VERTICAL ORIENTATION IN VISUAL AND MOTOR PERFORMANCE AND ITS RELATION TO READING

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ABSTRACT

VERTICAL ORIENTATION IN VISUAL AND MOTOR PERFORMANCE AND ITS RELATION TO READING

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Four hundred and sixty-one children of grades two, three, and four were presented, by classroom, six gestalt-type figures to copy and eighteen words from the Gates Reading Diagnostic Test for Reversals (Gates, 1935) to write (or print). The children were exposed to the individual figures or words for from three to ten seconds, depending on grade level and difficulty of the figure or word; then were requested to reproduce what they saw. Protocols were scored so that children rotating one or more of the figures 45° or more from the horizontal were classified in the Vertical Group; those making no rotations were in the Non-Vertical Group. Children reversing one or more words or letters were classified in the Reversal Group; those making no reversals were in the Non-Reversal Group. Already-formed classroom reading groups were used to classify children as Good, Medium, and Poor Readers.

The theory underlying the study is that children tend to be vertically oriented; i.e., it is easier for them to align what they see and what they do with the vertical axis of their body than with the horizontal axis. This tendency should interfere with reading, which is horizontal in orientation, by causing the rotation of letters away from the horizontal position.

The following five predicted relations were statistically significant by means of X^2 tests:

1) There is a decrease in the number of children showing vertical rotations from the second to the fourth grades. Fifty-five per cent of the second graders as compared to 28 per cent of the fourth graders showed vertical rotations, indicating an increase in discipline of direction with age.

2) Verticalization and reading and writing reversals are related.

3) There is a relationship between verticalization and reading ability as assessed by the classroom teacher, with the exception of the fourth grade.

4) There is a relationship between production of reading reversals and reading ability.

5) There is no difference between the tendency of left- and right-handed children to make vertical rotations.

The sixth hypothesis predicted that there would be a difference between boys and girls in the frequency of vertical rotations. It was found, however, that no significant difference exists.

Gates, A. I., The Improvement of Reading, The Macmillan Company, New York, 1935.

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By

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INTRODUCTION

Statement of Purpose. This study deals with the directional orientation of children in perceptual and motor tasks. The study focuses on an apparent tendency in children to align what they see and what they do with their body axis. Since their bodies are usually in an up and down position, their visual and motor tasks should also be oriented vertically rather than horizontally. This study, therefore, specifically treats vertical orientation. The subjects are children in grades two, three, and four.

The first aim of the study is to show that the tendency toward vertical orientation is of a developmental nature; that is, as the child grows older, vertically oriented behavior will decrease. It is specifically proposed that there will be a decrease from the second to the fourth grade in the number of children who show vertical orientation.

The second purpose of this research is to demonstrate a relationship between vertical orientation and reading and writing reversals. Let the term "verticalization" apply to instances of rotation of figures from a horizontal to a vertical position, and the term "reversal" cover cases of reversal of (1) a letter, such as "b" for "d"; (2) a complete word, such as "no" for "on"; or (3) a part of a word, such as "stop" for "spot". Since a lack of adeptness in left-to-right horizontal orientation is demonstrated in both vertical rotation of the figures and reversals in reading and spelling, an attempt will be made to

equate these and show that when one occurs, the other has a greater than chance probability of occurrence.

The third related purpose is to show a relationship between verticalization and general reading difficulties that would characterize a child as a "poor" rather than a "good" reader.

The study of the relationship between reversals and general reading difficulties will serve as the fourth purpose.

The fifth goal of the study is to determine if there is a difference between boys and girls in the frequency of vertical orientation. Specifically, do more boys produce vertical rotations of figures than girls, is the opposite the case, or is there no difference between the sexes?

The sixth and final purpose of this research is to learn whether handedness affects vertical orientation, that is, do children who are left-handed show a greater tendency to verticalization than is the case with right-handed children?

Background of Theory and Research. Many theories have been expounded and considerable research has been carried out regarding the apparent tendency of children to be vertically rather than horizontally oriented.

A major influence in the present study is the theory of perception proposed by Werner and Wapner (1949, 1951, 1952). The central concept in this theory is the interaction of sensory and motor factors. This "field theory" postulates a definite relationship between the organism and the object perceived. Werner and Wapner (1951) assert that the

state of the organism is part and parcel of perceptual events, and posture is given as a major dynamic state of the organism. A stimulus object is said to involve the total organism, thus when an object stimulates the sensorium, the perceptual result will depend on the relationship between the stimulus object and the sensory-tonic state of the organism (Werner and Wapner, 1952). If the stimulus interferes with the state of the body, the organism will tend to change its state toward alignment of the body with the object. An object which is in tune with body equilibrium is perceived as vertical. Werner and Wapner have shown that objects interfering with body equilibrium induce a shift of either the body or the object so that it can be perceived as vertical. Eberl (1953) asserts that seeing is integrated with the total action system in a holistic manner. Vision is said to be a total process--both sensory and motor. Bender (1938) and Townsend (1951) state that the whole setting of the stimulus and the whole integrative state of the organism determine the pattern of response. Witkin and Asch (1948) also indicate that a person perceives position and direction of objects as he perceives his own position and direction. Gibson and Mower (1938) postulate two factors in visual orientation: a perceptual factor which involves an implicit visual sense of the vertical (and horizontal) and a behavioral factor which involves postural orientation. They conclude from their studies that gravitational or postural factors are prior to visual factors in the determination of the perceived vertical. Koffka (Mawn, 1949) asserts that precision in perception of the vertical is due to visual framework or an anchorage in space. And, to quote Piaget and Inhelder (1956), "The reconstruction

of shapes rests upon an active process of 'putting in relation', and it therefore implies that the abstraction is based on the child's own actions and comes about through their gradual coordination."

A more empiricistic explanation might be that a child becomes vertically oriented because he is dependent from birth for care and affection obtained from external, upright figures.

Skills of reading and writing involve both perceptual and motor components. Reading involves motor coordination in precise eye movement patterns. Gates (1935) states that left-to-right eye movements are unnatural and require considerable careful training to establish. Writing and copying make heavy demands for precise control of the writing hand. The untrained eye of the child tends to follow hand movements, and it is thought that muscular mechanisms favor up-and-down (vertical) movement (Fabian, 1945). Mira (Fabian, 1945) states that there is in "instinctive tendency to move hand, pencil, and elbow in the same oblique axis corresponding to the plane of semiflexion in which the parts are placed in relation to the arm." Freeman (1914) found in his studies that arm movements used in writing are acquired slowly and that most first grade children are not ready to write.

This motor control must also be guided by accurate perception of the form to be copied and of the child's own copy. Fabian (1945) points out that prior to encountering the printed letter or word, a child is accustomed to viewing the object from any angle, and to come to a meaningful identification. Children seem inclined to ignore or isolate insignificant aspects. It seems logical to assume that, upon first contact with words, the child will view them as he would a

picture (Fildes, 1923). It has been shown by Eng (1954, 1957), for example, that children can comprehend pictures as well if they are inverted as when they are correctly oriented. Therefore, words should also be independent of their spatial position to young children. Stern (1926) indicates that the idea of position is much more slowly learned than the idea of form. The letters and words are not discrete entities in space. Hildreth (1934) and Fildes (1923) state, therefore, that reversals are practically universal in early learning states. Fildes found that apparently the form can be grasped as a whole without knowledge of its direction or position in space, which is often unobserved. Theoretically, then, reading is an artificial situation, and the left-to-right eye movements must be acquired. And, according to several authors cited, it is acquired with more difficulty than up-and-down movements would be.

But, it should be asked, what is the effect of vertical orientation on reading, copying, and writing when tested experimentally? A study by A. A. Fabian (1945) has direct bearing on the present research. Fabian began with Bender's findings, showing that severely retarded readers rotate horizontally oriented Gestalt figures to vertical positions in copying. Fabian used kindergarten through third grade subjects and chose five Bender-Gestalt figures to which he added such forms as whole straight lines, broken straight lines, and straight lines accentuated with arrows--all on the horizontal plane. These he felt approximated the printed word. The closest approximation was thought to be those lines which had direction accentuated by arrows and markers, because such lines particularly represent the left-to-

right direction necessary in reading. More rotations occurred with these accentuated lines. These Gestalt figures were shown individually for a period of five seconds. Fabian also gave a choice of direction and had a group of six-year-old children draw three straight lines any way they wished. Sixty-nine per cent of these children drew vertical lines. From the Bender forms it was found that frequency of rotation declined from 63 per cent in kindergarten to 10 per cent in the third grade, while the frequency of horizontally accented lines drawn vertically declined from 51 per cent in the first grade to zero in the third grade. Also, with the copying of numbers and such letters as b, d, p, reversals declined from 51 per cent in the first to zero in the third grade.

Fabian's procedure was followed closely in the pilot study for the present investigation. Five good readers and five poor readers were selected from the first, second, and third grades at Walnut Street School in Lansing. A battery of five tests were presented to the children individually. The children were requested to (1) copy fifteen Gestalt figures which were presented for five seconds each; (2) draw three straight lines any way they wanted to; (3) use a marble board moving marbles from up to down and from right to left as quickly as possible; (4) read aloud thirty words from the Gates reversal test (Gates, 1935) presented on individual cards; (5) print the letters and numbers b, p, 3, 9, d, 7 which were presented verbally. The results showed that (1) 70 per cent of the first, 10 per cent of the second, and 30 per cent of the third grade rotated the Gestalt forms; (2) 40 per cent of the first, 40 per cent of the second, and 50 per cent of

the third chose to draw vertical lines; (3) 80 per cent of the first, 50 per cent of the second, and 80 per cent of the third moved the marbles from up to down more rapidly than from left to right; (4) 42 per cent of the first (three children could not read and were not included), 80 per cent of the second, and 50 per cent of the third gave reversals in reading the Gates words; (5) 90 per cent of the first, 10 per cent of the second, and none of the third graders reversed one or more of the letters and numbers. The figures found in the pilot study compare favorably with Fabian's findings for the same tests.

It appears evident, therefore, that the tendency to vertically rotate forms and to reverse letters and words decreases as the grade level increases. There seems to be a developmental factor involved and an indication of maturation of perceptual powers, increased experience, and familiarity with reading and writing as the child grows older. It also seems evident in the Fabian study that there is a much greater tendency to rotate configurations from horizontal to vertical than the reverse. Fabian says, "The absence of rotation when the stimuli are vertically oriented reinforces the impression that horizontal configurations are more likely to initiate figure-ground changes in young children" (1945). Since a vertical orientation has been hypothesized and since Eng (1957) states that a "simple straight line suggests a movement in its own direction on account of the motion of they eye in following it and the hand in drawing it", results from observing the copying behavior of children should show that hand and eye movements in a left-to-right horizontal direction and a general horizontal orientation is not as adequately developed in young children as

is the vertical.

From Werner and Wapner it may be recalled that vertical orientation consists of alignment of a perceived object with the body. One may ask for an explanation of the fact that the body is in an upright position in space whereas copying is done on a table which may be thought of as being at right angles to the body. However, it was concluded by Reid (1954) that up and down in the vertical plane is equivalent to movements away from and toward the body in a horizontal plane.

As for the relationship of verticalization to reading reversals, Fabian (1945) hypothesizes that, since we have three-dimensional vision, we could also have rotation in three spatial planes. Vertical rotation of figures would seem to indicate a "multiplaned axial rotation of symbols" (Fabian, 1945). He feels this also happens with words and gives the following examples of such rotation:

Word	Vertical	Reversal
u		n
saw		mas or was

Billingslea (1948) also defines a reversal as "a high degree or extreme rotation of parts of the figure".

In Teegarden's (1933) study the results showed that the strength of reversal tendencies bears a positive relation to reading achievement at the end of the first grade. Jastak also speculates that an inferior ability of symbol perception is much more frequently associated with reading defects than inferior ability to comprehend or think (Teegarden, 1933).

A study by Tinker (1955) is interesting to note. He attempted to compare the reading of vertical vs. horizontal material when the subjects were given systematic practice in reading vertically. With college sophomores it was found that after only 42 practice readings there was a 17.8 per cent improvement in vertical reading speed. On the initial test vertical reading was 50 per cent slower than horizontal reading, but after practice it was only 21.8 per cent slower. Also, eye movement patterns showed that vertical reading required fewer fixations, fewer regressions, and covered more words per fixation.

Handedness and sex are two systematic ways in which children might differ in their performance on the copying and writing tests, and they will be taken into consideration in the present study. It seems to be the general opinion that being right- or left-handed has no effect on copying forms or writing. Gesell and Ames (1946) found no consistent relationship between handedness and directionality. Fildes (1923) reports that in copying forms, errors are as great with right-handed children as with left-handers. Stern (Eng, 1954) states that reading and writing reversals have nothing to do with left-handedness. Likewise, Stevenson (1953) found that no more reversals were made by children with left eye-hand preference than with right eye-hand preference. Harris (1957) speculates that it is mixed dominance that causes reading difficulties. Being able to use either hand equally well, or having mixed dominance, causes directional confusion. This is also felt to be the case by Orton (1937).

There seems to be some disagreement as far as the influence of sex is concerned. Hildreth (1932) found a consistent slight superiority

of girls over boys in reading and writing tests, but too small a difference to be considered significant. Townsend (1951) discusses sex differences in terms of motor abilities and indicates boys are superior with regard to rate and accuracy of their movements. Kemal (Townsend, 1951) found little difference in the motor abilities of boys and girls between four and eight years old. Although there seems to be little conclusive evidence to show that one sex would perform consistently better than the other, it does seem to be the feeling that boys will do better on tasks such as drawing or copying which involve motor ability.

Hypotheses. On the basis of these earlier findings, the following hypotheses are formulated for study in this investigation.

1) There is a difference between the number of children showing vertical rotations of horizontal figures in the second grade and the fourth grade, with the greater number of verticalizations occurring at the second grade level of development.

2) There is a relationship between verticalizations and reading and writing reversals. The child who demonstrates vertical rotation of figures will show more evidence of reading and writing reversals than one who does not make vertical rotations.

3) There is a relationship between verticalization and reading ability as judged by the classroom teacher. The child assessed as a good reader will show less vertical rotation of figures than one who is assessed as a poor reader.

4) There is a relationship between production of reading reversals and reading ability as judged by the classroom teacher. The child

assessed as a good reader will make fewer reading reversals than one assessed as a poor reader.

5) There is a sex difference in the frequency of vertical rotations of horizontal figures in the three grades tested.

6) There will be no difference between the tendency of left- and right-handed children to demonstrate vertical rotations.

PROCEDURE

Subjects. Subjects were 461 public school children from grades two through four. In the pilot study it was found that many first grade children were unable to read adequately to perform the test. The second, third, and fourth grade pupils, it was felt, had received adequate instruction in reading and spelling to iron out expected initial learning difficulties so that problems which still existed at these levels would be of a more serious nature. In Lansing, Michigan, six schools provided the 461 children used for the main study (see Appendix A).

Within the individual classrooms, two additional sub-samples were procured. If it was the policy of the teacher to divide the class into good, average, and poor reading sections, as was the general case, these already formed groups were used to locate Good, Medium, and Poor readers. In the few instances where such was not the procedure, the teachers assessed the children's reading ability on the basis of classroom performance through the year, nominating those who performed in a superior, average, and inferior manner. Also, the names of left-handed pupils were procured.

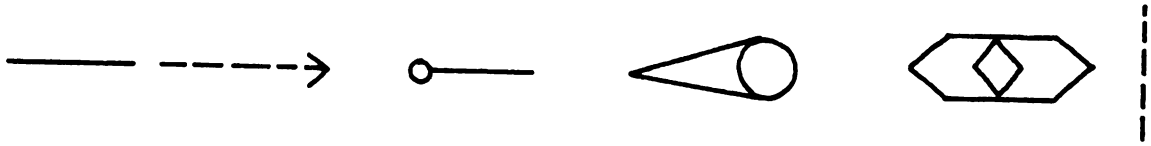
Testing Materials and Procedure. Each of the following words were printed on individual white 6- by 18-inch cards:

spot	on	won	dear	pot	tar
dab	am	ma	war	no	pal
even	saw	raw	now	ton	bad

These words were taken from the Gates Reading Diagnostic Test for Reversals (Gates, 1935). They were selected because they showed the most frequent reversals during the pilot study.

The words were presented one at a time to the class as a whole with the instructions to be found in the next section. Second grade children had a viewing time of 5 seconds for the two-letter words and 10 seconds for the three- and four-letter words. Third and fourth grades had 3 seconds for the two- and three-letter words and 5 seconds for the four-letter words. The shorter time span was believed adequate for these grade levels (third and fourth) since the words were simple enough to be easily recognized. The children printed or wrote the words on a single sheet of lined paper of the type on which they were accustomed to writing.

Each child then received six 8½-inch square sheets of white paper. These sheets were stapled together at one corner, and the whole sheaf was taped to the child's desk by means of a piece of masking tape attached to the bottom sheet and the desk. This was to prevent the child from turning his paper as he drew and also to enable the examiner to keep track of the top of each paper. Each sheet, then, could be easily turned back at the corner after completion of a drawing, leaving a clean sheet for the next drawing. Each of the following figures were presented on a white 22- by 22-inch square piece of cardboard:



It will be noted that all but one are horizontally oriented. The exception was to act as a control for the tendency to rotate because of

general difficulty with visual motor performance not directly related to direction. The first three figures are of the type used by Fabian (1945) as representative of the written word. The next two are of the Bender-Gestalt type and were developed by Dr. Mary Haworth. Each figure, with one exception, was shown for a period of five seconds. The exception is the figure shown above that is next to last. Because it is more involved, it was shown for 10 seconds. This method of presentation is similar to that used by Fabian (1945).

It is shown in a study by Hannah (1958) that the orientation of the cards and paper (being vertically or horizontally rectangular) influences the score for rotations with the Bender Gestalt test. His solution was to extend the vertical edges of the presentation card to give it the same proportions as the vertically rectangular copy sheet. It was felt that one step further was desirable in the present study; the cards and copy sheets were made square.

Instructions. The directions for taking the test were presented as though the activity were a game. Three drawings were made and presented to illustrate the following instructions (see Appendix B):

"To start, you will all put your pencils down on your desk, keep your heads up, and watch me (pointing to the first illustration). I am going to show you a card with a word on it. I want you to look at the word very carefully and read the word silently to yourself. It is very important that you keep your eyes on the card and your pencils down on your desk. Next (pointing to the second illustration) I will take the card away. When I do this, you are to pick up your pencil and spell the word you read on your paper. Then, when you have

finished writing (printing) the word on your paper (pointing to the third illustration), put your pencil on your desk and hold your head up high so that I will know when you are finished."

These instructions were repeated and questions answered. Then, two practice cards were presented with letters instead of full words. Following the practice, the 18 words previously listed were shown to the children.

The second part of the experiment was prefaced by the following:

"Now, instead of seeing a word on the card, you will see a picture. But, you will do just the same thing--while I hold up the card, your pencil will be on your desk, and you will be looking carefully at what is on the card (first illustration). Then, when I put the card down, you will pick up your pencil and draw what you saw on the card on your paper (second illustration). You will have a new piece of paper for each drawing, so, when you have finished your drawing, turn that piece of paper over, folding it at the corner. Then, put your pencil on your desk and hold your head up so I can tell when you are through (third illustration)."

These instructions were also repeated and questions were answered.

The children appeared to understand and follow all directions without difficulty.

RESULTS

The initial reading-spelling test was scored directly from the children's written sheets. The purpose of this test, according to Gates (1935), is "to ascertain the child's tendency to reverse words or mispronounce them as forms made up of the same or similar letters, that is to make errors falling into the categories of total and partial reversals." Protocols were scored with this purpose in mind, and children who made one or more reversals were classified in the Reversal group; those making no reversals were classified in the Non-Reversal group. Table 1 lists the 18 words together with the percentage that each word was wholly or partially reversed within the three grades separately, and for the three grades combined. The words are listed in order of decreasing frequency of reversal for the combined grades. The two most frequently reversed words were "dab" and "bad". These errors could be expected since "b" and "d" are so similar, with the exception of their direction, and they are easily confused. Incorrect reproduction of "spot" most frequently took the form of "stop". Words such as "saw", "ma", "no", were most frequently totally reversed. A major reduction of reversals through the grades was evident; 144 reversals were made by the 177 second graders; 62 reversals were made by the 127 third graders, and only 11 reversals were made by the 157 fourth graders.

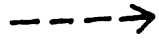
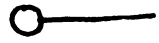
Table 1. Eighteen Words Presented to Second, Third, and Fourth Grade Pupils and the Percentage That Each Was Wholly or Partially Reversed.

Words	Percentage of Reversal			
	Second Grade	Third Grade	Fourth Grade	Total
dab	19.8%	12.6%	1.3%	11.5%
bad	15.8	10.2	1.9	9.5
spot	15.3	7.9	1.9	8.7
dear	7.9	2.4	.6	3.9
saw	4.5	.8	0.0	1.9
ma	1.1	3.9	.6	1.7
raw	2.3	1.6	0.0	1.3
no	2.3	.8	0.0	1.1
now	2.3	.8	0.0	1.1
won	2.3	.8	0.0	1.1
tar	2.3	.8	0.0	1.1
on	1.1	2.4	0.0	1.1
pal	1.7	.8	0.0	.9
pot	1.1	1.6	0.0	.9
ton	1.1	.8	0.0	.7
war	.6	.8	0.0	.4
ever	0.0	0.0	.6	.2

One or more reversals were produced by 46 per cent of the second grade, 34 per cent of the third grade, and 14 per cent of the fourth grade children. It will be recalled that Fabian (1945) found, with the copying of such letters as b, d, p, and numbers, that from 51 per cent in the first to zero per cent in the third grade showed reversals. The higher frequency of reversals in the higher grades found in the present study may be due to the use of words instead of single letters.

The copying task is scored in a manner similar to the reading-spelling test. A figure rotated 45° or more from the horizontal, as determined by the use of a protractor, is considered a vertical rotation. This is the degree of rotation used by Hannah (1958) to constitute a rotation. (See Appendix C for examples of scoring.) Those children rotating one or more of the figures to this vertical position were classified as "Vertical"; those showing no rotations or verticalizations were classified as "Non-Vertical". Table 2 lists the five horizontal figures and the percentages that each figure was wholly or partially (45° or more) rotated for the three grades separately and for the three grades combined. The figures are placed in order of decreasing frequency of rotation in the combined grades. One hundred thirty-nine verticalizations were made by the 177 second graders, 51 verticalizations were made by the 127 third graders, and 54 were made by the 157 fourth graders. Rotation of the vertical figure did not occur.

Table 2. Five Figures Presented to Second, Third, and Fourth Grade Pupils and the Percentage That Each Was Wholly or Partially Rotated to the Vertical.

Figures	Percentage of Rotations			
	Second Grade	Third Grade	Fourth Grade	Total
	39.6%	18.1%	19.1%	26.7%
	22.0	7.1	8.9	13.4
	7.3	14.2	1.9	7.4
	6.2	0.0	2.5	3.4
	3.4	.8	1.9	2.4

Each figure contains several factors which could be responsible for its frequency of rotation. Two possibilities follow. The first, second, and fourth most frequently rotated figures are all accentuated in the horizontal direction. Fabian (1945) also found that figures of this nature would induce the most rotations. Another factor might be the difficulty of the figure. The first and third most frequently rotated figures were the most complicated to draw. One explanation for this finding may be that, in their concentration on the detail of the figure, the children tended to deviate more frequently from their

horizontal orientation, which was learned with difficulty, to the vertical orientation, which is felt by many authors to be the more natural behavior. Again, there is a marked drop in the frequency of rotations from the second grade (139 rotations for the 177 pupils) to the fourth grade (51 rotations for the 127 pupils), although it is interesting to note that there is little difference between the third (54 rotations for the 157 pupils) and the fourth grade. One or more of these vertical rotations was demonstrated by 56 per cent of the second grade, 35 per cent of the third grade, and 29 per cent of the fourth grade children. It will be recalled that Fabian (1945) found that 63 per cent in kindergarten to 10 per cent in the third grade showed rotation of figures.

The number of children in several categories was used in testing the six hypotheses. Table 3 presents the percentages of second, third, and fourth grade pupils falling in these categories. The significance of the differences was tested by X^2, the .05 level being used for rejection of the null hypothesis. With one degree of freedom, X^2 would have to be 3.84 or greater to be significant at the .05 level.

Table 3. Percentages, by Grade, of Reversals and Verticalizations Made by Pupils in the Categories of Good, Medium, and Poor Readers, Boys and Girls, and Left- and Right-handed.

Grade	Category	Total in Grade	Per Cent With Verticals	Per Cent With Reversals
Second	Good	68	45.6%	23.5%
	Medium	60	58.3	53.3
	Poor	49	67.3	69.4
	Boys	76	53.9	
	Girls	101	59.4	
	Left	17	52.9	
	Right	160	57.5	
	Total	177	55.9	46.4
Third	Good	53	11.3%	11.3%
	Medium	26	46.1	46.1
	Poor	48	56.2	56.2
	Boys	66	31.8	
	Girls	61	45.9	
	Left	7	42.8	
	Right	120	38.3	
	Total	127	35.4	35.4
Fourth	Good	53	20.7%	7.5%
	Medium	69	31.9	11.6
	Poor	35	34.3	31.4
	Boys	76	22.3	
	Girls	81	27.1	
	Left	15	26.6	
	Right	142	24.6	
	Total	157	28.7	14.6

Hypothesis 1 states "There is a difference between the number of children showing vertical rotations of horizontal figures in the second grade and the fourth grade, with the greater number of verticalizations occurring at the second grade level of development."

Table 4. Incidence of Verticalizations in the Second and Fourth Grade.

	Verticalizations	No-Verticalizations	Total
Second Grade	99	78	177
Fourth Grade	45	112	157
Total	144	190	334

The data in Table 4 test Hypothesis 1. X^2 is 25.2 and, with 1 degree of freedom, is significant beyond the .0001 level. It can be concluded that a greater number of verticalizations occur at the second grade level. The same test was performed to compare the frequency of verticalizations in the second and third grades, shown in Table 5.

Table 5. Incidence of Verticalizations in the Second and Third Grade.

	Verticalizations	No-Verticalizations	Total
Second Grade	99	78	177
Third Grade	45	82	127
Total	144	160	304

X^2 in this instance is 12.4, which is also significant beyond the .001 level. Therefore, we can again conclude that there is a significant

difference between the number of children making vertical rotations in the second and the third grade, and again the second grade has the greatest number. The X^2 test for the data for the third and fourth grade shown in Table 6 is not significant (X^2 is 1.49).

Table 6. Incidence of Verticalizations in the Third and Fourth Grade.

	Verticalizations	No-Verticalizations	Total
Third Grade	45	82	127
Fourth Grade	45	112	157
Total	90	194	284

Clearly, Hypothesis 1 is true for the population sampled, in that second graders make significantly more reversals.

Hypothesis 2 states, "There is a relationship between verticalizations and reading and writing reversals. The child who demonstrates vertical rotation of figures will show more evidence of reading and writing reversals than one who does not make vertical rotations." X^2s for each grade test this hypothesis.

Table 7. Relation of Verticalization to Reversal in Second Grade Pupils.

	Verticalizations	No-Verticalizations	Total
Reversals	53	39	82
No-Reversals	46	49	95
Total	99	78	177

X^2 is 4.7, which is significant at the .014 level.

Table 8. Relation of Verticalization to Reversal in Third Grade Pupils.

	Verticalizations	No-Verticalizations	Total
Reversals	26	19	45
No-Reversals	19	63	82
Total	45	82	127

X^2 for the data in Table 8 is 15.2, which is significant beyond the .0001 level.

Table 9. Relation of Verticalization to Reversal in Fourth Grade Pupils.

	Verticalizations	No-Verticalizations	Total
Reversals	32	10	23
No-Reversals	32	102	134
Total	45	112	157

X^2 for the data in Table 9 is 10.2, which is significant at the .0007 level.

Hypothesis 3 states, "There is a relationship between verticalization and reading ability as judged by the classroom teacher. The child assessed as a good reader will show less vertical rotation of figures than one who is assessed as a poor reader." An X^2 test will be made for each grade.

Table 10. Incidence of Verticalization in Second Grade Pupils Assessed as "Good" or "Poor" Readers.

	Good	Poor	Total
Verticalizations	31	33	64
No-Verticalizations	37	16	53
Total	68	49	117

X^2 for the data in Table 10 is 5.5 which is significant at the .01 level.

Table 11. Incidence of Verticalization in Third Grade Pupils Assessed as "Good" or "Poor" Readers.

	Good	Poor	Total
Verticalizations	6	27	33
No-Verticalizations	47	21	68
Total	53	48	101

X^2 for the data in Table 11 is 23.1, which is significant above the .0001 level.

Table 12. Incidence of Verticalization in Fourth Grade Pupils Assessed as "Good" or "Poor" Readers.

	Good	Poor	Total
Verticalizations	11	12	23
No-Verticalizations	42	23	65
Total	53	35	88

X^2 for the data in Table 12 is 2.00, which is not significant.

It seems, therefore, that when a second or third grade pupil is assessed to be a good reader, he will demonstrate less vertical rotation of figures than if he is a poor reader. This relationship is absent in the fourth grade.

Hypothesis 4 states, "There is a relationship between production of reading reversals and reading ability as judged by the classroom teacher. The child assessed as a good reader will make fewer reading reversals than one assessed as a poor reader." An X^2 test was made for each grade.

Table 13. Incidence of Reversals in Second Grade Pupils Assessed as "Good" or "Poor" Readers.

	Good	Poor	Total
Reversals	16	34	50
No-Reversals	52	15	67
Total	68	49	117

X^2 for the data in Table 13 is 24.5, which is significant beyond the .0001 level.

Table 14. Incidence of Reversals in Third Grade Pupils Assessed as "Good" or "Poor" Readers.

	Good	Poor	Total
Reversals	6	27	33
No-Reversals	47	21	68
Total	53	48	101

X^2 for the data in Table 14 is 23.1, which is significant beyond the .0001 level.

Table 15. Incidence of Reversals in Fourth Grade Pupils Assessed as "Good" or "Poor" Readers.

	Good	Poor	Total
Reversals	4	11	15
No-Reversals	49	24	73
Total	53	35	88

X^2 for the data in Table 15 is 8.5, which is significant at the .002 level.

These tests all came out highly significant. Some relationship between reading ability and the tendency to reverse must exist.

Hypothesis 5 states, "There is a sex difference in the frequency of vertical rotations of horizontal figures in the three grades tested. An X^2 was made for the three grades.

Table 16. Relation of Sex to Verticalization in the Second Grade.

	Boys	Girls	Total
Verticalizations	41	60	101
No-Verticalizations	35	41	76
Total	76	101	177

X^2 for the data in Table 16 is .52, which is not significant.

Table 17. Relation of Sex to Verticalization in the Third Grade.

	Boys	Girls	Total
Verticalizations	21	28	49
No-Verticalizations	45	33	78
Total	66	61	127

X^2 for the data in Table 17 is 2.6, which is not significant.

Table 18. Relation of Sex to Verticalization in the Fourth Grade.

	Boys	Girls	Total
Verticalizations	17	22	39
No-Verticalizations	59	59	118
Total	76	81	157

X^2 for the data in Table 18 is .48, which is not significant.

Since none of the preceding three tests came out significantly, a relationship between sex and the tendency to verticalize must not exist. Therefore, the prediction made in Hypothesis 5 is incorrect.

Hypothesis 6 states, "There will be no difference between the tendency of left- and right-handed children to demonstrate vertical rotations." An X^2 test was made for each of the three grades.

Table 19. Relation of Handedness to Verticalization in the Second Grade.

	Left-handed	Right-handed	Total
Verticalizations	9	92	101
No-Verticalizations	8	68	76
Total	17	160	177

X^2 for the data in Table 19 is .01, which is not significant.

Table 20. Relation of Handedness to Verticalization in the Third Grade.

	Left-handed	Right-handed	Total
Verticalizations	3	46	49
No-Verticalizations	4	74	78
Total	7	120	127

X^2 for the data in Table 20 is .41, which is not significant.

Table 21. Relation of Handedness to Verticalization in the Fourth Grade.

	Left-handed	Right-handed	Total
Verticalizations	4	35	39
No-Verticalizations	11	107	118
Total	15	142	157

X^2 for the data in Table 21 is .23, which is not significant.

From the three preceding insifnificant tests, there appears to be no relationship between handedness and the tendency to verticalize.

DISCUSSION

Although forms are perceived correctly, the child tends to ignore their direction, according to such authors as Fabian, Fildes, Eng, and Stern. Thus, it was found in the present reading and writing test that words containing "b" and "d" were most frequently reversed (Table 1, page 17). This was predicted by Fildes (1923) because they are so nearly alike and are more open to suggestion and confusion, which may lead to reversals.

The difficulty of acquiring discipline of direction is also demonstrated in the rotations of horizontal figures. When the figures were difficult to draw, the child seemed to concentrate on the form and overlook direction, somewhat like the child who is toilet trained but, when he becomes distracted by involvement in some activity, has an "accident". He loses his learned behavior and reverts back to more primitive behavior.

However, as the child grows older, his learned behavior becomes more natural and disciplining himself to it is easier. Evidence of this occurring can be seen in the reduction of frequency of reversals from the second to the fourth grade. Hypothesis 1 was proved to be correct in that there were significantly more second graders showing verticalizations than third or fourth graders (Tables 4 and 5, page 22). No significant difference was found between the incidence of verticalizations in the third and fourth grades (Table 6, page 23).

It has been proposed that young children lack concern for direction or spatial position of objects they perceive, and that both words and objects would be affected in a like manner. It would seem logical to assume, then, that displacement of words or letters (reversals) and displacement of objects (vertical rotations) would be related. This was the prediction made in Hypothesis 2, and it was found that a relationship did exist in all three grades (Tables 7, 8, and 9, pages 23 and 24).

Reading involves accurate perception of the orientation of letters and words, and left-to-right eye movements, both of which have been said, by several authors (Gates, Fabian, Fildes, Eng, Hildreth), to be unnatural for the young child. A lack of this necessary accuracy and discipline of eye movement again indicates a lack of concern for direction and, seemingly, should impair reading ability. Therefore, an indication of difficulty in reading (reading ability as assessed by the teacher) should be related to an indication of difficulty with direction in reproducing objects (vertical rotations). This was the prediction made in Hypothesis 3 and was found to be correct for the second and third grades but not for the fourth grade (Tables 10, 11, and 12, page 25).

Since it was shown that verticalizations and reading reversals were related, the same reasoning used in evolving Hypothesis 3 would also lead to the prediction in Hypothesis 4. A relationship was found to exist between reversals and reading reversals in all three grades (Tables 13, 14, and 15, pages 26 and 27).

Hypotheses 5 and 6 are concerned with the effect of sex and handedness on the production of verticalizations. From the literature reviewed, it seemed that boys had superior skill in tasks involving motor abilities, although the evidence did not seem conclusive. It was felt, therefore, that boys should show fewer verticalizations than girls. The girls did show a greater percentage of verticalizations than the boys in every grade (Table 3, page 21), but this difference did not prove to be significant, and therefore Hypothesis 5 was not correct—no relationship exists between sex and verticalizations (Tables 16, 17, and 18, pages 27 and 28).

Hypothesis 6 is presented as favoring the null case for there was nothing in the literature reviewed which indicated a difference in performance resulting handedness. This did, in fact, prove to be the correct proposal, for no relationship was found to exist between handedness and verticalizations in any of the three grades tested (Tables 19, 20, and 21, pages 28 and 29).

It has not been the purpose in this study to draw any definite conclusions concerning vertical orientation in visual and motor tasks and its relationship to reading. Little conclusive research seems to have been done in this specific area, and it is hoped by the author that this study might add some further knowledge to the area and open doors to additional research projects. Several questions present themselves for study. Why are certain figures more apt to be verticalized than others? What factors are involved in these rotations, and which are most significant? Would there be a difference in the reaction of children copying figures from memory (as in the present experiment)

and copying figures from the source (having the figure in front of them while they are reproducing it)? Would a relationship exist between vertical rotations and mathematical ability, since mathematics involves vertically oriented columns of figures?

Although no definite conclusions can be drawn, or no specific recommendations can be made of an educational nature, it does seem worthwhile to suggest the possibility of an increased emphasis on left-to-right directional training of young children by their parents before they enter school and by their teachers after they enter school. Hildreth (1932) found that the children who had the most help and guidance from their parents and teachers in making symbols showed the least tendency to make reversals. Reading disabilities are felt by Jastak (1953) to practically always be a deficiency in the mastery of mechanics and not of comprehension. Factors more important than handedness or specific school instruction appear to be informal opportunities to learn and inner maturation in perception and motor skills. Townsend (1951) states that writing and reading are dependent on a child's experiences. These experiences should provide adequate emphasis on developing a horizontal orientation.

SUMMARY

Four hundred and sixty-one children of grades two, three, and four were presented, by classroom, six Gestalt-type figures to copy, and eighteen words from the Gates Reading Diagnostic Test for Reversals (Gates, 1935) to write or print. The children were exposed to the individual figures or words for from three to ten seconds, depending on grade level and difficulty of the figure or word, following which they were requested to reproduce what they saw. Protocols were scored so that children rotating one or more of the figures 45° or more from the horizontal were classified in the Vertical group; those making no rotations were in the Non-Vertical group. Children reversing one or more words or letters were classified in the Reversal group; those making no reversals were in the Non-Reversal group. Existing classroom reading groups were used to categorize pupils as Good, Medium, or Poor readers.

The theory underlying the study is that children tend to be vertically oriented; i.e., they are more likely to align what they see and what they do with the vertical axis of their body than with its horizontal axis. This tendency should interfere with reading, which is horizontally oriented. In this study the tendency to be vertically oriented is indicated by the rotation of figures from the horizontal position.

The following five predicted relations were statistically significant by means of X^2 tests:

1) There is a decrease in the number of children showing vertical rotations from the second to the fourth grades. Fifty-five per cent of the second graders as compared to 28 per cent of the fourth graders showed vertical rotations, indicating an increase in discipline of direction with age.

2) Verticalization and reading and writing reversals are related.

3) There is a relationship between verticalization and reading ability as assessed by the classroom teacher, with the exception of the fourth grade.

4) There is a relationship between production of reading reversals and reading ability.

5) There is no difference between the tendency of left- and right-handed children to make vertical rotations.

The sixth hypothesis predicted that there would be a difference between boys and girls in the frequency of vertical rotations. It was found, however, that no significant difference exists.

The study resulted in a recommendation for an increased emphasis on left-to-right directional training of young children in order to develop a horizontal orientation necessary in reading. This should be emphasized in home and in the school.

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APPENDICES

A

List of Participating Schools

Cavanaugh School
300 West Cavanaugh Street
Lansing, Michigan
Principal, Mrs. Georgia Mead

Fairview School
815 North Fairview Avenue
Lansing, Michigan
Principal, Miss Hilda Menger

Kalamazoo Street School
510 West Kalamazoo Street
Lansing, Michigan
Principal, Mr. Ford Ceasar

Lewton School
2000 Lewton Place
Lansing, Michigan
Principal, Miss Evelyn Anderson

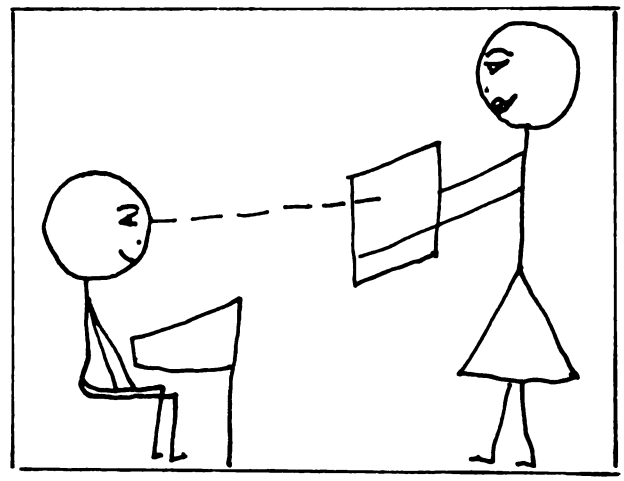
Michigan Avenue School
1019 West Michigan Avenue
Lansing, Michigan
Principal, Mr. Edward Spink

Pleasant Grove School
2130 West Holmes Road
Lansing, Michigan
Principal, Mr. William Webb

B

Illustrations to Accompany Instructions

1.



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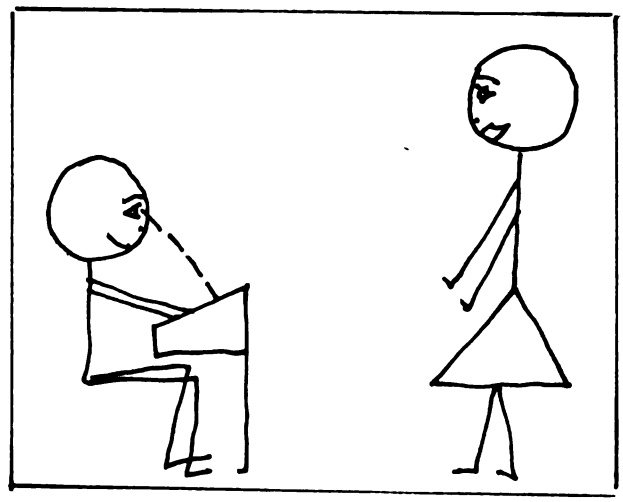
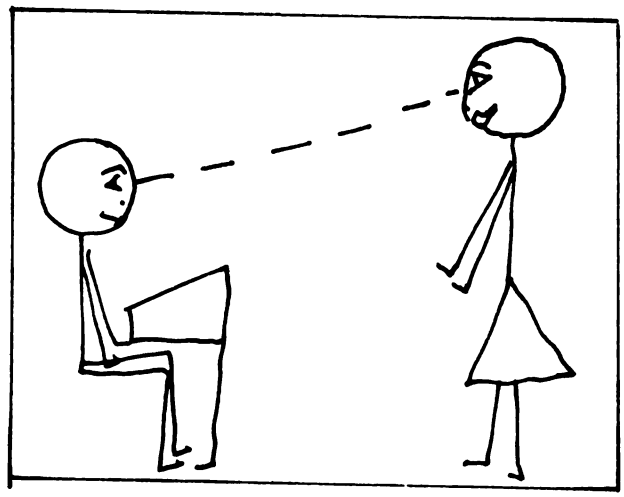


3.

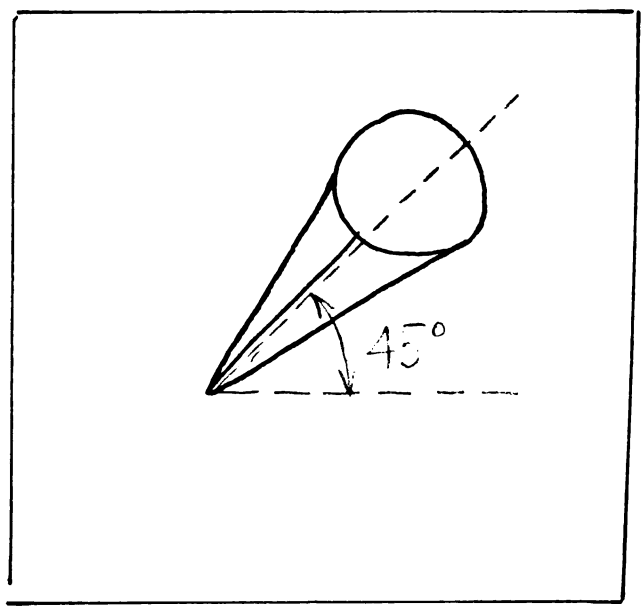


C

Examples of Scoring Technique for Copying Task

Verticalization

(A line bisecting the cone [blue line] is 45° or more from the horizontal; therefore, the figure is verticalized.)



No-Verticalization