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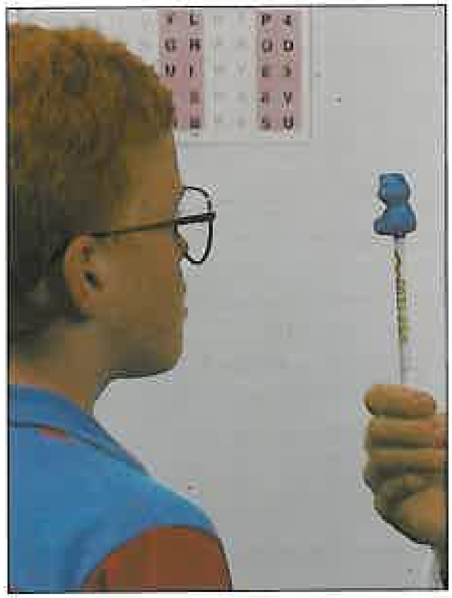

COMPARISON OF EYE MOVEMENT SKILLS BETWEEN ABOVE AVERAGE AND BELOW AVERAGE READERS

ABSTRACT

The influence of vision on academic skills has been the subject of much discussion. Oculomotor skills are among the primary vision skills implicated in this discussion of vision and school performance; but the role of oculomotor skills is not clear. It has been shown that the NSUCO Oculomotor Test has acceptable interrater and intrarater reliability. A previous study using this test indicated that it is failed significantly more often by learning-disabled children when compared to gifted children. The present pilot study compares the oculomotor skills of above average readers and below average readers. This study reveals that the above average readers score significantly better on all eight factors of this standardized oculomotor test.

KEY WORDS

oculomotor skills, pursuits, saccades, reading ability

The role of vision in the classroom and especially how it impacts the reading process is controversial. Some authorities state that there is little or no relationship between vision skills and school work.[1,2,3] Others defend a more positive relationship between these two factors.[4,5,6,7]

The whole area of pediatric/developmental vision and lens/vision therapy, has been identified by the American Optometric Association's Council on Research as being of very high priority. Specific areas targeted were the relationship between vision and learning.[8]

A specific visual skill which has been claimed to be related to reading ability is eye movement skills. Literature on the subject of eye movements is contradictory. Some researchers state that eye movements correlate positively to academic skill,[9,10,11] while others say that any eye movement deficit can be attributed to cognitive and linguistic deficits.[12,13]

This preliminary study was undertaken to discover if children who were performing above average on the critical academic skill of reading would show better eye movement skills than those children who were not reading on grade level.

REVIEW OF OCULOMOTOR TESTING

Three general types of tests can be used to evaluate oculomotor skills. These three types are:

1. Electrodiagnostic
2. Standardized Psychometric
3. Traditional Chair Skills

Electrodiagnostic methods are often used to objectively record oculomotor performance. These tests are expensive and time consuming. In addition, they are often seen as a threat by the young patient. If the child becomes anxious, then these anxieties could result in questionable accuracy of the data. These factors discourage the use of this method of testing oculomotor skills by the non-research optometric community.

The standardized oculomotor test which has received the most interest in the literature is the King-Devick test. It is a very popular test with the clinician and has been reported to be related to reading ability.[14,15,16] The King-Devick test has been criticized because it uses language/cognitive factors in its testing. These factors develop parallel to visual skills and it may well be that the King-Devick is measuring language or cognitive development rather than visual maturity.[17,18]

Recently, reliability of the King-Devick test has been questioned. Oride, et al. have found that children tend to perform significantly better the second time when the King-Devick test is repeated. This information would also make one suspicious of the results of this test.[19]

The traditional version test, most often used by the optometric clinician, is well accepted by optometry. Lack of standardized test procedures and observations has been the basis of criticism when this type of pursuit and saccade testing is used. Although there have been some attempts in the past to standardize oculomotor tests'[18,20] no one test has been universally accepted by the profession. The Northeastern State University College of Optometry (NSUCO) Oculomotor Test is a standardized version test which evaluates both pursuit and saccade functions.[20] Complete directions on the administration and procedure for the test may be found in Appendix A. Briefly, the child stands in front of the examiner who presents either one (pursuit) or two (saccade) targets to the subject, on their midline. The subject is then instructed to follow the target (pursuit) or to look back and forth between the two targets (saccades). No instructions are given to suppress head movement or body movements.

Binocular pursuits and saccades are scored on the following aspects: ability to complete the task, accuracy of performance, head movement to support behavior, and body movement to support behavior. Each aspect is graded on a scale of one to five; with one being the poorest performance and five being the best. A complete description of the scoring may be found in Appendix B.

Reliability data for the NSUCO Oculomotor Test has been previously reported.[20] The interrater reliability for pursuits averaged 73.5% while the same grading agreement for saccades was 75.0%. Thus, trained observers graded the same recorded eye movement. Their scores were then compared to one another. There was exact agreement on oculomotor skill rating three-fourths of the time.

Intrarater reliability was also acceptable.[2] Each trained observer evaluated the same recorded eye movements after one month. When the first rating was compared to the second, the saccade testing reliability averaged 83% and pursuit reliability averaged 90%. Again, these two percentage figures were above established criteria for reliable measurements.

Pavlidis is a strong proponent of the relationship between dyslexia and poor eye movements. He considers the eye movements of the dyslexic to be different from either the retarded or the normal reader. These abnormal eye movements are reported to be independent of the reading material.[11,21] Flax, et al. cited a highly significant study in which 52% of dyslexic students had jerky eye movements and only 11% of the controls showed such behavior.[22]

Eye movements and their relationship to academics are certainly recognized by optometry as being very complex. Inherent in the eye movement reading skill are both perceptual and attentional factors.[23] It is evident that a great deal more research must be performed to come to a reasonable statement of the relationship between oculomotor skills and academics, particularly reading performance. Given that a positive relationship between these two variables is identified, can remediation of oculomotor dysfunction impact positively on the academic skill of reading?

A recent review of the efficacy of vision therapy addresses this topic when it cites several articles which indicate that eye movement skills are deficient in children who also exhibit academic difficulty. More importantly, this article indicates that these oculomotor dysfunctions are sensitive to intervention by optometric vision therapy.[24]

A previous study[25] has shown that the NSUCO Oculomotor Tests differentiates between learning-disabled and gifted populations. These two populations (learning-disabled and gifted) are widely different segments of school populations. Oculomotor skill differences might not be significant if applied to a segment of the regular classroom. To investigate this possibility, a pilot study was designed. It was hypothesized that a group of children identified as poor readers would not score significantly lower at the .05 level on the NSUCO Oculomotor Test than would a group of children identified as good readers.

METHODS

A total of 38 elementary school children (28 boys and 10 girls) were categorized into two groups, good readers and poor readers. Seventeen of these children (13 boys and four girls in grades two to six) were identified as good readers by their teachers. School administrators then verified these groups by averaging available standardized achievement test data. The tests used for verification were either the Gates McGinitie or the SRA Achievement Reading Test. Neither reading test scores nor intelligence test scores were obtainable by the researchers. The good readers scored an average of one year and nine months above their actual grade placement, whereas the poor readers scored an average of one year and three months below their actual grade placement. This data thus provided evidence in support of the teachers' categorizations.

All children were administered the NSUCO Oculomotor Test. One experienced clinician performed all of the testing in a similar environment. Two video cameras recorded head, body and eye movements. The video tapes of oculomotor performance were scored by 24 third-year optometry students. These scorers did not know that the children differed in any way.

A total of 912 observations are represented in this study. This number consists of 24 scorers grading 21 poor readers (504) and 17 good readers (408). These data were submitted to both parametric and non-parametric statistical techniques in order to test the hypothesis.

RESULTS

The good readers were scored consistently better on the NSUCO Oculomotor Test in nearly all categories than the poor readers. Table 1 shows the percentages of good versus poor readers who were scored as low (1,2 or 3) and high (4 or 5) in each oculomotor category. This scoring division (1,2 or 3 versus 4 or 5) was consistent with a previous analysis and appears useful in determining success or failure on each of the oculomotor categories.[25]

Table 1 shows that the failure rate of poor readers is almost twice that of the good readers for every category except saccadic ability. The head movement category for both pursuits and saccades appears to show the greatest difference between good and poor readers.

Given the confusion over whether or not the summation of ordinal level data can be treated as interval (as in the case of grade point averages), the data were analyzed by both the Mann-Whitney U test (nonparametric) and the independent t test (parametric) for each oculomotor category. The results of these analyses were identical in that both parametric and nonparametric statistics showed significant differences between the groups at the .05 level. Table 2 shows the results of the parametric data analysis.

CONCLUSIONS

The NSUCO Oculomotor Test scores for individuals reading above grade level were significantly higher than those whose reading level was below their grade level. This pilot study would indicate that oculomotor skills of good readers are better than those of the poor readers. The reader is reminded that although the total N value of this pilot study was 38, each child was scored 24 times, and it was these scores (912) which were used in the calculation of the statistics. This procedure may have inflated minute differences to the significance level, but the importance of these preliminary findings warrants reporting and further investigation. A replication of this study with more stringent controls and a greater number of subjects is being planned.

This test may be useful where language factors are suspected to be impacting oculomotor scores. The NSUCO Oculomotor Test requires only minimal language and cognitive skills to perform since the subject is not required to respond verbally, but only to perform a simple oculomotor task. The verbal instructions for the oculomotor task are very simple and easily explained even to preschool children. The oculomotor difference between the two groups in the study is not likely to have been significantly influenced by a linguistic deficit.

Table 1

PERCENTAGES OF GOOD AND POOR READERS SCORING 1,2,3 (LOW) OR 4,5 (HIGH) ON THE NSUCO OCULOMOTOR SKILLS TEST

PURSUITS

Oculomotor Category	Good Readers	Poor Readers
Ability		
Low	0.2	11.9
High	99.8	88.1
Accuracy		
Low	13.3	29.3
High	86.7	70.7
Head Movement		
Low	16.1	32.7
High	83.9	67.3
Body Movement		
Low	8.6	32.7
High	91.4	86.3

SACCADES

Oculomotor	Good Readers	Poor Readers
Ability		
Low	0.0	0.0
High	100.00	100.0
Accuracy		
Low	12.0	29.5
High	88.0	70.5
Head Movement		
Low	19.0	43.4
High	81.0	56.6
Body Movement		
Low	8.1	14.7
High	91.9	85.3

Table 2

MEANS, STANDARD DEVIATIONS, AND t TEST RESULTS FOR GOOD VERSUS POOR READERS ON THE NSUCO OCULOMOTOR TEST

PURSUITS

	mean	SD	t
Ability			
Good Reader	4.99	.16	7.50*
Poor Reader	4.65	.88	
Accuracy			
Good Reader	4.45	.85	7.50*
Poor Reader	3.92	1.21	
Head Movement			
Good Reader	4.35	.98	9.46*
Poor Reader	3.58	1.37	
Body Movement			
Good Reader	4.66	.88	3.25*
Poor Reader	4.46	.96	

SACCADES

	mean	SD	t
Ability			
Good Reader	5.00	.00	2.86*
Poor Reader	4.98	.14	
Accuracy			
Good Reader	4.21	.64	6.91*
Poor Reader	3.85	.89	
Head Movement			
Good Reader	4.34	.86	4.13*
Poor Reader	3.45	2.04	
Body Movement			
Good Reader	4.72	.79	4.24*
Poor Reader	4.47	1.00	

*p.05

These data would not exclude a subtle dysfunction of the extraocular muscles or of a central nervous system dysfunction of spatial orientation as a causative factor. Such a spatial orientation dysfunction might cause the brain to misguide the eyes in tracking or fixating a target. The first factor, peripheral or extraocular system dysfunction, would not likely be present without other observable deficits in extraocular muscle function. In the latter case, a central nervous system dysfunction seems more likely since reading is a central nervous system function and such a dysfunction in the brain could be interfering with both reading and oculomotor skills.

The very fact that head and body movement are used in the oculomotor task over the course of a class day may cause fatigue of the head, neck and trunk. This fatigue could interfere with the total energy the child has to devote to academics and particularly reading. Certainly language factors could, and probably are, a significant factor in poorer reading scores. These linguistic dysfunctions, however, could be found in the presence or in the absence of the oculomotor dysfunction described in this paper.

It is unlikely, based upon the wide variations in the literature, that a simplistic, single causation, behavioral relationship exists between academic performance and oculomotor dysfunction. It seems reasonable that eye movement anomalies are not the product of faulty eye muscles, but rather spatial processing inaccuracies. The individual is having trouble attending to the task and/or processing the information gathered (with or without language factors). Language and visual auditory integration problems would only tend to exacerbate this dysfunction. It certainly cannot be concluded that every person who scores poorly on the oculomotor test will exhibit poor reading or, conversely, that every person who scores well on the test will be a good reader. This preliminary study does indicate that a relationship does exist between oculomotor performance and reading level. However, no causal relationship should be inferred.

The NSUCO Oculomotor Test battery may be useful as a diagnostic tool when used as part of a school screening program. Such a test could be a quick and inexpensive tool for education and optometry to identify possible reading problems. The identification of this high risk population would allow educators and optometrists to intervene at an earlier age. Remediation (either educational or optometric) could then be implemented before a child has spent months or years in a nonproductive or counterproductive academic environment.

Future research in this area should focus on the impact vision therapy would have on the low oculomotor scores as defined by this test. If vision therapy remediates the low oculomotor performance, then it would be necessary to compare reading scores after the oculomotor remediation.

APPENDIX A

STANDARD SET OF THE NSUCO OCULOMOTOR TEST

1. Posture: Standing, with feet shoulder width apart, directly in front of the examiner
2. Head: No instructions are given to the patient to move or not to move his head
3. Target characteristics: Small (approximately 1/2 cm) reflective sphere (with young children, use Disney targets on pencils)*
4. Movement of the target:
   A. Directional:
      a. Saccades are performed in the horizontal meridian only.
      b. Pursuits are performed rotationally, both clockwise and counterclockwise.
   B. Extent:
      a. Saccade extent should be estimated as no more than 10 cm on each side of the patient's midline (20 cm total).
      b. Pursuit path should be estimated as no more than 20 cm in diameter, performed on the midline of the patient.
5. Test distance from the patient: No more than 40 cm and no less than the Harmon Norm (estimated)
6. Ocular condition: Binocular only
7. Age of the patient: 2 years to adult
8. Instructions:
   A. Saccades: "When I say 'red,' look at the red ball. When I say 'green,' look at the green ball. Remember, don't look until I tell you to."
   B. Pursuits: "Watch the ball as it goes around. Try to see yourself in the ball. Don't ever take your eyes off the ball."
9. Observations: Eye, head and body movement
10. Scoring methods: See score sheet.

* Disney targets available from Bernell Company, 750 Lincolnway East, P.O. 4637, South Bend, IN 46634.

APPENDIX B

NSUCO METHOD OF SCORING SACCADES AND PURSUITS

ABILITY

(Can the patient keep his attention under control to complete five round trips for saccades and two rotations each way for pursuits?)

SACCADES

1. No attempt is made to perform the task to one round trip
2. Completes two round trips
3. Completes three round trips
4. Completes four round trips
5. Completes five round trips

PURSUITS

1. No attempt is made to follow the target to 1/2 rotation
2. Completes 1/2 rotations but not one full rotation
3. Completes one rotation but not two rotations
4. Completes two rotations in one direction but not two in the other direction
5. Completes two rotations in each direction

ACCURACY

(Can the patient accurately and consistently fixate so that no noticeable correction is needed in the case of saccades or track the target so that no noticeable refixation is needed when doing pursuits?)

SACCADES

1. Gross over-or undershooting is noted
2. Large to moderate over- or undershooting noted
3. Constant slight over- or undershooting noted

4. Intermittent slight over- or under-shooting noted
5. No over- or undershooting noted

PURSUITS

1. No attempt to follow the target to 10 refixations
2. Refixations four to 10 times
3. Refixations two to four times
4. Refixations two or less times
5. No refixations

HEAD AND BODY MOVEMENT

(Can the patient make the saccade or pursuit movement without moving his head or body? Both saccade and pursuit scoring use the same criteria for this aspect of the testing.)

1. Gross movement of the head (body)
2. Large to moderate movement of the head (body)
3. Consistent slight movement of the head (body)
4. Intermittent slight movement of the head (body)
5. No movement of the head (body)

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