

## RELATIONSHIP ANALYSIS BETWEEN VISUAL-MOTOR INTEGRATION ABILITY AND ACADEMIC PERFORMANCE

Débora Moraes Pereira<sup>1</sup>, Rita de Cássia Tibério Araújo<sup>2</sup>,  
Ligia Maria Presumido Braccialli<sup>3</sup>

### ABSTRACT

Visual-motor integration is a skill that involves visual perception and eye-hand coordination. Deficit in perceptual ability and motor organization capacity may reflect in reading, writing and arithmetic learning difficulties. This study aimed to verify the relationship between visual-motor integration ability and academic performance, as well, whether visual perception ability was correlated with reading performance and whether motor coordination ability was correlated with writing performance. Participants were 77 students in the 2nd. year of elementary education at a public school. To data collect were applied the Developmental Test of Visual-Motor Integration and the Academic Performance Test. The results showed a significant correlation between visual-motor integration ability and academic skills of reading ( $r = 0.230$ ,  $p = 0.044$ ), writing ( $r = 0.244$ ,  $p = 0.033$ ) and arithmetic ( $r = 0.277$ ,  $p = 0.015$ ). In addition, was also identified significant correlation between visual perception and reading performance ( $r = 0.407$ ,  $p = 0$ ) and between the motor coordination and cursive writing ( $p = 0.039$ ). The results of this study are consistent with the literature, concerning the verification of visual-motor integration, visual perception and motor coordination abilities influence on the students performance in school activities.

**Key words:** visual-motor integration; visual perception; motor coordination; academic performance; education, psychomotor abilities

- 1 Terapeuta Ocupacional. Especialista em Desenvolvimento Infantil. Mestranda em Educação pela Faculdade de Filosofia e Ciências, UNESP, campus de Marília. Endereço: Rua Antonio Hideto Kobayashi, 47, Condomínio San Marino, Jardim América, São José dos Campos, São Paulo, CEP 12235-845. Telefone (12) 3019-4467/ 9144-1406. E-mail: debora\_terapi@yahoo.com.br
- 2 Terapeuta Ocupacional. Doutora em Educação. Professora do Curso de Terapia Ocupacional da Faculdade de Filosofia e Ciências, UNESP, campus de Marília. Departamento de Educação Especial. Endereço: Av. Hygino Muzzi Filho, 737, Cidade Universitária, Marília, São Paulo, Cx Postal 181, CEP: 17.525-900, Telefone (14) 3402-1331. E-mail: ritac@marilia.unesp.br
- 3 Fisioterapeuta. Livre Docente em Reabilitação Física. Professora do Curso de Fisioterapia da Faculdade de Filosofia e Ciências, UNESP, campus de Marília. Departamento de Educação Especial. Endereço: Av. Hygino Muzzi Filho, 737, Cidade Universitária, Marília, São Paulo, Cx Postal 181, CEP: 17.525-900, Telefone (14) 3402-1331. E-mail: ligiapresumido@hotmail.com

**Correspondence to:** debora\_terapi@yahoo.com.br

Suggested citation: Pereira DM, Araújo RCT, Braccialli LMP. Relationship analysis between visual-motor integration ability and academic performance. Journal of Human Growth and Development 2011; 21(3): 808-817.  
Manuscript submitted Feb 06 2011, accepted for publication Aug 22 2011.

## INTRODUCTION

The visual-motor integration is an harmonious interaction ability between eyes and hands; involves visual perception and eye-hand coordination; requires the ability to translate visual perception in motor function and is necessary for many human activities like taking an object and throwing, writing, drawing, painting, cutting, etc<sup>1,2</sup>.

The visual-motor coordination construction has an essential role in writing learning<sup>3</sup>. Low perceptual ability or motor organization capacity may reflect in reading, writing and mathematics learning difficulties<sup>4</sup>.

Based on the idea that intelligence and knowledge are based on sensorio-motor skills and thinking about the need to identify children with learning difficulties, Keith E. Beery created in the 60's, with Norman A. Buktenica helps, the Developmental Test of Visual-Motor Integration, also known as Beery VMI. In 1990, Pinelli Júnior held the test adaptation for use in Brazil<sup>5</sup>.

According the Beery VMI authors, in the developmental process, the child can have the visual and motor skills, but be unable to coordinate them. Thus, this test aim is to assess the visual-motor integration maturation<sup>4</sup> as well distinguishing a set of features disorders of children with learning difficulties by geometric figures reproduction<sup>5</sup>.

This test is relatively independent in face of cultural aspects, which makes it valid for application in the U.S. and other countries and is particularly sensitive as a performance predictor of low socioeconomic groups<sup>4</sup>.

Since cognitive components like visual perception and visual-motor integration are involved in the learning process, the use of neuropsychological tests in learning area is presented as an important tool to unravel cognitive causes that may lead to learning difficulties<sup>6</sup>.

Another test that can also be used in learning area to identify learning disabilities is the Academic Performance Test (Teste de Desempenho Escolar - TDE).

The TDE is an instrument developed and standardized in Brazil, designed to assess the academic performance fundamental skills (writing, reading and mathematics) in 1<sup>st</sup> to 6th elementary school grades. It has adequate psychometric properties with regard to their internal reliability<sup>7</sup>.

Considering the Beery VMI purpose and the TDE application scope, this study aimed to verify the relationship between visual-motor integration ability and academic performance, as well, whether visual perception ability was correlated with reading performance and whether motor coordination ability was correlated with writing performance.

## METHODS

Participants in this study were 77 students (40 girls and 37 boys) in 2nd elementary education year at a public school in São Paulo State. The children's age ranged from 6 years and 9 months to 8 years and 4 months, with an average of 7 years and 6 months.

Two instruments were used to collect data: The Developmental Test of Visual-Motor Integration (Beery VMI) and the Academic Performance Test (Teste de Desempenho Escolar - TDE).

The Beery VMI is a test used to assess the visual-motor integration ability. It consists in reproduction of 24 geometric figures arranged in increasing difficulty order. This test is composed of two additional test, the Visual Perception (VP) and the Motor Coordination (MC) which were added in 1997 review in order to provide resource to statistically evaluate the visual and motor contributions to visual-motor integration performance.<sup>4</sup> This test was adapted for use in Brazil<sup>5</sup>, but there is no standardiza-

tion scores by age for Brazilian children. This situation, however, is not considered a methodological obstacle in this study because it was not the objective of this study verify if the score obtained was the score expected for their age group.

The TDE is an instrument consisting of three subtests: writing, reading and arithmetic. Its objective is assess the academic performance fundamental skills, indicating which school learning areas are preserved or impaired.<sup>7</sup> In this study the cursive writing use depended on the child initiative.

This work was referred to the Science Faculty Research Ethics Committee, UNESP – Marília, and approved by the 1923/2010 protocol. The student's caretakers signed a voluntary participation consent form.

The tests were administered during school period, but in a room reserved specifically for this purpose. The Beery VMI (visual-motor integration) was applied collectively in 5 or 6 students group. The TDE and the Beery VMI supplemental test were applied individually. The tests were administered on different days to avoid the tiring of students and the test application order (Beery VMI and TDE) varied between participants. Data collection was performed daily during a period of approximately two months.

After the data collected analyze, was drafted and delivered to the children's caretakers a report with children performance in the tests. For students who had significant delay in visual-motor integration, visual perception and/or motor coordination was provided to the school and children's caretakers, activities suggested to help develop these skills.

The tests scoring were performed according to their manuals instructions. Graphics were created for better viewing of the data and the MINITAB was used for statistical analysis. To measure the correlation degree between student performance on the Beery VMI and TDE was used de Pear-

son correlation coefficient. This test was also used to verify the correlation existence between visual perception and reading performance. To check the possible relationship between motor coordination ability and cursive writing was used the Two-sample T test. In all statistical analysis was adopted significance level of 5% ( $d'' 0,05$ ).

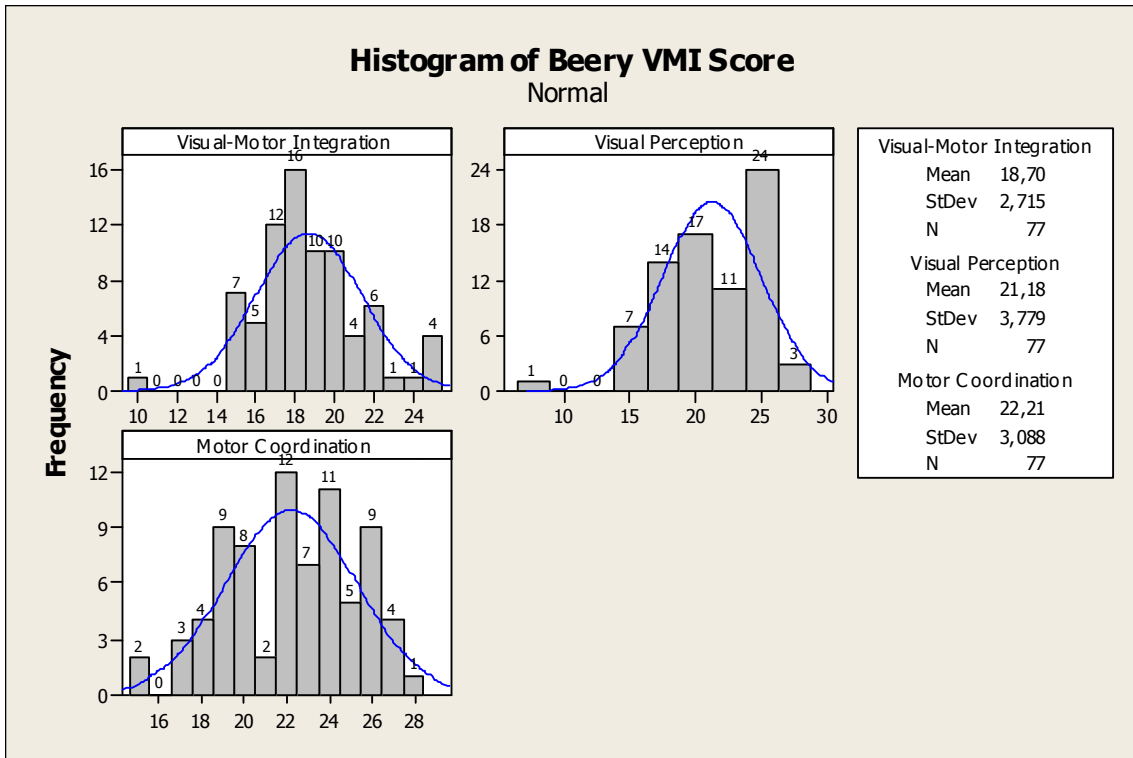
## RESULTS

In the histogram of VMI score (Figure 1) are showed the results obtained by 77 students on visual-motor integration test and visual perception and motor coordination additional tests. In the visual-motor integration test the scores ranged from 10 to 25, with an average of 18 hits. In the visual perception evaluation, students had an average score of 21, being 7 the lowest score and 21 the highest. In the motor coordination test, the score ranged from 15 to 28, being 22 the average achieved.

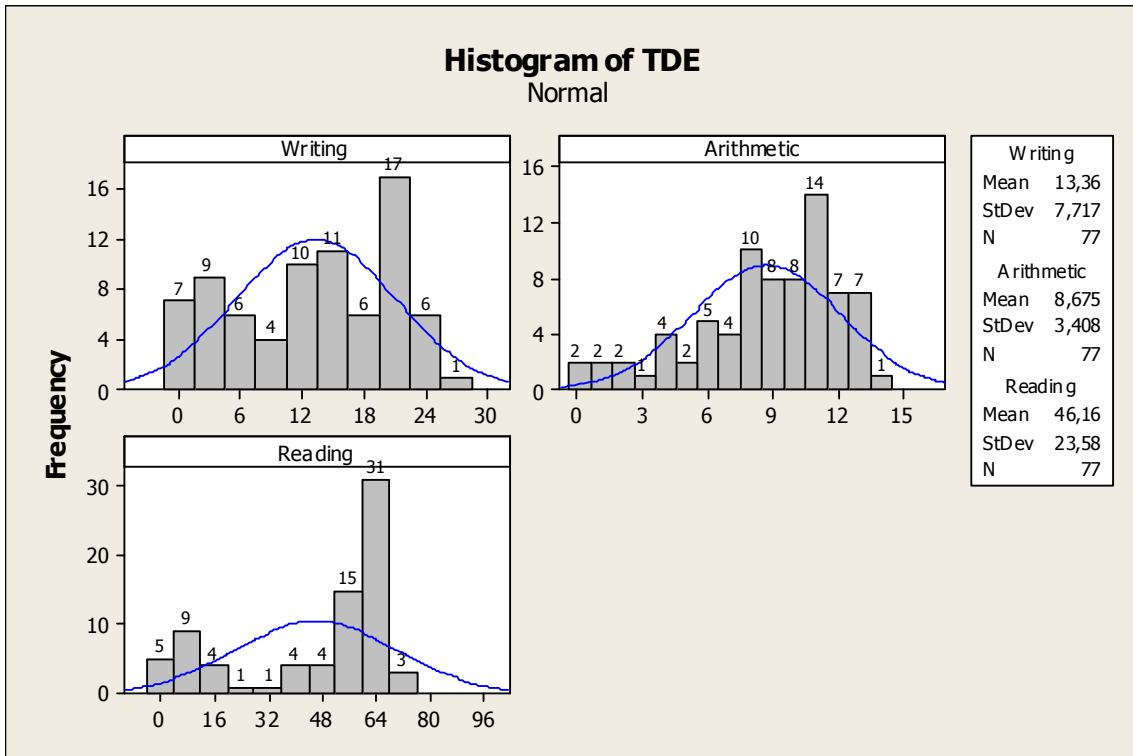
In the histogram of TDE (Figure 2) is verified the score obtained on writing, arithmetic and reading tests. The mean score on the writing subtest was 13 points, being the variation from zero to 28 points. In the arithmetic evaluation, the score ranged from zero to 14, with an average of 8 points. In the reading subtest, there was a score changing from zero to 70, with an average of 46 points.

To verify the correlation between visual-motor integration ability and academic skills (writing, arithmetic and reading) was applied the Pearson correlation statistical test. The Pearson correlation coefficients ( $r$ ) and "p value" obtained can be seen in Table 1. In figure 3 we can observe the positive relationship between visual-motor integration ability and the academic skills evaluated.

Pearson correlation test was also applied to verify the correlation existence between visual perception test performance and reading subtest performance. The



**Figure 1:** Histogram of Beery VMI score histogram.



**Figure 2:** Histogram of Academic Performance Test (Teste de Desempenho Escolar) score.

**Table 1:** Pearson correlation between visual-motor integration ability and writing, arithmetic and reading academic skills.

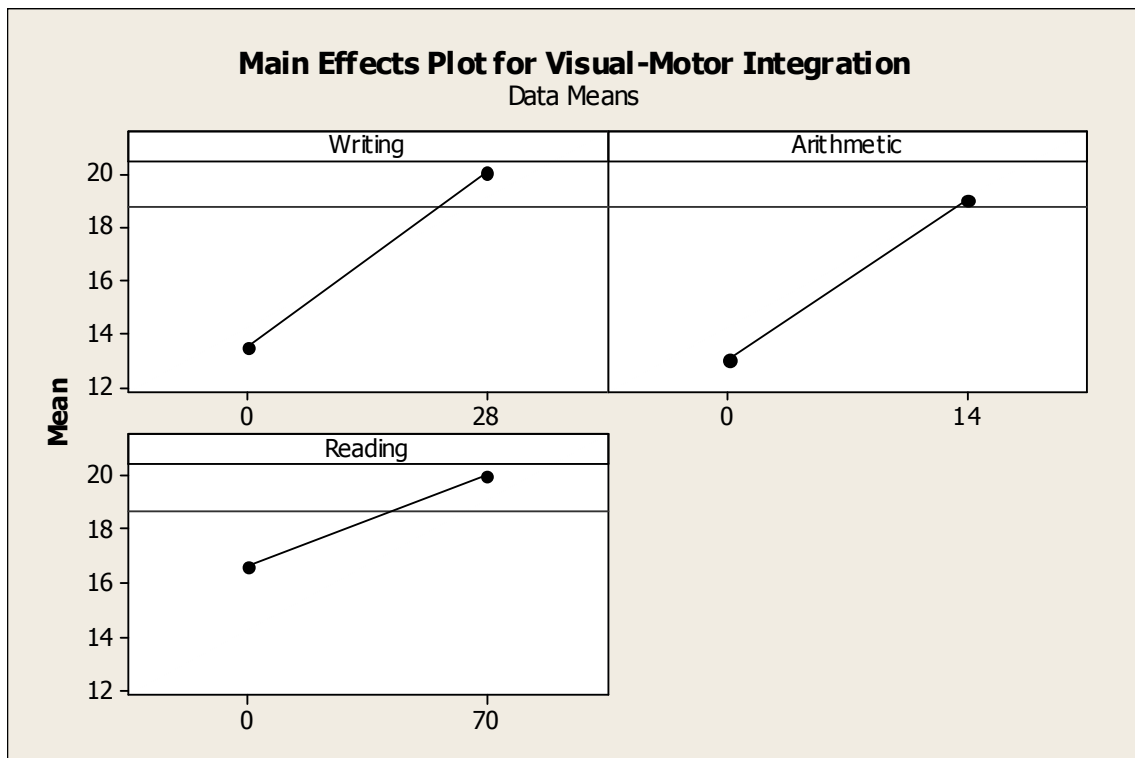
	Pearson correlation "P value"	coefficient (r)
Visual-Motor integration x Writing	0,244	0,033
Visual-Motor integration x Arithmetic	0,277	0,015
Visual-Motor integration x Writing	0,230	0,044

Pearson correlation coefficient obtained was 0,407 and the "p value" was zero.

To check the correlation existence between motor coordination ability and cursive writing was applied the Two-Sample t statistical test. This test is used to compare means of two samples with each other and determine if there is statistical difference between these averages.

In table 2 are showed the mean and standard deviation in motor coordination test according the writing (cursive writing or not) and the "p value" for the difference found between the letters types.

The figure 4 gives a better correlation image between motor coordination test performance and font (cursive writing or not).

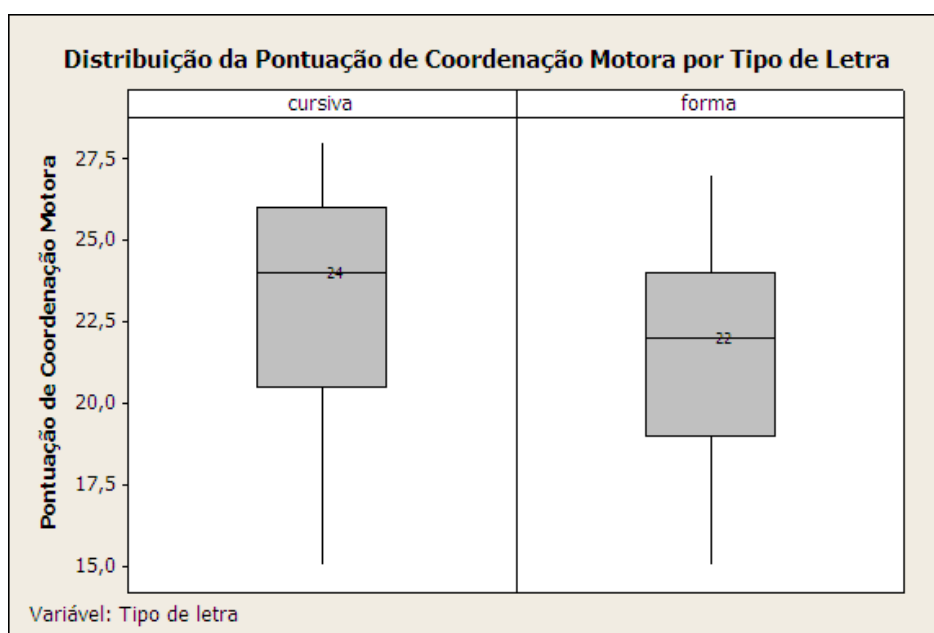


**Figure 3:** Main effects plot graph for the visual-motor integration average score by writing, arithmetic and reading factors.

**Table 2:** Two-sample T test of statistical significance between the motor coordination test performance and letter type (cursive writing or not).

Letter Type	Participants number (N)	Mean	Std Desv.
Cursive	25	23,32	3,33
Not cursive	52	21,67	2,85

\* difference T-Test = 0; "p value" = 0,039

**Figure 4:** Boxplot of motor coordination for letter types.

## DISCUSSION

The correlation statistical test results (Table 1) indicate that there was a significant correlation between visual-motor integration ability and academic abilities evaluated.

In the literature are found many studies dealing with the visual-motor integration ability accessed by Beery VMI with important skills for academic success. An example is the study that also aimed to examine the relationship between the visual-motor integration and academic performance. 191 students from an elementary school in Ohio, United States, aged between 7 and 9 years, participated in this study. The first-year students were assessed on visual-motor integration, reading, writing and mathe-

tics. The students in second and third years were assessed in those skills and also in spelling. The results cited by the author showed that the VMI performance was significantly related to the teachers evaluation in relation to reading, writing, mathematics and spelling<sup>8</sup>.

Another study that evaluated the visual-motor integration with Beery VMI and correlated it with important academic abilities was conducted in order to examine the relationship between VMI test performance and legibility writing. Participated in this study 54 children attended in day care. The results showed that the students were able to copy the first nine VMI geometric forms had a significantly better performance than students who failed to correctly copy the same nine forms. This result led the au-

thors to conclude that the visual-motor integration ability was related to ability to copy letters legibly<sup>9</sup>.

In an attempt to reduce school failure in early grades through the psychomotor skills recovery, a study was conducted with 20 students from 4 to 8 years in order to detect children psychomotor lags, emphasizing the body movements' importance to writing acquisition and to identify the multiple psychomotor aspects that influence the literacy process. In this studies were assessed, among other skills, fine motor coordination and visual-motor skills. The results pointed out that only 50% of the children were able to perform all activities that aimed to evaluate these aspects, indicating, according to the authors, participants' difficulty in performing activities that required the simultaneous use of hands and eyes (visual-motor integration). Another quite evident difficulty was related to the prehension movement: 60% of children held the pencil incorrectly. It was also noticed that children, in general, had the frame and copy records slowly, hold the pencil and/or pen incorrectly, and had inadequate pressure control applied on pen/pencil<sup>10</sup>.

Regarding the relationship analysis between visual perception and reading performance, in this study, the Pearson correlation test showed a significant correlation between the performance on the visual perception test and reading subtest.

Regarding the relationship analysis between motor coordination and writing performance, the "p value" (0,039) obtained from the Two-Sample T statistical test showed a statistically significant difference between the types letter (cursive writing or not), concluding, through the medium, that the initiative to write in cursive is relate to motor skills.

There were no studies found in literature studies about the relationship between the variables visual perception and reading or motor coordination and

cursive writing. However, there is the study that described the children with 6 and 7 years old performance in the Beery VMI and examined the relationship between the score on this test and the accuracy outline and the children motor ability level. In this study, the visual subtest showed significant correlation with the time taken for text copy activity completion and the motor test showed significant correlation with the copy time and the writing quality assessment realized by the teacher. According to the authors, the results supported the relationship between visual-motor performance and writing quality<sup>11</sup>.

Changes in the motor coordination development have been a constant among students who have learning problems. According the literature at least 50% of students with learning disorders have motor difficulties<sup>12</sup>. Concerned with such prevalence, a study was conducted aiming to characterize the fine, sensory and perceptive motor function performance in students with dyslexia, disorder and learning difficulties and to correlate these findings with students writing. The study included 80 students from 2<sup>nd</sup> to 4<sup>th</sup> grade, of both genders and aged between 7 and 11 years old. 20 students of these study had a interdisciplinary diagnosis of dyslexia (group I), 20 had learning disorders (group II), 20 had learning difficulties (group 3) and 20 had no such difficulties (group IV). These children were submitted to assessment of fine motor function (wich is divided into three parts: fine motor function, sensory motor function and perceptual motor function) and writing analysis through the dysgraphia scale application in the assessment of a note dictation writing. The results showed that the motor difficulties were presented in all students groups. Regarding the fine, sensory and perceptive motor function classification, among students with dyslexia, 20% had moderate dysfunction, 50 had mild dysfunction and 30%

had no dysfunction; among the students with learning disorders, 95% had mild dysfunction and 5% had no dysfunction; among students with learning difficulties, 90% had mild dysfunction and 10% had no dysfunction; among students without learning difficulties, 55% had mild dysfunction and 45% had no dysfunction. Regarding the dysgraphia presence, this was observed in 85% of students with dyslexia, 100% of students with learning disorders, 45% of students with learning difficulties and 15% of children without learning difficulties<sup>12</sup>.

For an adequate quality writing, that is, a good handwriting, it is necessary, among other things, appropriate fine motor control and visual-motor integration, motor planning, proprioception, visual perception, sustained attention and fingers sensory awareness<sup>13</sup>. The impairment in these skills can result in illegible handwriting and can compromise the child academic performance<sup>13</sup>.

In general, the learning process involves many skills, included motor abilities<sup>14</sup>. Read and writing learning is a complex and difficult process for children in early literacy, because encompasses both biological and social factors and requires cognitive, linguistic and motor skills<sup>15, 16</sup>.

Children with learning difficulties demonstrate perceptual difficulties to identification, interpretation and discri-

mination of stimuli, which seem to resonate in reading, writing and mathematics difficulties<sup>17</sup>. Regarding the social factors cited in the literature, that appear to interfere with academic learning are the school and familiar environment, learner's own motivation and positive reinforcement<sup>18, 19</sup>.

Some studies emphasize the motor abilities importance for academic performance, since problems in these skills can lead to delays in general learning<sup>20</sup>. There is a close relationship between what the child is capable of learning (cognitive) and what it is capable (motor),<sup>21</sup> therefore, the students motor skills monitoring is a preventive act for professionals involved with learning.

It is essential that the child before beginning to systematize the literacy process, acquire certain concepts or skills that will enable and facilitate the reading and writing learning<sup>14</sup>.

In this study we could verify the relationship existence between the visual-motor integration and academic skills (reading, writing and arithmetic). We also identified the relationship between the visual perception ability and the reading performance, and the relationship between the motor coordination and the cursive writing.

The results of this study point to the influence of visual-motor, visual perception and motor coordination abilities on school performance in reading, arithmetic and cursive writing activities.



## REFERENCES

1. Rosa Neto F. Manual de avaliação motora. Porto Alegre: Artmed Editora; 2002. 136p.
2. Sanghavi R, Kelkar R. Visual-motor integration and learning disabled children. *The indian journal of occupational therapy*. 2005; 37(2):33-8.
3. Ajuriaguerra J et all. A escrita infantil: evolução e dificuldades. Porto Alegre: Artes Médicas; 1988. 301p.
4. Beery KE, Beery NA. *The Beery-Buktenica Developmental Test of Visual-Motor Integration*. 6.ed. Texas: Pearson; 2010. 209p.
5. Pinelli Júnior B. Adaptação do Teste do Desenvolvimento da Integração Viso-Motora (VMI) para uso no Brasil [dissertação]. Brasília: Instituto de Psicologia da Universidade de Brasília; 1990.184p.
6. Oliveira CR, Rodrigues JC, Fonseca RP. O uso de instrumentos neuropsicológicos na avaliação de dificuldades de aprendizagem. *Revista de Psicopedagogia*. 2009; 26(79):65-76.
7. Stein LM. *Teste de desempenho escolar: manual para aplicação e interpretação*. São Paulo: Casa do Psicólogo; 1994. 31p.
8. Kulp MT. Relationship between visual motor integration skill and academic performance in kindergarten through third grade. *Optometry and vision science*. 1999; 76(3):159-63.
9. Daly CJ, Kelley GT, Krauss A. Relationship between visual-motor integration and handwriting skills of children in kindergarten: a modified replication study. *American journal of occupational therapy*. 2003; 57(4):459-62.
10. Nogueira LA, Carvalho LA, Pessanha F C, Lima SCL. A psicomotricidade na prevenção das dificuldades no processo de alfabetização e letramento. *Perspectivas online*. 2007; 1(2): 9-28.
11. Oliveira RT, Lopes LG, Magalhães LC. A relação entre integração visuomotora e escrita em crianças de 6 e 7 anos de idade. *Temas sobre desenvolvimento*. 2004; 13(75): 5-13.
12. Capellini AS, Coppede AC, Vale TR. Função motora fina de escolares com dislexia, distúrbio e dificuldades de aprendizagem. *Pró-fono revista de atualização científica*. 2010; 22(3): 201-8.
13. Feder KP, Majnemer A. Handwriting development, competency and intervention. *Developmental Medicine Child Neurology*. 2007; 49(4):312-7.
14. Silva AB, Borges PFB. A importância da psicomotricidade na educação infantil. *Revista de pedagogia perspectivas em educação*. 2008;3(1):1-20.
15. Capellini AS, Souza AV. Avaliação da função motora fina, sensorial e perceptiva em escolares com dislexia do desenvolvimento. In: Sennyey AL, Capovilla FC, Montiel JM. *Transtornos de aprendizagem: da avaliação à reabilitação*. São Paulo: Artes Médicas; 2008. p. 55-64.
16. Pelitero TM, Manfredi AKS, Schneck APC. Avaliação das habilidades auditivas em crianças com alterações de aprendizagem. *Revista CEFAC*. 2010; 12(4): 662-70.
17. Lucca AS, Mancine MS, Dell'agli BAV. Dificuldade de aprendizagem: contribuições da avaliação neuropsicológica. *Revista Científica UNIFAE*. 2008; 2(1): 32-42.
18. Felipe ACN, Colafêmina JF. Avaliação simplificada do processamento auditivo e o desempenho em tarefas de leitura- escrita. *Pró-Fono Revista de Atualização Científica*. 2002; 4(2): 225-34.

19. Siqueira CM, Gurgel-Giannetti J. Mau desempenho escolar: uma visão atual, Revista Associação Médica Brasileira. 2011;57(1):78-87.
20. Medina-Papst J, Marques I. Avaliação do desenvolvimento motor de crianças com dificuldades de aprendizagem. Revista Brasileira de Cineantropometria e Desempenho Humano. 2010; 12(1):36-42.
21. Rosa Neto F, Santos APM, Xavier RFC, Amaro KN. A importância da avaliação motora em escolares: análise da confiabilidade da Escala de Desenvolvimento Motor. Revista brasileira de Cineantropometria e desempenho humano. 2010; 12(6): 422-27.