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SPASTIC AND ATHETOID PERFORMANCE IN RELATION TO JENSEN'S TWO-LEVEL THEORY OF MENTAL ABILITIES

by

Donald Terry Stauffer

A Dissertation Submitted to the Faculty of the DEPARTMENT OF SPECIAL EDUCATION In Partial Fulfillment of the Requirements For the Degree of DOCTOR OF EDUCATION In the Graduate College THE UNIVERSITY OF ARIZONA 1972
I hereby recommend that this dissertation prepared under my direction by Donald Terry Stauffer
entitled SPASTIC AND ATHEOID PERFORMANCE IN RELATION TO JENSEN'S TWO-LEVEL THEORY OF MENTAL ABILITIES be accepted as fulfilling the dissertation requirement of the degree of Doctor of Education

Dissertation Director  

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

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SIGNED: Donald T. Stauffer
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>LIST OF TABLES</th>
<th>vi</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
<td>vii</td>
</tr>
<tr>
<td>I. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>Statement of the Problem</td>
<td>2</td>
</tr>
<tr>
<td>Hypotheses</td>
<td>2</td>
</tr>
<tr>
<td>Rationale of the Study</td>
<td>3</td>
</tr>
<tr>
<td>Spastic and Athetoid Cerebral Palsy</td>
<td>4</td>
</tr>
<tr>
<td>Jensen's Two-Level Theory of Mental Abilities</td>
<td>6</td>
</tr>
<tr>
<td>Definitions</td>
<td>9</td>
</tr>
<tr>
<td>II. REVIEW OF THE LITERATURE</td>
<td>11</td>
</tr>
<tr>
<td>Comparison of Spastic, Athetoid, and Normal Children on Sensory-Motor Abilities</td>
<td>12</td>
</tr>
<tr>
<td>Comparison of Spastic, Athetoid, and Normal Children on Psycholinguistic Abilities</td>
<td>15</td>
</tr>
<tr>
<td>Comparison of Spastic, Athetoid, and Normal Children on Perceptual and Cognitive Abilities</td>
<td>17</td>
</tr>
<tr>
<td>Summary</td>
<td>21</td>
</tr>
<tr>
<td>III. STUDY PROCEDURES</td>
<td>23</td>
</tr>
<tr>
<td>Subjects</td>
<td>23</td>
</tr>
<tr>
<td>Criteria for Selection of Subjects</td>
<td>23</td>
</tr>
<tr>
<td>Method of Selection</td>
<td>24</td>
</tr>
<tr>
<td>Description of Population Sample</td>
<td>24</td>
</tr>
<tr>
<td>Description of Instruments</td>
<td>27</td>
</tr>
<tr>
<td>Methodology of Data Gathering</td>
<td>29</td>
</tr>
<tr>
<td>Statistical Procedures</td>
<td>34</td>
</tr>
<tr>
<td>IV. RESULTS OF THE STUDY</td>
<td>35</td>
</tr>
<tr>
<td>Level I Results</td>
<td>35</td>
</tr>
<tr>
<td>Level II Results</td>
<td>37</td>
</tr>
<tr>
<td>Analysis by Sex</td>
<td>44</td>
</tr>
<tr>
<td>Summary of the Results</td>
<td>46</td>
</tr>
<tr>
<td>Discussion of the Results</td>
<td>48</td>
</tr>
</tbody>
</table>
## TABLE OF CONTENTS—Continued

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>V. SUMMARY AND RECOMMENDATIONS</td>
<td>50</td>
</tr>
<tr>
<td>Statement of the Problem</td>
<td>50</td>
</tr>
<tr>
<td>Procedures</td>
<td>51</td>
</tr>
<tr>
<td>Results</td>
<td>51</td>
</tr>
<tr>
<td>Discussion</td>
<td>52</td>
</tr>
<tr>
<td>Recommendations for Future Study</td>
<td>53</td>
</tr>
<tr>
<td>APPENDIX A: TEST OF PAIRED-ASSOCIATES</td>
<td>54</td>
</tr>
<tr>
<td>APPENDIX B: JENSEN'S THEORETICAL FORMULATION</td>
<td>67</td>
</tr>
<tr>
<td>APPENDIX C: RAW DATA FOR SPASTIC AND ATHETOID SUBSAMPLES</td>
<td>70</td>
</tr>
<tr>
<td>APPENDIX D: STATISTICAL ANALYSIS</td>
<td>73</td>
</tr>
<tr>
<td>SELECTED BIBLIOGRAPHY</td>
<td>74</td>
</tr>
</tbody>
</table>
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>School Placement of Spastic and Athetoid Subjects</td>
<td>25</td>
</tr>
<tr>
<td>II.</td>
<td>Chronological Age Distribution of Spastic and Athetoid Subjects</td>
<td>26</td>
</tr>
<tr>
<td>III.</td>
<td>Classification by Sex and Type of Cerebral Palsy</td>
<td>26</td>
</tr>
<tr>
<td>IV.</td>
<td>Spastic and Athetoid Performance on First Attempt of Paired-Associates Test (Level I)</td>
<td>36</td>
</tr>
<tr>
<td>V.</td>
<td>Spastic and Athetoid Performance on Total Score of Paired-Associates Test (Level I)</td>
<td>37</td>
</tr>
<tr>
<td>VI.</td>
<td>Spastic and Athetoid Performance on Digit Span Test (Level I)</td>
<td>38</td>
</tr>
<tr>
<td>VII.</td>
<td>Spastic and Athetoid Performance on Raven Progressive Matrices (Level II)</td>
<td>38</td>
</tr>
<tr>
<td>VIII.</td>
<td>Success or Failure of Spastics and Athetoids on Double Alternation Card Problem (Level II)</td>
<td>40</td>
</tr>
<tr>
<td>IX.</td>
<td>Verbalization or Non-Verbalization of Spastics and Athetoids on Double Alternation Card Problem (Level II)</td>
<td>40</td>
</tr>
<tr>
<td>X.</td>
<td>Total Trials of Spastics and Athetoids on Double Alternation Card Problem (Level II)</td>
<td>42</td>
</tr>
<tr>
<td>XI.</td>
<td>Total Errors of Spastics and Athetoids on Double Alternation Card Problem (Level II)</td>
<td>42</td>
</tr>
<tr>
<td>XII.</td>
<td>Errors Before End Concept for Spastics and Athetoids on Double Alternation Card Problem (Level II)</td>
<td>43</td>
</tr>
<tr>
<td>Table</td>
<td>Description</td>
<td>Page</td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
<td>------</td>
</tr>
<tr>
<td>XIII.</td>
<td>Errors After End Concept for Spastics and Athetoids on Double Alternation Card Problem (Level II)</td>
<td>44</td>
</tr>
<tr>
<td>XIV.</td>
<td>Analysis of Results by Sex</td>
<td>45</td>
</tr>
<tr>
<td>XV.</td>
<td>Raw Data for Spastic Subsample</td>
<td>71</td>
</tr>
<tr>
<td>XVI.</td>
<td>Raw Data for Athetoid Subsample</td>
<td>72</td>
</tr>
</tbody>
</table>
ABSTRACT

Statement of the Problem

The purpose of this study was to ascertain whether spastic and athetoid cerebral palsied children differ in performance on tasks which employ Jensen's Two-Level Theory of Mental Abilities.

Previous research established that spastic and athetoid children perform differently on tests which measure psycholinguistic abilities. Since language and intelligence are closely related, differences in psycholinguistic abilities may relate to different mental abilities. This study was designed to describe the Level I and Level II abilities of spastic and athetoid children.

Procedures

A list of cerebral palsied subjects was compiled from private and public schools and organizations in several southwestern communities. Twenty-six spastic and sixteen athetoid cerebral palsied subjects between the ages of 8-0 and 16-0 years were selected for this study on the basis of consistent medical diagnoses. Other eligibility criteria included a minimum IQ of 70 or equivalent learning ability, no severe accompanying handicaps, and understandable speech.
The two cerebral palsy types were divided into four age groups: 8-0 to 9-11, 10-0 to 11-11, 12-0 to 13-11, and 14-0 to 15-11.

The spastic and athetoid subjects were tested on four instruments which measure the Level I and Level II abilities described by Jensen. The paired-associates and digit span tests were used to measure Level I abilities and the Raven Progressive Matrices and double alternation card problem were used to measure Level II abilities.

Statistical analyses of the results were made with the Mann-Whitney U test, the Fisher Exact Probability Test, and the chi square test.

Results

The results of this study indicated that performance on Level I and Level II tasks did not effectively differentiate between spastic and athetoid subjects in this study. The .05 level of significance was selected to determine differences between spastic and athetoid subjects within the four age groups.

Specific results were:

1. Performance on the paired-associates test (Level I) revealed a significant difference (.05) in favor of the spastic 8-0 to 9-11 age group on the total score. There were no significant differences within the other age groups.
2. Performance on the digit span test (Level I) revealed no significant differences between spastic and athetoid subjects within the four age groups.

3. Performance on the Raven Progressive Matrices (Level II) revealed no significant differences between spastic and athetoid subjects within the four age groups.

4. Performance on the double alternation card problem (Level II) revealed no significant differences between spastic and athetoid subjects within the four age groups.

5. The results were analyzed for sex differences in the spastic, athetoid, and total cerebral palsy groups. A significant sex difference (>.01) was found in the total cerebral palsy groups on the first attempt of the paired-associates test (Level I) in favor of cerebral palsied boys. There were no other significant sex differences.

**Discussion of Results**

No significant differences were found between spastic and athetoid subjects in relation to their performance on tasks which were designed to measure Jensen's Two-Level Theory of Mental Abilities. The different patterns of functioning for spastic and athetoid subjects, such as found by previous research, were not established for this sample of subjects. The subjects did perform similarly on Level I and Level II tasks when analyzed
by medical classification. However, the wide variability
of test scores suggest that cerebral palsy groups are more
heterogeneous than homogeneous and that future research is
indicated using educational factors for grouping purposes
instead of the medical classification models.
CHAPTER I

INTRODUCTION

Spastic and athetoid cerebral palsied children present many educational problems. They usually are educated in classes for the physically handicapped and grouped for instruction. Because of this grouping, teachers need to know if spastic and athetoid children can be considered homogeneous in terms of education or if they differ to a degree which suggests different instructional approaches.

These children vary in terms of the extent and nature of their cerebral palsy, mental ability and associated handicapping conditions. The wide range of abilities and different levels of functioning in cerebral palsied children are produced by these inter- and intra-individual differences.

To use modern instructional technology appropriately, the classroom teacher must evaluate each child with regard to his specific needs and include remedial and prescriptive teaching techniques based upon behavioral objectives. In order to meet the cerebral palsied child's needs, the teacher must know more about the abilities and disabilities of spastic and athetoid children, and how they learn.
Statement of the Problem

The purpose of this study was to make a comparison of the mental abilities of a group of spastic and a group of athetoid cerebral palsied children through the use of tasks which employ Jensen's Two-Level Theory of Mental Abilities. An attempt was made to determine whether spastic and athetoid children differ on Level I and Level II abilities as described by Jensen (1968a).

Hypotheses

The following hypotheses were tested in this study.

1. There is no significant difference between performances of spastic and athetoid subjects grouped according to age (see Table II) on the paired-associates test (adapted from Price, 1971) designed to measure Level I abilities.

2. There is no significant difference between performances of spastic and athetoid subjects grouped according to age (see Table II) on the digit span test (Wechsler, 1949) which measures Level I ability.

3. There is no significant difference between performances of spastic and athetoid subjects grouped according to age (see Table II) on the Raven Progressive Matrices (Raven, 1956 revision) which measures Level II ability.

4. There is no significant difference between performances of spastic and athetoid subjects grouped
according to age (see Table II) on a double alternation card problem (Hunter, 1928; Hodges, 1953) used to measure Level II ability.

5. There are no significant sex differences between spastic and athetoid performances on the four tasks.

**Rationale of the Study**

Previous research by McCarthy (1957) and Myers (1963) found that spastic and athetoid children differ in psycho-linguistic abilities on tests based upon Osgood's (1952) language model. As both studies are discussed in Chapter II, it may suffice to state here that spastic children were superior to athetoids at the automatic-sequential level but athetoid children were superior to spastics at the representational level.

In discussing Osgood's model, Myers (1963, p. 8) states:

The three levels of neural organization to which Osgood relates the levels of language function may be categorized as spinal, subcortical, and cortical, with the cortical level being directly related to the representational level of language, the sub-cortical level to the integration level, and the spinal level to the projection level. Brain damage resulting in cerebral palsy may be cytoarchitecturally localized on different levels of neural organization.

The localization of brain damage was used by Myers to explain psycholinguistic differences between spastic and athetoid children. She mentioned that spasticity resulted from damage to the precentral gyrus of the cerebral cortex.
and that athetosis resulted from damage to the caudate
nucleus, putamen, or the globus pallidus which are part of
the extrapyramidal projections (Myers, 1963). The hypoth­
eses presented by Myers stated the level of language
expected by the spastic and athetoid child is based upon
the localization of brain damage.

Although it is difficult to establish the exact
neurological site for brain damage resulting in spasticity
and athetosis, the accompanying motor patterns allow us to
differentiate the types of cerebral palsy.

This study is based upon the fact that there are
different types of cerebral palsy and research has shown
that spastic and athetoid children differ in psycholinguistic
abilities. Since language and intelligence are closely
related, it is conceivable that the differences in psycho­
linguistic abilities between spastic and athetoid children
are related to differences in mental ability.

Spastic and Athetoid Cerebral Palsy

Classification of cerebral palsy has been done
according to type, topography, and severity. Several types
of cerebral palsy have been differentiated; spastic,
athetoid, ataxia, rigidity, tremor, and mixed. Approximately
seventy to eighty percent of all cerebral palsied fall into
either the spastic or athetoid group (Cruickshank, 1966).
The spastic is the largest group which has about three times the incidence of athetoids.

**Spasticity:** The spastic child can be distinguished by the exaggerated contraction of muscles subjected to stretch. The movements of the spastic child are uncontrolled and explosive. He may hold his forearm tightly towards his body with his hand clenched downward at a right angle to the forearm. If spasticity is observed on one side it is called hemiplegia; when one limb is affected, it is called monoplegia. In triplegia three limbs are involved, generally two legs and one arm. Paraplegia refers to involvement of both legs and quadriplegia is involvement of all four limbs. Diplegia refers to involvement of all four limbs with the lower limbs being more affected (Kirk, 1972).

**Athetosis:** The athetoid is characterized by random, purposeless motions and may have any or all limbs involved. The arms go through irregular, twisting movements while the fingers are extended in almost constant activity. Many times the head is drawn back and facial grimaces are present. The athetoid may walk with a writhing, lurching, and stumbling gait. He can bring his hand to his mouth but in so doing goes through twisting, worm-like motions. It seems the harder the athetoid tries to do something, the more tense the motions become (Kirk, 1972).
The other four types of cerebral palsy, rigidity, ataxia, tremor, and mixed are not discussed here because they were not included in this study.

**Jensen's Two-Level Theory of Mental Abilities**

Jensen has developed a theory of mental abilities based upon his research findings. Much has been published by Jensen about mental development, retardation, and minority groups but only his rationale and description of Level I and Level II abilities are discussed here.

Level I ability is called the "basic learning ability" and is the ability to receive stimuli and later recall it with some degree of accuracy. This ability does not require any manipulation or transformation of the input to produce the desired output. Jensen (1970) uses the tape recorder as an example of the functioning of Level I ability in a pure sense.

Level II ability is the complex pattern of decoding the stimuli before responding and is called "cognitive ability" by Jensen (1970). Performance on Level II tasks requires the more complex mental processes involved in abstraction, problem solving, and concept formulation.

The following theory of Level I and Level II abilities has been proposed by Jensen (1968b, p. 1335) to explain the differences noted above.
Level I processes are essentially associative and are best measured by tests such as digit span and serial rote learning; Level II processes involve transformations or complex operations performed on the stimulus input and are perhaps best represented in tests such as the Progressive Matrices and Cattell's Culture-Fair Tests.

Level II performance has some functional dependence upon Level I, but not vice versa. For example, short-term memory (Level I) is needed to solve the Raven Progressive Matrices (Level II), but cognitive functionings such as problem solving and abstract reasoning (Level II) are not necessary for serial rote learning (Level I). Jensen (1968b, p. 1336) makes the following statements about the differences between people with Level I and Level II abilities:

Children who are above the general average on Level I abilities but below the average on Level II performance usually appear bright and capable of normal learning and achievement in many situations, although they have inordinate difficulties in school work under the traditional methods of instruction. . . . On the other hand, children who are below average on Level I, and consequently on Level II as well, appear to be much more handicapped in the world of work. One shortcoming of traditional IQ tests is that they make both types of children look much alike.

Jensen bases his theory on the two-type concept of mental retardation; the primary and cultural. He states (1970, p. 34):

Two broad categories of mental retardation are generally recognized. The first category is diagnostically the most obvious; it is the variety of severe mental defects resulting in IQs for the most part below 50 and accompanied by physical abnormalities or clear signs of neurological damage.
In the IQ range from 50 to 70, on the other hand, at least 75% of the individuals included therein appear clinically normal, evincing no signs of neurological damage, sensory defects, or physical stigmata.

Jensen maintains that the cultural retardate possesses certain basic learning abilities which may not be evidenced by intellectual assessment or classroom performance. Children classified as retarded differ in their social and occupational competence after leaving school, and these differences do not appear to be related to IQ and scholastic performance (Jensen, 1970). Jensen reported that primary retardates have a deficiency in Level I ability and cultural retardates have a deficiency in Level II ability.

Most intelligence tests measure primarily cognitive functionings such as problem solving and abstract reasoning and are therefore tapping mostly Level II abilities. Some Level I abilities are measured by intelligence tests but it is difficult to parcel out the two types of processes from total scores. Most intelligence tests are heavily loaded with Spearman's $g$ factor, which is mainly a Level II function. The Stanford Binet (Terman and Merrill, 1960) and Wechsler (Wechsler, 1958) intelligence tests do contain tests that measure Level I ability; however, the net effect is that these tests place an individual along a continuum of intellectual ability without making any clear distinction between the person's Level I and Level II abilities (Jensen, 1970).
Jensen (1970) suggests that Level I and Level II abilities are differentially distributed in lower and upper socio-economic classes. Level I ability has little, if any, relation to socio-economic status (SES), while Level II ability is highly related to SES. He (Jensen, 1968b, p. 1336) states: "Level I is distributed approximately the same in all SES groups, whereas Level II is distributed about a higher mean in the upper classes than in the lower."

Therefore, children in the upper SES groups are more proficient in Level II abilities than children in the lower SES groups.

**Definitions**

For the purpose of this study the following definitions are given:

- **Spastic** children have explosive, jerky, uncontrolled movements. The stretch reflex and scissors gait are present and balance is poor. The clinical signs include hyperactive deep reflexes, clonus, and hypertonicity (Crothers and Paine, 1959).

- **Athetoid** children have random, purposeless motion. An overflow of motion can be seen and the gait has a lurching, stumbling manner. Facial grimaces, drooling, and the tonic neck reflex may be present (Crothers and Paine, 1959).

- **Mental ability** is made up of the complex mental processes involved in intellectual functioning.
Level I ability is needed for the simple memory and stimulus-response tasks that do not require processing of the informational input (Jensen, 1970).

Level II ability is needed for abstract problem solving and conceptual learning. This ability is characterized by the necessity of transformation and manipulation prior to responding to arrive at the desired output (Jensen, 1970).
CHAPTER II

REVIEW OF THE LITERATURE

Most of the studies about cerebral palsy were written in the 1950s and were descriptive rather than experimental in nature. There is a scarcity of recent research on how cerebral palseied children learn and few studies related to the mental abilities of these children. The reader is referred to Cruickshank (1966) for more complete descriptive literature on cerebral palsy.

A sample of representative studies was reviewed. The studies have been grouped under three headings to conform to the major lines of inquiry of the present paper:

2. Comparison of spastic, athetoid, and normal children on psycholinguistic abilities.
3. Comparison of spastic, athetoid, and normal children on perceptual and cognitive abilities.

Most authors agree that sensory-motor defects, language disabilities, and perceptual and cognitive disturbances play key roles in retarding the development of efficient mental abilities in individuals.
Comparison of Spastic, Athetoid, and Normal Children on Sensory-Motor Abilities

Many of the sensory-motor abilities of cerebral palsyed children are inferior to the sensory-motor abilities of normal children. This is not surprising as many of the etiological factors of cerebral palsy are analogous to sensory-motor disorders. The brain damage resulting in cerebral palsy is seldom so selective that only one function is impaired.

**Visual disorders:** Children with cerebral palsy have a high percentage of visual disorders and the incidence figure is several times greater than that for the general population, which is approximately three to five percent. The New Jersey Study (Hopkins, Bice, and Colton, 1954) indicates that 27.6 percent of the 1297 cerebral palsyed children studied had visual defects. Approximately 27 percent of the spastics and 20 percent of the athetoids had defective or questionable vision.

Denhoff and Robinault (1960, p. 63) stated: "Various authors agree that over 50 per cent of the cerebral-palsyed children have oculomotor defects and 25 per cent or more have subnormal vision."

In the following passage, Keats (1965, p. 275) discusses visual defects in cerebral palsyed children:

Cerebral palsyed children present a high proportion of visual abnormalities. These abnormalities are in most cases neurological abnormalities directly related to the cerebral
pathology and they include defective eye movements, blindness, impaired vision, and field of vision abnormalities. . . . Our experience with athetoids particularly the deaf athetoids of the pitch cut-off type has shown a high incidence of a specific defect of upward movement of the eyeballs. . . . The most frequent defects [sic] found in the spastic child, particularly the paraplegics, was an internal strabismus.

The spastics appear to have visual problems associated with muscle imbalance while the athetoids have a greater degree of hyperopia according to Donlon (1966).

Hearing disorders: Since most of the etiologic factors of cerebral palsy can concomitantly cause auditory damage, there is a significantly greater incidence of auditory impairment in cerebral palsied populations. Cerebral palsied children are also more susceptible to the adventitious childhood diseases that produce hearing losses.

According to Cardwell (1956, p. 314): "Hearing loss probably affects less than 4 per cent of the general population. In contrast to this, the incidence in children with cerebral palsy is much higher." Nober (1966, p. 279) found estimates of hearing loss in the cerebral palsied population ranging from six percent to 41 percent and stated: "When the various estimates of incidence are collated without regard to cerebral palsy type, the mean incidence is approximately 22 per cent and the median 17 per cent."

The New Jersey Study (Hopkins et al., 1954) reported 13.3 percent of the cerebral palsied as having hearing problems, with the athetoid rate three times that of the spastic.
There are three reasons for the disparity in studies dealing with hearing defects in cerebral palsy: disagreement as to the proper criteria for determining a significant hearing loss, the difficulty of separating a hearing loss from aphasia, autism, and mental retardation, and the use of different populations.

Speech impairments: The most frequent handicap accompanying cerebral palsy is defective speech. Lencione (1966, p. 221) stresses:

The term "cerebral palsy speech" is sometimes used to describe the slow, labored, distorted speech patterns of the child with cerebral palsy. Essentially, however, there is no speech and language disorder that is uniquely characteristic of the cerebral palsied child . . . Speech problems may range from mild to severe and . . . In general, these problems fall into several broad categories which include language delay, articulatory disorders, intelligibility, and breathing disorders.

Lorenze, Sokoloff and Cruz (1962) studied 192 cerebral palsied children and found 84 percent had speech problems. One-half of these children had delayed language development; one-quarter had inadequate speech-sound production; and a small number had a combination of both difficulties.

The speech and linguistic abilities of cerebral palsied children were studied by Hammill, Irwin and Myers (1968) and the spastics were found to be superior to athetoids on intelligibility and articulation. Differences between the spastic and athetoid groups on sound discrimination, abstraction, vocabulary and auditory decoding tests were non-significant.
The following statement by Hopkins et al. (1954, pp. 9-10) concerns the 1224 cerebral palsied children studied in the New Jersey Study for speech problems:
"Briefly stated, speech is the major involvement of all four [cerebral palsied] groups but this is also true in all typical groups of children. The extent of speech defects varying from 52.0 per cent for the spastic to 88.7 per cent for the athetoid is extremely significant."

Lencione (1966) reported that 70 percent of the spastics and 31 percent of the athetoids had intelligible speech.

All of the studies relating to the speech and language abilities of cerebral palsied children seem to indicate that these children are inferior to children in the general population in most aspects of oral language.

Comparison of Spastic, Athetoid, and Normal Children on Psycholinguistic Abilities

Two studies dealing with the psycholinguistic abilities of spastic and athetoid children found that these children possess different language abilities. Both McCarthy (1957) and Myers (1963) stated the differences between spastic and athetoid children could be related to the differential brain injury of each type.

McCarthy (1957) used the Differential Language Facilities Test with 61 spastic and 23 athetoid children between the chronological ages of 2-0 and 8-7. These
children were statistically matched on CA and MA. The Differential Language Facilities Test (DLFT) was a predecessor to the Illinois Test of Psycholinguistic Abilities (ITPA) which was developed in 1961 by Kirk, McCarthy, and Kirk (Rev. 1968). McCarthy found spastic children were significantly superior to athetoid children on the DLFT in the area of expressive language and that the differences in overall language ability in favor of the spastic were due chiefly to group differences on tests of fine motor coordination ability. The athetoid involvement appeared to be more devastating to expressive language ability than spasticity.

Myers (1963) conducted a similar study and used the experimental ITPA to test the 68 spastic, 24 athetoid, and 32 normal subjects. She statistically matched the subjects on MA and IQ before comparing the groups on language ability. In her summary, Myers (1963, pp. 89-90) listed the following results:

1. Normal children were clearly superior to both cerebral palsied groups on over-all psycholinguistic ability.

2. Athetoid children were superior to spastics on two tests at the representational level, but were inferior on the tests at the automatic-sequential level.

3. There was no difference between the cerebral palsied groups in over-all psycholinguistic ability.

4. Spastics were equal to normals on tests at the automatic-sequential level, but inferior on the remaining tests.
5. Athetoids were equal to normals on three of six tests at the representational level and inferior on the other tests.

6. Two factors—a Representational Level factor and an Automatic-Sequential Level factor—were extracted when the data for the cerebral palsied were factor analyzed.

7. Athetoids were superior to spastics on the representational factor; spastics were superior on the automatic-sequential factor.

8. Discriminant analysis demonstrated that the ITPA was adequate to separate the three groups used in the study.

The spastics responded as Myers postulated they would. The athetoids did not do as well on the representational level as she thought they would. It was believed by Myers (1963, pp. 90-91) that: "... athetoids in this sample showed evidence of having more diffuse brain damage than the spastics. ... The athetoids responded as a group with subcortical and cortical damage."

The above studies showed spastic and athetoid children can demonstrate different abilities when possessing similar IQ, MA, and CA.

**Comparison of Spastic, Athetoid, and Normal Children on Perceptual and Cognitive Abilities**

The studies reviewed in this section dealt with several facets of intellectual functioning. Assessment of perceptual and cognitive abilities is difficult for several reasons:
1. The associated handicaps, such as speech, hearing, visual, and mental impairments, may mask the intellectual functioning.

2. Assessment tasks which rely upon speech and/or motor ability put the cerebral palsied child at a disadvantage.

3. Adaptation of test materials, which is often necessary in assessing cerebral palsied children, may result in findings that can not be considered the same as when the test is administered in the standard procedure.

Perceptual abilities: Dolphin and Cruickshank (1951a, 1951b, 1952) did repeated research on cerebral palsy. The conclusions indicated that cerebral palsied subjects were inferior to children in the general population in distinguishing the figure from the background. The cerebral palsied group had visual and tactile problems not characteristic to children in the general population.

Wedell (1960, pp. 223-225) made the following three points about cerebral palsy and perceptual impairment:

(1) The results indicate fairly clearly that perceptual impairment is not a general concomitant of cerebral palsy, but rather that it is mainly associated with bilateral and left-sided spasticity. . . .

(2) Perceptual impairment has often been regarded as a diagnostic indication of brain injury. The present findings suggest that perceptual impairment does indicate brain injury, but that its absence has no diagnostic value. . . .
Since the performance levels of the control group are shown to rise in the M.A. and C.A. ranges studies, the improvement in performance in all groups is likely to represent normal maturational processes to some degree.

Abercrombie et al. (1964) studied 39 cerebral palsied children with a neurological examination, the Wechsler Intelligence Scale for Children, the Marianne Frostig Developmental Test of Visual Perception, the Shape Matching Test, and the Benton Battery of Right-Left Discrimination. They (1964, p. 623) concluded: "There was no clear pattern of relationship with impairments on the tests of somatic sensation and perception made in the neurological examination, and impairment in the psychological tests."

The studies reviewed about perceptual abilities were inconclusive and further research in this area is needed. The overall superiority of normal children was again apparent.

**Cognitive abilities:** The testing of intellectual functioning of cerebral palsied children has been typically done using the 1965 Wechsler and the 1960 Binet Intelligence Scales. Studies have found that the majority of cerebral palsied children fall into the retarded range (Taylor, 1961; Hohman and Freedheim, 1958; Schonell, 1956; Hopkins et al., 1954). Functionally retarded is the term many use to describe the intellectual abilities of cerebral palsied children.
Similar intellectual quotients were reported for the spastic and athetoid, 71.94 and 72.60 (Bice and Cruickshank, 1966). A group of physically handicapped children between the ages of six and twelve were studied by Love (1970).

He (1970, p. 301) compared 36 cerebral palsied children to 25 children classified as "other physical handicaps" and found:

Sixty-nine percent of all children in this study fell into the secondary general classification of mentally retarded (IQ's under 90). Of the cerebral palsied group, 80 percent were mentally retarded as compared to 52 percent of the "other" group.

In the cerebral palsied group, 44 percent were found to be educably retarded (IQ's 50-79), as compared to 20 percent of the "other" group.

Thirty-one percent of the cerebral palsied group and 28 percent of "others" were slow learners (IQ's 80-89).

Five percent of the cerebral palsied children and 4 percent of the "others" were trainably retarded (IQ's below 50).

Dundson (1952), Cardwell (1956), and Cruickshank (1966) reviewed the studies on intelligence and cerebral palsy and reported that from 48.8 to 58.8 percent of these children have intellectual quotients under 70.

According to Nielsen (1966, p. 52): "between one-third and one-quarter of the cerebral-palsied group are of average to above average intelligence, while the remainder suffer from a mild or severe form of mental retardation."

The findings reported in this section indicate the influence of the associated handicaps upon the intellectual functioning of cerebral palsied children. The diffuse brain damage along with speech and motor problems makes
intellectual functioning in cerebral palsied children extremely difficult to assess. The standard intellectual assessment procedures usually find about 50 percent of the cerebral palsied functioning in the retarded range.

Summary

The literature concerning the different abilities and disabilities of spastic and athetoid children was reviewed. The evidence indicates that non-handicapped children are superior to cerebral palsied children in most abilities. Different incidences of sensory-motor defects for the spastic and athetoid have been found. The findings suggest that the localization and degree of brain damage resulting in athetosis appears to be much more devastating to the expressive language ability than the localization and degree of brain damage resulting in spasticity. Despite similar IQ, MA, and CA, spastic and athetoid children differed in psycholinguistic ability. The relationship between language and intelligence is readily apparent and defects in either function influences the other ability. These differences may relate to different mental abilities in the spastic and athetoid.

This study utilized a new approach for investigating the possible differences in mental abilities of spastic and athetoid subjects. The theoretical framework of Jensen, which was derived from his study of mentally retarded and
culturally deprived subjects, was applied to cerebral palsied subjects; specifically spastics and athetoids.
CHAPTER III

STUDY PROCEDURES

This chapter is devoted to a description of the sampling and selection procedures, the instruments used, the methodology of data gathering, and the statistical procedures employed in the analysis of the results.

Subjects

Criteria for the Selection of Subjects

The population chosen for this study met the following criteria:

1. A medical diagnosis of either spastic or athetoid cerebral palsy. Only uncomplicated cases were used and rare or mixed cases were not included.

2. No severe visual or hearing defects. Subjects whose medical examinations reported "no pathology" or "within normal limits" in terms of vision and hearing were chosen.

3. Understandable speech. The intelligibility of the child's speech rather than the articulation was used as the guide.

4. Chronological age between 8-0 and 16-0. This was used because of apparent success of test instruments within this age range.
5. A minimum IQ of 70 or equivalent learning ability as determined by the examiner if no score was given.

The intent of the criteria was to select subjects essentially alike and to assure that the test results would be valid for the age ranges used.

Method of Selection

Several sources were used to locate the subjects for this study: Crippled Children's Clinic, Cerebral Palsy Foundation of Southern Arizona, Tucson School District No. 1, Sunnyside School District, Amphitheater School District, and Flowing Wells School District, all located in Tucson, Arizona. The United Cerebral Palsy Association of Central Arizona, Scottsdale School District, Washington School District, and Gompers Memorial Rehabilitation Center, all located in Phoenix, Arizona, and El Monte and La Puente Schools in Los Angeles County, California were also sources of subjects. Table I presents the different sources used to locate subjects.

Description of Population Sample

Twenty-six spastic and 16 athetoid subjects were used in this study. Each subject met the selection criteria and was personally interviewed by the author before testing. The athetoid subjects appeared to be more physically involved than the spastics. The speech and motor problems of the athetoid may be the reasons why so few are in regular classrooms.
TABLE I

SCHOOL PLACEMENT OF SPASTIC AND ATHETOID SUBJECTS

<table>
<thead>
<tr>
<th>Placement</th>
<th>Spastic N</th>
<th>Athetoid N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular Public School</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Public Special Class</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>Private Special Class</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>26</strong></td>
<td><strong>16</strong></td>
</tr>
</tbody>
</table>

Table II presents the age distribution of the subjects used in this study. The spastic and athetoid subjects were almost evenly divided over the age ranges.

Table III presents the composition of the population according to sex. The ratio of boys to girls in the spastic and athetoid groups is approximately identical to the overall sex ratio and the ratio of athetoids to spastics. Hopkins et al. (1954) report the incidence by sex of cerebral palsy to be 57.0 percent males and 43.0 percent females, which is similar to the population of this study.
### TABLE II

**CHRONOLOGICAL AGE DISTRIBUTION OF SPASTIC AND ATHETOID SUBJECTS**

<table>
<thead>
<tr>
<th>Chronological Age</th>
<th>Spastic N</th>
<th>Athetoid N</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-0 to 9-11</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>10-0 to 11-11</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>12-0 to 13-11</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>14-0 to 15-11</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>26</strong></td>
<td><strong>16</strong></td>
</tr>
<tr>
<td><strong>Age Range</strong></td>
<td><strong>8-3 to 15-0</strong></td>
<td><strong>8-3 to 15-5</strong></td>
</tr>
<tr>
<td><strong>Mean (X) Age</strong></td>
<td><strong>11-8</strong></td>
<td><strong>11-9</strong></td>
</tr>
</tbody>
</table>

### TABLE III

**CLASSIFICATION BY SEX AND TYPE OF CEREBRAL PALSY**

<table>
<thead>
<tr>
<th>Sex</th>
<th>Spastic N</th>
<th>Athetoid N</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>17</td>
<td>9</td>
<td>26</td>
</tr>
<tr>
<td>Girls</td>
<td>9</td>
<td>7</td>
<td>16</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>26</strong></td>
<td><strong>16</strong></td>
<td><strong>42</strong></td>
</tr>
<tr>
<td><strong>Percent</strong></td>
<td><strong>61.9</strong></td>
<td><strong>38.1</strong></td>
<td></td>
</tr>
</tbody>
</table>
Description of Instruments

Four instruments were used in this study. Level I abilities were measured by the paired associates (adapted from Price, 1971) and digit span (Wechsler, 1949) tests. Level II abilities were measured by Raven's Progressive Matrices (1956 revision) and a double alternation card problem (Hunter, 1928; Hodges, 1953). Since cerebral palsied subjects do better on verbal than performance items due to motor involvement, measures of a verbal nature were chosen for this study.

Level I Instruments: The digit span, forward and backward, from the subtests of the Wechsler Intelligence Scale for Children (Wechsler, 1949) was used as one measure of Level I abilities. Jensen (1970) mentions the digit span as a relatively pure measure of Level I ability. Wechsler (1958) says the memory span, whether for digits forward or backward, generally correlates poorly with other tests of intelligence. Therefore, the digit span, being primarily a measure of rote memory, appears to measure something other than the Level II abilities intelligence tests measure.

The other measure of Level I abilities was the paired-associates test. This test is an adaptation and revision of that used by Price (1971). The paired-associates test consists of twelve pairs of pictures which are drawn on 8" by 12" paper enclosed in plastic sheets. The first or stimulus picture is drawn on the back of the sheet identical
to the front. All of the drawings are of common objects that can be easily identified. The response figures have been organized by a speech therapist to represent words that require less air pressure and thoracic activity so that athetoids are not penalized. The paired-associates test has been used to study the abilities of normal and retardates (Baumeister, 1963; O'Connor and Hermelin, 1963; and Iscoe and Semler, 1964). Jensen and Rohwer (1970) stated the paired associates test is a reliable measure of Level I functioning.

**Level II Instruments:** The Progressive Matrices (Raven, 1956 revision) is highly regarded by Jensen (1968a, 1968b, 1970) as a measure of Level II abilities. The test consists of 60 problems which get progressively more difficult, requiring more complex mental activities for correct solution. Raven (1956) describes the test as a valid means of assessing a person's capacity for clear thinking and accurate intellectual work. The directions are simple and the subject can respond by pointing, naming, or gesturing. There is no time limit on this test.

The other test of Level II abilities is the double alternation card problem. Hunter (1928) developed the double alternation problem with animals as subjects. It has since been used with rats, cats, dogs, raccoons, monkeys, and humans (Gellerman, 1931; Hunter and Bartlett, 1948, Pascal
and Zax, 1955; and Hodges, 1953). Gellerman (1931, p. 199) has stated:

... differences in the double alternation behavior of different subjects indicate that double alternation problems require, in their solution, an ability which is present in the highest degree in human subjects. ... the double alternation problem may be placed with the delayed reaction experiment as a valid method of testing for the presence of symbolic processes in human and infra-human subjects.

Pascal and Zax (1955) used the double alternation problem to estimate the intellectual level of cerebral palsied children and found a high correlation between success on the double alternation problem and mental age. Hodges (1953) used the double alternation card problem with 240 males and found it to be a valid measure of conceptualization in children between the ages of six and twelve.

Methodology of Data Gathering

Each subject was examined individually by the author. The presentation order of each task in Level I and Level II was alternated but because of the hierarchial dependence of Level II tasks upon Level I ability, Level I tasks were always given first. The time required for all four measures varied from 35 to 75 minutes, with the average administration taking about 60 minutes. All of the subjects were tested in the school or facility they attended and every effort was made to standardize the administration procedure. The instructions were read from a typed sheet.
The Paired-Associates Test (Level I): For the paired-associates task, twelve pairs of pictures on separate sheets were used. The front side contained the stimulus item and the response item, while the back side contained only the stimulus item. The front side was shown the subject, one sheet at a time. The following instructions were given: "I am going to show you some pictures. At this time I only want you to tell me what the pictures are." After the subject had correctly identified the objects, the instructions continued:

Now I am going to show you each of the cards again--this time you must try to remember what the two pictures are on each card because the next time I will only show you the first picture on each card and you must remember and tell me what the other picture was [at this point the subject was shown the back of card one and saw that only the stimulus item was present](Price, 1971).

The cards then were placed in front of the subject at three second intervals. After showing the last card, they were reversed and the subject was shown only the stimulus picture on the back of each card beginning with card one. The answers were written down verbatim and the incorrect response cards were indicated on the record sheet. Next, the subject was instructed "We will try this one more time. This time I will show only the cards you missed and then we will try them again." The incorrect response cards were placed before the subject at regular intervals as before. The cards were then reversed and the examiner
recorded the subject's second attempts. A tabulation of the correct responses on the first attempt and the total score was then made.

The Digit Span Test (Level I): The digit span was administered according to the Wechsler (1949) manual for the Wechsler Intelligence Scale for Children (WISC). The digits were given at the rate of one per second on both the series, forward and backward, and one example was given to explain how to repeat digits backward. The total correct responses, on the first attempt for the digits forward and backward, were tabulated on the record sheet.

The Raven Progressive Matrices (Level II): The test contains a standardized procedure for administration. The booklet was given to the subject and the following directions were read:

Open the booklet to the first page. On the top of the page you see a pattern with a piece missing in the bottom right hand corner (pointing to the missing piece). At the bottom of the page you see six numbered pieces all of which will fit into the missing part but only one will fit and also complete the pattern. Which one do you think fits best? (If the subject indicated the wrong piece the correct piece and rationale for its selection is pointed out.) Continue through the book picking the best piece to complete the pattern on each page. There is no time limit on this test and you have as much time as you need (Raven, 1956 revision).

The examiner recorded the subject's choice on the answer sheet to conserve time and minimize physical problems.

The Double Alternation Card Problem (Level II): The other Level II task was the double alternation card problem.
Five ordinary playing cards, four black (clubs and spades) and one red (heart or diamond) were used in this test, with the red card designated as the goal card. The five cards are arranged out of the subject's vision so that the goal (red) card is twice in the first position and twice in the last position. The cards are placed before the subject in the following manner:

<table>
<thead>
<tr>
<th>1st presentation</th>
<th>2nd presentation</th>
<th>3rd presentation</th>
<th>4th presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject</td>
<td>Subject</td>
<td>Subject</td>
<td>Subject</td>
</tr>
<tr>
<td>*1 2 3 4 5</td>
<td>*1 2 3 4 5</td>
<td>1 2 3 4 5*</td>
<td>1 2 3 4 5*</td>
</tr>
</tbody>
</table>

*Indicates the position of the red card.

Four presentations, such as in the above diagram, represent one trial. Trials are continued until the subject can select the red card without error for two successive trials (eight presentations) or until 30 trials have been given. This test can be used with handicapped children because the subject can indicate his answer by either a verbal or motor response. A record sheet was used to record the position of each card the subject turned.

When the subject was successful in solving the double alternation problem, he was asked, "How did I place the red card so that you knew where to look for it?" The subject's reply was recorded verbatim. Seven scores can be obtained from this problem but only six were used. The
seventh score, total time, was discarded as the examiner felt it was more a measure of the examiner's dexterity in card shuffling than of the subject's ability.

The six scores that were used are from Hodges (1953):

1. Success or Failure--This score is merely whether the subject obtains the criterion of two correct trials on or before a total of thirty trials.

2. Verbalization or Non-Verbalization--If the subject is successful on the test, he is asked "How did I place the red card so that you knew where to look for it?" The subject must state that the red card was twice on the left and twice on the right or two times on this side (pointing) and two times on that side. If the subject is unable to verbalize the correct solution, his response is scored as Non-Verbalized.

3. The Number of Trials Score--This measure is the number of trials which the subject uses before he obtains the criterion of success. If the problem is not solved, his score is automatically thirty.

4. The Number of Total Errors Score--This is the number of black cards turned throughout the test. Even if the subject fails to solve the problem, the total number of errors can be counted.

5. The Number of Errors Prior to the Formation of the "End Concept"--The common pattern is random selection of cards until the subject becomes aware that the red card is
always on the ends. The point where the subject turns only the end cards (numbers one and five) is designated as the level at which the "end concept" occurs. The number of black cards turned up to this point are recorded for this score.

6. The Number of Errors After the Formation of the "End Concept"--This is the number of black cards turned after the "end concept" described above is established.

Statistical Procedures

The results from each of the instruments were tabulated and statistically treated by performing the Fisher Exact Probability Test and the Mann-Whitney U Test (Siegel, 1956) to the age ranges found in Table II. Two scores of the double alternation problem; success or failure and verbalization or non-verbalization, required the Fisher Exact Probability Test for analysis at the four age ranges and the chi square test was used on these two measures when analyzed for sex differences. The Mann-Whitney U Test was used with the other scores.

The .05 level of significance was used for two reasons. First, it was believed that it was more important to find any differences that may be present between spastic and athetoid subjects in this study than to miss differences at a higher level of significance. Second, the sample size for each age group was small and in order to find differences that may be present a lower significance level was employed.
CHAPTER IV

RESULTS OF THE STUDY

The purpose of this chapter is to report the findings in relation to spastic and athetoid performances on the four measures under investigation, two at Level I and two at Level II. The Level I measures were (1) the test of paired-associates (adapted from Price, 1971) and (2) the digit span subtest of the Wechsler Intelligence scale for Children (1949). The Level II measures were (1) the Raven Progressive Matrices (Raven, 1956 revision) and (2) the double alternation card problem (Hunter, 1928; Hodges, 1953).

Level I Results

Paired-Associates Test (P.A.): This test was administered in two trials to see the effect of practice upon the total score. The number of correct first attempt responses by the subjects of the four age groups is presented in Table IV. These data were subjected to four Mann-Whitney U Tests (M-W U) which yielded the values reported below.

The results from Table IV indicate that no significant differences were found between spastic (S) and athetoid (A) children at the four age groups on the first attempt of the paired-associates test.
TABLE IV

SPASTIC AND ATHETOID PERFORMANCE ON FIRST ATTEMPT
OF PAIRED-ASSOCIATES TEST (LEVEL I)

<table>
<thead>
<tr>
<th>Age Range</th>
<th>N</th>
<th>Score Low-High</th>
<th>M-W U</th>
<th>Lev. of Sign.</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-0 to 9-11</td>
<td>S = 7 A = 4</td>
<td>2 - 11</td>
<td>6</td>
<td>N.S.</td>
</tr>
<tr>
<td>10-0 to 11-11</td>
<td>S = 7 A = 5</td>
<td>1 - 9</td>
<td>14.5</td>
<td>N.S.</td>
</tr>
<tr>
<td>12-0 to 13-11</td>
<td>S = 7 A = 3</td>
<td>2 - 10</td>
<td>10.5</td>
<td>N.S.</td>
</tr>
<tr>
<td>14-0 to 15-11</td>
<td>S = 5 A = 4</td>
<td>1 - 9</td>
<td>7.0</td>
<td>N.S.</td>
</tr>
</tbody>
</table>

aN.S. = not significant

On the second trial, only the cards missed on the first attempt were presented. The total score is the combined number of correct answers on the first and second presentations. The total scores on the paired-associates test for the four age groups are presented in Table V.

The data from Table V reveals a difference at the .05 level between spastic and athetoid children in the 8-0 to 9-11 age group. A further analysis revealed that the median scores of the spastic and athetoid groups at this age range were 8.75 and 5.5 respectively. No significant differences between spastic and athetoid children on the total score of the paired-associates test was found in the other age groups.
### TABLE V

**SPASTIC AND ATHETOID PERFORMANCE ON TOTAL SCORE OF PAIRED-ASSOCIATES TEST (LEVEL I)**

<table>
<thead>
<tr>
<th>Age Range</th>
<th>N</th>
<th>Score Low-High</th>
<th>M-W</th>
<th>Lev. of Sign.</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-0 to 9-11</td>
<td>S = 7 A = 4</td>
<td>4 - 12 3 - 8</td>
<td>5</td>
<td>.05</td>
</tr>
<tr>
<td>10-0 to 11-11</td>
<td>S = 7 A = 5</td>
<td>1 - 12 5 - 12</td>
<td>15.5</td>
<td>N.S.</td>
</tr>
<tr>
<td>12-0 to 13-11</td>
<td>S = 7 A = 3</td>
<td>4 - 12 4 - 12</td>
<td>9</td>
<td>N.S.</td>
</tr>
<tr>
<td>14-0 to 15-11</td>
<td>S = 5 A = 4</td>
<td>2 - 11 6 - 10</td>
<td>9</td>
<td>N.S.</td>
</tr>
</tbody>
</table>

\[a\] .05 level of significance; N.S. = not significant

**Digit Span Test (D.S.):** The digit span test of the WISC was administered according to the manual. The results of the digit span, forward and backward, for the four age groups are presented in Table VI. The results reported in Table VI revealed no significant differences between spastic and athetoid children at the four age groups on the digit span test.

**Level II Results**

**Raven Progressive Matrices (R.P.M.):** The Raven Progressive Matrices (Raven, 1956 revision) are highly regarded by Jensen as a Level II indicator. The test was administered individually and the total correct responses
were tabulated. The scores and results of the Mann-Whitney U Test for the four age groups are presented in Table VII.

TABLE VI

SPASTIC AND ATHETOID PERFORMANCE ON DIGIT SPAN TEST (LEVEL I)

<table>
<thead>
<tr>
<th>Age Range</th>
<th>N</th>
<th>Score Low-High</th>
<th>M-W U</th>
<th>Lev. of Sign.</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-0 to 9-11</td>
<td>S = 7, A = 4</td>
<td>5 - 10, 3 - 8</td>
<td>6.5</td>
<td>N.S.</td>
</tr>
<tr>
<td>10-0 to 11-11</td>
<td>S = 7, A = 5</td>
<td>5 - 9, 5 - 9</td>
<td>14.5</td>
<td>N.S.</td>
</tr>
<tr>
<td>12-0 to 13-11</td>
<td>S = 7, A = 3</td>
<td>5 - 10, 6 - 7</td>
<td>4</td>
<td>N.S.</td>
</tr>
<tr>
<td>14-0 to 15-11</td>
<td>S = 5, A = 4</td>
<td>6 - 9, 7 - 9</td>
<td>5</td>
<td>N.S.</td>
</tr>
</tbody>
</table>

aN.S. = not significant

TABLE VII

SPASTIC AND ATHETOID PERFORMANCE ON RAVEN PROGRESSIVE MATRICES (LEVEL II)

<table>
<thead>
<tr>
<th>Age Range</th>
<th>N</th>
<th>Score Low-High</th>
<th>M-W U</th>
<th>Lev. of Sign.</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-0 to 9-11</td>
<td>S = 7, A = 4</td>
<td>8 - 32, 9 - 27</td>
<td>13</td>
<td>N.S.</td>
</tr>
<tr>
<td>10-0 to 11-11</td>
<td>S = 7, A = 5</td>
<td>6 - 20, 9 - 43</td>
<td>7.5</td>
<td>N.S.</td>
</tr>
<tr>
<td>12-0 to 13-11</td>
<td>S = 7, A = 3</td>
<td>8 - 29, 14 - 18</td>
<td>9.5</td>
<td>N.S.</td>
</tr>
<tr>
<td>14-0 to 15-11</td>
<td>S = 5, A = 4</td>
<td>9 - 37, 29 - 31</td>
<td>6.4</td>
<td>N.S.</td>
</tr>
</tbody>
</table>
The results reported in Table VII revealed that no significant differences exist between these spastic and athetoid children at the four age groups on the Raven Progressive Matrices.

**Double Alternation Card Problem (D.A.):** Six different measures of Level II abilities were obtained from the spastic and athetoid performances on the double alternation card problem: (1) success or failure; (2) verbalization or non-verbalization; (3) total trials; (4) total errors; (5) errors before the end concept; (6) errors after the end concept. The probability that the differences between the performances of the spastics and athetoids occurred by chance on the first two measures was determined by the Fisher Exact Probability Test (Siegel, 1956). The Mann-Whitney U Test (Siegel, 1956) was used to determine if significant differences existed between the spastics and athetoids on the four remaining measures. Table VIII reports the data about the number of subjects that solved the problem and the number that failed to solve the problem according to the criteria of two successful trials (eight presentation). Inspection of Table VIII reveals that no significant differences were found between spastic and athetoid subjects.

The ability to verbalize the correct solution was also investigated and the number of subjects who were successful or unsuccessful in verbalizing the solution are found in Table IX.
### TABLE VIII
SUCCESS OR FAILURE OF SPASTICS AND ATHETOIDS ON DOUBLE ALTERNATION CARD PROBLEM (LEVEL II)

<table>
<thead>
<tr>
<th>Age Range</th>
<th>N</th>
<th>Suc.</th>
<th>Fail.</th>
<th>Prob.</th>
<th>Lev. of Sign.</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-0 to 9-11</td>
<td>S = 7, A = 4</td>
<td>2</td>
<td>2</td>
<td>.38</td>
<td>N.S.</td>
</tr>
<tr>
<td>10-0 to 11-11</td>
<td>S = 7, A = 5</td>
<td>4</td>
<td>3</td>
<td>.44</td>
<td>N.S.</td>
</tr>
<tr>
<td>12-0 to 13-11</td>
<td>S = 7, A = 3</td>
<td>3</td>
<td>1</td>
<td>.50</td>
<td>N.S.</td>
</tr>
<tr>
<td>14-0 to 15-11</td>
<td>S = 5, A = 4</td>
<td>3</td>
<td>2</td>
<td>.48</td>
<td>N.S.</td>
</tr>
</tbody>
</table>

*a* Fisher Exact Probability; *b* N.S. = not significant

### TABLE IX
VERBALIZATION OR NON-VERBALIZATION ON DOUBLE ALTERNATION CARD PROBLEM (LEVEL II)

<table>
<thead>
<tr>
<th>Age Range</th>
<th>N</th>
<th>V.</th>
<th>N.V.</th>
<th>Prob.</th>
<th>Lev. of Sign.</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-0 to 9-11</td>
<td>S = 7, A = 4</td>
<td>1</td>
<td>0</td>
<td>.64</td>
<td>N.S.</td>
</tr>
<tr>
<td>10-0 to 11-11</td>
<td>S = 7, A = 5</td>
<td>4</td>
<td>3</td>
<td>.44</td>
<td>N.S.</td>
</tr>
<tr>
<td>12-0 to 13-11</td>
<td>S = 7, A = 3</td>
<td>3</td>
<td>1</td>
<td>.29</td>
<td>N.S.</td>
</tr>
<tr>
<td>14-0 to 15-11</td>
<td>S = 5, A = 4</td>
<td>3</td>
<td>2</td>
<td>.48</td>
<td>N.S.</td>
</tr>
</tbody>
</table>

*a* Fisher Exact Probability; *b* N.S. = not significant
Examination of Table IX reveals that there were no significant differences between spastic and athetoid subjects in the four age groups with respect to their ability to verbalize logical explanations for their success on the double alternation card problem.

The number of total trials of spastic and athetoid children on the double alternation card problem before criterion was reached or testing was terminated is presented in Table X. The Mann-Whitney U Test was used to determine if significant differences existed between spastic and athetoid subjects on this measure.

The results in Table X reveal no significant differences between spastic and athetoid subjects grouped according to age with respect to the number of total trials on the double alternation card problem.

Table XI presents the number of total errors of spastic and athetoid children on the double alternation card problem.

An inspection of Table XI reveals no significant differences were found in the number of total errors between spastic and athetoid children in any of the four age groups.

Table XII presents the number of errors before the end concept was reached on the double alternation card problem. The end concept is the point where the subjects picked only the end cards (numbers one and five).
### TABLE X

TOTAL TRIALS OF SPASTICS AND ATHETOIDS ON DOUBLE ALTERNATION CARD PROBLEM (LEVEL II)

<table>
<thead>
<tr>
<th>Age Range</th>
<th>N</th>
<th>Test Low-High</th>
<th>M-W</th>
<th>Lev. of Sign.</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-0 to 9-11</td>
<td>S = 7 A = 4</td>
<td>8 to 30</td>
<td>11</td>
<td>N.S.</td>
</tr>
<tr>
<td>10-0 to 11-11</td>
<td>S = 7 A = 5</td>
<td>12 to 30</td>
<td>15</td>
<td>N.S.</td>
</tr>
<tr>
<td>12-0 to 13-11</td>
<td>S = 7 A = 3</td>
<td>8 to 30</td>
<td>10</td>
<td>N.S.</td>
</tr>
<tr>
<td>14-0 to 15-11</td>
<td>S = 5 A = 4</td>
<td>4 to 30</td>
<td>7.5</td>
<td>N.S.</td>
</tr>
</tbody>
</table>

aN.S. = not significant

### TABLE XI

TOTAL ERRORS OF SPASTICS AND ATHETOIDS ON DOUBLE ALTERNATION CARD PROBLEM (LEVEL II)

<table>
<thead>
<tr>
<th>Age Range</th>
<th>N</th>
<th>Test Low-High</th>
<th>M-W</th>
<th>Lev. of Sign.</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-0 to 9-11</td>
<td>S = 7 A = 4</td>
<td>22 to 197</td>
<td>8.5</td>
<td>N.S.</td>
</tr>
<tr>
<td>10-0 to 11-11</td>
<td>S = 7 A = 5</td>
<td>39 to 107</td>
<td>17</td>
<td>N.S.</td>
</tr>
<tr>
<td>12-0 to 13-11</td>
<td>S = 7 A = 3</td>
<td>36 to 105</td>
<td>10</td>
<td>N.S.</td>
</tr>
<tr>
<td>14-0 to 15-11</td>
<td>S = 5 A = 4</td>
<td>7 to 108</td>
<td>7</td>
<td>N.S.</td>
</tr>
</tbody>
</table>

aN.S. = not significant
TABLE XII

ERRORS BEFORE END CONCEPT FOR SPASTICS AND ATHETOIDS ON DOUBLE ALTERNATION CARD PROBLEM (LEVEL II)

<table>
<thead>
<tr>
<th>Age Range</th>
<th>N</th>
<th>Test Low-High</th>
<th>M-W U</th>
<th>Lev. of Sign.◊</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-0 to 9-11</td>
<td>S = 7 A = 4</td>
<td>14 to 145 7 to 45</td>
<td>10</td>
<td>N.S.</td>
</tr>
<tr>
<td>10-0 to 11-11</td>
<td>S = 7 A = 5</td>
<td>17 to 71 13 to 61</td>
<td>14</td>
<td>N.S.</td>
</tr>
<tr>
<td>12-0 to 13-11</td>
<td>S = 7 A = 3</td>
<td>11 to 62 11 to 100</td>
<td>9.5</td>
<td>N.S.</td>
</tr>
<tr>
<td>14-0 to 15-11</td>
<td>S = 5 A = 4</td>
<td>7 to 82 4 to 55</td>
<td>9</td>
<td>N.S.</td>
</tr>
</tbody>
</table>

◊N.S. = not significant

There were no significant differences between spastic and athetoid children in the four age groups on the number of errors before the end concept of the double alternation card problem.

Table XIII presents the data for the number of total errors after the end concept for spastic and athetoid children on the double alternation card problem. The Mann-Whitney U Test was used to analyze the data for the four age groups.

There were no significant differences between spastic and athetoid children at the various age ranges on the number of errors after the end concept of the double alternation problem.
TABLE XIII

ERRORS AFTER END CONCEPT FOR SPASTICS AND ATHETOIDS ON DOUBLE ALTERNATION CARD PROBLEM (LEVEL II)

<table>
<thead>
<tr>
<th>Age Range</th>
<th>N</th>
<th>Test Low-High</th>
<th>M-W U</th>
<th>Lev. of Sign.</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-0 to 9-11</td>
<td>S = 7, A = 4</td>
<td>0 to 123, 6 to 30</td>
<td>14</td>
<td>N.S.</td>
</tr>
<tr>
<td>10-0 to 11-11</td>
<td>S = 7, A = 5</td>
<td>0 to 62, 0 to 45</td>
<td>20.5</td>
<td>N.S.</td>
</tr>
<tr>
<td>12-0 to 13-11</td>
<td>S = 7, A = 3</td>
<td>0 to 64, 0 to 43</td>
<td>8.5</td>
<td>N.S.</td>
</tr>
<tr>
<td>14-0 to 15-11</td>
<td>S = 5, A = 4</td>
<td>0 to 58, 1 to 92</td>
<td>6</td>
<td>N.S.</td>
</tr>
</tbody>
</table>

aN.S. = not significant

Analysis by Sex

The data were analyzed according to sex in the spastic, athetoid, and total groups using the Mann-Whitney U Test and the chi square test. The findings are presented in Table XIV.

The results from Table XIV indicate there were no significant sex differences except when comparing the total cerebral palsied group. A significant difference (>0.01) was found on the first attempt of the paired-associates test and further analysis indicated the median scores for the boys and girls were 5.75 and 4.3 respectively.
TABLE XIV
ANALYSIS OF RESULTS BY SEX

<table>
<thead>
<tr>
<th></th>
<th>Spastic</th>
<th>Athetoid</th>
<th>Total</th>
<th>Lev. of Sign.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N_B=17; N_G=9</td>
<td>N_B=9; N_G=7</td>
<td>N_B=26; N_G=16</td>
<td></td>
</tr>
<tr>
<td>1st Attempt (P.A.)</td>
<td>U = 54.5</td>
<td>U = 20</td>
<td>U = 140.5</td>
<td>&gt; .01^a</td>
</tr>
<tr>
<td>Total Score (P.A.)</td>
<td>U = 68.5</td>
<td>U = 18.5</td>
<td>U = 155.5</td>
<td>N.S.</td>
</tr>
<tr>
<td>Digit Span</td>
<td>U = 64.5</td>
<td>U = 30.5</td>
<td>U = 189.5</td>
<td>N.S.</td>
</tr>
<tr>
<td>R.P.M.</td>
<td>U = 53</td>
<td>U = 24.5</td>
<td>U = 186</td>
<td>N.S.</td>
</tr>
<tr>
<td>S. or F. (D.A.)</td>
<td>X^2 = .29</td>
<td>X^2 = .33</td>
<td>X^2 = .10</td>
<td>N.S.</td>
</tr>
<tr>
<td>V. or NV. (D.A.)</td>
<td>X^2 = .28</td>
<td>X^2 = 2.35</td>
<td>X^2 = .30</td>
<td>N.S.</td>
</tr>
<tr>
<td>Tot. Trials (D.A.)</td>
<td>U = 67.5</td>
<td>U = 27.5</td>
<td>U = 188.5</td>
<td>N.S.</td>
</tr>
<tr>
<td>Tot. Errors (D.A.)</td>
<td>U = 50</td>
<td>U = 28</td>
<td>U = 184.5</td>
<td>N.S.</td>
</tr>
<tr>
<td>Errors bef. End Conc. (D.A.)</td>
<td>U = 66</td>
<td>U = 23</td>
<td>U = 198.5</td>
<td>N.S.</td>
</tr>
<tr>
<td>Errors aft. End Conc. (D.A.)</td>
<td>U = 62.5</td>
<td>U = 21</td>
<td>U = 160</td>
<td>N.S.</td>
</tr>
</tbody>
</table>

U = Mann-Whitney U Test  
X^2 = chi square test

^a = >.05 level of significance; N.S. = not significant
Summary of the Results

Following are summary statements of the results of this study based upon the hypotheses stated in Chapter I.

1. There is no significant difference between performances of spastic and athetoid subjects grouped according to age (see Table II) on the paired-associates test (adapted from Price, 1971) designed to measure Level I abilities.

This hypothesis was divided into two parts, first attempt and total score. The analysis of the results revealed that the only significant difference (.05) between spastic and athetoid subjects was on the first attempt at the 8-0 to 9-11 age group. Further analysis revealed the difference was in favor of the spastic group. The null hypothesis for the paired-associates test was accepted because the requirements for rejection were not met.

2. There is no significant difference between performances of spastic and athetoid subjects grouped according to age (see Table II) on the digit span test (Wechsler, 1949) which measures Level I ability.

The results revealed no significant differences between spastic and athetoid subjects on the digit span test (Wechsler, 1949) at the four age groups. The null hypothesis for the digit span test was accepted.

3. There is no significant difference between performances of spastic and athetoid subjects grouped
according to age (see Table II) on the Raven Progressive Matrices (Raven, 1956 revision) which measures Level II ability.

The results revealed no significant differences between spastic and athetoid subjects on the Raven Progressive Matrices at the four age groups. The null hypothesis for the Raven Progressive Matrices was accepted.

4. There is no significant difference between performances of spastic and athetoid subjects grouped according to age (see Table II) on a double alternation card problem (Hunter, 1928; Hodges, 1953) used to measure Level II ability.

The double alternation card problem was divided into six measures. Analysis of the results revealed no significant differences between spastic and athetoid subjects on the double alternation card problem at the four age groups. The null hypothesis for the double alternation card problem was accepted.

5. There are no significant sex differences between spastic and athetoid performances on the four tasks.

The results of the four tasks were analyzed for sex differences in the spastic, athetoid, and total cerebral palsy groups. Only one significant difference (> .01) in the total cerebral palsy group was found on the first attempt of the paired-associates test. Further analysis revealed that the difference was in favor of the cerebral palsied
boys. The null hypothesis for sex differences was accepted because the rejection requirements were not met.

Discussion of the Results

The requirements for rejecting the five null hypotheses were not met so the findings of this study indicate there were no significant differences between spastic and athetoid subjects with regard to their performances on Level I and Level II tasks.

Several reasons may explain why an overall pattern of functioning, such as found by McCarthy (1957) and Myers (1963), was not established for this sample.

1. The psycholinguistic model used by McCarthy and Myers may not be measuring the same levels of abilities as the instruments used in this study, which were based on the Jensen model.

2. There may be no differences between spastic and athetoid subjects on Level I and Level II abilities.

3. The tests may not have been sensitive enough to find the differences.

4. The variability of scores may be masking any differences present.

5. Other variables (schooling, environment, process deficits, intellectual development, etc.) affecting performance of cerebral palsied subjects may have to be controlled.
One of the important findings of this study was the fact that none of the groups (cerebral palsy, spastic, or athetoid) can be considered homogeneous in terms of performance on learning tasks. The interindividual variances of cerebral palsied groups suggest that group teaching techniques would be ineffective. For example, Table XI revealed that the spastic and athetoid performances in the 8-0 to 9-11 age range varied from 22 to 197 on the total errors of the double alternation card problem (Level II). Spastic and athetoid performances in the 14-0 to 15-11 age range varied from 7 to 123 on the same measure. Table V also revealed the variability of test scores. The highest possible score for the total score of the paired-associates test (Level I) was 12 and spastic and athetoid performances varied from 1 to 12 within the four age groups.

Since the spastic and athetoid groups performed similarly in this study, teaching techniques based upon different mental abilities cannot be recommended. Teachers of cerebral palsied children must evaluate each child with regard to his specific needs and plan remedial and prescriptive teaching techniques based upon individual behavioral objectives.
CHAPTER V

SUMMARY AND RECOMMENDATIONS

Cerebral palsied children differ in terms of their type of disability, associated handicaps, and mental ability. Inter- and intraindividual differences produce a wide range of abilities and different levels of functioning in cerebral palsied children.

McCarthy (1957) and Myers (1963) studied spastic and athetoid children and found that psycholinguistic differences did exist between these two types of cerebral palsy. Since language and intelligence are closely related, a supposition about different mental abilities for the spastic and athetoid types of cerebral palsy was formed.

Statement of the Problem

Records were examined from public and private schools and organizations in several southwestern communities in order to compile a list of 42 cerebral palsied subjects. Each subject selected for this study had a medical diagnosis of either spastic or athetoid cerebral palsy with no significant accompanying handicaps. Subjects had to have an IQ of 70 or equivalent learning ability and be in the 8-0 to 16-0 age range for inclusion in this study. Each subject was checked by the author for possession of understandable speech.

50
The intent of the criteria was to select a sample of 26 spastic and 16 athetoid subjects who were essentially alike and assure reasonably valid test results. Approximately equal numbers of spastic and athetoid subjects were selected in the four age groups.

**Procedures**

Four instruments were adapted or devised, according to Jensen's rationale, to measure Level I and Level II abilities. The Level I instruments were a paired-associates test and the digit span sub-test from the WISC. Level II tests included the Raven Progressive Matrices and the double alternation card problem. Each spastic and athetoid subject was tested individually in his school setting by the author.

**Results**

The results were statistically analyzed using the Mann-Whitney U Test, the Fisher Exact Probability Test, or the chi square test. The findings revealed:

1. A significant difference (.05) was found on the total score of the paired-associates test (Level I) in favor of spastics between the ages of 8-0 and 9-11. No significant differences were found for the other age groups on the paired-associates test.

2. Results from the second Level I task, digit span, revealed no significant differences between spastic and athetoid subjects in the four age groups.
3. Results from the Raven Progressive Matrices (Level II) revealed no significant differences between spastic and athetoid subjects in the four age groups.

4. Results from the second Level II task, the double alternation card problem, revealed no significant differences between spastic and athetoid subjects on the six measurements in the four age groups.

5. Results from the analysis for sex differences in the spastic, athetoid, and total cerebral palsy groups revealed a significant difference ($>.01$) in favor of the boys in the total cerebral palsy group on the first attempt of the paired-associates test (Level I).

**Discussion**

The five null hypotheses for this study were accepted. This indicates that there were no significant differences between spastic and athetoid performances on tasks designed to measure Jensen's Level I and Level II abilities for the subjects in this study.

One of the most important findings of this study was the discovery of the variability of test scores in the cerebral palsy groups. Although no significant differences were found between spastic and athetoid groups, the inter-individual variability of test scores suggest that cerebral palsy groups are more heterogeneous than homogeneous in learning ability. Therefore, different teaching and
remediation techniques for spastic and athetoid children should be based upon individualized teaching approaches.

**Recommendations for Future Study**

The following implications for future research are indicated from the results of this study:

1. Further research should be done using Jensen's Level I and Level II Theories of Mental Abilities on normal subjects to establish norms for future comparative studies.

2. Further research on the learning abilities of cerebral palsied children needs to be done by grouping on educational factors, such as rate of intellectual development (IQ), quality of intellectual development (process deficits), etc., rather than grouping cerebral palsied children on medical classifications.
APPENDIX A

TEST OF PAIRED-ASSOCIATES

The following pages show the Level I test of paired-associates (adapted from Price, 1971) used in this study.
Card 3
Card 12
APPENDIX B

JENSEN'S THEORETICAL FORMULATION

The following pages contain (in direct quotation) Jensen's (1968b, pp. 13-15) rationale for his Two-Level Theory of Mental Abilities.
A theory is proposed to account for our empirical findings. It is admittedly tentative and intended mainly to give direction to further research.

The theory states that the continuum of ability tests going from simple associative learning to conceptual problem solving is the phenotypic expression of two functionally dependent but genotypically independent types of mental processes, which may be labeled Level I and Level II. Level I processes are essentially associative and are best measured by tests such as digit span and serial rote learning; Level II processes involve transformations or complex operations performed on the stimulus input and are perhaps best represented in tests such as the Progressive Matrices. The biological or structural basis of Level I and Level II are seen as independent but functionally related in such a way that the rate and asymptote of phenotypic development of Level II performance depends upon the individual's status on Level I processes. For example, short-term memory is necessary for solving Progressive Matrices, but the covert mental processes of generalization, abstraction, and symbolic mediation needed for the Matrices are not necessary for digit span performance.

The theory also states that Level I and Level II abilities are distributed differently in upper and lower socioeconomic classes. Level I is distributed about the same in all SES groups, while Level II is distributed about a higher mean in the upper classes than in the lower.

To summarize, our findings are understandable in terms of three hypotheses: (a) the genotypic independence of Level I and Level II processes, (b) the functional dependence of Level II upon Level I, and (c) the differential distribution of Level I and Level II genotypes in upper and lower social classes.

The findings are important in that they help to localize the nature of the intellectual deficit of children called disadvantaged; they bring a sharper focus to thinking and research on the nature-nurture problem as it relates to social class and racial differences; they show that to whatever extent environmental deprivation affects mental ability, all abilities are not equally affected; and they emphasize the need for standard tests that cover a broader spectrum of mental abilities than is sampled by current standard tests of intelligence.

Children who are above the general average on Level I abilities but below the average on Level II performance usually appear bright and capable of normal learning and achievement in many situations, although they invariably have inordinate difficulties in school work under the traditional methods of classroom instruction. Many such children who are classed as mentally retarded in school later become socially and economically adequate persons when they leave
the academic situation provided that they have not been too
damaged by an educational system that fails to take adequate
account of individual differences in patterns of ability.
On the other hand, children who are below average on Level I,
and consequently on Level II as well, appear to be much more
handicapped in the world of work. One shortcoming of tradi­t­
tional IQ tests is that they make both types of children
look much alike. Tests that reliably assess both Level I
and Level II abilities are needed in schools, personnel work,
and in the armed forces. Equally important is the discovery
or invention of instructional methods which more fully
utilize Level I abilities as a means of improving educational
attainments of many of the children now called culturally
disadvantaged.
APPENDIX C

RAW DATA FOR SPASTIC SUBSAMPLE
AND ATHETOID SUBSAMPLE
<table>
<thead>
<tr>
<th>Subject</th>
<th>Number</th>
<th>Sex</th>
<th>C.A.</th>
<th>1st P.A.</th>
<th>Attempt</th>
<th>Total</th>
<th>P.A.</th>
<th>Digit</th>
<th>Span</th>
<th>Prog.</th>
<th>Matrices</th>
<th>Sue. or Failure</th>
<th>Verb. or Non-verb.</th>
<th>Total</th>
<th>Total</th>
<th>Errors</th>
<th>Errors</th>
<th>Bef.</th>
<th>End</th>
<th>Aft.</th>
<th>End</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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APPENDIX D

STATISTICAL ANALYSIS

The three statistical procedures used in the analysis of the results of this study are the Mann-Whitney U Test, the Fisher Exact Probability Test, and the chi square test (Siegel, 1956).

The Mann-Whitney U Test (p. 123):

\[ U = n_1 n_2 + \frac{n_1(n_1 + 1)}{2} - R_1 \]

The Fisher Exact Probability Test (p. 97):

\[ p = \frac{(A + B)! (C + D)! (A + C)! (B + D)!}{N! A! B! C! D!} \]

The chi square test (p. 107):

\[ \chi^2 = \frac{N(|AD - BC| - \frac{N}{2})^2}{(A + B)(C + D)(A + C)(B + D)} \text{ df } = 1 \]
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