CONSTRUCT VALIDITY OF THE
PRESCHOOL VISUAL MOTOR
INTEGRATION ASSESSMENT

A Thesis
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By
Nicole Lynn Melin, B.S.

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Master’s Examination Committee:

Dr. Jane Case-Smith, Adviser
Dr. Marjean Kulp
Dr. Diane Sainato

Approved by

Jane Case-Smith
Adviser
School of Allied Medical Professions
ABSTRACT

The purpose of this study was to explore the construct validity of the Preschool Visual Motor Integration Assessment (PVMIA) through the known groups method. A second purpose was to investigate the relationship between the PVMIA scores and age. The results of the study support the construct validity of the PVMIA as a tool that measures visual motor integration and its ability to discriminate between children with visual motor delays and typically developing children. Typically developing children had statistically significantly higher scores than children receiving occupational therapy services on the total combined score, the two subtests: and the 8 individual categories that contribute to those subtests.

The results of this study also support the theory that visual motor integration is a process that moves along a developmental continuum during the preschool years. A Pearson Correlation found significant correlations between the age in months and the combined score on the PVMIA, the two subtests, and the 8 individual categories. The mean PVMIA scores for the four age categories, low, medium-low, medium-high, and high, were significantly different.
Dedicated to children with developmental disabilities and the occupational therapists who work with them.
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VITA

June 24, 1975...............................................................Born, Parkersburg, WV

1997..................................................................................B.S. Allied Medicine,
The Ohio State University

1998- present.................................................................Occupational Therapist
Greene County Educational
Service Center
Yellow Springs, OH

FIELDS OF STUDY

Major Field: Pediatric Occupational Therapy
School of Allied Medical Professions
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The enactment of the 1986 Amendment to Part B of the Education for all Handicapped Children Act (P.L. 99-457) guaranteed that preschool age children with special education needs could receive intervention services through the public school system (Garland, 2001). Under this legislation, occupational therapy is a related service that is delivered in conjunction with other special education services. When a child is first assessed to determine eligibility for special education services in the state of Ohio, it is required that vision be examined but the procedural interpretation of the law does not specify the exact type of examination (Ohio Department of Education, 2000). The school nurse is frequently responsible for completing a visual screening in the school environment (Fryer & Igoe, 1996).

If a preschooler's visual acuity is examined, it is often screened by using assessments such as the Lea Symbols Test (Scheiman, 2002). The use of a depth
perception test screens for problems with how the eyes are working together (Rouse, 1994). If the child’s eye movement system, which is defined as pursuits, saccades, and convergence, is assessed, it is by enticing the child to follow a moving target with the eyes, move the eyes between two targets, and watch as a target moves close to the nose and then away, respectively (Chaikin, 2001).

Unfortunately screening visual acuity and eye movement only assesses what Warren (1993) identifies as the foundational skills or the visual receptive skills that underlie all other visual cognitive skills. Foundational skills include visual acuity, eye teaming, focusing, oculomotor control, and visual fields. The visual cognitive components include visual attention, visual memory, visual discrimination, form and spatial perception and integration with other systems (Schneck, 1998). A child can have his or her foundational skills in place and still have disruption at the higher levels of perception. Therefore, a visual screening by a school nurse or other professional that only examines the visual receptive components does not rule out the presence of visual cognitive difficulties.

Furthermore, vision does not develop by itself, but in intimate relation to other abilities (Seideman & Marcus, 1989). Vision is a total process and all components, including integration with other systems such as the motor system, must also receive a thorough evaluation in order to assess and treat functional problems. Evaluation of these components using standardized assessment tools provides objective scores that enable unbiased communication among professionals and advancement of the profession through research (Campbell, 1989). Normed referenced assessments also enable
professionals to compare an individual child's behavior to what would be expected for a typically developing child (Laszlow & Bairstow, 1985).

SIGNIFICANCE OF THE PROBLEM

In human beings, vision is the dominant sense that contributes to the perception of the external world and therefore has a significant impact on the ability to complete functional tasks (Schneck, 2001). Visual-motor integration follows a processing model in which the sensory information is received through the structures of the eye and transmitted to the visual cortex of the brain. Then the information is processed through cognitive analysis skills, and finally there is an observable output that forms the basis of visual perceptual skills (Todd, 1999). A child's ability to fully integrate the visual information processing skills with fine motor movement is termed visual-motor integration (Scheinman, 2001).

In a preschool setting occupational therapists are often interested in a child's visual-motor integration skills as they relate to functional tasks such as prewriting and handwriting readiness skills (Oliver, 1990). Handwriting problems are commonly the reason for occupational therapy referrals in the school environment (Chandler, 1994). There are numerous studies that support the significance of visual-motor skills as they relate to handwriting performance (Cornhill & Case-Smith, 1996; Macland, 1992; Tseng & Chow, 2000; Tseng & Murray, 1994; Weil & Cunningham Amundson, 1994; Weintraub & Graham, 2000). Furthermore, several studies have demonstrated that a large portion of an elementary age child's day is spent on visual-motor tasks such as writing
(McHale & Cermak, 1992; Ritty, Solan, & Cool, 1993). Occupational therapists working with children have a responsibility to understand and assess the impact of visual-motor integration on functional performance (Todd, 1999).

Visual-motor integration is not well understood and sometimes difficult to assess because it is not a single process. A child could do poorly on a visual motor assessment because of decreased visual-cognitive skills alone, fine motor disturbances alone, or the integration of these skills (Schneck, 2001). Commonly used visual motor integration assessments include the Developmental Test of Visual Motor Integration (Beery, 1997), The Test of Visual Motor Skills-Revised (Gardner, 1995), and the Test of Visual-Motor Integration (Hammill, Pearson, & Voress, 1996). Other professionals, such as optometrists, educators or psychologists, who use these assessments may be examining the visual motor skills of a child from a different frame of reference than an occupational therapist may use. However, the newly published Preschool Visual Motor Integration Assessment, PVMIA, is an evaluation tool developed by two occupational therapists, Gertrude Deitchman and Cordelia Puttkammer (2001). The PVMIA is a standardized and norm referenced evaluation tool that strives to assess the intimate relationships of visual perceptual and fine motor skills in preschool age children through specific quantitative measurement of performance on drawing and block design subtests. The PVMIA has unique scoring characteristics that better enable an occupational therapist to develop appropriate therapeutic goals and objectives based on the child’s strengths and weaknesses.

In order to have confidence in an evaluation tool, it must have reliability and validity (DePoy & Gitlin, 1994). Reliability refers to the stability of an evaluation and
validity refers to whether the findings reflect the intent of the tool (Gyurke & Prifitera, 1989). When an evaluation tool is newly developed, it requires many studies to confirm its validity, and validity studies are typically considered to be an ongoing process (Benson & Clark, 1982). The authors of the PVMIA found it to have good concurrent validity when compared to Developmental Test of Visual Motor Integration (Deitchman & Puttkammer, 2001).

Construct validity is critical when an evaluation tool measures an observable output that is directly based on a theoretical concept (DePoy & Gitlin, 1994). When examining an evaluation tool such as the PVMIA, visual-motor integration is a concept that cannot be measured directly, but the behaviors that are a result of visual-motor integration, such as replicating drawings and block designs, can be measured directly. It is necessary to have data on an assessment’s validity because if the evaluation tool’s validity is in question so too will be the intervention based on the evaluation (Campbell, 1989).

RESEARCH APPROACH

The purpose of this study is to examine the construct validity of the PVMIA. There is no single method to confirm construct validity; however, construct validity of the PVMIA will be examined here through the known groups method. First the known groups method is used to discriminate between individuals who are known to have the trait that the evaluation tool tests and those individuals who do not have the trait (Portney & Watkins, 1993). The PVMIA will be administered to two groups of children,
one group of typically developing children and one group of children who receive occupational therapy services in a public preschool setting as determined by receiving a −1.50 or greater standard deviation from the mean on the Peabody Developmental Motor Scales- Fine Motor Scales. The authors of the PVMIA also used this approach when researching the validity of the assessment tool (Deitchman & Puttkammer, 2001). Higher PVMIA scores by the typically developing children will support the construct validity of the test as a measure of visual motor integration.

Another aspect of construct validity is that the evaluation tool should be related to external measures in a manner that is consistent with the construct (Ary, Jacobs & Razavieh, 1979). A hypothesis that is common in the literature is that visual motor integration is a process that moves along a continuum of development as a child matures (Borsting, 1994, Cratty, 1986; Williams, 1983). A significant relationship of the PVMIA scores to age in typically developing children will support the PVMIA.

RESEARCH QUESTIONS

The present study was designed to test the following hypotheses:

1. The PVMIA scores of typically developing children will be significantly higher than the scores of children who receive occupational therapy services in a public preschool setting as determined by scoring at least −1.50 standard deviations below the mean on the Peabody Developmental Motor Scales- Fine Motor Scale.

2. The PVMIA scores will demonstrate a significant relationship to age in typically developing children.
CHAPTER 2

LITERATURE REVIEW

INTRODUCTION

In this chapter, a model of visual-motor integration, which synthesizes perspectives from educators, optometrists, and occupational therapists, will be discussed. Examples of research investigating populations of children shown to have visual-motor integration difficulties will be explored. This will be followed by a review of research that demonstrates the functional impact of visual-motor integration difficulties. Evaluation tools currently used to assess visual-motor integration will be examined. This will be followed by a thorough review of the Preschool Visual Motor Integration Assessment (PVMIA). Next there will be a comparison of the existing visual-motor integration assessments with the PVMIA. Finally, test development, specifically forms of test validity and examples of research, will be described.
THE VISUAL-MOTOR INTEGRATION PROCESS

In human beings, vision is the dominant sense that contributes to the perception of the external world (Schneck, 2001). Therefore, occupational therapists have had a long history of concern for the impact that the visual system has on the completion of functional tasks (Todd, 1999). Visual perception results from an interaction between visual and cognitive skills. Furthermore, the integration of the visual information processing skills with the motor system is termed visual-motor integration (Scheiman, 2001). The ability to coordinate visual processing with the motor skills enables a vast majority of the interactions between an individual and the surrounding environment. Laszlo and Bairstow (1985) stated that “all movements, whether simple or complex, depend, for their efficient and smooth performance, on a number of perceptual and motor processes” (p. 11). Children initially develop visual and motor systems independent of one another (Cratty, 1986). Next, visual-perceptual and motor skills become closely paired and lastly can function together or independently, depending on the task demands.

Borsting (1994) explains visual-motor integration by elaborating on Laszlo and Bairstow’s (1985) closed-loop theory of perceptual-motor control. This framework consists of four interconnected components: input, central processing, output, and feedback. Visual input comes from the environment through the oculomotor system (Borsting, 1994).

Some call this input visual function (Lieberman, 1984) and others consider this visual-reception (Schneck, 2001). Warren (1993) has conceptualized a hierarchical model of visual perceptual development in which each visual skill is dependent on the
integration of the previous visual skills for optimal visual functioning. The model begins with the input of visual information to the brain through three foundational visual-receptive skills upon which all other visual skills are reliant. These foundation skills are oculomotor control, visual fields, and visual acuity. Ocular motor control refers to the eye movement system. Eye movement is controlled by six extraocular muscles, which enable the skills of pursuit eye movements or tracking, the fixation on a moving target, and saccadic eye movements or scanning, the rapid change of fixation between multiple targets (Chaikin, 2001). A third type of eye movement is the coordinate movement of the eyes together: inward, convergence, and outward, divergence. These vergence abilities result in depth perception or stereopsis. The visual fields are essentially a registration of the visual scene to the brain. Visual field registration begins in the photoreceptor cells in the retina, continues along the optic nerve and optic track, and travels through the temporal and parietal lobes of the brain to end in the occipital lobes. If visual fields refer to the quantity of visual information sent to the brain, visual acuity refers to the quality, or clarity of that information (Warren, 1993). Accommodation, occurring as the ciliary muscles acting on the lens of the eye, allows clear vision at various distances (Chaikin, 2001). A disturbance of these foundational skills, oculomotor control, visual fields, and visual acuity, will affect quantity and quality of visual input to the brain that is then available for higher level visual cognitive skills (Warren, 1993).

In addition to visual input, another important element to the input portion of the closed-loop model is kinesthesia, the incoming information regarding the posture of the body and limbs (Laszlo & Bairstow, 1985). This input comes through the receptors located in muscles and joints and carries information regarding the extent and direction of
movement, timing of the movement, and force produced by the muscles (Laszlo & Broderick, 1991). This input will be used to generate an appropriate motor plan in the next step of the model.

Central processing, the next step of closed-loop model, involves both the cognitive-perceptual and motor programming elements (Laszlo & Bairstow, 1985). The cognitive-perceptual processing skills that occur during this step have also been called cognitive analysis skills (Todd, 1999) and visual-cognitive components (Schneck, 2001). These skills include visual attention, visual memory, and visual discrimination (Todd, 1999). They also contribute to the visual-perceptual hierarchy (Warren, 1993). Visual attention has a critical effect on visual information analysis and learning, and it consists of four factors: alertness, selective attention, visual vigilance, and shared attention (Schneck, 2001). Alertness is an attentive state of mind. Selective attention refers to the ability to focus on important input and filter out extraneous visual information, while shared attention refers to the ability to attend to two or more simultaneous tasks.

Vigilance is the length of time spent on a visual task. Visual attention is necessary for visual memory to take place (Todd, 1999). Visual memory involves coding and categorizing visual information for storage and retrieval. Finally, visual discrimination involves recognizing key features, matching similarities, and categorizing similarities and differences of visual stimuli (Schneck, 2001). Visual discrimination includes both object perception, which are physical attributes such as color, texture, shape, and size, and spatial perception, how objects are located in space. Object perception includes form constancy, the recognition of objects in various environments, positions, and sizes, visual closure, the identification of an object from an incomplete presentation, and figure-
ground, the ability to differentiate between foreground and background objects. Spatial perception includes position in space, the spatial relationship of an object to itself or other objects, depth perception, the distance between objects, and the topographic orientation, the determination of the location of an object. Within the visual-perceptual hierarchy, disruption of any of these skills will affect the integrity of the entire system (Warren, 1993).

Central processing also includes the motor programming unit (Laszlo & Bairstow, 1985). Development of a plan is not only based on cognitive analysis but also information from the feedback loops and information stored in memory about the movement (Laszlo & Broderick, 1991). The motor programming unit selects the appropriate motor units, and the temporal sequence for the activation of the units so that it matches the task’s direction, extent, velocity, and force.

The next step of Laszlo and Bairstow’s (1985) closed-loop model is the output, or a muscle response. This muscle response creates an observable output that indicates the effectiveness of the interactions of the previous central processing components (Todd, 1999). One form of output that results is the ability to manually reproduce complex visual patterns (Borsting, 1994). Beery (1997) identified the ages at which at least 50% of the children studied were able to integrate the visual and motor systems to adequately copy various geometric forms. For preschool age children they were: vertical line, 2 years 10 months (2-10); horizontal line, 3-0; circle, 3-0; cross, 4-1; right oblique line, 4-4; square, 4-6; left oblique line, 4-7; oblique cross, 4-11; triangle, 5-3, and open square touching a circle, 5-6. Essentially, a child’s drawings are the transformation of mental images to pictures on paper through motor execution (Laszlo & Broderick, 1985).
The final step in the closed-loop model is feedback (Laszlo & Bairstow, 1985). Feedback comes from the output, reinforcing observable behaviors, and new input to the system in two forms, corollary discharge and sensory feedback. The corollary discharge loop provides a copy of the original motor plan, while the sensory feedback loop carries the information regarding the progress and outcome of the movement, including proprioceptive and visual input. The central processing component uses this feedback when forming the subsequent plans of action.

When using the closed-loop model to explain visual-motor integration development of a child, skill maturation throughout various stages of the model will have an impact on the observable output. Cognitive analysis skills, motor planning, fine motor control, and the ability to use kinesthetic and visual feedback improves markedly as a child develops (Borsting, 1994). Moreover, when a child is learning a new skill, each attempt yields better visual processing, motor planning, execution of motor act, and feedback. The cycle is repeated over and over, enabling an improvement on subsequent attempts and learning to occur (Laszlo & Bairstow, 1985). Williams (1983) stated that “it is only through opportunities for moving and interacting with the visual environment that task-specific patterns of visual-motor stimulation are laid down in the nervous system, and that visual cues ultimately can come to elicit rather automatic behavioral responses” (p. 120).
POPULATIONS WITH VISUAL-MOTOR
INTEGRATION DIFFICULTIES

When a child has difficulty with some aspect of the closed-loop model of visual-motor integration, it can have a pervasive effect on many functional tasks. There is a high incidence of visual motor difficulties within many of the populations of children that occupational therapists may encounter in the school setting (Scheiman, 2002). The visual motor integration skills of children with learning disabilities have been the subject of research studies for many years. Sherman (1973) found that of 50 children referred for visual exams who were diagnosed with a learning disability, between 72-80% had some form of visual perceptual-motor difficulties. Hoffman (1980) found that of 107 children (mean age of 8 years 8 months) referred for vision care who were diagnosed with a learning problems, 81% had visual motor integration problems as determined by performance of 1 or more years below age level. Rosner and Rosner (1987) investigated 757 case records of children between the ages of 6 and 12 years old who were seen at an optometry clinic. There were 261 children who had been identified as having learning difficulties and 496 non-learning disabled children. The group with learning difficulties had a significantly higher incidence of visual-motor difficulties, 78%, when compared with 25% in the non-learning disabled group. Waldron and Saphire (1992) examined 24 children who were of gifted intelligence but diagnosed with learning disabilities. The control group of gifted students without learning disabilities was matched for mental ability, age, sex, ethnic background, and socioeconomic status. Analysis of diagnostic
testing indicated that the learning disabled/gifted students were significantly weaker in visual discrimination, sequencing, and spatial abilities than the control group.

Visual-motor integration problems have also been found in children with psychiatric or emotional difficulties. Lieberman (1985) found that in a population of 55 students diagnosed with emotionally disabilities, greater than 50% had visual-motor development, visual-motor integration, and form reproduction scores significantly below their age. Daniels and Ryley (1991) also found that among 25 children ranging in age from 7 to 10 years old that had psychiatric disorders, there was a significantly higher incidence of visual-motor integration deficits when compared to typical children.

Children born prematurely have also been found to have visual-motor difficulties. A study of 60 children who were born with extremely low birth weight (ELBW) were assessed at age 4 and compared with randomly chosen comparison groups matched for age, gender, race, and socioeconomic status (Halsey, Collin & Anderson, 1993). The researchers found that the ELBW group’s scores on the VMI averaged one standard deviation below the mean of the comparison groups. The same researchers, Halsy, Collin and Anderson (1996) continued their longitudinal study in which 54 of the original 60 ELBW group were again assessed at age 7. The mean scores for the ELBW group on the VMI continued to average one standard deviation below those of the comparison group.
RELATIONSHIP BETWEEN VMI, FINE MOTOR SKILLS, HANDWRITING AND ACADEMICS

Children with visual-motor integration difficulties may have a variety of problems with functional tasks such as work, play, and self-care (Schneck, 1998). Work tasks for children predominantly involve educational activities and these educational activities largely involve the task of writing (McHale & Cermak, 1992; Ritty, Solan, & Cool, 1993). Handwriting problems are a common reason for occupational therapy referrals in the school environment (Chandler, 1994). Handwriting is a complex skill that is dependent on the integration of cognitive, perceptual, and motor skills (Maeland, 1992). Therapists must understand the elements that contribute to handwriting if they are to provide the appropriate intervention (Cornhill & Case-Smith, 1996). There is much published research that supports the relationships of visual-motor to a child’s handwriting skill.

Tseng and Murray’s (1994) study of 105 children in third through fifth grade examined the perceptual-motor skills of good and poor Chinese handwriters. The children were identified as 42 poor handwriters and 63 good handwriters. They were given a battery of tests that included the Developmental Test of Visual-Motor Integration (VMI), Test of Visual Perceptual Skills (TVPS), Upper Limb Speed and Dexterity (USLD) subtest of the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP), Motor Accuracy Test (MAC) of the Sensory Integration and Praxis Tests (SIPT), Finger Position Imitation Test (FiPIT), Kinesthesia (KIN) of the SIPT, and the Imitative Finger Movement (IFM) subtest of the Pediatric Examination of Educational Readiness at Middle Childhood
Multivariate analysis of variance was performed to compare the good and poor handwriter groups on the perceptual-motor tests and found a significant difference between groups. An overall correlation matrix of perceptual-motor measures and legibility found that legibility scores correlated significantly with all the measures, except the KIN test, and that of all the measures, the VMI had the strongest correlation with legibility ($r = .55$). Upon further analysis with a matrix of intercorrelations between the perceptual-motor measures and legibility for poor handwriters, they found that the VMI and FiPT were significantly related to legibility. A matrix of intercorrelations among the measures and legibility for good handwriters found that the VMI and the TVPS were correlated significantly. A stepwise multiple regression analysis used to identify the strongest predictors of legibility scores for the total group found that the VMI and the MAC were the only two significant predictors, with the VMI accounting for 30.5% of the variance. When examining the groups separately using stepwise regression, motor planing measured by the FiPIT was the best and only significant predictor of legibility (10.3% of variance), and, for good handwriters, visual perception measured by the TVPS was the best and only significant predictor of legibility scores (14% of the variance).

Weil and Cunningham Amundson’s (1994) study of 60 typically developing kindergarten children, between the ages of 64 months to 75 months, examined the relationship between the scores on the Developmental Test of Visual-Motor Integration, (VMI) and the ability to copy letters legibly. The children were administered the VMI short form and the Scale of Children’s Readiness In PrinTing (SCRIPT). Pearson product-moment correlation coefficient revealed a moderate correlation ($r = .47$) between performance on the VMI and the SCRIPT, indicating that visual-motor integration is a
factor in predicting handwriting performance. In addition, it was found that as a child’s ability to copy forms on the VMI increased, so did the ability to copy letters.

Cornhill and Case-Smith’s (1996) study of 48 normally developing first grade children, mean age of 7.3 years, investigated the components of handwriting that were most related to good or poor handwriting. The children were identified as either good or poor handwriters by their teachers using pre-established criteria. Of the 48 children, 23 were identified as having good handwriting and 25 as having poor handwriting. Each child completed the Motor Accuracy Test (MAC), Developmental Test of Visual-Motor Integration (VMI), two tests of in-hand manipulation, and the Minnesota Handwriting Test (MHT). Although all test scores for the children with good handwriting were significantly higher than those with poor handwriting, results indicate that the VMI scores were significantly lower for children with poor handwriting (15.0) than the children with good handwriting (23.6), $t = 5.02$, $p<.001$. Also following stepwise multiple regression analysis, it was found that VMI scores were significant predictors of MHT scores, indicating that the VMI was a significant predictor of handwriting performance.

Visual-motor skills are also an important factor in handwriting speed. A study of 34 slow handwriters and 35 normal speed handwriters in Taiwan, aged 7 to 11, used four measures to examine handwriting speed (Tseng & Chow, 2000). The Upper Limb Speed an Dexterity (ULSD) subtest of the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP), Test of Visual-Perceptual Skills-Non-Motor (TVPS), Developmental Test of Visual-Motor Integration (VMI), and Vigilance Task of the Gordon Diagnostic System were used to test the children. The normal speed handwriting group scored higher than
the slow handwriting group on all measures. The best predictors of handwriting speed among the slow handwriting group were age, visual sequential memory, and the VMI score. For the normal speed handwriters, age and the ULSD were the only significant predictors. The authors hypothesized that slow handwriters may rely more on visual processing and visual-motor integration than their counterparts with normal speed handwriting.

Weintraub and Graham’s (2000) study of fifth grade children, one group with good handwriting and one group with poor handwriting as determined by the Test of Legible Handwriting (TOLH), also investigated factors related to handwriting. The children were given a battery of tests. The tests included three tests measuring orthographic fluency and copying capacity, three finger function tasks, and the Developmental Test of Visual-Motor Integration (VMI). The researchers found that following logistic regression analysis of four factors, orthographic, finger function, visual-motor integration, and gender, only two factors, finger function and visual-motor integration, significantly predicted handwriting status.

Although handwriting is a common reason for referrals to occupational therapists, “therapy provided within the school setting is designed to enhance the student’s abilities to participate in the educational process” (Johnson, 1996, p. 696). School therapists are expected to examine how a delay in a performance component, such as visual-motor integration, might affect how a child accesses the entire regular education curriculum. Kulp (1999) investigated the relationship between visual-motor integration and various aspects of academic performance. The study of 191 children, with a mean age of 7.78 years old in kindergarten through third grade, examined visual-motor integration skills
with the Developmental Test of Visual-Motor Integration (VMI) and academic achievement with teacher reports and with standardized assessments that the school had administered. Each of the children’s teachers rated them in reading, math, and writing ability, while the second and third grade children were also rated in spelling. The Stanford Diagnostic Reading Test, 4th ed. had been administered to the first graders and the Otis-Lennon School Ability test (OLSAT), 6th ed. had been administered to the second graders. Spearman’s correlation analysis was performed and found that VMI performance was significantly related to reading, math, writing, and spelling ability for the entire group of children. The analysis by age group showed that VMI performance was significantly correlated with reading achievement ratings in 7 and 8 year olds, math and writing achievement ratings in 7, 8, and 9 year olds, and spelling achievement ratings in 8 and 9 years olds. When examining the standardized testing, the VMI was significantly correlated with performance on the Stanford Diagnostic Reading Test and with percentile scores on the OLSAT.

VISUAL-MOTOR INTEGRATION ASSESSMENTS

Visual-motor integration is a complex process and in order to avoid measuring it through subjective and individualized interpretation, standardized tools become critical (Campbell, 1989). The Developmental Test of Visual Motor Integration (Beery, 1997), Test of Visual-Motor Integration (Hammill, et.al., 1996), and Test of Visual-Motor Skills (Gardener, 1995) are visual motor assessments commonly used by occupational therapists (Todd, 1999). These assessments measure how accurately a child can visually
analyze a stimulus, dissect it into smaller parts, and, then by integrating the visual and motor systems, reconstruct an accurate copy of the stimulus. Several of the visual motor assessments have specifically stated similar aims such as identification of children with visual-motor difficulties, evaluating the effectiveness of intervention, and serving as a research tool (Beery, 1997; Hammill et al., 1996). However, visual motor assessments have similarities and differences in their approach to the measurement of visual motor skills.


The Developmental Test of Visual Motor Integration, 4th Edition, (VMI) by Keith Beery (1997) assesses the visual-motor integration skills of children age 3 to 18. The VMI has 27 geometric forms that are copied with paper and pencil providing a measurement of visual-motor integration; although a shorter, 18-item version is available for children ages 3 to 7. The VMI is an untimed test that should take approximately 15 minutes. Additionally there are also two supplemental tests, Visual Perception and Motor Coordination, which can be used following the VMI if an examiner suspects that the difficulties lie not in the integration of the two skills but within the components of visual motor integration separately. The Visual Perceptual requires a subject to examine 27 separate geometric forms and then point out a matching stimulus from several possibilities for each form within 3 minutes. The Motor Coordination test requires a subject to trace 27 forms with a pencil staying within a designated path within 5 minutes.
For the VMI, a testing booklet is used in which there are three geometric designs per page and the subject copies the design in a blank space that is 3 1/2 inches square below the stimulus design (Beery, 1997). Each attempt to copy the design is given a score of 1 point if the design meets the predefined criteria or 0 points if it does not meet the criteria. The manual provides descriptions and examples of scoring criteria as well as supplemental information such as developmental research and developmental trends for each form. The ceiling is reached when a child has not reached the criteria for 3 consecutive drawings. The Recording and Scoring sheet lists the “Norm Age,” that is 50% of the normed sample were able to meet the criteria when copying the form. Based on the summation of a raw score for the VMI and each of the supplemental tests if given, the examiner can then report standard scores, scaled scores and percentiles based on the norming population’s scores. While both supplemental tests use age groups that are in 4-month increments to derive the standard scores, the VMI uses age groups in 2-month increments.

The VMI and its supplemental tests were normed in 1996 on a sample of 2,614 children, ages 3 to 18 from the 5 major sections of the United States (Beery, 1997). School professionals were randomly selected from all 50 states and asked by mail to participate in collecting data from their school population. Twenty-six childcare, preschool, public, and private schools participated. Samples were selected to reflect the population of the 1990 U.S. census data, including gender, ethnicity, residence, geographic area, and socioeconomic conditions. These demographic characteristics are also equally distributed in each age group.
The VMI is reported to have strong psychometric properties (Beery, 1997). When three major indicators of overall reliability, interrater, internal consistency, and test-retest, are averaged for the VMI and its supplemental tests Visual Perception and Motor Coordination the results are .92, .91, and .89 respectively. The VMI also reports to have strong content, concurrent, construct and predictive validity. These forms of validity will be explored later in a section specifically examining test validity.

*The Test of Visual-Motor Skills-Revised (TVMS-R)*

The Test of Visual-Motor Skills-Revised (TVMS-R) by Morrison Gardner (1995) assesses the visual-motor integration skills of children 3 years to 13 years 11 months old. There are 23 geometric designs that a subject copies in a Test Booklet, 1 design per page. The stimulus design is in the upper half of a 7 x 8 1/2 inch piece of paper, making the lower half (7 x 4 1/2 inches) the space for copying the design. It should take approximately 10 minutes to administer the test. In addition to the Test Booklet, a Scoring Criterion Booklet is also used that details and illustrates the possible errors for each design. It is recommended that the examiner use a protractor and ruler when scoring the copied designs.

Each of the 23 geometric designs receives multiple points for accuracies and errors are also tallied (Gardner, 1995). There are eight classifications that can be used to score the designs: closure; angles; intersection and/or overlapping individual lines; size of design or part of design; rotation or reversal; line length; overpenetration or underpenetration; modification of design. The eight classifications help the examiner
pinpoint areas of concern when examining visual-motor integration. The accuracy raw scores are totaled and then using the normed data can be converted to a single motor age, standard score, scaled score, percentile rank, and stanine. The TVMS-R provides standard scores for age groups that are in 2-month intervals from 3 years 0 months to 6 years 11 months, then 4-month intervals from 7 years 0 months to 8 years 11 months, and finally 6-month intervals for the remaining ages.

The error scores are totaled for each of the eight Classifications and using the normed data the examiner can calculate a standard score, scaled score, percentile rank, and stanine for each classification in the 5 years 0 months and up age groups. The author remarks that the value of this scoring method gives “an examiner a more refined diagnosis of a subject’s visual-motor strengths and weaknesses” (Gardner, 1995, p. 10). However, if an examiner is only interested in visual-motor accuracies, the eight Classifications for error scores are not required to be scored. The TVMS-R does not have a basal or ceiling, so the subject is instructed to attempt all designs. However, examiner can discontinue the test after the subject completely fails four consecutive designs. If this occurs only the raw scores of the accuracies can be interpreted, not the error scores.

The TVMS-R was standardized and normed on 1,334 children from the San Francisco Bay Area in which approximately 52 percent were male and 48 percent female (Gardner, 1995). The children ranged from 3 years zero months to 13 years 11 months. The manual reports that the subjects were drawn from seven different schools, all either private or parochial.

Reliability of the TVMS-R was tested by two methods (Gardner, 1995). Kuder-Richarson reliability formula found reliability coefficients across all age levels to be .92
and Cronbach’s alpha found reliability across the age groups to be .90. The author reports that content validity of the TVMS-R was established during test development.

Construct validity was investigated and supported through positive correlation between the subscales and the test total. Gardner has completed concurrent validity studies with other visual motor measures. These will be discussed later in the section examining test validity.

*The Test of Visual-Motor Integration (TVMI)*

The Test of Visual-Motor Integration (TVMI) by Donald D. Hammill, Nils A. Pearson, and Judith K. Voress (1996) assesses the visual-motor integration skills of children age 4 through 17 years old. There are 30 geometric designs, 6 per page, that a child is asked to copy in a 2-inch square below the stimulus design. It takes approximately 15-30 minutes to administer. Each attempt to copy a design receives 0, 1, 2, or 3 points. The manual illustrates samples of drawings for each geometric design in each point category. A ceiling is reached when a subject scores a 0 on 3 items in a row. The raw scores are then converted to standard score, percentiles, and age equivalents utilizing the norming data. The TVMI uses age groups that are in 6-month intervals from 4 years 0 months to 7 years 11 months and then in 12 month intervals for the remaining age groups to derive the standard scores.

The TVMI was normed on a sample of 2,478 children living in 13 states (Hammill et al., 1996). Investigators were randomly chosen from a frame of professionals who had ordered visual-motor assessments sometime in the previous three years. Of the
initial sample, fourteen professionals agreed to collect data in a total of 29 different preschools, elementary and secondary school located in all 4 major United States census districts. When compared to the 1990 U.S. Census Data, geographic region, gender, race, residence, and ethnicity were represented appropriately in the sample.

Reliability for the TVMI appears to be strong (Hammill et al., 1996). Content sampling, or internal consistency, of items within the test for each age interval had a mean coefficient alpha of .91. Test-retest studies found $r = 0.80$ between testing times and interscorer studies $r = 0.96$. Overall reliability coefficients average $r = 0.91$ indicating good reliability. By utilizing the point biserial correlation technique, in which each item is correlated with the total test score, the authors were able to establish content validity during test development. In a concurrent validity study with 49 students, the correlation corrected for attenuation between the TVMI and the VMI was $r = 0.95$, suggesting equivalency between the two visual-motor measures. However, Beery (1997) refutes these results based on statistical errors. A construct validity study in which 24 subjects were given the Wechler Intelligence Scale for Children-Revised (WISC-R) and the TVMI found the following correlations: $r = 0.45$ (Verbal), $r = 0.93$ (Performance), and $r = 0.80$ (Full). The authors state that the results support construct validity of the TVMI because it showed a much higher correlation with the performance scale, a test which includes eye-hand coordination and block manipulation, rather than the verbal reasoning scale. Construct validity studies, such as the relationship of the TVMI and age and group differentiation have been completed and will be explored later in a section specifically examining test validity.
THE PRESCHOOL VISUAL MOTOR
INTEGRATION ASSESSMENT

The newly published Preschool Visual Motor Integration Assessment, PVMIA, is an evaluation tool developed by two occupational therapists, Deitchman and Puttkammer (2001). The PVMIA strives to assess the intimate relationships of visual perceptual and fine motor skills in preschool age children through specific quantitative measurement of performance on drawing and block design subtests that are standardized and norm referenced. To examine whether or not the PVMIA is a valid tool to use to assess a child’s visual motor skills, a thorough review of the tool is needed. The PVMIA’s purpose, test construction, item selection and psychometric properties are described here.

Purpose

The Preschool Visual Motor Integration Assessment (PVMIA) was designed to investigate the visual motor integration skills of children 3 1/2 to 5 1/2 years old (Deitchman & Puttkammer, 2001). Visual motor integration is defined as the ability of a child to reproduce what he or she sees. It is noted that visual motor integration relies both on visual perception and fine motor skills. The PVMIA was developed following the White House Conference on Early Childhood and Learning in April 1997 and the Individuals with Disabilities Education Act that was reauthorized in 1997. These governmental meetings recognized and mandated the importance of identifying and providing intervention for at risk children. The PVMIA provides a tool for professionals
to assess preschool children at risk for having visual motor integration difficulties, which may lead to future academic challenges.

The PVMIA is a norm referenced assessment that examines the developmental progression of visual motor skills first described by Gesell (Deitchman & Puttkammer, 2001). The PVMIA consists of both a Drawing and Block Patterns Subtests and two Behavioral Observation Checklists. The key feature of the PVMIA is the specific quantitative scoring for the two subtests which when combined with the detailed qualitative checklists provides a method to analyze visual motor difficulties in more detail than many of the current visual motor assessment tools. The detailed scoring of the PVMIA enables a professional to find specific areas of the visual motor skills that may not be fully developed and may be associated with functional problems.

Test Construction

The PVMIA consists of two Subtests and two Behavioral Observations Checklists. The first part is the Drawing Subtest which examines a child’s ability to recognize and reproduce lines and shapes through the two dimensional use of pencil and paper (Deitchman & Puttkammer, 2001). The eight drawings use the developmentally appropriate lines and shapes for preschool age children, but present them in novel designs to avoid commonly used prewriting strokes. For instance, rather than drawing a circle by itself there are 4 circles in a row so that the examiner is able to not only assess the motor accuracy of the production of the circles but also position in space, such as if the
sequence is parallel to the bottom of the paper, and spatial relationships, such as if there is adequate space between the circles and if the circles are similar in size.

The second part is the Block Patterns Subtest, which begins with nine items to determine if the child has the basic color and shape matching skills and position in space awareness to continue with further testing (Deitchman & Puttkammer, 2001). The remaining items are divided into two eight item sections of block pattern reproduction ("Reproducing Pictures") and block picture matching ("Matching Picture to Picture"). The goal is to examine a child's ability to recognize and reproduce three-dimensional patterns using colors and shapes. The block designs use colorful parquetry blocks and avoid the commonly used one-inch cubes that can be stacked and aligned.

The PVMIA has a total of 33 test items with quantitative analysis and the Behavioral Observation Checklist provides a qualitative method for the examiner to describe the process that the child uses to accomplish the test items. The subtest order was determined during test development after it was observed that the pencil tasks were more challenging and that children preferred the block play (Deitchman & Puttkammer, 2001). It was more logical for children to enjoy the block play after working hard to complete the drawings. When deciding the sequence of the sections of the Block Pattern Subtests, it was decided that although design matching ("Matching Picture to Picture"), a discrimination skill, was developmentally before block pattern reproduction ("Reproducing Pictures"), it was more logical to present it at the end to avoid a cumbersome process of introducing then removing the blocks multiple times.
Description of Test Items

The Drawing Subtest examines a child's ability to recognize and reproduce the lines and shapes of eight drawings, which were adapted from the Haworth Primary Visual Motor Test under the discretion of the authors. (Deitchman & Puttkammer, 2001). Each drawing has a variety of features that must conform to specific criteria to receive credit. These features are similarity, correct number of parts, motor accuracy, position in space, spatial relationships, and shape discrimination. Similarity means that the minimum features of the drawing must be included, while correct number of parts means that the drawing cannot have features that are added or deleted. Motor accuracy refers to the ability to produce round, closed circles and continuous straight lines. Excessive overshoots and/or gaps are not permitted. Position in space means that the drawing has correct orientation regarding horizontal and vertical planes. It also refers to the starting direction of the drawings, i.e. right to left, top to bottom, etc. Spatial relationships examine how the size and position of the parts of the drawing relate to each other and to the model test plate. Finally shape discrimination refers to the awareness of shape differences.

The Block Patterns Subtest begins with three items of matching block to block and then has six items of matching block to a picture of a block. These determine if the child has the basic color and shape matching skills and position in space awareness to continue with further testing (Deitchman & Puttkammer, 2001). The remaining items are divided into two eight item sections of reproducing pictures and matching picture to picture. The visual motor integration skills that are assessed include color and shape
discrimination, position in space, and spatial relationships. For color discrimination, a child must be able to differentiate between red, yellow, blue, green, and orange. While for shape discrimination a child must be able to differentiate between a square, triangle, and diamond. Position in space refers to orienting the blocks correctly when compared with the test plate. Rotations and inversions are not acceptable. Spatial relationships mean that the position of the blocks in relation to each other and the test plate are correct.

Test Standardization

A total of 510 children were tested during the pre-standardization and standardization process of test development (Deitchman & Puttkammer, 2001). The authors had a sample of children from across the United States, in a variety of socioeconomic groups, and from varying levels of parental education levels from which to draw their sample for PVMIA standardization. The standard sample was constructed to use age and sex as the differentiating variables. The sample size was determined by using Kraemer and Theimann’s tables for one-tailed tests at the 5% significance level for correlation between test scores and age. Based on this analysis it was determined that 20-50 children of each sex would have a 99% chance of significant results. Therefore because the PVMIA uses four age groups, the sample of 100 children of each gender was distributed into 25 male and 25 female in each age group. The 1990 U.S. census data on children under age 5 was used to guide the random selection of 200 children from their original sample into cells according to the cultural group proportions in the general population.
Reliability

Deitchman and Puttkammer (2001) used the Spearman Brown prediction formula to investigate test reliability, the extent in which the PVMIA is consistent. They report reliability indices of 0.91, 0.88, 0.83, and 0.90 for the Drawing Subtest, Block Patterns Subtest Section C, Block Patterns Subtest Section D, and Combined Total Score respectively. The authors report that inter-rater reliability, the stability of a test given by multiple examiners, was examined by having numerous experienced pediatric occupational therapists score the Drawing Subtest for three children. Four of the 74 pairwise comparisons of test item scores demonstrated significant differences between the raters at the 5% significance level using ANOVA.

Inter-rater reliability was examined for the Block Patterns Subtest with eight randomly selected children. Two occupational therapists alternated in giving the test and observing. Both therapists independently scored the items and they were in 98% agreement on the scores.

Test-retest reliability of the Drawing Subtest was investigated by using 13 subjects who were retested by the same examiner 3 to 4 months after the first test (Deitchman & Puttkammer, 2001). The authors report that the results were insufficient for statistical analysis. However, they note that development of visual-motor integration skills during the time between testing would be expected and was evidenced by 12 of the 13 subjects demonstrating an increase in their scores on the PVMIA.
Validity

Concurrent validity of the PVMIA was examined by giving 57 children both the Beery Developmental Test of Visual-Motor Integration and the PVMIA Drawing Subtest (Deitchman & Puttkammer, 2001). The correlation coefficient in a regression analysis was $r = 0.834$, significant at the $p<.0001$ level. These results show high concurrent validity for the Drawing Subtest. The authors were unable to find an assessment tool to compare to the Block Patterns Subtest.

Using the Delphi method, 13 specialists in pediatric occupational therapy completed a questionnaire to determine the validity of The Behavioral Observation Checklist. Based on the responses, the authors concluded that the Behavioral Observation Checklist has high content validity (Deitchman & Puttkammer, 2001).

Construct validity was explored by the authors by administering the PVMIA to seven children enrolled in special education preschool who were receiving occupational therapy services due in part to their performance on the Peabody Developmental Motor Scales. Deitchman and Puttkammer (2001) reported that all seven children did poorly on the Drawing subtest, but two performed adequately on the Block Patterns Subtest.

COMPARISONS OF THE PVMIA TO OTHER VISUAL-MOTOR INTEGRATION ASSESSMENTS

The PVMIA shares similarities and differences with other visual-motor integration assessments for preschool age children. However, there are several factors in
the development, design, administration, and scoring that make it unique as well (Deitchman & Puttkammer, 2001).

The PVMIA (Deitchman & Puttkammer, 2001), VMI (Beery, 1997), and TVMI (Hammill et al., 1996) were normed on a sample of children that was representative of 1990 U.S. Census Data with a sample of 200, 2,614, and 2, 478 respectively. The TVMS-R (Gardner, 1995) uses a non-representative sample of 1,334 children from one geographic area.

The PVMIA (Deitchman & Puttkammer, 2001) is specifically designed only for the use of testing children between the ages of 3 1/2 to 5 1/2 years old, unlike the VMI (Beery, 1997) which tests ages 3 through 18, the TVMS-R (Gardner, 1995) which begins at age 3 and goes almost to age 14, and the TVMI (Hammill et al., 1996) which tests age 4 through 17. Because the other tests are given to older children, who likely have greater motor control, the space that they provide to copy the geometric designs, which is directly below the stimulus designs, are considerably smaller than the PVMIA. The VMI provides a space that is 3 1/2 inches square, the TVMS-R a space that is 4 1/2 x 7 inches, and the TVMI a space that is 2 inches square. Unlike the VMI, TVMS-R, and TVMI that use a test booklet with the stimulus and drawing space in close proximity to each other, the PVMIA uses a piece of paper that is 5 1/2 x 8 1/2 inches and separate from the stimulus design that is on a test plate. During test development the authors of the PVMIA found that if the space to draw was on the same sheet as the stimulus drawing, preschoolers often traced the drawing rather than reproducing their own. Unlike the VMI, TVMS-R, and TVMI that use very familiar drawings, such as horizontal and vertical lines, circles, crosses, squares and triangles, the PVMIA uses novel designs that
incorporate these shapes. Deitchman and Puttkammer (2001) claim that because children have been continually exposed to these shapes, they have learned to draw them through practice.

The PVMIA (Deitchman & Puttkammer, 2001) utilizes several additional approaches to measuring visual-motor integration that are unique when comparing it to the other existing visual-motor integration assessments. The Block Patterns subtest offers the opportunity to assess visual-motor integration skills through a 3-dimensional medium and not through 2-dimensional paper and pencil alone. The blocks that are used are also unique parquetry blocks, avoiding testing children with 1 inch blocks that they may have been exposed to previously and have learned how to build with. In addition to the block designs, the PVMIA also provides a Behavioral Observations Checklist, which is beneficial to guide the qualititative assessment aspects of a visual-motor evaluation. The other visual-motor integration assessments lack these unique approaches to providing a thorough evaluation.

Administration of the visual-motor assessment can occur in a group setting for the VMI (Beery, 1997), TVMS-R (Gardner, 1995) and the TVMI (Hammill et al., 1996). Although, the author of the VMI recommends that children below kindergarten should be tested individually. It is recommended that the PVMIA (Deitchman & Puttkammer, 2001) is always administered individually.

The authors believe that “a key feature of the PVMIA is that scores are based on quantitative measurements of performance in reproducing lines, circles, and drawn figures rather than on qualitative judgments about how well they are reproduced” (Deitchman & Puttkammer, 2001, p. 9). The VMI (Beery, 1997) utilizes a pass/fail score
for each drawing and the TVMS-R (Gardner, 1995) awards 0-4 points for each drawing. Neither of these assessments assess individual categories within each drawing. The TVMI (Hammill et al., 1996) is the most similar to the PVMIA in that both use measuring tools to assess specific objective accuracies of the drawings. While the VMI and TVMI provide one global score based on the accuracy of all the drawings, the PVMIA and TVMS-R also provide scores that analyze the drawings using a multi-categorical approach that helps to more specifically identify visual motor difficulties. However, the TVMS-R does not begin to use scoring for the individual components until 5 years 0 months while the PVMIA provides these scores with the youngest age group, 3 years 6 months. The PVMIA also assesses the raw scores based on age and gender of the child. The other visual motor integration assessments that have been discussed use the age of the child to analyze the raw scores. During test development of the PVMIA, it was found that although age is the primary variable affecting test scores, the gender of the child is also a significant variable at the younger ages, although these differences disappear as children reach 5-6 years old.

The PVMIA assesses the intimate relationships of visual perceptual and fine motor skills in preschool age children through specific quantitative measurement of performance on drawing and block design subtests (Deitchman & Puttkammer, 2001). It appears to have many positive attributes that may make it particularly helpful in assessing visual-motor integration in preschool aged children.
The use of standardized evaluation tools ensures that therapists have a method to obtain objective and quantitative data that are easily shared among professionals and can contribute to the advancement of the field through research (Dunn, 1989). Furthermore, it is essential that an evaluation tool demonstrates reliability and validity if a therapist is to have confidence in the ability of the tool to be an accurate and stable measurement instrument (DePoy & Gitlin, 1994).

The reliability of an evaluation tool refers to its consistency in providing a measurement (Deitz, 1989). Reliability can take many forms. It can refer to the stability of its use by different examiners, at different times, in an alternate form, and within the individual test items. Although a valid evaluation tool has reliability, a reliable tool does not ensure that it has validity (Portney & Watkins, 1993). Validity refers to the extent to which an instrument measures what it claims to measure and is critical in determining the use of a test in a particular situation (Dunn, 1989). Portney and Watkins (1993) identify four main types of validity: they are face validity, content validity, criterion validity, and construct validity.

Face validity ensures that an instrument appears to test what it claims to test, while similarly content validity ensures that an instrument adequately assesses the entirety of the domain that it claims to assess (Portney & Watkins, 1993). Content validity begins during test development in which the items should be well researched and constructed. Both face and content validity can be assessed subjectively through the opinions of experts within the field (Ary, Jacobs & Razavieh, 1979). For example, The
Delphi method of using a questionnaire to record the opinions of 13 specialists in pediatric occupational therapy was used to determine the validity of the Behavioral Observation Checklist used in the Preschool Visual Motor Integration Assessment (PVMIA) (Deitchman & Puttkamer, 2001). Based on the positive responses, the authors concluded that the Behavioral Observation Checklist has high content validity.

Objective measures are used to determine a tool’s criterion-referenced validity, or how well its scores correlate to an existing valid tool (Portney & Watkins, 1993). There are two forms of criterion-referenced validity: concurrent validity and predictive. The Developmental Test of Visual-Motor Integration (VMI) was found to have concurrent validity ($r = 0.60$) with the Wechsler Preschool and Primary Scale of Intelligence (WPPSI) Geometric Design subtest in a study of 91 children between 5 and 6 years old (Aylward & Schmidt, 1986). The VMI’s subtests, Visual Perception and Motor Coordination, were found to have concurrent validity with the Developmental Test of Vision Perception (DTVP-2) subtests, Position in Space ($r = 0.62$) and Eye-Hand Coordination ($r = 0.65$) in a study of 122 students in kindergarten through 5th grade (Beery, 1997). Concurrent validity of the PVMIA was examined by giving 57 children both the Developmental Test of Visual-Motor Integration (VMI) and the PVMIA Drawing Subtest (Deitchman & Puttkamer, 2001). The correlation coefficient in a regression analysis was $r = 0.834$ demonstrating high concurrent validity. Concurrent validity of the TVMS-R with the Bender Gestalt was moderate (median correlation .51) and with the VMI (median correlation .51) (Gardner, 1995).

In order to obtain predictive validity, an evaluation tool must be shown to be a valid predictor of a future behavior (Portney & Watkins, 1993). A test with strong
predictive validity will assist an evaluator in making decisions that forecast possible outcomes. In a six-year longitudinal study of 497 kindergarten children Fletcher and Satz (1980) found that the VMI performance in kindergarten accounted for approximately 32% of the variance in reading ability at the end of second and fifth grades.

According to Dunn (1989), construct validity is a more abstract concept than the before mentioned forms of validity because it involves the theoretical premises that are measured by an evaluation tool. Of the forms of validity, some consider construct validity to be the most complex and comprehensive (Benson & Clark 1982; DePoy & Gitlin, 1994). Ary, Jacobs, and Razavieh (1979) state that, "the term construct is used to refer to something that is not itself directly measured but which explains observable effects" (p. 261). When examining an evaluation tool such as the PVMIA, visual-motor integration is a concept that cannot be measured directly, but the behaviors that are a result of visual motor integration, such as replicating drawings and block designs, can be measured directly.

Construct validity can be examined through a variety of methods. Portney and Watkins (1993) identify five measures of construct validity: known groups method, multitrait-multimethod matrix, factor analysis, hypothesis, and criterion validation. The known group method is used to discriminate between individuals who are known to have the trait that the evaluation tool tests and those individuals who do not have the trait. The authors of the TVMI used this method to investigate construct validity by comparing the test results of children known to have neurological disorders, in which literature supports a greater degree of visual-motor integration problems, with the test results of normally
developing children (Hammill, et.al., 1996). They found that children with neurological disorders had significantly lower scores, supporting construct validity.

The multitrait-multimethod matrix is used to determine that a tool both measures a particular construct and does not measure other constructs by looking at it with other tests arranged in a matrix (Portney & Watkins, 1993). The test being examined should have a high correlation with other tests that measure the same construct and low correlation with tests that measure other constructs. This is often an advisable form of validation if a researcher does not have a large enough sample to conduct factor analysis studies (Benson & Clark, 1982).

Factor analysis is a statistical procedure that groups the construct’s underlying components into correlated variables called factors. Portney and Watkins (1993) explain that “a factor represents a subset of test items or behaviors that are related to each other, but are not related to items in other factors; that is, each factor represents a unique combination of items that reflects a different theoretical component of the construct” (p. 78). Factor analysis requires large samples, of approximately 10 people for every item (Benson & Clark, 1989). Polubinski, Melamed, and Prinzo (1986) factor analyzed the VMI using a sample of 193 children in kindergarten through 3rd grade. They found that, of the 22 designs they analyzed, the VMI assesses four distinct levels of visual-motor development: simple horizontal and vertical lines, open geometric designs, closed geometric designs, and three-dimensional designs. By obtaining four factors, the researchers have shown that the VMI measures four dimensions of visual-motor integration.
Hypothesis testing examines whether an instrument’s constructs support theories in existing literature (Portney & Watkins, 1993). For example, the VMI claims to measure visual-motor skills which, based on theory, are developmental in nature. Beery (1997) hypothesized that the test results would be related to chronological age. The 1996 norming data for the VMI supports this hypothesis with a correlation of .83. The authors of the TVMI also found that their norming data had strong correlations between age and test performance when children are between ages 4 through 10 years old (Hammill, et. al., 1996).

Another hypothesis of Beery’s is that certain medical diagnoses are known to have greater visual motor integration difficulties; therefore, the VMI should be able to discriminate those groups of individuals (Beery, 1997). Beery cites numerous published studies that support this hypothesis.

In order for a newly developed test, such as the PVMIA, to be used with confidence, validation must occur (Benson & Clark, 1982; Dunn, 1989). Moreover, the evaluation tool needs to be examined by multiple studies and through a variety of perspectives. Dunn (1989) also emphasizes the specific importance of construct validity studies on evaluation tools that examine abstract qualities of human behavior, such as perceptual organization.
CHAPTER 3

METHODOLOGY

INTRODUCTION

This study investigated the construct validity of the Preschool Visual Motor Integration Assessment (PVMIA). A methodological design called the known group method was used to examine the PVMIA’s ability to discriminate between children who received occupational therapy intervention services in a preschool setting and typically developing children. Using another method called hypothesis testing, the ability of the PVMIA’s scores to demonstrate a significant relationship to age in typically developing children was also examined. This chapter will discuss the research design, the hypotheses, subject selection, instrumentation and data collection, and statistical procedures.

RESEARCH DESIGN

First the known groups method was used to discriminate between individuals who are known to have the trait that the evaluation tool tests and those individuals who do not
have the trait (Portney & Watkins, 1993). This study used children with developmental
disabilities as the group with high probability of visual motor deficits. The PVMIA was
administered to two groups of children, one group being typically developing children
and one group children who receive occupational therapy services in a public preschool
setting as determined by receiving at least a −1.50 standard deviation on the Peabody
Developmental Motor Scales- Fine Motor Scales. The authors of the PVMIA also used
this approach when researching the validity of the assessment tool (Deitchman &
Puttkammer, 2001). Significantly higher PVMIA scores by the typically developing
children will support the construct validity of the test as a measure of visual motor
integration.

Another aspect of construct validity is that the evaluation tool should be related to
external measures in a manner that is consistent with the construct (Ary, Jacobs &
Razavieh, 1979). A hypothesis for the PVMIA is that it measures age-related visual-
motor integration, and, therefore, scores increase as the child becomes older. A
significant relationship between the PVMIA scores to age in typically developing
children will support the PVMIA’s ability to measure visual-motor integration as it
develops in the preschool child.

HYPOTHESES

The present study was designed to test the following hypotheses:

1. The PVMIA scores of typically developing children will be significantly higher
   than the scores of children who receive occupational therapy services in a public
preschool setting as determined by scoring at least −1.50 standard deviations below the mean on the Peabody Developmental Motor Scales- Fine Motor Scale.

2. The PVMIA scores will demonstrate a significant relationship to age in typically developing children.

SUBJECT SELECTION

The subjects that were used for this study were a convenience sample from two suburbs of Dayton, Ohio, Beavercreek and Oakwood. Forty five children, ranging in age from 3 1/2 to 5 1/2 years old were tested with the PVMIA.

The first group was comprised of 24 children, ages 3 1/2 to 5 1/2, attending Beavercreek City School’s Preschool Program and known to have a developmental disability. In order to qualify for services in this preschool, children either have a significant visual or hearing impairment, or have been evaluated by an educational team and found to be at least −2.00 standard deviations from the mean in one area or −1.50 standard deviations from the mean in two developmental areas. The areas include communication, motor, social-emotional/ behavioral functioning. Children who have a current score that was at least −1.50 standard deviations from the mean on the Peabody Developmental Motor Scales- Fine Motor Scale receive occupational therapy intervention services.

Children in this sample have a significant birth history, such prenatal drug exposure, a specific diagnosis from a medical doctor, such as pervasive developmental disorder (PDD), chromosomal abnormality, or global developmental delay, and/or a
general education label, such as preschooler with a disability. Children were eliminated from the group if they were not under constructional control, meaning that they did not have the attention or cognitive ability to participate in the evaluation in an appropriate manner, or if they had a major motor impairment, such as spastic cerebral palsy.

The remaining subjects for the known group method and hypothesis testing were from Beavercreek and Oakwood, Ohio. Twenty one children, ages 3 1/2 to 5 1/2, attending either private preschool programs or a public preschool program as typical role models were used for the group known to be typically developing children. These children were matched for ages to the group receiving occupational therapy services. Additional, the children were selected based on the criteria that they had no significant history of medical problems and were not suspected to have a developmental disability of any kind. This information was obtained through the completion of a “Child Information Form” (Appendix A), in which parents answered several questions regarding their child’s medical history and development.

Children were also given a visual screening by a registered nurse prior to the initiation of data collection if they attend public preschool or private preschool at BCLC (Appendix B). Children had to pass the screening for visual acuity, binocularity, and ocular mobility to be included in the study. Children who live in the Oakwood and attended private preschool were not screened by a nurse; however, their parents were asked if they suspected that their child had a visual impairment. They were only included if the parents had no concerns about their child’s vision.

Consent from a parent of each child in both groups was obtained prior to any testing procedures. Consent was also obtained from the preschool administrators of both
locations. Approval by the Behavioral and Social Sciences Human Subjects Review Committee at the Ohio State University was obtained prior to the initiation of collection of data (Appendix C). This ensured that the research methods conformed to accepted standards of ethical research.

INSTRUMENTATION

*Peabody Developmental Motor Scales - Fine Motor Scales*

The children attending Beavercreek City School’s Preschool Program are identified as having an educational disability and receive occupational therapy intervention services by having a current score that was at least \(-1.50\) standard deviations from the mean on the Peabody Developmental Motor Scales - Fine Motor Scale (PDMS-FMS). The PDMS is a standardized and norm referenced assessment that evaluates the gross motor and fine motor skills of children birth through 72 months (Folio & Felwell, 2000). The test can be administered and scored in one area of motor competency. It takes approximately 20-30 minutes to administer the Fine Motor Scale. The Fine Motor Scale is divided into two categories, Grasping (26 items) and Visual-Motor Integration (72 items), for a total of 98 items. Items receive 1, 2, or 3 points depending on how the child performs and meets the predefined criteria for each item.

Grasping includes a variety of items that primarily examines various grasping patterns and methods of manipulating materials such as how a child grasps cubes, pellets, and markers. Visual-Motor Integration includes similar tasks to the PVMIA such as
copying 3 stimulus drawings (circle, cross, and square) and replicating five one-inch cube block designs (train, bridge, wall, steps, and pyramid). Visual-Motor Integration also includes a variety of eye-hand coordination tasks such as stringing beads, using scissors to cut shapes, and folding paper.

*Testing Instrument*

The PVMIA takes approximately 20 to 30 minutes to administer and 30 minutes to score (Deitchman & Puttkammer, 2001). Only materials original to the test kit were used. In addition, the instructions and sequence of the test sections were followed as instructed by the test manual. The authors recommend that the testing environment have limited distractions, be well lit, and contain a table and chair appropriate for the size of the child. The test kit includes an examiner’s test manual, test plate booklet, record forms, drawing paper template, primary pencil, templates for scoring drawings, transparent ruler template, construction guide for block patterns subtest, block shapes, two blank cards, and a screen.

As a child completed each drawing in the Drawing Subtest, the examiner noted various observations on the recording form, for example the initial direction of the drawing or which part is drawn first (Deitchman & Puttkammer, 2001). The examiner made notes on the Behavioral Observations section immediately after testing, such as hand preference, position of the assistive hand, posture, paper placement, approach to task/attention, and type of pencil grasp used. Later when the examiner scored the assessment, the provided templates were used to determine detailed scores for the
drawings looking at these features: similarity, correct number of parts, motor accuracy, position in space, spatial relationships, and shape discrimination. The features of each drawing were scored "1" if it met the criteria and "0" if not. These points were then added to result in a total point score for each drawing, then the individual drawing scores were totaled for a Drawing Subtest raw score. In addition, the individual feature categories, similarity, correct number of parts, motor accuracy, position in space, spatial relationships, and shape discrimination, were also tallied.

The first section of the Block Patterns Subtest were not scored but instead used as a screening to ascertain if the child had the prerequisite skills, basic color and shape matching skills and position in space awareness, to continue testing (Deitchman & Puttkammer, 2001). If the child missed 3 or more items out of 6 items the Reproducing Pictures subtest was not administered and the examiner proceeded to the final section of the Block Patterns Subtest, Matching Picture to Picture. However, if the child successfully completed the prerequisite section, then the examiner administered Reproducing Pictures section next. This section involved reproducing pictures with blocks. The examiner noted any behavioral observations such as color confusion, shape discrimination difficulties, rotation of blocks, incorrect order of blocks, pattern reversals, and blocks positioned perpendicular to the table. In addition, immediately after testing, the examiner noted on the Behavioral Observation section grasp, manipulation, and release patterns, posture, bilateral integration, and approach to task/attention. Each Block Pattern item was scored based on the level of accomplishment using a weighted point system. The maximum number of points were given (5) for correct reproduction of a block design from a two-dimensional test plate. One point was subtracted if the child
needed a three-dimensional pattern, another point was subtracted to watch the evaluator build the design, and yet another point subtracted if the child needed a simplified block-to-block demonstration. Finally another point was subtracted if the child could correctly match the block on top of the test plate blocks, while no points were given if he or she could not complete the task at this level. Again this scoring method assisted the evaluator in better assessing the areas of weakness. The scores were then totaled for Reproducing Pictures.

The final section of the Block Patterns Subtest, Matching Picture to Picture, looked at the ability of the child to discriminate block patterns, a prerequisite to reproducing block patterns. The child had to choose between 3 two-dimensional block designs to match with a given design. A score of 1 point was given for each correct response. The scores were tallied in each separate category, Reproducing Pictures and Picture to Picture, and then the total points from both sections were added together for a total Block Patterns Subtest raw score. The raw score totals for both the Drawing Subtest and Block Patterns Subtest were completed separately and together for a Combined Total. The raw scores were divided into age groups in 6-month intervals for male and female in order to derive standard scores, which the examiner could then use to report stanines and percentile ranges to the parents. For the purposes of this study only raw scores were used in the data analysis.

Data collection

Data collection took place between May and September 2003. The entire sample of 45 preschoolers were tested individually by this researcher. A testing session
comprised one 20-30 minute session. The 24 children in the first group were tested while they were in attendance at Beavercreek City School’s Preschool Program. The researcher was the occupational therapist who provided direct therapy services to these children while they were in attendance at the preschool program; therefore, the children in this group were familiar with the researcher. The subjects were tested in this researcher’s office located in the same wing as the preschool classrooms. The office was well lit and free of visual and auditory distractions. A child-sized table and chair was used to facilitate optimal positioning.

The 21 typically developing children were tested while they were in attendance at either a private preschool program, BCLC, a public preschool, Beavercreek City School’s Preschool, or in his or her home in Oakwood. These subjects were not known to the researcher. Testing took place in a location that was well lit and free from visual and auditory distractions. A child-sized table and chair was used to facilitate optimal positioning.

For both groups of subjects, the PVMIA was administered precisely according to the Administration and Scoring Manual. This researcher sat opposite the child to maximize observation of pertinent behaviors. First the Drawing Subtest was administered. The child’s performance was recorded on the Record Form as the test was administered. There are specific prompts on the Record Form regarding the direction of the initiation of shapes, the sequence of the drawing, etc. The examiner also noted the child’s comments or behavioral responses next to each drawing. As each drawing was completed the researcher wrote the number of the corresponding drawing on the paper and set it aside for scoring later. Next the researcher gave the child the blocks and
allowed free-play while the completing Behavioral Observations Checklist for the Drawing Subtest. After the checklist was completed the researcher began the Block Patterns Subtest. The researcher noted observations of the child’s performance on the Record Form and scored each block design according to the level that the child performed. After the Reproduction of Block Patterns, the blocks were put away and the Matching Picture to Picture section was completed. This concluded the testing session. The researcher then completed the Behavioral Observations Checklists for the Block Designs Subtest.

STATISTICAL PROCEDURES

In order to test the first hypothesis that the PVMIA scores of typically developing children would be significantly higher than the scores of children who receive occupational therapy intervention services, the researcher used a t-test. The use of the t-test enabled a comparison of mean scores between two groups (Portney & Watkins, 2000). In this case the two groups were the typically developing children and the children who receive occupational therapy intervention services. Based on the hypothesis this researcher expected to find a significant difference between the mean scores of both groups, supporting the first hypothesis.

In order to test the second hypothesis only PVMIA scores from the typically developing children were used. The raw scores were correlated with chronological age to determine the relationship between PVMIA scores and age using a Pearson product-moment correlation. Additionally, a one-way analysis of variance (ANOVA) was used to
compare the four age groups, low, medium low, medium high, and high, and mean scores. Based on the hypothesis this researcher expected to find a significant relationship between the scores of the PVMIA and age and significant differences in scores according to age category.
CHAPTER 4

RESULTS

INTRODUCTION

This chapter reviews the results derived from data collection and analysis related to the construct validity of the PVMIA. First the research sample is described. Next, findings from the statistical analysis related to the research questions are reported. The differences between the mean scores on the PVMIA of the two groups of subjects, typically developing children and the children who receive occupational therapy intervention services, are explored. Also the relationship between the scores of the PVMIA and age and differences in scores according to age category of the typically developing children is reported. Additionally, differences in PVMIA scores according to gender are examined. Finally, interrater reliability on the scoring of the Drawing Subtest is reported.

DESCRIPTION OF THE SAMPLE

The subjects who participated in this study were a convenience sample from two suburbs of Dayton, Ohio, Beavercreek and Oakwood. Forty five children, ranging in age from 3 1/2 to 5 1/2 years old were tested with the PVMIA. The PVMIA age categories
are low: age 42-47 months, medium low: 48-53 months, medium high: 54-59 months, and high: 60-66 months.

The first group comprised 24 children, ages 3 1/2 to 5 1/2, attending Beavercreek City School’s public preschool program and known to have a developmental disability. There were five female and 19 male students. In order to qualify for services in this preschool, children had either a significant visual or hearing impairment or had been evaluated by an educational team and found to be at least -2.00 standard deviations from the mean in one developmental area or -1.50 standard deviations from the mean in two areas. The areas include communication, motor, social-emotional/behavioral functioning. Children who had a current score that was at least -1.50 standard deviations from the mean on the Peabody Developmental Motor Scales- Fine Motor Scale (PDMS-FMS) were eligible for consideration in this known group hypothesis testing. Qualifying scores on the PDMS-FMS were within the last year before PVMIA testing. While all children in this research sample received occupational therapy services (OT) and 10 hours a week of center-based preschool, they may also have received speech and language therapy (ST), physical therapy (PT), and/or adapted physical education (APE).

Children in this sample had either a medical diagnosis, as per their physician’s medical exam, or they had an educational label of “preschooler with a disability.” Table 4.1 contains the child’s age group, gender, diagnosis, and services received in preschool.
<table>
<thead>
<tr>
<th>Child</th>
<th>Age Group</th>
<th>Gender</th>
<th>Diagnosis</th>
<th>Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>High</td>
<td>M</td>
<td>Preschooler w/ disability</td>
<td>OT, ST, PT, APE</td>
</tr>
<tr>
<td>2</td>
<td>High</td>
<td>F</td>
<td>Preschooler w/ disability</td>
<td>OT, ST</td>
</tr>
<tr>
<td>3</td>
<td>High</td>
<td>F</td>
<td>Global Developmental Delay</td>
<td>OT, ST, APE</td>
</tr>
<tr>
<td>4</td>
<td>High</td>
<td>F</td>
<td>Preschooler w/ disability</td>
<td>OT, ST</td>
</tr>
<tr>
<td>5</td>
<td>High</td>
<td>M</td>
<td>Pervasive Dev. Delay</td>
<td>OT, ST, APE</td>
</tr>
<tr>
<td>6</td>
<td>High</td>
<td>M</td>
<td>Preschooler w/ disability</td>
<td>OT, ST, APE</td>
</tr>
<tr>
<td>7</td>
<td>Med high</td>
<td>M</td>
<td>Asperger’s syndrome</td>
<td>OT, ST</td>
</tr>
<tr>
<td>8</td>
<td>Med high</td>
<td>M</td>
<td>Left Hemiparesis</td>
<td>OT, ST, PT, APE</td>
</tr>
<tr>
<td>9</td>
<td>Med high</td>
<td>M</td>
<td>Preschooler w/ disability</td>
<td>OT, ST</td>
</tr>
<tr>
<td>10</td>
<td>Med high</td>
<td>M</td>
<td>Chromosomal abnormality</td>
<td>OT, ST, PT, APE</td>
</tr>
<tr>
<td>11</td>
<td>Med high</td>
<td>M</td>
<td>Preschooler w/ disability</td>
<td>OT, ST</td>
</tr>
<tr>
<td>12</td>
<td>Med high</td>
<td>M</td>
<td>Preschooler w/ disability</td>
<td>OT, PT, APE</td>
</tr>
<tr>
<td>13</td>
<td>Med high</td>
<td>M</td>
<td>Preschooler w/ disability</td>
<td>OT, ST</td>
</tr>
<tr>
<td>14</td>
<td>Med high</td>
<td>M</td>
<td>Preschooler w/ disability</td>
<td>OT, ST</td>
</tr>
<tr>
<td>15</td>
<td>Med low</td>
<td>M</td>
<td>Preschooler w/ disability</td>
<td>OT, ST</td>
</tr>
<tr>
<td>16</td>
<td>Med low</td>
<td>M</td>
<td>Global Developmental Delay</td>
<td>OT, ST, PT, APE</td>
</tr>
<tr>
<td>17</td>
<td>Med low</td>
<td>M</td>
<td>Preschooler w/ disability</td>
<td>OT, ST</td>
</tr>
<tr>
<td>18</td>
<td>Med low</td>
<td>F</td>
<td>Intrauterine drug exposure</td>
<td>OT, ST</td>
</tr>
<tr>
<td>19</td>
<td>Med low</td>
<td>M</td>
<td>Intrauterine drug exposure</td>
<td>OT, ST</td>
</tr>
<tr>
<td>20</td>
<td>Low</td>
<td>M</td>
<td>Preschooler w/ disability</td>
<td>OT, ST</td>
</tr>
<tr>
<td>21</td>
<td>Low</td>
<td>M</td>
<td>Preschooler w/ disability</td>
<td>OT, ST</td>
</tr>
<tr>
<td>22</td>
<td>Low</td>
<td>F</td>
<td>Preschooler w/ disability</td>
<td>OT, ST, APE</td>
</tr>
<tr>
<td>23</td>
<td>Low</td>
<td>M</td>
<td>Pervasive Dev. Delay</td>
<td>OT, ST, APE</td>
</tr>
<tr>
<td>24</td>
<td>Low</td>
<td>M</td>
<td>Preschooler w/ disability</td>
<td>OT</td>
</tr>
</tbody>
</table>

Table 4.1: Description of subjects receiving occupational therapy services.
The remaining subjects for the known group method and hypothesis testing were typically developing children from Beavercreek and Oakwood, Ohio. Twenty one children, ages 3 1/2 to 5 1/2, attending either a private preschool program or public preschool program as typical role models were used for the comparison group. These children were matched for ages to the group receiving occupational therapy services. There were 5 children in the low age category, 5 in the medium low age category, 6 in the medium high age category, and 5 in the high age category. There were 10 female and 11 male children. Additional, the children were selected based on the criteria that they had no significant history of medical problems and were not suspected to have a developmental disability of any kind. This information was obtained through the completion of a “Child Information Form” (Appendix A), in which parents answered several questions regarding their child’s medical history and development.

Eight of the children attended private preschool in Beavercreek, Ohio at BCLC, 7 of the children were typically developing role models in the Beavercreek City School’s public preschool, and 6 of the children attended other private preschool programs and lived in Oakwood, Ohio. Children were given a visual screening by a registered nurse prior to the initiation of data collection if they attended public preschool or BCLC (Appendix B). Children had to pass the screening for visual acuity, binocularity, and ocular mobility to be included in the study. Children who live in the Oakwood were not screened by a nurse; however, their parents were asked if they suspected that their child had a visual impairment. They were only included if the parents had no concerns about their child’s vision.
FINDINGS BASED ON HYPOTHESES

The first hypothesis was that the PVMIA scores of typically developing children will be significantly higher than the scores of children who score at or below -1.50 standard deviations below the norm on the Peabody Developmental Motor Scales- Fine Motor Scale. A t-test analysis was used to compare the means of the two groups. The typically developing children had statistically significantly higher scores (p < .01) on the total combined score, the two subtests, and the 8 individual categories that contribute to those subtests. Table 4.2 contains the mean scores, standard deviations, t statistics and p values.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Max Score Possible</th>
<th>Typically Developing</th>
<th></th>
<th>Receiving OT</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>Std Dev</td>
<td>Mean</td>
<td>Std Dev</td>
<td>t</td>
<td>p</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined Score</td>
<td>126</td>
<td>84.9</td>
<td>21.64</td>
<td>39.3</td>
<td>23.65</td>
<td>6.71</td>
<td>&lt;.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drawing Subtest</td>
<td>78</td>
<td>46.1</td>
<td>16.75</td>
<td>17.2</td>
<td>13.38</td>
<td>6.33</td>
<td>&lt;.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Similarity</td>
<td>8</td>
<td>7.6</td>
<td>.68</td>
<td>4.5</td>
<td>2.83</td>
<td>5.15</td>
<td>&lt;.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Parts</td>
<td>5</td>
<td>3.2</td>
<td>1.18</td>
<td>2.0</td>
<td>1.46</td>
<td>3.21</td>
<td>.003</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor Accuracy</td>
<td>26</td>
<td>11.9</td>
<td>6.92</td>
<td>2.8</td>
<td>3.12</td>
<td>5.54</td>
<td>&lt;.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Position in Space</td>
<td>9</td>
<td>4.5</td>
<td>2.42</td>
<td>1.5</td>
<td>1.82</td>
<td>4.77</td>
<td>&lt;.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spatial Relationships</td>
<td>28</td>
<td>17.6</td>
<td>6.02</td>
<td>6.3</td>
<td>5.14</td>
<td>6.84</td>
<td>&lt;.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shape Discrimination</td>
<td>2</td>
<td>1.1</td>
<td>.96</td>
<td>.1</td>
<td>.45</td>
<td>4.44</td>
<td>&lt;.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Block Patterns Subtest</td>
<td>48</td>
<td>38.8</td>
<td>6.68</td>
<td>22.0</td>
<td>12.90</td>
<td>5.56</td>
<td>&lt;.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reproducing Pictures</td>
<td>40</td>
<td>31.8</td>
<td>5.91</td>
<td>17.5</td>
<td>10.61</td>
<td>5.66</td>
<td>&lt;.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Picture to Picture</td>
<td>8</td>
<td>7.0</td>
<td>1.18</td>
<td>4.5</td>
<td>2.92</td>
<td>3.79</td>
<td>.001</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.2: Comparison and PVMIA scores for typically developing children and children receiving services.

The second hypothesis was that the PVMIA scores will demonstrate a significant relationship to age in typically developing children. A one-way Analysis of Variance (ANOVA) was used to compare the means of the four age categories, low, medium-low, medium-high, and high, and found significant differences between the scores on PVMIA, combined score, the drawing subtests, and 6 categories that contribute to the drawing subtest when age groups were compared (p < .01). The block patterns subtest and one
category, reproducing pictures, were also significant (p < .05). The category of picture to picture matching was not significantly different between groups. Table 4.3 contains mean scores and standard deviations for each age category, and f statistics and p values.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Max Score Possible</th>
<th>Low 42-47 mos</th>
<th>Med Low 48-53 mos</th>
<th>Med High 54-59 mos</th>
<th>High 60-66 mos</th>
<th>F</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined Score</td>
<td>126</td>
<td>62.8 (12.40)</td>
<td>70.6 (13.41)</td>
<td>96.7 (15.00)</td>
<td>107.0 (6.44)</td>
<td>14.54</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Drawing Subtest</td>
<td>78</td>
<td>29.2 (8.44)</td>
<td>35.2 (9.99)</td>
<td>53.3 (11.66)</td>
<td>65.2 (4.76)</td>
<td>16.2</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Similarity</td>
<td>8</td>
<td>7.0 (.71)</td>
<td>7.2 (.84)</td>
<td>8.00 (.00)</td>
<td>8.00 (.00)</td>
<td>5.13</td>
<td>.010</td>
</tr>
<tr>
<td>Number of Parts</td>
<td>5</td>
<td>2.0 (.71)</td>
<td>2.6 (.55)</td>
<td>4.0 (1.10)</td>
<td>4.20 (.45)</td>
<td>10.09</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Motor Accuracy</td>
<td>26</td>
<td>4.4 (3.21)</td>
<td>7.6 (4.93)</td>
<td>15.5 (4.14)</td>
<td>19.2 (1.92)</td>
<td>17.04</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Position in Space</td>
<td>9</td>
<td>2.4 (1.52)</td>
<td>3.6 (1.52)</td>
<td>4.8 (2.22)</td>
<td>7.0 (1.87)</td>
<td>5.55</td>
<td>.008</td>
</tr>
<tr>
<td>Spatial Relationships</td>
<td>28</td>
<td>13.6 (3.39)</td>
<td>13.6 (3.13)</td>
<td>18.8 (5.91)</td>
<td>24.8 (1.64)</td>
<td>9.50</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Shape Discrimination</td>
<td>2</td>
<td>.4 (.89)</td>
<td>.6 (.89)</td>
<td>1.5 (.84)</td>
<td>2.0 (.00)</td>
<td>4.96</td>
<td>.012</td>
</tr>
<tr>
<td>Block Patterns Sbt</td>
<td>48</td>
<td>33.6 (7.99)</td>
<td>35.4 (5.73)</td>
<td>43.3 (4.8)</td>
<td>41.8 (2.68)</td>
<td>3.86</td>
<td>.028</td>
</tr>
<tr>
<td>Reproducing Pictures</td>
<td>40</td>
<td>27.6 (6.58)</td>
<td>28.6 (5.27)</td>
<td>36.0 (4.94)</td>
<td>34.0 (2.35)</td>
<td>3.56</td>
<td>.036</td>
</tr>
<tr>
<td>Picture to Picture</td>
<td>8</td>
<td>6.0 (1.73)</td>
<td>6.8 (.84)</td>
<td>7.3 (.82)</td>
<td>7.8 (.45)</td>
<td>2.71</td>
<td>.077</td>
</tr>
</tbody>
</table>

Table 4.3: Comparisons among PVMIA scores for age categories of typically developing children.
The mean scores show that the total score, drawing subtest, 5 drawing subtest categories and 1 block pattern category the scores are higher for each subsequent age group. The exception is for similarity, in which it appears that scores reach a ceiling at the highest age group, and the block patterns subtest and contributing category of reproducing pictures. Most likely the block patterns subtest scores were affected by the small sample sizes. There were 5 children in the low group, 5 in the medium low group, 6 in the medium high group, and 5 in the high group.

A Pearson Correlation was used to correlate actual age in months with the combined score on the PVMIA, the two subtests, and the 8 categories. Correlations ranged from .46 to .84 and all were considered to be significant at $p = .05$ or below. Table 4.4 lists the Pearson Correlation Coefficients and p values.
<table>
<thead>
<tr>
<th>PVMIA Scores</th>
<th>Pearson Correlation Coefficient</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Combined Score</strong></td>
<td>.80</td>
<td>&lt; .001</td>
</tr>
<tr>
<td><strong>Drawing Subtest</strong></td>
<td>.84</td>
<td>&lt; .001</td>
</tr>
<tr>
<td><strong>Similarity</strong></td>
<td>.62</td>
<td>.003</td>
</tr>
<tr>
<td><strong>Number of Parts</strong></td>
<td>.77</td>
<td>&lt; .001</td>
</tr>
<tr>
<td><strong>Motor Accuracy</strong></td>
<td>.83</td>
<td>&lt; .001</td>
</tr>
<tr>
<td><strong>Position in Space</strong></td>
<td>.70</td>
<td>&lt; .001</td>
</tr>
<tr>
<td><strong>Spatial Relationships</strong></td>
<td>.76</td>
<td>&lt; .001</td>
</tr>
<tr>
<td><strong>Shape Discrimination</strong></td>
<td>.68</td>
<td>.001</td>
</tr>
<tr>
<td><strong>Block Patterns Subtest</strong></td>
<td>.50</td>
<td>.021</td>
</tr>
<tr>
<td><strong>Reproducing Pictures</strong></td>
<td>.46</td>
<td>.035</td>
</tr>
<tr>
<td><strong>Picture to Picture</strong></td>
<td>.52</td>
<td>.015</td>
</tr>
</tbody>
</table>

Table 4.4: Correlations between PVMIA scores and age of typically developing children.

**RELATED FINDINGS**

**Relationship to Gender**

During test development of the PVMIA, it was found that although age is the primary variable affecting test scores, the child’s gender also affected scores. As a result, the PVMIA standard scores vary according to both age and gender of children. A t-test analysis of male and female children using the data set from the typically developing children demonstrated no statistically significant difference in the mean scores. No
differences by gender were found for the total score, the two subtests, or of the 8 categories that contribute to the two subtests of the two groups. Table 4.5 presents the mean scores, standard deviations, t statistics and p values.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Maximum Score Possible</th>
<th>Female</th>
<th></th>
<th>Male</th>
<th></th>
<th>t</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>Std Dev</td>
<td>Mean</td>
<td>Std Dev</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined Score</td>
<td>126</td>
<td>84.2</td>
<td>25.28</td>
<td>85.5</td>
<td>18.98</td>
<td>-.129</td>
<td>.898</td>
</tr>
<tr>
<td>Drawing Subtest</td>
<td>78</td>
<td>46.1</td>
<td>19.64</td>
<td>46.1</td>
<td>14.63</td>
<td>.001</td>
<td>.999</td>
</tr>
<tr>
<td>Similarity</td>
<td>8</td>
<td>7.3</td>
<td>.82</td>
<td>7.8</td>
<td>.41</td>
<td>-.424</td>
<td>.095</td>
</tr>
<tr>
<td>Number of Parts</td>
<td>5</td>
<td>3.1</td>
<td>1.20</td>
<td>3.4</td>
<td>1.21</td>
<td>-.129</td>
<td>.621</td>
</tr>
<tr>
<td>Motor Accuracy</td>
<td>26</td>
<td>11.6</td>
<td>7.88</td>
<td>12.1</td>
<td>6.30</td>
<td>-1.84</td>
<td>.876</td>
</tr>
<tr>
<td>Position in Space</td>
<td>9</td>
<td>4.9</td>
<td>2.69</td>
<td>4.1</td>
<td>2.21</td>
<td>-.502</td>
<td>.459</td>
</tr>
<tr>
<td>Spatial Relationships</td>
<td>28</td>
<td>18.1</td>
<td>7.00</td>
<td>17.2</td>
<td>5.3</td>
<td>-.158</td>
<td>.737</td>
</tr>
<tr>
<td>Shape Discrimination</td>
<td>2</td>
<td>1.1</td>
<td>.99</td>
<td>1.2</td>
<td>.98</td>
<td>.757</td>
<td>.852</td>
</tr>
<tr>
<td>BlockPatterns Subtest</td>
<td>48</td>
<td>38.1</td>
<td>7.51</td>
<td>39.4</td>
<td>6.14</td>
<td>-.424</td>
<td>.676</td>
</tr>
<tr>
<td>Reproducing Pictures</td>
<td>40</td>
<td>31.2</td>
<td>6.13</td>
<td>32.3</td>
<td>5.95</td>
<td>-.407</td>
<td>.689</td>
</tr>
<tr>
<td>Picture to Picture</td>
<td>8</td>
<td>6.9</td>
<td>1.52</td>
<td>7.1</td>
<td>.83</td>
<td>-.361</td>
<td>.722</td>
</tr>
</tbody>
</table>

Table 4.5: PVMIA Scores According to Gender
Interrater Reliability

Interrater reliability was completed for the scoring of the Drawing Subtest. Two experienced occupational therapists scored ten drawing subtests. The first therapist scored five of the drawing subtests randomly chosen from the group receiving occupational therapy. The second therapist scored five of the drawing subtests randomly chosen from the group of typically developing children. The therapists were blind to which group the tests belonged. An item by item analysis occurred to count the number of items the raters agreed upon and then a total percentage was computed based on the item analysis. The first therapist and the researcher had an agreement of 94% while the second therapist and the researcher had an agreement of 90%. When combined, the interrater reliability is 92%.

SUMMARY

Forty five children, ranging in age from 3 1/2 to 5 1/2 years old were tested with the PVMIA. One group comprised 24 children attending Beaver Creek City School’s public preschool program and known to have a developmental disability and receiving occupational therapy services. The remaining 21 subjects were typically developing children from Beaver Creek and Oakwood, Ohio attending either a private preschool program or public preschool program as typical role models. The second group of children was matched for ages to the group receiving occupational therapy services. The data analysis indicates that the typically developing children had statistically significantly higher scores (p < .01) on the total combined score, the two subtests, and the
8 individual categories that contribute to those subtests. A one-way Analysis of Variance (ANOVA) was used to compare the mean scores of the four age categories, low, medium-low, medium-high, and high, and found significant differences for the PVMIA combined score, drawing subtest, 6 drawing categories (p < .01) and the block patterns subtest and reproducing pictures category (p < .05). The Pearson Correlation between the subjects' age in months with the combined score on the PVMIA, the two subtests, and 8 categories ranged from .46 to .84.
CHAPTER 5

DISCUSSION, RECOMMENDATIONS, AND CONCLUSION

INTRODUCTION

This chapter will present a discussion of the results of this construct validity study of the PVMIA and the implications for occupational therapists. Limitations of the study are reported and recommendations for future research are suggested.

DISCUSSION OF THE RESULTS

*Differences between Scores for the Typically Developing Children and Children Receiving Occupational Therapy Services*

Occupational therapists working with preschool aged children in the school setting are often interested in a child’s visual-motor integration skills as they relate to
functional tasks such as prewriting and handwriting readiness skills (Oliver, 1990). There are many methods to formally or informally assess visual motor integration skills. However, in the state of Ohio in order to qualify for intervention services from the public preschool, occupational therapists must use standardized norm-referenced assessments that enable a calculation of standard deviations from a mean score (Ohio Department of Education, 2000). As a result, there is a great need for valid standardized and norm-referenced evaluation tools. Pediatric therapists are often dependent on tools that have been developed by non-therapists that use different frames of reference than pediatric therapists may use (Campbell, 1989). However, the recently-developed standardized and norm-referenced assessment authored by two occupational therapists entitled the Preschool Visual Motor Integration Assessment, PVMIA, aims to assess the intimate relationship between visual perceptual and fine motor skills in preschool children through specific quantitative measurement of performance on drawing and block design subtests (Deitchman & Puttkamrner, 2001).

In order to have confidence in this newly developed evaluation tool, reliability and validity must be established (DePoy & Gitlin, 1994). Construct validity is critical when an evaluation tool measures an observable output that is directly based on theoretical concept. When examining an evaluation tool such as the PVMIA, visual-motor integration is a concept that cannot be measured directly, but the behaviors that are a result of visual-motor integration, such as replicating drawing and block designs, can be measured directly. In this study the construct validity of the PVMIA was examined using the known groups method. The known groups method is used to discriminate between individuals who are known to have the trait that an evaluation tool tests and those
individuals who do not have the trait (Portaey & Watkins, 1993). It has been documented that many children with developmental disabilities and/or learning disabilities have visual motor integration deficits (Halsey, Collin & Anderson, 1996; Rosner & Rosner, 1987; Sherman, 1973; Waldron & Saphire, 1992). This study used children with developmental disabilities who received occupational therapy services as the group with high probability of visual motor deficits.

The results of this study indicate that when comparing the PVMIA scores of typically developing children to children with developmental disabilities receiving occupational therapy services, the typically developing children had statistically significantly higher scores ($p < .01$) on the total combined score, the two subtests: drawing and block patterns, and the 8 individual categories that contribute to those subtests: similarity, number of parts, motor accuracy, position in space, spatial relationships, shape discrimination, reproducing pictures, and picture to picture. These results strongly support the construct validity of the PVMIA as a tool that measures visual motor integration and is able to discriminate between children who have deficits in these skills and those who do not.

Many of the existing visual motor integration tests, such as the VMI, TVMS-R and TVMI, rely on drawings alone as a measure of visual motor integration (Beery, 1997; Gardner, 1995; Hammill et al., 1996). However, the authors of the PVMIA state that by incorporating a Drawing Subtest and Block Designs Subtest “they provide a broader view of the child’s performance than each could provide alone” (Deitchman & Puttkammer, 2001, p. 108). In this study, when further examining the mean scores of the two subtests that comprise the total combined score between the two groups of subjects, the difference
between mean scores on the Drawing Subtest is 28.9 points while the difference on the Block Patterns Subtest is 16.8 points. Although both differences were significant, it is worth noting that children with disabilities did seem to perform closer to their typically developing peers on the Block Patterns Subtest than the Drawing Subtest. One reason for similarity in scores may be that the Block Patterns is an easier task allowing the children with disabilities to obtain higher scores. At the same time, the typical children’s scores seemed to reach a ceiling; therefore depressing their mean scores. Deitchman and Puttkammer recognized that the ability to manipulate a pencil does develop more slowly than the ability to manipulate blocks. One question might be, do the two subtests truly measure visual motor integration in an equitable manner?

The authors of the PVMIA explored construct validity using the known groups method in which the PVMIA was administered to seven children receiving occupational therapy services based on their performance on tests that included the Peabody Developmental Motor Scales (Deitchman & Puttkammer, 2001). All seven children did poorly on the Drawing Subtest but two children performed adequately on the Block Patterns Subtest. The authors identified this as a strength that might have otherwise not been identified for these two children. Although this may be true, another question may be are the two subtests equally challenging or is the Block Patterns Subtest simply easier than the Drawing Subtest?
Another aspect of construct validity is that the evaluation tool should be related to external measures in a manner that is consistent with the construct (Ary, Jacobs & Razavieh, 1979). In this case, visual motor integration skills are believed to be developmental in nature. The authors of the VMI and the TVMI report that their visual motor integration tests have strong correlation with chronological age (Beery, 1997; Hammill et al., 1996). The results of this study also support the theory that visual motor integration is a process that moves along a developmental continuum, because age was found to be significantly related to PVMIA scores in typically developing children. A Pearson Correlation was used to correlate actual age in months with the combined score on the PVMIA, the two subtests, and the 8 categories. Correlations ranged from .46-.84 and were significant at the p < .05. In addition, the mean scores for the four age categories, demonstrated significant differences, with children in older age groups scoring higher than younger children.

Gender as a Variable Effecting Test Scores

During test development of the PVMIA, it was found that although age is the primary variable affecting test scores, the child's gender also affected the scores (Deitchman & Puttkammer, 2001). Analysis of prestandardization test data found that females tended to have significantly higher average scores (p = .05) at the younger ages and that males caught up by the oldest age group. As a result, the PVMIA standard scores
vary according to both age and gender of children. However, in this study a t-test analysis comparing male and female children using the data set from the typically developing children demonstrated no statistically significant difference in the mean scores. This suggests that gender is not a significant variable related to test scores. Other frequently used visual motor integration tests, VMI, TVMS-R and TVMI, use age only and do not use gender as a variable that affects test scores (Beery, 1997; Gardner, 1995; Hammill, et al., 1996).

IMPLICATIONS FOR PRACTICE

Occupational therapists are often members of the educational team that assesses children suspected of having a disability in the public preschool setting. In the state of Ohio in order to qualify for intervention services from the public preschool, a child must have a significant visual or hearing impairment, or found to be at least -2.00 standard deviations from the mean in one developmental area or -1.50 standard deviations from the mean in two areas. The areas include communication, motor, social-emotional/behavioral functional. Because of this requirement, service providers must use standardized norm-referenced assessments that enable a calculation of standard deviations from the mean score.

As a result, the PVMIA, a standardized and norm referenced assessment, has the potential to be a very useful visual motor integration evaluation tool to use with the preschool population. Unfortunately the PVMIA does not begin until age 3 ½ and in Ohio the public school system is responsible for providing preschool services to children
promptly when they turn 3 years old (Ohio Department of Education, 2000). Therefore, therapists may not be able to use the PVMIA as an initial evaluation tool with many of the children who are transitioning from early intervention programs. Another age related potential problem is that the PVMIA cannot be used after a child is 5 ½ years old. However, in Ohio children are not compulsory age for kindergarten unless they are six years of age on or before the district’s entrance date of the school year, either August 1st or September 30th. As a result, many children in the public preschool setting do not transition to kindergarten until after they are 5 ½ years old or older, limiting the use of the PVMIA as an assessment tool for their transitioning evaluation. It would be beneficial if the PVMIA had norm referenced scores that better reflected the ages of children served in preschool settings by including 3 year olds and continuing through 6 years old.

However, the PVMIA appears to be a valuable assessment tool especially when compared to another commonly used evaluation tool that complements the Peabody Developmental Motor Scales (PDMS) which is the assessment most often used by occupational therapist in Ohio preschools. The PDMS- Fine Motor Scale (FMS), requires children to copy only 3 stimulus drawings, circle, cross, and square (Folio & Fewell, 2000). These figures use very common prewriting strokes that are frequently practiced. By using drawings that use more unusual combinations of the standard prewriting strokes, the PVMIA appears to be more valid measure of visual motor integration. It eliminates the memorization of how to produce simple prewriting shapes and providing a truer picture of the child’s visual motor integration abilities (Deitchman & Puttkammer, 2001).
The PDMS-FMS also includes five block designs using the common 1 inch cubes (train, bridge, wall, steps, and pyramid) that are imitated for the child and the child is expected to replicate (Folio & Fewell, 2000). The PVMIA uses more unusual parquetry blocks for constructional tasks and offers opportunities to measure if the child is able to copy from either a 2 dimensional test plate, a 3 dimensional pattern, imitation of the test administrator building the design, or matching their blocks on top of the test plate. This breakdown in skill components enables the evaluator to better assess the area of weakness in the visual motor integration skills. Although the PDMS will most likely continue to be a commonly used assessment for a preschool child's global fine motor functioning, the use of the PVMIA should be considered if the therapist suspects limitations in visual motor integration.

Finally, the most useful and unique attributes of the PVMIA are the scoring methods used for the Drawing Subtest and Block Patterns Subtest. The Drawing Subtest scores eight drawings using quantitative measurements in the categories of similarity, correct number of parts, motor accuracy, position in space, spatial relationships, and shape discrimination. Therefore the scoring method provides for specific analysis of skills components. Although the eight drawings are tallied for a total score on the Drawing Subtest, each of the categories is also tallied. This enables the evaluator to determine specific areas of weakness because based on age the evaluator can determine if the category score is normal, above normal, or below normal. The quantitative specifications used to score each drawing are especially helpful in eliminating subjective judgments regarding the quality of the drawing and in identifying the specific skill
difficulties the child demonstrates. This level of specificity can be helpful in designing intervention strategies such as short term and long term goals and objectives.

The Block Patterns Subtest also enables the evaluator to pinpoint the ability level of the child and the amount of assistance or cuing that a child needs to accomplish the task. The block pattern reproductions are scored based on the child's level of independent accomplishment, i.e., if a child can produce a block design from either a 2 dimensional test plate, a 3 dimensional pattern, imitation of the test administrator building the design with various levels of cueing, or matching their blocks on top of the test plate, using a weighted point system. Again this enables the evaluator to better assess the specific areas of weakness of the visual motor integration skills. The Block Patterns Subtest also includes a matching section, which examines the child's ability to discriminate block patterns, a prerequisite to reproducing block patterns. These individual categories, Reproducing Pictures and Matching Picture to Picture, contribute to the overall Block Patterns Subtest score but are also tallied individually to determine if based on age the score is normal, above normal, or below normal.

When completing any standardized evaluation, there remains a need for the occupational therapist's clinical observations and judgments. For example, although in the state of Ohio determining if a child is eligible for preschool services requires standardized scores, there is also a requirement for data obtained through interview and/or observation that confirm the reliability of standard scores and whether there is an adverse effect on the child's ability to function. The PVMIA provides a structure and criteria for clinical observations with two Behavioral Observations Checklists, one for each subtest. The checklist following the Drawing Subtest prompts the evaluator to examine behaviors
such as hand preference, position of the assistive hand, posture, paper placement, approach to task, and type of pencil grasp. The checklist following the Block Patterns Subtest prompts the evaluator to examine behaviors such as grasp, manipulation, and release patterns, posture, bilateral integration and approach to task. All of these qualitative behaviors are useful when providing a complete description of a child’s visual motor integration skills.

When using the PVMIA, therapists must remain cognizant that many children receiving occupational therapy services may also have a language and or cognitive delay that could affect performance on the assessment. The PVMIA contains verbal directions and does not include a physical demonstration item for the subtests. A child with a language or cognitive delay may not perform well due to those delays and not visual motor integration delays. In addition, a child may have a visual problem that has not been identified or treated by a doctor that may also affect performance on the assessment. In order to administer the PVMIA according to standardization, a child must have intact vision and hearing. A child must also have the motor ability to grasp a pencil and manipulate blocks.

LIMITATIONS

This study has limitations that will affect the generalization of the results to populations outside of the study. The children were from one geographical area in Southwestern Ohio. They were from predominantly middle-income Caucasian families. The two groups of children were convenience samples so they were non-randomized.
Furthermore the researcher was aware of the group identity of the subjects. A blind evaluation process would increase the study’s validity.

RECOMMENDATIONS FOR FURTHER STUDY

Suggestions for further research into the construct validity of the PVMIA include replicating this study with a greater number of subjects with a variety of ethnic and socioeconomic backgrounds. It may be beneficial to replicate this study using children receiving occupational therapy services but without language or cognitive delays to determine if these deficits have an effect on test performance. Another form of construct validity would be to complete a factor analysis using a large sample to determine if the PVMIA is a valid measure of the many factors of visual motor integration identified in the original study.

Concurrent validity could be investigated through examining the PVMIA compared to the Peabody Developmental Motor Scales-Fine Motor Subtest, the Battelle Developmental Inventory-Fine Motor Domain, or the VMI. A suggestion for a predictive validity study would be to investigate the PVMIA scores as a predictor of handwriting success/legibility in kindergarten.

CONCLUSION

The purpose of this study was to explore the construct validity of the PVMIA through the known groups method. The results of the study support the construct validity
of the PVMIA as a tool that measures visual motor integration and its ability to discriminate between children with visual motor delays and typically developing children. Typically developing children had statistically significantly higher scores on the total combined score, the two subtests: and 7 of the 8 individual categories that contribute to those subtests when compared to children receiving occupational therapy services.

The results of this study also support the theory that visual motor integration is a process that moves along a developmental continuum. A Pearson Correlation found significant correlation between the age in months with the combined score on the PVMIA, the two subtests, and the 8 individual categories. The mean scores of the four age categories, low, medium-low, medium-high, and high, were significantly different.

Based on the results, a therapist can use the PVMIA with confidence that it does have the ability to discriminate between children who have intact visual motor integration skills and those who do not. The PVMIA also appears to measure preschool aged children's visual motor integrations skills they age. In addition, the PVMIA provides quantitative and qualitative information that is unique from other visual motor integration assessments and is very useful in developing short term and long term goals for children.
LIST OF REFERENCES


Borsting, E. (1994). Overview of visual and visual processing development. In M. M. Scheiman & M. W. Rouse (Eds.), *Optometric management of learning-related vision problems (pp. 35-67)*. St. Louis: Mosby.


APPENDIX A
CHILD INFORMATION FORM

Name of child: ________________________________

Date of birth: ________________________________

Has your child’s motor development been typical, that is: has he or she reached motor milestones on time?

Yes or No

Has your child ever received occupational therapy? Yes or No

Does your child have a medical diagnosis? Yes or No

If so, what diagnosis? ________________________________

Does your child have a significant medical history, such as surgeries, trauma, hospitalization etc.?

Yes or No

If so, please describe: ________________________________

Does your child have a visual impairment that is or is not corrected by glasses?

Yes or No

If so, please describe: ________________________________

Do you suspect that your child has visual problems but you have not been to the doctor yet? (e.g. Have you observed squinting, eye watering, or rubbing of the eyes?)

Yes or No
APPENDIX B
VISUAL SCREENING

Student’s name: ___________________________ Date of Birth: ________________
Evaluator: _____________________________ Title: ___________________________
Permission to test date: ________________ Date of Screening: ________________

Acuity: With Glasses_________ Without Glasses_________
        R- Near_________ L- Near_________ Both_________
        R- Far_________ L- Near_________ Both_________

Tracking: With Glasses_________
          Without Glasses_________
          R-L_________
          Far-Near_________
          L-R_________
          Up-Down_________

Vergence: _____________________________________________________________

Alternate Cover Test: _________________________________________________
APPENDIX C
Research Involving Human Subjects

ACTION OF THE INSTITUTIONAL REVIEW BOARD

Full Committee Review
X Expedited Review
X Original Review
___ Continuing Review
___ Amendment

With regard to the employment of human subjects in the proposed research protocol:

2003B0116. Construct Validity of the Preschool Visual Motor Integration Assessment, Jane Case-Smith, Nicole L. Melin, School of Allied Medical Professions

The protocol was unanimously APPROVED WITH THE FOLLOWING CONDITIONS
by means of expedited review (category 7) on April 25, 2003:

The study was approved for the participation of minors, according to 45 CFR 46.404. Participation in the study (assessment of visual motor skills via standardized tool) does not place the subjects at greater than minimal risk. Adequate provisions are in place for soliciting the permission of each child's parents, as well as assent from the children, as required by 45 CFR 46, section 408.

THE BEHAVIORAL AND SOCIAL SCIENCES HUMAN SUBJECTS IRB HAS TAKEN THE FOLLOWING ACTION:

X APPROVED WITH CONDITIONS *

* Conditions stated by the IRB have been met by the Investigator and, therefore, the protocol is APPROVED.

- No procedural changes may be made without prior review and approval from the IRB.
- You are reminded that you must promptly report any problems to the IRB.
- You are also reminded that the identity of the research participants must be kept confidential.
- It is the responsibility of the principal investigator to retain a copy of each signed consent form for at least three (3) years beyond the termination of the subject's participation in the proposed activity. Should the principal investigator leave the University, signed consent forms are to be transferred to the Human Subjects IRB for the required retention period.

Date: April 25, 2003

Signed: Thomas E. Nygren, Chair

HS-025B (Rev. 2/04)
RESEARCH PROTOCOL

2003R0116  Construct Validity of the Preschool Visual Motor Integration Assessment, Jane Case-Smith, Nicole L. Melia, School of Allied Medical Professions

The protocol was unanimously APPROVED WITH THE FOLLOWING CONDITIONS by means of expedited review (category 7) on April 25, 2003:

was presented for review by the Behavioral and Social Sciences IRB to ensure proper protection of the rights and welfare of the individuals involved with consideration of the methods used to obtain informed consent and the justification of risks in terms of potential benefits to be gained, the IRB action was:

[ ] APPROVED
[ X ] APPROVED WITH CONDITIONS *
[ ] DEFERRED
[ ] DISAPPROVED
[ ] NO REVIEW NECESSARY

* Research cannot begin until conditions have been met.

* CONDITIONS/COMMENTS:

1. Provide a letter of support from the schools to be involved.
2. Revise the information/recruitment letter and consent form by moving the information from the current consent form into the letter describing the study, and replacing the consent form with the OSU standard template for participation in social and behavioral research.
3. In the information/recruitment letter, more clearly differentiate the two groups of participants to avoid confusing parents, particularly those whose children are not receiving occupational therapy services.

If you agree to the above conditions, PLEASE SIGN THIS DOCUMENT IN THE SPACE PROVIDED BELOW AND RETURN THE DOCUMENT WITH ANY ADDITIONAL INFORMATION REQUESTED to the Behavioral and Social Sciences Institutional Review Board, 310 Research Foundation, 1960 Kenny Road, Columbus, OH 43210-1053, within three weeks of the date shown at the top of the form. Upon such compliance, the approval form will be mailed to you.

Date:

5/20/03

Jane Case-Smith

5/20/03

Nicole L. Melia

Signature of principal investigator and all co-investigators

HS-023A (Rev. 2/92) (conditions/comments)