Structural Model of the Relationships Among Cognitive Processes, Visual Motor Integration, and Academic Achievement in Students With Mild Intellectual Disability (MID)

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This study aimed to test a proposed structural model of the relationships and existing paths among cognitive processes (attention and planning), visual motor integration, and academic achievement in reading, writing, and mathematics. The study sample consisted of 50 students with mild intellectual disability or MID. The average age of these students was 13.52 year (SD = 1.47), and their average IQ was 59.91 (SD = 2.64). The findings indicated significant positive relationships among all variables of interest ($p < 0.01$), and all of the model fit indices were well fit.

Keywords: **Structural model, cognitive processes, visual motor integration, academic achievement, mild intellectual disability.**

Students with intellectual disabilities (ID) often exhibit problems in perceiving and processing new information, learning quickly and efficiently, applying knowledge and skills to solve novel problems, and thinking creatively and flexibly (Henry Bettenay, & Carney, 2011). In addition, students with IDs are characterized by delay in reaching motor milestones and impairment of sensorimotor function, which affects sensory, neuro-musculoskeletal, and motor systems (Hogan, Rogers, & Msall, 2000). For example, children with Down's syndrome often present with hypotonia, a sensory integrative dysfunction resulting from limited sensory experience due to poor motor control, motor sequencing deficits, and specific verbal-motor difficulties (Charlton, Ihsen, & Lavelle, 2000; Maraj, Li, Hillman, Johnson, & Ringenbach, 2003; Uyanik, Bumin, & Kayihan, 2003), whereas Williams syndrome is associated with atypical postures and weakness in visuospatial cognition, which have implications for a variety of tasks requiring gross or fine motor control and visual-motor dysfunctions (Elliott & Bunn, 2004; Morris & Mervis, 1999). These sensorimotor deficits greatly impede the quality and quantity of a child's participation or performance in activities in school, at home, and in the community (Dolva, Coster, & Lilja, 2004).

Visual motor integration (VMI), that is, the ability to coordinate visual perception and finger-hand movements (Beery, 1997), is one of the most impor-

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tant skills involved in helping students with disabilities to learn (Memisevic & Sinanovic, 2012). VMI is also used in many aspect of everyday life, for example, when walking, running, eating, painting, writing, and using tools or computers. It develops rapidly in early childhood, and most six- or seven-year-old children are sufficiently mature to successfully participate in activities requiring VMI (Ercan & Aral, 2011).

VMI has been operationally defined as the ability to copy geometric shapes, and this hand-eye coordination is necessary for mastering educational tasks such as writing and copying, paper/pencil tasks, copying from the board, and drawing. Traditionally, VMI tasks involve copying figures in increasingly more complex series (Radovanovic, 2013).

Performance on a VMI test can be affected by visual spatial/discrimination ability and motor skills, as well as the ability to integrate the two. A substantial body of work has shown a positive relationship between visual perceptual skill and academic measures, such as learning readiness, reading, and mathematics (Justice, 2008; Memisevic & Hazdic, 2013). In addition, Seung-Hee and Meisels (2006) examined empirical evidence about the relationship between visual motor skills at the beginning of kindergarten and reading and mathematics achievement at the end of first grade using the Early Childhood Longitudinal Study-Kindergarten cohort national dataset (N = 12,583). The results of hierarchical regression analyses demonstrated that early kindergarten motor skills, especially visual motor skills, add a small but unique amount of variance to achievement in reading and mathematics at the end of first grade, even after controlling for initial skills and demographic information. Although differences of opinion on the relationship between VMI and academic skills exist (Willows, 1998), even authors who have expressed different viewpoints have reported a difference in visual motor skill between good and poor readers (Mazzola & Taylor, 2003).

Another issue that has not been explored in detail is the connection between VMI performance and cognitive processing functions in students with ID. Discrepancies exist regarding whether or not general cognitive ability affects VMI. According to Piaget and Inhelder (1966), cognitive development relies on the child's acquired movement capabilities. Similarly, motor development also appears to depend on intellectual capabilities. For instance, von Hofsten (2004, 2007), theorizing an action approach to motor development, ,postulated that humans perceive and plan movements in terms of actions. Mastery of actions depends on the extent to which a child is able to anticipate what will happen next and use that information to guide his or her behavior. This so-called "prospective control of actions" (von Hofsten, 2007, p. 58) is governed by cognitive and perceptual functions. A considerable number of empirical studies have lent support to the contribution of general cognitive processing function to visual motor skills in students with or at-risk for developmental disorders (Di Blasi, Elia, Buono, Ramakers, & Di Nuovo, 2007; Seitz, Jenni, Molinari, Caflisch, Largo, & Latal-Hajnal, 2006). Wassenberg, Feron and Kessels (2005) argued against such a relationship between cognitive and visual motor performance in a mixed group of five- to six-year-old normal children and those at risk of developing behavior problems. Nevertheless, Kizony and Katz (2002) supported the existence of a moderate relationship between cognitive components (attention, memory, and thinking process) and assessment of motor and process skills (AMPS). Apart from a discrepancy in the relationship between global cognitive ability and visual motor integration function, the relationship between specific aspects of cognitive functioning and VMI performance also remains unclear in students with ID.

People with ID show cognitive deficits in attention and planning tasks, which affects the development of VMI (Doughty & Williams, 2013; Simonoff, Pickles, Wood, Gringras, & Chadwick, 2007). In a study by Duke, Cash, and Allen (2011), participants were directed to focus their attention on either their fingers, the piano keys, the piano hammers, or the sound produced. Complete MIDI data for all responses were digitally recorded by software written specifically for this experiment. The results show that the greater the focus of attention, the more accurate the motor control. Boudien, Houwen, and Schoemaker (2006) sought to investigate fine motor skills in children with attention-deficit-hyperactivity disorder (ADHD). Their results demonstrated that children with both attention deficit hyperactivity disorder (ADHD) and developmental coordination disorder (DCD) have poorer quality handwriting, draw more rapidly and more fluently, but do so less accurately on graphomotor tasks. Furthermore, attention has been shown to be the best predictor of fine motor skills (Mei, Henderson, Chow, & Yao, 2004).

Planning, as another cognitive process interfering with visual motor skills, involves the search for the most important aspect of information, comparing each part of that information with other parts, and creating hypotheses and verifying those hypotheses with the original feature of the perceived object (Ashman & Das, 1980). The planning process is important for visual motor performance. Occupational therapy practitioners using a sensory integration frame of reference are particularly concerned with identifying and treating problems in motor performance, especially in the area of motor planning (Watling, Koenig, Davies, & Schaaf, 2011). Motor planning skills are viewed as a component of the larger process of praxis, which is one subtype of sensory integration and processing (Ivey, Lane, & May-Benson, 2014).

Due the logical relationship among cognitive processes (planning and attention), VMI, and academic achievement in reading, writing and mathematics (Di Blasi et al., 2007; Doughty & Williams, 2013; Justice, 2008; Mazzola

& Taylor, 2003; Memisevic & Hazdic, 2013; Seitz et al., 2006; Seung-Hee & Meisels, 2006; Simonoff et al. 2007; Wassenberg et al, 2005), the present study seeks to investigate the relationships among cognitive processes (attention and planning), VMI, and academic achievement with students with mild ID.

The study's two research questions are as follows:

1). Is there a statistically significant relationship among cognitive processes (attention and planning), VMI, and academic achievement with students with mild ID?
2). What structural model clarifies the effect of relationships and existing paths among cognitive processes (attention and planning), VMI, and academic achievement with students with mild ID?

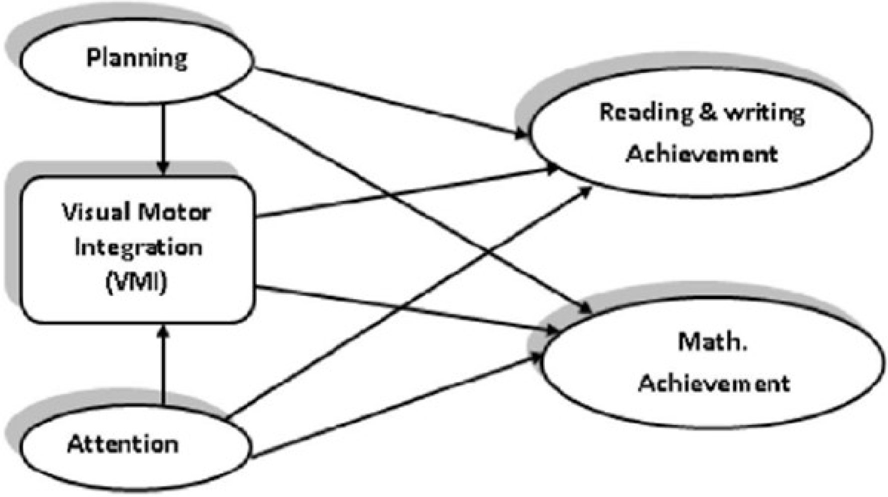
Method

The Proposed Model

The model used in this study is based on the notion that students with MID learn better in reading, writing and mathematics through VMI activities (Chan, Lambdin, Graham, Fragale, & Davis, 2014). In a study by Sullivan and McGrath (2003), four dimensions of motor competence were evaluated in four-year-old term and preterm children and were related to academic achievement and use of school services at age eight. The study sought to evaluate a graduated "stair-step" effect between perinatal morbidity, mild motor delay, and later school outcomes in 168 children (88 females, 80 males) stratified into four study groups: 134 healthy term infants > or = 37 weeks gestation, birthweight > or = 2500g); 134 preterm infants < or = 37 weeks gestation divided into healthy preterm (n=41), clinically ill pre-terms (n=59), and preterm infants with a neurological illness (n=34). Significant differences were found in total fine and gross motor performance and VMI at age four. Scores for the preterm groups decreased with increasing morbidity. At age four years, mild motor delay was found in all preterm groups. Children with mild motor delay had lower academic achievement scores (Wide Range Achievement Test-3) and higher rates of school service use at age eight. Thus, compromised motor performance is important precursors of educational underachievement.

VMI is expected to have a positive effect on reading, writing, and mathematics achievement. A second expectation is that developing a good VMI involves many cognitive processes. Therefore, both planning and attention are expected to have a positive effect on VMI (Boudien et al., 2006; Doughty & Williams, 2013; Duke et al., 2011; Ivey et al., 2014; Mei, et al., 2004; Simonoff et al., 2007; Watling et al., 2011).

Figure 1. **The Proposed Model of the relationships and existing paths among cognitive processes (attention and planning), visual motor integration, and academic achievement in reading, writing, and mathematics.**



Study Sample

After parental permission was obtained, 60 participants were seen individually for a 45-minute session in a large room at an institute for boys in a large city in Saudi Arabia during the years 2014/2015. With the help of the school's teachers, an intelligence test (SB5) was first completed, and then the Vineland Adaptive Behavior Scales Π (VABS Π) was administered. Six students were excluded due to absence, and four students were excluded because their total scores on the VABS Π were high. Fifty students with MID were selected as a final set for the study sample. The average age of these students was 13.52 years (SD = 1.47), and their average IQ was 59.91 (SD = 2.64). Other inclusion criteria for all participants were as follows: absence of coexisting autism, cerebral palsy, blindness and deafness, and the ability to follow test instructions in an attempt to minimize confusion. Two subscales (planning and attention) of the cognitive assessment system (CAS) with six subtests were administered individually on the 50 students with MID, the Beery (VMI) developmental test of visual motor integration was then administered individually, followed by the academic achievement tests for reading and mathematics, all of which were registered and analyzed using AMOS and SPSS programs.

Instruments

Cognitive assessment system (CAS). The Planning, Attention-Arousal, Simultaneous and Successive (PASS) theory of intelligence (Das, Kirby, &

Jarman, 1975) was operationalized by CAS (Naglieri & Das, 1997) in assessing cognitive functions, which consist of four subscales: planning, attention, simultaneous, and successive. The four subscales are comprised of three subtests to represent the entire score for cognitive functions. The entire battery (12 subtests) was translated into Arabic (*Ayman Eldeeb*). This study utilized two subscales (planning and attention) with six out of 12 subtests. The instruments obtained high reliability (Naglieri, 1999). The full average reliability coefficients for the four subscales are planning (0.88) and attention (0.88).

In the planning scale, the first subtest focused on matching numbers and consisted of four pages, each of which contained eight rows of six numbers per row. The subjects were instructed to underline the two numbers in each row that are the same. Numbers increased in length from one digit to seven digits across the four pages, with four rows for each digit length. Each item had a time limit. The subtest score was based on the combination of time and correct number for each page. Secondly, the planned codes subtest contained two pages, each with a distinct set of codes and arrangement of rows and columns. An example of how letters correspond to simple codes (e.g., A, B, C, and D correspond to OX, XX, OO, and XO, respectively) was shown at the top of each page. Every page contained seven rows and eight columns of letters without codes to be filled in by the subjects. The subjects were instructed to fill in the appropriate code in the empty box beneath each letter. On the first page, all As appear in the first column, all Bs in the second column, all Cs in the third column, and so on.

On the second page, letters were configured in a diagonal pattern. The subjects were permitted to complete each page in whatever fashion he/she wished. The subtest score is based on the combination of time and number correct for each page.

For the attention scale, the first subtest, expressive attention, used two different sets of items depending on the age of the subjects. Subjects eight years and older were presented with three pages. On the first page, the subject read color words (i.e., blue, yellow, green, and red) presented in quasi-random order. Next, the subjects named colors in a series of rectangles (printed in blue, yellow, green, and red). Finally, the words "blue," "yellow," "green," and "red" were printed in different colors than the words. The subjects were instructed to name the color ink of the words rather than to read the color words. The first two pages familiarized the subjects with the words and colors patterns. The score was counted on the last page, which is used as a measure of attention. The subtest score is based on the combination of time and correct number. The second subtest, number detection, consisted of pages of numbers that were printed in different formats. On each page, the subjects were required to find a particular stimulus (e.g., the numbers 1, 2, and 3 printed in an open font) on a page containing many distractors (e.g., the same numbers printed in a different font). There were 180 stimuli with 45 targets, or 25%, as targeted numbers on the pages. The subtest score reflected the ratio of accuracy (total correct number minus the number of false detections) to total time for each item summed across all items.

The Beery VMI developmental test of visual motor integration. The Beery VMI (Beery & Beery, 2004), a culture-free, non-verbal assessment, was used to test VSI development. It is a paper-and-pencil test that can be applied individually or in groups according to the age of the students. The Beery VMI-5 is a widely used test with very good psychometric properties (split-half correlation was 0.89 and alpha coefficient of internal consistency was 0.82). The test consists of 24 geometric shapes ordered from easy to difficult within a developmental design. In the test, the child is asked to copy the shape in the test booklet. The test is ended if the child cannot copy three consecutive shapes. Each correct answer is scored as 1 point, and each wrong response is scored as 0 points. Raw scores from the Beery VMI were used for the analysis. Higher scores indicate better performance.

Stanford Binet intelligence scales, fifth edition (SB5). The SB5 (Roid, 2003) is a standardized intellectual aptitude test for children and adults. The fifth edition was developed and structured based on the Cattell-Horn-Carroll (CHC) theory of intelligence. The CHC model conceptualizes intelligence as having a hierarchical structure with three levels: narrow abilities at the lowest level, broad cognitive abilities in the middle, and a general measure of cognitive ability (g) at the highest level.

The SB5 provides a general ability score reported as the FSIQ and five index scores that measure the broad cognitive concepts of fluid reasoning (FR), knowledge (KN), quantitative reasoning (QR), visual spatial processing (VS), and working memory (WM). These five indices are measured across two broad response domains, verbal (VIQ) and non-verbal (NVIQ), providing ten subtest scores in total. The subtest scaled scores were then combined and translated into index scores and the three intelligence quotients (VIQ, NVIQ, and FSIQ). The SB5 introduced a new scoring method for deriving extended IQ scores (EXIQ). Reliability was analyzed using Kuder Richardson's 20 (KR20) coefficient and test-retest correlation. The KR-20 coefficient varied between 0 .74 and 0 .93. Using test-retest correlation, reliability coefficients reached above 0.73. In the Arab environment, the reliability of SB5 has been calculated using the KR20 coefficient, test-retest correlation and Guttmann equation. The results showed high reliability values.In this study, the reliability of the Arabic version of SB5 (Safwat Farag, Trans.) has been calculated on a sample of 25 students of MID, using Cronbach's Alpha: The value was 0.76, indicating the high reliability of the scale.

Vineland adaptive behavior scales, second edition. The Vineland social maturity scale was created by Doll (1936) and later revised by Sparrow. Balla and Cicchetti (1984) as the Vineland Adaptive Behavior Scales (Vinland II). The Vineland II was developed to assess adaptive behavior in individuals from 0 through 90 years old (Sparrow et al., 2005). It is a widely used tool for assessing the personal and social skills needed for everyday life in four domains: communication (receptive, expressive and written), socialization (interpersonal relationships), daily living skills (play and leisure time, and coping skills), and motor skills (gross motor and fine motor). The Vineland II provides the information required to evaluate persons with developmental delays, functional skills impairment, and intellectual and developmental disabilities. The total score of the Vineland II, according to the Arabic version (Alotibi, Bander), were classified as low adaptive behavior (≤ 69), below average (70-84), average (85-115), above average (116-130), and high adaptive behavior (≥ 131). In the final analysis, only the low adaptive behavior category was considered a deficit adaptive behavior. The adaptive behavior composite and communication standard scores (ranging from 20 to 160) were used as criterion measures for the FSIQ and VIQ, respectively. The Vineland II has extensive representative normative data and strong psychometric properties (Widaman, 2010). In this study, the reliability of the Arabic version of Vineland II has been calculated on a sample of 25 students with MID: Using Cronbach's alpha, the value was 0.78, indicating the scale's high reliability.

Academic achievement tests for reading, writing and mathematics. These tests were designed to measure achievement in students with MID for reading, writing, and mathematics. When asked to help formulate vocabulary achievement tests, teachers suggested using tests such as multiple choice and sequel and arrange sentences. These tests consist of 40 question, 20 questions in the first part (academic achievement test in reading and writing), and 20 questions in the second part (academic achievement test in mathematics). The correct answer to each question equaled one degree and a wrong answer zero, bringing the total score range on the test academic achievement in reading and writing and the mathematics test to between zero and 20 degrees.

The validity of the academic achievement tests for reading, writing, and mathematics was examined by a group of faculty members who specialize in educational psychology, curriculum, and teaching methods, as well as teachers and supervisors of reading and writing (12 total members). Appropriate adjustments were made according to their reviews. Reliability coefficients were above 0.82 and 0.85 on the test-retest correlation of a sample of 25 students with MID, respectively, indicating good reliability. The consumed time averages and SD for answering the tests have been also calculated: The reading test time average was

45 min, and SD was 5.2 minutes, while the mathematics test time average was 35 min and SD was 4.4 min.

Results

The First Question

Is there a statistically significant relationship among cognitive processes (attention and Planning), VMI, and academic achievement in students with mild ID? Pearson correlation coefficients were used to investigate the relationships among cognitive processes (planning and attention), VMI, and academic achievement with students with mild ID (Table 1). Analyses were conducted with SPSS for Windows (version 20).

Table 1. ***Means, Standard Deviations, and Correlations for Variables***

Variables	Planning	Attention	VMI	Reading & Writing	Mathematics
Planning	—				
Attention	0.86**	—			
VMI	0.82**	0.86**	—		
Reading & Writing	0.78**	0.80**	0.78**	—	
Mathematics	0.81**	0.84**	0.85**	0.76**	—
M	18.42	19.72	11.52	12.83	13.56
SD	5.88	5.82	5.75	3.81	4.85

** = $p < 0.01$.

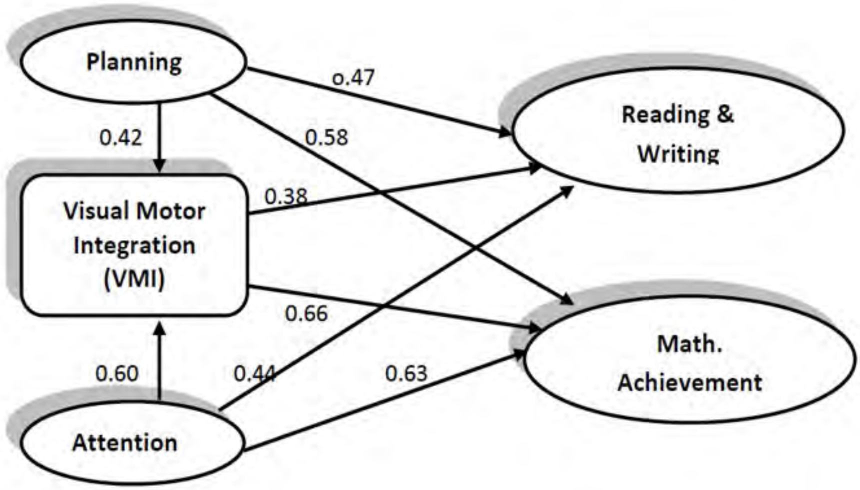
Note: Planning = planning total score; Attention = Attention total score; VMI= visual motor integration; R&W= reading and writing academic achievement; and Mathematics. = Mathematics academic achievement

Significant positive relationships were found among all variables of interest (p =0.01; see Table 1). The cognitive processes (planning and attention) correlated with visual motor integration (VMI), reading and writing academic achievement and mathematics academic achievement.

The Second Question

What structural model clarifies the effect of relationships and existing paths among cognitive processes (attention and Planning), VMI, and academic achievement in reading and writing and mathematics in students with MLD? Path coefficients were calculated via a series of multiple regression analyses using AMOS Graphics 7.0 and SPSS (version 20) based on the hypothesized model. The final results are presented in Table 2, Table 3, and Figure 2.

***Figure 2*. Final Path Model (path coefficients among Planning, attention VMI, academic achievement in R&W and Mathematics)**



The final model's goodness of fit was assessed via a chi-square test and goodness of fit indices such as root mean square error of approximation (RMSEA), goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), normed fit index (NFI), relative fit index (RFI), incremental fit index (IFI), the Tacker-Lewis index (TLI), and comparative fit index (CFI). Values for GFI, AGFI, NFI, RFI, IFI, TLI, and CFI range from 0 to 1, with values greater than 0.90 indicating a good fit. Conventionally, there good fit if RMSEA is less than 0.05, and there is adequate fit if RMSEA is less than 0.08 (Ye, Xu, Zhou, Gao & Li, 2011).

The final model, which fit well with the chi-square = 10.40 (DF = 5, P = 0.064), was not statistically significant, indicating that the tested model fits the data well. A second model fit index, the expected cross-validation index (ECVI), indicated a good fit because the value for the tested structural model (ECVI= 0.938) was lower than its value in the saturated Model (ECVI= 0.950). Model fit indices values are listed in Table 2.

Table 2. ***Model Fit Indices of Path Analysis Model Data***

Index	Value	Ideal Range of Index
GFI	0.904	0 – 1
AGFI	0.712	0 – 1
NFI	0.974	0 – 1
RFI	0.948	0 – 1
IFI	0.986	0 – 1
TLI	0.972	0 – 1
CFI	0.986	0 – 1
RMSEA	0.006	0 – 0.1

Note. GFI= Goodness of Fit Index, AGFI= Adjusted GFI, NFI= Normed Fit Index, RFI= Relative Fit Index, IFI= Incremental fit index, TLI= Tacker-Lewis index, CFI= Comparative Fit Index, and RMSEA= Root Mean Square Error of Approximation.

As shown in Table 2, all the Model fit indices (GFI, AGFI, NFI, RFI, IFI, TLI, CFI, and RMSEA) were well fit. The total effects in the path analysis model among the study's variables, T values, standard error of the effect estimation, and the statistical significance are listed in Table 3.

Table 3. ***The Effects in the Path Analysis Model Among Study Variables, t values, Standard Error of the Effect Estimation, and Statistical Ssignificance***

		VMI	Academic Achievement	
			Reading & Writing	Mathematics
Planning	Effect	0.42	0.47	0.58
	Standard error	0.057	0.095	0.124
	t value	7.36**	4.95**	4.67**
Attention	Effect	0.60	0.44	0.63
	Standard error	0.074	0.095	0.112
	t value	8.11**	4.63**	5.63**
VMI	Effect	-	0.38	0.66
	Standard error	-	0.087	0.114
	t value	-	4.39**	5.77**

** = $p < 0.01$.

The results in Table 3 and Figure 2 show the following:

- The presence of a positive significant effect of planning on VMI as a mediator variable with effect value=0.42, T value= 7.36, and p= 0.01.
- The presence of a positive significant effect of planning on R&W and academic achievement as dependent variables with effect value=0.47, 0, 58, and T value= 4.95, 4.67, respectively, and P= 0.01.
- The presence of a positive significant effect of attention on VMI as a mediator variable with effect value=0.60, T value=8.11, and p= 0.01.
- The presence of a positive significant effect of attention on R&W and academic achievement as dependent variables with effect value=0.44, 0, 63, and T value= 4.63, 5.63, respectively, and p< 0.01.
- The presence of a positive significant effect of VMI as a mediator variable on R&W and academic achievement as dependent variables with effect value=0.38, 0, 66, and T value= 4.39, 5.77 respectively. p< 0.01.

Discussion

Results any previous studies have documented the positive significant relationship between a) VMI and academic achievement and b) cognitive processes (planning and attention) and general academic achievement separately with non-disabled students (Justice, 2008; Seung-Hee & Meisels, 2006) and MID students (Memisevic & Sinanovic, 2012). However, the relationship between cognitive processes (planning and attention) and VMI has not been previously tested. This is the first known study to develop and test a structural model among cognitive processes (planning and attention), VMI, and academic achievement with MID students, clarifying the nature of the relationships among those three important variables for learning students with mild intellectual disabilities.

Regarding First Question

The relationships among study variables were examined (see Table 1). There is a significant positive relationship between VMI and the academic achievement in reading and writing and mathematics, (r= 78, 85, respectively, with P=0.01), which means that the better the VMI, the better academic achievement in reading, writing and mathematics. This finding is in line with Memisevic and Hadzic (2013), Justice (2008), and Seung-Hee and Meisels (2006). Another positive significant relationship was found between VMI and cognitive processes (planning and attention), (r=0.82, 0.86, respectively, with p= 0.01), indicating that good planning and attention as cognitive processes meet good VMI with MID students, which agrees with Simonoff et al. (2007) and Doughty and Williams (2013). Also the results in Table 1 showed a positive significant relationship between planning and academic achievement in reading, writing, and mathematics (r=78, 81) and between attention and academic achievement in reading, writing, and mathematics. (r=80, 84, respectively, with $p<0.01$), emphasizing the positive relationship between the cognitive processes and academic achievement with MID students.

Regarding Second Question

The proposed structural model was tested to clarify the effect relationships and existing paths among cognitive processes (attention and planning), VMI, and academic achievement in reading, writing and mathematics with MID students. The results indicate that planning and attention have a total positive effect on VMI (VMI= 0.42 * Planning + 0.60 * Attention). This means that enhancing both planning and attention skills may help in developing good VMI skills, indicating the need to encourage more training programs in this field. Also, the effect size indicates that attention (0.60) contributes to VMI more than planning (0.42). This finding emphasizes that attention is the best predictor of fine motor skills (Boudien et al., 2006; Mei et al., 2004).

In addition, planning, attention, and VMI have a total positive effect on academic achievement in reading and writing (Academic Achievement of R&W= 0.47 * Planning + 0.44 * Attention + 0.38 * VMI), which means that for successful academic achievement in reading and writing, we need a reasonable contribution from VMI, planning, and attention skills. Also, planning, attention, and VMI have a total positive effect on academic achievement in mathematics (Academic Achievement of Mathematics. = 0.58 * Planning + 0.63* Attention + 0.66 * VMI). And, according to the effect sizes, the three variables—planning, attention, and VMI—contribute to academic achievement in mathematics more than in reading and writing, indicating the importance of enhancing planning, attention, and VMI with MID students for successful academic achievement, especially in mathematics.

Conclusion and Recommendations

This study was based on the assumption that there is a logical relationship among cognitive processes (planning and attention), VMI, and academic achievement in reading, writing and mathematics (Di Blasi et al., 2007; Doughty & Williams, 2013; Justice, 2008; Mazzola & Taylor, 2003; Memisevic & Hadzic, 2013; Seitz et al., 2006; Seung-Hee & Meisels,2006; Simonoff et al. 2007; Wassenberg et al, 2005). Further, it sought to investigate the relationships among them. Through the development and testing of a structural model of cognitive processes (planning and attention), VMI, and academic achievement with MID students, this study showed a positive direct effect of the cognitive processes planning and attention for the visual motor integration, particularly for the attention process. Also, the study showed a positive direct effect of planning, attention, and VMI for MID students' achievement in reading, writing, and mathematics.

In light of the findings of this study, it is recommended that training programs for developing MID students achievement in reading, writing and mathematics consider the integration of motor and visual skills in their activities. Also, the educational activities for enhancing the VMI skills of the MID students should include adequate amounts of training on the cognitive processes, with a focus on planning and attention. Further research is recommended to buttress the findings made in this study.

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