

Visual Skills Have a Role in Predicting Academic Performance
Charles A Charbonneau, B.S.
Dr. Michael Cron, OD
Michigan College of Optometry

This research was conducted in accordance with Ferris State University Human Subjects
Review Committee guidelines.

Abstract:

This study examines the relationship between specific measures of visual skills and academic performance among school age children. Goal is to determine whether or not low academic achievement correlates with specific visual skills deficits. **Method:** A total of 60 sixth graders were evaluated on their stereopsis, accommodative facility, near phoria, and Developmental Eye Movements test. The sampling between genders was randomized. Thirty students with high academic achievement evidenced by accelerated placement in math, science, or language arts within the school were selected as the control group. Thirty students with below average achievement based on teachers assessments and scoring 4th grade level or below on the Developmental Reading Assessment test independently administered by the school were selected as the research group. Relative academic achievement was made blind to the experimenter prior to the measure of visual skills. Teachers were masked to the student performances on the visual testing. **Results:** Subjects with both high DEM ratio and high rate of errors combined had low achievement at 2 times the rate of those with high academic achievement. Phoric posture alone had no predictive value for low academic achievement for any magnitude in this study. Subjects with intermittent exotropia at near had low achievement at 2 times the rate of those with high academic achievement. Subjects with reduced accommodative facility had low academic achievement at 4.33 times the rate of those with high academic achievement. Subjects with reduced stereopsis had low academic achievement at 1.5 times the rate of those with high academic achievement. Subjects wearing glasses had high achievement at 3.67 times the rate of those with low academic achievement. **Conclusions:** Visual skills have an impact on academic performance. Ocular-motor skills, intermittent exotropia at near, and accommodative facility seem to have greater influences than phoric posture or stereopsis.

Introduction:

Optometry has evolved a great deal as a profession from its conception. Optometrists started off largely fitting and selling glasses, but have evolved to become full scope primary eye care providers. As a profession we have become more prominent, and with that prominence we have greater responsibility. Optometrists have the responsibility to ensure the best to care for all aspects of patients' vision. This includes correcting refractive errors, diagnosing and managing ocular disease, and caring for functional visual needs. These principles need to be applied both to the patients in exam chairs and responsibility to public health.

The goal of this study is to improve optometrist's ability to meet public health responsibilities to children that have unsatisfactory academic performance. Low achievement in school can result from a variety of influences. These could include poor visual function, low IQ, poor parental influence, developmental anomalies, poor instruction, societal and peer influences, etc. While many of these fall outside an optometrist's scope of practice, optometrists are the only experts on visual function. This study targeted the relationship between visual function and academic performance. The primary objective was to determine whether or not visual skills could be correlated with academic performance. Assuming there is a correlation, all optometric clinicians must embrace the task of determining what efficient visual testing that can be done that would appropriately recognize visual deficits which hinder academic performance. This would allow optometrists a tool to make treatment recommendations specifically for children with low achievement. This goal should be coupled with avoiding additional testing and treatments that pose no benefit, in the event that no correlation exists.

A significant body of research exists with this very same goal in mind. There are numerous studies that both support and refute that there is a relationship between visual skills and academic performance. There have also been models for clinical approaches that primary care optometrists should take for patients that struggle in school with the premise that visual-motor skills do have an impact on academic performance. (Wesson 6) This is why it is vital that optometric science be able to answer its call to struggling schoolchildren.

A study done to evaluate the specific ergonomic demands of 4th and 5th graders in the classroom was performed on eleven different classrooms evaluating physical space, lighting conditions, and academic task demands placed on the students. The purpose of the study was to determine if the typical academic day would be demanding to children's visual systems. The study concluded that there was considerable similarity between classrooms and that more than 50 percent of the students' time involved near tasks. It was concluded that students with ocular motor dysfunctions may have difficulty meeting the academic and behavioral expectations of the extended near tasks. (Ritty 4)

Another study done on kindergarten through third grade students was designed to examine the relationship between visual motor integration skill and academic performance. It was concluded that performance on visual analysis and visual motor integration tasks was significantly related to academic performance. In that study, 191 children in K-3 were assessed with the Beery Developmental Test of Visual Motor Integration (VMI). These students were also assessed by their teachers in reading, math, and writing ability. Teacher assessments were substantiated by significant correlations

with standardized test scores. Performance on the VMI was found to significantly relate to the students performance in all subject areas assessed. (Taylor 5)

Two more studies were done to compare visual factors with academic performance accounting for race and socioeconomic factors. The first concluded that visual factors were much greater predictors of academic performance than race or socioeconomic status. That study was undertaken to discover visual skills that were significantly correlated with academic performance problems. The study took place over three consecutive school years in which 540 school children underwent 2,659 examinations. Academic performance was measured by the Iowa Test of Basic Skills. Visual motor activities proved to be the greatest predictor of academic performance, followed by binocularity and accommodation. Race and socioeconomic status were also significant predictors, but to a lesser degree. (Maples 3) The second study tested sixty black and sixty white children of variant academic achievement with the Minnesota Percepto-Diagnostic Test for visual motor skill development. This study concluded that race was not a significant predictor of the relationship between achievement level and visual-motor test skills. The statistically significant result was the low achievers, compared to high achievers performed poorly on the copying tests. (Fuller 1)

Finally, a study done to compare near stereo acuity and academic performance was done. The study evaluated 117 students in kindergarten through second grade with a masked investigation. Stereo acuity was measured with the Randot 2 stereo test at 40 cm and the results were compared with teachers' grades as a means of assessing academic performance. Teachers' assessments were also substantiated by correlations with standardized test scores. The study concluded that good stereo acuity at near significantly correlated with academic performance. (Kulp 2)

The tests selected in this study for comparison with academic performance were the DEM, near phoria, accommodative facility, and near stereopsis. Each of these tests was individually included due to the negative impacts that deficits in these areas could have on the child's ability to learn.

Methods:

The control group for this research was 30 sixth grade students selected based on high academic achievement and advanced placement in math, science, or language arts. The research group was 30 sixth grade students selected based on poor academic achievement and Developmental Reading Assessment scores of 4th grade or lower. Both groups were independently selected by their respective school teacher. Classification of achievement was hidden from the researcher until after research was complete. Ethnicity, gender, and age were randomized. The age range for the high achieving group was ten to twelve years old, with one ten year old, twenty-two eleven year olds, and seven twelve year olds. The age range for the low achieving group was eleven to thirteen years old, with sixteen eleven year olds, twelve twelve year olds, and two thirteen year olds. This gives a mean age for the high achieving group of 11.2 years old, and a mean age of the low achieving group of 11.53. These means do not account for month of birth. Prior to selection for research subjects with significant physical, mental, emotional, or behavioral impairments that were easily observable were excluded from the study.

Subjects were assigned study numbers by their teachers that signified their academic achievement as being high or low, and achievement information was kept blind

from the researcher. Each subject was then subsequently given four tests administered over their current refractive correction if available. First, their near phoria was objectively determined with a near cover test at 40 cm using a word target to hold accommodation. Angles less than four prism diopters eso or exo were objectively determined in open space, and those of greater magnitude were neutralized with prism in open space. Second, they were evaluated on accommodative facility using plus/minus 1.50 diopter flippers lenses and a word target held at 40 cm. Third, they were evaluated on their stereopsis at 40 cm with a wirt stereo test and polarized glasses. Finally, the entire DEM (Developmental Eye Movement) Test was performed. The DEM is distributed by Bernell, and administration and scoring instructions were determined using the Bernell examiner's booklet. After all testing was complete, study numbers were matched with academic achievement.

Upon completion the subjects' visual skill data was categorized both internally, and against normative data as either normal or decreased skill. Finally, statistical calculations were made to compare the significance of the data collected in the research and the conclusions made between the relationship of visual skills and academic performance.

Ethics:

Research was done on human subjects for this study in accordance with guidelines set forth by Ferris State University's (HSRC) Human Subjects Review Committee. Application was approved by HSRC prior to the commencement of research in accordance with federal and university regulations.

Results:

The DEM yields three significant results for comparison. The vertical DEM time is hypothesized to be the amount of time it requires each patient to cortically process information with little influence from ocular-motor skills. The DEM horizontal time is the time required to read the same number set horizontally, thus accounting for ocular-motor skills. The DEM ratio in the comparison between the horizontal time and the vertical time, and is thus a measure of ocular-motor eye tracking skills. The DEM errors total is a measure of efficiency while make horizontal eye movements. Elevated DEM ratio and errors would result in greater difficulty both reading and comprehending text and thus could result in a child struggling in school as a result of poor reading skills, which could be at least partially accounted for by poor visual tracking skills.

The values from experimentation were compared with the normalized table in Bernell's DEM test booklet for sixth graders. Of the sixty subjects tested, 21 subjects had vertical DEM times at least one standard deviation (SD) below the mean. Of these, 14 had low academic achievement and 7 had high achievement. Twenty-five subjects had DEM vertical times of at least one SD above the mean, of these 15 had high achievement, and the other 10 had low achievement. The remaining 14 test subjects had DEM vertical values within 1 SD of the mean in either direction. Thirty-eight students had DEM ratios greater than one SD below the expected mean. Out of these subjects, 22 of them had low academic achievement and 16 had high achievement. Thirteen students had DEM ratios at least 1 SD above the expected mean, with 7 of them having high achievement and 6 of them having low achievement. Nine subjects had DEM ratios

within 1 SD of the mean. Two or more errors is considered to be nearly 2 sd below the expected mean, and of the subjects tested 19 of them recorded 2 or more errors. Out of these subjects, 12 had low academic achievement and 7 had high achievement. When errors and high DEM ratio were taken together, 15 students were below expected norms based on the criteria stated above and of these 10 had low achievement and 5 had high achievement.

Cover test is a measure of a subject's phoric posture. Phoric posture with greater magnitude puts more stress on the vergence system to maintain fixation on a given target. This stress could result in asthenopia; fatigue, headaches, and tired eyes with extended near tasks. This could result in lack of concentration, or simply avoiding near work, which could in turn negatively affect academic performance. Thirteen subjects had exophoric postures of four prism diopters or more, of those 7 had high achievement, and 6 had low achievement. Only one subject with high achievement was at least 4 diopters esophoric, and 6 had 3 diopters of esophoria, 4 of who had high achievement and 2 with low achievement. Six subjects had intermittent exotropia at near, of which 4 had low academic achievement and 2 had high achievement. There was one subject with constant tropia at near with high achievement. The rest of subjects tested had phoric postures of lower magnitude or orthophoria.

Accommodative facility is a measure of the flexibility of a subject's focusing system. Poor accommodative facility could result in trouble focusing back and forth from distance to near, or it could be a manifestation of stress on the binocular of focusing system of the eye, which may result in asthenopia. Six cycles in 30 seconds was the passing criteria considered for accommodative facility for this study. Of the subjects tested, 15 had accommodative facility that was decreased from six cycles in 30 seconds. Of these subjects, 12 had low academic achievement and 3 had high achievement.

Stereopsis is the measure of a subject's binocular depth perception at near. Reduced stereopsis could be indicative of binocular misalignment and result in symptoms of asthenopia. Passing criteria for stereopsis for this study was 40 seconds. Of the sixty subjects' tests, 10 had stereopsis of less than 40 seconds. Six of those had stereo of 50 seconds. Of subjects with reduced stereopsis, 6 had low academic achievement, and 4 had high achievement.

Testing was done with subjects habitual corrections in place if available. Of the subjects tested, 14 had glasses on and 4 stated that they had glasses, but they were either lost or not worn. Of those not wearing their prescribed corrections, 2 had high achievement and 2 had low achievement. Eleven of the 14 subjects with glasses had high achievement, and 3 had low achievement.

Discussion:

These numbers demonstrate that subjects with high DEM ratio had low achievement at 1.375 times the rate of those with high academic achievement. Subjects with increased DEM error rate had low achievement at 1.71 times the rate of those with high academic achievement. Subjects with both high DEM ratio and high rate of errors combined had low achievement at 2 times the rate of those with high academic achievement. Phoric posture alone had no predictive value for low academic achievement for any magnitude in this study. Subjects with intermittent exotropia at near had low achievement at 2 times the rate of those with high academic achievement.

Subjects with reduced accommodative facility had low academic achievement at 4.33 times the rate of those with high academic achievement. Subjects with reduced stereopsis had low academic achievement at 1.5 times the rate of those with high academic achievement. Subjects wearing glasses had high achievement at 3.67 times the rate of those with low academic achievement.

These results indicate that visual skills have an impact on academic performance. Ocular-motor skills, intermittent exotropia at near, and accommodative facility seem to have greater influences than phoric posture or stereopsis. Optometrists should discipline themselves to test the ocular-motor skills of patients that struggle in school and make the appropriate recommendations to improve those skills and increase patients' academic potential. Intermittent strabismus at near and accommodative dysfunctions should also be assessed for and managed in patients with low academic achievement.

In reality it is more difficult to make "appropriate recommendations" than it should be. Optometrists may feel that it is unpopular or unprofitable. Making referrals to another OD for ocular-motor training may result in a lost patient, or even family for the life of a practice. Also, optometrists face scrutiny from some factions of the medical model, who do not believe visual skills play a role in academic performance. There may also be gaps in experience or education that prevent optometrists from taking a more active role.

Optometry still does not have all the answers. Optometrists must continue to make advancements in this area of visual performance. The goals of identifying visual factors that have high correlations with low academic achievement, and ensuring that patients are able to receive treatments to improve visual performance are two challenges that optometry should warmly embrace.

References:

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