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EFFECTS OF DOMINANCE AND CONTROL ON READING ACHIEVEMENT.

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TWO DISPARATE STUDIES WERE REPLICATED WITH A PUBLIC SCHOOL POPULATION USED BY HILLERICH IN A 4-YEAR STUDY OF THE DEVELOPMENT OF HANDEDNESS AND EYEDNESS. SUBJECTS WERE 273 SEVENTH AND EIGHTH GRADERS WHO REMAINED FROM AN ORIGINAL POPULATION OF 400. TESTS WERE ADMINISTERED TO DETERMINE EYE DOMINANCE, HANDEDNESS, CONTROLLING EYE, READING ACHIEVEMENT, AND GROUP INTELLIGENCE. THE GROUP WAS DIVIDED ON THE BASIS OF TEST RESULTS INTO THREE DOMINANCE CATEGORIES -- UNILATERAL, CROSSED, AND MIXED. CHI SQUARE AND T TESTS WERE USED TO ANALYZE THE DATA. SUBJECTS TESTED IN GRADE 2 AND AGAIN IN GRADE 8 EXHIBITED A SHIFT FROM UNILATERAL DOMINANCE TOWARD AMBIDEXTERITY AND/OR AMBIEYEDNESS. THERE WAS NO SIGNIFICANT DIFFERENCE IN READING ACHIEVEMENT AMONG THE GROUPS, NOR WAS THERE A SIGNIFICANT DIFFERENCE IN EYE-HAND DOMINANCE PATTERNS BETWEEN MALE AND FEMALE SUBJECTS. TABLES, A DISCUSSION, AND REFERENCES ARE INCLUDED. (BK)

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# Effects of Dominance and Control on Reading Achievement[1]

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## INTRODUCTION

The question of laterality and its relationship to reading disability seems still to be prevalent in the literature. Reporting a study completed in 1962, Hillerich (1, 2) reviewed the research findings and reported a pattern which suggested that most clinical studies find a high incidence of crossed or mixed dominance among disabled readers, while public school studies usually report that dominance is not a significant factor in reading achievement.

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[1]This report is based on an investigation sponsored by the U. S. Office of Education, Bureau of Research. Robert Hillerich served as director; Robert Boos, as principal investigator.

In his study of 400 children, followed from kindergarten to grade three, Hillerich (1) found no significant relationship between eye-hand dominance patterns and reading achievement, reading differential, intelligence, or reversal errors. Nor was there significant difference in dominance characteristics of below grade readers as compared with subjects at or above grade level. As a corollary, the investigator found that unclear eyedness decreased by forty-four percent from kindergarten to grade two and that only the inclusion of a new handedness test at grade two prevented a similar finding for handedness.

Additional studies have added to the conflicting evidence. Belmont and Birch (3) and Ihinger (4), in public school studies, found no relationship between eye-hand dominance and reading achievement. Capobianco (5) found that determination of laterality among adolescent mental retardates was of dubious value. Conversely, Benton et al (6) reported clinical observations of 250 subjects, in all of whom they found either crossed dominance or greater than normal retinal rivalry.

In contrast to the "constellation of anomalies" theory which attempts to explain the difference between public school and clinical studies, Berner et al (7, 8) proposed a different theory. Following the thinking of Fink (9), these investigators proposed that the controlling eye in binocular vision--not the dominant eye in sighting--was the significant factor in reading disability. Hence, according to this theory, investigation should determine whether the controlling eye and dominant hand are on the same side. These investigators reported that it was "crossed control" rather than "crossed dominance" which was the significant factor in reading disability.

## THE STUDY

The present study was designed to test the Berners' hypothesis by replicating their study (7) as well as Hillerich's study (1) with the public school population used by the latter in his original four year investigation. This design had the advantage of testing both studies and, at the same time, of providing a nine year study of the development of eyedness and handedness.

The following null hypotheses were established:

1. There is no significant distinction between the dominant eye used in sighting and the controlling eye used in binocular vision.
2. There is no significant difference in reading achievement between children of unilateral dominance and those of crossed or mixed dominance.
3. There is no significant difference in reading achievement between children evidencing crossed control and those with corresponding control.
4. There is no significant change in the eye-hand dominance pattern of children between second and eighth grades.
5. There is no significant difference in eye-hand dominance patterns between male and female children.

## PROCEDURE

A total of 277 subjects remained from Hillerich's study. Of these, 261 were in grade eight; sixteen had been retained and were in grade seven. Four of the 277 subjects exhibited severe visual handicaps and could not be used in the study.

Tests were selected and administered in exact conformity to the studies replicated. Eye dominance was determined through V-scope and hole-in-paper tests, both of which were selected originally as minimizing the influence of the dominant hand. Agreement in three of five trials on each test was necessary to establish clear eye dominance.

Handedness for the dominance comparisons was determined through tapping and connecting dots. Hillerich's ratio score was used to establish handedness. In addition, the Berners' tests for handedness included cutting, writing, throwing, and eating, in which agreement on three of the four was essential for clear handedness.

Controlling eye was determined through use of the Keystone Telebinocular. Cards DB-2D and DB-3D were used for far point and DG-9, DG-10, and DG-11 for near point. Berner's criteria were used for determination of control.

Reading achievement was measured by the reading section of the California Achievement Test, Form W, Junior High Level, and intelligence scores were based on the California Short-Form Test of Mental Maturity.

On the basis of dominance tests, subjects were grouped into three dominance categories: unilaterally dominant, crossed dominant, and mixed dominant. The latter included all who were unclear in dominance of hand, eye, or both. In terms of control, subjects were classified as corresponding control or crossed control. The latter included all subjects whose controlling eye--at either near or far point--was not on the side of the dominant hand, as well as all subjects who were ambidextrous.

Significance of the difference between controlling eye and dominant eye was determined by chi square, as were the dominance characteristics

of below grade level subjects as compared with those at and above grade level in reading achievement.

Significance of differences in mean reading achievement for the three dominance and two control pattern groups was tested by *t*.

## THE FINDINGS

Table I indicates the results of dominance testing at grades two and eight. The great difference between the two grades is a result of shifts from established dominance to mixed or unclear dominance.

TABLE I

Number and Percent of Subjects in Each Dominance Group at Grades Two and Eight

| Eye-Hand Dominance | Grade 2 | | Grade 8 | |
|---|---|---|---|---|
| | Number | Percent | Number | Percent |
| R-R | 187 | 46.75 | 74 | 27.11 |
| L-L | 15 | 3.75 | 8 | 2.93 |
| R-L | 12 | 3.00 | 6 | 2.20 |
| L-R | 105 | 26.25 | 30 | 10.98 |
| Mixed | 81 | 20.25 | 155 | 56.78 |
| Total | 400 | 100.00 | 273 | 100.00 |

Hillerich reported a trend toward more established eyedness with age, based on dominance testing at kindergarten and at grade two. Table I reveals a reversal of that trend: it shows a great increase in the percent of mixed dominant subjects at grade eight.

The fact that this reversal of a tendency was not the result of an attritional change in the composition of the group is demonstrated by

Table II. Of the group included in the original study and tested at grade two (N-400), 273 subjects were available for this study.

TABLE II

Comparison of Unilateral, Crossed, and Mixed Dominant Groups in Terms of Percentage Dropped or Retained from the Original Grade Two Study

| Dominance | Remaining | Dropped |
|---|---|---|
| Unilateral | 49.82 | 52.04 |
| Crossed | 29.25 | 29.27 |
| Mixed | 20.93 | 18.69 |
| Total | 100.00 | 100.00 |

Only 105 individual subjects exhibited no change in dominance pattern from grade two to grade eight. The others, contrary to the trend exhibited from kindergarten to grade two, demonstrated a shift toward ambidexterity and/or ambieyedness. Table III illustrates the kinds of changes observed.

TABLE III

Changes in Individual Dominance Patterns from Grade Two to Grade Eight

| Dominance | Eye | Hand |
|---|---|---|
| No Change | | |
| Right and Right | 130 | 102 |
| Left and Left | 59 | 13 |
| Unclear and Unclear | 3 | 24 |
| Changed | | |
| Right to Left | 10 | 4 |
| Right to Unclear | 25 | 101 |
| Left to Right | 13 | 0 |
| Left to Unclear | 30 | 6 |
| Unclear to Right | 5 | 16 |
| Unclear to Left | 2 | 6 |

A basic question to the studies being compared--Is there a distinction between controlling eye and dominant eye?--is difficult to answer clearly. Table IV illustrates a chi square comparison of the two to an expected frequency, based on a hypothesis of independence.

TABLE IV

Computation of Chi Square
to Determine Distinction
Between Dominant and Controlling Eye

| Observed Frequency (fo) | | Expected Frequency (fe) | | fo - fe | | $(fo-fe)^2/fe$ ratios | |
|---|---|---|---|---|---|---|---|
| Dominant Eye | Controlling Eye | Dominant Eye | Controlling Eye | Dominant Eye | Controlling Eye | Dominant Eye | Controlling Eye |
| 147 | 152 | 149.5 | 149.5 | - 2.5 | 2.5 | 0.042 | 0.040 |
| 66 | 31 | 48.5 | 48.5 | 17.5 | -17.5 | 6.314 | 6.314 |
| 60 | 90 | 75.0 | 75.0 | -15.0 | 15.0 | 3.000 | 3.000 |

$df = (3-1)(2-1) = 2$ $\qquad x^2 = 18.712$

The chi square value of 18.712 indicates a significant difference beyond the .001 level. On the other hand, if one considers that fifty-four percent of the control cases were assigned on the basis of hand dominance--the eyes testing equally on the telebinocular--the difference is not so dramatic.

If the Berner study had allowed for "mixed" or "unclear" eyedness, only forty-four children determined as right eye dominant would have been classed as left eye controlling; only four classed as left eye dominant would have been right eyed in control.

Regardless of the distinction or lack of distinction between dominance and control, the question of the influence of each on reading achievement is an important one. Table V shows the comparison of mean reading achievement between unilaterally dominant subjects and those of crossed and mixed dominance.

TABLE V

Comparison of Differences in Mean Reading Achievement Between the Unilaterally Dominant Group and Groups of Crossed and Mixed Dominance

| Dominance | Number | Reading Achievement in Grade Equivalent | | t | t .05 |
|---|---|---|---|---|---|
| | | Mean | Variance | | |
| Crossed | 35 | 9.8971 | 2.2579 | 0.1527 | 1.96 |
| Unilateral | 83 | 9.8518 | 1.9557 | 0.5731 | 1.96 |
| Mixed | 155 | 9.9607 | 1.9383 | | |

The t test indicated no significant differences among the groups; however, the comparison did not control the influence of possible differences in intelligence. To accomplish this, an expected achievement was determined from intelligence test results and subtracted from actual achievement, providing a "reading differential" score. Comparison of the groups in terms of this differential is presented in Table VI.

Again t tests revealed no significant differences among the dominance groups in terms of mean reading differential. It is interesting to note that, in terms of tendency, the crossed dominant group had the highest mean differential score.

TABLE VI

Comparison of Differences in Mean Reading Differential
Between the Crossed and Mixed Dominant Group
and the Unilateral Dominant Group

| Dominance | Number | Reading Differential in Grade Equivalent | | t | t .05 |
|---|---|---|---|---|---|
| | | Mean | Variance | | |
| Crossed | 35 | 0.3257 | 1.1449 | | |
| | | | | 0.7715 | 1.96 |
| Unilateral | 83 | 0.1674 | 0.7766 | | |
| | | | | 0.1075 | 1.96 |
| Mixed | 155 | 0.1536 | 1.1506 | | |

Following the Berner classifications, subjects were organized in terms of corresponding control and crossed control. Table VII shows the comparison of the two groups in terms of mean reading achievement.

TABLE VII

Comparison of Differences in Mean Reading Achievement
Between the Crossed Control Group
and the Corresponding Control Group

| Control | Number | Reading Achievement in Grade Equivalent | | t | t .05 |
|---|---|---|---|---|---|
| | | Mean | Variance | | |
| Crossed | 101 | 9.7227 | 2.1561 | 1.7436 | 1.96 |
| Corresponding | 172 | 10.0348 | 1.8390 | | |

The three month difference in reading achievement was not significant at the .05 level, so a comparison, illustrated as Table VIII, was made between the groups in terms of reading differential. A t test revealed no significant difference in mean reading differential between the crossed and the corresponding control groups.

TABLE VIII

Comparison of Differences in Mean Reading Differential
Between the Crossed Control Group
and the Corresponding Control Group

| Control | Number | Reading Differential in Grade Equivalent | | t | t .05 |
|---|---|---|---|---|---|
| | | Mean | Variance | | |
| Crossed | 101 | .2703 | 1.0381 | 1.1057 | 1.96 |
| Corresponding | 172 | .1290 | 1.0381 | | |

Tables IV through VIII revealed no significant differences among the various dominance or control groups in terms of mean reading achievement or mean reading differential. In a further effort to discover a possible relationship between the supposed anomalies of dominance, subjects were divided into two reading achievement groups, those who scored below their grade norm of 8.2, and those who scored at or above the norm. Table IX reveals the dominance patterns of the groups.

TABLE IX

Eye-Hand Dominance of Subjects Below Grade Level
in Total Reading Score
Compared with the Dominance of Subjects
At or Above Grade Level

| Dominance | Below 8.2 | | At and Above 8.2 | |
|---|---|---|---|---|
| | Number | Percent | Number | Percent |
| Unilateral | 10 | 31.3 | 73 | 30.3 |
| Mixed | 17 | 53.1 | 138 | 57.3 |
| Crossed | 5 | 15.6 | 30 | 12.4 |
| Total | 32 | 100.0 | 241 | 100.0 |

While Table IX shows a tendency for a higher percentage of below level readers to be crossed dominant, a chi square of 0.885, compared to a table value of 5.991 for p .05, indicated no significant difference in the dominance pattern of the two groups.

A generally accepted premise has been that, because female students are more apt than male subjects to engage in small muscle activity, they are also more likely to establish handedness earlier and more firmly. This thought prompted a comparison of the eye-hand dominance patterns of boys and girls. A chi square of 1.296 (p .05 = 5.991) indicated no significant differences between the sexes in terms of dominance characteristics.

## CONCLUSIONS

This study was a replication of two disparate studies. Subjects were 273 children of eighth grade age who remained from Hillerich's original population of 400 that had been tested for dominance in kindergarten and again at grade two.

Based on results of the present study with this population, the following conclusions are supported:

1. There was a distinction between controlling eye, as measured by the Keystone Telebinocular, and the dominant eye, as determined by sighting tests.
2. There was no significant difference in mean reading achievement or mean reading differential among the unilateral, crossed, or mixed dominance groups.
3. There was no significant difference in mean reading achievement between groups with crossed control and those of corresponding control.

4. There was a change, in the direction of ambidexterity and ambi-eyedness, in the eye and hand dominance patterns of children from second to eighth grade.

5. There was no significant difference in eye-hand dominance patterns between male and female subjects.

## DISCUSSION

As stated by Hillerich earlier, "Any study of laterality is weakest at its very base. The tests used to determine laterality have not been conclusively validated" (2, p. 124). An interesting note, however, is a comparison of results of the Berners' hand dominance tests with Hillerich's: only one subject demonstrated a difference in established handedness, going from left handed on the one set to right handed on the other set of tests. Other differences in tested handedness were accounted for in terms of ambidexterity on Hillerich's tests as compared with right handedness on Berners', a phenomenon which relates to the fact that the former's tests recognized handedness as a continuum representing varying degrees of skill.

While "controlling eye" and "dominant eye" are apparently two different classifications, neither was found to have any relationship to reading achievement or disability in the population studied. Since the controlling eye is determined primarily from visual screening tests on the telebinocular, one might question whether it is measuring visual acuity, an element already well reported as unrelated to eye dominance in the literature (10, 11).

One might assume that maturation results in more firmly established handedness and eyedness. This assumption is discredited in the present

study. Subjects individually demonstrated a trend toward ambidexterity and ambieyedness from grade two to grade eight, despite the fact that the same tests were used at both levels. This finding could mean that motor activities of children become more diversified with age, leading to greater skill with both hands and eyes; it could also mean, in the case of the handedness tests, that one and one-half standard deviations is too broad a span for the ambidextrous category at an age when the spread of differences in motor skill has increased greatly over that observed in grade two.

In his original study, Hillerich found that a larger percentage of boys was mixed dominant and below grade level. He suggested the possibility of such sex differences helping to explain the clinical finding of a relationship between mixed dominance and reading disability, since the majority of clinical cases are boys. Such an hypothesis must be rejected as a result of the finding that no sex differences existed in terms of dominance characteristics.

In conclusion, this study failed to support thinking that a relationship exists between eye-hand dominance or control and reading achievement. While the longitudinal aspects of motor development in terms of sidedness might be interesting to pursue, there exist many areas for research into causes of reading disability which could prove more fruitful than the areas of dominance or control.

## REFERENCES


1. Hillerich, Robert L., A Study of the Relationship Between Eye-Hand Dominance and the Reading Achievement of Selected Primary Pupils, unpublished doctoral dissertation, Colorado State College, 1962.

2. Hillerich, Robert L., "Eye-Hand Dominance and Reading Achievement," American Educational Research Journal, March, 1964, 121-126.

3. Belmont, Lillian and Herbert G. Birch, "Lateral Dominance, Lateral Awareness, and Reading Disability," Child Development, March, 1965, 57-71.

4. Ihinger, Robert F., "Lateral Dominance and Reading Achievement," in Claremont Reading Conference Yearbook, 1963, 126-129.

5. Capobianco, R. J., "Ocular-Manual Laterality and Reading in Adolescent Mental Retardates," American Journal of Mental Deficiency, March, 1966, 781-785.

6. Benton, Curtis D., James W. McCann, and Marguerite Larson, "Dyslexia and Dominance," Journal of Pediatric Ophthalmology, July, 1965, 53-57.

7. Berner, George E., Dorothy E. Berner, Walter M. Uhler and Marguerite B. Horn, A Clinical Investigation of Crossed Control in a Residential Treatment Center, a printed report of the Devereaux Schools. Devon, Pennsylvania: The Devereaux Schools, 1963.

8. Berner, George E., Dorothy E. Berner, Walter M. Uhler and Marguerite B. Horn, Treatment of Visual and Visual Motor Problems in the Mentally Deficient, a paper presented at the Eighty-Seventh Annual American Association for Mental Deficiency. Devon, Pennsylvania: The Devereaux Schools, 1963.

9. Fink, W. H., "The Dominant Eye: Its Clinical Significance," A.M.A. Archives of Ophthalmology, April, 1938, 555-582.

10. Crider, Blake, "A Battery of Tests for the Dominant Eye," Journal of General Psychology, XXXI (1944), 179-190.

11. Robinson, Helen and Charles Huelsman, Jr., "Visual Efficiency and Progress in Learning to Read," Clinical Studies in Reading II, ("Supplementary Educational Monographs," No. 77) Chicago: University of Chicago Press, 1953.