.07	5.26	<.01	.43	.08	5.05	<.01
	x Vocabulary	.50	.07	7.35	<.01	.62	.06	9.68	<.01
	x Picture Comp.	.31	.08	3.78	<.01	.17	.10	1.66	>.05
	x Picture Arrang.	.37	.08	4.74	<.01	.16	.10	1.56	>.05
	x Object Assembly	.35	.08	4.37	<.01	.17	.10	.67	>.05
	x Digit Symbol	.27	.08	3.21	<.01	.24	.10	2.42	<.05
	x Block Design	.35	.08	4.37	<.01	.19	.10	1.88	>.05

TABLE XIII (cont'd)

COEFFICIENTS OF CORRELATION BETWEEN WECHSLER AND THURSTONE
SCORES, WITH RELATED CRITICAL RATIOS AND THEIR SIGNIFICANCE

Sections Correlated		Kendall plus Indiana scores				New Jersey scores			
		r	ϕ r	CR	p	r	ϕ r	CR	p
R	x Information	.64	.05	11.85	<.01	.53	.08	7.06	<.01
	x Comprehension	.59	.06	10.00	<.01	.44	.08	5.17	<.01
	x Arithmetic	.55	.06	8.73	<.01	.58	.07	8.40	<.01
	x Similarities	.60	.06	10.34	<.01	.46	.08	5.54	<.01
	x Vocabulary	.65	.05	12.50	<.01	.35	.09	3.80	<.01
	x Picture Comp.	.37	.08	4.74	<.01	.22	.10	2.20	<.05
	x Picture Arrang.	.53	.07	8.15	<.01	.35	.09	3.80	<.01
	x Object Assembly	.35	.08	4.38	<.01	.17	.10	1.66	>.05
	x Block Design	.47	.07	6.71	<.01	.37	.09	4.06	<.01
	x Digit Symbol	.50	.07	7.35	<.01	.50	.08	6.33	<.01
M	x Information	.72	.04	16.36	<.01	.43	.08	5.06	<.01
	x Comprehension	.34	.08	4.19	<.01	.40	.09	4.54	<.01
	x Arithmetic	.47	.07	6.71	<.01	.40	.09	4.54	<.01
	x Similarities	.37	.08	4.74	<.01	.23	.10	2.32	<.05
	x Vocabulary	.45	.07	6.25	<.01	.38	.09	4.22	<.01
	x Picture Comp.	.26	.08	3.06	<.01	.14	.10	1.36	>.05
	x Picture Arrang.	.30	.08	3.61	<.01	.12	.10	1.16	>.05
	x Object Assembly	.05	.09	.09	>.05	-.05	.10	.48	>.05
	x Block Design	.37	.08	4.74	<.01	.23	.10	2.32	<.05
	x Digit Symbol	.44	.07	6.02	<.01	.23	.10	2.32	<.05
Thurs.	x Wechs. V.	.76	.04	20.00	<.01	.76	.04	17.27	<.01
Thurs.	x Wechs. P.	.71	.05	15.77	<.01	.61	.07	9.24	<.01
Thurs.	x Wechs. T.	.83	.03	29.64	<.01	.77	.04	18.33	<.01

TABLE XIV
CORRELATIONS BETWEEN WECHSLER AND THURSTONE

Thurstone	Wechsler									
	q	r	s	t	u	v	w	x	y	z
A. Kend. plus Ind.										
Numerical	.67	.53	.76	.49	.61	.34	.31	.31	.44	.48
Verbal	.41	.40	.42	.36	.57	.13	.04	.03	.19	.27
Space	.34	.28	.39	.29	.31	.40	.37	.47	.69	.35
Word Fluency	.52	.46	.32	.40	.50	.31	.37	.35	.35	.27
Reasoning	.64	.59	.55	.60	.65	.37	.53	.35	.47	.50
Memory	.72	.34	.47	.37	.45	.26	.30	.05	.37	.44
B. New Jersey										
Numerical	.65	.64	.77	.49	.44	.19	.31	.09	.43	.60
Verbal	-.02	.05	.07	.14	.22	.04	-.04	-.05	-.17	-.25
Space	.45	.45	.51	.36	.42	.39	.40	.33	.64	.52
Word Fluency	.47	.48	.47	.43	.62	.17	.16	.07	.19	.24
Reasoning	.53	.44	.58	.46	.35	.22	.35	.17	.37	.50
Memory	.43	.40	.40	.23	.38	.14	.12	-.05	.23	.23

q--Information
 r--Comprehension
 s--Arithmetic
 t--Similarities
 u--Vocabulary
 v--Picture Completion
 w--Picture Arrangement
 x--Object Assembly
 y--Block Design
 z--Digit Symbol

All insignificant correlations are underlined. The first six sections of Table XIII present the coefficients of correlation, standard errors, critical ratios and significance between each of the Wechsler subtests and each of the Thurstone primary mental abilities. The last three lines present this data for the verbal section, the performance section and the full scale Wechsler when compared with the total Thurstone Tests.

The correlation between the Primary Mental Abilities Tests and the Wechsler verbal section (see Tables XIII and XIV) is $.76 \pm .04$ for both the Indiana and Kendall combined scores and for the New Jersey School. The correlation between the Primary Mental Abilities Tests and the Wechsler performance section is $.71 \pm .05$ for the Kendall and Indiana Schools and $.61 \pm .07$ for the New Jersey Schools. The full scale Wechsler and the Primary Mental Abilities Tests have a correlation of $.83 \pm .03$ for Kendall and Indiana Schools; $.77 \pm .04$ for the New Jersey School. In view of the fact that correlations between mental tests range from .60 to .90, (see Table XII) these findings show a fairly strong relationship between the two tests, particularly for the full scale Wechsler and the Thurstone for the Indiana and Kendall Schools, the more representative of the two sample groups. The larger correlations for the total tests, as compared to the subtests, reflect the increased reliability of the full scales.

The correlations between the subtests of the Wechsler and the Thurstone Tests range from negative correlations on the verbal factor¹ to .76 and .77, the correlations for the Kendall and Indiana Schools and the New Jersey School, respectively, between the numerical factor (Thurstone Tests) and arithmetic (Wechsler).

Correlations between .60 and .77 were obtained for eight of the subtest pairs; i.e., numerical factor with information, arithmetic and vocabulary (subtests in the Wechsler Scale), space factor with block design, reasoning factor with information, similarities and vocabulary, memory factor with information. In each case the Thurstone factor was mentioned first, the Wechsler subtests, second.

As will be seen from Table XIII, significant correlations as indicated by p less than .01, were found between scores made by the Kendall and Indiana Schools on all factors except the following: the verbal factor with Wechsler's picture completion, picture arrangement and object assembly; and the memory factor with Wechsler's object assembly. For the New Jersey School all correlations were significant except the following: the numerical factor with Wechsler's picture completion and object assembly; the verbal factor with all of Wechsler's subtests; the word fluency factor with

1. The distribution for the deaf on the Thurstone verbal subtest was extremely skewed; only one deaf individual scored above the mean for the hearing.

Wechsler's picture completion, picture arrangement, object assembly and block design; the reasoning factor with Wechsler's object assembly; and the memory factor with Wechsler's picture completion, picture arrangement and object assembly. The full scale Wechsler and the total Thurstone battery correlate highly enough for all practical purposes.

These correlations were computed to determine whether the Thurstone Tests were measuring what is measured by individual tests of intelligence. They were; therefore, conclusions regarding the deaf can be drawn from the Thurstone scores.

Relationship Between Type of Deafness and Test Performance.

The Chi Square Test was used to determine whether there was a significant difference on the Thurstone scores between the adventitious and congenital groups of deaf subjects tested in this study. Again the scores for the Indiana and Kendall Schools were combined while the New Jersey scores were treated separately. The table on the next page indicates the relationship.

TABLE XV
RELATIONSHIP BETWEEN TYPE OF DEAFNESS
AND TEST PERFORMANCE

Schools	Type of deafness	Thurstone Scores								N
		400 and above	350-399	300-349	250-299	200-249	150-199	100-149	Below 100	
Kend. plus Ind.	congen.	5	6	13	13	15	8	4	-	64
	advent.	5	7	11	10	9	3	4	-	49
New Jer.	congen.	-	5	5	7	11	12	12	6	58
	advent.	-	0	3	4	6	5	5	5	28

Chi Square = 2.46, $n = 6$, $p = .85$, for Indiana plus Kendall.
Chi Square = 3.62, $n = 6$, $p = .75$, for New Jersey.

The probability of obtaining a Chi Square as large or larger than the ones observed is considerably greater than .05, indicating that there are no differences between the congenital and adventitious groups in performance on the Thurstone Tests. These results agree with the findings of Burchard and Myklebust, published in 1942, and described in the previous section.

Relationship Between Degree of Hearing Loss and Test Performance.

The association between degree of loss and scores on the Thurstone Tests were studied in the same manner as that described for computing the relationship between type of deafness and test performance. The deaf individuals were divided into two groups, (1) those with a loss of 79 percent or less and (2) those with a loss ranging from 80 percent to total deafness. The results appear in the table on the following page.

TABLE XVI
RELATIONSHIP BETWEEN DEGREE OF LOSS
AND TEST PERFORMANCE

Schools	Decibel loss	400 and above	350- 399	300- 349	250- 299	200- 249	150- 199	100- 149	Below 100	N
Kend. plus Ind.	0-79	7	8	13	18	16	8	3	-	73
	80-100	4	6	11	8	9	4	5	-	47
New Jer.	0-79	-	2	0	7	6	3	3	2	23
	80-100	-	3	8	6	11	16	14	9	67

Chi Square = 4.11, $n = 6$, $p = .70$, for Kendall plus Indiana.
Chi Square = 11.44, $n = 6$, $p =$ between .05 and .10, for New Jersey.

Again, the differences between the two groups are a function of random error of sampling rather than true differences due to degree of loss of hearing.

Relationship between Age of Onset and Test Performance.

An attempt was made to divide the group into three sections: (1) those who lost their hearing before the age of two, and therefore had little or no speech and language development before the onset of deafness, (2) those who lost their hearing between the ages of two and five and therefore had some speech and language development but no formal education before the onset of deafness, and (3) those who lost their hearing after five years of age and therefore had some years in school before the onset of deafness. Since these 210 cases were drawn entirely from residential schools, where the majority of the students are congenitally deaf and very

severely deaf, there were insufficient cases in the last two groups to draw reliable inferences. For example, the distribution according to age of onset for the Indiana and Kendall Schools combined (the larger of the two groups considered) is as follows: number who became deaf before two years, eighty-eight; between two and five years, sixteen; after five years, nine; unknown, seven. In order to demonstrate whether there is any relationship between age of onset and test performance, deaf students in special classes and in the regular public schools who lost their hearing later in life than the typical residential school student, would have to be studied. Such a study is outside the limits of this investigation.

Relationship Between Teacher's Estimate and Test Performance.

A pupil rating scale was devised and submitted to the supervising teacher in the Indiana and Kendall Schools and to three of the teachers in the New Jersey School, since in the latter instance there was no one individual who knew all the students who had been tested. These teachers were asked to rate the academic ability of each student on a five point scale. The following questions were asked and five guide phrases given to aid the rating: (The entire rating scale appears in the appendix.)

1. How intelligent is he?
2. Is his attention sustained?

3. Is he slow or quick in thinking?
4. How well can he attack a problem and "reason it out?"
5. How good is his memory?
6. How well does he do in numerical calculations?
7. How well does he comprehend language?
8. How well does he use language?
9. How well does he read?

Since the teachers tended to rate the children either above average, average or below average, with very few ratings falling between these marks, the scale was analyzed on a three-step basis. Mean square contingency coefficients were calculated for the scores on both the Wechsler and the Thurstone Tests for the Kendall and Indiana Schools, individually and combined, and for the New Jersey School. Pearson's correction for "broad categories" was calculated. Table XVII gives the results of the analysis.

It would seem, therefore, that there is some positive relationship between teacher's estimate and performance on the two tests administered in this study. The relationship in the case of the Indiana School and for the Indiana and Kendall Schools combined, the most representative samples used, is a stronger one than for the small sample from the Kendall School alone or for the New Jersey School alone, where three individuals made the ratings.

These correlation coefficients agree with those reported

TABLE XVII
RELATIONSHIP BETWEEN TEACHER'S ESTIMATE
OF ABILITY AND TEST PERFORMANCE

Tests	Schools	Contingency coefficient	Coefficient corrected
Thurstone Tests	Kendall & Indiana	.48	.59
	Indiana	.52	.64
	Kendall	.37	.45
	New Jersey	.26	.32
Wechsler Tests	Kendall & Indiana	.60	.73
	Indiana	.51	.63
	Kendall	.25	.31
	New Jersey	.38	.47

by Wechsler for hearing students.¹ He compared Wechsler Intelligence Quotients with teachers' ratings for students from a Trade School in New York and from the General Commercial High School in Yonkers. An effort was made to have at least two ratings by different teachers for each subject. These ratings were averaged, distributed on a 6 point scale, and correlated against test scores by means of a four-fold contingency table. The correlation coefficients for the

1. Wechsler. op. cit. p. 130.

two groups were as follows:

Teachers' Ratings (General H.S.) X Bellevue I.Q.'s

C = .43, N = 45.

Teachers' Ratings (Trade H.S.) X Bellevue I.Q.'s

C = .52, N = 74.

He also compared subjects' scores on the Wechsler with estimates of their intelligence by psychiatrists. The resulting correlation was: $r = .79 \pm .048$.¹

1. Wechsler. op. cit. p. 130.

CHAPTER V

SUMMARY AND CONCLUSIONS

This investigation has attempted to determine whether the handicap of deafness carries with it the incapacity to develop abstract intelligence. The primary mental abilities of deaf and hearing children have been compared in order to determine whether, potentially, the deaf show the same degree and pattern of abilities. In addition, several other aspects of the problem have been considered: (1) the relationships between type of deafness and test performance, between age of onset and test performance and between degree of loss and test performance, (2) the correlation between scores made by the deaf on the Wechsler-Bellevue Intelligence Test and the Chicago Tests of Primary Mental Abilities, the two tests used in this study, and (3) the relationship between teacher's estimate of the deaf individual's ability and the individual's performance on these tests.

Sources of Data and Procedure Summarized.

The Wechsler-Bellevue Individual Intelligence Test and the Chicago Tests of Primary Mental Abilities were given to 210 deaf children. All students between the ages 11-17, inclusive, having no other handicap but deafness, in the intermediate and advanced grades of the academic departments of the following schools for the deaf were tested for this study: Kendall School, Washington, D. C., New Jersey State School, West Trenton and the Indiana State School,

Indianapolis. The number at each age level is not large, but it is the total sample in these three residential schools for the deaf.

The third edition, 1944, of the Wechsler-Bellevue Individual Intelligence Test for Adults and Adolescents, a point scale, was used in this study. The complete scale includes eleven subtests, one of which is an alternate. The six verbal subtests are: Information, Comprehension, Arithmetic Reasoning, Memory Span for Digits, Similarities and Vocabulary (the alternate). The latter subtest was substituted for Memory Span for Digits, since the subjects were deaf and could not hear the digits repeated. The five performance tests are: Picture Arrangement, Picture Completion, Block Design, Digit Symbol and Object Assembly. The five verbal subtests give the verbal score and intelligence quotient; the five performance subtests give the performance score and intelligence quotient. The total weighted score on all ten subtests gives the intelligence quotient for the full scale.

The second examination used in this study was the Chicago Tests of Primary Mental Abilities, 1941 edition, a group-administered test standardized by Thurstone and Thurstone. Instead of assigning each individual a composite score such as the intelligence quotient, this test gives scores for each of six mental abilities which statistical analyses have shown to be relatively independent. The battery provides tests for the following factors: Verbal,

Word Fluency, Space, Number, Memory and Reasoning. (For a more complete description of the two measuring instruments used in this study, see Chapter II.)

Each individual examination on the Wechsler-Bellevue required approximately one hour to complete. All tests were administered and scored by the writer. The directions as outlined by Wechsler were carefully followed, with the exception of certain modifications made necessary by the deafness of the subjects. All directions were given in pantomime. The deaf were neither aided nor penalized by the method of administration.

For the seventeen tests involved in the measurement of Thurstone's six factors, the total testing time was approximately 176 minutes, of which 101 minutes were devoted to the tests proper and 75 minutes to fore-tests or practice exercises. The tests were administered to groups of about twenty-five, with teachers at the three schools assisting as proctors. The tests were all administered in pantomime by the writer, and the directions as outlined by Thurstone were carefully followed.

For most of the calculations and analyses of the data the scores for the Kendall and Indiana schools were combined and those for the New Jersey School treated separately, since a Chi Square Test showed that the distributions for the first two schools could be combined, while the third distribution could not.

The scores for the deaf on the Thurstone Tests were compared with the norms for hearing children published by Thurstone and Thurstone to determine whether the abilities of the deaf follow the same pattern as those of the normally hearing. As an added investigation of the effect on mental abilities of the loss of one means of perception, the mean scores for the deaf on the verbal and performance sections of the Wechsler-Bellevue as well as on the full scale were compared with Wechsler's norms for the hearing.

In addition, each of the ten Wechsler subtests was correlated with each of the six Thurstone primary mental abilities to determine the extent to which they are measuring the same factors. The Wechsler performance section, the verbal section and the total Wechsler were each correlated with the total Thurstone score.

The effect of age of onset, type and degree of deafness were also studied to determine their effect on the abilities of the deaf child.

Finally, a rating scale was devised which would give the teacher's estimate of ability. This estimate was then compared with test performance.

Major Findings Summarized.

The comparison between the deaf and the hearing on the Wechsler and Thurstone Tests, suggested that the deaf do possess the capacity to develop abstract intelligence, at least those aspects of abstract intelligence which do not depend

upon ability to verbalize. Specifically, they show the same ability as the hearing in numerical ability, space perception and memory. When critical ratios of the differences to the standard error of the differences between the deaf and the hearing groups on the six Thurstone factors were computed, no significant differences were found on the three factors mentioned above. The hearing were superior to the deaf in verbal ability, word fluency and reasoning, as measured by this study. Statistical evidence for this conclusion is found in Table IX. The deaf also show the same ability as the hearing in those aspects of intelligence measured by the performance section of the Wechsler. The mean intelligence quotient for the Kendall and Indiana students on the performance section was 106.5; standard deviation, 14.43; standard error, 1.32; which is significantly higher than Wechsler's mean of 100 for hearing individuals. The mean intelligence quotient for the New Jersey School was 101.6; standard deviation, 14.25; standard error, 1.50; which is not significantly different from Wechsler's norms.

No significant relationships were found between type of deafness and test performance or between degree of deafness and test performance. The relationship between age of onset and test performance was not examined because of insufficient data.

Teacher's estimates of academic ability showed a fairly strong relationship to the appraisal of ability furnished by these tests.

In addition to the answers to these questions, correlations between the Wechsler and Thurstone Tests were computed to determine whether these tests were measuring what is measured by individual tests of intelligence. They were, therefore conclusions can be drawn.

Implications in this Study.

Although this study was not designed to outline a program for the education of the deaf, certain implications seem evident. The most important implications in the results of this study for the educator of the deaf lie in the evidence that the loss of one sense, i.e., hearing, does not preclude the possibility of the development of abstract intelligence. The ability to form concepts and to use a symbolic structure for the interpretation and expression of ideas does not necessarily depend upon auditory perception nor upon language.

What, then, are the reasons for the four or five years educational lag for the deaf student and what can be done to decrease the differences in academic achievement between the deaf and the hearing? Obviously the language handicap is a major factor. Most of the learning in the pre-school years and in the primary grades is auricular. In addition, the deaf child is a poor reader. Since a great deal of the information in the elementary and high school is taught by means of the printed page, the deaf child drops even farther behind the hearing. Perhaps the present-day academic

program for the deaf is too much concerned with giving him a means of communication with the hearing. Because of this aim, laudable though it may be, his acquisition of knowledge is slowed down to the speed with which he can master speech and lipreading.

This investigation has demonstrated, within the limits of its data, that in basic mental capacity, aside from ability to verbalize, the deaf individual is equal to the hearing. In at least three primary mental abilities, numerical, spacial and memory, he shows no retardation. Therefore, it would seem that, if his academic training were approached from a completely visual standpoint, the educational lag could be lessened.

Research has shown that reading can be taught apart from oral response. The child can respond to the printed word by pointing to an object or a picture of an object, or by performing an action. Abstract concepts can be demonstrated manually.

Speech and lipreading need not be neglected. It is not the purpose of this paper to minimize the importance of giving the deaf individual a means of communicating with the hearing world. However, the writer's teaching experience has shown that lipreading and speech are skills which can not be developed to an equal extent by all, that they are not dependent upon intelligence, that deaf children reveal early in their school careers whether or not they will develop superior, average or inferior ability to speak and to

read lips. Progress in the techniques of teaching speech and lipreading has developed but little in the past ten years. It seems hardly profitable, therefore, to hold the deaf child's progress in the acquisition of knowledge and skills to the level of his ability to speak and to read lips.

Further Research Suggested.

This investigation was limited to a study of the potential abstract intelligence of the deaf individual. Further studies in which an attempt is made to present instructional materials to the deaf from a visual standpoint, not neglecting training in speech and lipreading as a necessary means of communication, will demonstrate whether, through an emphasis on reading and educational films and other visual aids, the deaf individual could more nearly approach the hearing in educational achievement.

APPENDIX

PUPIL RATING SCALE

Pupil's Name _____ Date _____
School _____ Grade in School _____
Rated by _____

Directions for Using the Rating Chart

1. Let these ratings represent your own judgment. Do not confer with anyone in making them; to do so would alter the nature of this examining instrument.
2. In each trait or characteristic named below compare this pupil with the average deaf pupil of the same age.
3. In rating for any particular trait disregard every other trait except that one. Do not rate a pupil high on all traits simply because he is exceptional in some. Children are often very high in some traits and low in others.
4. Place a cross somewhere on the line running from "very high" to "very low" to indicate this child's standing in each quality. You may place your cross at any point on the line. It is not necessary to locate it at any of the division points or above any descriptive phrase.
5. Do not study too long over any one child. Give for each the best judgment you can and go on to the next.
6. Give a rating for each trait.
7. The ratings will be held strictly confidential.

-----o-----

I. Academic Ability

1. How intelligent is he?

'	'	'	'	'	'	'	'
Feeble- minded	Border- line	Dull (nor.)	Within aver. limits	Bright (nor.)	Super.	Very Super.	'

PUPIL RATING SCALE (continued)

2. Is his attention sustained?

Distracted: jumps rapidly from one thing to another	Difficult to keep at a task until completed	Attends adequately	Is absorbed in what he does	Able to hold attention for long periods
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3. Is he slow or quick in thinking?

Exceedingly rapid	Agile minded	Thinks with ordinary speed	Sluggish, plodding	Extremely slow
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4. How well can he attack a problem and "reason it out?"

No ability to find the solution to a problem	Little abil- ity to figure things out for himself	Average reasoning ability	Good ap- proach to problems	High degree of inductive and deductive reasoning
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5. How good is his memory?

Memorizes very rapidly	Memorizes rapidly	Memorizes adequately	Memorizes with dif- ficulty	Memorizes with great difficulty
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6. How well does he do in numerical calculations?

Very inade- quate number- ical ability	Makes frequent errors	Adequate facility with numbers	Makes few errors	Superior numerical ability
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PUPIL RATING SCALE (continued)

7. How well does he comprehend language?

Excellent understanding of language	Good understanding of language	Understands adequately	Frequently misunderstands	Very little language comprehension
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8. How well does he use language?

Very little ability to express himself	Frequently misuses words	Adequate command of language	Expresses himself well	Unusual ability to use language
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9. How well does he read?

Reads considerably below age level	Reads slightly below age level	Reads at age level	Reads slightly above age level	Reads considerable above age level
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