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by

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Scope and Content: An investigation was made into the relation between grade level, reading ability and performance on six different auditory-visual integration tasks. The subjects, 38 second grade and 38 fifth grade students selected on the basis of their scores on the Gates-MacGinitie Reading Test, were individually tested for ability to perform on the six tasks. The results showed a significant difference in ability to perform the integration tasks between the grade two and grade five subjects with the latter being better. A relation was found between reading level and certain of the integration tasks, with this relation varying between the two grades. Some of the tasks were found to be easier to perform than others with tasks involving skills used in reading, that is the visual spatial - auditory temporal ones, being the least difficult. Implications of the findings were discussed and further research suggested.

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CHAPTER ONE

INTRODUCTION

The degree to which reading retardation is a function of defective perceptual functioning has been a concern of investigators for some time. Early researchers were mainly interested in determining the effects of visual and auditory defects on reading ability in young children. More recently studies have been concerned with the investigation of visual and auditory functioning and reading achievement.

The most comprehensive and systematic approach to the study of reading skills has been carried out by Eleanor Gibson (1968). According to this author, prior to learning to read the child is usually able to communicate through speech. This is an essential aspect of learning to read because the structure of the written system, in most languages, is closely related to that of speech. Gibson has delineated three phases of learning to read which deserve consideration. The first phase consists of learning to differentiate graphic symbols, the second is learning to decode letters to sounds, and the third is learning to use progressively higher-order units of structure. These three phases are closely related to each other and the child must be able to complete one phase before moving on to the next.

Thus, the child must learn to differentiate between the written characters before he can decode them to speech, following the rules of correspondence for the language. If these two phases are analyzed it is evident that the first phase involves visual activity with material presented spatially, while the latter involves auditory activity occurring over time. Thus, the child who is learning to read has to be able to function effectively in the auditory and visual modalities, and must be able to integrate material obtained visually over space and aurally over time. The child who is unable to integrate written material through these two modalities in different dimensions and shift from one modality to the other will possibly have as much difficulty learning to read efficiently as the child with a gross defect in either the visual or auditory modality alone.

While the early investigations in this area dealt mainly with visual and auditory defects and their effects on reading efficiency, the more recent research has been directed to studying the various aspects of the reading process described by Gibson and to determining how these are related to reading ability. The present study evolved from this latter line of research and was designed to separate the effects of auditory - visual integration and temporal - spatial integration and to

compare the relation between these two factors and reading ability in children in grades two and five. In the historical review to follow, the literature dealing with the effect of visual and auditory defects on reading achievement will be presented first and then the studies dealing with integration and reading ability which led up to the present study will be outlined.

* * * * *

One of the earliest studies investigating the relation between a child's specific visual defect and his ability to read was reported by Farris (1936). He used groups of seventh grade pupils who had been equated for chronological age and mental ability as measured by the Kuhlman-Anderson Intelligence Test, but who differed in visual efficiency when tested in the areas of accommodation, convergence and focusing. Farris found hyperopia, or farsightedness; strabismus (the inability to focus both eyes on the same spot); and lack of binocular coordination (that is, the inability to control the movement of both eyes so they move in the same direction in harmony) were more common among poor readers. On the other hand, myopia or near-sightedness; myopic astigmatism (that is, a structural defect of the eye or lens causing near-sightedness); and monocular perception (the using of only one eye to focus on objects) were not

found to influence reading ability. He also reported that corrective lens aided reading ability in poor readers. It appears that only certain types of visual defects are related to poor reading achievement.

There has been some controversy over whether or not visual anomalies of various types are related to reading. In a study done in 1935, Fendrick (in Bond and Tinker, 1967) found that a higher percentage of poor readers had defective vision when compared to good readers. These defects were in the area of astigmatic anomalies, that is irregularities in the structure of the eye or lens affecting the convergence of the light rays and causing imperfect vision, and visual acuity. While Fendrick reported that the trends reported in his study were suggestive they did not indicate that visual anomalies could be used to differentiate good and poor readers.

Another area to be reviewed is that dealing with visual perception. Goins (1958) tested 125 first grade pupils using 14 tests of visual perception and the Chicago Reading Tests. The author wanted to determine the level of competence in various areas of visual perception and the relation of competence in any of the areas tested to reading achievement. Goins found that Pattern Copying, Reversals, and Strength of Closure (holding a figure in mind even when there is distraction), were the only tests of visual perception which appeared to be related to reading achievement. It is interesting to note, however, that the combined perceptual score obtained

by adding the standard scores on the 14 tests of perception correlated highly with reading achievement. Thus, it would appear that certain visual perception tests might be used to assess children's reading achievement.

While these investigators were interested in the relation of visual functioning to reading, other investigators were studying the relationship between audition and reading. Studies in the latter area have generally been concerned with auditory acuity, discrimination, memory span (amount of unrelated material presented auditorally which can be held in memory and repeated), and hearing loss for high or low frequencies.

In an early study, Wolfe (1941) tested normal and retarded readers on various auditory functions thought to be related to low reading achievement. She found that retarded readers were inferior in auditory acuity, auditory discrimination, and memory span for stimuli presented aurally. These findings confirmed the results of Bond's 1935 study (Bond and Tinker, 1967). Bond had reported a higher incidence of poor auditory acuity, blending and perceptual problems among poor readers. This trend was similar for auditory discrimination ability and reading.

Studies concerned with the relation of reading ability to hearing deficiency for certain frequencies have all reported that reading disability is related to loss of hearing

for frequencies above 2048 double vibrations (Kennedy, 1942; Robinson, 1946; and Johnson, 1947, in bond and Tinker, 1967).

It is evident from the research reviewed above that many visual and auditory defects can influence a child's ability to learn to read. Since some of these defects can be corrected, early diagnosis and treatment is essential if progress in reading is to continue normally. As Gibson pointed out, however, learning to read involves more than having normal vision and hearing. It consists of a long learning process; being able to visually discriminate letters presented spatially, to decode sounds temporally, to integrate material presented in both modalities and dimensions, and to shift from one modality to the other. Recent investigations have been concerned with these processes and their relation to reading ability.

For example, Budoff and Quinlan (1964) were interested in the relation between visual and auditory learning and reading ability. These authors tested second grade children using the Gray's Oral Reading Paragraphs. Those pupils who scored six months or more below the grade norm were classified as retarded readers while the normal group consisted of subjects who scored within six months of the grade norm. Lists of paired-associate words were learned under two conditions. In the visual condition the material was shown on a Hunter Cardmaster and in the aural condition

the stimuli were presented on magnetic tape. The results indicated that both retarded and average readers learned more rapidly when the material was presented aurally than when it was shown visually. It was also found that retarded readers required about twice as many trials to learn word pairs presented visually as they needed for word pairs presented aurally. The authors considered that in paired-associate learning aural presentation was more effective than visual for learning word lists and that retarded readers have a great deal more difficulty with visual than auditory material. If one considers the two phases of reading outlined by Gibson, that is visual discrimination and auditory decoding, the results of this study indicated that retarded readers do better on the auditory decoding than the visual discrimination. This could be because they are more familiar with the auditory characteristic of words than the visual.

Another ability required for efficient reading according to Gibson is the ability to shift from one modality to another. Raab, Deutsch, and Friedman (1960) studied the perceptual shifting ability of 24 grade four and five children who differed in reading achievement. The apparatus was a bimodal reaction timer with four different types of stimuli, a red and a green light and a high and low tone. There were two keys on the apparatus and the subject placing one

finger on each key was required to raise his finger as quickly as possible from the appropriate key when the stimulus was presented. The order of presentation of the stimuli was random; thus a visual stimulus might be followed by another visual stimulus or an auditory stimulus, and the same was true for auditory stimuli. The authors found that good readers shifted responses between stimuli presented in the two sense modalities more efficiently than poor readers. They also noted that the mean reaction time to the visual stimulus light was significantly faster for the two groups of subjects. Thus it would appear that ability to shift between stimuli presented in the visual and auditory modalities is related to reading ability with good readers shifting faster than poor readers.

Katz and Deutsch (1963) did a similar study using 48 Negro males from the first, third, and fifth grades. They found that age was negatively related to reaction time. It was also noted that in all three grades, poor readers had more difficulty than good readers in shifting from one modality to another, confirming the findings of Raab, et al. It would seem therefore that ability to shift between the visual and auditory sense modalities is one of the skills required for efficient reading, as Gibson suggested.

The fourth ability discussed by Gibson was that of being able to integrate auditory - visual information. Studies dealing with this ability will now be reviewed.

One of the earliest studies investigating the process underlying auditory - visual integration was carried out by Muehl and Kremenak (1964). They used 108 children from the first grade, chosen on the basis that none was repeating the grade nor had a known visual or auditory anomaly. All subjects were given the following tests: the Harrison-Strong Reading Readiness Profiles (1956); the Lorge-Thorndike Intelligence Test (Primary Battery) (1957); and the Metropolitan Achievement Tests (Primary Battery) (1959). A matching procedure was used to study auditory - visual integration. This involved the presentation of dot and dash patterns with the total number of dots and dashes increasing from two to four in the test series. When the stimuli were presented visually the subjects would see the dot and dash pattern on a card in the spatial dimension. For the auditory task the subject heard a pattern of dots and dashes in the temporal dimension. On each trial the subject had to say whether or not the two dot and dash patterns presented were the same or different. Muehl and Kremenak used a counter-balance technique so that a visual stimulus was matched with either a visual stimulus (V-V) or an auditory stimulus (V-A), and an auditory stimulus was

matched with either a visual stimulus (A-V) or an auditory stimulus (A-A). The subjects were randomly placed in one of two groups. Those in the first group were tested on the four matching tasks in the following order: V-V, V-A, A-V, and A-A, while those in the latter group received the tasks in the order V-V, A-V, V-A, A-A. Muehl and Kremenak found that their subjects matched the simple visual pairs easiest followed by the visual - auditory and the auditory - visual pairs with the most difficult matching being the auditory pairs. It was also noted that the ability to match visual - auditory and auditory - visual pairs at the beginning of the year made significant contributions to predicting reading ability at the end of the year. These findings differ from those of Budoff and Quinlan (1964) who reported that all subjects learned paired-associate lists faster when presented aurally than visually but retarded readers took much longer than normals. This difference could be due to the two types of task involved. However, Muehl and Kremenak's results were similar to those of Raab, et al., and Katz and Deutsch on reaction time in that all reported that good readers did better than poor readers when shifting between the two sense modalities.

Using a slightly different technique Birch and Belmont (1965) investigated auditory - visual integration using 220 children ranging from kindergarten to the sixth grade. Each subject was presented with an auditory test

stimulus in which the experimenter tapped with a pencil on the edge of the table. The subject was then required to choose the pattern he thought matched the auditory tapping from three comparison patterns presented visually on 5 x 8 inch cards. The number of dots in the test and comparison items increased from four to six over five trials. The authors reported a rapid improvement in auditory - visual integration between kindergarten and grade two, with a slower but steady improvement between grades two and five. A significant relation between auditory - visual integration to reading ability was found for the students in grades one and two but not for any of the other grades tested. In addition auditory - visual integration was found to be related to the child's intellectual level measured by the Otis Quick-Scoring Tests of Mental Ability.

In a similar study, Kahn (1965) used 350 boys from grades two and six and reported that auditory - visual integration ability improved with chronological age and with grade level. This study supported the findings of Birch and Belmont in that a relationship between auditory - visual integration ability and reading achievement was found for grade two but not grade six.

A more recent study by Beery (1967) compared average and retarded readers on their ability to match auditory and visual stimuli. She used 30 students ranging in age from

8 years 9 months to 13 years 3 months. The subjects were divided into two groups on the basis of their performance on the Iowa Test of Basic Skills, Reading Subtest. The retarded readers were those who scored at least two years below their appropriate grade level, while the average readers were selected from those who scored within two years of their appropriate grade level. The mean age and intelligence quotient for the retarded and average groups were very similar: the mean ages being 11.7 and 11.6, and the mean intelligence quotients 99.15 and 100.6 respectively. Beery used three tests to determine auditory - visual integration; the first was the Birch and Belmont ten item test of auditory - visual integration mentioned earlier (Birch and Belmont, 1965); the second consisted of the Birch and Belmont test (1965) plus ten items which Beery devised for use in the study; and the third test used the same test items employed in the second test but this time the test items were presented visually and the comparison items aurally. This latter test provided information concerning integration from the visual to the auditory sense modality. Beery found that the retarded readers were inferior to the average readers on all three tests. These findings differed from those of Birch and Belmont (1965) and Kahn (1965) in that they showed a relationship between ability to integrate auditory and visual stimuli and reading achievement at all

ages of subjects tested and not just for the younger children as the former investigators had reported.

The results of this group of studies indicated that poor readers were unable to perform auditory - visual integration tasks as well as average readers. However, there was some disagreement as to whether this was true for all grade levels between one and six. Birch and Belmont (1965) and Kahn (1965) reported the relationship to hold only for grades one and two, but Beery (1967) found it occurred at all grade levels. One of the purposes of the present study is to determine whether auditory - visual and visual - auditory integration ability is related to reading ability in both grades 2 and 5. The results should help clarify this issue.

A further area of investigation concerning integration and reading ability is suggested by a study by Blank and Bridger (1966). These authors, noting that in previous studies the spatial - temporal dimension had been confounded with the auditory - visual dimensions, investigated the ability of children to match a visual stimulus presented in a temporal dimension to comparison visual stimuli shown spatially. Blank and Bridger presented a number of tasks to a group of average and another group of retarded readers. The ages of the subjects ranged from 9 years 4 months to 9

years 11 months. In the first task, designed to test accuracy in matching stimuli, a single light was used to present a visual - temporal dot pattern followed by the comparison stimuli which consisted of three different visual - spatial patterns. The subject was asked to select the one visual - spatial pattern which corresponded to the visual - temporal pattern shown initially. Retarded readers were found to be much poorer than average readers on this spatial - temporal task. In the second task a dot pattern was presented spatially on a card for a period of five seconds and the subject had to select the corresponding pattern from a set of three dot patterns also presented spatially. The retarded and normal readers did not differ on this task. In the third task the experimenters used a row of lights to present visual stimuli in both a spatial and temporal dimension and the child had to report the sequence in which the lights had been presented. The retarded readers performed more poorly on this task than the normal readers. As a result of these findings the authors suggested that Birch and Belmont's (1965) and Kahn's (1965) results might have been due to difficulty in converting temporally presented stimuli to spatial responses rather than to auditory - visual integration.

The aforementioned studies indicated that the ability to integrate pairs of stimuli which vary over both modality

and dimension (auditory -- temporal and visual - spatial), or which vary only in dimension holding modality constant, is related to both grade level and reading achievement. However, they failed to determine whether the difficulty for poor readers was auditory - visual integration or temporal - spatial integration, or if the two tasks are of equal difficulty when studied separately and have an additive effect when combined thereby making the task more difficult. Since, as Gibson pointed out, the process of learning to read requires the individual to integrate material presented both auditorally and visually as well as temporally and spatially, it would be helpful if the relation of these two factors to reading and to each other could be ascertained. The present study was designed to study all possible combinations of the two modalities and dimensions and to determine which of these combinations are related to reading ability and grade level in young children. To accomplish this, three types of stimulus pairs, that is test and comparison stimuli, were used: two intermodal pairs, visual temporal - auditory temporal (VT-AT) and auditory temporal - visual temporal (AT-VT), the modality varying and the dimension being held constant; two interdimensional pairs, visual temporal - visual spatial (VT-VS) and visual spatial - visual temporal (VS-VT), in both cases the modality is held constant and the dimension varied; and finally, two intermodal - inter-

dimensional pairs, visual spatial - auditory temporal (VS-AT) and auditory temporal - visual spatial (AT-VS), where both modality and dimension are varied. These three types of stimulus pairs were chosen because they are similar in structure to those used in other studies, and they provide a means of testing a subject's ability to integrate auditory - visual and temporal - spatial material independently and in combination. It should be noted that the present study differs from those previously mentioned in that it deals with three types of integration tasks rather than just one, and it compares the performance of each subject on all tasks rather than making comparisons between groups of subjects on different tasks.

Subjects from two grade levels were used. It was decided to use subjects from grades two and five because previous studies had reported that the relation between reading and integration occurred in grade two but was doubtful above this level. Moreover, it was felt that subjects below grade two might have difficulty with the dot and dash patterns and this would tend to effect the results.

The reading tests used to differentiate between good and poor readers were selected on the basis of two criteria. Firstly, the reliability and validity coefficients had to be high, and secondly, the test had to have been revised within the last

five years. Two criteria used in selecting the intelligence tests were that reliability and validity information be available for the grades involved, and secondly, the test had to have been constructed so that it did not require the subject to be able to read.

The hypotheses to be tested in this study were formulated on the basis of previously reported findings and also in consideration of the questions which arose due to these different studies.

Hypotheses:

1. Children in grade 5 will score higher on all the integration tasks than children in grade 2.

2. Good readers will score higher on all the integration tasks than poor readers.

3. Good readers in grade 2 will have less difficulty integrating the intermodal - interdimensional pairs (VS-AT and AT-VS) and the interdimensional pairs (VS-VT and VT-VS) than poor readers.

4. Good readers in grade 5 will have less difficulty integrating the intermodal - interdimensional pairs (VS-AT and AT-VS) and the interdimensional pairs (VS-VT and VT-VS) than poor readers.

CHAPTER TWO

METHOD

All students enrolled in grades 2 and 5 in four public schools located in Grenville County in Ontario were administered group intelligence and group reading tests. The schools were selected because they were within a nine mile radius of each other and the children were from similar socio-economic backgrounds.

The intelligence test given to the grade 2 students was the Lorge-Thorndike Intelligence Test, Level 2, Form A, Primary Battery, and to the grade 5 students Level 3, Form A, Nonverbal Battery. The alternate form reliability scores of these two tests are .76 and .81 respectively and the odd even reliability scores are .59 and .94. The validity coefficients of the two tests are: with the Otis Intelligence Tests, .60 and .74 respectively; with the Stanford-Binet .63 and .54 respectively; and with the Wisc, .71 and .79 respectively (Buros, 1959).

The Gates-MacGinities Reading Tests were used to test reabing ability. The Primary B, Form 1 was used for grade 2 students and the reliability of this scale was reported as .93 for both the vocabulary and comprehension. The Survey D, Form 1 was used for the grade 5 students: the reliability coefficient of this scale was reported as .92 for vocabulary

and .96 for comprehension (Gates-MacGinities Technical Manual). The correlation coefficient for grades 2 and 5 on these tests with the Lorge-Thorndike Verbal IQ was .74 and .76 respectively.

To determine the reading ability of each child the vocabulary and comprehension scores for the reading tests were combined to determine a mean reading score. The mean scores for all subjects in each grade were then used to calculate a grade mean and standard deviation.

Subjects:

The subjects selected for this study included only those students in each grade whose scores fell one standard deviation or more above and below the grade means on the Gates-MacGinities Reading Test.

Thirty-eight second grade students, ranging in age from 6 years 5 months to 9 years 3 months, and 38 fifth grade students, ranging in age from 9 years 10 months to 13 years, served as subjects. The grade two sample consisted of 13 males and 6 female poor readers and 12 male and 7 female good readers. The grade five groups were equal, with 11 males and 8 females in both groups.

Apparatus:

A constant Illumination Tachistoscope, which consisted

of two Kodak carousel slide projectors, was used to present the visual spatial stimuli. The projectors were connected to a timing apparatus so that slides could be shown for a set interval automatically or the projectors could be operated manually. Since the auditory or visual temporal stimuli were presented between each of the visual slides the manual controls were used. The automatic timer was set at the 1 second interval and used as a metronome to pace the presentation of stimuli. The stimulus items, which consisted of 24 different patterns of dots and dashes, were prepared on slides. The number of dots and dashes increased from three to six in each of the test patterns and from three groups of three to six in the comparison patterns. Two sets of 24 slides were prepared, one set for the stimulus patterns and one for the matching patterns. The slides were projected onto a screen set five feet in front of the subject.

Below the screen was a one-watt light bulb which was used to present the visual temporal patterns. The light was connected to a silent hand-press switch which controlled the duration of the light flashes. The light was on for one-half second to indicate a dot and one second for a dash, with one second between the dots and dashes in a pattern.

A Phillips four track stereo tape recorder and magnetic tape were used to present the auditory temporal patterns

through a speaker. The auditory test patterns and matching patterns had been previously recorded using a 1000 c.p.s. tone. The tone lasted for one-half second to indicate a dot and one second for a dash, with one second between the dots and dashes in a pattern.

Procedure:

Six different matching tasks, in which the subject was required to indicate which of three comparison patterns was the same as the test pattern, were used.

The first task consisted of a visual spatial test pattern presented on the screen followed by three auditory temporal comparison patterns (VS-AT). In the second task, the test stimulus was the same, that is visual spatial, while the comparison stimuli were three visual temporal patterns presented by means of the one-watt bulb, (VS-VT). In the third and fourth tasks, the test pattern was visual temporal and the three comparison patterns were visual spatial and auditory temporal respectively, (VT-VS and VT-AT). The test stimulus in the fifth and sixth tasks was auditory temporal while the comparison stimuli were visual spatial and visual temporal respectively, (AT-VS and AT-VT).[1] The

1. See Appendix A for a detailed outline of the experiment for one subject.

order of presentation of the six tasks was counterbalanced so that each appeared before and after every other task.[2] The subjects were randomly assigned to one of the orders of presentation.

Each of the tasks was made up of 12 test problems. The first three problems consisted of either 2 dots and a dash or 1 dot and 2 dashes, the second three of 2 dots and 2 dashes, the third three of either 3 dots and 2 dashes or 2 dots and 3 dashes, while the last three were made up of 3 dots and 3 dashes. One of the comparison patterns was the same as the test pattern, while the other two differed but had the same number of symbols.[3]

The subjects were tested individually. When the subject entered the experimental room he was seated comfortably on a chair placed 5 feet away directly facing the projection screen. Prior to beginning any of the tasks the experimenter read the instructions to the subject. For example, for the visual spatial - auditory temporal condition the instructions were:

> "Each pattern you are going to see will be like the dot and dash pattern I will show you on the light (experimenter presented a sample stimulus), but the number of dots and dashes will increase. After you have seen the one pattern, you will then hear 3 different dot and dash patterns like this (sample given), and I want you to tell me which one is the same as the one on the light by saying number one, two or three."[4]

2. See Appendix B for counterbalance of problems.
3. See Appendix A for complete description of problems.
4. See Appendix A for instructions for other 5 tasks.

Preceding each test series the instructions appropriate for the task were read and the subject was then given three practice trials which consisted of either 1 dot and 1 dash or 2 dots. If it was apparent that he understood the task, the 12 test problems were presented. At the end of the 12 test problems the subject was given three minutes rest and then instructions appropriate for the next task were read following which the practice trials and series of test problems were given. This procedure was followed until all six tasks had been completed. The total experimental time was approximately 60 minutes.

The total number of correct responses for each subject on each of the six tasks was computed and these data were used in analyzing the results.

CHAPTER 3

RESULTS

The raw data consisted of the number of correct responses for each subject for each of the six integration tasks.[5] The mean number of correct responses on the six integration tasks for the four groups of subjects is shown in Table 1. It is clear that the retarded readers in each grade perform each of the integration tasks more poorly than the normal readers, while subjects in grade 2 do less well than those in grade 5. It is interesting that there is no inconsistency in this trend for any of the six tasks.

A summary of a 2 X 2 X 6 analysis of variance computed on the data can be seen in Table 2. The three main factors, grade level, reading level, and type of integration task are significant beyond the .01 level. None of the interactions is significant.

A number of Newman-Keuls Tests were carried out. The first was performed on the mean scores for the grade 2 and grade 5 groups and can be found in Table 3. It is evident that the differences between the two grades on all the integration tasks are significant at the .05 level of confidence. Clearly the grade 5 subjects' performance is better than that of grade two.

5. See Appendix C for the number of correct responses for each subject on each of the six tasks.

Table 1: Mean number of correct responses on the six integration tasks

	AT-VT	VT-AT	VT-VS	VS-VT	AT-VS	VS-AT	Total
Poor Readers Grade 2	2.84	3.37	3.74	4.68	4.63	4.79	3.96
Good Readers Grade 2	3.00	3.53	5.47	5.11	5.63	6.11	4.81
Poor Readers Grade 5	5.53	5.26	6.16	7.84	6.84	8.58	6.70
Good Readers Grade 5	8.95	8.74	8.74	8.89	9.63	10.16	9.19

Table 2: Summary of Analysis of Variance on the correct responses in six integration tasks for good and poor readers in grades two and five.

Source	Sum of Squares	df	Mean Squares	F
Between Subjects	3684.991	75		
Reading Level (A)	316.667	1	316.667	12.35*
Grade Level (B)	1445.929	1	1445.929	56.77*
A X B	75.870	1	75.870	2.96
Subj. w group (error term)	1846.526	72	25.646	
Within Subjects	2972.0	380		
Integration Tasks (C)	307.123	5	61.425	8.60*
A X C	25.465	5	5.093	1
B X C	24.939	5	4.988	1
A X B X C	42.841	5	8.568	1.20
C X Subj. w group (error term)	2571.632	360	7.143	
Total	6656.991	455		

* $p < .01$

AT - auditory temporal; VT - visual temporal; VS - visual spatial

Table 3: Newman-Keuls Tests on means of grade two and grade five subjects for the six integration tasks.

TASK	Grade 2 Mean	Grade 5 Mean	Difference
AT-VT	2.92	7.24	4.32*
VT-AT	3.45	7.00	3.55*
VT-VS	4.60	7.45	2.85*
VS-VT	4.80	8.37	3.57*
AT-VS	5.13	8.24	3.11*
VS-AT	5.45	9.37	3.92*

* significant at .05 level of confidence

Table 4: Newman-Keuls Tests on means of poor readers and good readers for the six integration tasks.

Integration Task	Poor Readers Mean	Good Readers Mean	Difference
AT-VT	4.18	5.98	1.80*
VT-AT	4.32	6.14	1.82*
VT-VS	4.95	7.10	2.15*
VS-VT	6.26	7.00	0.74
AT-VS	5.74	7.63	1.89*
VS-AT	6.69	8.14	1.45*

* significant at .05 level of confidence

The second Newman-Keuls Tests were carried out to determine the effects of reading level on the ability to perform the six integration tasks. The results of these tests can be seen in Table 4. The table indicates that the good readers' performance is significantly better than that of the poor readers on all the integration tasks except the visual spatial - visual temporal (VS-VT) one.

Two further Newman-Keuls Tests were done to determine the differences between good and poor readers at each of the two grades on the six integration tasks. The results of these tests are shown in Tables 5 and 6 respectively. Looking at Table 5 first, it can be seen that the difference in task performance of the good and poor readers in grade 2 is only significant for three of the six integration tasks. That is, the good readers performed significantly better on the visual temporal - visual spatial (VT-VS), the auditory temporal - visual spatial (AT-VS), and the visual spatial - auditory temporal (VS-AT) integration tasks but not on the other tests. Table 6 reveals that the good readers in grade 5 performed significantly better than the poor readers on all six of the integration tasks. It is evident, then, that at the lower grade level, only three of the integration tasks differentiate good from poor readers, that is the VT-VS, AT-VS, and VS-AT tasks, while at the higher grade level, good readers performed significantly better than the poor ones on all six tasks.

Table 5: Results of Newman-Keuls Tests on the means of good and poor readers in grade 2 for the six integration tasks.

Integration Task	Poor Readers	Good Readers	Difference
AT-VT	2.84	3.00	0.16
VT-AT	3.37	3.53	0.16
VT-VS	3.74	5.47	1.73*
VS-VT	4.68	5.11	0.43
AT-VS	4.63	5.63	1.00*
VS-AT	4.79	6.11	1.32*
* significant at .05 level of confidence			

Table 6: Results of Newman-Keuls Tests on the means of good and poor readers in grade 5 for the six integration tasks.

Integration Task	Poor Readers	Good Readers	Difference
AT-VT	5.53	8.95	3.42*
VT-AT	5.26	8.74	3.48*
VT-VS	6.16	8.74	2.58*
VS-VT	7.84	8.89	1.05*
AT-VS	6.84	9.63	2.79*
VS-AT	8.58	10.16	1.58*
* significant at .05 level of confidence			

Since the analysis of variance indicated a significant difference between the six integration tasks a Newman-Keuls Test was performed on the overall means to determine which tasks differed from each other. The results of this test can be seen in Table 7. It can be seen that the auditory temporal - visual temporal, and the visual temporal - auditory temporal tasks are significantly more difficult to perform than the auditory temporal and visual spatial ones (that is, AT-VS and VS-AT) and the visual spatial - visual temporal task. The only other significant difference is between the visual temporal - visual spatial task and the visual spatial - auditory temporal task with the former being more difficult than the latter.

While this provides a general indication of the relationship between the six integration tasks and the order of difficulty, further analysis is required to study the differences for good and poor readers in grades 2 and 5 separately. The results of Newman-Keuls tests applied to the means of the six integration tasks for good and poor readers in grades 2 and 5 can be seen in Table 8. Looking first at grade two, it is noted that the poor reader's performance differed from that of the good readers in two aspects. Firstly, the poor readers performed significantly better on the visual spatial - auditory temporal task than on the visual temporal - visual spatial one, while this was not true for the good readers. Secondly it can be seen that

Table 7: Results of Newman-Keuls on the means of the six integration tasks.

	AT-VT 5.08	VT-AT 5.22	VT-VS 6.03	AT-VS 6.61	VS-VT 6.63	VS-AT 7.41
AT-VT 5.08		0.14	0.95	1.53*	1.55*	2.33*
VT-AT 5.22			0.81	1.39*	1.41*	2.19*
VT-VS 6.03				0.58	0.60	1.38*
AT-VS 6.61					0.02	0.80
VS-VT						0.78

* significant at .05 level of confidence

AT - auditory temporal
VT - visual temporal
VS - visual spatial

Table 8: Summary of results of Newman-Keuls tests applied to the means of the six integration tasks for poor and good readers in grades 2 and 5.

Grade 2

	Poor Readers					Good Readers				
TASK	VT-AT	VT-VS	AT-VS	VS-VT	VS-AT	VT-AT	VT-VS	AT-VS	VS-VT	VS-AT
AT-VT	0.63	0.90	1.79*	1.84*	1.96*	0.53	2.47*	2.63*	2.11*	3.11*
VT-AT		0.37	1.26*	1.31*	1.42*		1.94*	2.10*	1.58*	2.58*
VT-VS			0.89	0.94	1.05*			0.16	0.36	0.64
AT-VS				0.05	0.16				0.52	0.48
VS-VT					0.11					1.00

Grade 5

	Poor Readers					Good Readers				
TASK	VT-AT	VT-VS	AT-VS	VS-VT	VS-AT	VT-AT	VT-VS	AT-VS	VS-VT	VS-AT
AT-VT	0.27	0.63	1.31*	2.31*	3.05*	0.21	0.21	0.68	0.06	1.21*
VT-AT		0.90	1.58*	2.58*	3.32*			0.89	0.15	1.42*
VT-VS			0.68	1.68*	2.42*			0.89	0.15	1.42*
AT-VS				1.00*	1.74*				0.74	0.53
VS-VT					0.74					1.27*

* $p < .05$

AT - auditory temporal; VT - visual temporal; VS - visual spatial

performance on the visual temporal - visual spatial task was significantly better than on the auditory temporal - visual temporal tasks among the good readers, but this was not so for the poor ones. Evidently, children who read better in grade 2 perform the interdimensional task better than the two intersensory tasks while the poor readers do not. Turning next to the grade 5 group it can be seen that the good reader's performance on the visual spatial - auditory temporal task is significantly better than on the visual spatial - visual temporal, visual temporal - visual spatial, visual temporal - auditory temporal and auditory temporal - visual temporal tasks, but not on the auditory temporal - visual spatial one. None of the other tasks differs from each other. It is clear that the two tasks involved in reading, that is, visual spatial and auditory temporal are more easily performed than the other tasks by subjects who are older and better readers. The poor readers in grade 5 show a somewhat different performance on integration tasks. For example, this group was similar to the grade 5 good readers in showing a significant difference in performance between the visual spatial - auditory temporal and the auditory temporal - visual temporal, visual temporal - auditory temporal and visual temporal - visual spatial tasks, but differed in the auditory temporal - visual spatial and the visual spatial - visual temporal tasks. They also show a significant difference

between the visual spatial - visual temporal tasks and the other four tasks as well as between the auditory temporal - visual spatial task and the visual temporal - auditory temporal and the auditory temporal - visual temporal tasks. It appears that good and poor readers perform certain integration tasks differently at the grade 5 level; and, that good readers do not differ in their ability to integrate stimuli which are presented in the visual spatial - auditory temporal dimensions, while poor readers find it significantly more difficult to integrate the auditory temporal - visual spatial task than the visual spatial - auditory temporal one. However, when the two tasks have the same test stimulus, that is visual spatial - auditory temporal and visual spatial - visual temporal, there is no difference in performance for the poor readers, whereas the good readers performance on these tasks differed significantly with the visual spatial - auditory temporal task being easier.

In summary, the results indicated the following:

(a) grade 5 subjects perform significantly better than grade 2 subjects on all six integration tasks.

(b) good readers perform better than poor ones on all the integration tasks, but this difference is only significant for the visual temporal - visual spatial, auditory temporal - visual spatial and visual spatial - auditory temporal tasks in grade 2, while the

difference between the performance of good and poor readers in grade 5 is significant for all integration tasks.

(c) when all four groups are combined, a difference in performance of the six integration tasks is found with the visual spatial - auditory temporal, visual spatial - visual temporal and auditory temporal - visual spatial tasks being significantly less difficult than either the auditory temporal - visual temporal or the visual temporal - auditory temporal tasks. It is also noted that the visual spatial - auditory temporal task is significantly easier to perform than the visual temporal - visual spatial one.

(d) there are apparent differences in task difficulty between the good and poor readers in grade 5 with the good readers performing significantly better on the visual spatial - auditory temporal task than on the visual spatial - visual temporal task, while this was not true for the poor readers. Moreover, the poor reader's performance on the visual spatial - auditory temporal task was significantly better than on the auditory temporal - visual spatial task, unlike the good readers. The other major differences noted between the performance of good and poor readers in grade 5 were for the visual spatial - visual temporal

task which the poor readers performed significantly better than the other four tasks and their performance on the auditory temporal - visual spatial task was significantly better than that on either the auditory temporal - visual temporal or the visual temporal - auditory temporal tasks; these differences were not found for the good readers. Further, the good readers differed from the poor readers in grade 2 in that the good readers performance was significantly better on the visual temporal - visual spatial task than on either task involving auditory temporal and visual temporal material and this was not true for the poor readers. Finally, the poor readers performed significantly better on the visual spatial - auditory temporal task than on the visual temporal - visual spatial task, unlike the good readers.

Since previous studies had reported a relation between reading achievement and intelligence quotients correlation coefficients between the reading scores and IQ scores were done for the subjects at both grade levels using the Pearson Product Moment Test. It was found that reading and IQ scores correlated at .86 for the good and poor readers in grade 2 and at .72 for the grade 5 subjects.

CHAPTER 4

DISCUSSION

It is evident from the results of this study that grade level, reading achievement, and the type of task are all related to performance of auditory - visual and/or spatial - temporal integration, at least for the particular sample tested.

The apparent increase in intersensory integration ability between grades 2 and 5 is in keeping with the findings of other studies, (Birch and Belmont, 1965; Kahn, 1965; and Beery, 1967). Birch and Belmont (1965) and Kahn (1965) used an auditory temporal stimulus followed by visual spatial matching tasks, and reported a significant difference between the upper and lower grades, with the former being better than the latter. Beery (1967), in a slightly more comprehensive study, found that this difference in performance between the lower and upper grades was also true when the original stimulus was visual spatial and the matching tasks auditory temporal. Thus, the findings of the present study supported the earlier results of auditory - visual integration ability. Furthermore, they agreed with the Blank and Bridger (1967) study which reported a relation between grade level and ability to integrate material which varied in the temporal and spatial dimensions. It appears, therefore, that there is a relation between grade level and intersensory and interdimensional

integration ability since the subjects in the upper grades performed all integration tasks significantly better than those in the lower grade. Thus, the first hypothesis was supported; that is, "Children in grade 5 will score higher on all the integration tasks than children in grade 2."

The results of the present study also indicated that good readers performed all integration tasks except the visual spatial - visual temporal one better than the poor readers.

Examination of the data for each grade separately, revealed that good readers in both grades differed from poor readers in their ability to perform the visual spatial - auditory temporal, auditory temporal - visual spatial, and visual temporal - visual spatial tasks. The visual spatial - auditory temporal and auditory temporal - visual spatial tasks are similar to those used in previous studies reporting a relation between reading achievement and auditory - visual integration ability when the auditory stimulus was presented temporally and the visual stimulus spatially (Birch and Belmont, 1965; Kahn, 1965; and Beery, 1967). These latter studies failed to agree, however, on whether this relation was true for the lower grades only or if it held for the upper grades. While Beery (1967) had reported that reading achievement and integration ability on such tasks were related at all grade

levels, Birch and Belmont (1965) and Kahn (1965) did not find this relation to hold above the grade two level. Thus, the results of the present study support Beery's findings. The only other integration task which was performed differently by the good and poor readers at both grade levels was the visual temporal - visual spatial task where only the dimension was varied. Blank and Bridger (1966) also found a relation between visual temporal - visual spatial integration ability and reading; the results of this study supported their findings.

Since by the fifth grade good readers perform all six integration tasks better than poor readers, while at the second grade level only tasks involving the visual - spatial dimension differentiate good from poor readers, it seems clear that different skills are required to perform the various types of integration tasks and that these skills develop at varying rates. It appears that good readers in the lower grade develop sensory skills related to visual spatial tasks faster than the poor readers; by grade 5, however, all three integration skills, that is, intermodal, interdimensional, and intermodal-interdimensional are performed better by good readers than by poor ones.

The findings fit in well with Gibson's (1968) formulation of the abilities that a child must develop in order to be an efficient reader. First he must learn to discriminate symbols

presented in a visual spatial context. Then, he must decode the symbols into speech, the auditory temporal task. Finally he must be able to integrate and shift between the visual and auditory dimensions, that is, between visual spatial - auditory temporal and the auditory temporal - visual spatial tasks. Thus, at a very early stage in learning to read, the acquisition of these abilities appears essential for normal development in reading. The finding that good and poor readers also differed on the visual temporal and visual spatial integration task may well be a function of the visual spatial component alone, since the act of reading does not usually involve a visual temporal factor. It should be noted that this type of integration task was the only one in which performance of the poor readers in grade 5 was not significantly better than that of the good readers in grade 2. This suggests that the processes required for this type of integration are learned more slowly by the poor reader than by the good reader. In other words, good readers in grade 3 and 4 must be learning to integrate symbols presented in the visual temporal - auditory temporal, auditory temporal - visual temporal, and visual spatial - visual temporal tasks while reading.

On the basis of these and previously mentioned findings regarding the relation of integration ability to reading, it can be seen that the second and fourth hypotheses are supported

for the good and poor readers in grade 5, and that the third hypothesis is supported for the visual spatial - auditory temporal, the auditory temporal - visual spatial, and the visual temporal - visual spatial tasks when comparing good and poor readers in grade 2. Thus it appears that in order to improve the reading skills of children diagnosed as retarded readers in the early grades tasks involving the practice of integration skills should be developed.

Finally, the results of the study indicate a relationship between the type of task and integration ability. The most difficult tasks were those in which sensory changes occurred while dimension was held constant, that is, auditory temporal - visual temporal (AT-VT) and visual temporal - auditory temporal (VT-AT). This is not surprising since neither of these tasks is involved in the reading process although the auditory component occurs in reading. Blank and Bridger (1966) suggested that the results obtained by Birch and Belmont (1965) and Kahn (1965) were due to difficulty in converting temporally presented stimuli to spatial responses rather than to auditory - visual integration ability. Since the tasks involving only temporal - spatial differences were easier to perform than the tasks with only auditory - visual differences it appears that the difficulty is auditory - visual integration and not temporal - spatial as suggested by Blank and Bridger (1966).

Furthermore, it is apparent that tasks having both sensory and dimensional differences, that is visual spatial - auditory temporal and auditory temporal - visual spatial are easier than tasks with only sensory or dimensional differences. Obviously the combining of these two factors facilitates the performance of integration tasks because these two tasks are used in reading.

In summary, the results of the present study were: the ability to integrate material which differs in modality and dimension is a function of grade level, with grade 5 subjects doing better than grade 2 on all tasks. The ability to integrate intermodal - interdimensional material and inter-dimensional material is related to reading achievement, with good readers performing these tasks better than poor readers. Lastly, performance on the integration tasks was found to differ as a function of the type of task. In general, tasks involving visual spatial - auditory temporal and auditory temporal - visual spatial integrative skills, that is, skills normally used in reading, were easier than those involving the visual temporal dimension.

A number of suggestions for further research can be made as the result of these findings. First, the six integration tasks should be given to subjects from grades 1 to 6 inclusive to determine which ones differentiate the normal and retarded readers at each level. Once these have been determined,

training tasks for each of the integration tasks could be developed and tested for appropriateness. Secondly, longitudinal studies of the same good and poor readers over the six grades would help assure the reliability and validity of the results of such tasks. Finally, a study using the six integration tasks and comparing performance on these to that on various types of perceptual task would help to determine which sensory skills were involved in each integration task, and thus point out the weaknesses of retarded readers.

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APPENDIX A

DETAILED OUTLINE OF THE METHOD FOR ONE SUBJECT

When the subject arrived at the experimental room he was seated comfortably a distance of five feet from the tachistoscope screen with the light below and the auditory apparatus on the floor. The subject was read the following instructions:

> "Each pattern you are going to see will be like the dot and dash pattern I will show you on the light (experimenter presented a sample stimulus), but the number of dots and dashes will increase. After you have seen the one pattern, you will then hear three different dot and dash patterns like this (sample given), and I want you to tell me which one is the same as the one you saw on the light by saying number one, two, or three."

The experimenter then showed the subject the following sample series:

Original Pattern (Visual temporal)	Matching Patterns (Auditory temporal)		
-•	••	•-	-•
•-	•-	-•	--
••	-•	•-	••

After the experimenter presented the subject the task in the sample items, if the subject's choice was wrong, the experimenter told him which one was right and explained why it was right. The second and third items were presented without correction for errors. When the experimenter was certain that the subject understood the task he proceeded with the test series.

The test series for this task was as follows:

Original Pattern	Matching Patterns		
-..	-..	..-	-.-
--.	--.	.--	-..
-.-	..-	-.-	.--
-.-.	-.-.	.--.	--..
..--	-.-.	..--	.-.-
--..	-..-	..--	--..
.-.-.	-.-.-	.-.-.	.-.--
..--.	-..-.	..--.	-.-..
.---.	.---.	-.-.-	.--..
.--..-	...---	--..-.	.--..-
---...	---...	--...-	--.-..
-...--	..--.-	-...--	.--.-.

This completed the first task and the subject was given a three minute rest period prior to beginning the second task. The subject was given the following instructions:

> "This time you are going to hear some dot and dash patterns like this (sample presented) and the number of dots and dashes will increase like the last time. After you have heard the dot and dash pattern you will then see three different dot and dash patterns on the light like this (sample given), and I want you to tell me which one is the same as the dot and dash pattern you heard by saying one, two or three."

The experimenter showed the subject the sample series as before but the items were in a different order. After the experimenter presented the first item, if the subject's choice was wrong the experimenter told him which one was right. The second and third sets of patterns were then presented. When the experimenter was certain the subject understood the new task he proceeded with the test series which was as follows:

Original Pattern (Auditory temporal)	Matching Patterns (Visual temporal)
•–•	••– •–• ––•
•––	–•– –•• •––
••–	••– –•• –•–
–••–	•––• –••– ••––
•–•–	––•• ••–– •–•–
•––•	•––• –••– –•–•
•–•––	–•–•– •–•–– •–•–•
•––•–	•––•– –••–• ••––•
–•–••	––••– –••–• –•–••
••–––•	••–––• ––••–• –•••––
–•••–•	––•••– •–••–– –•••–•
––••–•	–––••• •–––•• ––••–•

Once again the subject had a three minute rest before receiving the instructions for the third task.

> "This time you are going to see dot and dash patterns from the light (sample presented) and the number of dots and dashes will increase like before. After you have seen the one pattern you will see a picture of three different dot and dash patterns on the screen (sample given). I want you to tell me which one is the same as the dot and dash pattern you saw on the light by saying number one, two or three (experimenter pointed to the three positions from left to right)."

The experimenter showed the subject the sample series following the same procedure as outlined previously and proceeded with the test series when he was certain that the subject understood the task.

Original Pattern (Visual temporal)	Matching Patterns (Visual spatial)
.--	-.. -.- .--
-..	-.- -.. ..-
.-.	.-. --. -..
-..-	.--. ..-- -..-
.-.-	-.-. .-.- --..
--..	-.-. .-.- --..
.-..-	.--.- .-..- ---..
.---.	.---. --..- -..-.
.-.-.	.--.. .-.-. ..-.-

Original Pattern (Visual temporal)	Matching Patterns (Visual spatial)		
.-.-.-	--.-..	.-.-.-	-...--
-.--..	-.--..	.-.-.-	.---..
..-.--	-..--.	-..-.-	..-.--

Again the subject had a three minute rest and then received the instructions for the next task.

"This time you are going to hear dot and dash patterns like this (sample presented) and the number of dots and dashes will increase like before. After you have heard the dot and dash pattern you will see a picture of three different dot and dash patterns on the screen (sample given). I want you to tell me which one is the same as the dot and dash pattern heard by saying number one, two, or three."

Once again the presentation of the sample series preceded the test series.

Original Pattern (Auditory temporal)	Matching Pattern (Visual spatial)		
..-	.-.	.--	..-
.--	.--	-.-	.-.
--.	-..	--.	..-
..--	-..-	..--	--..
-..-	..--	.--.	-..-
--..	--..	-..-	.--.
---..	--.-.	-...-	---..
-.-..	-.-..	..---	..-.-
.-.--	.--.-	.-.--	...--

Original Pattern (Auditory temporal)	Matching Patterns (Visual spatial)		
-..-.-	...---	--...-	-..-.-
--...-	..-.--	--.-..	--..-.
-.--..	-.-.-.	-.--..	..---.

After another three minute rest period the subject received the instructions for the fifth task.

"This time each pattern you are going to see will be like the dot and dash pattern you see in this picture (sample presented), but the number of dots and dashes will increase as before. After you have seen the one pattern you will then see three different dot and dash patterns from the light like this (sample shown). I want you to tell me which one is the same as the dot and dash pattern you saw in the picture by saying number one, two, or three."

The test series was as follows:

Original Pattern (Visual spatial)	Matching Patterns (Visual temporal)		
-.-	--.	.-.	-.-
.-.	.--	.-.	--.
-..	-..	.--	.-.
.--.	.--.	--..	..--
-.-.	-..-	.--.	-.-.
.-.-	--..	-..-	.-.-
-.--.	.--.-	-.--.	.--..
-.-.-	-.-..	..-.-	-.-.-
..-.-	..-.-	--...	.--..

Original Pattern (Visual spatial)	Matching Patterns (Visual temporal)		
--...-	..----.	..--.-	--...-
.--.-.	..-.--	.--.-.	-.--..
...---	...---	--..-.	--...-

After a three minute rest the subject received the instructions for the last task.

"This time each pattern you are going to see will be like the dot and dash pattern you see in this picture (sample presented), and the number of dots and dashes will increase as before. After you have seen the one pattern you will hear three different dot and dash patterns like this (sample given). I want you to tell me which one is the same as the one you just saw by saying number one, two, or three."

The test series for the last series was as follows:

Original Pattern (Visual spatial)	Matching Patterns (Auditory temporal)		
-..	-..	.-.	..-
-.-	.--	--.	-.-
.--	.-.	.--	-.-
.--.	.-.-	-..-	.--.
.-.-	-..-	.-.-	..--
..--	..--	-.-.	--..
-...-	.--..	..---	-...-
.--..	.--..	.---.	..---
..--.	-.-.-	..--.	.-.-.

Original Pattern (Visual spatial)	Matching Patterns (Auditory temporal)		
..---.	..---.	-.--..	--..-.
-...--	-.-..-	--...··	-...--
-.-..-	.--..-	-.-..-	...---

APPENDIX B

Counterbalancing of the six tasks to eliminate errors due to task position effect.

1	2	3	4	5	6
VS-VT	AT-VS	VT-AT	VT-VS	VS-AT	AT-VT
VT-VS	VS-VT	VS-AT	AT-VS	AT-VT	VT-AT
VS-AT	VT-AT	VS-VT	AT-VT	VT-VS	AT-VS
AT-VS	VT-VS	AT-VT	VS-VT	VT-AT	VS-AT
VT-AT	AT-VT	AT-VS	VS-AT	VS-VT	VT-VS
AT-VT	VS-AT	VT-VS	VT-AT	AT-VS	VS-VT

VS - visual spatial

VT - visual temporal

AT - auditory temporal

APPENDIX C

Raw Scores of the Poor Readers in Grade 2 on the 6 Integration Tasks

Subject	VS-VT	VT-VS	VS-AT	AT-VS	VT-AT	AT-VT
1	3	6	4	2	1	0
2	5	0	11	9	7	1
3	5	7	5	1	0	1
4	8	5	8	7	3	6
5	1	4	8	6	1	1
6	11	7	8	8	0	5
7	11	2	6	7	8	8
8	10	6	1	0	2	3
9	9	1	5	8	8	0
10	0	4	3	3	2	0
11	1	0	4	0	7	3
12	6	9	9	9	4	7
13	0	3	2	4	0	2
14	3	3	2	1	2	7
15	0	5	4	1	0	2
16	5	4	2	1	6	1
17	0	3	5	9	2	4
18	2	1	1	6	2	1
19	4	1	3	0	9	2

Raw Scores of the Good Readers in Grade 2 on the 6 Integration Tasks

Subject	VS-VT	VT-VS	VS-AT	AT-VS	VT-AT	AT-VT
1	7	9	8	8	1	0
2	6	7	3	7	4	2
3	12	11	7	7	8	7
4	11	7	9	7	3	5
5	10	7	10	9	10	1
6	1	10	10	3	6	9
7	3	9	8	10	4	1
8	5	3	9	7	0	1
9	3	2	9	10	3	0
10	8	0	9	6	2	3
11	5	0	2	2	3	0
12	1	5	4	0	0	5
13	0	0	1	4	0	5
14	2	1	3	2	2	0
15	8	9	11	4	11	6
16	6	5	10	7	4	4
17	8	5	3	7	5	4
18	1	7	0	2	0	1
19	0	7	0	5	1	3

Raw Scores of the Poor Readers in Grade 5 on the 6 Integration Tasks

Subject	VS-VT	VT-VS	VS-AT	AT-VS	VT-AT	AT-VT
1	9	10	11	8	9	4
2	10	9	11	7	10	10
3	12	3	8	8	0	5
4	11	7	10	8	6	10
5	0	1	2	5	6	0
6	11	9	12	8	4	8
7	9	8	12	9	0	10
8	9	11	7	7	8	5
9	4	1	10	10	1	7
10	8	3	10	4	7	0
11	11	8	11	10	11	10
12	5	4	8	0	1	2
13	3	5	9	8	5	7
14	8	10	11	0	9	7
15	10	4	0	5	4	2
16	9	5	9	7	2	1
17	9	8	10	7	6	8
18	10	9	12	10	7	7
19	1	2	0	9	7	7

Raw Scores of the Good Readers in Grade 5 on the 6 Integration Tasks

Subject	VS-VT	VT-VS	VS-AT	AT-VS	VT-AT	AT-VT
1	11	11	12	11	4	8
2	11	12	12	9	12	10
3	6	11	10	12	8	9
4	12	11	11	11	12	12
5	12	9	11	9	8	9
6	10	10	11	12	11	10
7	10	6	12	10	11	10
8	11	12	12	9	10	10
9	2	0	0	11	12	11
10	11	10	12	9	11	10
11	12	10	12	11	10	11
12	8	0	10	8	7	8
13	12	8	11	9	9	11
14	4	11	9	4	1	1
15	1	7	11	10	3	7
16	12	11	11	11	9	10
17	3	11	6	11	10	9
18	11	8	10	6	8	8
19	10	8	10	10	10	6

APPENDIX D

Raw Score for the Reading and Intelligence Tests Grade Two

Subject	Reading Test	Intelligence Quotient	Subject	Reading Test	Intelligence Quotient
1	27	85	49	30	80
2	22	81	50	24	80
3*	15	86	51*	14	79
4	29	125	52*	18	106
5*	20	101	53*	16	96
6	26	106	54	25	93
7	31	130	55	28	94
8*	18	104	56	32	117
9*	18	110	57	32	123
10	23	87	58	34	129
11	28	124	59*	36	129
12	24	99	60*	36	117
13	29	102	61	28	120
14	30	114	62	32	91
15*	37	129	63	26	113
16*	38	123	64*	18	91
17	22	97	65*	36	105
18	26	120	66*	16	101
19	32	140	67	28	91
20*	40	135	68	25	108
21*	40	123	69*	14	90
22*	20	96	70*	18	108
23	30	126	71	24	87
24*	36	126	72*	18	94
25*	38	108	73	22	96
26*	38	135	74*	36	118
27	23	99	75*	36	113
28	29	96	76	32	106
29	27	106	77	28	104
30	21	82	78	29	93
31*	16	91	79	24	92
32	24	133	80	26	108
33*	36	129	81*	14	109
34*	37	120	82	26	97
35*	36	112	83	23	114
36*	38	135	84*	36	98
37*	38	146	85*	16	104
38*	18	99	86	28	110
39	28	76	87	24	100
40	22	119	88*	14	87
41	30	117	89*	9	104
42	30	107	90	24	107
43*	36	105	91	22	95
44	34	125	92	22	92
45	35	139	93	24	116
46	32	123	94	21	80
47	28	124	95	28	95
48	28	110			

* Subjects used for experiment

Raw Score for Reading and Intelligence Tests Grade Five

Subject	Reading Test	Intelligence Quotient	Subject	Reading Test	Intelligence Quotient
1	34.5	93	50	40	115
2	37.5	97	51	36.5	88
3	30	99	52*	28.5	106
4*	46	109	53	37.5	128
5	33.5	96	54	40	109
6*	45.5	127	55	31	134
7*	27.5	91	56	31	108
8*	42.5	130	57	33	96
9	30.5	106	58	35	122
10	38.5	99	59*	27.5	88
11	30.5	90	60*	26.5	98
12	36.5	105	61	33	121
13	39	104	62	39	102
14	40	111	63*	26.5	84
15	38	106	64*	47.5	118
16*	40.5	96	65	36.5	111
17*	26	108	66	36.5	112
18*	40.5	116	67*	42.5	100
19	37.5	108	68	34.5	115
20*	27	95	69*	24.5	99
21	38.5	109	70	31.5	92
22	38	104	71	37.5	120
23	34	103	72	29.5	111
24	36.5	120	73*	42.5	116
25	31	110	74	37.5	120
26*	26	100	75*	28.5	99
27*	26	69	76*	44	110
28*	27.5	83	77	31	94
29*	26.5	100	78*	41	110
30	32.5	92	79*	42.5	113
31*	24	95	80	32.5	117
32	38	110	81	36.5	109
33	36	103	82	37.5	99
34*	40.5	133	83	31	82
35	38.5	117	84	34	104
36*	44.5	105	85	33	92
37	35	115	86	31	79
38*	40.5	122	87	33	96
39*	41	114	88*	25.5	112
40	36	127	89	34	119
41*	27	98	90*	25	94
42	39.5	109	91	34.5	87
43*	41	127	92	38	136
44	38	115	93	33.5	94
45*	42	112	94	37	89
46	35	115	95	37	106
47	37	108	96*	24.5	103
48*	45.5	123	97	34.5	86
49*	22	91	98*	41.5	106

* Subjects used for experiment