BINOCULAR VISION, CODING TESTS AND CLASSROOM ACHIEVEMENT

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ABSTRACT

Numerous studies have investigated the relationship between binocular vision and learning. An area not previously studied is the relationship between scores on Coding Tests (used in psychological evaluations) and binocular vision. This relationship was evaluated in a randomly selected third grade class and was found to be significant. Additionally, the relationship of both of these factors and classroom achievement was evaluated and also proved to be significantly related. The importance of these findings and the need for further research on this subject is presented.

KEY WORDS

binocular vision coding, fusion, ocular motility, classroom achievement, WISC-R Coding Test, MILKAN Coding Test

The influence of binocular vision defects on reading and learning has been a subject of debate for some time. The preponderance of optometric opinion holds that poor control of fusion, accommodation and ocular motility are related factors in learning problems.[1-13] The weight of ophthalmologic opinion has essentially been that no such connection exists.[14-19] Arguments on both sides have often stressed the dearth of qualified "double blind" studies on the matter.

While this study was not designed to provide a definitive answer to the above issue, the results do apply. In the course of my work as an educational psychologist, it gradually became apparent that a group of children shared the following characteristics: reading difficulties, binocular defects and low scores on the Coding Subtest of the Wechsler Intelligence Test for Children - Revised (WISC-R). When I presented this information to other professionals, it was met by general skepticism because of the lack of research to support such a theory. It was to answer this need that this research was undertaken.

The WISC-R is an intelligence test used to evaluate children's learning potentials.[20] The Coding Subtest is most often used to determine the child's ability to encode and decode symbols and measures of short term memory. However, it is a task with a high visual demand and requires sustained detailed near work and frequent shifts of gaze. As such, it is somewhat similar to reading and copying tasks in the classroom. Since compromised binocularity is thought to adversely affect these classroom skills, it would not be unreasonable to expect a similar influence on this type of test. This would be analogous to the effect that auditory defects can have on the WISC-R Digit Span Subtest. However, the null hypothesis, that binocular vision deficits do not affect performance on Coding Tests, remains a possibility.

METHODS

In order to test the hypothesis on a group basis, it was not possible to use the WISC-R since this test can only be given individually. However, there is an Israeli group psychometric test that contains a virtual duplicate of the WISC-R Coding Test within its format. This test is called the MILKAN, which is an acronym for Mivchan Le'kitot Nemuchot (Test for Lower Elementary Grades).[21] It consists of three parts: a picture vocabulary section, a sequencing section and a timed (two minutes) Coding Test (see Figures 1, 2, 3). The number of figures and the time span of the coding test are quite similar to the WISC-R (see Figure 4).

A single, normally achieving third grade class was selected at random and a school psychologist not involved in the research administered the MILKAN. The number of subjects was 34 (18 boys, 16 girls) and the mean age was 8.5. The results were scored by an outside agency also not involved with this project.

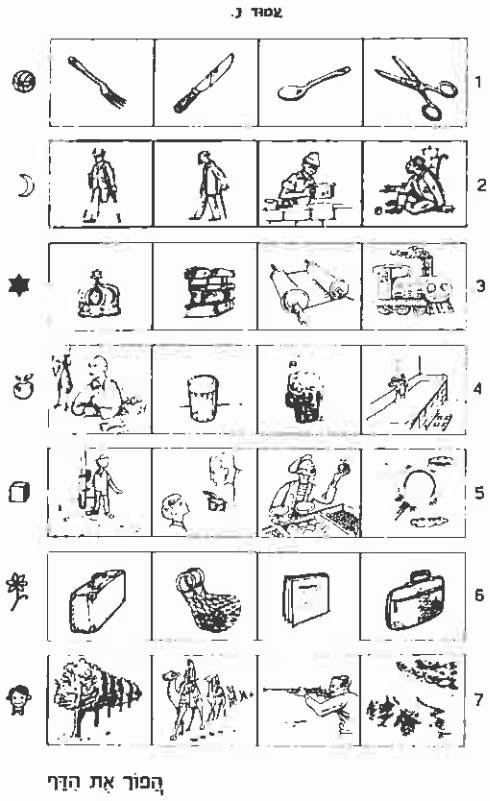

Figure 1. MILKAN: Picture Vocabulary Test.

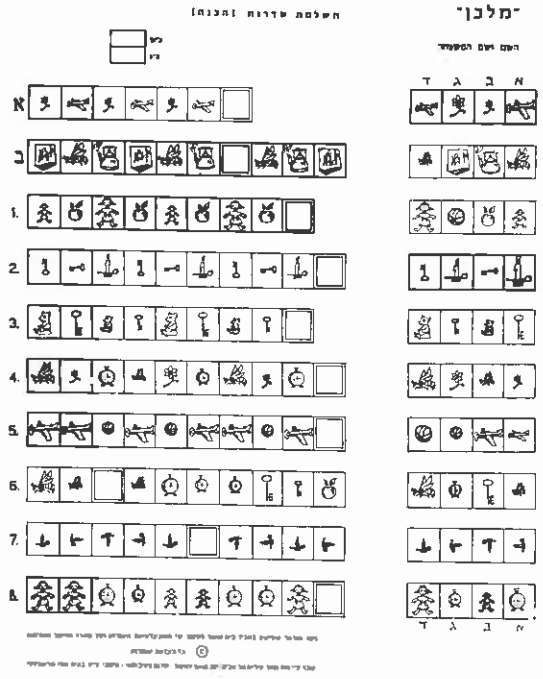

Figure 2. MILKAN: Sequencing Test.

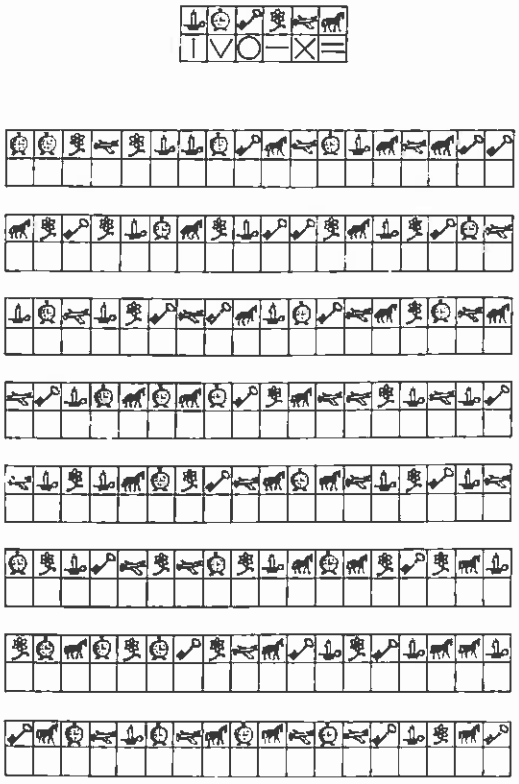

Figure 3. MILKAN: Coding Test.

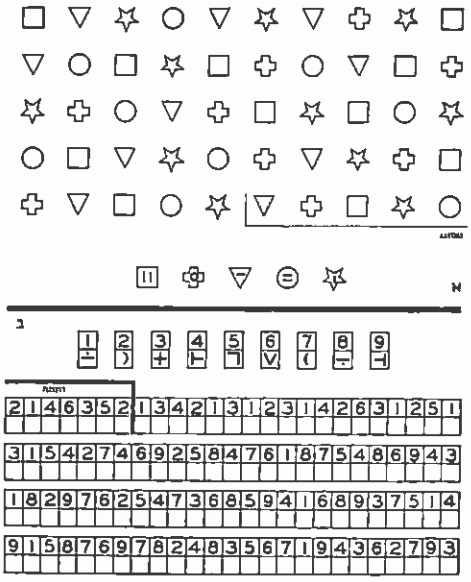

Figure 4. WISC-R: Coding Test

Concurrently, the class underwent a visual screening evaluation, based on the Modified Clinical Technique (MCT),[22] administered by two optometrists and one teacher. This screening included assessments of visual acuity, static retinoscopy, cover tests, convergence nearpoint, ocular motility and stereopsis (Stereofly Test[a]). Although such a screening is not a substitute for complete visual analysis, it does have a high degree of predictability in the diagnosis of binocular and visual defects.[22-24]

As this study was conducted during my regular work as school psychologist in the district, additional information was also available and was included in the study. At the end of each school year (when the project was undertaken) all of the teachers are requested to supply the psychology clinic with a ranked list of

their students. Five categories are used for the teachers' evaluation of these students'. The rankings are: Superior, Above Average, Average, Below Average and Poor. These rankings were assigned numerical values, with one being superior and five poor, in order to facilitate statistical evaluation and also evaluated in relation to the other data.

RESULTS

Fourteen students (41% of the total) failed the binocular vision portion of the visual screening according to the MCT criteria.[22]. There were twice as many failures due to exophoria than esophoria (8 vs. 4). Two of the exophoric failures also failed the convergence nearpoint test while one of the esophores also failed the ocular motility test. Five subjects failed the screening for reasons unrelated to binocular vision (i.e., undercorrected myopia, astigmatism, etc.).

On the Coding Test, 24% of the students received a failing grade (below 10 on a scale from 1 to 18). The mean grade was 12 while the scores ranged from 8 to 18 with a standard deviation of 2.80. The data, along with class rank, is summarized in Table 1.

A statistical analysis of the data was made utilizing a hypothesis test for proportions from independent groups to evaluate if these two populations were significantly different (see Table 2). The analysis compared the proportion of "binocular failures" who passed the Coding Test versus the proportion who failed it and the converse. At a level of certainty of $p<.05$ the two population samples proved to be significantly different and not representing a random distribution (null hypothesis rejected).

The results can also be expressed in percentage form. In the group passing the binocular portion of the vision screening, 90% scored 10 or above (passing) on the Coding Test. In the group failing the binocular screening, 57% passed the Coding Test. Equally meaningful is that only 25% of those students scoring below 10 on the Coding Test passed the binocular screening (Table 2, P4 data).

An analysis was also made relating the visual screening (binocular portion) and coding results to schoolroom achievements as evaluated by the teacher. Using the Mann-Whitney U-Wilcoxon Rank Sum W Test (Table 3), failure on the binocular vision screening was concurrent with below average school achievement with a degree of certainty at the $p<.02$ level, while failure on the Coding Test was similarly concurrent at the $p<.03$ level of certainty. The relationships of the three variables coding vs. binocular vision, class rank vs. binocular vision and coding vs. class rank was evaluated, using the Pearson R statistic (Table 4). In each case the relationship was significant.

TABLE 1

Passed Binocular Screening (N=20, 59%)

Variable	Mean	Std. Dev.	Range	
Coding Score	13.15	2.72	9.00	18.00
Class Rank	2.15	1.27	1.00	5.00

Failed Binocular Screening (N=14, 41%)

Variable	Mean	Std. Dev.	Range	
Coding Score	11.36	2.90	8.00	17.00
Class Rank	3.29	1.27	1.00	5.00

Percentage Breakdown of Data

Proportion of Total Subjects:

Binocular Passes:	59%
Binocular Failures:	41%
Coding Passes:	76%
Coding Failures:	24%

TABLE 2

Hypothesis Test for Two proportions from Independent Groups

P1 = proportion of binocular passes who passed coding

P2 = proportion of binocular failures who passed coding

N1 = total number of subjects who passed binocular screening

N2 = total number of subjects who failed binocular screening

P1 = .900 N1 = 20.

P2 = .5714 N2 = 14.

z = 2.223 p = .0131

P3 = proportion of coding passes who passed binocular

P4 = proportion of coding failures who passed binocular

N3 = total number of subjects who passed Coding Test

N4 = total number of subjects who failed Coding Test

P3 = .6923 N = 26.

P4 = .2500 N4 = 8.

z = 2.223 p = .0131

TABLE 3

Mann-Whitney U-Wilcoxon Rank Sum W Test:

1. Class Rank vs. Binocular Vision

Mean Rank	Cases	
14.18	20	Passed Binocular Screening
22.25	14	Failed Binocular Screening

Significance: p = .0185

2. Class Rank vs. Coding Score

Mean Rank	Cases	
15.44	26	Passed Coding Test (score of 10 or above)
24.19	8	Failed Coding Test (score of below 10)

Significance: p = .0256

The term "Mean Rank" in the above Table must be explained in order to avoid confusion. It in no way refers to the class rank. In this statistical method the rank of an observation is obtained by plotting the two sets of data on a common scale, the smallest observation receiving a rank of 1, the next a rank of 2 and so forth. In this way a mean rank is determined.

DISCUSSION

To many optometrists, the high correlation between failing the Coding Subtest and failure on the binocular screening is, perhaps, a not unexpected result. This type of Coding Test requires rapid shifts of gaze, focusing and fixation. Additionally, the fact that there is a time limit would add even more weight to the smallest differences between children. Poor control of accommodation, fusion or ocular motility would be a likely cause for difficulty. What is of possibly even more significance is the serendipitous information provided by the teacher class ranking. Failure on a binocular screening proves to be a good indicator of classroom success in this third grade class. The Coding Subtest also is an equally good indicator. The previously noted correlation of the two tests explains the similarity of these findings.

The results of this study indicate that a suspiciously low score on a Coding Subtest may be an adequate reason for referral for a full visual evaluation, especially in the area of binocular vision. The value of this information is that although the WISC-R (which contains such a test) is widely used in the fields of education and psychology, this particular use has been ignored. This is vital information for optometrists to know and transmit to other professionals. The Coding Subtest can be used to help identify a disorder not realized by its originator and thus its interpretation should be expanded.

The possible influence of binocular vision on learning also receives further support from the results of this study: a high proportion (43%) of students classified by their teacher as below average or poor students failed the binocular screening. It is important to note that this study was done on third grade students, a group undergoing the transition from "learning to read" to "reading to learn." As such, school achievement as classified by the teacher is highly related to reading achievement. It is difficult to extrapolate the results to either younger or older school children, so that further research in this area seems necessary.

TABLE 4

Correlation of variables
V_1 = Binocular Vision Result
V_2 = Coding Result
V_3 = Class ranking by teacher

V_1 vs. V_2			
Pearson R Value:	.38122	Significance:	.0131
V_2 vs. V_3			
Pearson R Value:	.41370	Significance	.0075
V_1 vs. V_3			
Pearson R Value:	.41382	Significance:	.0075

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SOURCE

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