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Kevin S. Lee
Pacific University

Cameron VanRoekel
Pacific University

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Assessing Saccades and Pursuits in Children with Attention Deficit Disorder Using the DEM and Groffman

By

Kevin S. Lee
and
Cameron VanRoekel

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Adviser:

Hannu Laukkanen O.D. M.Ed.

Authers:

Kevin Lee,

Cameron VanRoekel,

Advisors:

Hannu Laukkanen O.D. M.Ed.

Abstract

It has been suggested that the presence of Attention Deficit Disorder (ADD) does not appear to influence children's performance on eye movement tasks. In this study children between the ages of eight to twelve, diagnosed with ADD, were each administered two eye movement tests and a test of verbal intelligence. The three test used were the Developmental Eye Movement test, Groffman Visual Tracing Test, and the Peabody Picture Vocabulary Test. All subjects in this experiment except one were on medication to control their ADD. Trends pointed towards higher then average scores on verbal intelligence, below average scores for saccadic eye movement ability and visual-verbal response time. The test used to analyze pursuits was indecisive, no trend was evident on pursuit eye movement performance with these ADD subjects.

Key Words: Attention Deficit Disorder (ADD), Developmental Eye Movement Test (DEM), Groffman Visual Tracing Test.

Introduction

Attention Deficit Disorder (ADD) is characterized by a short attention span, inability to control impulses, and increased motor activity. For a diagnosis of ADD to be mad the condition must manifest itself before age six. ADD is also known as Attention Deficit Hyperactive Disorder (ADHD). The incidence of childhood ADD is estimated to be 5 to 10% of the school aged population. The occurrence of ADD is much higher for boys than girls, with a ratio of six males to every one female. (M. Schimelfenig)

ADD has a genetic association. A family having one child with ADD has a 35% chance of having a second child afflicted with ADD. (Wallis C.) ADD is believed to be caused by a dysfunction in the frontal limbic region of the brain which is responsible for control of behavior. (Roscoe Dykman)

There are three telltale behaviors associated with ADD children. The first is difficulty in maintaining concentration on specific tasks. Second, ADD children tend to be impulsive, and exhibit rapid mood swings. The third common behavior is hyperactivity which may or may not be present in all ADD children. These children are often described as being fidgety, or squirmy and as a result they are always on the go. (M Schimelfenig) (C.Wallis)

ADD is not only a childhood disorder, but also afflicts adults, however symptoms are generally reduced and less noticeable in adulthood. (M Schimelfenig) Adults and teenagers who channel their extra energy into sports or other physical activities are better able to manage their condition. Adults with ADD are not well suited for desk jobs, or occupations that require sustained attention. (C. Wallis)

Only 65% of children diagnosed with ADD are actively being medicated. Of these medicated children, 70% respond positively to the medication. Ritlin is the most frequently prescribed of the three common ADD medications. The others are Dexedrein and Cylert, which are all central nervous system stimulants. (C. Wallis)

Ocular side affects of Ritlin include urticaria (itching) and subconjunctival hemorrhages. Visual hallucination have been associated with toxic levels of Ritlin. However, most side affects are rare, and are reversible with discontinuation of the drug. (Ft Franfelder.) Cylert has been known to cause nystagmus and oculogyric crises. (PDR 47th edition) Dexedrine can cause decreased accommodation and convergence, but side effects are rarely seen except when associated with overdose. (Ft Franfelder)

In one study Rothlind has shown that ADD children have slower eye movements when compared to non-ADD children, this decreased is thought to be associated with control of the right cerebral hemisphere. (Johannes C. Journal of cognitive Neuroscience) Bala reported that ADD children manifest more saccadic eye movements during pursuits than non-ADD children. (Stanley p. Bala)

The purpose of this study was to evaluate the visual skills of ADD children using tests which are common to many Optometric practices. We also wanted to determine if there was a difference between the eye movements with children who have ADD as compared to those who do not. The eye movement tests selected for this study assess different aspects of eye movement behaviors. There was no mention in the previous literature of using this

particular combination of tests we have chosen. Electrography, d-c coupling and a combination of television and video equipment devices have been used in previous ADD research.

A widely used clinical instrument for measuring eye movements is the Developmental Eye Movement Test (DEM). The DEM is a visual-verbal saccadic eye movement test. The DEM is administered by having the subject first call out numbers printed in vertical rows as quickly as possible. Since horizontal eye movements are not necessary for part A and part B of the DEM, the time required to call out the vertical numbers relates to the subjects visual verbal response speed. In part C of the DEM, the subject has to quickly read out loud numbers that are arranged horizontally; this requires horizontal scanning of the page while searching for the next number. Both sections of the test are scored based on time and accuracy. Final scores are compensated for omissions and additions. The ratio of horizontal over vertical time represents the subject's efficiency with horizontal eye movements. The calculated ratio thus takes into account verbal automaticity factors such as expressive language deficits (such as articulation and speech difficulties) as well as a visual discrimination and verbal output integration dysfunction.

The DEM is a valid test with validity scores of the vertical, horizontal and ratio scores of r=.089, 0.86 and 0.57 respectively. The DEM has high validity scores $P < 0.001$ when correlation's were made with coefficients between components of the DEM. (Ralph P Garzia, et al Journal of the American Optometry Association.) Research shows there is a strong link between DEM scores and reading achievement. (Ralph P Garzia, et al Journal of the American Optometry

Association.) There are two main eye movements children use in the classroom, saccades and pursuit. The DEM was chosen because it is a simple way for practitioners to measure saccadic eye movement.

The Groffman is another in office test that can be used to measure eye movement skills. This test is reported to measure pursuit ability by having the patient track a line with his/her eyes. The test consist of four lines that curve around a page and cross each other many times. The test is scored based upon the time required to visually track the lines and on accuracy of arriving at the correct number. The Groffman visual tracing test assess pursuit eye movements, it can also assess figure ground visual perceptual ability. In addition saccadic eye movement ability is being measured as well.

The Peabody Picture Vocabulary Test (PPVT) is a measure of auding vocabulary, and verbal intelligence, from which a verbal based IQ score can be derived. (The Sixth Mental Measurements Yearbook) The PPVT is administered by having the examiner say a word to a subject, who must then match the word to one of the four pictures illustrated on a page of the test booklet.

The PPVT has been shown to have a reliability factor of r= 0.67 to .084. The validity score is 0.58 to 0.61. (The Sixth Mental Measurements Yearbook)

All of the three tests provided a conversion factors to convert raw scores into percentiles scores. All 15 subjects were diagnose as having ADD and ranged in age from 8 to 12 years old. Each subject performed all three test. Percentile scores results were compared between the three tests.

Subjects & Methods

Our subject inclusion criteria included all of the following. A prior positive diagnosis of ADD by a medical doctor or a psychologist with PsyD. or PhD. credentials. Qualifying age for this study was eight to thirteen. The DEM, PPVT and Groffman are all specifically normed for these ages. Lastly, all subjects had to have English as their primary language, because the PPVT is a vocabulary test and it is given in English.

Subjects were recruited via press releases to local newspapers. Each participant was screened with the aid of a pre-exam form to help rule out developmental deficiencies. Subjects who were at high risk for cognitive and developmental impairments were not included in this study. All subjects were prescreened by a telephone interview, with one of his/her parents or guardians who knew of the subject's medical and developmental history.

All testing was performed at a table with the subjects sitting in a chair. Light was provided with fluorescence bulbs to obtain standard room illumination. There were no windows in the room which could add outside distractions.

The Groffman Visual Tracing Test and the Developmental Eye Movement Test (DEM) were each given twice. The Groffman test has two versions whereas there is only one version of the DEM test. A second version of the DEM test was created by the authors for this study. The second DEM test was identical to the original in size and spacing, only the numbers were changed. (Each original number was increased by one.)

The test sequence was uniform for all subjects. The test order was as follows: DEM version one, DEM version two, Groffman Visual Tracing Test A, Groffman Visual Tracing Test B, and The Peabody Picture Vocabulary Test (PPVT). Subjects were given breaks between the tests while the examiner prepared the next test.

Total test time for the fifteen subjects ranged from 30-60 minutes. Test's for all subjects were scored at the conclusion of the data gathering.

RESULTS

Ages of our subjects ranged between eight and twelve years with a distribution of 4,3,4,2 and 2 subjects at ages 8,9,10,11 and 12 years respectively. Fourteen of the fifteen subjects were on medications for their disorder. The study included thirteen boys and two girls.

All raw test scores were converted to percentile scores. Each percentile score was rated high, low or average. One Standard Deviation (SD) above the mean was considered a high score. A low score was one that fell more than one SD below the mean. Any score within one standard deviation of the mean was labeled as average.

On the PPVT, four of the fifteen subjects scored more than one standard deviation below the mean. Seven were one standard deviation above the mean. Four were within one SD of the mean. Eleven of the subjects in this study had average or above verbal average intelligence.

On the vertical sub-test of the DEM, five of the fifteen were more than one standard deviation below average. Ten were within one SD of the expected mean on the vertical time. Out of the ten who obtained an average score, only one was above the 50th percentile.

For the DEM Ratio Score, eleven of the fifteen scores were more than one SD below the average range. Only one subject obtained a ratio score in the average range zone. Three subjects had ratio scores in the above average band. Overall nearly all of the subjects had poor ratio scores on the DEM. This means they had poor oculomotor efficiency even when their automatically defects were taken into account.

The Groffman Visual Tracing Test yielded the following results. Seven of fifteen were more than one SD below average, and eight were more than one SD above average. All but two of the test subjects were above the ceiling or below the floor of the normative data published for this test. Only two of the subjects generated scores between the 1st and 99th percentiles. Eight subjects scored above the 99th percentile and five scored below the 1st percentile.

Table of Results.

age	PPVT %	Groffman %	DEM Vertical %	DEM Ratio %
8	88H	99H	45A	55A
8.08	55A	1L	30A	1L
8.66	75A	1L	1L	1L
8.92	45A	5L	40A	1L
9.08	13L	99H	40A	20L
9.25	95H	99H	15A	85H
9.5	79A	1L	1L	1L
10.08	14L	1L	1L	1L
10.08	98H	99H	70A	99H
10.08	5L	1L	1L	1L
10.41	14L	99H	5L	15L
11.5	99H	5L	45A	95H
11.92	92H	99H	35A	25L
12.17	84H	99H	25A	25L
12.33	95H	99H	50A	1L

L= Score was more than one SD below the mean.
A= Score was within one SD of the mean.
H= Score was greater than one SD above the mean.

Conclusion

This project was carried out as a pilot study to evaluate eye movement performance of children with ADD. Based upon previous eye movement studies of ADD children, we suspected that ADD children's eye movements would differ from non-ADD normal children. Our original study design included statistical analysis, but this was precluded because we were unable to recruit a sufficient number of subjects. Even though only fifteen subjects participated in this study, these medicated children with ADD showed some strong trends. The following were some of the conclusions from this study.

Below average scores on the PPVT do appear to be linked to low DEM ratio and automaticity scores. This means children with low verbal IQ scores are likely to have poor saccadic eye movement ability and have slow visual-verbal number naming ability. (There appeared to be a positive correlation between low PPVT and vertical DEM and ratio scores) Average or high scores on the PPVT did not appear to be correlated with DEM vertical or DEM ratio scores; this was not expected. In other words, low scores on the PPVT seem to predict low DEM scores, however with bright children, verbal intelligence did not predict eye movement efficiency.

The Groffman Visual Tracing Test results were inconclusive. The Groffman was not useful due to ceiling and floor effects of the test. Most subjects scores fell outside the normative boundaries provided with the Groffman Visual Tracing Test. No predicative relationships were found between the Groffman and DEM. From this

we concluded the Groffman Visual Tracing Test probably measured different eye movements skills than did the DEM with our subjects.

Our subjects had a tendency to exhibit poor eye movement skills on the DEM. A high percentage of our subjects demonstrated slow visual-verbal response times or decreased automaticity. This has been shown by others to correlate with poor reading ability. (Ralph P. Garzia) Dyslexics and people with learning disabilities tend to show slow verbal automaticity times. (Korhonen 1995) Korhonen suggests a problem with phonological coding as a possible explanation for this slow naming performance.

We feel this study needs to be replicated with a larger ADD sample. Because so many of the children in this study had high verbal IQ's, our sample may not accurately represent the true distribution of verbal ability in ADD children at large. The usually high proportion of children with high verbal IQ's in this study may have been partially due to our recruitment methods. We advertised this study in press releases as an educational opportunity for the subjects. Perhaps our recruitment methods attracted a high proportion of parents who were very curious and concerned about their very bright youngsters as well as motivated to have them participate.

An unknown variable in this study is the effect of ADD medication upon eye movement performance. Future studies are needed to determine whether ADD children who are medicated perform differently on eye movement tests than those who are not medicated.

Appendix A

PRE-EXAM QUESTIONS

NAME/AGE		
PRENATAL COMPLICATIONS	YES	NO
WHERE THERE ANY COMPLICATIONS DURING BIRTH	YES	NO
ANY SIGNIFICANT TRAUMA TO THE HEAD	YES	NO
HI FEVER	YES	NO
LOSS OF CONCISENESS	YES	NO
IS THE CHILD ON ANY MEDICATIONS	YES	NO
SCHOOL HISTORY	YES	NO
LEARNING DISABILITIES	YES	NO
INVOLVED IN CHAPTER ONE OR LRC	YES	NO
DIAGNOSED AS ADD	YES	NO

About the Authors.

Kevin Lee graduated from the University of Washington in 1987 with a B.S. in Microbiology. Kevin loves to travel and has incorporated his zest for Optometry with his love of travel by participating in four Eye Care Missions, three to Mexico and one to Indonesia. Providing vision care and eye glasses to the undeserved in sight. Upon graduation Kevin plans to start a group practice in the Seattle metropolitan area specializing in Pediatric Optometry and Vision Therapy.

Cameron VanRoekel graduated from Eastern Oregon State College in 1991 with a BS. in Chemistry. Upon completion of Optometry School in May of 95, Cameron is going into the United States Army to serve as an optometrist.

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