THE RELATIONSHIP BETWEEN VISUAL-MOTOR INTEGRATION AND READING ACHIEVEMENT IN STUDENTS IN FIRST THROUGH THIRD GRADE

A Dissertation Presented to the
Faculty of the College of Education
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In Partial Fulfillment
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Doctor of Education

by

Turquessa P. Francis

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Abstract

A student’s ability to read grade level material allows for optimal performance with all other subjects. A large component of a student’s ability to be a successful reader involves visual skills. Though there is an understanding of the importance of visual acuity, the ability to see visual stimuli, there is less of an understanding of the importance of visual information processing skills, namely visual-motor integration skills, on a student’s reading ability. Visual-motor integration utilizes visual information processing skills to process and interpret visual stimuli for a student to read. This can include the ability to determine the orientation of letters, the spacing of words, maintenance of line orientation when reading, and to understand the relationship between letters and words. In this study, the relationship between visual-motor integration skills and reading achievement was investigated in students from first through third grade in two private elementary schools [School A with 77 students in the sample and School B with 20 students in the sample], located in a metropolitan city. To determine the students’ visual-motor integration skills, the *Beery-Buktenica Developmental Test of Visual-Motor Integration (Beery VMI)*, 6th edition was administered to determine a student’s visual-motor integration skills. Reading achievement was determined using teacher administered annual reading assessments, *STAR Reading Assessment*, *Reading A-Z*, and *Fountas and Pinnell Benchmark Assessment System*. The purpose of this study was to determine: (1) whether there is a relationship between visual-motor integration skills and reading achievement; (2) the relationship between visual-motor integration and reading

achievement across each individual grade; and (3) the relationship between gender and visual-motor integration skills.

In School A results indicated (1) a statistically significant correlation between visual-motor integration skills and reading ability (r=.54, p<0.01); (2) a positive, non-statistically significant relationship between visual-motor integration and reading ability in participants in 1st grade (r=.33, N=26, ns); (3) a statistically significant correlation between visual-motor integration skills and reading ability in the 2nd and 3rd grade, where the strongest correlation was seen in the third grade (2nd grade r=.487, N=27, p<0.01and 3rd grade r=.49, N=24, p<0.05) and (4) a non-statistically significant relationship between visual-motor integration skills and gender [F (1,75)=.090, ns]. In school B, results indicated a small, but non-significant correlation (r=.29, N=20, ns) between visual-motor skills and reading achievement.

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Chapter I

Introduction

Background

A student's ability to read grade level material allows for optimal performance with all other academic subjects--from subjects that involve primarily reading such as social studies, to other subjects such as math where word problems can become verbally complex as the grade levels increase. Poor readers lag behind in vocabulary development and in reading comprehension, making the task of reading difficult with subsequent negative effects on academic achievement (Cunningham and Stanovich, 1998; Lyons, 2003).

A student not being able to read grade level materials has far reaching effects well into high school, where decreased reading skills leave students at risk for dropping out and/or not continuing into college. Of the 10 to 15% of children who will eventually drop out of school, more than 75% will report difficulties learning to read (Lyons, 2003). This lack of a strong educational background has far reaching effects, limiting a student's success in their community, with respect to employment, financial stability, and general well-being (Zaba, 2001). With those ramifications, it becomes pivotal to look at the whole child when determining a child's reading ability. This includes not only the primary factors in reading achievement, but also, secondary factors such as their visual abilities, namely visual perceptual skills, specifically visual-motor integration abilities.

Difficulty with reading can occur, because of physiological reasons, namely optimal functioning of the visual system (Garzia, Bersting, Nicholson, Press, Scheiman, & Solan, 2008; Lane, 2005). Though there is an understanding of the need for visual skills for optimal reading, the main focus on visual skills lies primarily with visual acuity-the resolving power of the eye or the ability to see. But, there are additional visual skills that are necessary for a student to read beyond being able to see the words and these skills are as equally important as visual acuity in ensuring student success with reading tasks. An important component of reading is optimal visual information processing skills (Lane, 2005; Massaro & Sanocki, 1993; Vernon, 1971). This includes visual spatial ability, visual perceptual skills, and visual-motor integration skills. These skills allow students to perform tasks such as reading from left to right, staying on the line while reading, determining the orientation and spacing of letters to properly perceive words (Lane, 2005; Massaro & Sanocki, 1993). Visual acuity skills are important to view visual stimuli while visual information processing skills are equally as important to correctly interpret the information that is seen to perform the complex task of reading.

Visual information processing skills includes visual-motor integration ability, where visual-motor integration is a higher level skill which requires a combination of many of the visual information processing skills of the visual system. A general definition of visual motor integration skills is “an individual’s ability to integrate information processing skills with motor movement” (Scheiman, 2002, p. 96). Another term that is used for visual-motor integration is eye-hand coordination. Research has shown that optimal visual-motor integration skills are correlated with reading ability (Kulp, 1999; Maples, 2003; Son & Meisels, 2006). The visual-motor ability of a student has been shown to be one of the best predictors of reading achievement in first through third grades (Tramontana, Hooper, & Selzer, 1988). Therefore, understanding a student's visual-motor integration abilities can assist educators in accurately determining reasons for a student's decreased reading skills and provide appropriate intervention to address the specific problem areas. With such an important relationship between visual-motor integration skills and academic achievement, it becomes important to establish consistent correlation visual-motor integration and reading ability.

Research has pointed to a relationship between visual-motor integration and reading ability (Kulp, 1999; Maples, 2003; Son & Meisels, 2006). However, the determination of a student's reading ability is established using standardized testing that test general reading ability rather than assessments that are utilized on a more specific level within a school system.

This lack of a more school-specific reading assessment is seen in the study of researchers such as Sortor & Kulp (2003) who sought to determine whether there was a correlation between the scores on the *Beery VMI* and achievement tests where the focus was not primarily on reading district level books, but on a student's performance on the *Otis-Lennon School Ability Test* and *Stanford Achievement Test.* Therefore, the results did not directly measure a student's performance with school-specific, grade-level reading texts. Rather, their performance on reading was obtained using a general testing instrument that did not assess a student's performance in the classroom with assessment measures that were directly taught and utilized in the classroom. It is important when assessing a student's reading ability to use instruments that are directly utilized in the classroom to ensure that they are being assessed with measures with which they are trained on, which will be a more valid measure of their ability.

Other studies look at the role of visual-motor integration on other academic performance factors such as writing and the role in academic achievement. Barnhardt, Borsting, Deland, Pham, & Vu (2005) researched the relationship between visual-motor integration skills and spatial organization of written language and math where results indicated that students with decreased visual-motor integration skills made more errors when writing and copying items. Therefore, the main focus was not on reading achievement, but copying and math performance.

The importance of the visual perceptual factors that ensure visual-motor integration performance has been punctuated by studies that show: (1) the detrimental effects on student success when visual information processing deficits are not addressed, thereby affecting not only student performance, but also long-term community success (Zaba, 2001) and (2) the positive effects of vision therapy on improving the reading ability of students with visual information processing deficits (Birnbaum, 1993; Brodney, Mallinson, & Kehoe, 2001; Sigler & Wylie, 1994). Therefore, the need to determine the specific relationship between visual-motor integration skills and reading achievement is important in providing knowledge to teachers and administrators to guide teacher practice.

The relationship between visual-motor integration visual information processing. Visual-motor integration is a skill that utilizes many of the components within the more comprehensive area of visual information processing skills. Visual information processing skills refers to "a group of visual cognitive skills used for extracting and organizing visual information from the environment and integrating this information with other sensory modalities and higher cognitive functions" (Scheiman, 2011, p. 79). Visual information processing skills are divided into three components: visual spatial, visual analysis, and visual motor.

Specifically defined, visual-motor integration skills are related to an individual's ability to integrate visual information processing skills with fine motor movement. Therefore, visual-motor integration ability is a representation of the capacity of an individual to adequately perform many of the components of visual information processing skills such as visual spatial ability and visual analysis. Issues that are noted with the performance of visual-motor integration tasks can be attributed to deficits in an individual's ability to perform other components of visual information processing skills. Therefore, the relationship between visual information processing skills and visual-motor integration skills is one where deficits in other areas of visual information processing skills can have a direct impact on visual-motor integration skills and performance of perceptual tasks such as reading.

Visual information processing deficits effect on student success

In the 1990s, evaluation of students found significant numbers in an academic and behavioral at-risk population have undetected and untreated visual problems (Zaba, 2001). Johnson, Nottingham, Stratton, and Zaba (1996) found an 85% failure rate on one or more subtests on a comprehensive vision screening performed in elementary, middle, and high school populations. The tests performed were not just distance acuity tests; also included was testing that measured visual information processing skills such as tracking, convergence, and visual-motor ability. The pattern of decreased academic and community success due to visual deficits was mirrored with a study completed in 1999 that indicated that 74% of a population of adjudicated adolescents failed at least one of the sub tests utilized to screen for vision problems (National PTA Resolution, 1999). The authors pointed to the lack of efficacy of other interventional measures such as psychological, educational, and vocational treatments as the main issue where vision problems were not being addressed. Finally, research looking at Title I students found that 85% of the Title I students who were evaluated failed at least one subtest of the comprehensive vision screening battery (Johnson, Blair, & Zaba, 2000). Specifically, the Title I students had a much higher failure rate on tracking, convergence, and visual motor-integration tests. The end result of inadequate assessment and lack of intervention may lead students who struggle with reading due to visual deficits to become school dropouts, juvenile offenders, and/or illiterate adults (Zaba, 2001). In addition to the long-term ramifications of not addressing visual deficits, there is the more positive aspect of improvement of visual information processing skills deficits with vision therapy.

Visual information processing intervention

Studies have shown that ophthalmic intervention, including focusing on increasing skills such as visual-motor integration in the elementary school years has the ability to increase reading achievement (Birnbaum, 1993; Brodney , Mallinson, & Kehoe, 2001; Sigler & Wylie, 1994). Results have been found to increase reading rate, tracking, and visual-motor integration skills (Tzuriel & Eiboshitz, 1992). Therefore, it is important to determine a student's vision needs and address them with appropriate intervention which can ultimately result in increasing the student's reading achievement, thereby increasing their chances of academic success.

The results of this study can help determine the relationship between visual-motor integration skills and reading levels, specifically using school-specific, grade-level reading texts, which can allow educators to understand the visual information processing skills, namely visual-motor integration skills, that are important during reading assessment tests. This understanding can guide methods of intervention when it is determined that a student's reading disability is related to visual information processing deficits. Intervention can also include educators contacting the appropriate specialists within the academic environment and the outside community to address the needs of the student.

Statement of the Problem

The focus on reading in the current academic climate. With the passage of the *No Child Left Behind Act of 2001* (No Child Left Behind [NCLB], 2002) assessment has been catapulted to the forefront of education with an intense focus on standardized tests that focus on major academic subjects, including reading. With the *NCLB Act of 2001*, there was a creation of assessments in each state that measured a child's abilities in reading, with student test achievement tied directly to state funding of educational institutions. In addition, the NCLB Act of 2001 stipulated that all students in all states were expected to be proficient in reading by the end of the third grade by 2013-2014 (Dillion, 2011). As of 2011, based on a comprehensive study by the National Center for Education Statistics, only one-third of students performed at or above the *Proficient* level, falling far short from expectations (National Center for Education Statistics, 2011). The implications for optimal student achievement are at an all-time high. Therefore, educators having an understanding of deterrents to optimal reading achievement are paramount in the current educational climate.

In addition to assessment, successful reading also has implications for other subjects and future academic success. A student's ability to read grade level material allows for optimal performance with all other academic subjects--from subjects that involve primarily reading such as social studies, to other subjects such as math where word problems can become verbally complex as the grade levels increase. Poor readers lag behind in vocabulary development and in reading comprehension, making the task of reading difficult with subsequent negative effects on academic achievement (Lyons, 2003).

The consequences for children who do not learn to read in the early grades have been well documented. As noted previously, the implications for the future include dropping out of school, which greatly affects employment and quality of life prospects in the future. Juel (1988) reported that 88% of the children who scored in the lowest quartile in reading comprehension at the end of first grade remained below the 50th percentile at the end of fourth grade indicating that reading deficits continue throughout a child's academic career. Further longitudinal studies point to evidence that children who are poor readers at the end of first grade are at risk for not acquiring average-level reading skills during the remainder of their elementary school education (Francis, Shaywitz, Stuebing, Shaywitz, & Fletcher 1996; Torgesen & Burgess 1998).

A student not being able to read grade level materials has far reaching effects well into high school, where decreased reading skills leave students at risk for dropping out and/or not continuing into college (Lyons, 2003). With those ramifications, it becomes pivotal to understand the factors that affect reading success is pivotal. One factor that is important in reading success is teacher instruction (Lose, 2007). With so many contingents upon a child's reading ability, the need to understand reading, intervention, and teacher's role in the efficacy of a reading assessment and intervention is pivotal to quality instruction. As part of understanding the whole child, teachers must understand the physiological components of reading that go beyond the child's ability to see text and understand the visual-perceptual deficits that affect reading. Having this understanding will provide teachers with the knowledge to intervene as needed or to contact the necessary individuals outside the classroom to address the visual-perceptual needs of the student to increase visual-motor integration skills, and eventually reading ability.

Teachers' understanding of the role of visual processes on reading. Research has indicated that teachers have large amounts of misconceptions of the role of vision on the reading ability of children (Jones, Stilley, Bither, & Round, 2005). In addition to being unaware, teachers also indicated that they felt underprepared to provide intervention to students with reading deficits. When considering the question of "*how much of your college curriculum dealt with vision and its impact on reading ability*," close to half of the respondents felt there was no part of their education that dealt with this area.

The elementary educators did recognize some of the signs and symptoms of learning-related visual problems; however, they apparently lacked an adequate educational foundation to appreciate how academically devastating such problems might become to the child. The results point to the need for organized professional teacher education courses about visually related learning problems should be developed and integrated into the teachers' core curriculum. During their professional education, teachers should be taught that vision is an essential factor in struggling readers, rather than gaining this information after they have been teaching for a while (Jones, et al., 2005).

Purpose of the Study

The purpose of this study was to determine the relationship between students' visual-motor integration skills as determined by results from the *Beery-Buktenica Developmental Test of Visual Motor Integration Test* (*Beery VMI*), *Sixth* edition and the child's reading level as assessed by using the reading assessment system in two private schools located in a metropolitan area. Through the analysis of results of students in first through third grade, it can be established whether there is a relationship between visual motor-integration skills and reading ability. The results of this study can be used to add to educators' understanding of the skills necessary to be able to read and provide any necessary intervention or modifications to ensure academic success.

Significance of Study

Reading is a skill that begins in toddlerhood and continues throughout a child's academic career. The foundation of reading is determined by a student's ability to display skills such as phonological awareness, phonological decoding, naming speed, orthographic processing, morphological awareness, and vocabulary (Kirby, Desrochers, Roth, & Lai, 2008). However, there are other components to reading that are not readily apparent in the academic community, namely visual-motor integration skills. With the evidence of the relationship between reading and visual-motor integration, it becomes important to realize the importance of intervention to improve visual-motor integration skills when deficits are affecting reading ability (Shin, Park, & Maples, 2010; Sigler & Wylie, 1994)

Studies have pointed to the efficacy of vision therapy on improving visual perceptual skills, including visual-motor integration skills, with a resultant positive effect on academic skills, namely reading ability (Brodney, et al., 2010). Research has pointed to the neuroplasticity of the young brain (Huang, 2009) as an indicator for utilization of vision therapy. The implementation of a systematic intervention over a period of time can aid in increasing synaptic connections in the brain with creation of novel neural pathways that aid in reading achievement despite any neurological deficits (Huang, 2009). In addition to forming novel neural pathways, there is also the general efficacy of vision therapy has been noted to not only improve the underlying visual skill deficit, but also improve reading ability (Brodney, et al., 2010; Shin et al., 2011). Overall, establishing the relationship between visual-motor integration skills and reading achievement using leveled reading texts will assist with cementing the importance of these skills in reading. This knowledge will assist teaching staff to understand the role of visual-motor integration in reading and provide teachers with knowledge of appropriate intervention options to benefit children who are struggling to read due to poor visual-motor integration skills.

Research Questions and Hypotheses

The importance of visual-motor integration cannot be overstated when analyzing a student's reading ability. Research has shown visual-motor skills as one of the best predictors of reading achievement in first through third grades (Tramontana, et. al, 1988). However, these research studies (Kulp, 1999; Maples, 2003) utilized assessment methods that did not directly evaluate a child's reading skills by utilizing assessment methods that were used by school districts. Rather, standardized assessments and measures formulated by the researchers were utilized. An important component of providing reading intervention is to have an accurate and valid assessment of a child's reading ability. Utilizing an assessment tool that is employed by a school has the ability to garner information that is a better measure of reading skills that are lacking within the classroom, in addition to assessing specific school district reading standards. With that in mind, the following questions guiding this study were:

(1) What is the relationship between visual-motor integration skills and reading achievement?

Hypothesis: There will be a positive correlation between a student's visual-motor integration skills and reading achievement. Therefore, students who display visual-motor skills deficits will display poorer reading skills than their peers who display higher level visual-motor integration skills.

(2) What is the relationship between visual-motor integration skills and reading achievement at each grade level?

Hypothesis: The relationship between visual-motor integration skills and reading achievement will be maintained first, second and third grade, where there will be statistically significant positive correlations between visual-motor integration skills and reading achievement. The strongest correlation will be seen in the first grade.

(3) What is the relationship between gender and visual-motor integration skills?

Hypothesis: Females will have higher visual-motor integration skills when compared to males.

Chapter II

Review of Literature

Visual System

To understand visual-motor integration, it is important to understand how the visual system functions for an individual to not only see, but also interpret what they are viewing. Vision requires coordination of the visual system consisting of both eyes and their parts and the neurological system, mainly the visual cortex (Hubel, 1995). The eye obtains information from the outside environment and that information travels through the structures of the eye. Information is brought to the brain via the optic nerves, where the brain interprets that information and the visual process occurs. The human eye and its structures work to view all aspects of one's environment. Important structures to note are the cornea, retina, lens, fovea, optic nerve, and the muscles (lateral rectus and medial rectus) in following the path of how an object is seen. For an individual to see, "Light reflected from an object passes through the cornea of the eye, moves through the lens which focuses it, and then reaches the retina at the very back where it meets with a thin layer of color-sensitive cells called the rods and cones. Because the light criss-crosses while going through the cornea, the retina "sees" the image upside down. The brain then "reads" the image right-side up." (Spectrum Eye Institute, 2012).

The second component of visual processing involves the brain. The part of the brain known for processing visual information is known as the visual cortex. The visual cortex system is located in the back of the brain, known as the occipital region. The second part of the visual cortex is the eyes and its structures. The eye works to view the environment, while the neurological region in the occipital area of the brain works to process what is seen. Therefore, the process to focus on an image is a complex one that requires high levels of coordination between two physiological systems. If at any point in the process there is miscommunication between the systems, the ability to see and perceive items will be affected. In this case, the ability to read will be affected.

Visual system and the process of reading

Reading is one of the most difficult functions the human brain has to complete. As mentioned before, the visual cortex in the brain works with the structures of the eye to interpret information such as words. Vision begins with the structures of the eye viewing the information and bringing that information via the optic nerve to the brain where it is interpreted. Reading involves a multitude of functions physiologically involving the visual and neurological systems. It begins with the eye muscles functioning properly to move in the vertical and horizontal plane to actually encode the words. Lester Krueger's study (1993) noted that encoding allows the brain to form a visual or nonvisual code of the word and place it in working memory. After encoding visual information, decoding occurs, where the letter components are accessed and compared against target letters in memory and the word is remembered. Therefore, the ability to move both eyes is the initial part of the reading process affecting the second part of the reading process, interpretation of material viewed.

There are two important functions of the visual system that are related to reading, saccades (quick movements of the eye) and fixation (pause to take in visual information). Research has shown that there are physiological pathways that are affected with students with reading difficulties, both of which are related to saccades and fixations. These pathways consists of M (magnocellular) and P (parvocellular) cells that work to move the eye in a sequential manner and then stop the eye to take in visual information, employing saccades and fixations mentioned previously to read information. Deficits in these structures have been found to affect the reading ability of students.

M (magnocellular) and P (parvocellular) pathways and reading

One key process that occurs within the visual system occurs in the retina and is an important component of reading. This process involves the parvocellular (P cells) and magnocellular (M cells) pathways. These two pathways work together to ensure that an individual can read, whereby, as one system works to move the eye along (saccades), the other works to fixate on forms for a long enough period of time to allow for processing of visual information.

These two parallel visual subsystems operate from the retina to the visual cortex to allow for viewing and subsequent interpretation of information from the environment (Lane, 2005). The first system, the magnocellular (M cells) pathway is the transient system and the other, the parvocellular (P cells) is called the sustained system. The two subsystems originate in the retinal ganglion cells of the eye's retina. It is important to understand how these subsystems operate because they are important in reading. Two terms that are important with these systems are saccades and fixation. Lane (2005) encapsulated the relationship of these two terms with vision, noting, "The eyes move across the page in a series of quick movements called saccades and pause to take in visual information called fixations" (p. 14). Retinal images, in this case words that are being viewed, are sampled first by the transient (M cells) and then by the sustained system (P cells). They are first sampled by the transient system to get the general view of an object or an upcoming word on paper. They are then sampled again by the sustained system to obtain detailed information from the word. Therefore, the two systems work together where the sustained system first takes in visual information on a global level and the transient system goes further and takes in the fine detail of what is seen to interpret the information that is seen.

This is further explained by Breitmeyer (1993) who noted:

> "Efficient pick-up of visual information during reading would depend, for one, on a properly functioning sustained system that processes the form or pattern content during a fixation. Additionally, it would depend on a properly functioning transient system whose saccadeproduced activity provides a basis for saccadic suppression. Deficits in either system could thus contribute to visual problems with reading. With regard to such problems, the sustained/transient approach has proven useful in the study of dyslexia and specific reading disability (SRD)." (p. 104).

Research has pointed to the role of the M cells and P cells pathways in reading disability. Through the usage of psychophysical studies of phenomena such as visual persistence, flicker sensitivity, temporal order judgments, and meta-contrast, transient-channel deficit (M-cells) have been found in about 70% to 80% of children with Specific Reading Disability (SRD) children (Breitmeyer, 1993). One important consequence of a transient-channel deficit and, consequently, of a deficit in the transient-sustained inhibition in specific reading disability would be a weakened saccadic suppression. This is important because the two systems of saccades and fixations work together to complete the process of reading. Breitmeyer (1993) noted, "This saccadic suppression would result in a partial temporal overlap, rather than a clear temporal segregation, of successive frames of retinotopic sustained activity from successive fixations" (p. 104). The lack of segregation in the performance of eye-movement (saccades) and eye fixations (fixations) contributes to poor reading. Instead of a system where the eyes move to see information and then stops to interpret information, the eye is able to move to take in the data, but is unable to fixate to interpret the data. Transient deficit hypothesis suggests that a weak transient channel can adversely affect the two systems combining properly during reading. A sluggish transient channel may cause a superimposition of letters, causing the child with specific reading disability to see letters that appear to overlap (Lovegrove, 1993).

Further studies pointed to the relationship between deficits in the M and P Pathways and the effect on visual perceptual skills. Matin (1974), found that transient-channel deficits affected the retinal image smear during saccades by preventing perception of forms and words. Festinger and Holtzman (1978) pointed to the relationship between retinal smear and visual processing noting, "...the absence of normal retinal smear during a saccade increases the uncertainty in the information available to the perceptual system and that this uncertainty results in a tendency to perceive smaller than veridical amounts of movement" (p.573). Optimal functioning of the M and P pathways is important in maintaining constancy of visual direction and a stable visual world despite continual retinal image shifts while scanning the environment. Thus a transient deficit in Specific Reading Disability also could be associated with increased retinal image smear, loss of visual direction constancy, and instability of the visual world.

The neurological differences seen in children with reading deficits points to a system where there are physiological reasons that affect a child's visual perceptual skills and ultimately their reading ability. Therefore, the physiological structures cannot be altered. However, intervention can be implemented to increase an individual's functional ability with the deficits that are present. Breitmeyer (1993) noted, "…visual deficits in SRD are due to neural abnormalities that cannot be corrected and therefore may not be directly amenable to treatment. Even if the neural problems underlying the perceptual deficits cannot be treated, there is reason to be optimistic about devising treatment techniques that will alleviate the attendant perceptual deficits" (p. 105). Therefore, addressing the visual perceptual deficits of an individual with intervention strategies can provide the individual with an opportunity to improve reading ability. With an understanding of the pathways that function to take in and interpret visual information for reading, it becomes important to understand the higher level cognitive skills that are necessary to interpret information to complete the process of reading, which includes visual-motor integration skills, which are an important component of visual information processing skills.

Visual information processing skills and visual-motor integration

To appreciate the definition of visual-motor integration, it is important to comprehend visual information processing skills otherwise known as visual perceptual skills. When we think of vision, we tend to think of visual acuity, the ability to clearly see forms without refractive assistance. However, an individual's ability to participate in higher level tasks such as copying forms occurs with their visual perceptual skills and not solely with their visual acuity ability.

Visual information processing skills involves being able to, "analyze, interpret, and make use of incoming visual information in order to interact with the environment" (Scheiman, 2011, p.79). Visual information processing refers to cognitive skills that extracts and organizes visual information from the outside environment and integrates this information with sensory stimuli and higher cognitive functions (Scheiman, 2011). Other terms that have been used to describe similar skills include visual perception, visual-perceptual motor, and visual processing. It is important to note with these skills is the need for the combination of vision and cognition to interpret and act on incoming visual information rather than solely utilizing vision to complete a task.

Visual processing is made up of many components that allow an individual to successfully interpret incoming environmental stimuli. One of these component skills is visual motor integration. Garzia, et al., (2008) noted:

> "Visual-motor integration (or visually guided motor response) is the ability to integrate visual information processing with fine motor movements and to translate abstract visual information into an equivalent fine motor activity, typically the fine motor activity of the hand in copying and writing. Visual-motor integration involves three individual processes: visual analysis of the stimulus, fine-motor control (or eye-hand coordination), and visual conceptualization, which includes the integration process itself" (p. 14).

Another term that is used for visual-motor integration is eye-hand coordination.

On a motoric level, visual-motor integration skills can be seen with the task of catching a ball. The motor component of the task is apparent where one must catch the ball. However, the skills necessary to perform the task is more involved than reaching out and catching the ball. The skills needed to catch a ball also require visual spatial skills. Visual spatial skills allow the individual to "make judgments about location of objects in visual space in reference to other objects and to the individual's own body" (Scheiman, 2011). Components needed to complete a visual spatial task include bilateral integration, laterality, and directionality (Scheiman, 2011). Bilateral integration is the ability to utilize both sides of the body separately and simultaneously. The ability to perform these skills indicates that the left and right hemispheres of the brain are communicating optimally. Laterality is the ability to differentiate between left and right. Directionality is the ability to interpret left and right in the external environment. In the example of catching a ball, the individual must have display adequate visual spatial skills to catch the ball. The individual must determine whether the ball is coming from the left or right side (laterality) and must display adequate bilateral coordination where both sides of the body work together (bilateral coordination) to move in a manner that will allow the individual to catch the ball. What is important to understand about visual-motor integration is that the components that allow an individual to complete a visual-motor task involve many visual information processing skills. Therefore, having an understanding of an individual's visual-motor integration skills can provide information on other perceptual abilities. To appreciate the role of visual information processing in reading, it is important to understand the theoretical background behind the importance of and development of visual information processing skills.

Sequence of development of visual-motor integration skills

Visual-motor integration is the extent to which the visual and motor system are able to work together to produce motor output. Beery and Beery (2004) pointed out that, "a child could have well-developed visual and motor skills but be unable to integrate the two" (p. 11). Therefore, for integration to occur, a child must show normal development of both his visual and motor systems, and be able to utilize both systems for a motor output. What is important to note is that visual development begins as the ability to perform tasks such as following a moving object during the early infant months. However, the visual system matures further to perceive visual stimuli in a manner that supersedes just being able to see an object. With the ability to perceive objects, the process of the development of higher level cognition can begin. Beery and Beery (2004) noted that visual perception is the "intermediate step between simple visual sensation and cognition" (p. 10). Therefore, the foundation for visual perception forms during the early infant years where a child is able to view an object and make conclusions about the object's form or purpose.

The second component of visual-motor integration, motor development is also important. As noted previously, motor patterns are important to foster the development of fine motor skills, which are pivotal in performing tasks as coordinated movement of the small muscles of the eyes for tasks such as reading. However, motor development occurs in a systematic manner. In order for a child's to be able to perform fine motor tasks optimally, he must display appropriate development of the large motor tasks. During the early infant years, a child is unable to display control of the fine motor groups until they display gross motor development. Therefore, an infant must display optimal head control (proximal muscle group) in order to perform a task such as following an object with his eyes. Collectively, the development of both a child's visual and motor system function to sets the foundation for the development of visual-motor integration skills. These skills begin from birth and are further developed throughout a child's development.

The role of visual information processing skills on reading

The role of visual information processing skills in reading has been debated for many years where research studies point to solely phonetic indicators of reading. One recent study (Kirby et al., 2008) found that longitudinal predictors of reading were: phonological awareness, phonological decoding, naming speed, orthographic processing, morphological awareness, and vocabulary. Along the same lines as Kirby et al. (2008), Hammill (2004) found, completing a meta-analysis of reading research, that the best predictors of reading are print awareness, letters, phoneme-letter correspondences, word recognition, and alphabet knowledge. An earlier study by Busch (1980) found the single best predictor of reading achievement was the ability to recognize upper-case and lower-case letters and beginning sounds and the second best predictor of reading achievement was measured intelligence. However, in Busch's (1980) study visual-motor integration is also studied to determine the relationship of this variable to reading.

In Busch's study, one thousand fifty-two children [523 boys and 529 girls] were randomly selected from all first grade classrooms within the state of Missouri in an effort to determine which battery of tests would be the best predictor of reading ability. The battery of tests included the *Cognitive Abilities Tests*, the *Developmental Test of Visual-Motor Integration*, the *Pre-Reading Screening Procedures*; the *Stanford Early School Achievement Test*, the *Alphabet and Numbers subtest of the Metropolitan Readiness Test*, *The Boehm Test of Basic Concepts*, and the *Behavior Rating Scale*. The criterion variable, reading ability was measured with the *Gates-MacGinitie Reading Tests*.

Analysis of the data, using Pearson's product moment coefficient revealed that the highest correlation (r=.68) was between the *Gates-MacGinitie Reading Tests* and the Letters and Sounds subtest of the *Stanford Early School Achievement Tests*, with visual-motor integration skills being one of the smaller (r=.38) correlations. These results pointed to phonetic and intelligence as greater factors in reading ability than visual perceptual skills.

The researchers then sought to determine the best combination of tests that could be utilized to predict reading ability. Using a stepwise regression procedure, the first variable to enter the model was the Letters and Sounds subtest of the *Stanford Early School Achievement* test with a multiple R^2 of .464. The next variable, I.Q., raised the multiple R^2 to .552. When the *Behavior Rating Scales* was added to the model the R^2 value became .588. Therefore, the three variables, the subtest Letters and Sounds of the *Stanford Early Achievement Test*, I.Q., and the *Behavior Rating Scale*, accounted for 58 percent of the variance seen with the value of the dependent variable, reading, as assessed by the *Gates-MacGinitie Reading Tests*. These results solidify findings that differences in reading skills can be seen more from the phonetic ability and intelligence of a child rather than their visual perceptual skills. Continuing to look for explanations for variance with reading disparities, Eden, Stein, Wood, and Wood (1995) found that a high proportion of variance (68%) in both disabled and non-disabled children could be predicted by combining visual and phonological scores in a multiple regression.

Though research has been focused on either phonological ability or visual perceptual ability, few studies have looked specifically at these skills in a comprehensive manner to determine the role of visual perceptual skills, specifically visual-motor skills and the effect on reading ability. One study that sought to address this was the work of O'Malley, Francis, Foorman, Fletcher, & Swank, (2002). In this study, researchers looked at eight factors: (1) phonemic awareness, (2) rapid serial naming, (3) perceptual discrimination, (4) visual-motor integration, (5) word reading, (6) spelling, (7) reading, and (8) intelligence and the effect on reading development.

O'Malley et al. (2002) compared three groups of children. One group was a low reading achievement group, another group was an IQ-discrepancy group and the final group consisted of non-impaired readers. The IQ-achievement discrepancy model is a method traditionally used to identify children with learning disabilities. If a student's score on the IQ test is at least two standard deviations (30 points) higher than his or her scores on an achievement test, the student is described as having a significant discrepancy between IQ and achievement and, therefore, as having a learning disability. With the low reading achievement group, the same discrepancy is not seen between IQ test scores and achievements tests. However, these students display decreased reading skills, but are not designated as learning disabled due to the lack of discrepancy between IQ scores and achievement test scores, as seen in the IQ discrepancy group.

The results of the study found that when compared to the non-impaired group, low achieving readers demonstrated poorer performance and development in all skills, including visual-motor integration skills, while the IQ-discrepant readers demonstrated poorer performance and development in phonemic awareness, rapid naming of letters and objects, spelling, and word reading. These results point out that visual-motor integration skills, in addition to the traditional predictors of reading development, can be a factor in reading achievement with students that are not diagnosed as learning disabled.

Reading and the role of visual-motor integration skills

Predictors of the attainment of reading skills include the ability to differentiate upper- and lower-case letters and the beginning sounds of these letters (Busch, 1980), understanding the concept of word in text, spelling with beginning and ending consonant sounds, and word recognition (Morris, Bloodgood, & Perney, 2004). In addition to the phonological processes involved in reading, studies have shown that there are visual perceptual processes involved in reading, namely visual-motor integration.

There has been consistent evidence that visual-motor integration skills has played an important role in reading achievement. Kavale (1982), in his meta-analysis of the relationship between visual perceptual skills and reading achievement, found that across

161 studies, visual-motor integration was shown to have a consistently moderate relationship with reading processes with stronger relationships for word reading versus other reading outcomes. Furthermore, Kulp (1999) specifically studied the relationship between visual-motor integration skill and academic performance in kindergarten through third grade. Kulp (1999) examined the relationship between visual-motor integration skills and academic performance in students in kindergarten through third grade. In the study, 191 children (mean age = 7.78 years, 52% male) from an upper-middle class, suburban, primarily Caucasian elementary school were used in the study. Visual-motor integration skills were analyzed using the *Beery VMI*. Reading ability, in addition to math and writing ability, was assessed on a five-point rating scale, developed by the researchers, using the numbers 1-5, where one indicated the best academic performance. The *Stanford Diagnostic Reading Test, Fourth edition* was also used, in addition to the teacher rating scale, to measure reading ability of first graders. The *Otis-Lennon School Ability Test, Sixth edition* was used a measure of school-related cognitive ability. Performance on the *Beery VMI*, which measured visual-motor integration skills, was found to be significantly related to teachers' ratings of the children's reading ($p=0.0001$), writing ($p=0.0001$) and spelling ($p=0.0118$) ability. An analysis by age group revealed that performance on the *Beery VMI* was significantly correlated with reading achievement ratings in the seven-, eight-, and nine-year olds ($p<0.001$ and $p=0.002$, respectively), with math and writing achievement ratings in the seven, eight, and nine-year olds (math: $p<0.001$, $p=0.004$, and $p=0.003$, respectively; writing: $p<0.001$, $p=0.008$, and $p=0.016$ respectively), and with spelling achievement ratings in the eight and nine-year olds ($p=0.040$ and $p=0.007$ respectively). These statistical results indicate

that performance on a visual-motor integration task is significantly related to academic performance related to reading ability in seven, eight, and nine-year olds.

Also important in visual-motor integration skills are visual perceptual skills, important components of visual-motor ability. Studies have also found a link between decreased visual perceptual skills and reading ability. Eden et al. (1995) found that children with reading disabilities were worse than children without disabilities at many visual and eye-movement tasks, supporting the hypothesis that reading difficulties may be partially due to dysfunction of the visual and occulomotor systems. Eden and colleagues (Eden et al., 1995) studied the phonological and visuospatial abilities of 93 children. The children were divided into four groups: Nondisabled (ND) [n=39, 21 boys], Reading Disability (RD) [n=26, 17 boys], and Backward Readers (BR) [(n=12, 7 boys]. Visual skills were compared between the Nondisabled (ND) and Reading Disability (RD) groups. Results found that vertical tracking was significantly more difficult for the RD group compared to the ND group. The RD group also showed decreased eye stability when reading compared to the ND group, indicating decreased ability to fixate on words when reading. The RD group also showed lower divergence power than the ND group. Collectively, the ability to track, fixate, and diverge/converge are necessary component of visual perceptual skills important in visual-motor integration skills. Therefore, decreased ability in any one of these areas has the potential to affect reading skills.

Gender and visual-motor integration skills

Males have been found to perform better than females with tasks that involve visual spatial skills. Linn and Petersen (1985) found that the magnitude of gender differences in visual spatial skills, where boys outperform girls, was largest for mental rotation, medium for spatial perceptual, and smallest for spatial visualization tasks. Voyer, Voyer, & Bryden (1995) completed a meta-analysis of research studies that looked at gender differences and visual spatial skills and found that males outperformed females with all three forms of visual spatial skills, mental rotation (*d*= 0.56), spatial perceptual (*d*=0.44), and spatial visualization (*d*=0.19, ns). In other studies, Masters and Sanders (1993) showed an effect size of .90 with mental rotation tasks. Collectively, the results of these studies indicate a clear gender advantage for males with visual spatial skills, more specifically mental rotation tasks with minimal differences with spatial perception and visualization tasks.

With the substantial research that indicated the better performance of males over females in the area visual spatial skills, it stands to reason that other visual perceptual skills, including visual-motor integration skills, will also show that males will outperform females. However, research has pointed that with visual-motor integration tasks, females perform better than their male counterparts.

Vogel (1990) completed a review of literature looking at the performance of males and females in the area of visual-motor integration skills. Findings indicated that females performed better than their male counterparts in the areas of reading, writing, spelling, and visual-motor tasks (Vogel, 2001). Females had been found to perform better with the task of copying geometric designs (Beery & Buktenica, 1967). Higher female performance over males in the area of copying designs had been demonstrated from 4 years of age through the adult years (Culbertson & Gunn, 1966; Keogh & Smith, 1968; Maccoby & Jacklin, 1974). These findings are important as research has found that males are more likely to have difficulties with reading than their female counterparts

(Berninger, Nielson, Abott, Wijsman, & Rasking, 2008), which lends support to the link between visual-motor integration skills and reading ability. Having an understanding of the role of visual-motor integration on reading is important to ensure that the needs of all students are addressed in the classroom, beginning with a comprehensive look at deficits that affect their reading ability. Understanding this area of development will be instrumental in providing the necessary intervention, which has been found to be successful, to improve reading ability.

Visual-motor integration and intervention

With the role of visual-motor integration skills and reading ability, it is important to note that intervention has proven to be successful in remediating not only the visual perceptual skills that are affected, but also reading ability. Research has pointed to the efficacy of vision therapy in improving a child's visual perceptual skills (components of visual-motor integration skills) with maintenance of the improvements seen long-term. Shin et al. (2011), studied the effectiveness of vision therapy on school children (n=57, ages 9-13) with convergence insufficiency (eyes not turning inward to adequately view an object) and accommodative insufficiency (eyes not being able to focus on an object). These skills are important components of visual fixation and eye tracking, important components of visual perceptual skills. In this study, children had convergence insufficiency (CI) only (n=27) or both convergence and accommodative insufficiency (AI) (n=30). They were independently divided into a treatment group and a control group matched by age and gender. The treatment group received 12 weeks of vision therapy (VT). Significant differences were found in the treatment group following vision therapy as compared to the control group supporting the notion that VT is a successful method of treating CI and CI combined with AI. Most importantly, improvements were maintained when researchers examined the students one-year later, pointing to the long-term effectiveness of the intervention.

Another testament of the effectiveness of vision therapy was found with the study of Brodney et al. (2010). This was a pilot study that sought to determine the effect of a computerized vision therapy program on ocular-motor functioning (visual tracking) on elementary school children. The study consisted of 41 students in grades 1-6 that were divided into two groups: a first grade group (n=13) and a second through fourth grade group (n=28). Visual tracking ability was evaluated using the Developmental Eye Movement and Visagraph II. Students were provided with 20 weeks of computerized vision therapy. The results indicated significant improvements in visual tracking in all grades and improvement in reading scores for second through third grade. This study points to the importance of visual skills on academic performance, in addition to improving the visual skills of the students, academic performance.

Using a smaller sample size, Sigler and Wylie (1994), looked at the effect of vision therapy on reading rate on three subjects, two ages 8 and one age 10. Participants in the study displayed symptoms that included the inability to stay on the line while reading, skipping lines and words while reading, and word substitutions. Reading rate measures were taken prior to initiation, at the conclusion, and 90 days post-visual therapy. The results indicated that all subjects had had accelerated reading rate gains during the period of vision therapy and that the reading rates for two of the three subjects continued to increase post-therapy. These findings point to ability of vision therapy to not only address the visual perceptual skills that affect reading, but to also improve reading skills short-term and long-term. Also of importance, is realizing that these physiological structures cannot be changed, however, their functional abilities can be improved with intervention.

In addition to vision therapy, intervention to improve visual-motor integration skills can also take the form of participating in that focus specifically on visual-motor integration skills. Dankert, Davies, and Gavin (2003) completed a study looking at the effect of occupational therapy intervention on the improvement of the visual-motor integration skills of 43 preschool children. These 43 children were divided into three groups, preschool children with developmental delays (n=12). The students with developmental delays (n=12), received occupational therapy intervention on an individual basis one time per week, 30 minutes per session and one group 30-minute session per week. Therefore, these students were receiving occupational therapy intervention to address visual-motor skills two times per week during the entire school year.

The second group (n=16) consisted of students without disabilities, but were receiving the same occupational therapy services as the students with developmental delays. The students in this second group received services in a group, 30 minutes per session, for the school year. The third group (n=15) consisted of students without disabilities and did not receive occupational services. The therapeutic methods used in the first two groups included: (a) fine motor activities involving small manipulatives (b) gross motor skills that worked larger muscle groups such as dancing and maneuvering around obstacle courses and (c) visual-motor and visual-perception activities such as creating forms, cutting, and fabricate items. Students were tested prior to, in the middle, and at the end of the school year using the Beery VMI to determine progress in the area of visual-motor integration skills.

Results indicated that: (1) students with developmental delays displayed statistically significant improvements in mean raw scores [t (80) =5.71, p<.0005] pretreatment and post-treatment as evidenced by scores on the *Beery VMI*; and (2) children without disabilities also had statistically significant visual-motor integration skills gains, though there was a smaller effect size.

To provide evidence that results seen were not due to maturation, the developmental delay group results were compared to the group without developmental delays who were also not receiving occupational therapy. Students with disabilities were able to form more shapes during the final administration of the *Beery VMI* to determine visual-motor integration skills. Results were similar for the students who did not have a disability and were not receiving occupational therapy. However, the researchers pointed to the much larger effect size (1.15) with results of the scores of the developmental delayed group compared to the effective size (.16) group without developmental delays as evidence of the effectiveness of therapy. Results also indicated that the children in the developmental delayed group were making improvements with visual-motor integration at a rate much faster (7.09) than their non-disabled peers (.56 for non-disabled students receiving group intervention and 1.00 for non-disabled students not receiving occupational therapy intervention), with respect to the making improvements towards the standardized sample.

Overall, results point to the efficacy of visual-motor integration intervention with children with delays where: (a) students make great gains towards the standardized sample, and (b) the effect size of student improvement with visual-motor integration tasks provide evidence of the efficacy of visual-motor integration intervention with students who initially displayed poor visual-motor integration skills.

Further studies, all using varying intervention times, point to the effectiveness of visual-motor integration. Tzuriel and Eiboshitz (1992) found that a structured visual-motor integration program applied for four months was effective in significantly improving performance in the following areas when the treatment group (n=45) compared to the control group(n=45): (a) perceptual-motor test and (b) measures of cognitive modifiability. These findings add to the effectiveness of visual-motor intervention, in addition to pointing to the effect of intervention on cognitive function. Additional studies also point to the effectiveness of visual-motor integration in kindergarten and elementary school children (Lahav, Apter, & Ratzon, 2008; Ratzon, Lahav, Cohen-Hamsi, Metzger, Efraim & Bart, 2009). Finally intervention has also been found to be beneficial by parents when provided with a home visual-motor integration program for parents to administer to their child at home (Ratzon, Zabaneh-Tannas, Ben-Hamo, & Bart, 2009). Though these interventions take many forms with respect to setting and intervention time, these results point to the effectiveness of visual-motor integration programs in improving visual-motor skills.

Theoretical support

Piaget and the Theory of Conservation. The development of visual information processing skills progresses with providing a child with sensory experiences that develops the component parts of visual information processing skills such as visual spatial ability, laterality, and bilateral integration. The development of these perceptual skills lays the foundation for the development of higher level cognitive skills, including visual-motor integration skills. To understand these abilities, it is important to comprehend the progression of a child's development and the role of perceptual skills in cognitive development.

Developmental theorist Jean Piaget has pointed to the importance of sensory experiences to guide the development of visual spatial skills which serves to develop cognitive skills (Singer & Revenson, 1996; Wadsworth, 1984). Piaget categorized cognitive development in children development into four predictable stages: (1) Sensorimotor (2) Preoperational (3) Concrete Operational and (4) Formal Operational. The progression from one stage to another is dependent on a child's sensory experiences and knowledge is built from an understanding of these sensory experiences (Singer & Revenson, 1996). It is through these sensory experiences that children begin to understand their world, fostering higher level cognitive abilities.

One key theory of Piaget's stages of cognitive development has been the theory of conservation and its relationship to reading readiness (Brekke, Williams, & Harlow, 1973; Roberts, 1976). Pulaski (1971) defined conservation as the, "ability to realize that certain attributes of an object are constant, even though it changes in appearance" (p. 72). For example, if a child is shown a glass of water in a short glass and the same amount of water it placed in a tall glass, the child is able to understand that the amount of water stays the same even though there is a change in the form of the water.

Piaget identified three stages of development with conservation: non-conservation, transitive conservation, and natural conservation. In the first stage, no conservation is found. A child at this stage is unable to determine that an object's characteristics remain the same if there is a change in orientation. In the second stage, some conservation may appear, but the child's perception of an object is still affected by any transformational changes. In the third and final stage, the child is able to demonstrate the ability to understand the properties of an object despite any transformational changes of that object. Therefore, a child understands that the letters of the alphabet are the same despite any changes in orientation or understands that though levels appear different, the liquid form is the same amount despite changes in form. Conservation occurs within the concrete operational stage (ages 7-12) of cognitive development where a child begins to understand higher level concepts.

At the operational stage, children are still at a point where their ability to disregard irrelevant information to understand abstract concepts are still forming. However, at the concrete operational stage, children are able to utilize concepts learned to make conclusions about abstract concepts. It is during the transition from the preoperational stage to the concrete operational stage that a child commences the task of learning to read (Roberts, 1976). Roberts noted: " In learning to read children are faced with several problems: (1) they must develop the concept that the written word or symbol stands for the spoken word that they have come to know and (2) they must answer the written symbol in the task we refer to as word recognition" (p. 247). Almy (1966) believed that the abilities that were necessary to understand the concept of conservation were similar to the skills needed to read.

Conservation and reading. Early research found that a child's performance on selected tasks of conservation was significantly related to certain factors on reading readiness (Brekke et al., 1973). In their study, Brekke et al. (1973) utilized the *Gates-MacGinitie Readiness Skills Test*, the *SRA Primary Mental Abilities Test*, and conservation of number and substance to determine the relationship between conservation and reading readiness and found a significant relationship between a child's performance on conservation tasks and their reading ability. Support of the relationship between conservation and reading is further conveyed by the study of Hurta (1973) who conducted research on two groups of 25 children between the ages of seven and eight and a half years old. One group of students were six months or more below their expected reading level while the other group was six months or more above their expected reading level. Results indicated significant differences between those who were below reading level and those above grade reading level with the performance of Piagetian tasks measuring the conservation of length. These results established a relationship between the ability to understand the concept of conservation and reading ability. On a more theoretical level, it points to the importance of perceptual skills and the development of cognitive ability. This ability to conserve aligns with a child's ability to indicate the development of the perceptual skills necessary to perform a task requiring visual-motor integration skills. As noted before, there is a motor component to visual-motor integration skills. This motor component is also important as it further lays the foundation for other perceptual skills important in cognitive development.

Motor experiences and reading. Piaget believed that motor activity served as the foundation of cognitive development (Ginsburg, 1969; Piaget, 1952; Rao, 2006). In the beginning of life, motor activity develops before cognitive ability, and then both work together for optimal motor output. It is important to understand that proper development of motor skills is critical for cognitive development. Lane (2005) noted, "For a child to have the eye movement skills necessary to keep his eyes on the proper letters in a word when he reads and to be able to have the eye-hand coordination [visual-motor integration skills] necessary to write, his motor skills must be developed to the point of being automatic" (p. 69). This pointed to the importance of the development of both fine and gross motor skills for the performance of academic tasks. As a child matures, he develops proper balance and gross motor skills, meaning the large muscle such as those used for walking and standing. Development then progresses from gross to fine motor. Fine motor skills include the small muscles like those used for writing. The larger muscle groups that are more proximal in the body precede development of the small muscle groups lying at the more distal portion of the body. Overall, proximal stability is needed for distal mobility. Thus total arm precedes elbow, which precedes the wrist, which precedes the fingers, and so forth (Kephart, 1960). This is why there is such a large prevalence of children with learning disabilities who also have deficits in coordination, balance, and/or motor skills (Lane, 2005; Son & Meisels, 2006) The lack of optimal development of motor function, affects their ability to control gross motor movement patterns, which also affects fine motor control patterns. To have optimal motor function, one must display adequate proximal stability (of the gross muscle groups) to allow for adequate distal mobility (fine motor muscle groups). This is exhibited not only in gross motor abilities, but also in fine motor, such as visual motor (eye hand coordination) and ocular motor (eye movement), which can have a direct effect on reading.

Therefore, a child's visual-motor ability which combines concepts of perceptual skills and motor ability is an important component of reading tasks. In addition to the role in reading, it is apparent that sensory experience helps to improve these abilities, pointing to the justification in addressing the needs of the students with remediation in the classroom.

Summary

The role of reading in a child's academic career is pivotal. Juel (1988) reported that 88% of the children who scored in the lowest quartile in reading comprehension at the end of first grade remained below the 50th percentile at the end of fourth grade indicating that reading deficits continue throughout a child's academic career. Further longitudinal studies point to evidence that children who are poor readers at the end of first grade are at risk for not acquiring average-level reading skills during the remainder of their elementary school education (Francis et al., 1996; Torgesen & Burgess 1998).Therefore, educators must have a comprehensive understanding of the component skills of reading and ensure appropriate assessment and intervention of a student's reading ability early in a student's academic career.

Research has pointed to the importance of the phonetic skills, such as phonological awareness, phonological decoding, naming speed, orthographic processing, morphological awareness, vocabulary, phoneme-letter correspondences, word recognition, and alphabet knowledge as prime indicators of reading (Hammill, 2004; Kirby et al., 2008,). However, the role of visual perceptual skills, namely visual-motor integration skills has also been instrumental in a child's reading ability (Kavale, 1982; Kulp, 1999). Also noteworthy is the success rate of intervention to improve visual-motor integration skills (Dankert et al., 2003; Lahav et al., 2008; & Ratzon et al., 2009). With the consequences of decreased reading ability on academic success, the role of visual-motor integration on reading ability, and the research pointing to the success of intervention, it is important to better get a more comprehensive understanding of the role of visual-motor integration on reading achievement. This understanding will help guide assessment and intervention to ensure students' academic success.

Chapter III

Methodology

Research Design

This was a correlational research design. The two variables that were being studied were student performance on the *Beery VMI*, a standardized instrument that assesses the visual-motor integration skills of individuals from 2-99 years old and reading achievement as assessed in respective school.

Participants

The total number of participants equaled 97 students in first through third grades from two different private schools in a metropolitan area. The first school [School A] had 77 participants (male=43, female=34), while the second school [School B] had 20 participants (male=12, female=8). The students' ages in School A ranged from five years eleven months old to 9 years five months old. Participants per grade are as follows: School A—first grade=26 [male=12, female=14], second grade=27 [male=19, female=8], and third grade=24 [male=12, female=12]. The students' ages in School B ranged from six years two months old nine years 2 months old. For School B, participants per grade are as follows: first grade=11 [male=7, female=4], and third grade=9 [male=5, female=4].

Instruments

Assessment of visual-motor integration skills

Assessment of visual motor integration skills was obtained utilizing the *Beery-Buktenica Developmental Test of Visual-Motor Integration (Beery VMI), Sixth edition*. The *Beery VMI* was first published as the VMI in 1967. The *Beery VMI* has been found to be a strong predictor of academic success in studies of children in first through fifth grade (Maples, 2003) and kindergarten through third grade (Kulp, 1999). The *Beery-Buktenica Developmental Test of Visual-Motor Integration (Beery VMI) with Supplemental Developmental Tests of Visual Perception* and *Motor Coordination* is a pencil and paper test that uses a developmental sequence of 30 geometric shapes to test visual-motor integration skills in children ages 2.0-99 years old. The *Beery VMI* is the first instrument that must be administered. Depending on the results of the *Beery VMI*, where the student performs below average, the *Visual Perception* and then *Motor Coordination* subtests are to be administered. The administration of the Visual Perception and Motor Coordination subtests are voluntary and are to be used as an assessment measure to further determine if a below average result on the *Beery VMI* is due to either a deficit in perception or fine motor coordination (Beery & Beery, 2004) Therefore, for the purposes of this research study, only the *Beery VMI* was utilized and the subtests were not employed.

Reliability and validity of the Beery VMI. The *Beery VMI* was normed in the United States on 11,000 children five times over a period of 40 years (Beery & Beery, 2004). The first norming began in 1964 and the fifth norming in 2003 with the addition of three more test items to the assessment instrument. The norms from various editions of the test have remained uniform over the span of those 40 years, despite changes in the instrument. Screening tests such as the *Beery VMI* should have an overall reliability of at least .80 (Beery & Beery, 2004). Reliability and validity measures of the Beery VMI are summarized in Table 1, which follows:

Table 1

Reliability and Validity of the Beery VMI

Type of Reliability	*Beery VMI*
Inter-rater reliability	.92
Internal Consistency	.96
Test-retest	.89

Predictive validity of the Beery VMI. With respect to predictive validity, researchers found the *Beery VMI* to be a valuable predictor when used in combination with other measures, especially with reading ability. The *Beery VMI* was found to be a predictor of achievement in children from pre-kindergarten through first grade (Beery & Beery, 2004; Maples, 2003; Kulp, 1999; Kulp & Schmidt, 1996) Comparison of a battery of assessments of a group of children from pre-kindergarten through the end of first grade found that the *Beery VMI*, in combination with a test of auditory-vocal association, best predicted achievement (University School District, 1969). The *Beery VMI* was also a strong predictor of high-risk boys in kindergarten who had reading difficulty (Satz & Friel, 1974). *Beery VMI* scores has also been found to be a predictor of kindergarten students' reading and language scores on the *Iowa Test of Basic Skills* at the end of first grade in the Early Prevention of School Failure Program (Terbush, 1990 as cited in Beery & Beery, 2004, p. 114). Fletcher and Satz (1982) found *that Beery VMI*, along with three other assessment measures, were able to predict 85% of kindergarten children with reading problems seven years later. These studies point to the ability of the results of the

Beery VMI to be a predictor of language and reading ability in children in the elementary school years.

Utilization of Beery VMI as an assessment measure of visual-motor integration skills. The choice to use the *Beery VMI* as the primary assessment of visual-motor integration skills stemmed from predictive studies that found the strong predictive ability of the *Beery VMI* with the reading ability of children in the elementary school years (Beery & Beery, 2004; Maples, 2003; Kulp, 1999; Kulp, 1996). There are other measures that could have been utilized to measure a child's visual-motor integration ability, including the *Bender Gestalt II* (revised from the Bender-Gestalt) and the Geometric Design subtest of the *Wechsler Preschool and Primary Scale of Intelligence* (*WPPSI*). The *Beery VMI* and the *Bender Visual-Motor Gestalt Test* has been the most frequently used test to assess visual-motor skills (Brannigan and Decker, 2006; Stinnett, Harvey, & Oehler-Stinnett, 1994). Correlations between the two tests have been moderately high, where Volker et al. (2010) found that the Bender Gestalt copy score and *Beery VMI* were correlated(r=.48) for typically developing children.

The original *Bender Gestalt Test* (1938) was a popular assessment that was utilized as a predictive instrument to determine learning disabilities, academic achievement, and reading ability (Ackerman, Peters, Dykman, 1971; Connor, 1968; Lesiak, 1984). The test, which was made to assess individuals ages 4-85 years old, was used to determine visual-motor integration ability. The original test consisted on 9 forms for the subject to copy and forms were scored from 1 (unrecognizable) to 5 (all parts present and recognizable).

In 2003, revisions were made to the *Bender-Gestalt Test* and it was renamed the *Bender-Gestalt II* (Brannigan & Decker, 2006). The *Bender Gestalt II* revisions included adding four easier shapes for individuals below eight-years old and the addition of three designs for individuals ages eight and older. The makers of the *Bender Gestalt II* hoped that these additions would be instrumental in diagnosing organic pathology, predicting learning problems, and assessing personality dynamics (Brannigan & Decker, 2006).

Though the *Bender Gestalt Test* had successively predicted learning problems and academic performance, the test has not been as consistent with predicting reading achievement (Ackerman et al., 1971; Connor, 1969; Koppitz, 1975; Lesiak, 1984). Koppitz (1975) compared two groups of 23 special needs students with learning disabilities and a control group of 30 average public school students. The special education students had little to no reading ability while all individuals in the control groups were readers. Results indicated that the Bender-Gestalt Test was able to differentiate between students with learning disabilities and the control group, but not between the readers and non-readers in the learning disabled group. The Bender-Gestalt Test was also unable to differentiate the good readers from those with reading difficulties in the control group. Connor (1969) found similar results with the utilization of the Bender-Gestalt Test with 30 second grade girls. Results found both good and poor readers had poor Bender-Gestalt Test scores. Therefore, the research from studies using the *Bender-Gestalt Test* did not show this test as a good predictor of reading ability compared to the *Beery VMI*. There is a dearth of current research with the predictive ability of the *Bender-Gestalt II* with reading achievement. However, this may be due to previous studies which have not established a solid relationship between scores on the Bender Gestalt and reading ability.

In addition to poor predictive validity, the *Bender-Gestalt (II) Test* also had administrative limitations compared to the *Beery VMI*. This includes the number of shapes to be drawn. With the *Beery VMI*, students are provided with 30 shapes compared to the 25 total shapes available in the *Bender Gestalt II*. Increased number of shapes allows students a greater chance of showing their true visual-motor integration ability as they have more opportunities to complete forms. In addition, the *Beery VMI* can be administered in a group, which was a necessity for this research study to maintain classroom instructional time. Scoring was also a limitation with the *Bender Gestalt II*. The *Beery VMI* utilizes a two-point scoring system—zero if the form does not meet set criteria and one if the form meets the criteria. The *Bender-Gestalt II* scoring system has a five-point scoring criteria, which has implications for reliability.

As noted previously, the Geometric Design subtest of the *Wechsler Preschool and Primary Scale of Intelligence (WPPSI)* had also been utilized to determine a child's visual-motor ability. However, the WPPSI is intended for usage with children ages four to six and a half, which would not be applicable with students in the later elementary grades. Therefore, the WPPSI was not utilized. With strong research indicating the relationship between the *Beery VMI* scores and reading ability, ease of administration and scoring, and strong content validity, the *Beery VMI* was utilized to determine the visual-motor integration scores of students in this study.

Assessment of students' reading ability in School A

STAR Reading Assessment. School A utilized the STAR Reading assessment to determine a student's reading ability. With the STAR Reading assessment, students were assessed using computer software. The students were presented with multiple choice items one by one, with students selecting the correct answer. Students in the first and second grades had up to 60 seconds to answer each test item. Students in the third grade were allowed 45 or 60 seconds, depending on the type of question. There was a warning to students when 15 seconds remain for answering an item. If a student did not select answer prior to going to another question, the initial question was marked as being incorrect.

The STAR Reading software delivered test items based on the student's estimated reading ability. If the student answered the question correctly, the software provided a more difficult question to answer. If the student answered the question incorrectly, the software provided the student with a question of less difficulty. The test items were provided in this manner until testing is complete. The test was completed after the student answers 25 questions. A final score was calculated by the program and teachers were provided with information regarding the student's performance.

The information that was provided to teachers to assess a student's reading ability included a student's Instructional Reading Level (IRL), percentile rank (PR), and grade equivalent (GE). The makers of the STAR Reading assessment noted that, "Instructional Reading Level is the highest grade level at which the student can comprehend 80 percent of the text" (Renaissance Learning, 2010, p 6). For example, if a student had an IRL of 3.5, that student could comprehend 80 percent of the text that students in the fifth month of third grade were expected to comprehend (Renaissance Learning, 2010). Percentile rank provided information on a student's reading performance compared to students nationwide of the same grade at the same time of the year. For example, if a student was in the 75 percentile rank, that student performed better than 75 percent of students in the same grade at the same time of year nationwide. The grade equivalent (GE) score compared student's performance against students nationally. Therefore, a student with a GE score of 3.6 meant a student was reading at a level equivalent to students nationwide who were in the six month of the third grade (Renaissance Learning, 2010).

To asses reading comprehension, STAR Reading test items were presented in two formats based on a student's grade. In the first format, students in first through second grade, students were presented with a single sentence with a blank to indicate a missing word. Students were presented with a choice of three or four comprehension words to complete the sentence. In the second format, students in the third grade were provided with 20 single-sentence items and five passages. Students in the first grade were provided with three comprehension words to choose from to complete the sentence while those in the second through third grade were provided with four comprehension words to complete the sentence. Regarding the ability of the STAR Reading assessment to determine comprehension with this testing format, the makers of the STAR Reading assessment noted:

> "While the format of STAR Reading items sometimes leads educators to believe that it only assesses vocabulary knowledge, the test actually draws on a much more complex set of reading skills. Each item is carefully constructed so that the correct answer fits both the semantics and the syntax of the sentence. The incorrect options either fit the syntax of the sentence or relate to the meaning of something in the sentence, but they do not do both. Thus the test-taker must not only apply vocabulary knowledge but must also utilize background knowledge and semantic and syntactical skills. Only if the student uses all these cognitive

> skills can he derive meaning from the text, which, experts agree, is the essence of reading comprehension" (p.8).

Through these formats, a student's ability to comprehend text presented can be determined as the questions have been formulated to ensure that with each question evaluated not only vocabulary, but also semantics and syntax of a sentence, both important in reading comprehension.

Reliability and validity of STAR Reading assessment. An important component of an instrument is the reliability and validity of that instrument. The makers of the STAR Reading assessment point out that, "According to the National Center on Response to Intervention (NCRTI), a reliability level of .60 and higher is good; .80 is very good. We have collected and analyzed four types of reliability data, including test-retest reliability. In all types of analysis, the reliability level of STAR Reading exceeded .90" (p. 8). Initially conducted in 1999, the analysis was based on three different methods of reliability—split-half and test-retest. Test results from a sample of 30,000 students from 269 schools in 47 states were utilized to establish the instrument's reliability.

In 2001, to determine the validity of the STAR Reading assessment, makers conducted a study utilizing the reading, early literacy, readiness, and social skills from other assessments. These assessment measures varied from standardized tests such as the *Iowa Test of Basic Skills* to state assessments from various parts of the United States.

Results related to predictive validity across the grades can be seen in Table 2, which follows. Results related to concurrent validity across the grades are found in Table 3, which also follows.

Table 2

Predictive Validity of Star Reading Assessment

Grade	Number of Studies	Students	Average Correlation
1	6	74,877	.68
2	10	184,434	.78
3	30	200,929	.80

Table 3

Concurrent Validity of Star Reading Assessment

Grade	Number of Studies	Students	Average Correlation
1	15	1,135	.77
2	32	4,142	.72
3	44	4.051	.75

Assessments of students' reading ability in School B

Reading A-Z Assessment. School B used the Reading A-Z assessment to measure reading ability in students. This reading assessment was used in tandem with Fountas and Pinell Benchmark Assessment System (BAS) where Reading A-Z assessment outcomes were used for small group instruction and Fountas and Pinnell BAS was also used as a further measure of reading ability and intervention**.** Reading A-Z assessment measured children's reading ability in six key areas of reading ability: alphabet, phonological awareness, phonics, high-frequency words, fluency, and comprehension. These tools were designed to help diagnose a student's instructional needs and their understanding of the instruction delivered.

Reliability and validity of Reading A-Z assessment. The makers of Reading A-Z assessment focused research efforts on content validity. Reading A-Z has focused on the findings of the National Reading Panel's recommendations, in addition to other research findings to determine the components of Reading A-Z's assessment categories.

On the Reading A-Z website, makers indicated:

> "In 2000, the National Reading Panel published its research-based findings on the reading strategies and instructional practices that demonstrated the best results for reading achievement in developing readers. The panel reviewed more than 100,000 reading studies, and from those, analyzed several hundred key studies that met its criteria for sound scientific research. The results are organized around five key areas of reading instruction--phonemic awareness, phonics, fluency, vocabulary, and comprehension" (Research and Reading A-Z, 2012).

Therefore, the focus is on content validity, ensuring that the information provided is an adequate measure of reading assessment based on extensive research on the part of the makers of Reading A-Z.

Fountas and Pinnell Benchmark Assessment System. The Fountas and Pinnell Benchmark Assessment System, is a formative reading assessment tool that looks at the ability of a student to read materials grouped in a certain way. Assessment of reading ability is based on: reading rate, accuracy score, self-correction ratio, fluency score, comprehension score, and writing response (Heinemann, 2010). Reading levels were assigned a letter level from A-Z, with the following leveled expectations for students from kindergarten through fifth grade: Kindergarten A-C, Grade One B-I, Grade Two H-M, Grade Three L-P, Grade Four O-T, Grade Five S-W (Heinemann, 2010). Students were determined to have the grade appropriate reading levels if the reading levels fall within the range that is indicated in the *Fountas and Pinnell Benchmark Assessment* leveling system described above. The assessment was completed by the teacher with the provision of reading materials, looking at the above mentioned areas where teachers determine the reading level based on the set criteria. The students were then provided with reading material based on that grade level and a plan was implemented to increase the student's reading level throughout the school year. In addition to being a reading assessment, Fountas and Pinell Benchmark Assessment System, also pointed to the benefits of using such as system to make gains in reading using their Leveled Literacy Intervention (LLI).

Reliability and validity of Fountas and Pinnell Benchmark Assessment System. Fountas and Pinnell Benchmark Assessment System collected data from 457 students from kindergarten through eighth grade from a total of 22 schools. The schools were from the following areas in the United States: Boston, MA (one school), Providence, RI (two schools), Houston, TX (five schools), Los Angeles, CA (six schools), Columbus, OH (five schools), and Orlando, FL (three schools).

To measure test-retest reliability, the students' reading scores on the fiction books were correlated with the reading scores on the non-fiction books (Heinemann, 2010). Test-retest reliability measures of the Fountas and Pinnell Benchmark Assessment System of fiction and non-fiction books can be found in Table 4, which follows.

Table 4

Test-retest Reliability of Fountas and Pinnell Benchmark Assessment System Fiction and Non-fiction Books

Book Series	Reliability coefficient
Book Series A-N	.93
Book Series L-Z	.94
All Books (A-Z)	.97

To measure convergent validity, makers of the Fountas and Pinnell Benchmark Assessment System compared the Fountas and Pinnell BAS to the Reading Recovery assessment due to the similarities with both tests with assessing students reading. Both of these assessment measures assess decoding, fluency, vocabulary, and comprehension. Results found correlations of .94 for fiction and .93 for nonfiction books between the reading accuracy rates of both assessment measures (Heinemann, 2010). These results point to an assessment measure that is both valid in its structure and allows for reliable scoring by all teachers.

Data collection procedures

A Human Subjects Application was completed and provided to University of Houston’s Committee for the Protection of Human Subjects for approval of the study prior to data collection. Following approval (Appendix A), a total of 177 (School A, N=110; School B N=67) students in kindergarten through third grade from two middle to upper middle-class, suburban, private schools in a metropolitan area were requested to participate in the study.

Students were selected based on the following criteria: (1) attendance at the school that was chosen by the researcher; (2) general education student; and (3) student in grades kindergarten through third grade. All participating teachers were provided with a ten-dollar gift card to a chain store as a token of gratitude for ensuring that consent forms were provided to students to take home and returned in a timely manner.

A total of 177 consent forms (Appendix B) were sent out to parents in these two schools for participation in the study with a return rate of 73% (N=77) for School A and 61% (N=41) for School B. Prior to the sending out consent forms, the researcher was informed that the kindergarten students in School A were not assessed on their reading ability and would not be assessed until the end of the school year. Therefore, they were not eligible to participate in the study as the researcher needed their reading scores for the purposes of this study. The researcher was informed that in School B, students in kindergarten and second grade did not have reading achievement scores resulting in scores for kindergarten and second grade not being utilized in the final results. With the lack of reading scores for the above-mentioned classes, the final number of participates are as follows: School A—first grade—26, second grade—27and third grade—24; School B: first grade—11, third grade—9. Students ranged in age from five years eleven months to nine years five months in School A and six years two months to nine years two months in School B.

Materials. The *Beery-Buktenica Developmental Test of Visual-Motor Integration (Beery VMI), sixth edition* is a pencil and paper test that was used to determine visual-motor integration abilities. Testing materials consisted of *Beery VMI* testing booklet and subtests, and a number two pencil without an eraser attached, as per test instructions. Reading levels were obtained from teachers and administrators. In School A, the STAR Reading assessment was utilized as the primary reading assessment while in School B, Reading A-Z and Fountas and Pinnell Benchmark Assessment System were the primary reading assessment measures.

Procedures. On the day of data collection, teachers were informed by the researcher, of the students that returned consent forms and were able to participate in the study. After the participating students signed the assent form (Appendix C), agreeing to participate in the study, the *Beery VMI* was administered to the students as a group, by grade, with the researcher (a registered occupational therapist trained in the administration of the *Beery VMI*) and the classroom teacher supervising the students to ensure that they were completing the assessment correctly. Students who were not participating in the research study were able to engage in a scholastic activity of their choice until their classmates were finished with the *Beery VMI*.

In School A, the administrator provided the researcher with reading assessment abilities prior to data collection. In School B, reading achievement scores were provided to the researcher by the teachers prior to and on the day of data collection. Data collection was completed in one day for both School A and on a separate day for School B. Scores from the reading assessment provided by the school were compared with the scores obtained from the *Beery VMI* to determine the relationship between the two variables—visual-motor integration ability and reading achievement.

Data Analysis

The *Statistical Package for Social Sciences® 20* (*SPSS ®20*) was used to first determine descriptive statistical data, including the mean, mode, median, standard deviation, skewness, and kurtosis of visual-motor integration and reading ability scores of the population. Inferential statistical information was then determined, also using *SPSS®20* to answer each research question.

The first question to be answered was: *What is the relationship between visual-motor integration skills and reading achievement?* The Beery VMI was used to assess visual-motor integration skills and the specific reading assessment results of two metropolitan private schools were used to assess student reading achievement. To determine the relationship between visual-motor integration and reading achievement, a Pearson correlation coefficient (*r*) was determined using *SPSS® 20* for both School A and School B. The two variables utilized were visual-motor integration percentile rank as obtained by the *Beery VMI* and reading grade equivalent as determined by either the STAR Reading® assessment (used by School A) or Reading A-Z/Fountas and Pinnell Benchmark Assessment System (used by School B).

The second research question to be answered was: *What is the relationship between visual-motor integration skills and reading achievement at each grade level?* This question was posed to understand the long-term relationship between visual-motor integration skills and reading achievement. To determine the relationship between visual-motor integration and reading achievement across each grade, a Pearson Correlation coefficient, *r*, was determined, using *SPSS® 20*, looking at the two variables visual-motor integration percentile rank as obtained by the *Beery VMI* and reading grade equivalent as determined by either the STAR ® Reading assessment . This information was analyzed in School A per grade (first, second, and third) to determine the strength of the relationship between these two variables by grade.

The third research question to be answered was: *What is the relationship between gender and visual-motor integration skills?* This question was posed to determine whether gender plays a factor in the visual-motor integration skills of students and to determine its effect on reading achievement. This question provided increased validity to the results of the findings where gender could be removed as a factor that affected visual-motor integration skills. To determine the effect of gender on the visual-motor integration skills, a Univariate Analysis of Variance (one-way ANOVA) was completed in *SPSS® 20* looking at the differences between the means of males and females with respect to participants' VMI percentile rank score in School A. This statistic was used to determine whether one gender group performed better than the other gender group on *the Beery VMI*, the primary indicator of visual-motor integration skills in this study.

Chapter VI

Results

Introduction

The purpose of this study was to explore the relationship between visual-motor integration as determined by the *Beery VMI* and reading achievement as measured by either the STAR Reading assessment, Reading A-Z/Fountas and Pinnell Benchmark Assessment System in students in first through third grade. The study participants included 77 students from School A and 20 students from School B. Both School A and School B were private schools in a large metropolitan area. Students in School A ranged from five years eleven months old to nine years five months old and six years 2 months old to nine years two months old in School B.

The first question that guided this research study was: *What is the relationship between visual-motor integration skills and reading achievement?* The Beery VMI was used to assess visual-motor integration skills and the specific reading assessment results of two metropolitan private schools were used to assess student reading achievement. It was hypothesize that there would be a positive correlation between a student's visual motor integration skills and reading achievement. Therefore, students who displayed visual-motor skills deficit would also display poorer reading skills than their peers who displayed higher level visual-motor integration skills. To determine the relationship between visual-motor integration and reading achievement, a Pearson correlation coefficient (r) was determined using *SPSS® 20*, looking at the two variables visual-motor integration percentile rank as obtained by the *Beery VMI* and reading grade equivalent as determined by either the STAR Reading assessment or Reading A-Z/Fountas and Pinnell Benchmark Assessment System.

The second research question that guided this study was: *What is the relationship between visual-motor integration skills and reading achievement across each individual grade?* This question was posed to understand the long-term relationship between visual-motor integration skills and reading achievement. It was hypothesized that the relationship between visual-motor integration skills and reading achievement would be maintained across each individual grade where there would be statistically significant positive correlations between visual-motor integration skills and reading achievement. The strongest correlation would be seen with the first grade where students are expected to have the lowest visual-motor integration score and therefore will also have lower reading ability. To determine the relationship between visual-motor integration and reading achievement across each grade, a Pearson Correlation coefficient, *r*, was determined, using *SPSS 20*, looking at the two variables visual-motor integration percentile rank as obtained by the *Beery VMI* and reading grade equivalent as determined by either the STAR Reading assessment . This information was analyzed in School A per grade (first, second, and third) to determine the strength of the relationship between these two variables by grade.

The third research question that guided this study was: *What is the relationship between gender and visual-motor integration skills?* This question was posed to understand whether gender plays a factor in the visual-motor integration skills of students and to determine its effect on reading achievement. It was hypothesized that females would have higher visual-motor integration skills when compared to males. To determine the effect of gender on the visual-motor integration skills, a Univariate Analysis of Variance (one-way ANOVA) was completed in *SPSS 20* looking at the differences between the means of males and females with respect to participants' VMI percentile rank score in School A. This statistic was used to determine whether one gender group performed better than the other gender group on *the Beery VMI*, the primary indicator of visual-motor integration skills in this study.

Prior to the analysis of inferential statistics, descriptive statistic information was obtained to determine the visual-motor integration means of both School A and School B, standard deviation of visual-motor integration scores, kurtosis and skewness of the distribution of scores to determine the variability in the visual-motor integration scores. Therefore, prior to the introduction of the inferential statistics, descriptive statistical information is presented. The descriptive statistical information of School A is presented in Table 5 and the descriptive statistical information of School B is found in Table 6, providing information on means and standard deviation information on visual-motor integration reading scores.

Descriptive statistics of the population of school A.

Table 5

Descriptive Statistics of School A Population

	VMI raw Score	VMI Standard Score	VMI Percentile Rank	Reading Grade Equivalent	Reading Percentile Rank
Mean	23.06	115.94	75.84	2.72	64.10
Median	24.00	116.00	86.00	2.50	67.00
Mode	26	128	99	.90	60
Std. Dev.	3.96	16.55	25.59	1.67	26.31
Skewness	-.420	.063	-1.096	.592	-.388
Kurtosis	-.880	-.542	-.037	-.558	-.953

With the sample of 77 participants from school A, the mean was 75.84, the mode was 86.0, and the median was 99. The standard deviation between the scores was 25.6, which was expected as students in first grade are generally expected to have significantly lower percentile rank scores than students in second and third grade. Therefore, variability between the grades was expected.

The skewness and kurtosis provided information on the distribution of the VMI scores and reading ability. The skewness value of the VMI percentile rank value was -1.09 while the kurtosis value was -.037. A negative skew indicated that the tail is on the left side of the distribution and is longer than the right side. Therefore, the majority of the VMI percentile rank values lie to the right of the mean. This points to a distribution where the majority of the students performed at or above the mean. The kurtosis value of -.037 indicates a normal peak. The skewness value with the reading grade equivalent values was 0.592 while the kurtosis value was -.0.558.

Descriptive statistics of the population of school B.

Table 6

Descriptive Statistics of School B Population

	VMI raw Score	VMI Standard Score	VMI Percentile Rank	Fountas Pinnell Reading Level
Mean	23.35	114.00	76.35	14.40
Median	23.00	118.00	88.50	12.50
Mode	29	104	99	9
Std. Dev.	4.06	31.50	27.05	6.99
Skewness	.057	-1.80	-1.04	.41
Kurtosis	-1.08	5.24	.004	-1.61

With the sample of 20 participants from school B, the variable VMI Percentile Rank had a mean of 76.35, a mode of 99, and a median of 88.50. The standard deviation between the scores was 27.05, which is to be expected as students in first grade were generally expected to have significantly lower percentile rank scores than students in second and third grade.

The skewness and kurtosis measures provided information on the distribution of the VMI scores and reading ability. The skewness value with the VMI percentile rank value was -1.041 while the kurtosis value was .004. The range for the skewness of a distribution must fall between -3 to 3 for the distribution to be considered close to normal. Therefore, the value of -1.041 falls within this range. A negative skew indicates that the tail is on the left side of the distribution and is longer than the right side. Therefore, the majority of the VMI percentile rank values lie to the right of the mean. This points to a distribution where the majority of the students performed at or above the mean. The kurtosis value of .004 indicates a normal peak, with a value close to the optimal normal distribution value of zero.

Relationship between visual-motor integration skills and reading achievement

Results of School A. To determine whether there was a relationship between visual-motor integration skills and reading achievement, a Pearson correlation statistic, *r*, was obtained using *SPSS® 20*. The two variables that were compared were *VMI Percentile Rank* and *Reading Grade Equivalent*. As noted previously, the VMI percentile rank was determined from the VMI raw score, which was converted to a standard score based on norms determined by test makers. The Reading Grade Equivalent (RGE) score compared student's performance against students nationally. Therefore, a student with a RGE score of 3.6 meant a student is reading at a level equivalent to students nationwide who were in the six month of the third grade. Results of the correlations between variables of the *VMI Raw Score*, *VMI Percentile Rank*, and *Reading Grade Equivalen*t are found in Table 7 (N=77) which follows:

Table 7

Correlations between Variables in School A

		Reading Grade Equivalent
VMI Raw Score	Pearson Correlation	.72**
VMI Percentile Rank	Pearson Correlation	.54**

**Correlation is significant at the 0.01 level (2-tailed).

The variable *VMI Percentile Rank* was utilized as this value provides information on student performance compared to the expectations of students nationally for a specific age group. The *VMI raw score* provided information specifically on student performance without comparing students across particular age groups. Results indicated a Pearson correlational statistic, *r*, of .54, which was statistically significant at the 0.01 level (r=0.54, N=77, p<.01). The positive value of the correlational statistic indicated that this was a positive correlation. In this case, as the student's visual-motor integration score increased or decreased, so did the student's score respectively. The *r* value of 0.54 indicated a correlation with a large effect size, which pointed to a strong correlation between the variables of visual-motor integration ability (*VMI Percentile Rank* and reading ability (*Reading Grade Equivalent*). Further analysis of the data also indicated that there was a statistically significant correlation between a student's *VMI Raw Score* and *Reading Grade Equivalent* ($p=.72$, $p<.01$), which pointed to a consistent relationship between the two variables. These results supported the research hypothesis that there would be a positive correlation between the two variables of visual-motor integration skills and reading ability.

Results of School B. Table 8 (N=20), which follows, contains the summary of the correlation values between the variables visual-motor integration, using the student's *VMI Percentile Rank* scores and reading achievement, using the *Fountas and Pinnell Reading Scores*, in School B.

Table 8

Correlations between VMI Percentile Rank and Fountas and Pinnell Reading Scores in School B

		VMI Percentile Rank	Fountas Pinnell Reading Score
VMI Raw Score	Pearson Correlation	.77**	.66**
VMI Percentile Rank	Pearson Correlation	1	.29

**. Correlation is significant at the 0.01 level (2-tailed).

To determine whether there was a relationship between visual-motor integration skills and reading achievement, a Pearson correlation statistic, *r*, was obtained using *SPSS® 20*. The two variables that were compared were *VMI Percentile Rank* and the students' scores on the Fountas and Pinnell reading assessment. The VMI percentile rank was determined from the VMI raw score, which was converted to a standard score based on norms determined by test makers. The VMI scaled score was then converted to a percentile rank.

The Reading A-Z Assessment and the Fountas and Pinnell Benchmark Assessment System (BAS) reading scores were used to determine a student's reading ability. Reading A-Z scores are assigned a letter from aa-z. Reading scores for Fountas and Pinnell Benchmark Assessment System were assigned a letter assessment system from A-Z based on set criteria. Conversion factors between Reading A-Z and Fountas and Pinnell BAS was determined by the makers of Reading A-Z where letters matched letter for letter, with the exception on aa for Reading A-Z. With Reading A-Z, aa was matched with A on the Fountas and Pinnell BAS and the second A of Reading A-Z was matched with a second A on the Fountas and Pinnell BAS. Once information was obtained on letter grade, information was converted to a number score to ensure ordinal scores for analysis in *SPSS 20*. In this case, letter scores ranged from A-Z and the number conversion scores ranged from 1-27, taking into account aa and A from Reading A-Z assessment. Following the conversion, scores were obtained numerically for analysis.

For School B information was analyzed to determine the relationship between visual motor integration skills and reading achievement. The variable *VMI Percentile Rank* was utilized as this value provides information on student performance compared to the expectations of students nationally for a specific age group. Results are summarized in Table 8. There was a moderate, statistically significant, positive correlation between (r=.66, N=20, p<.01) *VMI raw scores* and reading level (*Fountas and Pinnell Reading Score*). The Pearson correlation coefficient, r, indicated a small, non-significant, positive correlation (r=.29, N=20, ns) between *VMI percentile rank* and reading ability (*Fountas and Pinnell Reading Score* as seen in Table 8). Though statistically non-significant, the r value of .29 indicated a moderate effect size between the two variables VMI percentile rank and reading level. This effect size supported the correlation between the two variables, despite the lack of statistical significance.

Relationship between visual-motor integration skills and reading ability across individual grade groups

To determine the relationship between visual-motor integration skills and reading achievement, by individual grade, a Pearson correlation statistic, *r*, was obtained using *SPSS 20*. A two-tailed analysis was completed. The two variables that were compared were *VMI Percentile Rank* and *Reading Grade Equivalent* of School A. The relationship of these variables was analyzed by grade where Pearson correlation coefficients were obtained per grade. The results obtained are indicated in the Tables 9 (first grade), 10 (second grade), and 11 (third grade) below:

Table 9

Correlations between VMI Percentile Rank and Reading Grade Equivalent in School A—first grade

		VMI Percentile Rank	Reading Grade Equivalent
VMI Percentile Rank	Pearson Correlation	1	.33
	Significance (2-tailed)		.09
N		26	26

Correlation is not significant at the 0.01 or 0.05 level (2-tailed).

Table 10

Correlations between VMI Percentile Rank and Reading Grade Equivalent of School A—2nd Grade

		VMI Percentile Rank	Reading Grade Equivalent
VMI Percentile Rank	Pearson Correlation	1	.48**
	Significance (2-tailed)		.010
N		27	27

**. Correlation is significant at the 0.01 level (2-tailed).

Table 11

Correlations between VMI Percentile Rank and Reading Grade Equivalent of School A—3rd Grade

		VMI Percentile Rank	Reading Grade Equivalent
VMI Percentile Rank	Pearson Correlation	1	.49*
	Significance (2-tailed)		.013
N		24	24

*. Correlation is significant at the 0.05 level (2-tailed).

There was non-significant, positive correlation between visual-motor integration skills and reading ability (r=.33, N=26, p>0.05) with students in the first grade. Though not statistically significant, the Pearson r value of .33 indicated a moderate effect size between the two variables *VMI percentile rank* and reading level (*Reading Grade Equivalent*). The strength of the effect size provided further support for the correlation between the two variables, despite a lack of statistical significance. With students in the second and third grades, there was a significant positive correlation between visual-motor integration skills and reading ability (second grade—r=.48, N=27, p<.01; and third grade—r=.49, N=24, p<0.05). The strongest correlation was seen in the third grade

(r=.49, N=24, p<0.05). With this research question, the hypothesis was not supported where it was predicted that students in the first grade would have the strongest correlation. Instead a strong, positive, statistically significant correlation was seen with students in the third grade.

Relationship between gender and visual-motor integration skills

In Table 12, which follows, information is provided on the *Levene's Test of Equality of Error Variances* across the gender groups using VMI Percentile Rank as the dependent variable.

Table 12

Levene's Test of Equality of Error Variances Across Gender Groups and Visual-motor Integration of School A

F	df1	df2	Significance
.46	1	75	.50

In Table 13, which follows, information is provided on the means of the gender groups of School A across *VMI Percentile Rank.* The standard deviation between scores is also provided.

Table 13

Means of Gender Groups of School A

Gender	Mean	Std. Deviation	N
1	76.63	25.52	43
2	74.85	26.04	34
Total	75.84	25.59	77

In Table 14, which follows, a summary of the ANOVA data of School A is found between gender groups and scores on the *Beery VMI*.

Table 14

Summary of ANOVA Data of School A Across Gender Groups and Scores on the Beery VMI

Source		df	F	Sig	Partial Eta	Observed Power
Gender	Hypothesis	1	0.90	.76	0.001	0.060
Reading Percentile Rank	Error	75				

To determine the effect of gender on the visual-motor integration skills of a student, a Univariate Analysis of Variance (one-way ANOVA) was completed using *SPSS® 20*. Of the 77 participants, 43 were male and 34 were female. The mean VMI Percentile Score for the males was 76.63 while the mean VMI Percentile Score for the females was 74.85. In each case, the standard deviations were similar, where the standard deviation for males was 25.52 while the standard deviation for females was 26.04. The *Levene Test for the Equality of Error Variances* (Table 12) indicated a non-significant p-value (p=.50) between the two groups indicating that the variance across the two groups were not statistically different (Table 13); therefore, the underlying assumption of homogeneity of variance was supported. These results leads to the inability to reject the null hypothesis which stated the means between the groups were not statistically different. In this case, the F-value (Table 14) also indicated that the differences between the two groups were not significant [F (1, 75) =.090, ns], where *p*=.76. The power value (Table 12) for this study was .60 indicating that this result has moderate power, so interpretations of the statistical data are acceptable. Overall, the statistical values from this analysis points out that there are not statistically significant differences between the means of the gender groups with performance in visual-motor integration tasks. With these results, the research hypothesis stating that females would have higher visual-motor integration skills than males was not proven.

Summary

In School A results indicated (1) a statistically significant correlation between visual-motor integration skills and reading ability (*r*=.54, p<0.01); (2) a positive, non-statistically (moderate effect size) relationship between visual-motor integration and reading ability in participants in first grade (*r*=.33, N=26, ns); (3) a statistically significant correlation between visual-motor integration skills and reading ability in the second and third grade, where the strongest correlation was seen in the third grade (second grade *r*=.48, N=27, *p*<0.01and third grade *r*=.49, N=24, p<0.05) and (4) a non-statistically significant relationship between visual-motor integration skills and gender [F (1,75)=.090, ns]. In school B, results indicated a small, but non-significant (moderate effect size) correlation (*r*=.29, N=20, ns) between visual-motor skills and reading achievement. These results point to a positive correlation between visual-motor integration skills and reading achievement, supporting a relationship between visual-motor integration skills and reading. To further strengthen the results of this relationship are the data that point to a statistically insignificant difference in the means between visual-motor integration skills across gender groups. The lack of a difference between these groups provides further support that the results seen between visual-motor integration skills and reading achievement is not affected by a student's gender.

Research has supported that reading ability involves more than phonological awareness, phonological decoding, naming speed, orthographic processing, morphological awareness, and vocabulary. Rather, the role of visual information processing skills, specifically visual-motor integration skills, is an important factor in the reading ability of a student. These results point to the need for educators to understand this role and provide adequate assessment, intervention or support services to students with decreased reading skills to improve students' success with reading.

Chapter V

Discussion

Reading is an important component of student's academic success and eventual success in the community. Research has pointed to a variety of factors that are important to the development of reading skills and the subsequent success of young readers (Hammill, 2004; Kirby et al., 2008) These factors include phonological awareness, phonological decoding, naming speed, orthographic processing, morphological awareness, print awareness, alphabet knowledge, phoneme-letter awareness, and vocabulary (Hammill, 2004; Kirby et al., 2008) One area that has been studied as being important in reading, is the role of visual perceptual skills and the effect on reading (Eden et al., 1995; Kulp, 1996. Lipa, 1983; Massaro & Sanocki, 1995). Within the area of visual perceptual skills, visual-motor integration has also been studied specifically to determine the effect on reading (Kavale, 1982; Kulp, 1999; Solan, Mozlin, & Rumpf, 1985; Maples, 2003) due to the unique combination of visual perceptual skills that are manifested in the completion of a visual-motor task. The results of these studies have indicated that visual-motor integration skills can be one important component and predictor of reading achievement.

In the study of the role of visual-motor integration on reading achievement, previous research studies had not utilized classroom specific reading assessment to determine a student's reading ability (Kavale, 1982; Kulp, 1999; Maples, 2003; Solan et al., 1985). The goal of this was research was to utilize school specific reading assessments to determine (1) the relationship between visual-motor integration skills and reading achievement between students in first through third grade; (2) the relationship between visual-motor integration skills and reading achievement across each individual grade; and (3) the effect of gender on visual-motor integration skills. Establishing the role of visual-motor integration skills on reading achievement will provide teachers and administrators with a deeper understanding of the skills needed to read grade-level material. This understanding will allow for a more comprehensive view of the skills necessary to ensure reading success of students, which will be an important factor in reading intervention.

For this study, the visual-motor skills of students in two private schools in first through third grades were analyzed using the *Beery VMI*. The reading scores of the same students using school-specific reading assessments, STAR Reading Assessment, Reading A-Z, and Fountas and Pinnell Benchmark Assessment System were matched with the same students' visual-motor integration skills to determine the relationship between these two variables. Also, analyzed was the role of gender on the performance of visual-motor integration skills in an effort to ensure that gender is not a factor with the results from the Beery VMI and its effect on reading.

Summary of Findings

The results from this study found (1) a moderate, statistically significant, positive correlation between visual-motor integration skills and reading achievement in School A, which had a larger sample size (N=77); (2) a small, non-statistically significant (moderate effect size), positive correlation between visual-motor integration skills and reading achievement in School B, which had a small sample size (N=20); (2) a moderate, statistically significant, positive correlation between visual-motor integration skills and reading achievement across second and third grade, in School A, with the strongest correlation being seen in the third grade; (3) no mean differences between visual-motor integration skills and gender.

These results mirrored findings from previous studies where there was a relationship found between reading achievement and visual-motor integration skills. However, the key difference between previous studies and this study was the utilization of school-specific reading assessment measures rather than standardized tests as the primary measures of reading ability. With the results that provided support for a correlation between reading achievement and visual-motor integration skills, it becomes important for educators to understand that reading success in not dependent on solely the traditional indicators of reading ability, such as phonological awareness or phonological decoding. Rather, when a student has decreased reading skills, visual perceptual factors, specifically visual-motor integration, can also be analyzed to ensure a comprehensive view of the limitations that may affect the student's reading achievement.

Having an understanding of visual-motor integration skills, in reading achievement will also allow educators to determine the most optimal course of intervention to address reading deficits. The remedy for visual-motor integration deficits for a child may be as simple as making adjustments such as using a ruler to maintain line orientation when reading to more complex interventions such as visual therapy. Whatever, the level of intervention, the sooner it is implemented, the higher the rate of success for the student. Therefore, if educators are aware to look at these deficits early in the assessment process, there is an increased likelihood that it will be address quickly, thereby assisting the student with reading skills.

Limitations of the Study

The limitations in this study are in three general areas: (1) sampling procedures, (2) sample size, and (3) reading assessment instruments. The first limitation is the sampling procedures utilized in this study. The school was not selected randomly, nor were the participants. This was a convenience sample. The students who were given consent to participate in this study were probably provided parental consent based on two concerns of the parents, either their child had a reading issue and the parents wanted to know if decreased visual-motor integration ability was the issue for the reading skills. A second reason would be that their child was a high performer and the parents were curious if the child's visual-motor integration skills were also an area where the child excelled. This disparity in the scores would make for large variability between the scores affecting the level of the relationship.

The second limitation was sample size. Though the correlation was strong with School A which had a larger sample size than School B, generalization still cannot be fully applied. This was due partly to the lack of random sampling. But, also, with such a small sample size, without much variability in the performance of the students with visual-motor integration tasks, generalization cannot be fully met. What would be more optimal would be to have a larger sample size where scores were much closer to a normal distribution. If a correlation was found between the two variables with such a sample, it would be more appropriate to generalize the results to the general population, where visual-motor integration skills would be more varied. The issue with the small sample size was also seen with School B where though there was a correlation, it was not statistically significant. This was largely due in part to the small sample size which affected the variability that was seen in the scores on both visual-motor integration skills and reading achievement.

The third limitation was the reading assessment instruments that were utilized. With School A, the STAR Reading Assessment was used to measure reading skills. This assessment provided scores per grade that had more variability than the Reading A-Z and Fountas and Pinnell Benchmark Assessment. For example, a third grade student's reading score can range from 3.0-3.11, with the number after the decimal indicating the month (11 month) of the school grade (third grade) in which the student displays reading ability. On the other hand, the Reading A-Z and Fountas and Pinnell Reading Benchmark system has the third grade reading achievement within three letters, which has less variability than the STAR Reading assessment. Therefore, the data from School A, which has more variability, is more likely to indicate a correlation as oppose to the data from School B, where there is less variability in the reading assessment. For the results to be truly generalizable, schools that utilize the same reading assessments should have been analyzed. Therefore, if School A, with a larger sample size, used the same reading assessment as School B, and garnered the same statistical data, it would have been more generalizable.

Implications for Future Research

The limitations of this study pointed to the need to conduct a study that had a larger, random, sample size using the same reading assessment measures between each school. A strength of this study was the analysis of two different schools to determine the relationship of visual-motor integration skills on reading achievement. A correlation was established between these two variables, though the relationship in School B, was not statistically significant. However, a correlation was seen in two different groups using two different reading assessment measures, pointing to the relationship between visual-motor integration skills and reading achievement.

For future research, there can two avenues of study. One would look at visual-motor integration and reading ability in a large, random, sample using the same reading assessment across all schools. Another option may be to look at visual-motor integration skills and reading ability in two different schools from two different SES areas, thereby strengthening the findings that, irrespective of other variables, such as economic status, visual-motor integration skills does have an effect on reading ability.

Summary

The results of this study supports findings of previous research that show a relationship between visual-motor integration and reading achievement. The strength of the correlation in School A and the strength of the effect size in School B supported the strong relationship between these two variables. This research pointed to the importance of understanding that reading achievement is not solely based on factors such as phonetic ability, but there were also physiological factors, such as optimal functioning of the visual cortex, important in the visual perceptual skills, namely visual-motor integration ability. Having this understanding will allow educators to assess the student in a comprehensive manner, looking at visual-motor integration skills, as one factor in the reading achievement with resultant intervention as needed.

To address intervention, implementation can occur on a variety of levels. The first level needs to occur with pre-service teachers. Research had shown that in-service teachers feel that their education of the role of visual skills were not adequate to meet the reading needs of students. Therefore, having education during the pre-service training years will allow new teachers to understand that visual-motor integration can play a part in reading ability. The second level of intervention must occur at the in-service level where teachers are informed of the role of visual-motor integration skills on reading achievement. With teachers having acquired knowledge of the role of visual-motor integration on reading achievement, the next step is to address the curriculum to include an environment that will assist with the development of visual-motor integration skills.

Addressing curriculum begins at the preschool level. At this stage, children should be provided with as many opportunities as possible to play in their natural environment to increase their body awareness, important in developing spatial and proprioception skills. Also important during the preschool years is the utilization of terms such as, “next to”, “around”, “to the right of”, “to the left of”, “in front” and “behind”. These terms increases a child’s awareness of their body in relation to other objects. It also helps them understand the relationship of objects to each other. These terms are also important for a child to understand when reading and writing and becoming proficient with these terms has the ability to transfer over with the aforementioned academic tasks of reading and writing. With writing students need to understand directionality when forming letters (to write the letter A, go down, back up and down, and write a line across). With reading, students need to understand that text is read from left to right and the relationship of letters to each other to form words.

To further develop visual-motor integration skills at the preschool level, students can be provided with an environment where they are exposed to forming lines and various shapes (square, triangle, and rectangle). Depending on the age of the child, this can be done using paper-pencil tasks or other materials such as sticks to form standard shapes. These activities can be done with teacher guidance for students to be exposed to these concepts in a manner that will foster their development.

To continue the development of visual motor skills during the later elementary school years, students can be provided with opportunities to develop higher level perceptual skills. This can include playing sports, riding bikes on various surfaces, and participation in activities that require higher level coordination such as dance.

In addition to being cognizant of curriculum changes necessary to develop visual-motor integration skills, educators must also be aware of treatment of deficits. The initial interventions begin with minor accommodations that can be made with reading to address the visual-motor deficits of students. This can include the utilization of a ruler with reading to assist with maintaining line orientation for students with eye-tracking difficulties. Other accommodations include dark-lined paper with writing and copying tasks to provide students with boundaries with paper-pencil tasks. These clear boundaries will assist students understand the exact area when writing or copying. This accommodation will allow students to focus on what is being written instead of needing to determine where to write, this singular focus will allow student to learn material optimally. Though accommodations are important in assisting children with visual-motor integration deficits, intervention is equally important in remediating visual-motor integration skills to improve academic performance.

The first step in proper intervention is to first understand members within the school that can assist with the development of visual-motor integration skills. Professionals such as occupational therapists can provide methods of improving visual-motor integration skills in the school, while outside the school setting professionals such as developmental optometrists can provide vision therapy to improve visual-motor integration skills. In this manner, educators become aware of the professionals both in and out of the classroom who can assist students with reading deficits. In the end, the student's needs are met to address reading achievement with resultant success in the classroom and the future. Once an understanding of the individuals that can assist with intervention, it is important for educators to understand what types of interventions are beneficial.

The most beneficial interventions have three important elements: (a) time and duration of treatment (b) types of activities (c) the level of interaction of the student with intervention activities. Research has shown the importance of having intervention be at least 30 minutes per treatment session, with interventions lasting anywhere from 12 weeks to a full school year (Brodney, et al, 2010; Dankert et al, 2003; Shin, et al 2011; Sigler and Wylie, 1994; Tzuriel and Eiboshitz ,1992;). Intervention can occur on an individual basis or on a group-level. Having these key time elements will be beneficial in developing visual-motor integration skills.

Research has also shown key elements with intervention activities. These include fine motor activities, drawing of shapes and forms with and without a model, and gross motor activities to develop large muscle groups (Dankert, et al, 2003; Lahav et al., 2008; Ratzon et al., 2009; Tzuriel & Eiboshitz, 1992). A final area that is supported as efficacious by research is the role of the student in the intervention (Tzuriel and Eiboshitz, 1992). Rather than having students complete forms in a rote manner, there must be a high level of cognitive interaction with completion of activities. This allows students to understand their deficits and internalize the methods they are being taught to address their areas of weakness. Tzuriel and Eiboshitz (1992) indicated, " 'pure' perceptual-motor practice is not enough to bring about a change in performance, but that a combination of training with metacognitive and other nonintellective factors will form an effective 'solution' that will bring about change." Therefore, allowing children have an understanding of what they are doing with the interventional strategies will be more beneficial to improvement rather than rote performance of intervention tasks.

Finally, caregivers can be provided with activities that can be performed at home to improve visual-motor integration skills. An important component of any intervention is carryover in the home environment. Caregivers can also be provided with the knowledge of the types of interventions and the most optimal environment to develop visual-motor skills. Ratzon et al. (2009) found that parents who were provided with a home parental program to address visual-motor integration skills were not only compliant with the home parental program, they were more satisfied than parents whose children received only classroom intervention. Therefore, parents also want a role in their child's visual-motor skills development making it beneficial to provide education and strategies to use at home.

With research to support the correlation between visual-motor integration and reading ability, it is important for educators to understand this unique relationship and its implications. Having an understanding of this relationship will provide educators with the knowledge necessary to adequately assess the reading skills of a student, looking at a comprehensive set of abilities necessary to read, including visual-motor integration skills. This knowledge will also assist educators to develop curriculum, interventions, and make the necessary referrals to the appropriate professionals if higher levels of interventions are needed to benefit the student.

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Appendix A

Human Subjects Approval

UNIVERSITY of HOUSTON

DIVISION OF RESEARCH

November 1, 2012

Turquessa Francis
c/o Dr. Nicole Andrews
Curriculum and Instruction

Dear Turquessa Francis,

The University of Houston Committee for the Protection of Human Subjects (1) reviewed your research proposal entitled "The Relationship between Visual-Motor Integration and Reading Achievement in Students in Kindergarten through Third Grade." on September 21, 2012, according to institutional guidelines.

At that time, your project was granted approval contingent upon your agreement to modify your proposal protocol as stipulated by the Committee. The changes you have made adequately respond to those contingencies made by the Committee, and your project has been approved. However reapplication will be required:

1. Annually
2. Prior to any change in the approved protocol
3. Upon development of the unexpected problems or unusual complications

Thus, if you will be still collecting data under this project on **August 1, 2013**, you must reapply to this Committee for approval before this date if you wish to prevent an interruption of your data collection procedures.

If you have any questions, please contact Alicia Vargas at (713) 743-9215.

Sincerely yours,

Daniel O'Connor

Dr. Daniel O'Connor, Chair
Committee for the Protection of Human Subjects (1)

PLEASE NOTE: (1) All subjects must receive a copy of the informed consent document. If you are using a consent document that requires subject signatures, remember that signed copies must be retained for a minimum of 3 years, or 5 years for externally supported projects. Signed consents from student projects will be retained by the faculty sponsor. Faculty is responsible for retaining signed consents for their own projects; however, if the faculty leaves the university, access must be possible for UH in the event of an agency audit. (2) Research investigators will promptly report to the IRB any injuries or other unanticipated problems involving risks to subjects and others.

Protocol Number: 13026-01 Full Review __X__ Expedited Review_____

316 E. Cullen Building Houston, TX 77204-2015 (713) 743-9204 Fax: (713) 743-9577
COMMITTEES FOR THE PROTECTION OF HUMAN SUBJECTS

Appendix B

Consent Form

Turquessa Francis, MS, OTR/L
Doctoral Student
University of Houston
Department of Curriculum and Instruction
343 Farish Hall
Houston, TX 77204-5027

Informed Consent Form for participation in the Following Study: The Relationship between Visual-Motor Integration Skills and Reading Achievement of students in First through Third Grade.

Project Director: Turquessa Francis, MS, OTR/L

To Parents or Guardians of ____:

Ms. Turquessa Francis, a doctoral student from the University of Houston's Early Childhood Education Department within the College of Education, is conducting a study called *The Relationship Between Visual-Motor Integration Skills and Reading Achievement of students in First through Third Grade.* We invite you to participate in this important research study.

This study is an investigation into the developmental skill of visual-motor integration (eye-hand coordination) and reading ability. Your child has been randomly selected to participate in this study during normal classroom hours. The *Beery Visual-Motor Integration Developmental Test (Beery VMI)*, an established test used to determine the level of visual-motor integration skills will be used. Reading levels will be provided by the teacher as obtained using the reading assessment system used by __________________ to evaluate their students' reading abilities. The reading levels have already been determined by the teacher at the beginning of the school year. Therefore, no time will be used by the researcher to determine reading levels. It takes no more than 15 minutes to administer the *Beery VMI*. So, the maximum amount of time it will take for your child to participate in this study is 15 minutes. Administration of the *Beery VMI* will occur in a separate, quiet location, in the academic building, at a time that has been determined by teacher to not interrupt with instruction.

PERMISSION REQUEST FOR PARTICIPATION: For all students, the researcher will meet with your child once in November 2012, depending on the schedule provided by ___________'s principal and staff, to administer the *Beery VMI*. The test takes a maximum of 15 minutes to administer. During this time, your child will draw a series of shapes that will test their visual-motor integration skill. Visual-motor integration is also known as eye-hand coordination. Therefore, completing the shapes will provide information on your child's eye-hand coordination ability.

The score results of the *Beery VMI* will be provided to the parents (who opt to have results sent home) and teachers of all students who completed the instrument, to provide teachers with an understanding of the student's visual-motor integration ability. If there are any questions regarding the scores or intervention, the researcher will be available to address those questions and provide intervention strategies if requested.

We are asking for permission to: 1. Test your child using the *Beery VMI* and 2. Have access to your child's reading levels as administered and recorded by the teacher. Your child's participation in this study is **VOLUNTARY**.

There will be no consequences should your child not participate in this study and completion of testing is not mandatory. You or your child can refuse to partake in testing at any time, even if consent has been granted by you. Your child also has the right to refuse to participate during testing should he or she feel uncomfortable with the test. All identifying information will be kept confidential.

BENEFITS: Your child will take part in a study that will be important in providing insight into the skills necessary for optimal reading. Each classroom teacher who has a student that is participating in the research study will receive written strategies that address visual-motor integration skills, a developmental skill that is important in other aspects of academic success, including writing and math skills. The researcher, an occupational therapist who is knowledgeable about visual-motor integration skills and interventions, will also be available to answer any questions related to visual-motor integration skills.

RISKS: Due to the short duration of the test and the simplicity of the test where only developmentally appropriate shapes are asked to be drawn, it is highly unlikely that participation in this test will pose a danger to your child. There may be a certain level of discomfort when a child hears that he or she has to take a "test". But, experienced test administrators are fully aware of possible test anxiety and will take every measure to help your child understand what is expected of them during the test, ease them into participating in the test to further decrease anxiety, and help them understand that should they feel uncomfortable at any time during the test, they have the right to inform the researcher that they no longer want to participate.

COMPENSATION: The teachers in all participating classrooms will receive a $10.00 gift certificate from Target.

CONFIDENTIALITY: All information collected in this study will be kept confidential. All testing materials will not contain the student's name. Rather a code will be used to identify the test taker. The same code will be used when matching the *Beery VMI* test results with the reading levels that are provided by the teacher. The master sheet that contains the names of the students with coordinating codes will be stored in a locked file at the University of Houston for three years, after which it will be shredded. Any reports that come out of this study will never identify any of the participants or their school in any way.

TESTING SCHEDULE IS AS FOLLOWS:

FOR QUESTIONS ABOUT THE STUDY: Please contact Turquessa Francis, Principal Investigator at, ___________ or Dr. Nicole Andrews, Faculty Sponsor at ____________. If you need to contact Ms. Francis and Dr. Andrews at the University of Houston, the address is as follows:

University of Houston
Department of Curriculum and Instruction—Early Childhood Education
____

Houston, TX 77204

FOR QUESTIONS REGARDING YOUR RIGHTS AS A PARTICIPANT: Please contact the University of Houston Committee for the Protection of Human Subjects at (713) 743-9204. The Committee for the Protection of Human Subjects ensures the protection of volunteers in research projects. Their office hours are between the hours of 8:00 AM and 5:00 PM. Please note that all research projects that are carried out by investigators at the University of Houston are governed by requirements of the University and the federal government.

Please note that the assent form that has been provided is for your child to complete at the time of the test. That assent form will be provided to your child on the day that test is administered. The copy that has been sent home can be saved for your records.

THE UNIVERSITY OF HOUSTON COMMITTEE FOR THE PROTECTION OF HUMAN SUBJECTS HAS REVIEWED THIS PROJECT FOR THE PROTECTION OF HUMAN SUBJECTS IN RESEARCH.

SUBJECT RIGHTS

1. I understand that informed consent is required by me and my child to participate in this study.

2. All procedures have been fully explained to me and all my questions have been fully answered.

3. Any risks and benefits related to this study have been explained to me to my full satisfaction.

4. I understand that, if I have any questions, I may contact the principal investigator, Turquessa Francis at ________________.

5. I have been informed that I may refuse to allow my child to participate or to stop their participation in this project at any time before or during the project.

6. I understand that any questions regarding my child’s rights as a research subject may be addressed by the University of Houston’s Committee for the Protection of Human Subjects. They can be reached at (713)743 9204, Monday through Friday between 8a-5p.

7. All research projects that are carried out by investigators at the University of Houston are governed by requirements of the University and the federal government.

8. All information that is obtained in connection with this project and that can be identified with my child will remain confidential. Information gained from this study that can be identified with my child may be released to no one other than the principal investigator. The results may be published in scientific journals, professional publications, or educational presentations and my child’s name will not be identified.

CONSENT FORM
PLEASE RETURN BY FRIDAY, NOVEMBER 9, 2012

If you wish to participate in this study, please detach and sign this consent form and return it to the teacher no later than **Friday, November 9, 2012**. Please maintain the remaining portion of the consent documents for your records to refer back to should you wish to review the study protocol and your rights as study participants. If you wish to withdraw your child from the study, for any reason, please call Turquessa Francis, at _______________. We hope to have the privilege of having your child participate in our research study.

CONSENT: I HAVE READ THE CONTENTS OF THIS CONSENT FORM. I HAVE BEEN ENCOURAGED TO ASK QUESTIONS TO ADDRESS ANY CONCERNS THAT I MAY HAVE WITH PROVIDING CONSENT. ALL MY QUESTIONS HAVE BEEN ADDRESSED.

(Please check where appropriate)

1. I give my child consent to be administered the *Beery VMI* by study researchers and to allow the researchers access to my child's reading scores.

__________ **YES** __________ **NO**

If you choose "YES" please indicate whether you would like the results of the *Beery VMI* sent home

__________YES, I WANT THE RESULTS ________NO, I DO NOT WANT THE RESULTS

First and last name of my child (print name): ____________________________________

Parent/Guardian (print name): ____

Signature of Study Subjects Parent/Guardian: _____________________________________

Date: ____

Thank you for your participation in this study!

Appendix C

Assent Form

Turquessa Francis, MS, OTR/L
Doctoral Student
University of Houston
Department of Curriculum and Instruction
Farish Hall
Houston, TX 77204-5027

Informed Assent Form for participation in the Following Study:
The Relationship Between Visual-Motor Integration Skills
and Reading Achievement in Children in First through Third Grade.
Project Director: Turquessa Francis, MS, OTR/L

Child Name: ________________________ Tester Name: __________________

Teacher: _________________________ Date: _________________________

ASSENT FOR PARTICIPATION
Today I want you to show me how well you can draw some shapes. This will show me how well your eyes and hands work together. Seeing how well your eyes and hands work together will teach me about how students read.

You can draw the shapes only if you want to. If you do not want to draw the shapes, let me know. It will be okay. If you have any questions, please let me know.

DOCUMENTATION OF PARTICIPANT'S ASSENT

I agree to participate in this study called: The Relationship Between Visual-Motor Integration Skills
and Reading Achievement in Children in First through Third Grade

Signature of minor participant: ____
Date: ____________________________

FOR QUESTIONS ABOUT THE STUDY: Please contact Turquessa Francis, Principal Investigator at, ____________ or Dr. Nicole Andrews, Faculty Sponsor at _________. If you need to contact Ms. Francis and Dr. Andrews at the University of Houston, the address is as follows:

University of Houston
Department of Curriculum and Instruction—Early Childhood Education
____
Houston, TX 77204

FOR QUESTIONS REGARDING YOUR RIGHTS AS A PARTICIPANT: Please contact the University of Houston Committee for the Protection of Human Subjects at (713) 743-9204. The Committee for the Protection of Human Subjects ensures the protection of volunteers in research projects. Their office hours are between the hours of 8:00 AM and 5:00 PM. Please note that all research projects that are carried out by investigators at the University of Houston are governed by requirements of the University and the federal government.