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A COMPARATIVE STUDY OF CERTAIN MOTOR SKILLS OF DEAF AND HEARING MENTALLY RETARDED CHILDREN

by
Ralph Lynn Hoag

A Dissertation Submitted to the Faculty of the
COLLEGE OF EDUCATION
In Partial Fulfilment of the Requirements for the Degree of
DOCTOR OF EDUCATION
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1961
I hereby recommend that this dissertation prepared under my direction by Ralph Lynn Hoag entitled A COMPARATIVE STUDY OF CERTAIN MOTOR SKILLS OF DEAF AND HEARING MENTALLY RETARDED CHILDREN be accepted as fulfilling the dissertation requirement of the degree of Doctor of Education.

Dissertation Director

After inspection of the dissertation, the following members of the Final Examination Committee concur in its approval and recommend its acceptance:*

*This approval and acceptance is contingent on the candidate's adequate performance and defense of this dissertation at the final oral examination. The inclusion of this sheet bound into the library copy of the dissertation is evidence of satisfactory performance at the final examination.
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>The Problem</td>
<td>4</td>
</tr>
<tr>
<td>The Importance of the Problem</td>
<td>5</td>
</tr>
<tr>
<td>Hypothesis</td>
<td>7</td>
</tr>
<tr>
<td>Selection Criteria and Study Limitations</td>
<td>7</td>
</tr>
<tr>
<td>Chronological Age</td>
<td>8</td>
</tr>
<tr>
<td>Intelligence</td>
<td>8</td>
</tr>
<tr>
<td>Age of Onset</td>
<td>9</td>
</tr>
<tr>
<td>Extent of Hearing Loss</td>
<td>9</td>
</tr>
<tr>
<td>Sex</td>
<td>10</td>
</tr>
<tr>
<td>Hearing Subjects</td>
<td>10</td>
</tr>
<tr>
<td>Motor Skill Tests</td>
<td>11</td>
</tr>
<tr>
<td>Definitions and Terminology</td>
<td>11</td>
</tr>
<tr>
<td>Summary</td>
<td>13</td>
</tr>
<tr>
<td>REVIEW OF RELATED LITERATURE</td>
<td>17</td>
</tr>
<tr>
<td>Related Research of More Recent Origin (Since 1945)</td>
<td>34</td>
</tr>
<tr>
<td>Summary</td>
<td>42</td>
</tr>
<tr>
<td>SELECTION AND CLASSIFICATION OF SUBJECTS</td>
<td>45</td>
</tr>
<tr>
<td>Selection of Deaf Subjects</td>
<td>45</td>
</tr>
<tr>
<td>Selection of Hearing Subjects</td>
<td>48</td>
</tr>
<tr>
<td>Etiological Classification of Subjects</td>
<td>48</td>
</tr>
<tr>
<td>Matching Procedure</td>
<td>52</td>
</tr>
<tr>
<td>Selection of Tests</td>
<td>58</td>
</tr>
<tr>
<td>Intelligence</td>
<td>58</td>
</tr>
<tr>
<td>Visuo-Motor</td>
<td>60</td>
</tr>
<tr>
<td>Tactual-Motor</td>
<td>62</td>
</tr>
<tr>
<td>Spatial Relationships</td>
<td>63</td>
</tr>
<tr>
<td>Manual Dexterity</td>
<td>65</td>
</tr>
<tr>
<td>Locomotor Coordination</td>
<td>65</td>
</tr>
<tr>
<td>Summary</td>
<td>67</td>
</tr>
<tr>
<td>MEASURING DEVICES AND TECHNIQUES OF TESTING</td>
<td>70</td>
</tr>
<tr>
<td>Visuo-Motor</td>
<td>70</td>
</tr>
<tr>
<td>Tactual-Motor</td>
<td>76</td>
</tr>
<tr>
<td>Spatial Relationships</td>
<td>79</td>
</tr>
<tr>
<td>Manual Dexterity</td>
<td>82</td>
</tr>
<tr>
<td>Locomotor Coordination</td>
<td>84</td>
</tr>
<tr>
<td>Summary</td>
<td>86</td>
</tr>
<tr>
<td>Topic</td>
<td>Page</td>
</tr>
<tr>
<td>--------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>INTERPRETATION OF DATA</td>
<td>88</td>
</tr>
<tr>
<td>Visuo-Motor</td>
<td>89</td>
</tr>
<tr>
<td>Tactual-Motor</td>
<td>95</td>
</tr>
<tr>
<td>Spatial Relationships</td>
<td>98</td>
</tr>
<tr>
<td>Manual Dexterity</td>
<td>100</td>
</tr>
<tr>
<td>Locomotor Coordination</td>
<td>103</td>
</tr>
<tr>
<td>Comparative results of Deaf and Hearing Subjects on All Tests</td>
<td>105</td>
</tr>
<tr>
<td>SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS</td>
<td>111</td>
</tr>
<tr>
<td>The Problem</td>
<td>111</td>
</tr>
<tr>
<td>Previous Related Research</td>
<td>112</td>
</tr>
<tr>
<td>The Study</td>
<td>113</td>
</tr>
<tr>
<td>Comparison of Group Performances to Previous Research</td>
<td>115</td>
</tr>
<tr>
<td>Conclusions</td>
<td>116</td>
</tr>
<tr>
<td>Recommendations for Further Research</td>
<td>118</td>
</tr>
<tr>
<td>BIBLIOGRAPHY</td>
<td>120</td>
</tr>
<tr>
<td>APPENDIX</td>
<td>128</td>
</tr>
</tbody>
</table>
# LIST OF TABLES AND FIGURES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Comparison of Advanced Performance Series and Other Performance Tests</td>
<td>30</td>
</tr>
<tr>
<td>II</td>
<td>Tabular Summary of Comparative Studies Between Deaf and Hearing Children (1920-1941)</td>
<td>32</td>
</tr>
<tr>
<td>III</td>
<td>Number of Subjects Screened and Selected From Schools for the Deaf Used in the Study</td>
<td>47</td>
</tr>
<tr>
<td>IV</td>
<td>Number of Subjects Included in Each of the Four Groups Used in the Study</td>
<td>52</td>
</tr>
<tr>
<td>V</td>
<td>Comparison of Mean Age and I.Q. Scores of Total Deaf and Total Hearing Groups</td>
<td>54</td>
</tr>
<tr>
<td>VI</td>
<td>Comparison of Mean Age and I.Q. Scores of Total Familial and Non-Familial Groups</td>
<td>55</td>
</tr>
<tr>
<td>VII</td>
<td>Comparison of the Mean Age and I.Q. Scores of Deaf and Hearing Groups of Familial Mentally Retarded Children</td>
<td>56</td>
</tr>
<tr>
<td>VIII</td>
<td>Comparison of the Mean Age and I.Q. Scores of Deaf and Hearing Groups of Non-Familial Retarded Children</td>
<td>56</td>
</tr>
<tr>
<td>IX</td>
<td>Comparison of Mean Age and I.Q. Scores of Familial and Non-Familial Mentally Retarded Groups of Deaf Children</td>
<td>57</td>
</tr>
<tr>
<td>X</td>
<td>Comparison of Mean Age and I.Q. Scores of Hearing Familial and Non-Familial Groups of Mentally Retarded Children</td>
<td>57</td>
</tr>
<tr>
<td>XI</td>
<td>Comparison of Matched Groups in Accuracy of Responses on the Marble Board Test</td>
<td>91</td>
</tr>
<tr>
<td>XII</td>
<td>Comparison of Matched Groups According to Coherent or Incoherent Types of Performances on the Marble Board Test</td>
<td>94</td>
</tr>
<tr>
<td>XIII</td>
<td>Comparison of Matched Groups in Accuracy of Responses on Figure-Ground Portion of the Tactual Motor Test</td>
<td>97</td>
</tr>
<tr>
<td>Table</td>
<td>Page</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>XIV</td>
<td>Comparison of Matched Groups in Number of Correct Responses on the Stencil Design Test</td>
<td>99</td>
</tr>
<tr>
<td>XV</td>
<td>Comparison of Matched Groups in KLB Scores on the Purdue Pegboard Test</td>
<td>101</td>
</tr>
<tr>
<td>XVI</td>
<td>Comparison of Matched Groups in Assembly Scores on the Purdue Pegboard Test</td>
<td>102</td>
</tr>
<tr>
<td>XVII</td>
<td>Comparison of Matched Groups in Weighted Scores on the Heath Rail-walking Test</td>
<td>104</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Strauss-Werner Marble Board Patterns</td>
</tr>
<tr>
<td>2</td>
<td>Special Testing Table</td>
</tr>
<tr>
<td>3</td>
<td>Strauss-Werner Tactual-Motor Test</td>
</tr>
<tr>
<td>4</td>
<td>Comparison of Group Mean Scores, Converted to Standard (z) Scores, of Total Groups of Deaf and Hearing Subjects on All Tests</td>
</tr>
<tr>
<td>5</td>
<td>Comparison of Group Mean Scores, Converted to Standard (z) Scores, of Familial Groups of Deaf and Hearing Subjects on All Tests</td>
</tr>
<tr>
<td>6</td>
<td>Comparison of Group Mean Scores, Converted to Standard (z) Scores, of Non-Familial Groups of Deaf and Hearing Subjects on All Tests</td>
</tr>
</tbody>
</table>
CHAPTER I

INTRODUCTION

Evidence indicating a steady increase in the number of multiple handicapped children in schools for the deaf in the United States has been reported in recent years. Among these are the mentally retarded deaf whose additional handicap poses special educational problems. Recent research findings, together with improved testing, advanced diagnostic techniques, and more accurate case identification have shown that these children cannot be classified or treated as a single group. It has been demonstrated that these children differ as much in relation to their educational problems as they vary according to etiology of mental retardation. In separate studies of deaf and hearing children the differences among deaf mentally retarded children seem to be similar to those found among the hearing. Prior to the present research, however, there does not appear to have been any evidence that mentally retarded deaf children have been directly compared experimentally in any way with hearing mentally retarded children.

Until more recent years there has been a tendency to consider the mentally retarded as a single group. The origin or cause of retardation in this general group was considered to be genetic. Careful research has now indicated the existence of increasing numbers of children whose mental retardation is a result of some injury or insult to the brain. These findings have also shown children to manifest many in-group differences.

Strauss, Lehtinen and others have shown the needs of the familial
group of mentally retarded youngsters to differ sufficiently from brain injured mentally retarded children in behavior that different techniques of teaching and training must be employed.\textsuperscript{1} Previous studies of hearing children who were retarded have shown familial and non-familial mentally retarded children to perform quite differently on certain kinds of tests. Frisina also found comparable differences among mentally retarded deaf children.\textsuperscript{2} For the most part, however, the comparisons that have been made between the performances of deaf and hearing children of this type have been largely subjective.

The present study was undertaken in an effort to determine whether or not statistically significant differences existed between selected groups of deaf and hearing mentally retarded children as determined by their performances on certain tests. The instruments used in this study were chosen largely on the strength of previous success in similar efforts. In addition, consideration was given to the matter of ease of administration, scoring, and interpretation.

Since 1920, a number of studies have been made in an effort to compare general intelligence and motor ability between mentally normal deaf and hearing children. These studies have been carefully reviewed and included in the thesis. It was noted that earlier studies tended to vary appreciably as to techniques used for gathering data and subsequently in the obtained results.

\textsuperscript{1} Strauss, A., Lehtinen, E., \textit{Psychopathology and Education of the Brain Injured Child}, pp. 118-167.

Earlier findings indicated that as much as two to three years difference in intelligence existed between deaf and hearing children.\(^1\) Recent studies, however, particularly those done in the last fifteen years, have indicated that the differences that do exist between the normal deaf and hearing child may not be as great as had previously been determined. This is not to say that measurable differences are not present, but rather that there is a need to more clearly differentiate those differences that do exist. Research in this area has produced evidence supporting this direction, suggesting a further classification of both deaf and hearing subjects according to etiological types. Differences in behavior between etiological types within groups of deaf and hearing mentally retarded subjects seem to vary considerably.

To date only one research dealing with certain psychological characteristics of mental retardation among deaf children has been attempted. This was done by Frisina.\(^2\) He investigated the incidence and etiology of mental retardation as well as the perceptual, mental, and motor functioning abilities in these children. Nothing in the literature appeared to indicate that research had been done using comparative techniques to determine whether or not differences existed between groups of deaf and hearing mentally retarded children.

Much of what has emerged from past research with hearing mentally retarded children has been applied in principle at least to the mentally retarded.


retarded deaf child. How alike or dissimilar these two groups of children are has not been generally known. The evidences developed in this thesis may cast some additional light on the general problem and give direction to future research into the basic differences that exist between these youngsters.

The Problem

Research in the area of mental retardation has been focused for the most part on normal hearing groups of children and their comparative relationship to mentally normal children. Many studies in recent years have been concerned with comparisons of within-group differences in youngsters identified according to etiology of mental retardation. These comparisons have been confined largely to familial and non-familial mentally retarded children. Only one previous study was found that dealt primarily with mentally retarded deaf children. No information was found about how different or how similar deaf mentally retarded children are in relation to hearing mentally retarded children.

This investigation was an attempt to explore the presence or absence of certain differences between several groups of mentally retarded children. Comparisons were made between mentally retarded deaf and mentally retarded hearing children in the performance of selected motor skill tasks. The motor skill areas selected for measurement included visuo-motor, tactual-motor, spatial relationships, manual dexterity, and locomotor coordination.

The study was extended further to include an exploration of the relationship between similar etiological groups of mentally retarded deaf
and mentally retarded hearing children. Subjects used in the study were classified as follows:

Deaf familial mentally retarded children
Hearing familial mentally retarded children
Deaf non-familial mentally retarded children
Hearing non-familial mentally retarded children

The Importance of the Problem

In a recent paper delivered at a conference on the health aspects of hearing conservation in Washington, D.C., Doctor made the following statement:

There is a new aspect in the field of deafness that needs careful scrutiny, and that is in the field of multiple handicaps. We list six groups in the American Annals of the Deaf: the aphasic deaf, the mentally retarded and deaf, the crippled and deaf, the brain injured and deaf, the deaf-blind child, and the cerebral palsied and deaf. Each year the number of such pupils reported becomes larger. It may be that this situation is brought about by better diagnostic services, or that, educationally, we are becoming more aware of the problems. It may also very well be that medicine in the 20th century is saving lives of many multiple handicapped deaf boys and girls who twenty-five years ago would have been in the graveyard.¹

Doctor's report concerning this growing problem is a consensus of opinions held by a number of educators and administrators in schools for the deaf in the United States. Workers in the field are constantly seeking new ways to help these children. The largest single group of multiple

handicapped children attending schools for the deaf are the mentally re-
tarded. These youngsters have been a constant source of interest to edu-
cators in the field. This concern has been augmented in more recent years
by an increase in incidence. Experimental studies in psychology and edu-
cation have also shown many differences to exist in the behavior of these
people. When the principles suggested by research are applied in the edu-
cation and management of mentally retarded deaf children, such differences
have also been noted. These have many implications for the education of
mentally retarded deaf youngsters and point up the importance of further
research.

Research evidence has indicated the possible existence of distinct
differences among children who have generally been classified as mentally
retarded. Individual case analyses have shown mental retardation to be
due to many causes. The differences in etiology have been partly respon-
sible for the observed differences in learning and in behavior. It is
therefore clearly evident that in studying the problems of these children
they cannot be treated as a single group. More reasonable groupings for
research purposes must be determined by similarities and dissimilarities
as determined by objective classification. An effort was made in this
research to apply objective data not only in classification of the children,
but also in the reporting of the findings.

The present study was limited to an evaluation of differences be-
tween several groups of deaf and hearing mentally retarded children. In
attempting to determine the existence of differences, certain motor skill
tests were utilized. These motor skill instruments had been used in pre-
vious research studies involving both deaf and hearing children.
Hypothesis

Mental retardation has long been accepted as a major disability. The mentally retarded person has been typified as having inferior perceptive ability, poor neuromuscular coordination, and limited learning capacity. These limitations have been demonstrated by the performances of such youngsters on performance tests. From the results of previous research it would seem that if in addition to being mentally retarded the child were also deaf, the added disability imposed by deafness would cause a less proficient level of performance in certain tests.

For comparative purposes, matched groups of hearing mentally retarded were also selected. A group intelligence test was used to select the various mentally retarded deaf and mentally retarded hearing children. In the determination of possible differences in performance, certain motor skill tests were used. These tests and devices were selected for this investigation on the basis of ease of administration, simplicity, and the fact that each had been successfully used with either or both deaf and hearing mentally retarded children.

Selection Criteria and Study Limitations

The deaf youngsters used in this study were selected from three residential schools for the deaf in the southwestern part of the United States. The schools used were the Arizona State School for the Deaf and the Blind located in Tucson, the New Mexico School for the Deaf in Santa Fe, and the California School for the Deaf in Riverside. The following criteria were used as guides in the selection of subjects.
**Chronological Age**

A chronological age limit of from 10.0 to 15.0 years was selected because children in this age range have been generally considered in the pre-vocational group in so far as present day school curricular programs are concerned.

**Intelligence**

The range of mental ability was limited to scores of 65 to 85 as determined by use of the Chicago Non-Verbal Examination (see Chapter 3). These limits were selected because within this range were included most of the children who seem to experience the greatest academic difficulty in schools for the deaf.¹ The children in this group have required special educational considerations in these schools. Myklebust, in a paper presented at the 38th bi-annual meeting of the Convention of American Instructors of the Deaf stated:

> On the basis of experience in trying mentally retarded children in schools for the deaf, both day and residential, we have learned that it is rarely possible to classify such a child in these schools unless his intelligence level falls above 65; about two-thirds of normal or higher. This suggests that the educable mentally retarded fall between the mental levels of 65 and 85. Other significant factors are emotional adjustment, degree of deafness, and presence of other involvements such as cerebral palsy and specialized language disorders. The educable mentally handicapped child usually benefits most from special class placement and emphasis on concreteness rather than mainly academic success.²


²Ibid., pp. 315-316.
Age of Onset

The limitation of age of onset of hearing loss was set at 3.0 years of age. This was done in an effort to eliminate those children who sustained their loss of hearing after the onset of speech or verbal communication. The educational problems of such a child are more nearly similar and representative of the majority of mentally retarded children enrolled in schools for the deaf. Children who have acquired natural verbal language do not seem to be as handicapped in academic learning as those who have not been afforded the opportunity of hearing and learning spoken language.

Extent of Hearing Loss

Hearing losses as shown by pure tone audiometric testing were required to be greater than 70 decibels (db) in the middle three frequencies (500, 1,000, 2,000). Individuals whose hearing losses are greater than 70 db in these three frequencies are for all practical purposes deaf as defined in this study. With this degree of hearing loss, the individual is unable to comprehend aural communication. Children with losses in hearing less than 70 db seem to respond more to verbalization in varying degrees and therefore present a less complex educational problem.

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Sex

Subjects for the study were limited to males. Research has shown that there are differences between pre-adolescent boys and girls in rate of maturation. In the area of general intelligence, for example, Anastasi and Foley have pointed out that among elementary school children, ages eight to sixteen, girls excel at all levels.\(^1\) Francis and Rarick in their recent study of motor characteristics of hearing mentally retarded children demonstrated the existence of very significant differences in performance between sexes.\(^2\) Since an intelligence test and several motor ability tests were utilized in the present research, subjects used were all of one sex (male).

Hearing Subjects

Similar criteria were used in the selection of the hearing mentally retarded children. These youngsters were chosen from the special education classes of the Tucson (Arizona) public schools. An analysis of the physical and medical records available on these children was made in an effort to determine the absence of hearing loss and/or other physical defects. These records indicated that periodic hearing tests and physical examinations had been required for all children attending school in this district. Such examinations were given under competent medical or technical supervision.


Motor Skill Tests

The specific motor skills that were measured in this study and the instruments used for gathering the data to compare the four groups of children were as follows:

- **Visuo-Motor** - Werner-Strauss Marble Board Test
- **Tactual-Motor** - Werner-Strauss Tactual Motor Test
- **Spatial Relationships** - Grace Arthur Stencil Design Test
- **Manual Dexterity** - Purdue Pegboard Test
- **Locomotor Coordination** - Heath Rail-Walking Test

Each of the tests selected had been previously used in studies with both deaf and hearing children. The instructions required for administration were rather elementary, and in many cases only a demonstration of procedure was necessary. Verbal and pantomime instructions were added where deemed essential.

Definitions and Terminology

For purposes of clarification certain terms used frequently throughout this thesis have been defined. Definitions were taken from standard sources of reference.

- **The deaf**: are those in whom the sense of hearing is non-functional for ordinary purposes of life. This general group is made up of two distinct classifications based upon the time of onset of the loss of hearing.
- **The congenitally deaf**: are those who were born deaf.
- **The adventitiously deaf**: are those who were born with normal hearing but in whom the sense of hearing became non-functional later
through illness or accident.¹

**The hard of hearing:** are those in whom the sense of hearing, although defective, is functional with or without amplification.²

**Mental Retardation:** or the mentally retarded, are those children who, when tested by means of standardized intelligence tests, obtain scores of less than 85. Tredgold identifies this group as the children who are within the lower twelve per cent of the population.³ For the purposes of this investigation the term mentally retarded will apply to those students who have been selected for this study and whose intelligence quotients range from 65 as the lower limit to 85 as the upper limit.

**Endogenous:** for purposes of etiological identification, refers to those individuals whose retardation resulted from familial or hereditary causes.³

**Familial:** is used synonymously with endogenous.

**Exogenous:** to identify an etiological classification, refers to those individuals whose retardation resulted from causes outside the genes or from causes other than hereditary ones. In these cases the mental retardation is acquired. The acquisition of retardation outside of genetic influence may have been pre-natal or postnatal depending upon the disease

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²Ibid., p. 3.

or trauma suffered.¹

Non-familial: is used synonymously with exogenous.

Summary

A growing incidence of multiple handicapped deaf children in schools for the deaf in recent years is strongly in evidence. The largest single group of children among these is the mentally retarded deaf. It has been noted by educators that traditional methods of educating normal deaf children and mentally slow deaf children have not always produced satisfactory results.

Recent research with hearing children has shown that etiologies of mental retardation differ considerably. Differences have also been observed in the behavior, mental, and motor functioning of these children. Similar differences have also been observed among mentally retarded deaf children.

The purpose of this investigation was to compare groups of mentally retarded deaf and hearing children in order to determine what effect the additional handicap of deafness would have on such persons in certain areas of motor functioning. Each child used in the study was classified according to known etiology, since this classification system has become rather standard in educational and psychological research. The behavioral characteristics of children classified into these two groups have also been found to manifest measurable differences.

The research was a comparison of four matched groups of mentally retarded deaf and hearing children in the performance of certain motor

¹Tredgold, A. F., A Textbook of Mental Deficiency, 1949, p. 51.
skill tasks. The groupings used were divided as follows:

- **Deaf** familial mentally retarded children
- **Hearing** familial mentally retarded children
- **Deaf** non-familial mentally retarded children
- **Hearing** non-familial mentally retarded children

A much larger sample of children was originally chosen for use in this study. This group was carefully screened according to the criteria established before the investigation was undertaken.

Certain specific sample requirements were established in order to set up matched experimental and control groups for the study. The subjects selected were male children between the ages of ten and fifteen years. All children used in the study had scored between 65 and 85 on the Chicago Non-Verbal Examination. All four groups were statistically matched according to age, sex, and intelligence.

An additional set of requirements was imposed on the deaf youngsters. The amount of hearing loss had to exceed 70 decibels in the middle three frequencies and had to have been sustained prior to the age of three years. The hearing subjects were screened for normal hearing and review of each child's school record was made in an effort to eliminate those having other dominant physical handicaps.

Those eventually selected were given the motor skill tests used in the study. The research data was used to compare the performance of each of the two groups of deaf mentally retarded children with the two matched groups of hearing mentally retarded children.

Each of the motor skill tests selected for use in this study had previously been successfully employed in similar research with mentally
normal deaf and hearing children. The performance areas considered were visuo-motor, tactual motor, spatial relationships, manual dexterity, and locomotor coordination.

The four groups of mentally retarded subjects were matched according to age and intelligence. The t-test of significance was used to test the null hypothesis of no difference between the means of four groups. Paired groups were matched as follows:

Deaf familial - Hearing familial
Deaf non-familial - Hearing non-familial
Deaf familial - Deaf non-familial
Hearing familial - Hearing non-familial

In addition to matching these four groups, the total group of deaf subjects was compared to the total group of hearing subjects. Similarly the total group of familial mentally retarded subjects were matched with the total population of non-familial subjects. These comparisons were as follows:

Total group deaf - Total group hearing
Total group familial type - Total group non-familial type

The arrangement of matched groups in all possible combinations made possible a comparison between the data derived from this research with that of previous investigations.

The procedure used for the selection and classification of subjects has been reported in Chapter III, and information concerning the selection of tests and their respective relationship to this study has
been reported in Chapter IV.

The data gathered from individual performances on the various tests used in the study has been subjected to the same t-test of significance as had been used for matching purposes. Mean scores of each group on the various motor skill tests were compared in an effort to determine the existence of significant differences between means.
CHAPTER II

REVIEW OF RELATED LITERATURE

A considerable amount of research has been undertaken comparing the deaf child with the hearing child. These studies have included evaluation of mental and intellectual functioning as well as proficiency skills in motor activity. The more pertinent of these have been reviewed for purposes of this research.

One of the earliest studies involving the measurement of mental and educational functioning in the deaf was done by Reamer in 1920.\(^1\) Her summary of previous research efforts to evaluate the deaf child indicated that these were, for the most part, subjective observations of performances in a variety of activities. Examples of the kind of behavior observed included reactions to bright colored pictures and the constructive ability to use blocks.

The first formal attempt to develop a set of tests for use with deaf children was undertaken by Pintner and Patterson in 1915.\(^2\) These two researchers endeavored to adapt the Binet Scale for use with the deaf. Although unsuccessful, this effort did reveal the fact that in order to possibly measure the mental ability of the deaf child, consideration had to be given to the prominent differences in the language ability of deaf

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children.

Using tests that depend upon verbal or written communication for administration have proven ineffective in the evaluation of the deaf. Similarly, instruments requiring verbal or written responses were found to be equally poor. These early discoveries were extremely helpful. Psychologists have been able to incorporate many of these findings into tests constructed for use in securing a more accurate measure of the deaf. Many of these early studies were directed by Pintner and Patterson.

One of the earliest and most complete surveys of the education and psychology of the deaf was made by Day, Fusfeld and Pintner during the years 1924 and 1925.¹ This report contained a section comparing the general intelligence of deaf children with hearing children. The Pintner Non-Language Mental Test and the Pintner Educational Survey Test were administered to some 4,432 children twelve years of age or older in thirteen day schools and twenty-eight residential schools for the deaf. The results of this research produced norms for deaf children for the tests used. With these instruments the authors were able to measure the intelligence of a great number of deaf youngsters. The results obtained from a comparison of scores made by deaf and hearing children at all age levels seemed to indicate the deaf child to be two or more years retarded.²

This report inspired considerable debate and controversy among educators of the deaf during the period following its publication. Because of this dispute, additional studies were undertaken in an effort to

² Ibid., pp. 273-277.
learn more about the intellectual differences that existed between deaf and hearing children. In 1928, Drever tested 1,474 deaf children with the Drever-Collins Scale. This instrument, which was a performance test, had been constructed so as to eliminate the language variable. From tabulation of data obtained in this study Drever established norms for the deaf. Results on the Drever-Collins Scale indicated that there was less than one year difference in intelligence between matched groups of deaf and hearing children. It was Drever's opinion that if the language factor could be completely removed from a test the deaf would not be found to be retarded in mental functioning.

Peterson and Williams used the Goodenough Draw-A-Man Test in a study conducted in 1929. They subsequently reported the degree of retardation of the deaf child as compared to hearing children of similar chronological ages to be one year and ten months. In arriving at this estimate, comparisons were made of 330 deaf students, ages five to fourteen years. The modal I.Q. was found to be 90 and the median 80. These results were somewhat comparable to those obtained by Pintner in his earlier survey of 1924-25. Mentioned in this report, however, was the fact that researchers could not entirely remove the limiting factor of verbal instruction in the proper administration of the test. The idea that the child should put forth his very best effort in the drawing could

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not be conveyed to those being tested.

Long compared the motor skills of a group of deaf and hearing children that had been equated as to age, sex and race.\(^1\) Fifty-one pairs of boys and thirty-six pairs of girls ranging in age from eight to seventeen years were used in the study. These were selected from the Lexington Avenue School for the Deaf and the Hebrew Orphan asylum in New York City. The following tests were used in the study:

- **The Brown Spool Packing Test:** For measuring speed of bi-manual coordination.
- **A Serial Discriminator:** To measure the speed of finger movements in discriminative reactions to a visual series.
- **The Koerth Pusnit Rotor:** To measure eye-hand coordination in following a target moving in a circular path.
- **A Tapping Key:** For measuring speed of finger movement.
- **The Miles Motility Rotor:** For measuring speed in turning a small hand drill.
- **The Smedley Hand Dynamometer:** To give a simple measure of strength.
- **A Balancing Board:** To yield a rough measure of the sense of balance.

From the results of this study it was inferred that in each of the seven tests administered the deaf girls were more inferior to deaf boys than hearing girls were to hearing boys. Both sexes of the deaf were superior to the hearing in spool packing, tapping, and motility rotor tests. Hearing subjects were superior to the deaf in two of the tests, the serial

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discriminator and the balance test. These conclusions were based upon a comparison of the difference between the means. However, when tested statistically for the difference between means the only findings that reached a level of significance was the balance test, the results being in favor of the hearing group. The difference in balance skill shown in this study was consistent with other previous studies as well as more recent research on balance between these two groups.

In a comparative study of the intelligences of deaf and hearing children conducted by MacKane in 1932, the performances of 130 deaf children and an equal number of hearing students matched as to age, sex, nationality and socio-economic status were compared. In this study the Arthur Performance Test, the Pintner-Patterson Performance Test, the Drever-Collins Performance Scale, and the Pintner Non-Language Test were used. In assessing the results, the author concluded that the performance scales and the non-language tests as used in this study definitely measured different intellectual factors. On performance scales, deaf children seemed to be less than one year retarded, whereas, on the Pintner Non-Language Test they fell two years below the hearing group. These findings parallel somewhat those reported by Drever and by Pintner in the National Research Council Survey.

In this same year Goodenough and Shirley tested all the known deaf school age children in the state of Minnesota, a total of 406 youngsters.

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The sample represented approximately ninety percent of all deaf school age children in the state. The Pintner Non-Language Test and the Goodenough Intelligence Test were administered to the group. Scores obtained for the deaf children on the Goodenough test were somewhat below the standards for hearing children of similar ages. On the Pintner test, however, deaf children averaged very close to the results Pintner and others had obtained for hearing children on the National Survey. The median scores for deaf children in the Goodenough and Shirley study were much higher than the median scores obtained for the deaf on the National Survey. The median I.Q. for the deaf in the Minnesota research on the Pintner test was 98.4 and on the Goodenough test it was 87.7. The coefficient of correlation between the Goodenough and Pintner tests was positive .326. This rather low correlation was given no further explanation by the authors.

Also in 1932, Hofmarksrichter, in Germany, published a report of his observations of visual functioning of deaf and hearing children. He advanced the hypothesis that the deaf may see more than hearing children since they possibly observe more detail in the environment. Hofmarksrichter tested deaf and hearing children tachistopically, varying the exposure time from 1/10th to 1/100th of a second. His investigations involved more than 1,000 trials with each group. At an exposure of 1/25th of a second, 93 percent of the deaf were able to recognize all the figures correctly, as against 42 percent of the hearing who were able to recognize all the figures. The differences between the two groups became greater as

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the exposure time was decreased. No statistical treatment of the data was reported.

Schick and Meyer, using a lectometer, compared the performances of groups of deaf and hearing children. The lectometer, designed by Meyer, is a visual-kinesthetic performance test. The study was undertaken in an effort to select a test which could be quickly administered to both deaf and hearing children without the use of verbal language. Schick and Meyer successfully demonstrated that this test could be administered easily to both groups. Scores obtained for both deaf and hearing subjects were essentially the same. Mean scores for both deaf and hearing groups at all ages were also very similar.

In another study done in 1931, Schick used the Randall's Island Performance Series. This test was designed for use with pre-school children ages two to six years. The series was given to forty-three children of pre-school age at Central Institute for the Deaf in St. Louis. Of this group thirty were deaf and thirteen were speech defectives. There were no significant differences between the performances of the two groups.

In 1932 this same test was administered to a total of fifty-nine pre-school children, twenty-nine deaf and thirty speech defectives. The median score was 97 and the difference between the deaf and hearing groups was smaller than in the previous study.

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Morsh in 1932-1934 conducted a comparative study between deaf and hearing groups under a National Research Council Fellowship at Johns Hopkins University. Deaf subjects used in the study were students at Gallaudet College and Kendall School for the Deaf in Washington, D.C. The control group of hearing students was secured from the public schools of the District of Columbia and American University. The study was an attempt to compare the performances of these two groups in the areas of tapping, steadiness, balance, location memory, speed of eye-movement, and hand-eye coordination.

Results of the study indicated that the deaf were significantly superior to the hearing in steadiness and location memory. The hearing were superior in balance and speed of eye-movement. On double plate tapping and hand-eye coordination there were no significant differences between the means of the two groups.

Lane in a study of the performance of fifty school aged children in 1936 secured means of 105 and 122 on the Drever-Collins Performance Scale. These results were better than those obtained by Drever some six or seven years earlier. The reason for this large difference was not explained.

Springer, in response to the obvious differences in the results

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obtained on tests between deaf and hearing groups prior to 1937 felt the need for additional research. In formulating his own effort in this direction he posed the following often repeated question: "Do 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?" Springer selected 330 deaf and 330 hearing children from public day and residential schools in New York City. These children in so far as could be determined were American born whites of similar socio-economic level. They ranged in age from six to twelve years. Using the Goodenough Draw-A-Man Test, Springer demonstrated that neither the deaf nor the hearing group was superior. An analysis of the results by age and sex substantiated the lack of difference between the two groups. As a final test he analyzed individual items. Both groups were equally successful on these as well.

Stanton, at Teachers College, Columbia University, under the direction and sponsorship of Rudolph Pintner, conducted still another study of the performances of equated groups of deaf and hearing children. The Minnesota Test of Mechanical Ability was used to compare 121 deaf boys and 36 deaf girls with a similar number of hearing children. The range in age of the two groups was from twelve to fifteen years. Deaf children


2 Ibid. p. 138.

were selected from schools for the deaf in New York City and the State of New Jersey. Hearing children used in the study were from public schools in the city of New York.

From this study it was found that deaf boys seemed to be equal to hearing boys in mechanical ability. Deaf girls on the other hand seemed to be slightly inferior to hearing girls in the groups compared. Differences between groups, however, were not statistically significant.

In a summary of his report Stanton indicated that for the groups tested the deaf and the hearing were similar in mechanical ability. He further pointed out that the deaf have apparently not been especially endowed with mechanical ability as a compensating factor for the loss of hearing as has so often been inferred.

In 1939 Zekel and Van der Kolk, who were associated with the psychological laboratory of the Institution for the Deaf in Rotterdam, Holland, conducted a study comparing deaf and hearing students in the use of the Porteus Maze Test. This study involved deaf subjects whose loss of hearing had been diagnosed as congenital. One hundred deaf and one hundred hearing subjects, ages seven to fifteen, were used. These were matched according to age and socio-economic status.

Differences in performance between deaf and hearing groups were statistically significant. The hearing group achieved higher scores than the deaf. The mean I.Q. score for each group was 96.36 for the hearing and 86.09 for the deaf. In qualifying the results, the authors stated

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that hearing children in Holland have much more of an opportunity to practice puzzles and other games found in local newspapers. They felt that these experiences gave the children an advantage. The authors were careful to state that broad generalities concerning overall intelligence should not be made on the basis of the Porteus Maze Test alone. Zekel and Van der Kolk indicated that a more comprehensive test with a larger number of sub-tests would be necessary before actual comparisons in all aspects of mental ability could be made.

Hiskey, prior to 1931, constructed a non-language test for deaf children based upon specific criteria. This test was designed as a measuring instrument of learning aptitude and was felt to be more suited to the specific needs of this group than any of the tests previously adapted for this purpose. The preliminary scale consisted of 204 separate items. The Hiskey test was administered to seventy-three pupils whose ages ranged from three years ten months to nine years eight months. In its original form, two hours were required for administration so that two sittings with each subject were necessary. The construction of the test was based on specific criteria which Hiskey felt were essential for measuring intelligence or, as he termed it, learning aptitude of young deaf children. These criteria were as follows:

(1) Was the item similar to the task, or tasks, which the young deaf child did in school? (2) Was it the type of item which could be included in a non-verbal test? (3) Could the item be presented in such a way that directions could be

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1 Hiskey, M. S., A Non-Verbal Test of Learning Aptitude Especially Adapted for Young Deaf Children, Dissertation, University of Nebraska, 1940.
given through simple pantomime? (4) Was it the type of item which experience had shown to yield high correlation with acceptable criteria of intelligence or learning ability? (5) Could the item be constructed and presented in such a way that the child could make a definite response, thus making the scoring objective and easily done? (6) Would the item be appealing or attractive to the subject? (7) Could the item be scored without the score being based on time? (8) Did the difficulty of the item appear to be within the age range of the standardized group? (9) Did the item seem likely to show a high discriminative capacity? ¹

Following the preliminary investigation, steps were taken to standardize the test and to establish norms for use with deaf children. ²

The effectiveness of this test as a measuring instrument of learning potential together with simplicity of design contributed to its popularity. The test has also been used effectively with young hearing children. In order to meet this trend, Hiskey prepared verbal instructions for the test and ultimately standardized it for use with the hearing.

Hiskey reported the results of his studies and standardization attempts on the Nebraska Test for Learning Aptitude in the American Annals of the Deaf. Part of the summary in which a comparison was made between the performances of deaf and hearing children follows:

The impressions gained from this study were that the deaf closely approximate the hearing in mean level of intelligence but that their mean rating (I.Q.) is likely to be slightly lower due to (a) communication difficulties between the examiner and the examinee, and (b) the ability of hearing children to utilize their native potential more efficiently (than the deaf) in those situations where verbalization aids retention and possible analysis. Perhaps the first point suggests the desirability of future tests having even more practice exercises than are utilized in present scales. It is doubtful

¹Hiskey, M. S., Nebraska Test for Learning Aptitude, Manual of Instructions, University of Nebraska, Lincoln, Nebraska, 1955, Rev., p. 3.
²Ibid., p. 1.
that the deaf (as a group) can ever overcome completely the
loss of efficiency resulting from deafness and less facility
with verbal abstractions. It is encouraging to have addi­
tional evidence that the deaf are likely to equal the hear­
ing where language is not a primary factor and even to excel
where visual perception is of paramount importance.¹

The studies reviewed have indicated that under controlled condi­
tions and in certain areas of mental functioning, the deaf and the hear­
ing are equally proficient. On the other hand it has been implied that
in certain other aspects of mental functioning the loss of hearing impairs
mental efficiency.

Lane and Schneider, borrowing sub-tests from existing performance
tests constructed a battery for use with deaf children.² The criteria
followed were similar to those used by Hiskey.³

From this effort emerged the Advanced Performance Series. The
test was given to 133 deaf children including some speech defectives, and
also to 106 hearing children. The deaf and speech defective children
were selected from the Central Institute for the Deaf in St. Louis, and
the hearing group from the public schools of that same city.

Results of this experiment were correlated with similar standard­
ized performance and non-verbal tests of intelligence. These comparisons
as reported by Lane and Schneider have been included in Table I.⁴

¹Hiskey, M. S., "A Study of the Intelligence of Deaf and Hearing
²Lane, H., Schneider, J., "A Performance Test for School-Age Deaf
⁴Lane and Schneider, Op. Cit., p. 442. (Table reprinted from report).
TABLE I. COMPARISON OF ADVANCED PERFORMANCE SERIES
AND OTHER PERFORMANCE TESTS

<table>
<thead>
<tr>
<th>Test</th>
<th>N.</th>
<th>r.</th>
<th>P.E.r.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectometer</td>
<td>68</td>
<td>.78</td>
<td>±.03</td>
</tr>
<tr>
<td>Randall's Island</td>
<td>65</td>
<td>.65</td>
<td>±.04</td>
</tr>
<tr>
<td>Performance Series</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>133</td>
<td>.71</td>
<td>±.03</td>
</tr>
</tbody>
</table>

From this table it will be noted that there was a correlation of .78 between the Advanced Performance Series and the Lectometer. The correlation between the Advanced and Randall's Island Performance Series was .65. The authors suggested that the Randall's Island Performance Series and Lectometer correlation results were not as high as had been expected. It was felt that the similarity of the two series should have yielded a much higher coefficient of correlation. Possible deficiencies in individual scores could have been due in part to behavioral maladjustments as well as the lapse of one year or more between administrations of the tests compared.¹

The Advanced Performance Series was also correlated with results on four different standardized intelligence measures. These included the Binet, Henmon-Nelson, Kuhlman-Anderson, and the Detroit. Observed correlations ranged from a low of .19 on the Kuhlman-Anderson to a high of .68 on the Henmon-Nelson.²

¹Ibid., pp. 442-443.
²Ibid., p. 443.
A comparison of the performances of deaf and hearing groups on this Series indicated greater variability for the hearing group and a slightly higher than average Intelligence Quotient. In conclusion Lane and Scheider stated that:

In its present form the series compares favorably with other measures of intelligence and gives further evidence to support the conclusion that the deaf child is normal mentally if his ability is measured on a test that does not involve the use of language for direction or response.¹

Cutler, in 1942, surveyed all known major studies in the area of mental and motor functioning with respect to the deaf.² Results of this effort were tabulated and published in the *American Annals of the Deaf*. The table from this report shows a comparison of the results of each of the previous studies excluding the Hiskey and Lane researches which were done between 1940-1941. Because of its importance to the overall problem, this report has been included here as Table II.³

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³ *Ibid.*, p. 183. (Table reprinted from this report.)
<table>
<thead>
<tr>
<th>Reference</th>
<th>Chronological Order</th>
<th>Author</th>
<th>Number Deaf Subjects</th>
<th>Number Hearing Age</th>
<th>Instrument of Measure</th>
<th>Result: Median I.Q. or comparison with scores of hearing children</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-School Children</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Lane</td>
<td>43</td>
<td></td>
<td>Randall's Performance</td>
<td>96 in 1931; 97 in 1932</td>
<td></td>
</tr>
<tr>
<td>51</td>
<td>Scyster</td>
<td>50</td>
<td></td>
<td>Merrill-Palmer Scale Minnesota Pre-School Pintner-Patterson</td>
<td>No retardation, close correlation with ability in school subjects</td>
<td></td>
</tr>
<tr>
<td><strong>Primary and Secondary Children</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Goodenough &amp; Shirley</td>
<td>406</td>
<td>5-20</td>
<td>Goodenough Drawing Pintner Non-Language</td>
<td>87.7 98.4</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>Meyer &amp; Schick</td>
<td>132</td>
<td>1251</td>
<td>Lectometer</td>
<td>Very slight difference in ability</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Lyon, et.al.</td>
<td>253-406</td>
<td>9-19</td>
<td>Pintner Non-Language Arthur Performance Institute Juvenile Research</td>
<td>84 92</td>
<td>Not standardized</td>
</tr>
<tr>
<td>34</td>
<td>MacKane</td>
<td>130</td>
<td>130 10-12 equated</td>
<td>Drever-Collins Pintner-Patterson Arthur Performance Pintner Non-Language</td>
<td>Less than 1 yr. retarded Less than 1 yr. retarded Less than 1 yr. retarded Two year retardation*</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Lane</td>
<td>50</td>
<td></td>
<td>Drever-Collins</td>
<td>105 or 122 (according to method of scoring)</td>
<td></td>
</tr>
</tbody>
</table>

*The author concluded that the performance scale and the non-language test measure different abilities.
<table>
<thead>
<tr>
<th>Reference Chronological Order</th>
<th>Author</th>
<th>Number Deaf Subjects</th>
<th>Number Hearing Subjects</th>
<th>Age</th>
<th>Instrument of Measure</th>
<th>Result: Median I.Q. or comparison with scores of hearing children</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Primary and Secondary Children</td>
</tr>
<tr>
<td>7</td>
<td>Amoss</td>
<td>288</td>
<td></td>
<td>5-22</td>
<td>Ontario School Ability</td>
<td>94</td>
</tr>
<tr>
<td>8, 9</td>
<td>Bishop</td>
<td>90</td>
<td></td>
<td>5-16</td>
<td>Arthur Performance</td>
<td>97</td>
</tr>
<tr>
<td>42</td>
<td>Peterson</td>
<td>100</td>
<td></td>
<td>5-17</td>
<td>Kohs Block Design</td>
<td>95</td>
</tr>
<tr>
<td>28, 29</td>
<td>Lane</td>
<td>200-250</td>
<td></td>
<td>5-19</td>
<td>Lectometer</td>
<td>Equal ability</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Randall's Performance</td>
<td>97.6</td>
</tr>
<tr>
<td>52</td>
<td>Springer</td>
<td>330</td>
<td>330</td>
<td>6-12</td>
<td>Goodenough Drawing</td>
<td>96.24 (mean)</td>
</tr>
<tr>
<td>24</td>
<td>Kirk</td>
<td>89</td>
<td></td>
<td></td>
<td>Arthur Performance</td>
<td>99.4</td>
</tr>
<tr>
<td>53</td>
<td>Springer</td>
<td>377</td>
<td>416</td>
<td>6-12</td>
<td>Goodenough Drawing</td>
<td>Almost similar test scores</td>
</tr>
<tr>
<td>56, 6</td>
<td>Stanton</td>
<td>157</td>
<td>157</td>
<td>12-14</td>
<td>Pintner Non-Language</td>
<td>No statistically significant difference</td>
</tr>
<tr>
<td>57</td>
<td>Streng &amp; Kirk</td>
<td>97</td>
<td></td>
<td>6-18</td>
<td>Arthur Performance</td>
<td>100.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Chicago Non-Verbal</td>
<td>95.5</td>
</tr>
</tbody>
</table>

Adults—None Reviewed
From Table II it will be noted that a wide range of mean I.Q. scores were obtained from the research studies included in this survey. The scores varied from a low of 84 to a high of 122. Though it is difficult to draw a truly objective conclusion from all these scores there seems to be evidence to the effect that the deaf child is retarded one year or more in overall mental functioning. More recent studies have tended to show more clearly the nature of these variations and elimination of the language variable has appeared to have been helpful in rendering measured intellectual differences.

**Related Research of More Recent Origin (Since 1945)**

An outstanding research worker in this general area who has emerged since 1945 is Helmer Myklebust from the Institute of Language Disorders and the School of Medicine, Northwestern University. In 1945, Myklebust investigated differences in motor ability among deaf children using an etiological classification or origin of hearing loss.¹ He made comparisons in performance with the following groups of children: endogenous-deaf, presumptively endogenous-deaf, exogenous-deaf other than meningitis, meningitic deaf, and undetermined deafness.² Although general comparisons of deaf and hearing children were not made in this particular study the emergence of etiological considerations was deemed important. This was the


²The terms endogenous and exogenous here as contrasted to the use of the terms in other portions of this report are etiological classifications of deafness and may or may not have relationship to the terms describing etiology of retardation as they are used in the present research.
first in a series of studies to demonstrate more clearly the wide variations in results which were obtained in previous studies.

Myklebust made a comparison of the results he obtained from deaf children on the Heath Rail-Walking Test with norms for hearing children.\(^1\) The mean score of deaf children as a group fell far below the norm for hearing children. This difference in locomotor coordination was significant at the one percent level and in direct relationship to previously reported comparisons between deaf and hearing children in balance skill.

MacPherson and Lane, using subjects from Central Institute for the Deaf in St. Louis, attempted to discover the relationship between the Nebraska Test for Learning Aptitude and the Advanced Performance Intelligence Scale.\(^2\) Comparisons were made on these tests between deaf and hearing groups. The obtained results were as follows: on the Nebraska Test the mean score for the deaf was 113.87, the hearing scored 101.67; on the performance series the mean score for the deaf was 116.62, the hearing scored 101.05. No explanation for the differences between the means was reported.

Oleron, in 1949 in France, attempted to isolate the elements that cause the deaf to score lower on intelligence tests.\(^3\) He selected Raven's Progressive Matricies and concentrated his efforts on abstract intellectual

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functioning. This was an attempt to determine how the deaf compare with the hearing in abstract intelligence. Oleron made the following statement regarding the relationship of his research to what had been previously done.

The theory suggested here is that the inferiority of the deaf is due to the close connection normally existing between language and abstract thought. This theory differs from that held by some authors (e.g., Pintner) who also admit the inferiority of the deaf. For these the inferiority proceeds either from the cause (e.g., illness) which provoked deafness or from some factor linked (e.g., genetically) to this cause. This point of view appears to be correct in certain particular cases, (when one is dealing with mentally deficient subjects) but not in general. Indeed it does not explain why the deaf succeed in concrete tests.¹

The Raven's Progressive Matrices, 1938 edition, was given to 246 deaf children from the school for the deaf in Paris. The median scores of each deaf age group when compared to norms for hearing children ranged from two to eight years lower. This represented a possible progressive change as the deaf child advances chronologically.

Myklebust and Brutten in a study of visual perception of deaf children, compared the results of tests administered to 55 deaf and 55 hearing children between the ages of eight and eleven years.² The youngsters were matched according to age, sex, and Intelligence Quotients. The deaf group was divided into three etiological classifications: endogenous-deaf, exogenous-deaf, and an undeterminate class.

The study was an effort to measure the visual perception of deaf

¹Ibid., Translation, p. 191.
children. The experimental (deaf) group was compared to a control (hearing) group in several visual perception tests. Comparisons of etiological sub-types of deaf children were also made, although these sub-groups were not matched. On the basis of their findings Myklebust and Brutten advanced the following hypothesis: "It may be theorized that visual perception in deaf children is not as firmly structured developmentally as it is in the normal population because it does not arise out of the same background of synesthetic experience." Visual perceptive ability of the deaf was purported to have not improved because of the hearing loss. Rather, it was felt that such perceptive ability functioned less efficiently because of limitations in experience caused by the loss of hearing. Involved also was the concept that deafness produced limitations on the ability of the deaf to think abstractly. In summary, these two researchers stated:

A deficiency in abstraction seemed to underlie the disturbed perceptual functioning of the deaf child. The perceptual stimuli used in this study were revealing in the way that they passed unmanageable perplexities to the mental equipment of the deaf child; the deaf were characterized by a perceptual approach which was largely concrete. The deaf child's visual perception was more adequate in the structuring of stimuli which could be concretized with facility; he could not readily cope with stimuli which were intractable to concretization or association with things of experience.

Myklebust, in an important article entitled "Towards a New Understanding of the Deaf Child," discussed the relationship found between deaf

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1 Ibid., p. 17.
2 Ibid., p. 119.
and hearing children from his own and other research. In this paper he reviewed briefly the work of Piattner in 1924 and the work of researchers from 1938 to 1953. In his summary he reiterated his belief that when language was eliminated as a factor, the deaf were not greatly inferior to the hearing in mental functioning. He also felt that the deaf child was quantitatively equal to the hearing child, but that differences between the two varied qualitatively. He also suggested the need for more research to help clarify the nature of intellectual capacities of deaf children.

Blair reported the results of a comparative study between deaf and hearing groups in the area of visual memory. In this study he selected 53 deaf and 53 hearing children matched according to age, sex, and intelligence. The two groups were compared in performances on the Knox Cube Test, Memory for Designs Test, Object Location Test, and four memory span tests including digit span forward, digit span reversed, picture span, and domino or dot pattern span.

On the Knox Cube Test the difference between the means was significant at the 5% level in favor of the deaf group. Similarly on the test of Memory for Designs the difference was significant in favor of the deaf. Blair felt that these tests demonstrated the deaf to be superior in ability to visually memorize and recall. It was further pointed out that these

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2. Ibid., p. 351.
tests seemed to show the deaf able to achieve on the infra-conceptual level as well or better than hearing children.\textsuperscript{1} In general this represented a skill of memory for movement and a memory of the patterns of stimuli that were not interrelated as parts of a whole concept or idea. It was felt that this did not involve any abstract or conceptual thinking.

In tests of digit span, forward and reverse, picture span and domino span, the differences between the means of the two groups were significant at the 1\% level in favor of the hearing. These results according to the author, indicated the deaf to be inferior to the hearing in memory span which involved, in this series of tests, discreetly related units of meaningful sequences. This he felt was an abstract type of mental process and thus concurred with the results of previous studies in the fact that the deaf consistently fall short of their hearing counterpart in this activity.

The only known study in this general area using retarded deaf children was done by Frisina.\textsuperscript{2} He employed classification and research techniques similar to those used by Myklebust and his associates. Frisina's research was prompted by an apparent lack of information about mentally retarded deaf children. He also recognized the growing incidence of such children in schools for the deaf and the need for more information about techniques of training.\textsuperscript{3}

\textsuperscript{1}Ibid., p. 261.
\textsuperscript{3}Ibid., pp. 171-172.
Frisina investigated areas related to the incidence, etiology, genetic development, motor capacity, intellectual functioning, auditory capacity, and reading achievement in mentally retarded deaf children. He used 82 deaf mentally retarded children from three mid-western schools for the deaf having a mean mental age of 7.69 years and a mean chronological age of 13.65 years. The mean Intelligence Quotient for the group on the Grace Arthur Point Scale of Performance Test was 62.29 with a range of from 37 to 79.1

The incidence of seriously mentally retarded children in three mid-western schools for the deaf was twelve per cent.2

Fifteen per cent were reported as having difficulty making school progress. Three of the fifteen per cent were apparently experiencing difficulty because of problems other than mental retardation.

Frisina indicated the specific need for a better understanding of the existing differences between the performance of two etiological types of mentally retarded children as classified in his study. These types were the familial, or endogenous; and the non-familial, or exogenous types of mental retardation. The findings in brief were that the etiological types, endogenous and exogenous mentally retarded deaf children, differed significantly in the area of general locomotor functioning on the basis of results on the Heath Rail-Walking Test. Such differences did not exist in intellectual functioning and reading achievement. Frisina summarizes his opinion as follows:

1Ibid., pp. 103-104.
2Ibid., p. 171.
The difference between Rail-Walking performance of etiological groups revealed significant superiority of the familial group. This result agrees with studies dealing with mentally defective groups so classified. This difference between etiological types is similar to that found in early motor development as revealed in sitting unsupported and walking unaided. The significant inferiority of the present non-familial group as compared to the familial group in a task requiring organismic integration suggests that damage or disturbance characterizes the former, whereas generalized retardation marks the latter. This indicates that the exogenous mentally retarded deaf child is likely to be less proficient than the familial child in the area of motor ability. This implies disturbed development in such aspects as gross motor coordination, manual dexterity, perceptual thinking, and speech.\(^1\)

Frisina has implied that the non-familial mentally retarded child performs less efficiently in general motor ability than the familial type. This was based upon results he obtained on the Rail-Walking test and comparisons of early genetic development. In studies of locomotor coordination in normal deaf children Myklebust also found significant differences between normal deaf and hearing groups.\(^2\) From the results of these two researchers together with findings of other related studies the hypothesis for the present study was taken. It was felt that these studies indicated a trend supporting the possibility that the additional factor of auditory deprivation on mentally retarded children would affect proficiency in some other motor skills.

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\(^1\)Ibid., pp. 174-175.

Summary

Prior to 1945 there seemed to have been considerable disagreement among researchers concerning the intellectual capacity of the deaf. Studies by Pintner, Fusfeld and others indicated that a span of from two to three years existed between the mental abilities of deaf and hearing children. These efforts have been supplemented by more recent study in which the language variable between deaf and hearing children has been more carefully controlled. Such research has demonstrated the deaf to be more nearly like the normal hearing in mental capacity.

Historically the greatest differences between deaf and hearing persons have been in performances on verbal tests, tests of abstract reasoning, and tests of balance. In these areas the deaf have been shown to be inferior to the hearing. In studies where these variables have been controlled, however, deaf subjects scored more readily like the hearing.

During the period of 1920 to 1950 there has been considerable evidence of an ever increasing awareness of the many intricate factors that must be considered in the measurement of intelligence and performance abilities in the deaf. Frequent attempts have been made to control the language factor, since all too often this has become a barrier to accurate measurement. Early studies were mostly attempts to evaluate intellectual abilities and motor functioning. More recent evidence on the subject has indicated that verbalization and other related language factors normally present in standardized tests were insufficiently controlled so that a true measure of the child as well as comparisons with hearing
children were not possible. This led to the development of specially
designed instruments which exercised control of the language variable
and placed more emphasis on the performance aspects of intelligence.
Studies using such instruments have shown the difference in performance
of certain tests between the deaf and the hearing to be less than one
year.

An early concept about the differences that have been found be­
tween the performances of the deaf and the hearing were termed largely
organic. Not until 1945 following extensive and significant research
by Myklebust and others, using the inter-disciplinary approach to the
study of the problems of the deaf, did any change in attitude begin to
emerge. These researchers indicated that the deaf have been endowed
with the same mental potential as the hearing. Myklebust has referred
to this as a quantitative capacity.¹

Myklebust reported that the deaf were able to perform equally as
well as the hearing in the area of conceptualization limited to the con­
crete. However, because of the loss of hearing, the deaf seem to perceive
differently and as a result behave according to a different set of basic
concepts. Due to this loss of hearing, especially at birth or before
the onset of verbal language, they seem to be less able to deal in the
area of abstract reasoning.² Myklebust indicated that the qualitative
aspects of intelligence of the deaf show marked inferiority to hearing
groups when measured by testing instruments that make demands on abstract

¹Myklebust, H. R., "Towards a New Understanding of the Deaf Child,"
²Ibid., p. 351.
reasoning.

In studies dealing with the performance of motor skills, the deaf have been found to be equal to the hearing. In fact, in some respects their performances were slightly superior. Studies dealing with balance, however, showed significant differences between deaf and hearing in favor of the hearing. These differences were due to damage to the semi-circular canals or to those brain centers that are related to balance control.

Current practice has shown the need for a closer evaluation of the individual who functions without hearing. There has also been more cognizance of the fact the deaf individual is one who has to function under extreme handicaps. In spite of this he seems to have made remarkable achievement in many areas of general behavior.
CHAPTER III

SELECTION AND CLASSIFICATION OF SUBJECTS

In this investigation a comparative study was made between the performance abilities of mentally retarded deaf children and mentally retarded hearing children on certain motor skills. Two groups of deaf boys were compared with equated groups of hearing boys.

Research has demonstrated that differences in the cause of mental retardation among individuals seems to produce differences in efficiency in the performance of a number of motor tasks. A commonly employed classification system used in studies of this kind has been to separate the familial type of mentally retarded subject from the non-familial type. This classification system was used in this study. Deaf and hearing groups of children were divided into two sub-groups according to this etiological classification. The groups used in this study were identified as follows:

Deaf familial mentally retarded
Deaf non-familial mentally retarded
Hearing familial mentally retarded
Hearing non-familial mentally retarded

Selection of Deaf Subjects

A preliminary survey of availability of subject material was made to determine the number of male deaf mentally retarded children in
residential schools for the deaf located in Arizona, New Mexico, and Southern California. Frisina's research on the incidence of mentally retarded children in schools for the deaf was consulted as a guide to this preliminary survey. He reported an incidence of twelve percent deaf mentally retarded children between the ages of seven and nineteen years in the schools used in his study. It was assumed that a similar incidence would be found in the schools of the southwest.

The State Residential School for the Deaf in Arizona had a total population of 168 children at the time the survey was made. A cursory search of the records in this school indicated some ten to twelve boys, whose ages and I.Q. scores would fall within the limits established for this study. The school for the deaf in New Mexico at the time had a population of 166 students. It was expected that possibly some ten to twelve students would be available from this school as well. The California School for the Deaf at Riverside, a much larger institution, had a student population of 502. It was estimated that approximately thirty boys would be available from Riverside for the study.

A more definitive search of the records in the Arizona School for the Deaf showed twelve boys whose previous test results and school performance records indicated that they could possibly be included in the study. After testing and screening the subjects for purposes of selection and etiological classification, however, only four students actually qualified. A similar search was made at the New Mexico School for the

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Deaf. Of seventeen students screened only seven could be used for the study. The California School for the Deaf at Riverside produced eleven of a total of thirty-three students who were originally selected as possible subjects.

Table III shows the number of mentally retarded deaf children screened and selected from these schools.

TABLE III. NUMBER OF SUBJECTS SCREENED AND SELECTED FROM SCHOOLS FOR THE DEAF USED IN THE STUDY

<table>
<thead>
<tr>
<th>School</th>
<th>Total school population</th>
<th>Students Screened</th>
<th>Students Selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Arizona</td>
<td>168</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>2. New Mexico</td>
<td>166</td>
<td>17</td>
<td>7</td>
</tr>
<tr>
<td>3. California</td>
<td>502</td>
<td>33</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>836</td>
<td>62</td>
<td>22</td>
</tr>
</tbody>
</table>

From this table it will be noted that twenty-two boys were ultimately selected for use in this study. This number was much smaller than what might have been expected using the Frisina estimate of incidence. This difference in incidence was accounted for after the following facts were considered. Frisina used mentally retarded children having an age range from seven to seventeen years, and intelligence quotients of from 37 to 79. In the present research the age range was from ten to fifteen years, and the I.Q. distribution 65 to 85. Frisina counted both boys and girls in his report of incidence while in this study only boys were used. Frisina classified all his subjects according to etiology of mental retardation and included in his percentage report those who could not be clearly
classified as familial or non-familial types.\textsuperscript{1} In this study only those who could be identified as familial or non-familial types were retained; the others were not included. The additional limitations imposed by the specific selection criteria used for the study, substantially reduced the number of available subjects.

\textbf{Selection of Hearing Subjects}

The special education program of the Tucson (Arizona) public school district number one included numerous classes for the mentally retarded. The administration of the district cooperated by making available school records on children who might possibly be used in the study. The administration also assisted with the scheduling of appointments and made available school testing facilities for the screening of subjects.

The hearing boys used in this study were selected from special education classes for mentally retarded children in the Tucson (Arizona) school district. A preliminary search of the records on these children revealed that some ninety-four boys might possibly qualify as subjects. After careful screening and classification, using the same matching criteria previously employed with deaf children, twenty-seven hearing boys were chosen.

\textbf{Etiological Classification of Subjects}

Previous studies have shown that mentally retarded children are

\textsuperscript{1}Ibid., p. 111.
frequently classified into two major groups according to the origin or cause of their retardation. These two categories are usually etiologically identified as familial and non-familial.\(^1\) Studies employing this categorization system have also indicated that there are many mentally retarded children that do not fit into either of these two groups. The etiology of retardation is not always discernable either clinically or by other systems of classification.

French and others in their work with mentally retarded children at the Vineland Training School devised a rather simple yet effective method for differentiating between familial and non-familial types.\(^2\) The following statement from the summary report describes the basis of the author's confidence in the system:

A comparison of classification of 230 cases by this system and by a previously employed clinical diagnosis indicated that cases previously diagnosed as endogenous and exogenous tended strongly to be classified as familial and non-familial respectively, except that many cases with clinical diagnoses of exogenous and endogenous fell into the does not classify group in the new classification, and some cases with clinical diagnoses of mixed or unknown fell into the familial or non-familial group in the new classification.

The usefulness of the new classification system for research is indicated by the findings that the groups classified by it as familial and non-familial show significant differences in the measures from the Heath Rail-Walking Test,


the Cassel modification of the Witmer Formboard Test, and the Ellis Design Test. These differences are in the same directions as the differences formerly reported on the basis of diagnoses of endogenous and exogenous. This indicates the attainment of our goal of developing an objective and highly reliable classification of the mentally deficient, useful for research purposes, and related as closely as possible to the earlier etiological classification. Although this system is particularly fitted to the needs of the Vineland Laboratory, it is felt that it may well be of value to other workers in the field who are faced with similar problems.\footnote{Ibid.}

This system for the classification of the mentally retarded according to etiology has considerable merit. It was particularly helpful in the present study, since it made possible a more accurate separation of familial and non-familial types.

In utilizing the system, the investigator had to review critically the case data available on each subject used in the study. The following information was necessary for accurate identification:

1. The presence or absence of mental deficiency in the subject's family.

2. The education and the occupational level of the subject's father.

3. The presence or absence of possible causes of acquired mental deficiency.

From the results of extensive use of the system, French and others prepared a special code letter technique as an aid to classification.\footnote{See Appendix I.} This coding technique was utilized by the investigator in the present study.

\footnote{Ibid.}
The French classification system was used in this study since a more complete clinical diagnosis involved a prohibitive cost factor. The value of the French system was also limited by the incompleteness of school records. Case histories on file were apparently sufficient for the needs of the particular school, but were often found lacking for purposes of this study. In an effort to possibly make up for these weaknesses, it was necessary to consult with parents, teachers, counselors and other workers.

In an effort to develop a rather complete history on each subject a parent questionnaire was used. These were mailed to the parents of the children on whom data was lacking. Cooperation in the return of these questionnaires was excellent. This was due in part to the assistance of the administration in each of the schools furnishing subjects for the study. Each administrator was asked to send a covering letter along with the questionnaire in order to encourage parent cooperation. Sixty percent of the questionnaires sent out were returned.

All subjects were screened and identified as to etiology. Only those who could be definitely classified as familial or non-familial were included in the study. For purposes of comparison the various deaf and hearing children were divided as to type. An additional arrangement of subjects for study purposes included total deaf and hearing, and total familial and non-familial types. Finally it was possible to divide the children into four equated groups. These four groups were equated according to age and I.Q. The number of hearing subjects available was

1 See Appendix II.
greater than the number of deaf subjects. The number of subjects included in each of the four groups has been included in Table IV.

**TABLE IV. NUMBER OF SUBJECTS INCLUDED IN EACH OF THE FOUR GROUPS USED IN THE STUDY**

<table>
<thead>
<tr>
<th>Pupils</th>
<th>Familial</th>
<th>Non-Familial</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deaf</td>
<td>14</td>
<td>8</td>
<td>22</td>
</tr>
<tr>
<td>Hearing</td>
<td>19</td>
<td>8</td>
<td>27</td>
</tr>
<tr>
<td>Total</td>
<td>33</td>
<td>16</td>
<td>49</td>
</tr>
</tbody>
</table>

From this table it will be noted that the following group comparisons were possible:

- Total deaf and hearing groups
- Total familial and total non-familial groups
- Familial deaf and familial hearing groups
- Non-familial deaf and non-familial hearing groups
- Deaf familial and deaf non-familial groups
- Hearing familial and hearing non-familial groups

In order to make comparisons in performance skills between the various groups it was necessary to guarantee that all groups represented were part of the same population with respect to ages and I.Q. scores.

**Matching Procedure**

The t-test was used to determine the significance of differences between means. This method was recommended in that it was one that could
be used with uncorrelated data secured from a small sample. In view of
the fact that each distribution used in this study involved a very small
N, it necessitated the use of a modification of the usual formula for
finding the standard error of the difference between means. This proce­
dure involved using pooled variances of two samples. The formula for
this procedure is as follows:

\[ SE_D = \sqrt{\frac{(\sum X_1^2 - (\sum X_1)^2/N_1) + (\sum X_2^2 - (\sum X_2)^2/N_2)}{(N_1 + N_2) - 2}} \times \left(\frac{1}{N_1} + \frac{1}{N_2}\right) \]

An F-test is required first to test the difference between vari­
ances before proceeding to the step to secure the standard error of the
difference between means using the pooled variance technique. The formu­
la used for finding F-ratio is as follows:

\[ F = \frac{S_1^2}{S_2^2} \]

In this formula, \( S_1^2 \) is the variance of the larger of the two
samples and \( S_2^2 \) is the variance of the smaller. If the F-test demon­
strated that this ratio was not significant the t-test could be employed.
This involved using the above formula for \( SE_D \).

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1 Downie, H. M., Heath, R. W., *Basic Statistical Methods*, 1959,
and Education*, 3rd Ed., 1956.
After determining the standard error of the difference between means the test of significance was made. The formula used for finding the t-ratio is as follows:

\[ t = \frac{M_1 - M_2}{SE_D} \]

Each pair of groups defined earlier in this research was subjected to this t-test. The five percent confidence level was used to determine the basis for rejecting the null hypothesis. This was the method used for equating the groups.

Table V shows the means of ages and I.Q. scores of the total group of deaf subjects in comparison with the total group of hearing subjects.

<p>| TABLE V. COMPARISON OF MEAN AGE AND I.Q. SCORES OF TOTAL DEAF AND TOTAL HEARING GROUPS |
|---------------------------------|--------|--------|---------|--------|--------|--------|</p>
<table>
<thead>
<tr>
<th>Gp.</th>
<th>M</th>
<th>S²</th>
<th>N</th>
<th>D_m</th>
<th>SE_D</th>
<th>t</th>
<th>.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf</td>
<td>12.34</td>
<td>381.76</td>
<td>22</td>
<td>.69</td>
<td>.40</td>
<td>1.76</td>
<td>2.02</td>
</tr>
<tr>
<td>Hear.</td>
<td>13.03</td>
<td>237.76</td>
<td>27</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I.Q.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf</td>
<td>77.05</td>
<td>36.71</td>
<td>22</td>
<td>2.83</td>
<td>1.94</td>
<td>1.45</td>
<td>2.02</td>
</tr>
<tr>
<td>Hear.</td>
<td>74.22</td>
<td>53.65</td>
<td>27</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

According to this table, the total groups of mentally retarded deaf and hearing can be considered representative of similar populations since the t-ratio for both age and I.Q. of these groups fall below the 5% level. The results of the t-test indicated that the hypothesis (H: \( \bar{X}_1 = \bar{X}_2 \))
could not be rejected since there was no significant difference between the means of the two groups.

In Table VI the mean ages and I.Q. scores of the total familial mentally retarded group have been compared to the total group of non-familial type.

**TABLE VI. COMPARISON OF MEAN AGE AND I.Q. SCORES OF TOTAL FAMILIAL AND NON-FAMILIAL GROUPS**

<table>
<thead>
<tr>
<th>Age</th>
<th>Gp.</th>
<th>M</th>
<th>$S^2$</th>
<th>N</th>
<th>$D_m$</th>
<th>$SE_D$</th>
<th>t</th>
<th>.05</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>153.73</td>
<td>203.03</td>
<td>33</td>
<td>3.39</td>
<td>5.20</td>
<td>.65</td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>NF</td>
<td>150.34</td>
<td>486.00</td>
<td>16</td>
<td>.63</td>
<td>3.21</td>
<td>.25</td>
<td>2.02</td>
</tr>
<tr>
<td>I.Q.</td>
<td>F</td>
<td>75.69</td>
<td>42.65</td>
<td>33</td>
<td>.63</td>
<td>3.21</td>
<td>.25</td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>NF</td>
<td>75.06</td>
<td>259.53</td>
<td>16</td>
<td>.63</td>
<td>3.21</td>
<td>.25</td>
<td>2.02</td>
</tr>
</tbody>
</table>

From this table it will be noted that when all the familial mentally retarded children including both deaf and hearing subjects were compared with all of the non-familial subjects, the t-ratios of the differences between means did not reach the 5% level. Therefore it can be hypothesized that these subjects were representative of similar populations.

In Table VII the mean ages and I.Q. scores of the familial group of mentally retarded deaf children were compared to the familial group of mentally retarded hearing children. This table has shown that when the mean age and I.Q. scores of non-familial mentally retarded deaf and hearing groups were compared, the t-ratios were both below the 5% level. These two groups then were also considered equated in age and intelligence.
TABLE VII. COMPARISON OF THE MEAN AGE AND I.Q. SCORES OF DEAF AND HEARING GROUPS OF FAMILIAL MENTALLY RETARDED CHILDREN

<table>
<thead>
<tr>
<th>Gp.</th>
<th>M</th>
<th>S^2</th>
<th>N</th>
<th>D_m</th>
<th>SE_D</th>
<th>t</th>
<th>.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D-F</td>
<td>150.21</td>
<td>254.00</td>
<td>14</td>
<td>.48</td>
<td>4.95</td>
<td>1.16</td>
<td>2.04</td>
</tr>
<tr>
<td>H-F</td>
<td>144.38</td>
<td>161.00</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I.Q.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D-F</td>
<td>77.00</td>
<td>30.76</td>
<td>14</td>
<td>2.25</td>
<td>2.30</td>
<td>.63</td>
<td>2.04</td>
</tr>
<tr>
<td>H-F</td>
<td>74.74</td>
<td>51.33</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In Table VIII the mean age and I.Q. scores of non-familial groups of mentally retarded deaf and hearing children were compared.

TABLE VIII. COMPARISON OF THE MEAN AGE AND I.Q. SCORES OF DEAF AND HEARING GROUPS OF NON-FAMILIAL RETARDED CHILDREN

<table>
<thead>
<tr>
<th>Gp.</th>
<th>M</th>
<th>S^2</th>
<th>N</th>
<th>D_m</th>
<th>SE_D</th>
<th>t</th>
<th>.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D-NF</td>
<td>144.38</td>
<td>405.00</td>
<td>8</td>
<td>12.00</td>
<td>10.46</td>
<td>1.14</td>
<td>2.14</td>
</tr>
<tr>
<td>H-NF</td>
<td>156.38</td>
<td>469.00</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I.Q.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D-NF</td>
<td>77.13</td>
<td>52.98</td>
<td>8</td>
<td>4.13</td>
<td>3.84</td>
<td>1.08</td>
<td>2.14</td>
</tr>
<tr>
<td>H-NF</td>
<td>73.00</td>
<td>64.85</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From these results it can possibly be inferred that the deaf and hearing groups of non-familial type mental retardation may also be considered equated groups since the t-test ratios obtained here were below the 5% level.
Table IX shows a comparison of the mean ages and I.Q. scores of familial and non-familial groups of deaf children in the study.

**TABLE IX. COMPARISON OF THE MEAN AGE AND I.Q. SCORES OF FAMILIAL AND NON-FAMILIAL MENTALLY RETARDED GROUPS OF DEAF CHILDREN**

<table>
<thead>
<tr>
<th>Gp.</th>
<th>M</th>
<th>S^2</th>
<th>N</th>
<th>D_m</th>
<th>SE_D</th>
<th>t</th>
<th>.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-D</td>
<td>150.21</td>
<td>254.00</td>
<td>14</td>
<td>5.83</td>
<td>7.76</td>
<td>.75</td>
<td>2.09</td>
</tr>
<tr>
<td>NF-D</td>
<td>144.38</td>
<td>405.00</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I.Q.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-D</td>
<td>77.00</td>
<td>30.76</td>
<td>14</td>
<td>1.13</td>
<td>2.75</td>
<td>.47</td>
<td>2.09</td>
</tr>
<tr>
<td>NF-D</td>
<td>77.13</td>
<td>53.00</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From this table it will be noted that the t-Test results of this comparison again fell below the 5% level. These groups were therefore considered equated in age and intelligence.

A similar comparison was made of mean age and I.Q. scores of familial and non-familial groups of hearing children in the study. These are shown in Table X.

**TABLE X. COMPARISON OF MEAN AGE AND I.Q. SCORES OF HEARING FAMILIAL AND NON-FAMILIAL GROUPS OF MENTALLY RETARDED CHILDREN**

<table>
<thead>
<tr>
<th>Gp.</th>
<th>M</th>
<th>S^2</th>
<th>N</th>
<th>D_m</th>
<th>SE_D</th>
<th>t</th>
<th>.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-H</td>
<td>156.32</td>
<td>161.00</td>
<td>19</td>
<td>.06</td>
<td>6.96</td>
<td>.008</td>
<td>2.06</td>
</tr>
<tr>
<td>NF-H</td>
<td>156.38</td>
<td>558.43</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I.Q.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-H</td>
<td>74.74</td>
<td>51.88</td>
<td>19</td>
<td>1.74</td>
<td>4.12</td>
<td>.42</td>
<td>2.06</td>
</tr>
<tr>
<td>NF-H</td>
<td>73.00</td>
<td>207.71</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The results of this final comparison were the same as all previous comparisons of groups in age and intelligence in that the t-test ratios were below the 5% level. All of the various groupings of subjects involved in this study represented asamples of similar populations. It can possibly be said, therefore, that these groups represented similar populations and can be considered equated groups in sex, age, and intelligence.

Selection of Tests

From the results reported by previous research workers there was considerable evidence to the effect that special care should be exercised in the choice of all tests to be used with deaf children. The major consideration in this selection involved the language variable. The following criteria were followed in the selection of the various instruments used in the study.

1. Tests should be of a non-language type that can be administered without verbalization either in the instructions for administering or in the responses required.

2. Tests should have been previously used successfully with the deaf as measuring instruments of performance and motor abilities.

3. Standardized tests used should have norms applicable to measuring the deaf as well as having norms for hearing children.

4. Tests selected should be those which can be easily administered to both deaf and hearing children with equal facility.

Intelligence

The Chicago Non-Verbal Examination was used as the screening
device for measuring the intelligence of the subjects. This test has been specifically designed for use with children having a language handicap.¹ The test as standardized includes two methods for administration; one involving verbal instructions and one for pantomime directions.²

The reliability of the use of verbal instructions in the administration of the Chicago Non-Verbal Examination, has been tested. Test-retest reliability was +.80 and the split-half reliability, using the Spearman-Brown formula +.89. The reliability of the use of pantomime instructions for the administration of this test, as reported by the authors ranged from +.91 to +.93.³

The results of validation studies done on the Chicago Non-Verbal Examination were reported as follows:⁴

1. Correlation of test score and chronological age, verbal directions, was +.75 and +.64.

2. Correlations of test score and chronological age, pantomime directions, was +.81 and +.57.


   Chicago Non-Verbal: M = 61, SD = 12.0  
   Stanford Binet: M = 62, SD = 6.2

A study using all deaf subjects was made by George Lavos in an


⁴Ibid., p. 3.
effort to further validate this test. In his study he correlated results of the Chicago Non-Verbal Examination and two other well known non-language tests that had been used with some success in testing the deaf. These tests were the Pintner General Ability Test (Non-Language Series) and the Revised Beta Examination. His criteria for the selection of deaf subjects were similar to those employed in the present research with respect to age of onset of hearing loss and extent of hearing loss. Lavos administered these three tests to 90 pupils attending a residential school for the deaf. Correlations between tests were made by partialling out age as a common factor since there was a time differential between administration of the tests.

The correlation coefficients between the Chicago Non-Verbal Examination and the Revised Beta were +.65 and +.59. All correlations were tested for significance at the .05 level of confidence and the results were found to be statistically significant.  

This instrument was also used with fair success by Elizabeth Johnson in her study of the effect of academic level on scores on the Chicago Non-Verbal Examination for primary deaf pupils.

Visuo-Motor

The Strauss-Werner Marble Board Test was used to measure Visuo-

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² Ibid., p. 307.

motor performances in the several groups. The various materials comprising this test were designed by the authors to measure visuo-motor integration in mentally defective children.\(^1\) The test permits both objective and qualitative analysis of visuo-motor performance in children. It has been used effectively to demonstrate the differences between the performances of brain-injured and non brain injured children.\(^2\) Myklebust and Brutten in their study of visual perception reported that the test was also adaptable for use with deaf children.\(^3\)

The Marble Board Test consists of two matching boards eleven inches square, each containing ten rows of ten holes. The construction of the boards for this study was done according to the descriptions given by Strauss in his text on the brain-injured child.\(^4\) The only deviation made in construction was that the boards for this study were made of 1/4 inch plywood instead of cardboard. The centers of the holes on the boards were spaced one inch apart and all were 6/16ths of an inch in diameter. Seventy black marbles (11/16 inch diameter), and forty red marbles (8/16 inch diameter) were secured and used. In the administration of the test the following general procedure was used:

It is required that the examiner set up one mosaic or design at a time on one board while the subject is turned

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\(^2\) Ibid., p. 31.


away or otherwise occupied. Six different designs make up this test. In administration of the test the subject is asked to duplicate each of the six designs so as to match those constructed by the examiner on his board. There are no time limits. While the subject performs his task, the examiner records each successive move numerically in chronological order on a record blank. The use of a prepared record form with squares drawn for each hole on the marble board facilitates scoring the child's performance.¹

The Marble-Board Test has been successfully adapted for use with deaf children. Originally, however, it was used to demonstrate differences between familial and non-familial types of mentally defective hearing children.

**Tactual-Motor**

Werner and Strauss have also written extensively concerning the measurement of the integration of tactual and motor functioning ability of mentally retarded children.² This test has been summarized and described as follows:

The test consists of two sets of form boards. Each set is composed of three boards. One set of three is constructed with a figure-ground arrangement formed by rows of flat enameled thumbtacks. Raised out of this background is a figure constructed of semispherical rubber thumbtacks. The figures used are the three Binet figures, a square, an oval, and a triangle. The second set of boards has the same three figures in solid form without any background configuration. These forms are in smooth relief on a smooth wooden background.³

¹See Appendix III.
³See Figure 3, p. 77.
The Tactual-Motor Test was selected for use in this study because of a demonstrated ability to discriminate between differences in the performance skills of groups of endogenous and exogenous types of mentally retarded children. This test was used also because of its ability to measure figure-ground disturbances in brain injured children.¹

The marked similarity in ease of administration of the Tactual-Motor Test and the Marble Board Test plus the interest holding factor of both indicated these as having value for comparison purposes in this research. The Tactual-Motor Test was used in a preliminary trial with deaf children. Pantomime instructions were used. The obtained results on the preliminary run were satisfactory, indicating that the children understood the pantomime instructions as had also been true with the Marble Board Test.

Spatial Relationships

The Grace Arthur Stencil Design, Test I, was used for measuring the ability to integrate a visual, mental, and motor activity involving spatialization. According to Webster, spatialization as a mental activity, is a conceptualization of spatial relationships involving a means of mentally localizing objects in space.² The Arthur Stencil Design was selected to provide an objective measurement of this ability in the children used in the study. The following has been included to show

what is required in the administration of the test:

In performing the test one is required to mentally arrange colored design cards in a certain specific order. The subject must arrange these cards manually in such a way as to match the demonstration or test design. Though there is a time limit for each item in the test, there is sufficient time provided to perform the task required almost completely by trial and error, providing some orderly system of trial and error is used.

The test is composed of twenty designs printed in bright colors on cards three inches square. There are eighteen single colored cards with cut out designs geometrically arranged so that they may be used in any position. The subject, after having been instructed, is required to reproduce the design on the test card by putting together certain two or more of the cut out design cards. The items of this test are arranged in order of difficulty, so that it is in effect a power test. Other than the fact that the examiner allows a four minute limit on each test item, the pressure of time is not imposed on the subject.

Further evidence of the fact that this test is related in a positive way to spatial visualization or thought processes requiring such mental organization is shown in a study by Arthur. This report cited the fact that the top two quarters of classes in mechanical and architectural drawing scored above average on this test. Those who were failing or doing poorly in these subject areas scored low on the test. This instrument as part of the Grace Arthur Point Scale of Performance, like other tests previously described, has been used successfully for classification of the deaf and in research. The instructions for the Grace Arthur Stencil Design may be pantomimed making ease of administration possible and also fostering maximum interest in the subject being tested.

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Manual Dexterity

The Purdue Pegboard is an instrument designed to test the manipulative dexterity of an individual. It was developed in an effort to measure the finger dexterity of adults being screened for employment in industry. Test results provide information of the relative manipulative skill of potential employees for positions in assembly, packing, operation of certain machines, and other jobs of a manual but exacting nature.

The test has separate measures of right and left handedness, gross arm, hand, and finger movement, and fingertip dexterity in assembling small parts. The test can easily be administered to the deaf and is an instrument which can be used to compare the manual skills of such children.

Locomotor Coordination

The Heath Rail-Walking Test has frequently been used to measure the balance and general locomotor control of both deaf and hearing mentally retarded children. This device was designed originally to measure the locomotor coordination and balance of adults in the military forces. In studies of deaf children in locomotor balance and coordination using the Heath test, comparisons have been made between the relative


performance abilities of deaf and hearing children.\textsuperscript{1} The deaf have been shown to be significantly inferior to the hearing in performance on the test. Frisina, in his study of the mentally retarded deaf used the Heath Rail-Walking Test.\textsuperscript{2} He compared the differences between the performance abilities of endogenous and exogenous deaf mentally retarded children. Frisina found a significant difference between the performance abilities of exogenous and endogenous mentally retarded deaf children with the endogenous group scoring higher on the Heath test.

Heath conducted a study of the effect of etiology of mental retardation on performance on the Rail-Walking Test.\textsuperscript{3} His subjects were hearing mentally retarded individuals from two schools for the mentally retarded. His findings also seemed to indicate the familial group to be significantly superior to the non-familial in rail-walking performance.

The Heath Rail-Walking Test was used in the present research. In addition to providing raw data in the subjects used in this study, comparisons were also possible between the present findings and those of previous research efforts.


This study was a comparison of certain specific performance abilities of a selected group of deaf and hearing mentally retarded children. It was designed to compare sub-groups of etiological types within the basic deaf and hearing groups. The study required the selection of mentally retarded deaf and hearing children. Children attending three state residential schools for the deaf in the southwestern part of the United States were used to supply the deaf experimental subjects. The hearing mentally retarded children, screened for possible inclusion in the study, were secured from the special education department of the Tucson (Arizona) public schools. These children served as the control group for the study.

The experimental group of deaf mentally retarded children was made up of all available boys in the geographical area. They ranged in age between ten and fifteen years, and had I.Q. scores between sixty-five (65) and eighty-five (85) as determined by their performance on the Chicago Non-Verbal Examination. A total of twenty-two deaf children and twenty-seven hearing children participated in the research.

The Chicago Non-Verbal Examination was used to measure general mental ability of both groups of mentally retarded children. There was a total of 166 of these tests administered in groups of not more than five subjects at one time. This screening process, together with subsequent classification of the subjects according to etiology of retardation, reduced the original number of available subjects to forty-nine.

The various deaf and hearing children were classified into two
sub-groups depending on the etiology of mental retardation. This classification process followed closely the technique developed by French, Cassel, Arbitman, and Weissenberg. This system makes use of certain basic individual and family history information, some of which was available in school records. Information not available from school records had to be secured through other means. A questionnaire was prepared and sent to parents in cases where school information was incomplete. All children whose etiological classification could not be clearly determined by this system were rejected from the study. Eight of the twenty-two deaf children actually were classified etiologically as non-familial, with the remaining classified as familial.

The twenty-seven hearing mentally retarded children finally selected as a control group were divided into similar etiological sub-groups. Eight were classified as non-familial and nineteen as familial.

The placement of subjects in the four groups was such that all groups were statistically matched in age and intelligence. This arrangement made possible group comparisons in performance ability through the use of different combinations. Group comparisons that were made in this study were as follows:

- **Total groups** - deaf and hearing
- **Total groups** - familial and non-familial
- **Familial type** - deaf and hearing
- **Non-familial type** - deaf and hearing
- **Deaf groups** - familial and non-familial
- **Hearing groups** - familial and non-familial
Mean group scores of all the above groups were compared statistically in both age and intelligence. A test of significance was made of the differences between variances and between means employing F-test and t-test techniques. The results of these comparisons indicated that all groups used in the study represented similar populations and could be considered as matched groups.

The motor skill performance tests which were administered to all subjects in the above groups were as follows:

**Visuo-motor** - Werner-Strauss Marble Board Test  
**Tactual-motor** - Werner-Strauss Tactual Motor Test  
**Spatial relationships** - Grace Arthur Stencil Design Test  
**Manual dexterity** - Purdue Pegboard Test  
**Locomotor coordination** - Heath Rail-Walking Test

Tests employed in the study were selected because of previous successful use with deaf children. This was also true with respect to the mentally retarded hearing children.
A number of materials, measuring instruments, and tests were used in this investigation. The procedures employed in the administration of the various tests have been described in this chapter beginning with the instrument used to measure visuo-motor performances.

**Visuo-Motor**

The Marble Board Test devised by Strauss and Werner was used to measure differences in visuo-motor integration between the various groups of children used in this study. This test was employed by the authors to compare the results of the performances of endogenous and exogenous mentally retarded hearing children. Since this test has also been utilized by Myklebust and Brutten in studies of deaf children, the techniques used for administering the test followed their recommendations quite closely. It was clearly indicated from their study that the test could be adapted for use with deaf children. The instructions were easy to comprehend and the test itself was attractive and stimulating.

Construction of the marble boards was done according to

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the specifications set forth by Strauss and Werner. The author described these as follows:

The marble board test consists of two identical cardboards eleven inches square, each containing ten rows of ten holes. The cardboard is light grey and the holes are dark grey. The distance from the center of one hole to the center of another is one inch; the diameter of a hole is 6/16 inch. Some fifty black marbles (diameter, 11/16 inch) and some thirty red marbles (diameter 8/16 inch) are used. One board is the examiner's board, on which he constructs the mosaic patterns; the other is the subject's board, on which he copies the patterns constructed by the examiner. 1, 2

The following modifications in the above specifications were made. One-quarter inch plywood was substituted for the cardboard. The boards were painted light grey as suggested by the authors. Figure 1 shows the mosaics or patterns used in the test. 3 The record form for scoring the various sub-tests was printed on sheets of eight and one-half by eleven inch paper. 4 Each record sheet also contained a large square consisting of one hundred smaller squares. Space at the top of the work sheet was provided for the recording of test performance and observations of the subject during actual testing. This record blank provided means for recording numerically as well as chronologically each move by the subject on the marble board. Errors in movements were easily identified by crossing out the squares in which the error occurred.

2 The number of red marbles actually needed was thirty-eight.  
3 Ibid., p. 32.  
4 See Appendix III.
Figure 1. Strauss, Werner Marble Board Patterns
A special table was constructed in an effort to provide subjects with a standardized work area. The top of the table was thirty inches square, constructed of heavy plywood, and painted a medium grey. A shelf was built beneath the table top, open toward the subject and the examiner. This allowed for the passage of materials between the examiner and the subject. A wooden stool, nineteen inches in height, provided the subject easy access to the work area. Figure 2 shows the table as described.

The administration of the Marble Board Test was done according to the following instructions:

After the subject is brought into the room and seated he is told to do a few simple things for the examiner. For deaf children the examiner gestures in pantomime: "I have some things I want you to make. They (pointing to the materials for the first test) are not hard. I will show you how." For the hearing children the examiner instructs the subject verbally saying: "There are some simple things I want you to make for me with these materials. I will tell you what you must do."

During the actual testing period the examiner and the subject sit opposite each other at the specially constructed table. A marble board is placed on the table in front of the subject and one is placed in front of the examiner. A square plastic box containing the marbles is placed near the right side of the subject's board. Another plastic box is placed beside the examiner's board.

The examiner then instructs the subject to turn away from the table. When the subject is turned away the examiner constructs the first pattern. When this is completed the examiner places his board in front of the subject's board. The subject is then instructed to turn

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1The instructions for administration of the Marble Board Test was taken for the most part from those as written in Myklebust and Brutten's study of visual perception of the deaf. Adaptations of these instructions were made to accommodate differences in seating arrangement at the table used in the present study.
Figure 2. Special Testing Table
around. The hearing child is asked: "Turn around and look at the board." The deaf subject is tapped on the shoulder and his attention is brought to the first pattern placed before him by use of the gesture: "Look."

The subject is then asked to reproduce the test pattern on his board with the marbles in the box provided. The examiner says to the hearing subject: "Make one like this on your board with these marbles. Take all the time you need." The deaf child is told similar instructions in the following manner. The examiner points to the pattern, then to the subject, then to the box of marbles, then to the blank marble board in front of him. He then pantomimes in gestures telling the subject: "Make it the same. No hurry, you have plenty of time."  

Subjects are not allowed to pick more than one marble at a time in reproducing the design. This procedure provides the examiner with ample time to record each move made by the subject on the record sheet. After the first design is completed any errors made by the subject are pointed out to him and time allowed to correct these errors. No further corrections are made for any of the remaining five patterns.

Immediately after the administration of design II and design V the examiner removes the subject's board from the table and places a blank sheet of standard typing paper on the table in front of him. The deaf subject is asked in pantomime: "Draw a picture the same as this (pointing to the pattern on the marble board.)" The hearing subject is told: "Draw a picture of the pattern on the marble board."

All other patterns for the construction of mosaics are to be administered in the same manner without any further corrections or special help. A time record of the construction of each pattern is to be kept without involving the subject with the pressure of time in his performance on the test. If he does become aware of the use of a stop watch he is to be immediately assured that he is to take as much time as he needs.

These instructions for the Marble Board Test were repeated for

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1 All deaf students selected for this study were from residential schools for the deaf. The simple gestures and signs used for communication of instructions in this testing program were those most universally used and understood by deaf children in these residential schools. Sign language is used fluently by these children as a means of accurate and easy communication between themselves and other deaf individuals.
each of the six patterns used. Upon completion of the last item of the test, all materials were removed from the table and preparations made for the next test.

**Tactual-Motor**

The figure-ground Tactual Motor Test designed by Strauss and Werner was used for this part of the study. Strauss and Werner had used this instrument to demonstrate differences in tactual sense perception and motor skill integration of endogenous and exogenous mentally retarded hearing children.¹ The simplicity in design of the test together with a strong interest holding quality made the test adaptable to the research. There was no evidence to show that this test had previously been employed with deaf children. This instrument, however, had been purported to have the same measuring characteristics as the marble board test. Instruction for administering this particular series of tests together with a description of the materials were as follows:²

Two sets of boards are used in this test. Each set consists of three boards. The first set of three boards are covered with rows of enameled thumbtacks which are equally spaced over the whole board. Rising out of this background of flat tacks is a figure which is constructed of semispherical rubber headed thumbtacks. The three figures in this type of relief on each board is the square, oval, and the triangle. The boards used for this set of tests are twelve inches square, constructed of quarter-inch plywood.

Figure 3 is a drawing illustrating the designs in relief on each

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² Ibid., p. 47.
Figure 3. Strauss, Werner Tactual-Motor Test
board. In administering this test the subject is first exposed to set I. Each design board was placed on the shelf beneath the table top in the following order: oval, square, triangle. Instructions given each subject were as follows:

Board number one (figure-ground oval) is placed on the shelf under the table while the subject is turned away or otherwise occupied. A blank sheet of paper is placed on top of the table along with a freshly sharpened pencil. The deaf subject is tapped on the shoulder to draw his attention. The examiner then pantomimes the following instructions: "Turn around, don't look under the table." Hearing children are told verbally: "Please turn around but do not look under the table." The examiner then instructs the deaf subject in signs: "Put your hands on the shelf under the table and feel what I put there." Hearing subjects are told: "Put your hands on the shelf under the table and feel what I have put there."

Next, the deaf subject is asked in pantomime: "Feel all over the board with your hands; when finished, draw a picture of what you feel. Take plenty of time. You can feel the board more if you want to." Hearing subjects are told verbally to: "Feel the board with your hands, when you are through, draw a picture of what you feel. Take all the time you need. You may feel the board as often as you like."

Each successive board of Sets I and II is placed before the subject in the same manner as described above. After the first test the instructions need not be repeated other than to ask the subject to draw what he feels, and to caution him that he may take all the time he needs. The order of presentation of set number II (figures in smooth relief) is as follows: the square, the oval, and the triangle. For each new design or board a new sheet of paper is furnished the subject. A record of time taken to complete each item is kept by the examiner. This again is to be without the knowledge or concern of the subject.

In using this particular series each subject was kept physically close to the table in an effort to prevent him from seeing the boards.

1Ibid., p. 47.
This was done since all drawings produced by the subject had to be tac­tual impressions only, without any additional sensory clues. No time limit was imposed, and the subject was instructed to complete each item to his own satisfaction.

Spatial Relationships

The Grace Arthur Stencil Design Test I was used in an effort to measure the area of mental activity which involves spatial relationships.¹ This test was designed by the author as part of the Revised Form - II of the Point Scale of Performance Tests. Included in the manual are special instructions for giving the tests to deaf children. This whole series of tests has produced good results in a number of studies involving deaf children. The series has also been utilized in schools for determining relative mental ages and mental functioning levels of deaf children.

Following the completion of the tactual-motor test series the stencil design test was introduced to the subject. The same general procedure for testing prescribed by the author was followed. A description of the test and the instructions for administration are as follows:²

Description

The Stencil Design Test I consists of twenty designs, each three inches square, and eighteen colored cards, also three inches square, to be used to reproduce the designs. Six of these colored cards are solid and twelve are stencils. All the color cards and stencils are reversible, so that no

²Ibid., pp. 1-2, (Procedure for testing).
time is lost if a card is laid face down on the table.

The designs and stencils are symmetrical so that there is no possibility of difficulty with up-down or right-left reversals. The colors have been selected so that even patients known to be handicapped by a considerable degree of color blindness will have no difficulty in distinguishing them.

The designs are arranged and numbered by order of difficulty. This order must be followed in presenting the designs since the degree of difficulty is affected by the position in the series. The cards for reproducing the designs are numbered to facilitate placing them on the table in the correct order. If the table is either black or white, a cover of some neutral color should be provided so that the stencils may be easily seen.

A stop watch is needed for timing the work on each design. The time needed to complete each design should be recorded on the record sheet as well as whether the design is correctly reproduced.

Procedure

Place the stack of designs before the subject, about ten inches from the edge of the table. Lay down the eighteen colored cards in numerical order as shown in the picture on the cover.

Say: "You can make all these designs (pointing to the stack) with these cards." Point to the Sample Design which is on top of the stack and say: "Pick out the cards you need and make this one." Allow time for the subject to comprehend that he is to copy the design both in form and in color. Encourage him to build in the space between the stack of designs and the edge of the table, but do not insist if he clings to some other method. Give him any help that is needed to complete the Sample Design, but do not give any verbal explanations.

When the design is completed, say: "Get the edges even, so that you can see whether the design is right or not. Always take a good look to make sure the design is the way you want it before you tell me it is finished." When the subject signifies that he is satisfied, say: "Put the cards that you used back where they were, so that you can find them when you need them again." Do not insist that the cards be replaced in their original positions, but make sure after each design is either completed or failed that all cards are placed on the table without
overlapping, so that they can be readily seen. As soon as the used cards have been placed back on the table, turn the completed design face down between the stack of design cards and the examiner, exposing the next design. Tell the subject to reproduce the new design and start the stop watch. The time limit is four minutes for each design.

If Design I is not completed within the time limit, record as failed. Then give whatever help is necessary for the patient to complete it. Do the same for Designs II, III, IV, or V, unless Designs I, II, and III are all failed, in which case the test is discontinued. Do not allow extra time for the completion of the designs after Design V, or give any hints as to their solution, as these may effect the work on subsequent designs.

As soon as the subject indicates that he has completed a design, stop the watch. Record the time in seconds (as 20") or in minutes and seconds (as 2' 15") and if the design is correct, put a check in the correct-items column. Record any fraction of a second as a whole second. If the subject shows his reproduction of the design to the examiner asking "is this right?" the watch is stopped and the solution recorded. He should then be warned that he, and not the examiner, is the one to decide when he has completed the task to his own satisfaction.

When Design IV is presented, say: "Use as many as you need to make this one." Design VIII offers the only exception to the rule stated above that no hint as to the correct solution shall be given after Design V. For Design VIII there is a frequent tendency to omit the white border. When this occurs, the failure is recorded, and then the examiner points to the white border and says: "The whole card is the design, not just the center. You forgot this part, didn't you?"

Continue testing until three designs in succession have been failed. However, Design XIX is given only to those who have completed Design XVIII within the four-minute time limit. Similarly, Design XX is given only to those who have completed Design XIX within the time limit.

The following instructions in pantomime were used in the administration of the test to deaf subjects:

After placing the cards on the table the examiner says to the subject in pantomimed gestures: "Make one like this,
(pointing to the Design card) from these (pointing to the construction cards on the table)." After the subject completes the design to his own satisfaction the examiner helps him get the edges of the cards even and shows him manually where to place it when he is finished. All other instructions are followed in the manner stated above for hearing subjects with appropriate pantomime and demonstration where needed and permitted by the author's instructions.

After the subject had progressed to the limit of his ability in this test, the table was cleared and prepared for the next administration.

Manual Dexterity

The Purdue Pegboard was selected to compare relative performance skills in manual and finger dexterity between groups used in the study. This test was designed particularly to test the manipulative dexterity of prospective employees in industrial jobs requiring this skill. The test provides separate measures of right hand, left hand, and both hand performances involving gross movements of the hands, fingers and arms. This test also measures tip-of-finger dexterity as required in small assembly.

Instructions for administering the test were found to be relatively simple and easily conveyable verbally or in pantomime as needed. Materials used in the test were as follows:

The major item is a flat rectangular board with four shallow cups or pockets at the top. Drilled into the board are two rows of twenty-five small holes running parallel down the center. In each of the two extreme right and left cups at the top are placed twenty-five round pins approximately one inch long. These pins fit the holes that are in

the center of the board. The cup to the right of the center contains twenty collars that fit the pins. The cup to the left of the center contains forty washers that also fit the pins.

The examiner is required to place the board immediately in front of the subject. It should be placed close enough so that all parts of the board can be comfortably reached. The cups at the top of the board should be at the end of the board away from the subject.

The instructions for each part of the test were given as follows:

The subject is seated in front of and across the table from the examiner. He is told to watch the examiner. The examiner, using his left hand (which is opposite the subject's right) picks up several pins, one at a time, and places them into the subject's right-hand row of holes starting at the top. The subject is told to do the same for practice. The examiner helps the subject physically with his own hand to show the subject how to do the task if it is necessary. When the subject places four or five pins in the holes correctly without assistance he is stopped and is told to return all the pins to the pocket.

The examiner says verbally to the hearing subject: "When I say go, put as many pins as you can in the holes here (pointing to the top of the row of holes.) Put them in one at a time as fast as you can. Keep going until I tell you to stop." The deaf subject receives similar instructions in signs: "When I say Yes (nodding the head to indicate starting) you pick up one pin and put it here (pointing to the top hole of the row of right-hand holes.) Then get another and do the same, then get another. Work fast until I say stop." When the examiner is sure the subject understands and is ready, he says: "Go", or nods his head "Yes" indicating the respective hearing or deaf boy to start the test. At the end of thirty (30) seconds the examiner says: "Stop." For deaf subjects this is accomplished by holding up the hand to indicate stopping.

The second test is the same as the first except that it is done with the left hand. The instructions are repeated in the same manner as was done for the right hand test. Thirty (30) seconds are allowed for this test as well.

The third test involves the use of both hands at the same time. Instructions are given in the same manner as
was done in tests for right and left hands. Proper demonstration of this test in using the hands simultaneously is most essential. The time allowed for this test is thirty (30) seconds.

The last test in the series is the assembly test. The examiner instructs the subject to watch him. He picks up one pin from the right hand cup with his right hand and places it in the top hole of the right-hand row of holes. At the same time he is placing the pin in the hole he picks up a washer in his left hand and places it over the pin. While the washer is being placed over the pin with the left hand, he is to pick up a collar with the right hand. While the collar is being dropped over the pin he picks up another washer with the left hand and puts it over the pin on top of the collar. This is the first assembly. The same process is continued for several more assemblies.

The subject is then asked to do the same thing. The examiner works with the subject until he is able to do several assemblies in proper sequence without assistance. The subject is then permitted to complete at least four assemblies without help. The board is then cleared and the subject readied for the timed test. The time allowed for this is one (1) minute.

Each subject was given one timed performance in each of the various parts of the Purdue Pegboard test. Results were then recorded along with other data already assembled on the particular subject.

Locomotor Coordination

The Heath Rail-Walking Test was used to compare the relative performances in locomotor coordination between the various groups of subjects. This test, which was originally designed for a study of military personnel, has frequently been adapted for studies involving groups of children at different age levels. It has also been employed with
deaf and mentally defective children as well. In the present research effort, the administrative procedure followed closely those recommended by Heath.

Test Description

The Heath Rail-Walking test involves the use of three rails made of wood, each with a different width. One rail, the first one to be used in this test, is four inches wide and nine feet long. This is made from a piece of hardwood one inch by four inches by nine feet. The second rail is two inches wide and nine feet long. This is made from a piece of hardwood two inches by two inches by nine feet. Short six inch cleats are fastened to the bottom of the rail at intervals of twelve inches on center in order to give the rail stability when in use. The third rail is one inch wide and only six feet long. This is made from a piece of hardwood one inch by one inch by six feet. Cleats are fastened to this rail at intervals of twelve inches on center also.

Directions for Administration

The subject is required to walk each of the three rails without support. This is to be done with bare feet. To hearing subjects the examiner says: "Watch me as I do it. Touch your heel to your toe every step and walk to the end without falling off. Take your time." To deaf subjects the examiner pantomimes: "Watch me, then you do the same." The examiner demonstrates with a few toe to heel steps on the first rail pointing to his feet while doing it to indicate touching heel to toe with each step.

The examiner then walks the length of the four inch rail as a demonstration. When completed he directs the subject to do the same saying verbally to hearing children: "Now let's see you try it. Be careful to walk heel to toe and take your time. Try not to fall off before you reach the end." To the deaf the examiner pantomimes: "You do the same as I did from here to there (pointing carefully from the beginning to the end of the rail.) Touch heel and toe every step. You have plenty of time, no hurry, do not fall."

Each subject is asked to make three trials on each rail. An attempt is recorded when the subject falls off the rail before his weight is placed on the second step. Five attempts are counted as one trial. Before beginning rail number two, the subject is allowed to take several

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long steps on the rail to accustom himself to the added height of this rail. One such run is sufficient. This practice is not permitted on rail three. When the subject fails to adhere to the heel-to-toe rule he is credited with an attempt and is warned to take his time and observe the heel-to-toe requirement.

As a matter of convenience for the examiner, the rails are marked at six inch intervals with a line to facilitate scoring. A total of nine feet, or a raw score of nine must be obtained on the first rail in order for the subject to be allowed to attempt the second. The same minimum score must be obtained on the second rail in order to attempt the third.

The administration of this test to each subject completed the formal evaluation. This was supplemented in each instance by recordings of the results of the examiner's personal observations.

**Summary**

The various children used in the experimental and control groups were carefully selected and screened according to the procedure described in Chapter III. The several tests used in the study were administered to both deaf and hearing subjects in the manner just described and outlined. The physical surroundings for testing were arranged in such a way as to provide a uniform testing environment. The arrangement and placement of equipment and materials were made in an effort to give each subject an opportunity to put forth maximum effort.

Times selected for testing were carefully chosen in order not to conflict with activities the children preferred not to miss. School personnel were most cooperative in providing sufficient time for testing. The testing rooms provided adequate space for testing and were in the more quiet parts of the schools. The site selected for testing in each of these rooms was usually near a bare wall away from any view of windows.
or other possible distracting influences. Lighting was adequate, in most cases being of the fluorescent type.

The special table was placed in such a way as to have the subject facing the wall when seated. The examiner sat facing the subject during the testing period. All materials not in use were stored in a small carrying case. This case was kept out of sight of the subject and the table was clear of all articles and materials not being used.

Following the introduction to the examiner, the child was taken to the testing room. A comfortable, relaxed atmosphere was created in an effort to put the child at ease. When rapport had been confirmed, the various tests were administered in the following order:

Marble Board Test
Tactual-Motor Test
Stencil Design Test
Purdue Pegboard Test
Heath Rail-Walking Test
CHAPTER V

INTERPRETATION OF DATA

The data derived from the results of this study have been collated into tables to facilitate a statistical evaluation of the findings. The order in which the results have been reported is similar to that used in the administration of the various tests. The statistical procedure used to test the differences between groups was the same as that used for originally matching the groups. This has been previously described in Chapter III.

A t-ratio using the pooled variance technique was employed to test the significance of differences between means. Additional comparisons were made, where feasible, between the results of this study and the findings of other research workers. The arrangement of groups as set up for matching purposes made such comparisons possible.

As previously indicated, much is known about the hearing mentally retarded child with respect to differences in performances on the tests used. The particular arrangement of groups compared in this research provided a means for checking the consistency of the performances of the familial and non-familial mentally retarded hearing children used in this study with the performances of similar groups reported in other research. Comparisons were also possible between the deaf familial and non-familial mentally retarded children and other known research. Since it was necessary to deal with a small N in each group of children used in the study, it was felt that additional comparisons might add to the
value of the data.

**Visuo-Motor**

The Marble Board Test was used to measure the level of visuo-motor integration in the subjects. Two sets of scores were obtained on each child. The first set of scores was derived from a quantitative appraisal of accuracy of reproduction of the six designs contained in the test. The additional set of scores was obtained from an evaluation of the type of procedure or method used by the subject in the reproduction of each design.

In this test the subject had to reproduce six mosaics or designs. Scores were obtained by employing a technique developed by Myklebust and Brutten in their study of the visual perception of deaf children. This system provided a rating scale for determining the accuracy of design reproduction. Scoring was based on a range of values from one to three for each design reproduced. From the six designs it was possible to obtain scores ranging from zero to eighteen. The criteria established for scoring the design reproductions by Myklebust and Brutten are as follows:

- **Perfect Accuracy:** No errors whatever in marble placement. The position of the pattern on the board, and the relation of the major portions of the pattern to each other are entirely correct. Score Value: 3 credits.

- **Great Accuracy:** No more than one or two errors in marble placement. An error in marble placement is defined

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2Ibid., pp. 82-83.
as a misplacement, interpolation, omission, or (in pattern 5 only) a color substitution. In pattern 6 only, the displacement of the entire pattern either one space up or one space down on the marble board is considered a single error, provided that the reproduction of the pattern is correct in other respects. Score Value: 2 credits.

**Moderate Accuracy:** The general correctness of shape, orientation on the board and relatedness of major parts are retained despite the fact that there are more than two errors in marble placement. The reproduction recognizably retains the general principle of the stimulus pattern.

**Little or No Accuracy:** The reproduction bears little or no recognizable correspondence to the stimulus pattern. The principle or the stimulus pattern is distorted, fragmented, or cluttered by excessive marble placement which obscures the pattern. Score Value: 0.

This technique for scoring gives credit in relative values for nearly correct and partially correct responses. A comparison of the means of the matched groups on the Marble Board Test, using the Myklebust-Brutten criteria for scoring, has been included in Table XI.
TABLE XI. COMPARISON OF MATCHED GROUPS IN ACCURACY OF RESPONSES ON THE MARBLE BOARD TEST

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>M</th>
<th>$S^2$</th>
<th>t</th>
<th>t at .05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Group—Familial</td>
<td>33</td>
<td>13.60</td>
<td>19.96</td>
<td>#1.96</td>
<td>2.02</td>
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<tr>
<td>Total Group—Non-Familial</td>
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<td></td>
</tr>
<tr>
<td>Deaf—Familial</td>
<td>14</td>
<td>13.57</td>
<td>20.11</td>
<td>2.15</td>
<td>#2.09</td>
</tr>
<tr>
<td>Deaf—Non-Familial</td>
<td>8</td>
<td>8.50</td>
<td>44.14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hearing—Familial</td>
<td>19</td>
<td>13.63</td>
<td>19.88</td>
<td>.41</td>
<td>2.06</td>
</tr>
<tr>
<td>Hearing—Non-Familial</td>
<td>8</td>
<td>12.62</td>
<td>29.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf—Total Group</td>
<td>22</td>
<td>11.73</td>
<td>27.32</td>
<td>.11</td>
<td>2.02</td>
</tr>
<tr>
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<td>13.33</td>
<td>22.93</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf—Familial</td>
<td>14</td>
<td>13.57</td>
<td>20.08</td>
<td>.04</td>
<td>2.04</td>
</tr>
<tr>
<td>Hearing—Familial</td>
<td>19</td>
<td>13.63</td>
<td>19.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf—Non-Familial</td>
<td>8</td>
<td>8.50</td>
<td>44.14</td>
<td>1.32</td>
<td>2.14</td>
</tr>
<tr>
<td>Hearing—Non-Familial</td>
<td>8</td>
<td>12.62</td>
<td>33.12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*t-ratio significant at the .05 level.
#F-ratio significant at the .05 level.

This table shows a comparison of mean scores in accuracy of responses on the Marble Board Test of familial and non-familial groups including both deaf and hearing subjects. Homogeneity of variances with the F-test showed that the two groups differed significantly at the 5% level. In view of this disparity of variances a t-test using the pooled variance technique could not be considered a valid test of the difference between means of these two groups. The mean score on this test for the familial
group exceeded the mean of the non-familial group.

The familial subjects within the deaf population achieved a higher mean score than the non-familial. This difference between means was significant at the 5% level. There was no significant difference between the means of familial and non-familial groups within the hearing population.

The chosen level of significance was not reached in tests of the differences between means of total deaf and hearing groups, between familial deaf and hearing groups, and between non-familial deaf and hearing groups.

In an effort to quantify the evaluation of each child's plan of attack in the reproduction of the various designs in the Marble Board Test a modification of the techniques recommended by Strauss and Werner was used. These two researchers had set up criteria for a qualitative evaluation of the mode of attack used by children in reproducing the designs of the test.¹ Strauss and Werner labeled the methods as global, constructive or incoherent. A global performance was one that involved viewing the problem as a whole and constructing the design moving continuously from one segment or portion to another. A constructive performance involved building each part of the design as one unit upon another. An identification of incoherent performance was given when jumping from one side to another or from one segment to another, without any particular plan or organization, was observed.

¹Strauss, A. A., Lehtinen, L. E., Psychopathology and education of the Brain-Injured Child, pp. 33-35.
In the present study the performance of each subject on the Marble Board Test was evaluated and classified as either coherent or incoherent. A score of one (1) was given in each instance where it was felt that the performance was coherent and the subject was observed to attack the problem with organization that was either global or constructive. If there was evidence of two or more distinct direction changes or moves to other areas of the design and a general indication of lack of planning, the reproduction was labeled incoherent and no score was given.

Table XII has been included to illustrate the results of tabulated scores obtained according to the criterion for evaluation stated above.
### TABLE XII. COMPARISON OF MATCHED GROUPS ACCORDING TO COHERENT OR INCOHERENT TYPES OF PERFORMANCES ON THE MARBLE BOARD TEST

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>M</th>
<th>S²</th>
<th>t</th>
<th>t at .05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Group—Familial</td>
<td>33</td>
<td>4.45</td>
<td>2.94</td>
<td>2.31</td>
<td>*2.02</td>
</tr>
<tr>
<td>Total Group—Non-Familial</td>
<td>16</td>
<td>3.19</td>
<td>3.66</td>
<td>2.31</td>
<td>*2.02</td>
</tr>
<tr>
<td>Deaf—Familial</td>
<td>14</td>
<td>5.14</td>
<td>1.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf—Non-Familial</td>
<td>8</td>
<td>3.75</td>
<td>3.64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hearing—Familial</td>
<td>19</td>
<td>3.95</td>
<td>3.72</td>
<td>1.61</td>
<td>2.06</td>
</tr>
<tr>
<td>Hearing—Non-Familial</td>
<td>8</td>
<td>2.63</td>
<td>3.98</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf—Total Group</td>
<td>22</td>
<td>4.64</td>
<td>2.43</td>
<td>2.07</td>
<td>*2.02</td>
</tr>
<tr>
<td>Hearing—Total Group</td>
<td>27</td>
<td>3.56</td>
<td>4.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf—Familial</td>
<td>14</td>
<td>5.14</td>
<td>1.21</td>
<td>#2.08</td>
<td>*2.04</td>
</tr>
<tr>
<td>Hearing—Familial</td>
<td>19</td>
<td>3.95</td>
<td>3.72</td>
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<td></td>
</tr>
<tr>
<td>Deaf—Non-Familial</td>
<td>8</td>
<td>3.75</td>
<td>3.64</td>
<td>1.15</td>
<td>2.14</td>
</tr>
<tr>
<td>Hearing—Non-Familial</td>
<td>8</td>
<td>2.63</td>
<td>3.98</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* t-ratio significant at the .05 level.
# F-ratio significant at the .05 level.

From this table it will be noted that when the total familial group was compared to the non-familial group according to obtained scores on coherent and incoherent performances on the Marble Board Test, the familial group, including both deaf and hearing subjects, outperformed the non-familial. The difference between the means of these two groups was significant at the 5% level.

A comparison of mean scores obtained by familial and non-familial...
groups within the deaf population alone could not be carried out conclusively by a t-test of relationship due to the disparity of variances between the two groups.

A comparison of mean performances between total groups of deaf and hearing subjects was significant at the .05 level. The deaf as a group exceeded the hearing in number of coherent responses on the test. The result of an F-test of the homogeneity of variances limited to familial deaf and hearing subjects was significant, therefore ruling out the value of a t-test of this relationship.

A time score in seconds was recorded for each subject's performance on the Marble Board Test. This gave an indication of the extent to which the subject persevered in his attack upon the problem. The results obtained from comparisons of differences between means for perseverance did not reach significant levels in any of the comparisons made. The means of total groups of deaf and hearing subjects were almost identical.

**Tactual-Motor**

Differences in performances between groups on the Strauss-Werner Tactual-Motor Test, used to measure the relative skills of tactual-motor integration in subjects, were not nearly as great as those found in the use of other tests. This test contains two separate sets of items. The first set of three test items contain figures which rise out of a background designed to confuse or disturb some individuals in a tactual evaluation of what each figure represents. The other set of three items contain similar figures in relief on a smooth surface. Figure 3 gives a pictorial description of the items of this test. It is interesting to
note that, on the second set of test items, nearly all subjects were able to make perfect scores. This particular set of three items did not involve any figure-ground pattern to confuse or disturb the subject in his attempt at an evaluation of each sub-test. These findings are consistent with the results obtained by Strauss and Werner in the performances they reported on this aspect of the Tactual-Motor Test.¹

The first set of three items of the Tactual-Motor Test involved figure-ground patterns. Administration of this set produced quite different results. The scoring procedure used was similar to that employed for scoring the accuracy of responses on the Marble Board Test. The criteria used for evaluation of these responses are as follows:

Perfect Accuracy: A correct straight line drawing of the triangle, square or ellipse is required with closure of all segments of the figure. The only additional drawing permitted on the paper in this classification is an outline square signifying the board upon which the figure was placed. Score: 3 credits.

Great Accuracy: A correct drawing of the triangle, square or ellipse using either dots or small circles in the construction of the design is acceptable. An outline of the board, if added, is acceptable for this category also. Other lines, dots or circles depicting the background is not acceptable in this classification. Score: 2 credits.

Moderate Accuracy: A correct reproduction of the triangle, square or ellipse is required. Use of either lines, dots or small circles in the drawing of the test item is acceptable in this classification. An outline of the board, if added, is acceptable, as well as other lines, dots or circles depicting the background. Score: 1 credit.

No Accuracy: Any drawing not conforming to the requirements outlined above or any drawing which does not bear resemblance to the item of the test. Score: 0.

¹Ibid., p. 47.
The Tactual-Motor Test was administered according to the procedure outlined in Chapter IV. The tabulated results of pupil performances on this test have been reported in Table XIII.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>M</th>
<th>$S^2$</th>
<th>t</th>
<th>$t$ at .05</th>
</tr>
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<tbody>
<tr>
<td>Total Group—Familial</td>
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<td>8.25</td>
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<td>Total Group—Non-Familial</td>
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<td>1.18</td>
<td>5.23</td>
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<td>2.14</td>
<td>8.90</td>
<td>.11</td>
<td>2.09</td>
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<tr>
<td>Deaf —Non-Familial</td>
<td>8</td>
<td>2.00</td>
<td>8.00</td>
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<tr>
<td>Hearing —Familial</td>
<td>19</td>
<td>2.16</td>
<td>8.25</td>
<td>.15</td>
<td>2.06</td>
</tr>
<tr>
<td>Hearing —Non-Familial</td>
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<td>1.63</td>
<td>3.12</td>
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<tr>
<td>Deaf —Total Group</td>
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<td>2.09</td>
<td>3.42</td>
<td>.16</td>
<td>2.02</td>
</tr>
<tr>
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<td>2.00</td>
<td>4.15</td>
<td></td>
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</tr>
<tr>
<td>Deaf —Familial</td>
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<td>2.14</td>
<td>8.90</td>
<td>.01</td>
<td>2.04</td>
</tr>
<tr>
<td>Hearing —Familial</td>
<td>19</td>
<td>2.16</td>
<td>8.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf —Non-Familial</td>
<td>8</td>
<td>2.00</td>
<td>8.00</td>
<td>.31</td>
<td>2.14</td>
</tr>
<tr>
<td>Hearing —Non-Familial</td>
<td>8</td>
<td>1.63</td>
<td>3.12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* t-ratio significant at .05 level.
# F-ratio significant at .05 level.

This table shows the mean scores representing the performances of each group of subjects used in the study. These scores were obtained from performances on the figure-ground test items only. The collective performances of individuals in each group were very similar. No reason for
the similarity was determined. It is conceivable, however, that the ability of the test to measure was affected by lack of clear understanding on the part of the subject as to what was expected of him. Some children, for example, were quick to discover what had to be done while still others only labored unproductively. The test might have been more effective as a measuring instrument had additional instructions been given and the test possibly lengthened to include more figure-ground items. Preliminary use of the test prior to the actual study failed to bear out the difficulties encountered under actual research conditions.

**Spatial Relationships**

The Grace Arthur Stencil Design Test used to measure the level of mental functioning in spatial relationships was administered and scored according to the instructions published in the manual. Scoring was based on item responses of right or wrong and the obtained results of group scores have been reported in Table XIV.
### TABLE XIV. COMPARISON OF MATCHED GROUPS IN NUMBER OF CORRECT RESPONSES ON THE STENCIL DESIGN TEST

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>M</th>
<th>S²</th>
<th>t</th>
<th>t at .05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Group—Familial</td>
<td>33</td>
<td>7.58</td>
<td>14.19</td>
<td>.89</td>
<td>2.02</td>
</tr>
<tr>
<td>Total Group—Non-Familial</td>
<td>16</td>
<td>6.31</td>
<td>16.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf —Familial</td>
<td>14</td>
<td>8.50</td>
<td>8.69</td>
<td>.75</td>
<td>2.09</td>
</tr>
<tr>
<td>Deaf —Non-Familial</td>
<td>8</td>
<td>7.38</td>
<td>16.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hearing —Familial</td>
<td>19</td>
<td>6.55</td>
<td>17.77</td>
<td>2.31</td>
<td>*2.06</td>
</tr>
<tr>
<td>Hearing —Non-Familial</td>
<td>8</td>
<td>5.25</td>
<td>17.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf —Total Group</td>
<td>22</td>
<td>8.09</td>
<td>11.32</td>
<td>1.52</td>
<td>2.02</td>
</tr>
<tr>
<td>Hearing —Total Group</td>
<td>27</td>
<td>6.41</td>
<td>17.71</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf —Familial</td>
<td>14</td>
<td>8.50</td>
<td>8.69</td>
<td>1.49</td>
<td>2.04</td>
</tr>
<tr>
<td>Hearing —Familial</td>
<td>19</td>
<td>6.55</td>
<td>17.77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf —Non-Familial</td>
<td>8</td>
<td>7.38</td>
<td>16.85</td>
<td>1.03</td>
<td>2.14</td>
</tr>
<tr>
<td>Hearing —Non-Familial</td>
<td>8</td>
<td>5.25</td>
<td>17.86</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* t-ratio significant at the .05 level.
# F-ratio significant at the .05 level.

From this table it can be noted that the difference between means of familial and non-familial groups including both deaf and hearing subjects on the Stencil Design Test was not significant. The same was true of comparison between the means of familial and non-familial groups within the deaf population alone. The difference between means of familial and non-familial groups within the hearing population was significant at the 5\% level. The familial group achieved a significantly greater number of correct responses on the Stencil Design Test than the non-familial group.
In the comparison of differences between means of deaf and hearing groups including all classification types, there were no significant differences. In comparing the means obtained by each group, the average of the deaf were greater than those of the hearing. In order to determine whether or not the actual performance abilities of mentally retarded deaf children generally, differ significantly from performance abilities of mentally retarded hearing children in this area, a larger N would be necessary.

**Manual Dexterity**

The Purdue Pegboard Test was used to demonstrate possible manual dexterity differences between the various groups. The Purdue test was administered and scored according to the procedures outlined in the manual. The differences between groups of children as compared were very slight in most cases. Two sets of scores were obtained on each subject. The first score used was the combined performances of right hand, plus left hand, plus both hands (R L B score). The score was obtained by adding the number of pegs inserted by the subject in the board using all three methods, each performed during a thirty second time period.

A tabulation of group mean scores on this phase of the Purdue Pegboard and the comparisons made between the groups has been included in Table XV...
TABLE XV. COMPARISON OF MATCHED GROUPS IN RLB
SCORES ON THE PURDUE PEGBOARD TEST

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>M</th>
<th>S²</th>
<th>t</th>
<th>t at .05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Group—Familial</td>
<td>33</td>
<td>35.61</td>
<td>18.00</td>
<td>#1.67</td>
<td>2.02</td>
</tr>
<tr>
<td>Total Group—Non-Familial</td>
<td>16</td>
<td>32.94</td>
<td>45.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf—Familial</td>
<td>14</td>
<td>36.64</td>
<td>8.70</td>
<td>1.75</td>
<td>2.09</td>
</tr>
<tr>
<td>Deaf—Non-Familial</td>
<td>8</td>
<td>33.63</td>
<td>27.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hearing—Familial</td>
<td>19</td>
<td>34.84</td>
<td>23.00</td>
<td>#1.01</td>
<td>2.06</td>
</tr>
<tr>
<td>Hearing—Non-Familial</td>
<td>8</td>
<td>32.25</td>
<td>68.57</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf—Total Group</td>
<td>22</td>
<td>35.55</td>
<td>16.59</td>
<td>.32</td>
<td>2.02</td>
</tr>
<tr>
<td>Hearing—Total Group</td>
<td>27</td>
<td>34.07</td>
<td>36.79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf—Familial</td>
<td>14</td>
<td>36.64</td>
<td>8.70</td>
<td>1.16</td>
<td>2.04</td>
</tr>
<tr>
<td>Hearing—Familial</td>
<td>19</td>
<td>34.84</td>
<td>24.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf—Non-Familial</td>
<td>8</td>
<td>33.63</td>
<td>27.12</td>
<td>.40</td>
<td>2.14</td>
</tr>
<tr>
<td>Hearing—Non-Familial</td>
<td>8</td>
<td>32.25</td>
<td>68.57</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* t-ratio significant at .05 level.
# F-ratio significant at .05 level.

From this table it will be noted that the differences in variance between familial and non-familial groups including both deaf and hearing subjects were significant. Further testing of the actual differences between means with the t-test could not be carried out due to the significant differences between variances. The difference between the variances of all other groups was such that a t-test could be made. None of these, however, were significant.

A comparison of the means between each pair of deaf and hearing
groups seemed to indicate equal performances by each group on the RLB sub-test of the Purdue Pegboard Test.

The second set of scores for this test was obtained from the results of the children's assembly performances on the Purdue Pegboard Test. This sub-test required the subject to make minute finger movements. The dexterity level required was much greater than that necessary for performance on the first set of sub-tests.

A comparison of the means between groups on the assembly sub-test of the Purdue Pegboard Test has been included in Table XVI.

<p>| TABLE XVI. COMPARISON OF MATCHED GROUPS IN ASSEMBLY SCORES ON THE PURDUE PEGBOARD TEST |
|---|---|---|---|---|---|</p>
<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>M</th>
<th>S$^2$</th>
<th>t</th>
<th>t at .05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Group—Familial</td>
<td>33</td>
<td>23.12</td>
<td>41.68</td>
<td>.89</td>
<td>2.02</td>
</tr>
<tr>
<td>Total Group—Non-Familial</td>
<td>16</td>
<td>21.43</td>
<td>34.46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf—Familial</td>
<td>14</td>
<td>24.43</td>
<td>37.61</td>
<td>2.09</td>
<td>*2.09</td>
</tr>
<tr>
<td>Deaf—Non-Familial</td>
<td>8</td>
<td>22.75</td>
<td>24.42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hearing—Familial</td>
<td>19</td>
<td>22.16</td>
<td>44.61</td>
<td>.72</td>
<td>2.06</td>
</tr>
<tr>
<td>Hearing—Non-Familial</td>
<td>8</td>
<td>20.12</td>
<td>45.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf—Total Group</td>
<td>22</td>
<td>23.82</td>
<td>32.28</td>
<td>.71</td>
<td>2.02</td>
</tr>
<tr>
<td>Hearing—Total Group</td>
<td>27</td>
<td>22.56</td>
<td>43.92</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf—Familial</td>
<td>14</td>
<td>24.43</td>
<td>37.61</td>
<td>1.00</td>
<td>2.04</td>
</tr>
<tr>
<td>Hearing—Familial</td>
<td>19</td>
<td>22.16</td>
<td>44.61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf—Non-Familial</td>
<td>8</td>
<td>22.75</td>
<td>24.42</td>
<td>.89</td>
<td>2.14</td>
</tr>
<tr>
<td>Hearing—Non-Familial</td>
<td>8</td>
<td>20.12</td>
<td>45.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*#-ratio significant at .05 level.
F-ratio significant at .05 level.
From this table it can be noted that the differences between groups in performance on the assembly portion of the Purdue Pegboard Test were very similar to the obtained comparisons on the previous portion (RLB) of this same test. The only significant difference between means was in the deaf population. The mean for the familial group exceeded the non-familial group and this difference was significant at the 5% level.

**Locomotor Coordination**

The Heath Rail-Walking Test was used to compare the relative performance abilities in locomotor coordination between groups used in this study. Scoring of the test was done according to the procedure recommended by the author and the score of each individual's performance was the weighted score based on the totals of each sub-test. A description of the entire procedure for testing is in Chapter IV.

The mean weighted scores on this test have been included in Table XVII.
TABLE XVII. COMPARISON OF MATCHED GROUPS IN WEIGHTED SCORES ON THE HEATH RAIL-WALKING TEST

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>M</th>
<th>s²</th>
<th>t</th>
<th>t at .05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Group—Familial</td>
<td>33</td>
<td>77.88</td>
<td>1452</td>
<td>2.95</td>
<td>*2.02</td>
</tr>
<tr>
<td>Total Group—Non-Familial</td>
<td>16</td>
<td>45.13</td>
<td>1103</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf—Familial</td>
<td>14</td>
<td>59.36</td>
<td>1548</td>
<td>1.19</td>
<td>2.09</td>
</tr>
<tr>
<td>Deaf—Non-Familial</td>
<td>8</td>
<td>38.88</td>
<td>1468</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hearing—Familial</td>
<td>19</td>
<td>91.53</td>
<td>1001</td>
<td>3.10</td>
<td>*2.06</td>
</tr>
<tr>
<td>Hearing—Non-Familial</td>
<td>8</td>
<td>51.38</td>
<td>806</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf—Total Group</td>
<td>22</td>
<td>51.91</td>
<td>1550</td>
<td>2.60</td>
<td>*2.02</td>
</tr>
<tr>
<td>Hearing—Total Group</td>
<td>27</td>
<td>79.63</td>
<td>1258</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf—Familial</td>
<td>14</td>
<td>59.36</td>
<td>1548</td>
<td>2.62</td>
<td>*2.04</td>
</tr>
<tr>
<td>Hearing—Familial</td>
<td>19</td>
<td>91.53</td>
<td>1001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf—Non-Familial</td>
<td>8</td>
<td>38.88</td>
<td>1468</td>
<td>.74</td>
<td>2.14</td>
</tr>
<tr>
<td>Hearing—Non-Familial</td>
<td>8</td>
<td>51.38</td>
<td>806</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* t-ratio significant at .05 level.
# F-ratio significant at .05 level.

This table shows that differences between means on the Rail-Walking Test were greater than in previous comparisons. The differences between means of familial and non-familial groups included both deaf and hearing subjects was significant at the 5% level in favor of the familial group. The difference between means of the familial and non-familial subjects within the hearing population was also significant at the 5% level. In comparing the means of familial and non-familial subjects within the deaf population the difference between the means was not significant.
The scores obtained within the total group of hearing subjects, as expected, far exceeded those of the total group of deaf subjects. The difference between means in this case was significant. Similarly, in comparing the mean scores of deaf and hearing subjects within the familial group the difference was significant in favor of the hearing. In a comparison of the mean scores of deaf and hearing non-familial subjects, the hearing group had a higher mean score. This difference, however, was not significant.

Comparative Results of Deaf and Hearing Subjects on All Tests

The relative differences between groups of deaf and hearing subjects on the various tests employed was the primary intent of this research. The results of performances of groups of subjects on each of the tests were organized graphically so that they could be more easily reviewed. The group mean scores on each of the various tests used for both deaf and hearing groups were converted to standard (z) scores and placed on a graph. These z scores show the relative deviation of each mean from the common total group mean in standard tenth score units.

Figure 4 shows a comparison of the total group mean scores of deaf and hearing subjects on each of the tests used. From this figure it will be noted that there seems to be a reversal of performance on tests one and two of the Marble Board Test. The difference between the means of the two groups on accuracy of responses was not a significant one. The difference between the two groups on the type of construction used, however, was a significant one. The differences between total groups of deaf and hearing subjects were not significant in any of the
Figure 1* Comparison of Group Mean Scores, Converted to Standard (z) Scores, of Total Groups of Deaf and Hearing Subjects On All Tests
other tests used with the exception of the Heath Rail-Walking Test. In this test the difference between the two groups was significant in favor of the hearing group.

Figure 5 shows the divergence between familial mentally retarded groups of deaf and hearing subjects. The mean standard score comparisons of these two groups were similar to those found between the total groups of deaf and hearing subjects. The difference between group means on type of construction of the Marble Board Test was a significant one in favor of the deaf indicating the possibility that the deaf mentally retarded subjects performed more coherently than the hearing group. On the Rail-Walking Test the difference between group performances was also significant. In this instance the hearing familial group performed better than the deaf. The group performance differences on the other tests were not significant.

Figure 6 shows the relationship between non-familial mentally retarded deaf and hearing subjects. The extremely small N in these two sub-groups seems to have affected the results of comparisons between the performances of subjects.
Figure 5. Comparison of Group Mean Scores, Converted to Standard (z) Scores, of Familial Groups of Deaf and Hearing Subjects On All Tests
Figure 6. Comparison of Group Mean Scores, Converted to Standard (z) Scores, of Non-Familial Groups of Deaf and Hearing Subjects On All Tests
From the graph in Figure 6 it will be noted that greater differences existed between these two groups than was true in the case of the familial deaf and hearing. Although none of the comparisons reached significant levels, the differences between the two groups were in the same direction as was true in the previous comparison.
CHAPTER VI

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

In recent years educators of the deaf have expressed concern about the increasing incidence of multiple handicapped deaf children in schools for the deaf. This growth in numbers can be traced through the reports by administrators and teachers in the various state, public, and private residential schools for deaf children in the United States. Among the many types and kinds of multiple handicapped children are the mentally retarded deaf. This group makes up the majority of the multiple handicapped children in schools for the deaf.

The Problem

This study was a comparative study of similarities or differences between groups of mentally retarded deaf and hearing school-aged boys in several motor skill areas. Past research has revealed a substantial quantity of information about the various types of normal hearing mentally retarded children. Only recently has any investigation of the psychological aspects of deaf mentally retarded children been done, although many studies have been conducted in which more normal deaf and hearing children have been compared. Among these were studies of performance ability, mental functioning, and motor skills. The relative differences between these two groups in these specific areas have been quite well determined. To date, however, there has been no research reported in which mentally retarded deaf and hearing children have been
Previous Related Research

In the review of previous research there was an attempt to limit the analysis to studies having a direct relationship to the problem. A survey of the historical evolution of solutions to the problems involved in the actual mechanics of testing deaf children was also included. This review produced evidence to the effect that much more information would be needed before a more complete understanding of the psychological bases for the many complex learning problems of the deaf could be evolved.

Earlier research seemed to have been concentrated on an exploration of the problems of the deaf in relation to acquisition of language skills. It was found, for example, that when language as a variable was more completely controlled in the administration of tests to the deaf, the obtained results improved. This led one research worker to state that deaf children, at least quantitatively, were more nearly equal to the hearing than had been originally thought. Consideration was also given to the problem of age of onset of deafness in these early studies. Eventually researchers recognized that the deaf child whose loss of hearing had occurred prior to the establishment of verbal language was a much different individual than the one whose deafness occurred after the establishment of verbal language skills.

More recent research has focused attention on the effects of etiology of deafness on test performance. This concern for differences in abilities among the individuals according to type or cause of deafness had been preceded by research into the effects of etiology of mental
retardation on performance abilities of mentally retarded children.

The selection of testing instruments was based upon previous success with deaf children. An attempt was also made to consider the many variables which had previously been found to effect the performances of deaf children on the tests used.

The Study

Twenty-two mentally retarded deaf boys from three residential schools for the deaf located in the southwestern part of the United States and twenty-seven mentally retarded hearing boys from special education classes in the public schools of Tucson, Arizona, were used. The deaf and hearing boys were grouped into two etiological categories in order to facilitate separate considerations of the known behavioral differences between these two general types of mentally retarded children. Both deaf and hearing subjects were classified into familial and non-familial mentally retarded sub-groups.

The nature of the selection criteria limited the number of children actually used in the study. The careful screening of possible subjects resulted in a considerable number having to be eliminated. The value of the study, therefore, has been limited by the small (N).

In order to possibly add to the validity of the results of the investigation, comparisons were made with known findings from other research involving similar groups of familial and non-familial mentally retarded children. It was hypothesized that if the performances of the groups of subjects used in this study were consistent with what had already been found, a further study of the performance differences of
these two groups when compared directly might be of value.

The performances of the following groups of subjects were compared. These comparisons were limited to the motor skill areas as determined by the tests employed as well as the results of studies involving similar groups as reported by other researchers:

- **Familial and non-familial** groups - including all subjects
- **Familial and non-familial** groups - hearing subjects only
- **Familial and non-familial** groups - deaf subjects only

Subjects used in the study were re-arranged into the following matched groups in an effort to make comparisons of the unknown relationships between deaf and hearing mentally retarded children. These were as follows:

- **Deaf and hearing** groups - including all subjects
- **Deaf and hearing** groups - including familial subjects only
- **Deaf and hearing** groups - including non-familial subjects only

Tests used for comparison of the relative motor skills of these groups were selected because of previous success in studies involving both deaf and hearing children. The motor ability areas considered and the tests used were as follows:

- **Visuo-motor** - Werner-Strauss Marble Board Test
- **Tactual-motor** - Werner-Strauss Tactual-Motor Test
- **Spatial relationships** - Grace Arthur Stencil Design Test
- **Manual Dexterity** - Purdue Pegboard Test
- **Locomotor coordination** - Heath Rail-Walking Test
Comparison of Group Performances to Previous Research

A comparison was made of the results of the various tests between the total familial and non-familial groups including both deaf and hearing subjects. This comparison suggested that the groups of children used in the research performed according to what previous research had indicated. The following evidences would seem to have supported this hypothesis:

1. The difference between group mean performance of the total familial mentally retarded group and the non-familial group on the type of construction procedure used in doing the marble board test was significant. The familial group performed more coherently than the non-familial group. This was consistent with what has been found to be true of these two types of mentally retarded children in previous research.

2. The difference between group mean performances of these two groups on the Heath Rail-Walking Test was also significant. The familial group was able to do much better on this test than the non-familial group. This was consistent with the findings in previous research.

3. Results of comparisons made of group mean performances on the Heath Test and the construction procedure used on the Marble Board Test, between familial and non-familial groups of deaf subjects considered separately, were also consistent with what has been found to be true of these two groups as reported in previous research.

4. The differences in group mean performances on the Heath Rail-Walking Test between total groups of deaf and hearing boys were similar to evidence as reported in previous studies. The results of the differences between means were significant in favor of the hearing.
Conclusions

The results of this study were limited by the small (N). The findings, however, are strengthened by the facts that: (1) the sample of deaf subjects included all available boys in the geographical area, (2) the sample of hearing subjects included all available boys in the special education department of Tucson (Arizona) public schools, (3) the groups as matched performed according to expectations, and (4) the performances of the deaf and hearing children used in this study compared favorably to results that had been obtained in previous similar research.

The following conclusions have therefore been developed:

1. The motor tests used in the study were found to be of value for measuring the motor performances of both deaf and hearing individuals. Although the Marble Board Test was difficult to score, it did prove to be a more effective measuring instrument than the Tactual-Motor Test.

2. The mentally retarded deaf subjects were found to have made more coherent responses than the hearing group in their approach to the construction patterns on the Marble Board Test. This was also observed in the familial groups of deaf and hearing children. Mean group performance differences between total groups of deaf and hearing subjects were found to have been significant at the .05 level.

3. A comparison of the results between all groups of deaf and hearing subjects in the area of spatial relationships, manual dexterity and finger tip dexterity produced no significant differences. Differences in performance between all groups were consistent, with the deaf groups making slightly higher scores. A much larger (N) would be necessary, however, in order to determine whether or not the small differences
found in this study were truly significant.

4. The hearing subjects used in the study were significantly superior to the deaf in performance on the Heath rail-walking Test. This was true in a comparison of total groups of deaf and hearing subjects, and in a comparison of familial type mentally retarded groups of deaf and hearing subjects. The differences between non-familial groups on the Heath Test were not significant. This implies the possible conclusion that both deaf and hearing individuals, whose mental retardation is due to some form of brain injury, experience somewhat similar locomotor balance difficulties.

5. The lack of significant difference between the performances of non-familial mentally retarded deaf and hearing children on all tests used, could indicate that these two groups were more similar in their performance abilities than were familial groups of deaf and hearing children. A larger (N) would be required in order to be able to make a more positive statement in this regard.

6. In general, the differences found between deaf and hearing mentally retarded children did not seem to have been greater or less than what had been found to be true of differences between more mentally normal groups of deaf and hearing children.

7. On the basis of the results of tests used in this research, it has been necessary to reject the hypothesis that the additional handicap of deafness when coupled with mental retardation imposes a greater handicap on the individual in the performance of certain motor skills.
Recommendations for Further Research

Certain recommendations for further investigation seem appropriate and have been included here:

1. This research has indicated the possible need for a battery of tests which could be easily and reliably administered to mentally retarded deaf children. A number of the instruments used in this study could very well become a part of such a battery.

2. An investigation might be undertaken into the possible adaptations and improvements of the Marble Board Test and the Factal-Motor Test developed originally by Strauss and Werner for use with deaf mentally retarded children.

3. There is a definite need for continued exploration into the possibility that mental retardation as a handicap is of such magnitude as to reduce the impact of additional handicaps such as deafness.

4. Research should be undertaken to determine the training objective necessary for occupational independence for the mentally retarded as well as for the mentally retarded deaf with special emphasis on possible differences.

5. There is a need for an evaluation of the difficulties the mentally retarded deaf seem to encounter in their attempt to achieve successful occupational independence. The results of this study seemed to indicate that in the performance of some motor skills there is very little difference between the mentally retarded hearing and the mentally retarded deaf. The question arises, therefore, as to whether success for the mentally retarded deaf individual depends more on the sociological
aspects of deafness than upon the fact that he is mentally retarded.

6. There is a need for careful analysis of the benefits to be derived from early identification and assessment of the skills and abilities possessed by the mentally retarded individual.
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APPENDIX I
CLASSIFICATION SYSTEM FOR DETERMINING ETIOLOGY OF MENTAL RETARDATION

The French, Cassel, Arbitman, Weissenberg, Irwin Classification system for determining exogenous and endogenous types of mental deficiency was used by Frisina in his study of the psychology of the mentally retarded deaf children. This system was used in the present study for classification of subjects according to etiology of mental retardation.

Classification Categories and Code Letters

A code lettering system is used to designate the presence or absence of mental deficiency in the family history. The various code letters along with their various interpretations have been included here:

V. One or more of the subject's family objectively diagnosed as mentally retarded.

W. Evidence, not necessarily objective, for the presence of mental deficiency in the subject's family.

X. Insufficient information.

Y. Evidence, not necessarily objective, for the absence of mental deficiency in the subject's family.

Z. All members of the family objectively tested normal or above.

The number of years of formal education of the father is used as classification criteria. The code letters and their designated categories follow:

A. Education above high school.

B. Education up to grades seven through twelve.

C. Education below the sixth grade
The occupational level of the father is coded as follows:

D. Professional or managerial occupation.

E. Clerical, protective, sales, or skilled.

F. Domestic, semi-skilled, or unskilled.

As to the probable cause of the mental deficiency, the following facts must be ascertained and coded.

Yes Evidence for the presence of certain pre-natal or post-natal conditions associated with mental deficiency.

No No evidence of pre-natal or post-natal conditions associated with mental deficiency.

After each subject's case history has been checked for information needed in each of the four areas considered above, the results are reduced to a code formula. This formula is applied to a code key for classification.

Subjects are classified as familial if their code patterns match either of the two groups listed below:

(V) or (W) with (No) possible cause.

(X) or (F) with (No) possible cause, and no (A).

Subjects are classified as non-familial if their code patterns resemble any of the following:

(X) and (E) and (Yes) possible cause.

(X) and (D).

(X) and (A).

(Y) but no (F).

(Z).
APPENDIX II

CHILD STUDY QUESTIONNAIRE - DEAF AND HEARING CHILDREN

Child's Name: ___________________________ Age ______

Home Address: _______________________________________

School now attending: ________________________________

FATHER: Please answer the following questions about the father.

1. Father's name ________________________________

2. Father attended grade school to
   (name of school) ______ (grade) ______
   ____________________________ high school to ______ (grade) ______
   ____________________________ college or univ. ______ (graduated) ______
   ____________________________ trade school ______

3. Father is now working as a __________ (kind of work or position) ______

4. List jobs held by father during past 10 years: ____________________________
   ____________________________
   ____________________________

MOTHER: Please answer the following questions about the mother.

1. Mother's name ____________________________

2. Mother attended grade school to ______ (grade) ______
   ____________________________ high school to ______ (grade) ______
   ____________________________ college or univ. ______ (graduated) ______
   ____________________________ trade school ______

CHILD: Please answer the following questions about the child.

1. __________ was born ______ (place of birth) ______
2. He has had the following illnesses. (Please check.)

- Meningitis, at the age of ___ yrs.
- Encephalitis, at the age of ___ yrs.
- Convulsions, at the age of ___ yrs.
- Serious high fever, at the age of ___ yrs.
- Serious accident, at the age of ___ yrs.

Type of injury

Other.

Specify at the age of ___ yrs.

FAMILY: Please answer the following questions about the family.

1. Has anyone in the family been in a hospital for any of the following reasons? (Mother, father, brother, sister, grandparent.)

- Tuberculosis  ___Yes  ___No  Who __________________________ (Mother, father, etc.)
- Mental illness  ___Yes  ___No  Who __________________________
- Operation  ___Yes  ___No  Who __________________________

Type of operation

Serious illness  ___Yes  ___No  Who __________________________

Kind of illness

ANY ADDITIONAL COMMENTS ABOUT THE CHILD OR THE FAMILY THAT MAY BE HELPFUL:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
APPENDIX III

REPORT FORM FOR THE MARBLE BOARD TEST

Visio-Motor

Name ___________________________ Date ___________________________

School ___________________________

REMARKS: ___________________________

Scoring:
Jump Score __________
Correct __________
Constr. Type __________
Time __________ min. __________ sec.