Using shapes to determine visual discrimination

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The topic of this comprehensive essay is vision processes and their contributing factors to learning and learning difficulties. The literature reviews the symptoms associated with eye deficits/deficiencies and disorders. The literature also examines how symptoms from vision deficits/deficiencies may be mistaken and misidentified and attributed to other deficiencies and disorders. The more information decision makers have with regard to how a child/student functions, and the more accurate information is, it is more likely decision makers will develop effective interventions. If a child’s symptoms are not identified correctly, then it may be correct to infer the interventions developed may be less than effective and impede a child’s academic progress.

“Eyes are the tools of vision which feed the environmental information to the brain” (Blankenship, 1971). To ensure healthy vision, the availability of vision screening and comprehensive eye/vision exams are examined. Studies reveal there are underserved populations with regard to vision care. Different ethnic groups have been identified to be more likely to have particular vision issues (Heslin, Casey, Shaheen, Cardenas, & Baker, 2006). Undetected vision deficits have the potential to have long-lasting effects on learning and social-emotional well-being (Zaba, 2001).

Research Problem
When a child is referred for a comprehensive psychoeducation evaluation, it is often determined the child is not making satisfactory progress at the RTI Tier III level. This may suggest the interventions to date have not been effective. Consider if a vision problem is a contributing factor to a child’s difficulty accessing their education. There is a national movement to bring awareness to healthy vision. The literature explores the association of healthy vision, vision disorders and deficits with learning, academic achievement and the achievement gap (Basch, 2003; Vaughn et al., 2006; Vision Council of America, 2004; National Commission of Vision and Health, 2006). The national initiatives are developed to promote vision and eye health among all children and stakeholders. Schools may play an important role in the process of vision screening for children (American Association for Pediatric Ophthalmology and Strabismus, 2003).

Purpose of the Study
The purpose of this study is to examine what contributing factors vision has with learning and achievement difficulties as measured by elementary grade reading levels. As educators, what symptoms do we
look for to determine if a child has a vision deficit? The Visual Efficiency Rating screening program (VERA) (Gallaway, 2010) used a checklist with four areas: visual-difficulty with or avoidance of tasks that required concentration, memory, reading or problem solving; visual motor- complains of words and letters jumping around; reading/language- omits words/letters when reading/writing; attention- trouble remembering or relating to material that is read. Teachers are in the position to observe children in their learning/school environment on a daily basis. This study will examine children’s reading levels and the results of vision screenings completed in elementary schools that use the VERA screening programs and the vision checklists completed by teachers. This study will explore how many of the children who are referred for further evaluation are on grade level for reading or better. It is the hypothesis that many of the children referred for further eye evaluations will be below grade level for reading.

Vision Awareness
There is a national movement to bring awareness to healthy vision. The literature explores the association of healthy vision, vision disorders and deficits with learning, academic achievement and the achievement gap (Basch, 2000; Vaughn et al., 2006; Vision Council of America, 2004; National Commission of Vision and Health, 2006). In October 2002, the National Center for Children’s Vision and Eye Health supported by the U. S. Department of Health and Human Services, recommended a strategy to provide universal vision screening to children before entering school, and keep records of such screenings and results through the Immunization Registry process.

Children as young as newborns are recommended to have eye exams to determine healthy eye function. These exams are recommended for all babies. However, there are babies who may be more at risk; those babies born prematurely, babies born with complications during birth, low oxygen, low Apgar scores, and babies whose mothers have infections (AIDS, herpes) at the time of their birth (American Optometric Association, 2003). Studies show that children with special needs may not receive the necessary vision care and as a result are even more at risk for developmental delays, socially and academically (Heslin et al., 2006).

At-Risk Populations for Vision/Eye Disorders
The Multi-Ethnic Pediatric Eye Disease and Baltimore Pediatric Eye Disease Studies (2001) concluded in their study of 9,770 children, ages six months to seventy-two months, that African-American children and Hispanic children may be more at risk than non-Hispanic whites for myopia (nearsightedness). Hispanic and non-Hispanic white children are more likely to have hyperopia (far-sightedness). Children with health insurance, and those children whose mothers smoked during pregnancy are also more at risk for hyperopia.

There are many programs in place for children at-risk, community/home/school partnerships, Head Start, Title 1 reading programs and all-day kindergarten. However, many children may not have functional vision to be successful in school and as a result may not complete high school (Johnson, Nottingham, Stratton & Zaba, 1996). The National Center for Education reports people that do not graduate high school...
earn $10,000.00+ less a year than their counterparts who have earned a high school diploma or alternate certificate (GED) (Laird, Cataldi, Ramani, & Chapman, 2006).

To ensure children receive eye care, schools may create multidisciplinary teams that include all members of the child study team, teachers, school psychologists, administrators, social workers, and school nurses to come together and create programs that prevent children from falling through the cracks with regard to obtaining eye care and the necessary follow up care. Some families have obstacles in their way that prevent them from obtaining care (Kimel, 2006). These obstacles may be financial worries, lack of transportation, use of a phone, working hours that are not convenient to communicating with a doctor’s office or making and keeping appointments. Some children do not have a permanent address, some are in the foster system, and do not know where they may be week to week (Kimel, 2006).

Vision Screenings
Early intervention is important before the age of three years old to detect certain conditions that may result in a permanent reduction in vision. In 2010, The US Preventive Services Task Force (USPSTF) updated their 2004 recommendation regarding screenings for visual impairments among children. The 2001 recommendation is for all children between the ages of 3 and 5 years old to have at least one vision screening to detect the presence of amblyopia or its risk factors. The following professional organizations' recommendations for vision evaluations/screenings similar to USPSTF, though not limited to, are The American Academy of Family, the American Academy of Ophthalmology and the American Association for Pediatric Ophthalmology and Strabismus (AAPOS), The American Optometric Association (AOA).

In the United States, all but eight states have vision screening requirements and recommendations before a child enters school or within a certain timeframe of entering school (American Association for Pediatric Ophthalmology and Strabismus, 2003). For school-age children the recommended frequency of eye exams after the age of five is every two years up to the age of eighteen. Many of the states that have requirements require interval vision screenings up to eighth or ninth grade, and optional screenings when in high school. Those persons who are at-risk (i.e., develop diabetes, or have a family history of eye disease) are to receive exams as recommended by their health professional.

Vision screenings are often administered using a Snellen Chart assessing one’s visual acuity from 20' using one eye at a time. Though schools may provide vision screenings beyond just a visual acuity test, studies have indicated that one-third of the children had a condition that was not detected (Vision Council of America (VIP), 2005). It is important to note that a vision screening is not a comprehensive exam. It is therefore recommended that children receive a comprehensive exam from an optometrist or ophthalmologist.

An analysis of the National Health Interview Survey revealed that insured children have their medical needs met almost four times more than those children who are not insured (Newacheck, Stoddard, Hughes, & Pearl, 1998). However, studies have shown that vision care and the accessibility to vision care are often related to insurance. A study of children who
receive their health benefits from State Children’s Health Insurance Program and Medicaid may be better served for their vision needs than uninsured children, and children with private insurance. Those with private insurance often have additional premiums to pay for vision care and do not choose to carry the additional insurance. As a result, many do not receive vision care as often (Heslin et al.).

Gallaway and Mitchell (2000) included visual skill screening in the schools investigated. The Visual Efficiency Rating (VERA) screening program. VERA is a computer program whose effectiveness as compared to clinical optometric testing was studied in six elementary schools. One hundred and fifty-four children, grades 3 through 5, ages ranging from 8 to 12 were tested. The children tested were referred by their classroom teachers as students experiencing difficulties in the classrooms. The vision areas screened with the VERA software in addition to visual acuity were: accommodative, binocular, hyperopia and ocular motor disorders. The clinical optometric testing included the standard protocol, the Developmental Eye Movement, the Convergence Insufficiency Symptom Survey (CISS) and the Word Recognition and Fluency subtests from the Woodcock-Johnson III Tests of Achievement. The results indicated that the VERA is a reasonable method for visual skill screenings in school settings. An important factor to implementing the VERA in the schools, as compared to the clinical optometric testing, was school personnel may be trained to administer the assessment. This would provide more comprehensive vision skill assessments to children, as compared to the traditional Snellen Chart often used in vision assessments in schools.

Gallaway (2000) reported that the VERA was conducted as part of the routine annual health and vision screenings; and as the visual skills screenings for children underperforming and exhibiting behaviors suggesting a vision problem. The VERA became part of the Pupil Assistance Committee and Child Study Team process for those children who exhibited learning related vision problems, or frequent visits to the nurse with headaches or other vision related symptoms. Teachers also used the checklists and surveys as a guide during the referral process. The checklist consists of items in four areas. An example of an item is included for each area: Visual (difficulty with or avoidance of tasks requiring concentration, memory, reading or problem solving); Visual Motor (complains of words and letter jumping around); Reading/Language (omits words/letters when reading or writing); Attention (trouble remembering or relating to material that is read); and an area for comments. This article did not report academic data, only anecdotal information as reported by the principal of the school. Future studies might include the change in the percentage of children referred to special education, and/or the academic improvement pre and post vision therapy. That may be difficult as a child having academic difficulty would most likely have received interventions (Atzmon, Nemet, Ishay & Karni, 1993). Future studies may also consider using the checklist provided in the study to measure teachers' awareness and skills addressing goal setting and interventions for those children experiencing difficulties in the classroom.

Comprehensive Eye Exam
When a child has a comprehensive vision and eye exam a child’s visual system, child’s
visual development, the general health of the child’s eyes, and refraction abilities are examined. Other visual systems included in the assessment are the child’s ability to move their eyes, and their vergence and accommodative abilities. Whenever a child is referred for a comprehensive vision and eye exam, perhaps due to vision-related learning problem to an eye doctor, it is important to know child development to determine age appropriate skills and abilities. Of course, during a comprehensive evaluation, a thorough developmental history to gather information about general health, medical history, developmental milestones, family eye health and history is completed (Cotter & Barnhardt, 2006; Solan, 2006). An interview with the child would allow the examiner to learn how the child feels about him/herself. A child's self-esteem and how they interact with others and their environment may be the result of a deficiency, whether it is a learning disability or a vision disorder (Kavner, 1985).

Visual acuity is important to assess to evaluate visual perceptual measures, facial recognition, visual scanning and spatial relationships in other assessments (Skeel, Nagra, VanVoorst & Olson, 2003). This study revealed the majority of the study’s participants did not accurately know their visual acuity skills. Visual acuity testing would ensure accurate measures when measuring central nervous system function, for example, neuropsychological assessments. As indicated in their study, it is important to know the degree of visual abilities when testing or evaluating an individual in which visual acuity is required. The findings from the study suggested the possibility to attribute low scores from an evaluation/testing to dysfunctions in the central nervous system, when the low scores may actually be attributed to deficient visual acuity.

**Vision Processes**
The development of visual processing is one of a rapid rate from infancy, then gradually decreases as the child gets older, leveling off somewhat in one’s teens. It is important for the clinician to understand the development of visual processing when determining the skills a child demonstrates with his same age peers, as deficits may be identified incorrectly due to age and the stage of development for that age group. Visual processing, perception, includes the function of one’s eye and what one’s choses to see, using cognitive abilities to integrate information from the environment through our senses. (Borsting, 2006).

Perception includes life experiences, and the interpretation of those experiences. Visual perception skills are developed through exploring the environment, through trial and error, to learn about spatial relationships and one’s spatial relationship to objects and space (Blankenship, 1971). Perception includes the other senses, so a child learns where their body is in relationship to space. Due to the amount of information in our environment, one cannot possibly attend to all of the information; therefore, one must be selective in the selecting information. The more experience a child has acquiring perceptual experiences, and the better they become attending to their environment, they may expand attention and their selection to a larger canvas in their environment. From these expanded experiences, a child creates a toolbox of sorts from which to draw upon, and associations are made more freely. In addition to learning from the experiences, problem-solving abilities are formed. The ability to associate a less familiar object...
with one that is familiar comes to mind more easily. The visual perception process involves one to be an active participant in their environment. Motivation plays a key role in the process (Blankenship, 1971).

Visual motor integration is the ability to integrate both the motor system with the visual system. When assessing the visual motor integration system, one is interested in how the two systems work together. The ability to have a visual stimuli and a motor response in a timely manner is important to visual-motor tasks. Visual motor integration is used for handwriting, copying, playing with toys, building towers with blocks and playing sports (Bortsing, 2006).

Visual spatial skills help organize the environment; up and down, back and forth, and right and left. Laterality is the term when describing the left and right sides of the body. Directionality is used in reference to the organization of an external visual space. To fully assess a child’s ability to determine visual spatial skills, one must keep in mind the developmental stage of the child. A child may demonstrate their ability to determine the left and right sides of their body first, however, they will have difficulty correctly identifying the correct right and left sides of another person standing across from them. The ability to identify the correct sides of their body and another person’s body are more stable at approximately eight years old (Borsting, 2006).

Visual analysis consists of a group of skills that are used to store and manipulate visual information. The ability to recognize and recall visual information is important when determining what is familiar, what is the same, what is different, and how do objects compare to each other. It is important to recognize different forms and the details of the form/object. Important details may include color, shape, size and patterns (Borsting, 2006).

Visual attention is considered the process in which a child attends to some things and ignores others (Bortsing, 2006). Paying attention requires action; it is an active process. Visual attention is an important action to perceiving one’s environment. Richman (2006) lists aspects to visual attention as arousal/activation, sustained attention/vigilance/alertness, effort, alertness, selectivity, central processing capacity and automaticity. Richman lists the areas of the brain that have roles in visual attention as the posterior parietal cortex, frontal lobes, cerebellum and superior colliculus. Visual attention is described as, but is not limited to, engaging and activating attention to a target of interest; directing/orienting attention to specific location in the field; locking attention on that location; suppressing irrelevant information from other locations. Visual attention also requires maintenance of attention, knowing how to sustain attention and when to disengage attention, as well as knowing how to shift attention. Planning and execution of eye movements are important as jerky eye movements may interrupt cognitive processing (Steinman and Steinman, 2005).

Researchers have studied the effects of the two visual pathways; the magnocellular pathway (M-cell) which is a motion detecting subsystem activated when reading; and the parvocellular pathway (P-cell) which when activated extracts text details. The magnocellular system may be responsible for spatial localization, depth perception, hyperacuity, figural grouping, illusory border perception, and figure/ground segregation (Livingstone,
Rosen, Drislane & Galaburda, 1991). The structures involved in the magnocellular system are the retina, lateral geniculate nucleus of the thalamus and occipital lobe (Feifer & De Fina, 2000; Trachtman, 2006). Deficiencies in the M-cell function may have a basis in reading disabilities (Skottun & Parke, 1999; Solan, Shelley-Tremblay, Hanson & Larson, 2007; Solan et al., 2004). Both systems must work in sync with each other when reading (Solan, 2006). If they do not, it is suggested there is interference in what one sees and reduction in the efficiency of the oculomotor function.

Visual memory assists in being able to picture something in your mind and recalling details. There are several types of memory, sequential memory, long and short-term memory, procedural memory, episodic memory, factual memory, automatic memory and working memory. There are different variables that may cause problems with anyone of the different types of memory. One must be able to stay focused, attend, retrieve information from storage, and hold information for the moment, for example a phone number (Selznick & Blaskey, 2006). Evaluating a child’s memory is important to determine if there are memory deficits with a child’s visual skills, or if there are deficits across modalities.

Vision Disorders
The following are some of the more common vision disorders in less clinical terms, easier for teachers and parents to recognize. The vision disorder Amblyopia (lazy eye) is the reduction of vision in the eye; this condition may be difficult to detect and glasses may not resolve the condition. Myopia is the condition of nearsightedness. This would affect a child seeing the blackboard in a classroom; however, reading close up is not as affected with this condition. This condition may be easy to detect with a visual acuity screening. On the other hand, if a child were farsighted, Hyperopia, it has been suggested they may be able to pass a visual acuity screening and the condition may go undetected (Cook, 2004).

The combination of both disorders is the condition Astigmatism. A child has trouble with both far and near vision. The ability to shift from one distance to another clearly is referred to as accommodation. This ability to shift focus near (desk) to far (blackboard) is required for effective visual functioning in the classroom. When both are focused and eye movement is coordinated inward, this is referred to as convergence (Rouse et al., 2000; College of Optometrists in Vision Development, 2001). Double vision occurs when both eyes are not aimed at the same target. Each eye sends information to the brain, and when the image is not a single composite image, it causes distraction and confusion. Inefficient eye movements may cause a child to lose their place while reading, as they see with both their central and peripheral vision (Cook, 2004; Borsting et al., 1999).

Convergence Insufficiency (CI) is a common binocular vision disorder (Scheiman, Cotter et al., 2006). CI is reportedly prevalent within the school age population. Additionally, an accommodation insufficiency may be present, creating a co-morbid condition (Marran, DeLand & Nguyen, 2006). When there is a deficiency in the convergence ability this may cause headaches, fatigue, eye soreness and double vision (Borsting, Rouse, DeLand & CIRS, 1999; Rouse et al., 2009). Additionally, CI reportedly contributes to distractibility, frustration and
attention problems (Borsting et al., 1999). These conditions may contribute to slow reading and difficulty with reading comprehension.

There may be higher incidences of Attention Deficit Hyperactivity Attention Disorder (ADHD) among those diagnosed with CI (Granet, Gomi, Ventura & Miller-Scholte, 2005). The authors analyzed and reviewed 266 patients diagnosed with Convergence Insufficiencies (CI). The study revealed 15.9% of those children diagnosed with CI also had ADHD. Rouse et al (2009) indicated that children with CI and parent reported ADHD, had higher scores as measured by the Academic Behavior Survey (ABS), indicating more difficulty with a child's behaviors in the last month, than those children with CI and without parent reported ADHD, or as compared to those children with normal binocular vision (NBV).

**Summary**

There is a national incentive to improve vision awareness and the importance of vision health (American Association for Pediatric Ophthalmology and Strabismus, 2013). The U. S. Department of Health and Human Services recommended a strategy to provide universal vision screening to children before entering school. Studies have indicated at-risk populations for undetected vision deficits. The results from undetected vision issues may contribute to poor academic achievement (Basch, 2000). The early detection of a vision deficiency and/or learning disabilities is important. Research indicates the effectiveness of early interventions to address any disability. There are many professionals, medical and educational, to aid in the remediation of learning disabilities and/or vision deficiencies (Garzia et al., 2008). Visual acuity and optimal visual functions are important for school success. Vision screenings are often administered using a Snellen Chart assessing one’s visual acuity from 20’ using one eye at a time (Cook, 2004). Symptoms that may indicate functional visual deficits may include double vision, blurriness, fatigue, headaches, burning eyes, difficulty sustaining attention, which may interfere with reading fluency and distract from reading comprehension. The inability to sustain attention and focus may look like characteristics of those persons who have Attention Deficit Hyperactivity Disorder (ADHD) (Borsting et al., 1999). Vision screenings that include more methods and instruments to assess more than visual acuity may detect deficiencies early on and allow early interventions that may include working with a vision eye care professional, in addition to developing school-based interventions (Garzia et al., 2008).

Brodney, Kehoe, and Sinha (2000) showed the effectiveness of computer software in the improvement of words read per minute by those children who needed and participated in vision therapy. Solan et al (2004) reported increases in reading comprehension scores after 15 therapy sessions. Included in the sessions was executive function support, self-monitoring and encouragement from vision therapist. Schools have also incorporated the VERA program and have trained school personnel to administer the assessments to children as their annual vision screening and for those who exhibit problems with their vision within the classroom. There are standardized, direct and indirect forms of assessments available to those members of an interdisciplinary team to address the individual's needs to determine the best interventions and goal setting (AOA, 2006; Kulp & Schmidt, 1995).

Parents, teachers and other professionals seek the expertise of optometrists to evaluate, diagnose, and treat visual problems
that may contribute to learning problems. As indicated in the AOA guidelines (Garzia et al., 2003), optometrists are members of multi-disciplinary teams both health and educational, as part of a comprehensive approach to caring for individuals with learning problems. The goal of interventions by optometrists is to improve visual functions and to reduce the symptoms associated with vision deficiencies. The intervention of an optometrist is one of many interventions to help those with learning issues. There are studies and anecdotal evidence in support of the effectiveness of vision therapy, especially in the area of reducing convergence insufficiency symptoms (Atzmon, Nemet, Ishay, & Karni, 1993; Borsting, et al., 2002).

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