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A TEST OF VERBAL PROBLEM-SOLVING ABILITY
AND ITS RELATION TO SELECTED NEUROPSYCHOLOGICAL MEASURES
IN CHILDREN WITH LEARNING DISABILITIES

by

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B.Sc., McGill University, 1971

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1974
ABSTRACT.

Among the skills and abilities assessed by neuropsychological test batteries and the Wechsler Intelligence Scales, problem-solving abilities reflect most readily the relative intactness of brain functions. The majority of problem-solving tasks are, however, of a nonverbal nature, and may be more closely related to the integrity of the right cerebral hemisphere than the left. It has been demonstrated in several studies that chronic disorders of the left cerebral hemisphere are less consistently detected than those of the right cerebral hemisphere. It has been suggested that this might be due to the relative lack of verbal problem-solving tasks in the neuropsychological test batteries presently in use. The Word Finding Test (WFT), which is a verbal problem-solving task used by Reitan (1972) with brain damaged adults, proved to be a powerful instrument for differentiating between the groups of brain-damaged Ss with lesions confined to the left hemisphere and the control groups (Reitan, 1973).

The purpose of the present study was to modify the WFT for use with children and to explore its relationship to selected neuropsychological measures including a nonverbal problem-solving task -- the Category Test (CT).

The level of difficulty of the original WFT with respect to a group of 20 children, 9 and 10 years old was established. Thirteen items suitable for this age group were selected and,
together with 7 newly-constructed items, formed a 20 item test. This new WFT, modified for use with children (CWFT), was subsequently administered to a control group of 40 children from normal classrooms and a clinical group of 20 children with learning disabilities. The two groups were equated for age and WISC Full Scale IQ. Large differences in the performance of these two groups on the CWFT were found, with the control group performing much better than the clinical group.

Spearman's correlation coefficients were calculated for the CWFT and Verbal IQ, CWFT and Performance IQ, and CWFT and Full Scale IQ for both groups. It was found that the CWFT was very closely related to the Verbal as well as Performance measures of the WISC in the 9-year-old control group. For the 10-year-old control group the relationship of CWFT and Verbal IQ was also significant, but no such relationship was found between the CWFT and the Performance IQ. The absence of significant correlations between the CWFT and both VIQ as well as PIQ for the clinical group raised the possibility of qualitative rather than merely quantitative differences between these two groups of children.

In the clinical group the CWFT appeared to be more closely related to the Wide Range Achievement Test (WRAT) scores than to the FSIQ. The WRAT is a measure of academic achievement (with emphasis on verbal skills); the CWFT would seem a better predictor of this than the IQ, which is more heterogeneous than either WRAT or CWFT. When the groups of
children with learning disabilities were formed on the basis of the difference between their ranked CWT scores and CT scores, some interesting patterns were found on a number of neuropsychological measures. These patterns suggested that problem-solving ability was not a unitary concept; rather that it had different components (verbal and nonverbal) which are differently related to a number of abilities measured by the neuropsychological test battery. These relationships may reflect the relative lateralizing value of the two problem-solving tasks (verbal -- CWT and nonverbal -- CT) investigated in the present study. Due to the small sample sizes of the groups no statistical analyses were performed and the patterns were discussed in terms of direction for further research.
ACKNOWLEDGEMENTS

I wish to express my gratitude to Dr. R. Robert Orr, who, as a chairman of my supervisory committee offered generous guidance by thoughtful criticism and encouragement throughout the preparation of this paper; to Dr. Byron P. Rourke for making available to me the facilities of the Neuropsychology Laboratory and for his many helpful suggestions in planning and execution of the project; to Dr. R. C. Pinto and Dr. David V. Reynolds for their interest in the project and their constructive comments which facilitated its completion; to Elizabeth L. Havelock who tirelessly recorded all the tapes needed for the present study.

A special note of appreciation is extended to M. Alan J. Finlayson, who provided the initial idea for this investigation and generously participated in its progress with his advice at all stages from inception to completion.
The purpose of the present study was twofold: first, to develop a verbal problem-solving task for children, similar to Reitan's (1972) Word Finding Test (WFT) developed for adults, and second, to compare the neuropsychological implications of the verbal problem-solving task with one involving essentially nonverbal skills.

Reitan (1972) used the WFT in order to add a problem-solving component to the verbal tests in a neuropsychological test battery for adults. A modified form of the battery is currently in use (e.g., Knights, 1966; Rourke, Orr, & Ridgley, 1973) in the neuropsychological assessment of children, but this battery lacks an analogous verbal test involving a problem-solving component. There seems to be sufficient evidence regarding the value of such a test in diagnosing brain dysfunction in adults to warrant incorporating such a task into an assessment of children.

It is now a well-accepted fact that, for the vast majority of people, the left cerebral hemisphere is primarily responsible for the processing of language symbols and associated cognitive processes. On the other hand, the right cerebral hemisphere appears to be primarily responsible for the mediating of nonverbal, visuospatial, temporal, and nonverbal cognitive functions (Milner, 1971). In adults, well-documented lateralized cerebral lesions have been found to be related to Verbal IQ - Performance IQ differences on
the Wechsler-Bellevue scales (Wechsler, 1939). Subjects with left cerebral lesions typically exhibit lower Verbal than Performance scores on the Wechsler-Bellevue (Reitan, 1955). Consistent lateralized impairment on motor and psycho-motor tasks had also been demonstrated in patients with lateralized cerebral lesions (Reitan, 1958). These lateralized deficits are particularly striking in patients with acute and extensive brain lesions in either hemisphere. Impairment resulting from lateralized, chronic, long-standing lesions of a lesser extent is often not as clear-cut (Fitzhugh, Fitzhugh, & Reitan, 1962 a; 1962 b), showing less significant differences between groups than is the case with acute lesions. Consequently, as several studies have shown, deficits related to chronic left hemisphere damage are less consistently diagnosed by means of the existing neuropsychological tests than are deficits related to chronic right hemisphere lesions (Kløve, 1959; Kløve & Reitan, 1958; Reitan, 1964).

It has been pointed out by Reed and Fitzhugh (1966) that many manipulatory tests of a "performance" nature contain a problem-solving component. These tests are presumably related primarily to the functions of the right cerebral hemisphere because of the nonverbal content, and the skills required (visuospatial, temporal sequencing, and nonverbal cognitive functions). On the other hand, most verbal tasks do not involve problem solving; rather, they seem to tap overlearned language abilities which have developed over the years. These latter abilities are thought to be
subservied by the left cerebral hemisphere.

It is possible that problem solving per se is the component of tasks which is most sensitive to the integrity of higher cognitive functions because it involves the complex interaction of many different parts of the hemispheres. The absence of such problem solving in verbal tasks may be the reason why the left-sided lesions are detected less consistently. This has an important practical implication. It is generally assumed that both cerebral hemispheres are equally susceptible to the effects of brain dysfunction. That is, an insult of a certain type, extent and recentness will occur with the same frequency in one hemisphere as in the other and will affect the functions of each hemisphere to an equal degree. Consequently, an error in the detection of lateralized dysfunctions may adversely affect the effectiveness of recommendations for treatment programmes made on the basis of the results from the neuropsychological test battery. Especially in children with suspected learning disabilities, the more accurately it is possible to detect brain dysfunction, the more efficiently it will be possible to devise an adequate remediation programme to help these children cope with their academic problems.

Reitan (1972) concluded that "If problem-solving ability tends to be a minimal factor in verbal and language tests, it appears advantageous to develop tests which emphasize this component (p. 515)." The test he developed as a partial solution to this problem was the WFT. It was designed in
order to provide a measure of verbal ability within the framework of a problem-solving situation. The test requires the subject to discern the meaning of a nonsense word through the appreciation of its verbal context.

When the test was administered to adults with known cerebral lesion and to non-brain-damaged adult controls, striking differences in performance were found, with the controls performing in almost all cases (94%) better than the brain-damaged patients. The results suggested that the WFT was a sensitive measure of the integrity of brain function in adults. In order to evaluate the lateralizing significance of the WFT (that is, its power to differentiate between the performance of patients with left-sided lesions versus patients with right-sided lesions) homogeneous groups of subjects with lesions confined to either hemisphere would be required.

In a latter study, Reitan (1973) compared the performance of patients with left or right cerebral lesions with a normal control group on several verbal tasks. The verbal tasks without the problem-solving component did not reflect deficits in the group of patients with right cerebral hemisphere damage. Their performance was impaired only on verbal tasks which involved problem solving. The patients with left-sided damage performed poorly on all verbal tasks. Their performance was, however, most impaired on tasks which included a problem-solving component. It appeared that the Word Finding Test was the most sensitive measure employed in the study. It was suggested that the problem-solving abilities probably "resided" in both
cerebral hemispheres, while the language-related abilities were specific to the left hemisphere.

The batteries of neuropsychological tests for children mentioned above (Knights, 1966; Rourke et al., 1973) include many tests developed by Halstead and Reitan. Neither contains a verbal problem-solving task. If the WFT is a good measure of problem-solving ability in the verbal sphere (discriminating between brain-damaged and non-brain-damaged adults) then such a problem-solving task may prove to be a valuable adjunct in the assessment of brain dysfunction in children.

In order to pursue the first objective of this study -- i.e., to develop a verbal problem-solving task for children -- a modification of Reitan's (1972) test was used. Twenty 9- and 10-year-old children participated in the initial testing. On the basis of this initial testing, the test was further modified and was then administered to a group of forty 9- and 10-year-old normal controls and a group of twenty children with learning disabilities.

In the present study, the criteria for designating a child as being one with a learning disability were as follows: (a) the child was referred for a neuropsychological assessment by his school because he was not profiting from a traditional form of education, and evidenced failures in one or several school subjects; (b) the child had a normal level of psychometric intelligence as determined by the Full Scale IQ of 85 - 115 on the Wechsler Intelligence Scale for Children (Wechsler, 1949); (c) the child had no visual or auditory
acuity deficits; (d) the child was not "culturally deprived"; (e) the child was not judged to be in need of psychiatric treatment for emotional problems.

The second objective of this study was to determine the neuropsychological significance of two types of problem-solving tasks, a verbal (GWFT) and nonverbal one (Halstead Category Test). The Halstead Category Test (CT) was modified by Reitan (1953) for use with older children. It is a test which is very sensitive to deficits due to brain damage/dysfunction (Knights & Tymchuk, 1968). It requires the noting of similarities and differences among nonverbal stimuli, postulating hypotheses, and testing them in the context of positive and negative feedback. When a subject's response is correct, it is immediately followed by a pleasingly sounding bell. When the response is wrong it is followed by a buzzer.

Doehring and Reitan (1962) investigated the lateralizing value of the CT for the assessment of brain-damaged adults. They concluded that the test did not differentiate between a group of patients with right-sided brain damage and a group of patients with left-sided brain damage. They offered two explanations for their findings: viz., first, the concept attainment tested by CT may be impaired by any insult to any region of the cortex; and, second, successful concept attainment may be dependent upon an integration of a number of primary abilities, verbal as well as nonverbal.

Recent data related to the lateralizing significance of the CT for children demonstrated a tendency for the score to
be more dependent on the intactness of the right cerebral hemisphere (Rourke, Young, & Flawelling, 1971; Rourke, Yanni, MacDonald, & Young, 1973) and suggested that, in children, the CT may differentiate between groups with lateralized brain dysfunction.

It appears that the CT may be more related to the functions of the right cerebral hemisphere in children than in adults. This could be due to the tendency of the adults whose verbal skills were already well developed (before they sustained a brain damage) to use more verbal mediators in a problem-solving situation than would be expected of children employed in the above studies.

On the basis of the findings related to the CT used with children it was expected that the performance of the clinical group of children on the CT would be similar to their performance on tasks which reflect more the functions of the right than the left cerebral hemisphere. With the results of Reitan's (1973) study as a background it was expected that the scores on GWT of the children in the clinical group would be positively correlated with their scores on verbal tasks which depend on the integrity of the left cerebral hemisphere.

The children in the clinical group were administered a battery of neuropsychological tests as a part of a routine assessment. Selected measures from this battery previously found to be related to the integrity of either cerebral hemisphere were used to explore the above expectations. Due to a small number of Ss in the clinical group these data were
considered to be a pilot investigation, all aspects of which are presented in the Discussion.
METHOD

The present study has two parts. In Part I the original Word Finding Test (WFT) developed by Reitan (1972) was modified for use with children. In part II the performance on the children's WFT (CWFT) of a control group of children from normal classrooms was compared with the performance of a clinical group of children with learning disabilities.

Part I.

Subjects

Twenty males, nine and ten years old, formed the sample for this part of the study. Ten of these Ss were recruited through parents who were adult students at the University of Windsor. The sample also included ten boys, nine and ten years old, from a normal classroom of a Separate School in Windsor. The only restrictions were that none of these children had received attention for a suspected learning disability or had failed a grade.

Measures

The test used was a modified version of a verbal problem-solving task developed by Reitan (1972) for the use with adults. It is a word-finding task in which the meaning of a nonsense word, "Grobnick", is to be identified from the over-all context of the sentence. Every item is composed of five sentences in which "Grobnick" is to be replaced by
a word which is the same for all five sentences within one item. Of the twenty items used by Reitan (1972) seventeen items were used in their original form, and three items were slightly modified. An additional five items were constructed by the experimenter in order to substitute for some of the more difficult original items. This resulted in a test which consisted of 25 items.

**Procedure**

The 25 items were administered to the Ss. The test was presented by means of a tape recorder in order to insure standardized presentation for all Ss. There was a 10-sec interval between sentences during which the Ss were asked to write down their response for a particular sentence. Initially, a group administration of the test was employed. However, it proved difficult to maintain the necessary attention of the Ss and, subsequently, the test was administered individually. Also, it was found that a 10-sec interval was too short for a child to write down his response. Therefore, in the individual administration, the Ss verbalized their responses and these were recorded by the E.

**Analysis**

The answers of each of the 20 children in this group were analyzed and items that received no correct answers and sentences which were not clearly understood by the children were eliminated. Item analysis was done on all sentences but item selection was based mainly on the index of difficulty of
the third sentence of each item. This was done for the following reasons. The sentences within each item were arranged so as to progress from very general ones to very specific. Each subsequent sentence provided additional cues about the meaning of the word "Grobnick" for that particular item. Due to this ordering, most of the first two sentences of each item would be expected to have a very low coefficient of item difficulty, since passing (guessing correctly) was a matter of chance. On the other hand, if the child understood the concept of the WFT and had correctly identified the word "Grobnick", the last two sentences would be expected to be answered correctly and have a very high coefficient of item difficulty. The coefficient of item difficulty ($p_i$) is calculated by adding all correct answers for a particular item, and dividing this total by the number of individuals in the sample. The coefficient of item difficulty is, therefore, the arithmetic mean for the individual item. The coefficient of item difficulty such as $p_i = .05$ means that the item is very difficult one. A $p_i = .90$ would mean that the item is very easy. Items with coefficients of item difficulty of the third sentence between .30 and .70 were included in the new form of the WFT.

Another consideration for selection a particular item (a set of five sentences) was its simplicity. That is, short and simple sentences were preferred over longer and more complex ones. This criterion was adopted since it was the
purpose of the test to assess verbal problem solving. The ability to find an easy word through its association with the context of the sentences was the point of the test, rather than an assessment of the child's comprehension or vocabulary.

These procedures resulted in a newly constructed test of 20 items each with five sentences which were recorded on a tape recorder for use in the subsequent parts of the study.

Part II.

Subjects

Two groups of 9- and 10-year-old males participated in the second part of the project. One group included 20 boys with learning disabilities. These children had been referred for neuropsychological assessment by school officials because they were not profiting from a traditional form of education and evidenced failure in one or several school subjects. These children had a roughly normal level of psychometric intelligence, as determined by a Full Scale IQ of 85 - 115 on the Wechsler Intelligence Scale for Children (WISC). They had no visual or auditory acuity deficits, were not "culturally, & deprived", and were not judged to be in need of psychiatric treatment for an emotional problem.

The control group was composed of 40 children from normal classrooms (grades 3, 4, and 5) of three schools in Windsor. Any child from the normal classroom who had received attention for a suspected learning disability or who had failed a grade
was not included as a $ in the control group.

Subjects were finally selected so as to result in nonsignificant differences between the control and clinical groups on age (Table 1) and WISC Full Scale IQ (Table 2).

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insert Table 1 about here
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insert Table 2 about here
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Measures

An estimate of Full Scale IQ for the control group was obtained by using an abbreviated form of the WISC (see Pulvermacher, 1970). Children with suspected learning disabilities were administered the complete WISC. The CWT was administered to both groups. In addition, children in the clinical group were given an extensive battery of neuropsychological tests as a part of their assessment.

Procedure

$ in the control group were administered five subtests of the WISC: Comprehension, Vocabulary, Arithmetic, Picture Arrangement, and Object Assembly. Their scores were prorated and Full Scale IQ as well as Verbal and Performance IQs were estimated. The administration and scoring was done by the E. The children with learning disabilities were given the complete WISC by one of three trained psychometrists.
## TABLE 1
Means and Standard Deviations for Age (in Months)

<table>
<thead>
<tr>
<th>Group</th>
<th>Control</th>
<th>Clinical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>114.35</td>
</tr>
<tr>
<td></td>
<td>S.D.</td>
<td>4.16</td>
</tr>
<tr>
<td>9 years old</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 years old</td>
<td>Mean</td>
<td>126.45</td>
</tr>
<tr>
<td></td>
<td>S.D.</td>
<td>3.41</td>
</tr>
<tr>
<td>combined 9 and 10 years old</td>
<td>Mean</td>
<td>120.40</td>
</tr>
<tr>
<td></td>
<td>S.D.</td>
<td>5.19</td>
</tr>
</tbody>
</table>
TABLE 2.
Means and Standard Deviations for Full Scale IQ.

<table>
<thead>
<tr>
<th>Group</th>
<th>Control</th>
<th>Clinical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>9 years old</td>
<td>101.30</td>
<td>9.33</td>
</tr>
<tr>
<td>10 years old</td>
<td>101.85</td>
<td>9.41</td>
</tr>
<tr>
<td>combined, 9 and 10</td>
<td>101.58</td>
<td>9.25</td>
</tr>
</tbody>
</table>
Both groups were administered the CWFT by means of a tape-recorded presentation. The test was administered individually and the verbal responses from the Ss were recorded by the E.

It was thought important that the child demonstrate some understanding of the concept underlying the test prior to Item 1 of the actual test (on the tape). In other words, he had to be able to guess correctly at least one of the two example items presented as a part of instructions. These two items were not timed. During the tape-recorded presentation of the test itself, however, each verbal response had to occur within the 10-sec interval provided at the end of each sentence to be included as a correct response.

The CWFT was first administered to the 40 control Ss. The responses of all Ss were subjected to an item analysis. The results of this analysis were consistent with the expectations outlined in Part I. Specifically, most normal children were able to identify correctly nearly all items by the time they heard the last sentence of the item. The coefficients of the item difficulty based on the third sentence of each item remained, for most items, within the range of .30 to .70.

Next, the CWFT was administered to the 20 children with learning disabilities. The test was scored for the total number of correctly identified sentences. This score was taken as a basis for comparisons between the control group and the group of children with learning disabilities.
RESULTS

The aim of Part I was to determine the suitability of the WFT for use with children 9 and 10 years old. Since it was expected that some of the items would be too difficult, additional items were constructed and included in the pretest. The first version of the WFT used was thus formed from 17 original WFT items, 3 modified items, and 7 newly formulated items (2 of the new items were used for demonstration purposes).

Table 3 shows the coefficients of item difficulty for this first version of the WFT. It can be seen that 4 of the original items were failed by all 20 subjects, and 5 of the original items were passed by, at most, 3 children. These 9 items were, therefore, discarded since they were too difficult for the 9- and 10-year-old children tested. Two of the original items and one modified item were passed by 5, 7, and 6 children respectively. A number of children commented that the sentences and words used in these items were too complex and unclear so these items were also excluded.

insert Table 3 about here

The purpose of Part II was to construct a new WFT which would (1) have a difficulty level suitable for 9- and 10-year-old children, and (2) differentiate between the performance of children from normal classrooms and children
### TABLE 3

Coefficients of Item Difficulty for WFT (25 Items)

Based on 20 normal children

<table>
<thead>
<tr>
<th>Item</th>
<th>Sentence 1</th>
<th>Sentence 2</th>
<th>Sentence 3</th>
<th>Sentence 4</th>
<th>Sentence 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>*01a</td>
<td>.50</td>
<td>.65</td>
<td>.65</td>
<td>.95</td>
<td>1.00</td>
</tr>
<tr>
<td>*02a</td>
<td>.50</td>
<td>.60</td>
<td>.60</td>
<td>.90</td>
<td>1.00</td>
</tr>
<tr>
<td># 1</td>
<td>.20</td>
<td>.15</td>
<td>.75</td>
<td>.95</td>
<td>1.00</td>
</tr>
<tr>
<td>2</td>
<td>.00</td>
<td>.00</td>
<td>.00</td>
<td>.05</td>
<td>.05</td>
</tr>
<tr>
<td>*3m b</td>
<td>.00</td>
<td>.15</td>
<td>.85</td>
<td>.75</td>
<td>.65</td>
</tr>
<tr>
<td># 4</td>
<td>.10</td>
<td>.35</td>
<td>.35</td>
<td>.75</td>
<td>.75</td>
</tr>
<tr>
<td># 5</td>
<td>.15</td>
<td>.20</td>
<td>.35</td>
<td>.80</td>
<td>.95</td>
</tr>
<tr>
<td>6</td>
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<td>.00</td>
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<td>.00</td>
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<tr>
<td>7</td>
<td>.00</td>
<td>.05</td>
<td>.00</td>
<td>.05</td>
<td>.15</td>
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<tr>
<td>8</td>
<td>.00</td>
<td>.05</td>
<td>.15</td>
<td>.45</td>
<td>.95</td>
</tr>
<tr>
<td>* 9</td>
<td>.00</td>
<td>.05</td>
<td>.15</td>
<td>.95</td>
<td>1.00</td>
</tr>
<tr>
<td>*10m b</td>
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<td>.95</td>
<td>.60</td>
<td>.95</td>
<td>1.00</td>
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<td>.05</td>
<td>.05</td>
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<td>.05</td>
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<td>*13</td>
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<td>.25</td>
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<td>.00</td>
<td>.00</td>
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<tr>
<td>18m b</td>
<td>.00</td>
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<td>.10</td>
<td>.10</td>
<td>.30</td>
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<tr>
<td>19</td>
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<td>.35</td>
<td>.25</td>
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<td>.00</td>
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</tr>
<tr>
<td>*21</td>
<td>.30</td>
<td>.55</td>
<td>.75</td>
<td>.70</td>
<td>.80</td>
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<tr>
<td>*22</td>
<td>.05</td>
<td>.55</td>
<td>.70</td>
<td>.75</td>
<td>.80</td>
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<td>*23</td>
<td>.55</td>
<td>.50</td>
<td>.60</td>
<td>.75</td>
<td>1.00</td>
</tr>
<tr>
<td>*24</td>
<td>.10</td>
<td>.50</td>
<td>.80</td>
<td>.95</td>
<td>.30</td>
</tr>
<tr>
<td>*25</td>
<td>.05</td>
<td>.05</td>
<td>.65</td>
<td>.70</td>
<td>.90</td>
</tr>
</tbody>
</table>

**Note.** - The higher the coefficients, the easier the item

*aExample items

bModified items

*Items included in the CWFT*
with learning disabilities. The first objective was achieved by selecting from among the pretest items those whose coefficients of item difficulty on sentence 3 fell between .30 and .70 and those which met the additional criteria detailed in the method section.

Thirteen pretest items were judged to be suitable for use in the subsequent WFT modified for use with children (CWFT). In some cases, the order of the 5 sentences making up one item was changed to progress from the lowest to the highest coefficient of difficulty. An additional 5 items were formulated and included in the CWFT. Table 4 shows the coefficients of item difficulty for the CWFT based on 40 control children. Included in the Table 4 are also data for 20 clinical Ss.

insert Table 4 about here

It can be observed that all 20 items were passed by most of the children in the control group. The coefficients of item difficulty used for selecting questions initially were based on the passing of the third sentence of each item (see method section for details). In the control group, 13 of the 20 items had third-sentence coefficients within the range of .30 to .70. Two items had coefficients .10 and .15 and five items ranged from .82 to .92. This provided a range of difficulty suitable for the 9- and 10-year-old children.
### TABLE 4

Coefficients of Item Difficulty for CWFT

Based on 40 Control Ss and 20 Clinical Ss

<table>
<thead>
<tr>
<th>Item</th>
<th>Group</th>
<th>Co</th>
<th>Cl</th>
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</thead>
<tbody>
<tr>
<td>1</td>
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</tr>
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<td>.32</td>
<td>.50</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>.01</td>
<td>.10</td>
</tr>
</tbody>
</table>

Note: The higher the coefficients, the easier the item.

*aControl group  
bClinical group*
The second objective of Part II was to establish whether or not the CWFT would differentiate between two populations of children (normal and children with learning disabilities). These findings are summarized in Table 5. The t value's for the comparisons between the control group and the group of children with learning disabilities were significant beyond the .001 level. Comparisons between the 9-year-old and 10-year-old Ss in the control group did not yield a significant t ratio. The 9-year-old and 10-year-old children with learning disabilities also did not differ significantly.

At least in terms of statistical comparison between the two populations, the CWFT does differentiate between the normal children and children with learning disabilities. Individual inspection of data presented in Table 1 indicates considerable separation between the two populations. With a cut-off score of 52.5, five of the 20 children with learning disabilities were "misclassified", while all 40 control Ss (100%) were "classified" correctly.

The scores of the control group on the CWFT were ranked and compared with their ranked Verbal, Performance and Full
TABLE 5

Means and Standard Deviations for HWFT

and t Values for the Comparisons between Groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Control</th>
<th>Clinical</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 years old</td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td></td>
<td>59.35(^a)</td>
<td>4.13</td>
</tr>
<tr>
<td></td>
<td>41.80(^c)</td>
<td>11.66</td>
</tr>
<tr>
<td>10 years old</td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td></td>
<td>62.45(^a)</td>
<td>6.05</td>
</tr>
<tr>
<td></td>
<td>49.00(^c)</td>
<td>7.92</td>
</tr>
<tr>
<td>combined 9 and 10 years old</td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td></td>
<td>60.90(^b)</td>
<td>5.35</td>
</tr>
<tr>
<td></td>
<td>45.40(^a)</td>
<td>10.38</td>
</tr>
</tbody>
</table>

Comparison of 9-year-old and 10-year-old control \( t = 1.893 \text{ NS} \)

Comparison of 9-year-old and 10-year-old clinical \( t = 1.617 \text{ NS} \)

\(^a\) \(N = 20\)
\(^b\) \(N = 40\)
\(^c\) \(N = 10\)

\(* p < .001\)
Fig. 1. Distribution of CWPT scores for 2 groups of children (control, \( n = 40 \) and clinical, \( n = 20 \)).

Note. - The score is a number of correct sentences out of 100.
Scale IQs. (See Table 6). It was found that, in case of the 9-year-old Ss, there was a strong positive correlation of the CWFT with their VIQ ($\rho = .889, \approx .01$), to a lesser degree with their PIQ ($\rho = .607, \approx .01$) and with their FSIQ ($\rho = .805, \approx .01$). Thus, for this group, all correlations were significant beyond the .01 level. This was also the case when the correlation coefficient was computed for the control group as a whole, that is 9- and 10-year-old Ss combined. When the same comparisons were made for the 10-year-old group alone, however, only the Verbal IQ and the Full Scale IQ were found to be correlated with the CWFT scores and yielded $\rho$ of .731 and .638, both significant beyond the .05 level.

----------------------------------
insert Table 6 about here
----------------------------------

Similar comparisons were carried out for the clinical group. As can be seen from Table 6, the correlations assume a similar pattern as that observed for the control group. In the clinical group, however, none of the correlation coefficients were significant at or beyond the .05 level. The highest coefficients were .482 and .412, both significant at the .10 level. These are the coefficients expressing the association between the CWFT and VIQ and the CWFT and FSIQ, respectively, for the 9-year-old clinical group. (See Fig. 2).
**TABLE 6**

Summary Table for Spearman’s $\rho$ and Fisher’s $Zr$ Transformations for CWFT, VIQ, PIQ, and FSIQ by Age and Group

<table>
<thead>
<tr>
<th>Tests</th>
<th>CWFT - VIQ</th>
<th>CWFT - PIQ</th>
<th>CWFT - FSIQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groups</td>
<td>$\rho$</td>
<td>$z$</td>
<td>$\rho$</td>
</tr>
<tr>
<td>Control 9-year-old$^a$</td>
<td>.839**</td>
<td>1.422</td>
<td>.607**</td>
</tr>
<tr>
<td>10-year-old$^a$</td>
<td>.686*</td>
<td>.839</td>
<td>.266</td>
</tr>
<tr>
<td>combined 9 and 10-year old</td>
<td>.731**</td>
<td>.930</td>
<td>.453**</td>
</tr>
<tr>
<td>Clinical 9-year-old$^c$</td>
<td>.482+</td>
<td>.524</td>
<td>.218</td>
</tr>
<tr>
<td>10-year-old$^c$</td>
<td>.130</td>
<td>.131</td>
<td>.012</td>
</tr>
<tr>
<td>combined 9 and 10-year old</td>
<td>.304</td>
<td>.354</td>
<td>.189</td>
</tr>
<tr>
<td>All 9-year-old $N^d$</td>
<td>.721**</td>
<td>.910</td>
<td>.335*</td>
</tr>
<tr>
<td>All 10-year-old $N^d$</td>
<td>.393*</td>
<td>.415</td>
<td>.130</td>
</tr>
</tbody>
</table>

$^a N = 20$
$^b N = 40$
$^c N = 10$
$^d N = 30$

* $p < .10$
* * $p < .05$
** ** $p < .01$
Fisher's $z_r$ transformation was used to make possible comparisons of the differences between the obtained correlations (see Table 7). Statistically significant differences existed between the correlations between CWFT and VIQ when 9-year-old control group was compared with 9-year-old clinical group ($z < .05$), as well as with 10-year-old clinical group ($z < .006$). The difference between the 9- and 10-year-old control groups was significant at the .09 level, and the difference between all 9-year-old $S$s (control and clinical groups combined) and all 10-year-old $S$s was significant at the .07 level. None of the differences between correlations of the CWFT and PIQ were statistically significant, although trends in a direction similar to that found between CWFT and VIQ were present.

In summary then, the highest association exists between the CWFT and VIQ and it appears to decline with age. The association between CWFT and PIQ is somewhat lower and also appears to decline with age. The CWFT and FSIQ correlations displayed similar patterns.
Fig. 2. Relationships between the CWFT and VIQ, and CWFT and PIQ by Age and Group (control and clinical), based on Spearman's $\rho$. 
TABLE 7

Summary Table of Differences Between Correlation Coefficients from Table 6
(Using Fisher's z Transformations)

<table>
<thead>
<tr>
<th>Groups</th>
<th>CWFT-VIQ</th>
<th>t</th>
<th>CWFT-PIQ</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control 9 - Control 10</td>
<td>1.699+</td>
<td>.09</td>
<td>1.257</td>
<td>.18</td>
</tr>
<tr>
<td>- Clinical 9</td>
<td>2.004+</td>
<td>.05</td>
<td>1.076</td>
<td>.22</td>
</tr>
<tr>
<td>- Clinical 10</td>
<td>2.882**</td>
<td>.006</td>
<td>1.542</td>
<td>.12</td>
</tr>
<tr>
<td>Clinical 9 - Clinical 10</td>
<td>0.735</td>
<td>.30</td>
<td>0.391</td>
<td>.37</td>
</tr>
<tr>
<td>All Ss 9 - All Ss 10</td>
<td>1.813+</td>
<td>.07</td>
<td>0.797</td>
<td>.29</td>
</tr>
</tbody>
</table>
DISCUSSION

The purpose of this investigation was to devise a verbal problem-solving task for children (CWFT), and to explore the neuropsychological implications of performance on this language-dependent problem-solving task and another involving essentially nonverbal skills (CT). The verbal problem-solving task was based on Reitan's (1972) Word Finding Test (WFT). He has demonstrated that this task differentiates well between a group of control Ss and a group of brain-damaged Ss, with the control Ss performing strikingly better than the brain-damaged group.

It has been hypothesized by some (e.g., Rourke, 1974) that children with learning disabilities suffer brain dysfunction which interferes with their proper adjustment and achievement in school, in spite of their normal IQ as assessed by the WISC. On the basis of this hypothesis, it was predicted that a relationship similar to that found by Reitan (1972) would exist between the performance of a control group of children from normal classrooms and a clinical group of children with learning disabilities. The WFT was modified for use with children (CWFT) and administered to the two groups. Consistent with the above prediction, it was found that the CWFT differentiated well between the two groups of children, with the control group performing significantly better than the clinical group. The similarity of this finding with the results obtained by Reitan (1972) with brain-damaged adults
lends support to the contention of Rourke (1974) that cerebral
dysfunction may be a principal limiting factor in the
performance of children with learning disabilities.

Furthermore, the CWFT may have practical value as a
predictor of academic success in children with learning
disabilities. The results of the present study demonstrate
that the performance of children with learning disabilities
on the CWFT was closely related to their Wide Range Achievement
Test (WRAT) scores. Within the limits imposed by constraining
the range of the WISC FSIQ to 85 - 115, their WISC FSIQ, which
is a composite measure used to assess a number of verbal and
nonverbal abilities, did not appear to be related to either
CWFT or WRAT scores. This would be expected since the WISC
is a heterogeneous scale, while both the CWFT and WRAT
are rather homogeneous in that they involve primarily verbal
skills. Thus, it would seem that the CWFT is a more powerful
predictor of WRAT scores (academic achievement) than WISC
FSIQ. Among the abilities assessed by WISC, verbal problem
solving is the least adequately represented, and it is this
ability that is reflected in the scores of the CWFT. On the
basis of the finding that CWFT and WRAT scores are closely
related, it would appear that the CWFT would be a useful
instrument in assessing the potential for academic achievement
in children with learning disabilities.

In addition to its practical utility the CWFT also
provides data on some theoretical issues: (1) qualitative
versus quantitative changes in abilities as a result of brain
dysfunction; (2) neuropsychological implications of differential performance on verbal and nonverbal problem-solving tasks.

Relevant to the first issue are: (a) the patterns of performance on the CWT of the clinical and control groups (see Table 4), and (b) findings concerning the relationships between the CWT and the Verbal and Performance IQs for different groups of children (see Fig. 2).

(a) A closer inspection of the patterns of performance on the CWT of the clinical and control groups shows that whereas the control group on the whole attempted to integrate the meaning of each of the 5 sentences of every item to capture the concept conveyed by that item, the clinical group often responded to the individual sentences as separate units. This type of dissociation of sentences from the context of the item produced great variability of scores within one item for the clinical group. In other cases the clinical Ss persevered on their initial responses and continued using a word which was quite obviously inappropriate for the following sentences within the item. This perseverative behaviour sometimes extended to the next item as well.

In a few instances the clinical Ss obtained higher scores than the control Ss. When this occurred on the first two sentences of an item, it was attributed to a chance factor, since as was pointed out earlier, the first two sentences of most items were very general and the correct answer was a matter of guessing. This would also be true when the word in
the third sentence of such a correctly guessed item was retained. There were also 3 items on which the clinical group obtained slightly higher score only on sentences 3 or 4. In the view of the small differences—in $p_1$ (.90 versus .95, .82 versus .85, and .10 versus .15) these were also attributed to chance.

Thus, it can be concluded, that the clinical group demonstrated a much less systematic performance than did the control group. Such a performance suggests a qualitative difference between the approaches to the problem-solving task of the two groups of children in addition to the quantitative differences observed on the whole.

(b) When the relationship between the CWFT and the WISC was explored it was found that the highest correlation existed between Verbal IQ and the CWFT in the group of 9-year-old control Ss. This correlation declined for control Ss a year older. The lowest correlation between Verbal IQ and the CWFT was found for the 10-year-old clinical group. The correlations between the Performance IQ and the CWFT were lower and declined similarly. This may mean that for the 9-year-old control group the abilities assessed by the 3 verbal and 2 performance subtests of the WISC were related to the verbal problem-solving ability. For the 10-year-old control Ss only the verbal abilities were related to verbal problem solving, while the abilities assessed by the performance subtests were not.

For the clinical clinical group, neither the VIQ nor the
IQ were significantly correlated with the CFT scores. Thus, the relationship between abilities measured by the WISC and the problem-solving ability assessed by the CFT observed for the control group were not replicated for the clinical group. This might indicate that the differences found between these two groups of children are of a qualitative rather than quantitative nature, and therefore are not consistently reflected in the patterns of scores obtained on measures of different abilities by these two groups of children.

Quantitative differences would be indicated if the same abilities existed in both groups but in a different amount. Qualitative differences, on the other hand, imply that the abilities observed in one group are different in kind from the abilities observed in the other group.

The view that qualitative changes of abilities occur as a result of a brain damage in adults was first expounded by Goldstein (1940, 1942). Later this position was challenged by Reitan (1955a, 1959b). He was able to show that the deficits in the abilities of brain-damaged adults were more of a quantitative nature by comparing their performance with the performance of normal Ss. He found that correlation matrices based on results from tests of neuropsychological abilities of the brain-damaged Ss showed a high degree of agreement with correlation matrices derived similarly for the control Ss. It was concluded that the abilities of these two groups of Ss were similar in kind but different in level.
This issue is not as clear cut in the case of brain-damaged children. Patterns of deficits in these children often resemble patterns found in brain-damaged adults (Raitan, 1974b). However, there is also some evidence to show that, in children, cerebral dysfunction may have more qualitative effects on their performance than is the case with adults. Boll (1974) found significant differences among correlations based on the performance on neuropsychological measures of control children and brain-damaged children. The results of the present study employing children with learning disabilities appear consistent with the conclusions reached by Boll (1974) with the brain-damaged children. The similarity of these results offers further support for the notion that cerebral dysfunction may be a contributing factor in the case of children with learning disabilities.

At least three methodological aspects of the present study should be considered in connection with the above (b) interpretations. First, the correlations for the clinical group were based on n of 20, while the control group had an n of 40. Second, seven of the 20 clinical Ss were administered the WISC more than two years before the CWFT, which raises a question of comparability of the scores, especially since all of the control Ss were administered the CWFT and WISC, at the most 4 months apart. Thirteen clinical Ss were given the CWFT and the WISC on the same day or within 18 months. Third, while the clinical group was given the complete WISC, the control group was given an abbreviated form of the WISC and the scores of the Ss in the
control group were prorated to obtain VIQ, PIQ and FSIQ. To what extent these three methodological aspects might have affected the observed differences of patterns between the control and clinical group cannot be established at present. However, if these differences in pattern were confirmed, it would further strengthen the position that the abilities of normal children are qualitatively different from those of children with learning disabilities, and this should be taken into account when educational programmes are devised. It implies that "special education" should indeed be special and not merely an extension of existing teaching techniques. Further investigation would appear to be necessary to explore this question further.

The second theoretical issue touched upon in the present study was the relationship between one verbal problem-solving task (the CWFT) and another problem-solving task which involves essentially nonverbal skills (the Category Test). This issue was explored in a form of two pilot investigations.

As was pointed out earlier all Ss in the clinical group were administered a battery of neuropsychological tests. For the first pilot investigation, seven of the 20 Ss from the clinical group had to be excluded because comparable test data were not available in their files. Thus, 13 of the 20 children with learning disabilities were employed in the first investigation. These children were divided into 3 groups on the basis of their ranked CWFT and CT scores and their performances on
selected measures previously found to differentiate between Ss with left and right cerebral dysfunctions were compared. The three groups were as follows:

Group 1 (N = 5) performed relatively better on CWFT than on CT (CWFT rank at least 2.5 ranks greater than CT rank).

Group 2 (N = 4) performed relatively better on CT than on CWFT (CT rank at least 2.5 ranks greater than CWFT rank).

Group 3 (N = 4) included Ss who had high scores on both tests, low scores on both tests or were in the middle. Their scores were less than 2.5 ranks apart. Because of the small n in these 3 possible cases and the presumed heterogeneity of the sample, Group 3 was not included in the subsequent analyses.

Group 1 and Group 2 were subsequently compared with respect to their performance on the following neuropsychological tests: the Halstead Category Test (CT) modified by Reitan (1953) for use with older children, the Sentence Memory Test, the Verbal Fluency Test, the number of aphasoid errors on Reitan's modification of the Halstead-Wepman Aphasia Screening Test for older children, the Target Test, the Grooved Pegboard Test, the Trail Making Test modified for use with older children by Reitan (1971). These tests are described in detail in Appendix A.

Knights and Tymchuk (1968) found that when groups of Ss were equated for FSIQ there were no differences among their performances on the Category Test (CT). They suggested that this problem-solving ability was closely related to FSIQ. In
the present study, it was found that, even when the groups were equated for FSIQ, the differences in their performance on a problem-solving task which involves language (the CWFT) were highly significant. Thus, it would seem that at least for the clinical group, the problem-solving task which involves language is not correlated with FSIQ. A high positive correlation was found between the nonverbal problem-solving task (CT) and WISC FSIQ for the same group of children. It would appear, on the basis of these results, that problem-solving ability has different components which are differentially related to FSIQ and probably are differentially affected by deficits resulting from brain dysfunction suspected in the children with learning disabilities.

Since the CWFT involves language, it was expected that performance on it would be positively correlated with other language-related tasks from the neuropsychological battery. Significant positive correlations were obtained for the CWFT and the Aphasia Screening Test and for the CWFT and Part B of the Trail Making Test (Trails B). Both of these tasks involve language. However, it is of interest that a higher correlation was found for Trails B than for the Aphasia Screening Test. Trails B can be viewed as a language-related problem-solving task, while the Aphasia Screening Test involves primarily the recollection and reproduction of previously learned material. This finding is consistent with Rourke & Finlayson (1974) study as well as with Reitan's (1973) results. He found
He found that, of the language tasks administered to the brain-damaged adults, performances on the tasks that involved new concepts and problem solving were more impaired than were those of a highly overlearned nature.

Since the CT is essentially a nonverbal problem-solving task, correlations with nonverbal "performance" tasks on the neuropsychological test battery would be expected (Rourke et al., 1971, Rourke et al., 1973). A significant positive correlation was found between the CT and the Target Test. The small sample size in the present pilot investigation dictates the need for caution in the interpretation of these results. Further research in this area would appear to be necessary.

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*insert Table 3 about here*

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When the two problem-solving tasks (CT and CWFT) were compared, no significant correlation was found. However, an interesting pattern appeared on the scatter diagram (see Fig. 3). Two extreme groups were clearly separated along the diagonal, each with a conspicuous negative slope. This suggests that the relationship between the abilities to perform well on the CWFT and CT may be complex and that the abilities reflected by the scores on the two tests may be negatively correlated.
### TABLE 8
Summary Table for Spearman's $\rho$ for CWFT, CT, Trails A, Trails B, Trails Total, Target Test, and Aphasia Screening Test

<table>
<thead>
<tr>
<th>Tests</th>
<th>CWFT</th>
<th>CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>CWFT</td>
<td>--</td>
<td>.180</td>
</tr>
<tr>
<td>CT</td>
<td>.180</td>
<td>--</td>
</tr>
<tr>
<td>Trails A</td>
<td>.170</td>
<td>.352</td>
</tr>
<tr>
<td>Trails B</td>
<td>.639*</td>
<td>-.052</td>
</tr>
<tr>
<td>Trails Total</td>
<td>.538*</td>
<td>.068</td>
</tr>
<tr>
<td>Target Test</td>
<td>.370</td>
<td>.481*</td>
</tr>
<tr>
<td>Aphasia S.T.</td>
<td>.481*</td>
<td>-.002</td>
</tr>
</tbody>
</table>

* $p < .05$
In order to evaluate this relationship more fully, two groups (described above), were compared with respect to their performance on a number of neuropsychological measures. These two groups differed on 16 of the 22 measures considered. Fourteen of the obtained differences were in the expected direction. The Ss with CWFT scores better than CT scores (Group 1) were expected to perform better on language-related tasks. This would be expected were they to have a relatively intact left cerebral hemisphere. For the group with CT scores better than their CWFT scores (Group 2) the expected direction was to perform better on nonverbal tasks, especially those involving some form of problem solving and new learning. This would be expected of Ss with a relatively intact right cerebral hemisphere.

It was shown previously (Reitan, 1973) that tasks involving problem solving appear to be more sensitive to the effects of brain damage than tasks without such a problem-solving component. The data from the first pilot investigation suggest that differential hemispheric integrity may be reflected in different
Fig. 3. Scatter diagram of rank ordered scores on CWFT and CT
<table>
<thead>
<tr>
<th>Tests</th>
<th>$\bar{X}_1$</th>
<th>$\bar{X}_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>CWFT</td>
<td>53.8</td>
<td>36.5</td>
</tr>
<tr>
<td>CT</td>
<td>56.6</td>
<td>45.3</td>
</tr>
<tr>
<td>Trails A</td>
<td>26.2 *</td>
<td>29.5</td>
</tr>
<tr>
<td>B</td>
<td>52.6 *</td>
<td>119</td>
</tr>
<tr>
<td>Total</td>
<td>79.8</td>
<td>143.8</td>
</tr>
<tr>
<td>Target Test</td>
<td>15.6 *</td>
<td>16.5</td>
</tr>
<tr>
<td>APHASIA (errors)</td>
<td>10.6 *</td>
<td>13</td>
</tr>
<tr>
<td>SP-PER</td>
<td>20</td>
<td>19.5</td>
</tr>
<tr>
<td>AUDCLO</td>
<td>11.8 *</td>
<td>9.5</td>
</tr>
<tr>
<td>SEMIL</td>
<td>12.4</td>
<td>14</td>
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<tr>
<td>FLUNGY</td>
<td>6.3</td>
<td>7.9</td>
</tr>
<tr>
<td>PEG-D</td>
<td>72.2 *</td>
<td>84.3</td>
</tr>
<tr>
<td>PEG-N</td>
<td>84.6 *</td>
<td>91.8</td>
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<td>VIQ</td>
<td>94</td>
<td>96</td>
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<td>FSIQ</td>
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<td>104</td>
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<td>7.6 *</td>
<td>6</td>
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<td>CORP</td>
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<td>9.5</td>
</tr>
<tr>
<td>ARITH</td>
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</tr>
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<td>SIRHIL</td>
<td>10.8</td>
<td>10.5</td>
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<td>VOCAB</td>
<td>11</td>
<td>10.8</td>
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<tr>
<td>DIGITS</td>
<td>7.6 *</td>
<td>10.5</td>
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<td>PICCOM</td>
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<td>PICTAR</td>
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<td>BLOCDE</td>
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<tr>
<td>OBJSASS</td>
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<tr>
<td>CODING</td>
<td>10.8</td>
<td>10.3</td>
</tr>
</tbody>
</table>

$\bar{X}_1$ = means for Group 1 (CWFT better than CT)
$\bar{X}_2$ = means for Group 2 (CT better than CWFT)

* means which show a tendency to differ in the expected direction
means which show a tendency to differ in a direction opposite to the expected one.
Footnote for Table 9
Abbreviated: CWFIT = Children’s Word Finding Test; CT = Category Test; Trails A (B, Total) = Trail Making Test, Part A (B, Total Score); APHASIA = Aphasia Screening Test; SP-PER = Speech Sounds Perception Test; AUDCLO = Auditory Closure Test; SEMEM = Sentence Memory Test; FLUNCY = Verbal Fluency; PEG-D = Grooved Pegboard Test - Dominant hand; PEG-N = Grooved Pegboard Test - Nondominant hand; VIQ = WISC Verbal IQ; PIQ = WISC Performance IQ; FSIQ = WISC Full Scale IQ; INFO = Information; COMP = Comprehension; ARITH = Arithmetic; SIKIL = Similarities; VOCAB = Vocabulary; DIGITS = Digit Span; PCCOX = Picture Completion; PICTAR = Picture Arrangement; BLOCDE = Block Design; OBJASS = Object Assembly.
problem-solving tasks (i.e., verbal or nonverbal) and that these two types of tasks may have a lateralizing significance in assessing Ss' brain dysfunction which may not be detected by other, perhaps less sensitive, neuropsychological tests.

Further research exploring these directions with a larger number of Ss appears necessary. This could be accomplished by composing groups of Ss on the basis of their ability to perform on the CT and the CWFT and to observe their performance on several measures of auditory-verbal, visuo-perceptual, language and nonverbal ability.

In the second pilot investigation the division of the group of 20 children with learning disabilities was suggested by comparing their CWFT scores with the CWFT scores of the control group (see Fig. 1). Three groups were formed:

Group A (N = 5) whose scores overlapped with those of the control group.

Group B (N = 6) whose scores cluster just below the lowest score of the control group.

Group C (N = 9) whose scores are well below those of the control group.

A qualitative analysis of the information available on these children revealed that (1) the primary reason for referral and (2) the discrepancy between the Ss' Wide Range Achievement Test (WRAT; Jastak & Jastak, 1965) scores and expected grade placement (based on chronological age) were most related to the CWFT score differences between these three groups (see Table 10).
The findings of the second pilot investigation suggested that the CWFT may differentiate between those children that do not achieve well in school whose primary problem is a behavior one and those whose primary problem is a learning disability as defined above.

In summary, the CWFT was found to be a powerful discriminator of verbal problem-solving ability in normal children and children with learning disabilities. The practical value of the CWFT as a useful predictor of academic achievement was demonstrated and contrasted with the lack of such predictive potential in the case of WISC FSIQ. The present study also provided additional data with respect to two theoretical issues: (1) qualitative versus quantitative changes in abilities of children with learning disabilities, and (2) neuropsychological implications of differential performance on the CWFT and CT. Further research was suggested which would explore these issues more fully along the guidelines provided by the present study.
<table>
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<tr>
<th>Group</th>
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<td>2. behavior and learning problem</td>
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<td>3. learning problem</td>
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<td>( EGPD ):</td>
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<td>1. at the expected level</td>
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<td>2. 1 year below</td>
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<td>3. 2 years below</td>
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<td>4. more than 2 yrs below</td>
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<td>6</td>
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</table>

\( a \)Reason for referral (RFR) - the initial clinical group was selected from among children referred for neuropsychological assessment because of suspected learning disability. The selection was based on the reason for referral as stated in the neuropsychological report. Subsequent inspection of all information available on files suggested that in several cases the primary reason for their learning difficulties was a behavior problem. The latter information was used in this Table.

\( b \)Expected Grade Placement Discrepancy (EGPD)
APPENDIX A

REVIEW OF LITERATURE

The objectives of the present study were to develop a Word Finding Test (WFT) for 9- and 10-year-old children, and to investigate its neuropsychological relevance. The WFT is a verbal problem-solving task and has been developed as a counterpart to problem-solving tasks of non-verbal type, such as, for example, the Category Test (CT).

The study was divided into two parts. In the first part, the original WFT (Reitan, 1972) used with adults, along with 3 modified items and 7 newly constructed items was administered to 20 children 9 and 10 years old from normal classrooms, in order to establish the level of difficulty appropriate for use with children.

In the second part, 13 pretest items and 7 new items formed a WFT modified for use with children (CWFT). The performance of two groups of children on the CWFT was compared. The two groups were: 40 children from normal classrooms, and 20 children with learning disabilities, in order to determine the power of the test to discriminate between groups of such children. The CWFT scores of both groups were also compared with their Verbal, Performance and Full Scale IQs.

The relationship of the CWFT to selected neuropsychological measures was explored in a form of a pilot investigation. The group of children with learning disabilities was divided
into two groups, according to their relative performance on two problem-solving tasks; the CWFT, which is the verbal problem-solving task, and the Category Test (CT) which is the nonverbal problem-solving task. The groups were formed as follows: one group in which the children performed better on CWFT than on CT; and a second group, in which CT performance was better than CWFT. The two groups of children thus formed were previously administered a battery of neuropsychological tests. Number of observations were made with respect to the patterns of functioning (that is, their abilities and disabilities) associated with the different performances on the two problem-solving tasks.

The present review of literature deals selectively with topics related to the areas of interest investigated in the study and briefly outlined above. The topics to be dealt with will be presented in the following order:

- Children with learning disabilities
- The neuropsychological approach and laterization studies
- The battery of neuropsychological tests
- The problem-solving tasks

Children with learning disabilities

Depending on the method of estimation, between five and twenty percent of the non-retarded child population have learning disabilities (Tarnopol, 1971). It is important to differentiate between a specific and a general learning
Disability (Johnson and Nyklebust, 1967; Tarnopol, 1971). The child with a general learning disability is usually referred to as a familial retardate and their IQ scores form the low end of the normal distribution curve. On the other hand, the child that has a specific learning disability is described by Dykman, Ackerman, Clements, and Peters (1971) as one who is not able to keep pace academically with his age mates despite his normal intelligence, adequate cultural opportunity, and generally satisfying family emotional background. The concept of learning disabilities is defined by Heinicke (1972) as "those deviations in the learning processes which are associated with an educationally significant discrepancy between apparent intellectual capacity and actual performance on academic tasks (p. 663)".

Learning disabilities are often associated with behavioral disorders which may include hyperactivity, impulsivity, low frustration tolerance and increased aggressiveness. There is also ample evidence that inattentiveness, short attention span and distractibility are frequent characteristics of the population of children in question (e.g., Tarnopol, 1971). Some kind of cerebral dysfunction is presumed to be a relevant factor after having eliminated those children whose behavior and disorders can be understood on a basis different from cerebral dysfunction (McCarthy and McCarthy, 1969). The specific learning disability may occur in number of school subjects, for example, mathematics, reading, writing, spelling (Kirk and Beteman, 1962).
In the present study the following description of children with learning disabilities has been adopted: the youngster referred for neuropsychological assessment by school teachers, or other school officials, because they were not profiting from a traditional form of education and evidenced failure in one or more school subjects. These children have normal psychometric intelligence as determined by their Full Scale IQ on the WISC of 85 to 115. They have no visual or hearing acuity deficits. They are not "culturally deprived" nor are they in need of psychiatric treatment for an emotional problem. This description is felt to be most appropriate as it takes into account all of the relevant aspects of the disorder reviewed above.

Neuropsychological approach and lateralization studies

The problem of learning disabilities has been approached from many points of view depending chiefly on a particular symptom or a constellation of symptoms considered central to its etiology. The areas of interest included the behavioral disorders (Freibergs, 1965), various degrees and types of perceptual disorders (e.g., Monroe, 1932; Fernald, 1943; Myklebust and Johnson, 1962), developmental lags (Critchley, 1964), emotional disorders (Rabinovitch, 1959), genetic predispositions (Hallgren, 1950), and primary attentional deficit (Dykman et al., 1971).

The results of several recent investigations conducted by Rourke and Telegdy (1971), Rourke, Young and Flewelling
(1971), Rourke, Yanni, MacDonald, and Young (1973), and
Rourke & Orr (1973) lend support to the hypothesis of possible
cerebral dysfunction in children with learning disabilities.
These investigations are based on a neuropsychological
approach, which is a study of the relationship between the
brain and behavior. It utilizes a battery of neuropsycholo-
gical tests that is administered to children with learning-
disabilities and inferences are made about the integrity
of their brain on the basis of the pattern of their
performance on these various tests. The battery includes
tests of perceptual-motor, language-related, problem-solving
and visuo-spatial abilities. The information about the
relative weaknesses and strengths of the children on this
broad spectrum of behaviours can serve as a basis for devising
a remedial programme and as a base line against which the
future development can be compared.

Certain numbers of the tests in the battery are more
closely associated with functions of the left hemisphere while
a number of others reflect the integrity of the right cerebral
hemisphere (e.g. Rourke et al., 1971, 1973). The differentiation
of the hemispheric functions has been demonstrated many times
in patients with well documented lesions (see Reitan, 1972).
It is now a well accepted fact that in the vast majority of
people the left hemisphere is related to verbal intelligence
and the processing of language symbols. Conversely, the
right cerebral hemisphere subserves primarily nonverbal
visuospatial and temporal adaptive abilities.
In adults, well documented lateralized cerebral lesions have been shown to be related to Verbal-Performance IQ differences on the Wechsler-Bellevue (W-B; Benton, 1962; Reitan, 1955), and to consistent lateralized impairment on motor and psychomotor tasks (Reitan, 1958). The following patterns were observed: Subjects with left cerebral lesions had lower Verbal than Performance scores on the W-B. Ss with right cerebral lesions had higher Verbal than Performance scores on the W-B (Reitan, 1955). Adults with left-sided motor deficits were superior on all verbal measures when compared to Ss with right-sided motor deficits. Additionally, Ss with no lateralized motor deficits showed intermediate performance on verbal tasks and were somewhat better on performance tasks relative to the other two groups (Reed and Reitan, 1963).

Studies conducted with older (9 to 14 years old) children with learning disabilities showed comparable results: Rourke et al. (1971) studied the relationships between WISC Verbal-Performance discrepancies and selected verbal, auditory-perceptual, visual-perceptual, and problem-solving abilities in older children with learning disabilities. They found that children with learning disabilities with high Verbal IQ and low Performance IQ (HV-LP) were significantly better on a number of other measures of verbal skills and auditory perceptual abilities than the group with high PIQ - low VIQ (HP-LV). The latter group was superior on tasks involving primarily visual-perceptual skills. These results were interpreted
to be consistent with the view that VIQ-PIQ discrepancies on WISC reflect the differential integrity of the two hemispheres. This was also supported by results of study by Rourke and Telegdy (1971). In this study the HP-LV group was superior to HV-LP group on most measures of complex motor and psychomotor abilities.

In a latter study by Rourke et al. (1973) the older children with learning disabilities were divided into groups on the basis of the absence or presence of lateralized motor deficits on the Grooved Pegboard Test (GPT) as follows: normal right-impaired left (NR-IL), impaired right-normal left (IR-NL), and normal right-normal left (NR-NL). When the patterns of performance of these four groups on the WISC and Halstead battery for children was compared with the results of the Reed and Reitan (1963) study, similar patterns were found. Children with left-sided deficits (right hemisphere) were superior on most verbal measures of WISC to children with right-sided deficits. Children with right-sided deficits tended to do better on the performance subtests but the differences were not statistically significant. The NR-NL and IR-IL groups were not significantly different from one another and were intermediate to those with lateralized deficits.

In the summary then, the neuropsychological approach adopted in this study is aimed at discerning the patterns of performance on a variety of neuropsychological tests by different groups of children with learning disabilities. The lateralization studies reviewed above provided evidence
that some tests are more sensitive to deficits of right
cerebral hemisphere, and others are more sensitive to deficits
of left cerebral hemisphere. The known lateralizing tests
served as a measure for comparisons between groups in the
attempt to explore the relative lateralizing significance of
the two problem-solving tasks.

The battery of neuropsychological tests

As was pointed out earlier, the Neuropsychological approach
relies on the use of a battery of neuropsychological tests. The
battery currently employed with children is constructed so as
to reflect the strengths and weaknesses of the children across
a broad spectrum of verbal, perceptual-motor, and problem-solving
abilities. The tests employed in the present study selected
from the battery include: WISC, Aphasia Screening Test,
Speech Sounds Perception Test, Auditory Closure, Sentence
Memory, Verbal Fluency, Target Test, and Trail Making Test.

The WISC according to Seashore, Wesman, and Doppelt (1959)
is an extension (for children 5 - 15 years old) of the original
Wechsler-Bellevue intelligence scale (Wechsler, 1939). It
consists of twelve subtests of which 11 are used in the present
study. The subtests are divided into Verbal and Performance
Scales. The Verbal Scale includes: General Information,
General Comprehension, Arithmetic, Similarities, Vocabulary,
and Digit Span. The Performance Scale consists of: Picture
Completion, Picture Arrangement, Block Design, Object

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1 The description of individual tests has been adapted from the
following sources: Reitan & Heineman (1968), Rourke (1972),
and Rourke and Finlayson (1973).
Assembly, and Coding. The raw scores are transformed into scaled scores which are then added and converted into Verbal IQ, Performance IQ, and Full Scale IQ scores.

The WISC taps many functions. In general, language receptive and expressive skills are needed in order to comprehend the instructions and questions and respond to them. Non-verbal functions, such as, for example, visuo-spatial orientation, and visuo-motor coordination are assessed by means of the tasks on Performance Scale of the WISC.

Research with brain-damaged adults indicates that insults to the left hemisphere will produce deficiency on the Verbal scale of Wechsler-Bellevue, while right cerebral hemisphere injury interferes with efficiency on the tasks of the Performance scale (e.g. Reitan, 1955). Somewhat similar findings are reported in studies with older children with learning disabilities using WISC (e.g. Rourke et al., 1971, 1973).

In order to broaden the extent of assessing different abilities other tests are also used. Among those are some tests developed by Halstead which form the Halstead Neuropsychological Test Battery.

The modified Halstead-Wepman Aphasia Screening Test (Halstead and Wepman, 1949) investigates possible aphasic and related deficits. Various abilities are examined through specific sensory modalities. "The test samples the ability of the Ss to name common objects, spell, identify individual numbers and letters, read, write, calculate, enunciate,
understand spoken language, identify body parts, and differentiate between right and left (Reitan, p. 14)." The receptive and expressive character of the deficit can be determined. The score is the number of errors.

Of the Speech Sounds Perception Test (Reitan and Heineman, 1968) the first 30 items are used. This test examines the ability of the subject to sustain attention through the 30 items, to perceive the auditory stimulus sound, and to relate it through vision by identifying the heard pattern of letters among three written alternatives on the test form. The score is the number of sounds correctly identified.

In the Auditory Closure Test (Kass, 1964) the S is required to blend 23 progressively longer chains of sound elements into words. Higher order analysis and synthesis of auditory stimuli is required. The score is the number of words correctly identified.

Sentence Memory (Benton, 1965) tests the ability to repeat increasingly longer sentences (from 1 – 26 syllables). The score is the number of sentences correctly repeated.

The Verbal Fluency Test (Strong) requires the S to name as many words as he can, within 60 seconds, which begin with the sound "f", as in pig, and then with the sound "g" as in cake. The score is the mean number of correct words for the two trials.

The following two tests have in common the essentially nonverbal manipulatory character. They are positively
correlated with items on the Performance scale of WISC and are presumably related to the functions of the right cerebral hemisphere.

The Target Test (Reitan, 1970) is a measure of the ability to reproduce graphically visual-spatial configuration after a 3 second delay. The configurations tapped out by the examiner are of increasing complexity. The score is the number of items correctly reproduced out of 20.

Part A of the Trail Making Test (Reitan and Heineman, 1968) is used to examine spatial visualization and spatial orientation. It is a timed test, which requires the individual to connect, by drawing a line, the numbers 1 to 15 arranged on a page. The score is the number of seconds to finish the task.

Part B of the Trail Making Test requires the S to connect 15 circles which contain both numbers and letters. S is directed to begin with number 1 and to proceed to A, then to 2, to B, and so on, alternating between numbers and letters until he reaches the end. The score is the amount of time required to complete the task.

The tests reviewed above were selected from a much greater number of tests that are routinely administered to the children referred for neuropsychological testing. The selection was guided by the emphasis on the lateralizing value of the tests. Thus there is a distinct group of verbal and language-related tasks involving functions of the left cerebral hemisphere, and a group of "performance" tasks traditionally related to functions of the right hemisphere.
Problem-Solving Tasks

A test which is one of the most sensitive measures of the integrity of adult brain function is the Halstead Category Test (Halstead, 1947; Knights and Tymchuk, 1968). This test was modified by Reitan (1953) for use with children. The Halstead-Reitan Category Test for children (CT) is a relatively complex concept-formation task which requires noting similarities and differences among presented stimuli. Postulating hypotheses and their testing which leads to a particular response is positively or negatively reinforced by bell or buzzer, respectively. This test is one of the nonverbal problem-solving tasks on the neuropsychological test battery.

Studies pertaining to the neuropsychological significance of the CT were reviewed by Knights and Tymchuk (1968), and were further supplemented by their two original studies in an attempt to determine the power of the test to differentiate among several populations of children. Their review of literature suggests that the differences on CT between brain-damaged and non-brain-damaged children may be at least in part attributed to IQ differences. They also pointed out that lower CT scores are obtained by children with problems in school or emotional adjustment which may be symptoms of brain dysfunction. In such a case the CT is suggested to be a measure of abstract reasoning more sensitive to brain dysfunction than all of the evidence from the history of the child.

The data concerning the lateralizing value of the CT are
sparse. In general, there are two trends: first, no significant differences were found by comparing adults with left and right hemisphere damage (Doehring, & Reitan, 1962; Parson, Jones, and Vega, 1971). Second, there was a tendency for the older children with learning disabilities with high Performance - low Verbal IQ on WISC (HP-LV) to have higher scores on CT than the children with high Verbal - low Performance (HV-LP). The discrepancy on VIQ-PIQ of the WISC was interpreted to suggest a laterализed dysfunction of the left (HP-LV) or right (HV-LP) cerebral hemisphere (Rourke et al., 1973). Thus, the association of higher scores on CT with HP-LV and low scores with LP-HV may reflect the necessity that right hemisphere be intact for a good performance on this task. Similarly, in a study by Rourke et al. (1973) older children with learning disabilities were divided on the basis of their performance on the Grooved Pegboard Test into four groups, as described above. There was a tendency for NR-NL group to do better than NR-IL and IR-IL (which were almost identical), with the IR-NL in intermediate position. The impaired performance with left hand (IR-IL, NR-IL) presumably reflecting right-sided cerebral dysfunction is associated with the lowest scores on the CT.

On the battery of neuropsychological tests administered to adults with well documented cerebral lesion of a chronic, stabilized type, the deficits of right hemisphere were more consistently reflected than the deficits of the left hemisphere.
(Fitzhugh, Fitzhugh, and Reitan, 1962). The tests pertaining to the functions of right hemisphere are primarily the nonverbal performance tasks with a number of manipulatory problem-solving tasks. The tests related to functions subserved by the left hemisphere, namely the language-related abilities, lack the problem-solving component as they are mainly concerned with abilities which have developed over the years.

Reitan (1972) used the Word Finding Test (WFT) as a verbal problem-solving task. It attempts to evaluate the ability to discern the meaning of a nonsense word through appreciation of its verbal context. It has been designed in order to supply a measure of verbal ability in a problem-solving framework, thus becoming a counterpart of the nonverbal problem-solving tasks. When this test was administered to adults with known cerebral lesion and to several groups of adult controls striking differences in performance were found, with the controls performing better than the brain-damaged patients. The results thus showed that the WFT is a very sensitive measure of cerebral functioning in adults.

In a later study Reitan (1973) has compared the performance of patients with left or right cerebral lesions with a normal control group on several verbal tasks. The tests that lacked the problem-solving component did not reflect deficits in the group of patients with the right cerebral lesions, while the patients with the left-sided damage
performed poorly on all the verbal tasks. It was suggested that the problem-solving abilities "reside" in both cerebral hemispheres, while the language related abilities are specific to the left hemisphere. Furthermore, the patients with the left-sided damage were most impaired on tasks involving both semantic content and verbal problem solving as opposed to slight impairment on tests where words were used for memory testing.

In summary, the importance of the CT as one of the most sensitive measures of the integrity of brain functioning, raises the question of its possible lateralizing value. Information is also lacking about the discriminative and lateralizing value of WFT. These issues were explored in a pilot investigation which is a part of the present study.
APPENDIX B

Children's Word Finding Test (CWFT)
Instructions
Answer sheets
CHILDREN'S WORD FINDING TEST (CWFT)

Item 1. (BLACKBOARD)
1. Every classroom has at least one grobnick.
2. Grobnicks usually hang on the wall.
3. The teacher writes on the grobnick.
4. Grobnicks can be green or black.
5. You write on a grobnick with chalk.

Item 2. (MONTH)
1. January is a very cold grobnick.
2. People usually pay their rent every grobnick.
3. Most people go for vacations during summer grobnicks.
4. There are 12 grobnicks in a year.
5. Some grobnicks have 30 days.

Item 3. (MIRROR)
1. Some people believe that breaking a grobnick brings bad luck for seven years.
2. A grobnick reflects light.
3. A grobnick has a shiny surface.
4. A grobnick has a smooth surface.
5. You can see yourself in a grobnick.

Item 4. (TREES)
1. Some grobnicks are very old and very large.
2. Many grobnicks have fruit.
3. Some grobnicks have needles and some have leaves.
4. Wood comes from grobnicks.
5. There are many grobnicks in a forest.
Item 5. (EYES)
1. Everyone has two grobnicks.
2. Grobnicks are usually brown or blue.
3. Sunglasses help keep the sun out of our grobnicks.
4. When you go to sleep you close your grobnicks.
5. We see with our grobnicks.

Item 6. (HOUSE)
1. There are many windows in every grobnick.
2. There many grobnicks in a city.
3. You can't move a grobnick.
4. Every grobnick has a roof.
5. People live in grobnicks.

Item 7. (CLOUD)
1. Grobnick is usually suspended high in the air.
2. Sometimes you can't see sun because of grobnicks.
3. Grobnick can be dark or white.
4. You cannot touch grobnick.
5. Airplanes often fly above grobnicks.

Item 8. (VACATIONS)
1. Grobnicks are supposed to be fun.
2. The summer months are the most frequent time for grobnicks.
3. Employer grants grobnicks to his employees.
4. Many people spend their grobnicks travelling.
5. Grobnicks is a time usually spent away from home.
Item 9. (FIRE)

1. Grobnick is a very useful thing.
2. When not controlled, grobnick can be a very harmful thing.
3. Grobnick is used to keep us warm.
4. The first grobnick known to man was probably caused by lightning.
5. Children who play with matches often cause grobnicks.

Item 10. (PENCIL)

1. Grobnicks are used in school.
2. With most grobnicks you can do something with one end and undo it with the other.
3. You often have to sharpen a grobnick.
4. Grobnicks are commonly used for writing.
5. Grobnicks are not recommended for writing cheques.

Item 11. (SCHOOL)

1. A grobnick is a building with a special purpose.
2. Grobnicks are usually large.
3. You can learn things in a grobnick.
4. There are many rooms in a grobnick.
5. There are many teachers in every grobnick.

Item 12. (BALL)

1. There are many games you can play with a grobnick.
2. A grobnick can be hard or soft.
3. A grobnick is usually round.
4. Some grobnicks are smaller than your hand.
5. You can throw, kick or catch a grobnick.
Item 13. (NAME)
1. Everyone has a grobnick.
2. Sometimes people change their grobnicks.
3. Grobnicks are one means of identification.
4. A woman legally acquires her husband's grobnick when she marries.
5. It's always best to sign your own grobnick to a cheque.

Item 14. (CAR)
1. A grobnick can move very fast.
2. Most families have at least one grobnick.
3. A grobnick is usually very expensive.
4. There are many kinds of grobnicks that people can buy.
5. A grobnick has four wheels.

Item 15. (CATS)
1. Most grobnicks have long tails.
2. Grobnicks of a certain breed have very short tails.
3. Grobnicks can climb trees.
4. Birds are afraid of grobnicks.
5. Grobnicks are said to have nine lives.

Item 16. (CANDY)
1. Most children like grobnick.
2. Grobnick is usually very inexpensive.
3. You are not supposed to eat grobnick before dinner.
4. Grobnick is usually sweet.
5. Grobnick may cause cavities.
Item 17. (SUN)
1. Without the grobnick we would not live very long.
2. The grobnick is very big.
3. The grobnick is very far away.
4. We cannot see the grobnick at night.
5. The grobnick is hot and bright.

Item 18. (MILK)
1. Grobnick comes from certain animals.
2. Grobnick is a food.
3. Grobnick is white.
4. Grobnick has a lot of protein.
5. You can drink grobnick.

Item 19. (APPLES)
1. Grobnicks grow on trees.
2. Grobnick can be green, red or yellow.
3. Grobnick is a fruit.
5. Grobnick is usually round.

Item 20. (LIGHT BULB)
1. The grobnick is a very useful invention.
2. Without electricity the grobnick would not operate.
3. The grobnick has no moving parts.
4. The grobnick is especially useful at night.
5. Thomas Edison invented the grobnick.
Instructions:

"We are going to play a word game. Here is what we'll do:
I have a word that does not mean anything. The word is grobnick.
I would like you to try and find a word that you know that could
replace the word grobnick in the sentences that you will hear.
Each time there will be a group of 5 sentences which will describe
the word that you are looking for. Listen carefully and after
each sentence tell me what the grobnick is.

For example:
Sentence 1. You can see through a grobnick. What is a grobnick?
Sentence 2. You can break grobnick very easily. What is
    grobnick?
Sentence 3. There are many grobnicks in every house. What are
grobnicks?
Sentence 4. We usually keep grobnicks closed during winter
to keep the rooms warm.
Sentence 5. People usually put curtains over their grobnicks.

Do you understand how to play this game? O.K. Now, let's
try another group of sentences:
Sentence 1. The grobnick is always older than you.
Sentence 2. The grobnick can be a man or a woman.
Sentence 3. You can learn things from a grobnick.
Sentence 4. There are many grobnicks in every school.
Sentence 5. The grobnick gives you homework.

When the child makes a correct guess, say O.K. and continue
with the next sentence. When the guess is incorrect but fits
the sentence well, ask what other word could replace grobnick.
When the guess is obviously wrong, point out the inconsistency before you proceed to the next sentence.

It is important that the child demonstrate some understanding of the concept underlying this test prior to Item 1 on the actual test (on the tape). In other words, he should be able to guess correctly at least one of the 2 example items.

After the last sentence of example item 2, ask again: "Do you know how to play this game now? O.K. You will hear the rest of the sentences from a tape recorder. It is important that you tell me your guess immediately after each sentence and before you hear the next sentence. Ready?" Start the tape recorder. Occasionally the child may not understand or hear well the sentence just played. Play it again to prevent any unnecessary anxiety in the child but do not score the answer.
APPENDIX C

Table 11 - Raw Data (Control group, N = 40)
Table 12 - Raw Data (Clinical group, N = 20)
Table 13 - Raw Scores on Neuropsychological Measures for 3 Groups of Children with Learning Disabilities.
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**TABLE 13**

Raw Scores on Neuropsychological Measures
for 3 Groups of Children with Learning Disabilities

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References


Goldstein, K. The two ways of adjustment of the organism to cerebral deficits. *Journal of the Mount Sinai Hospital*, 1942, 9, 504-513.


Kløve, H., & Reitan, R. M. The effect of dysphasias and spatial distortion on Wechsler-Bellevue results. AMA Archives of Neurology and Psychiatry, 1958, 80, 708-713.


Reitan, R. M. Qualitative versus quantitative mental changes following brain damage. *Journal of Psychology, 1958, 46, 339-346.* (c)

Reitan, R. M. Impairment of abstraction ability in brain damage: Quantitative versus qualitative changes. *Journal of Psychology, 1959, 48, 97-102.* (b)


Rourke, B. P. Description of Tests. Personal communication, 1972.


Rourke, B. P., & Orr, R. R. A neuropsychological approach to the explanation of learning disabilities in children.


Wechsler, D. *The measurement of adult intelligence*. Baltimore: Williams & Wilkins, 1939.

VITA AUCTORIS

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