The Open Journal of Occupational Therapy

Volume 2
Issue 2 *Spring 2014*

Article 4

April 2014

Visual-Motor Skills Performance on the Beery-VMI: A Study of Canadian Kindergarten Children

Melissa Coallier
Université de Sherbrooke - Canada, melissa.coallier@usherbrooke.ca

Natasha Rouleau
Université de Sherbrooke - Canada, n.rouleau@edme.org

Florence Bara
IUFM de Bretagne, Université de Bretagne Occidentale - France, florence.bara@bretagne.iufm.fr

Marie-France Morin
Université de Sherbrooke - Canada, marie-france.morin@usherbrooke.ca

Recommended Citation

Coallier, M., Rouleau, N., Bara, F., & Morin, M. (2014). Visual-Motor Skills Performance on the Beery-VMI: A Study of Canadian Kindergarten Children. *The Open Journal of Occupational Therapy, 2*(2). https://doi.org/10.15453/2168-6408.1074

Visual-Motor Skills Performance on the Beery-VMI: A Study of Canadian Kindergarten Children

Abstract

The Beery VMI is one of the standardized assessment tools most widely used by occupational therapists to assess visual-motor integration. Currently, no specific norms exist for Canadian children. This study was developed to assess whether kindergarten children in Canada compared similarly to the norms established in the U.S. sample of the Beery VMI in order to validate its use with Canadian children. Possible gender differences were also examined. The Beery VMI was administered to 151 kindergarten children, aged 5 to 6 years, at the end of the school year. The data collection took place in seven schools, where the participants were individually assessed. T-tests were used to compare the mean standard scores of the Canadian sample to those provided in the Beery VMI, as well as gender differences. Overall, the study sample showed a similar score (p = .997) compared to the U.S. norms, as well as a significant gender difference; girls obtained higher mean scores than boys (p = .003). These findings support the use of the Beery VMI reference norms to interpret performance results obtained by Canadian kindergarten children. However, the significant gender difference observed should be addressed in future studies.

Keywords

Beery VMI, visual-motor skills, pediatric occupational therapy, kindergarten, handwriting

Cover Page Footnote

We would like to thank all of the children who participated in this study. This population was followed in a larger study that was conducted by Marie-France Morin and Michèle Venet: Learn to Write in Kindergarten, I Like it! (Apprendre à écrire en maternelle, moi j'aime ça!). This longitudinal research was supported by CREALEC, the Research Chair on Reading and Writing Acquisition with Young Children (Chaire de recherche sur l'apprentissage de la lecture et de l'écriture chez le jeune enfant), directed by professor Marie-France Morin, Faculté d'Éducation, Université de Sherbrooke.

Credentials Display

Melissa Coallier, B.Sc.O.T., M.Sc., PhD student; Natasha Rouleau, B.Sc.OT., M.A. student; Florence Bara, PhD; Marie-France Morin, PhD

DOI: 10.15453/2168-6408.1074

Visual-motor integration has been described as being multifaceted and influenced by a number of factors: visual receptive functions; visual cognitive functions; fine motor ability; and the integration of visual, cognitive, and motor processes (Dankert, Davies, & Gavin, 2003; Schneck, 2010a). Some authors consider the terms visual-motor integration and eye-hand coordination to have the same meaning, i.e., the ability to use vision to perform motor tasks accurately (Schneck, 2010b). This is how Beery and Beery (2004) also define this component, arguing that "visual-motor integration is the degree to which visual perception and finger-hand movements are well coordinated" (p.12).

Background

Visual-motor integration is an important component in children's development; it is linked to many functional skills and the ability to participate in daily tasks (Marr & Cermak, 2002). For example, visual-motor integration appears to play an important role in the development of handwriting (Volman, van Schendel, & Jongmans, 2006). Feder and Majnemer (2007) described handwriting as a "complex perceptual-motor skill encompassing a blend of visual-motor coordination abilities, motor planning, cognitive, and perceptual skills, as well as tactile and kinesthetic sensitivities" (p. 313). An estimated 10% to 30% of school-aged children experience handwriting difficulties (Karlsdottir & Stefansson, 2002).

Several researchers have noted that visual-motor integration is a significant predictor of handwriting performance in young students (Cornhill & Case-Smith, 1996; Dankert et al., 2003; Feder & Majnemer, 2007). Specifically, this relationship has been found to be more important in early grades, particularly because young students tend to rely more on visual feedback and motor information to guide their movements to form and copy letters (Klein, Guiltner, Sollereder, & Cui, 2011; Overvelde & Hulstijn, 2011).

In addition to influencing handwriting development, visual-motor problems are likely to affect academic performance in reading and mathematics (Sortor & Kulp, 2003). Improving visual-motor skills is, therefore, one of the main objectives of occupational therapists who work with preschool and early elementary school children (Ratzon, Efraim, & Bart, 2007).

The Beery VMI

To identify visual-perceptual factors that limit occupational performance and participation, occupational therapists need to assess how visual-perceptual difficulties may affect a child's daily life. To do so, a norm-referenced test is almost always used, in addition to interviews and clinical observations (Chan & Chow, 2005). Of the norm-referenced tests available, the Beery VMI (Beery & Beery, 2004) is one of the standardized assessment tools most widely used by occupational therapists to assess visual-motor integration, a performance component (Brown, Rodger, Brown, & Roever, 2007; Burtner, McMain, & Crowe, 2002; Feder, Majnemer, & Synnes, 2000). A survey of 272 Canadian occupational therapists aimed at profiling the pediatric practice in occupational therapy showed that the Beery VMI was the most commonly used assessment tool cited (Brown et al., 2007). Despite a lack of Canadian norms, a survey of 50 Ontario and Quebec pediatric occupational

therapists revealed that the Beery VMI is the most commonly used assessment tool for children with handwriting and related fine-motor problems (Feder et al., 2000). This assessment tool has been demonstrated to be particularly useful for the assessment of writing readiness in 5- and 6-year-old children (Marr & Cermak, 2002).

Described as a valid measure of visual-motor integration (Goyen & Duff, 2005; Parush, Lifshitz, Yochman, & Weintraub, 2010), the Beery VMI was designed to assess the extent to which individuals can integrate their visual and motor abilities (Beery, Buktenica, & Beery, 2010). The Beery VMI has been standardized and normalized six times between 1964 and 2010 with a United States population of more than 12,500 children aged 2 to 18 years. Stability of outcomes by age group across the revisions has been certified and it has shown good psychometric properties, including a test-retest reliability of 0.88 and an interrater reliability of 0.93 (Beery et al., 2010). In terms of psychometric properties, van Hartingsveldt, de Groot, Aarts, and Nijhuis-van der Sanden (2011) found that the Beery VMI—along with the Bruininks-Oseretsky Test of Motor Proficiency, 2nd edition (BOT-2) (Bruininks & Bruininks, 2005)—stood out among other instruments assessing writing readiness.

Beery VMI: Cross-Cultural Aspects

Currently, the Beery VMI scores of Canadian children are compared to the established U.S.-based norms. However, several studies have indicated that standardized assessment tools may not be valid when they are used to assess persons from a cultural group other than the one on which the assessment had been standardized, and that translation is not sufficient (Cermak et al., 1995; Josman, Abdallah, & Engel-Yeger, 2006).

Even though a number of studies have considered the Beery VMI to be a culture-free assessment tool (Goyen & Duff, 2005; Overvelde & Hulstijn, 2011; Parush et al., 2010; van Hoorn, Maathuis, Peters, & Hadders-Algra, 2010), some study results have shown different visual-motor skill performance patterns in different cultures, especially among preschool and early school-age children (Josman et al., 2006; Tekok-Kilic, Elmastas-Dikec, & Can, 2010). These findings support Roselli and Ardila's argument against the concept of culture-free neuropsychological nonverbal assessments, thus supporting the idea that cultural variables may affect the performance of children on tests assessing visual-motor skills (Roselli & Ardila, 2003).

Beery VMI: Gender Differences

Given that visual-motor integration has been found to be one of the most significant predictors of handwriting performance (Tseng & Murray, 1994; Weil & Amundson, 1994) and that more boys than girls tend to experience difficulties in handwriting (Berninger & Fuller, 1992; Ziviani & Wallen, 2006), it seems justified to compare the gender difference on the Beery VMI. Studies that contributed to the development of the Beery VMI (Beery et al., 2010) showed a difference between boys and girls that was not significant enough to be taken into account (explaining less than 1% of the variance). However, some developmental assessment tools, for instance the BOT-2 (Bruininks & Bruininks, 2005), show different reference values

for boys and girls in the field of motor accuracy and visual-motor integration.

Methods

Purpose of Study

The purpose of this study was to assess whether kindergarten children in Canada compared similarly to the norms established on the Beery VMI U.S. sample in order to validate its use with Canadian children. More specifically, the objectives of the study were: (a) to compare the mean Beery VMI scores of a sample of Canadian children to those obtained by the American reference population, and (b) to examine possible gender differences in the sample.

Participants

Using convenience sampling, 151 Canadian children attending kindergarten within the province of Quebec participated in the study. In Quebec, children attend one year of kindergarten (from the ages of 5 to 6 years) before beginning formal education in grade 1. The children in the study came from seven primary schools.

To be included, the children needed to: (a) attend kindergarten; (b) be 5 years of age as of September 30, 2009; and (c) speak and understand French. Children who presented a disability indicating a central nervous system dysfunction were excluded. Ethics approval from the Université de Sherbrooke and parental consent were both obtained.

Data Collection

To meet the first objective of the study (i.e., comparison of mean scores to the American Beery VMI reference population), participants were individually assessed at the end of their kindergarten year (May and June 2010). Data collection took place at school, in a room near the student's classroom. Three trained research assistants administered the standardized Beery VMI administration protocol. To ensure consistent scoring, all assessments were scored by a research assistant who did not participate in data collection and who was blind to the study's objectives. A graduate student served as a second rater and scored 30% of the assessments, selected randomly. Interrater reliability was 0.995.

Participant Assessments

Visual-motor integration for each participant was assessed using the Beery VMI, 5th edition (Beery & Beery, 2004), the most current edition available at the time of the study. For this study, the short form was used. Each child's task was to copy different geometric shapes that become progressively more complex and challenging to copy. The first three test items, intended for very young children, consisted of three types of scribbling. The next three tasks required the child to imitate shapes drawn by the evaluator (i.e., vertical line, horizontal line, and circle). Then the child had to copy 15 developmentally sequenced geometric shapes.

The participating children received one point for each correctly completed shape. The assessment ended after three consecutive errors, based on scoring criteria defined by the authors of the tool. The administration time was approximately 10 minutes per child.

Data Analysis

Following the assessment process, the raw score for each child was converted into a standard

score according to a scale, based on the child's age. The scale was divided into a series of two-month age intervals; the mean standard score was 100, with a standard deviation of 15.

Descriptive analyses were then performed to describe the sample. A one sample t-test was used to compare the mean standard scores of the Canadian sample and those provided in the Beery VMI. An independent sample t-test was used to compare the mean standard scores between the boys and girls participating in this study. Data analyses were performed using SPSS software (version 19.0).

Results

The total sample (N = 151) consisted of 85 boys (56%) and 66 girls (44%), aged 68 months to 79 months. The mean age was 75 months (6.2 years of age). The children were grouped according to VMI age group (68-69 months, 70-71 months, 72-73 months, 74-75 months, 76-77 months, and 78-79 months). Table 1 shows the mean scores obtained by the Canadian sample on the Beery VMI, by age group and compared with U.S.-based norms. It also shows the number of participants per age group, as determined in the Beery VMI manual.

Comparison With U. S.-Based Norms

Overall, the study sample showed a similar score (p = .997) to the U.S. norms. The mean scores of the different age groups were comparable to the standard score of 100 set for this tool. They showed no significant difference except for the 68-69 months age group, which obtained a significantly higher score than the norm [t (29) = 4.16, p < .005]. This age group consisted of the youngest children in the sample.

The mean scores of all the girls (mean = 104.20, CI [101.61-106.78]) were compared with the mean scores of all the boys (mean = 99.29, CI [97.33-101.26]) in the sample. The results revealed a significant difference, in which the girls obtained a higher mean score compared to the boys (p = .003). Moreover, the mean score of the girls was significantly higher than the reference value established by the Beery VMI authors (p = .002). The boys' mean score was comparable to the reference value (p = .476).

Table 1

Mean Scores Obtained by Canadian Children on the Beery VMI at the End of Kindergarten, Compared With U.S.-Based Norms

Beery VMI Age Group (Months)	***n***	**M (SD)**	***t***	***p* Value**	**Comparison with U.S.-Based Norms** (X=100)
68-69	30	107.53 (9.91)	4.16	.000**	↑
70-71	22	104.36 (10.42)	1.97	.063	=
72-73	26	99.92 (6.56)	-0.06	.953	=

https://scholarworks.wmich.edu/ojot/vol2/iss2/4
DOI: 10.15453/2168-6408.1074

74-75	22	99.00 (10.58)	-0.44	.662	=
76-77	24	96.29 (10.88)	-1.67	.109	=
78-79	27	100.30 (7.80)	0.20	.845	=
Total	151	101.44 (10.0)	-0.004	.997	=
Girls	66	104.20 (10.5)* †	3.22	.002**	↑
Boys	85	99.29 (9.1)	-0.72	.476	=

Note. * $p < .05$. ** $p < .01$. ↑ score statistically superior to U.S.-based norms. = score comparable to U.S.-based norms (x=100). † There was a significant gender difference in sample ($p = .003$).

Discussion

The first specific objective of this study was to compare the mean Beery VMI scores of a sample of Canadian kindergarten children to those obtained by the American reference population. The findings showed that the visual-motor integration skills of the Canadian sample were broadly comparable to the U.S-based norms. Therefore, these results support the use of the American Beery VMI norms with kindergarten children in Quebec, Canada. However, no clear argument can explain the significant difference found in the youngest Canadian age group (68-69 months). This age group obtained a significantly higher score in comparison with the same U.S. age group. As Roselli and Ardila (2003) suggested, this surprising result might point to the influence of certain cultural variables in visual-motor skills development. Thus, it would be advisable to conduct further research to confirm or refute this trend.

The second specific objective was to examine possible gender differences in the Canadian sample. In addition to being superior to the normative sample, the performance of the girls in this sample significantly differed from the performance obtained by the boys in the sample. This result is consistent with many findings from previous research, which have clearly shown that boys tend to perform less well than girls in handwriting in elementary school and throughout their school years (Berninger & Fuller, 1992; Blöte & Hamstra-Bletz, 1991; Ziviani & Wallen, 2006). Given these findings, the following questions may arise: Is there a gender difference in visual-motor skills developmental trajectories? If so, is the gender difference specific to Canadian children?

In the U.S. norms issued by the Beery VMI, performances between boys and girls do not differ. However, the results of this study suggested a significant gender difference, pointing in the same direction as other assessment tools—such as the BOT-2 (Bruininks & Bruininks, 2005), which recently introduced different norms for boys and girls:

> Sex specific norms are provided due to the differences in performance between females and males on items in certain subtests. For example, females in the BOT-2 norm sample scored higher on average than males on items in the Fine Motor Precision, Fine Motor Integration, and Manual Dexterity subtests. (p. 6)

To further understand this potential gender difference, factor analysis would allow more precise exploration of the factors influencing the developmental trajectory of visual-motor skills; this could explain the differences in performance between boys and girls on the Beery VMI. This analysis would show whether the two groups have the same factors and whether the weight of those factors is the same for boys and girls.

Limitations

One limitation was the fact that the study took place in only one Canadian province; thus, findings may not be generalizable to all Canadian kindergarten children. Another limitation of the study was that some of the Beery VMI age groups had a limited number of children (e.g., age group 70-71 months of age had 22 participants). However, despite these limitations, the results raise some questions that can be considered as stepping stones for further studies.

Implications for Practice

To better understand some handwriting difficulties, which are a primary reason for referral to occupational therapy in schools (Feder et al., 2000), occupational therapists frequently use the Beery VMI in their evaluation process. The findings of this study appear to be particularly relevant for occupational therapists who work with preschool children, especially those working in Québec, Canada. To the best of the authors' knowledge, this is the first study that compares the performance of Canadian kindergarten children with the Beery VMI U.S.-based norms. Overall, the use of U.S. norms in the occupational therapy evaluation process in Canada appears valid when targeting those children presenting with visual-motor difficulties. Until further research occurs, however, it is important that occupational therapists remain cautious when interpreting the results obtained on the Beery VMI by Canadian preschoolers.

Taking into account that visual-motor integration difficulties can have a negative effect on a child's occupational performance and academic achievement, occupational therapists need to consider it in a broader perspective in the evaluation process. In addition to norm-referenced tests such as the Beery VMI, interviews and clinical observations can document how the visual-perceptual difficulties affect a child's daily activities (Chan & Chow, 2005). Also, triangulation of data obtained from norm-referenced assessments with observations of academic and self-

care tasks in ecologically natural contexts, such as school and home, would allow an occupational therapist to better understand a child's participation.

Conclusion

The purpose of this study was to assess whether kindergarten children in Canada compare similarly to the norms established on the U.S. Beery VMI sample. The findings showed that the visual-motor integration skills of the Canadian preschoolers in the sample were broadly comparable to the U.S. sample, except for the Canadian youngest age group, and thus support the use of the Beery VMI reference norms to interpret performance results obtained by Canadian kindergarten children. The results of this study also suggested a significant gender difference that points in the same direction as other assessment tools assessing visual integration and fine motor precision. Further investigation of the potential gender difference in young children's visual-motor developmental trajectories would be worthwhile. Future study results could possibly support the importance of developing gender-specific norms for Canadian children, namely preschoolers.

References

Beery, K. E., & Beery, N. A. (2004). *The Beery-Buktenica developmental test of visual-motor integration: Administration, scoring, and teaching manual* (5th ed.). Minneapolis, MN: NCS Pearson.

Beery, K. E., Buktenica, N. A., & Beery, N. A. (2010). *The Beery-Buktenica developmental test of visual-motor integration: Administration, scoring, and teaching manual* (6th ed.). Minneapolis, MN: NSC Pearson.

Berninger, V. W., & Fuller, F. (1992). Gender differences in orthographic, verbal, and compositional fluency: Implications for assessing writing disabilities in primary grade children. *Journal of School Psychology*, *30*(4)*,* 363-382.

Blöte, A. W., & Hamstra-Bletz, L. (1991). A longitudinal study on the structure of handwriting. *Perceptual and Motor Skills*, *72*(3), 983-994.

Brown, G. T., Rodger, S., Brown A., & Roever, C. (2007). A profile of Canadian pediatric occupational therapy practice. *Occupational Therapy in Health Care*, *21*(4), 39-69. doi:10.1300/J003v21n04_03

Bruininks, R., & Bruininks, B. (2005). *The Bruininks-Oseretsky test of motor proficiency* (2nd ed.). Minneapolis, MN: NCS Pearson.

Burtner, P. A., McMain, M. P., & Crowe, T. K. (2002). Survey of occupational therapy practitioners in southwestern schools: Assessments used and preparation of students for school-based practice. *Physical and Occupational Therapy in Pediatrics*, *22*(1), 25-38.

Cermak, S. A., Katz, N., McGuire, E., Greenbaum, S., Peralta, C., & Maser-Flanagan, V. (1995). Performance of Americans and Israelis with cerebrovascular accident on the Loewenstein occupational therapy cognitive assessment (LOTCA). *American Journal of Occupational Therapy*, *49*(6), 500-506.

Chan, P. L., & Chow, S. M. (2005). Reliability and validity of the test of visual-perceptual skills (non-motor): Revised for Chinese preschoolers. *American Journal of Occupational Therapy*, *59*(4), 369-376.

Cornhill, H., & Case-Smith, J. (1996). Factors that relate to good and poor handwriting. *American Journal of Occupational Therapy*, *50*(9), 732-739.

Dankert, H. L., Davies, P. L., & Gavin, W. J. (2003). Occupational therapy effects on visual-motor skills in preschool children. *American Journal of Occupational Therapy*, *57*(5), 542-549.

Feder, K. P., & Majnemer, A. (2007). Handwriting development, competency, and intervention. *Developmental Medicine & Child Neurology*, *49*(4), 312-317.

Feder, K. P., Majnemer, A., & Synnes, A. (2000). Handwriting: Current trends in occupational therapy practice. *Canadian Journal of Occupational Therapy*, *67*(3), 197-204.

Goyen, T. A., & Duff, S. (2005). Discriminant validity of the developmental test of visual-motor integration in relation to children with handwriting dysfunction. *Australian Occupational Therapy Journal*, *52*(2), 109-115. doi:10.1111/j.1440-1630.2005.00488.x

Josman, N., Abdallah, T. M., & Engel-Yeger, B. (2006). A comparison of visual-perceptual and visual-motor skills between Palestinian and Israeli children. *American Journal of Occupational Therapy*, *60*(2), 215-225.

Karlsdottir, R., & Stefansson, T. (2002). Problems in developing functional handwriting. *Perceptual and Motor Skills*, *94*(2), 623-662.

Klein, S., Guiltner, V., Sollereder, P., & Cui, Y. (2011). Relationships between fine-motor, visual-motor, and visual perception scores and handwriting legibility and speed. *Physical & Occupational Therapy in Pediatrics*, *31*(1), 103-114. doi:10.3109/01942638.2010.541753

Marr, D., & Cermak, S. (2002). Predicting handwriting performance of early elementary students with the developmental test of visual-motor integration. *Perceptual and Motor Skills*, *95*(2), 661-669.

Overvelde, A., & Hulstijn, W. (2011). Handwriting development in grade 2 and grade 3 primary school children with normal, at risk, or dysgraphic characteristics. *Research in Developmental Disabilities*, *32*(2), 540-548. doi:10.1016/j.ridd.2010.12.027

Parush, S., Lifshitz, N., Yochman, A., & Weintraub, N. (2010). Relationships between handwriting components and underlying perceptual-motor functions among students during copying and dictation tasks. *OTJR: Occupation, Participation & Health*, *30*(1), 39-48. doi: 10.3928/15394492-20091214-06

Ratzon, N. Z., Efraim, D., & Bart, O. (2007). A short-term graphomotor program for improving writing readiness skills of first grade students. *American Journal of Occupational Therapy*, *61*(4), 399-405. doi:10.5014/ajot.61.4.399

Roselli, M., & Ardila, A. (2003). The impact of culture and education on nonverbal neuropsychological measurements: A critical review. *Brain and Cognition*, *52*(3), 326-333.

Schneck, C. (2010a). Visual perception. In J. Case-Smith & J. C. O'Brien (Eds.), *Occupational therapy for children* (6th ed.) (pp. 373-403). Maryland Heights, MO: Mosby Elsevier.

Schneck, C. (2010b). A frame of reference for visual perception. In P. Kramer & J. Hinojosa (Eds.), *Frame of reference for pediatric occupational therapy* (3rd ed.) (pp. 349-389). Baltimore, MD: Lippincott Williams & Wilkins.

Sortor, J. M., & Kulp, M. T. (2003). Are the results of the Beery-Buktenica developmental test of visual-motor integration and its subtests related to achievement test scores? *Optometry and Vision Science*, *80*(11), 758-763. doi:1040-5488/03/8011-0758/0

Tekok-Kilic, A., Elmastas-Dikec, B., & Can, H. (2010). Evaluation of visual-motor integration functions in children between 6-15 years of age. *Turkish Journal of Psychiatry*, *21*(2), 97-104.

Tseng, M. H., & Murray, E. A. (1994). Differences in perceptual-motor measures in children with good and poor handwriting. *Occupational Therapy Journal of Research*, *14*(1), 19-36.

van Hartingsveldt, M. J., de Groot, I. J. M., Aarts, P. B. M., & Nijhuis-van der Sanden, M. W. G. (2011). Standardized tests of handwriting readiness: A systematic review of the literature. *Developmental Medicine and Child Neurology*, *53*(6), 506-515. doi:10.1111/j.1469-8749.2010.03895.x

van Hoorn, J. F., Maathuis, C. G. B., Peters, L. H. J., & Hadders-Algra, M. (2010). Handwriting, visuomotor integration, and neurological condition at school age. *Developmental Medicine and Child Neurology*, *52*(10), 941-947. doi:10.1111/j.1469-8749.2010.03715.x

Volman, M. J. M., van Schendel, B., & Jongmans, M. J. (2006). Handwriting difficulties in primary school children: A search for underlying mechanisms. *American Journal of Occupational Therapy*, *60*(4), 451-460.

Weil, M. J., & Cunningham Amundson, S. J. (1994). Relationship between visuomotor and handwriting skills of children in kindergarten. *American Journal of Occupational Therapy*, *48*(11), 982-988.

Ziviani, J., & Wallen, M. (2006). The development of graphomotor skills. In A. Henderson & C. Pehoski (Eds.), *Hand function in the child: Foundations for remediation*, (2nd ed.) (pp. 217-238). St. Louis, MO: Mosby Elsevier.