EUROPEAN PSYCHOMOTRICITY JOURNAL

http://www.psychomotor.gr/epj.htm

ISSN 1791-3837
European Psychomotricity Journal 2009; 2; 1, 8-18
Published by: Athlotypo Sports Publishing
http://www.athlotypo.gr/

ORIGINAL ARTICLE

Validity and Reliability of the developmental Test of Visual-motor integration and its supplemental tests of Visual perception and Motor coordination in Pre-school children in Luxembourg

Johan Simons & Christine Probst
Faculty Kinesiology and Rehabilitation Sciences, KULeuven, Department of Rehabilitation Sciences

Abstract
This study aims to control for the validity and reliability of the Developmental Test of Visual-motor Integration and its supplemental tests of Visual Perception and Motor Coordination in pre-school children in Luxembourg. Additionally it serves to compare the performance of the pre-school children in Luxembourg to the age-related norms, established in the United States. In total 68 children, aged between 4 and 7 years old, participated in the study. The children were inscribed to 2 pre-schools in Luxembourg-city. One week after performing the first test 30 children performed a retest. The results indicated that the performance of the girls did not differ significantly from the performance of the boys. In general, the scores of the children of the pre-schools in Luxembourg differed significantly from the norms established in an age-related population in the United States. The children in Luxembourg scored significantly higher when comparing their standard scores of the 3 tests to the reference means. The test-retest reliability of our data was lower than in the Beery administration manual (2004). Our results show moderate to high degrees of construct validity, compared to the results of the Beery administration manual, 5th edition, 2004.

Key words: Beery, (VMI), test-retest, norms

Introduction

Visual-motor integration (VMI) is the capacity to coordinate hand and eye movements. Hand-eye coordination is the ability of the vision system to coordinate the information received through the eyes to control, guide, and direct the hands in the accomplishment of a given task, such as handwriting or catching a ball. Hand-eye coordination uses the eyes to direct attention and the hands to execute a task (retrieved from http://www.health.enotes.com). According to the research of Aylward and Schmidt (1986), Dunn (2001) describes visual-motor integration as the child's ability to integrate visual-perceptual skills with fine motor coordination. A child can have well-developed visual and motor skills but be unable to integrate the two. A lack of visual-motor integration can lead to academic problems of the child (Beery & Beery, 2004).

The standardization studies of the Beery Developmental test of Visual-motor Integration, (VMI) in 1981 found no significant differences between female and male performance in the Visual-motor Integration test (Beery VMI), the visual perception test (Beery VP), and the motor coordination test (Beery MC). These results agree with the results of Aylward and Schmidt (1986), and Baard (1998). These researchers found no difference between boys and girls when comparing their results on the Beery VMI. Schlodder (1986) and Leonard (1986), cited in Vorster and Brand (1995), found no significant influence of gender on the obtained test scores when performing the Beery Developmental test of Visual-motor Integration with a group of pre-school children. This is in accordance with the results of Vorster and Brand (1995). The authors found no significant correlation on the Beery VMI 1982 and 1989 edition and the biographical variable, gender. However, Marr and Cermak (2002) found out in a study in which they predicted handwriting performance on the Script-test by the outcome of the Beery VMI test scores, that these scores were good handwriting predictors for girls, but not for boys.

Correspondence: Johan Simons, Faculty of Kinesiology and Rehabilitation Sciences, KULeuven, B 3001 Leuven, E-mail: Johan.simons@faber.kuleuven.be

One aim of our study is therefore to see if there is a difference between boys and girls on the performance of the Beery Visual-motor Integration test and its two supplemental tests of visual perception and motor coordination (H2). In the 1964 Beery VMI standardization studies the researchers found no significant differences among rural, urban, and suburban children's performance (Beery & Beery, 2004). The authors stated that there is no bias for residence in the Beery Developmental Test of Visual-motor integration and its supplemental tests of visual perception and motor coordination (Beery & Beery, 2004). Even though our tests were administered to children in two kindergartens in Luxembourg-city, we want to compare if there is a difference between the two schools, to control if residence has an effect on the scores of the tests. One pre-school is situated in an area where a lot of families have a high socioeconomic level, whereas this is not true for the other school. As there are no bias for the socioeconomic status and no bias for residence in the Beery Visual-motor Integration Test and its supplemental tests (Beery & Beery, 2004), we suppose that there is no difference between the results of the two pre-schools in Luxembourg (H3).

Early screening of children with visual-motor integration problems is important to prevent or remediate further difficulties through early educational, medical or other interventions (Beery & Beery, 2004). The developmental stage from 2-6 years is called "early childhood" or "pre-school period". During this stage, cognitive and physical-motor abilities develop considerably (Dunn, 2001). The Beery VMI test was designed to measure visual-motor integration and to reflect developmental age differences in that area. Vorster and Brand (1995) stated clearly that the results on the Beery VMI 1982 and 1989 edition are related to the age. The older the children, the better they performed on the tests. We decided to evaluate the relation between age and the outcome of the Beery visual-motor Integration test and its two supplemental tests of visual perception and motor coordination (raw scores). If older children get better results than younger children, the test is related to the age (H4).

The Beery Developmental test of Visual-motor Integration is, by far, the best researched and has the most effective age range (birth to adulthood) of any other instrument purporting to measure "visual-motor integration" (Beery & Beery, 2004). The authors stated that reliability (test-retest, interrater reliability, internal consistency) and validity are high. Vorster and Brand (1995) controlled for the validity of the Beery visual-motor integration test and its two supplemental tests in the South African context for a group of South African pre-school children. They compared the outcome of the Beery VMI 1982 and 1989 to the South African standardized Copying Test. The three tests are significantly correlated and they also show relations with teacher evaluations of specific scholastic skills of the subjects. Both editions of the visual-motor integration test show valid results with the group of children used in this study. These results confirm the validity of the Beery VMI for use in the South African context (pre-school children). We evaluate the relation of the results of the Beery Visual-motor Integration test and its two different subtests for a group of pre-school children in Luxembourg to confirm the validity of the test in two kindergartens in Luxembourg (H5).

Beery and Beery (2004) stated that the visual-motor integration test and its two subtests have a very high test-retest reliability. The authors found a test-retest reliability of .89 for the visual-motor integration test, .85 for the visual perception test and .86 for the motor coordination test for a group of 115 children aged between 5 and 11 years old. The children performed the retest after 10 days. Beery and Beery (2004) indicated that for a screening test such as the Beery Developmental Test of Visual-motor Integration overall reliability has to be at least .80. We control if we find a test-retest reliability of the same level found by Beery and Beery (H6).

Beery and Beery (2004) stated that the visual-motor integration test, the visual perception test, and the motor coordination test can be used cross-culturally. They indicated standardized values (corrected for age) for the raw scores obtained in an American group of children in the Beery VMI scoring manual. The standardized score has a mean of 100 and a standard deviation of 15. Following the guidelines in the Beery VMI manual, we converted our raw scores to standardized scores, and compared them to the reference constant. By this way, we compared if the results of a sample of pre-school children in Luxembourg differ significantly of the norms established in the United States, and if the test can be used in Luxembourg (H7).

As the Beery VMI is a test not commonly used in Luxembourg, the aim of this research is to compare the performance of pre-school children (aged 4 - 7 years) in Luxembourg to the USA age related norms. This will show if the visual-motor development of children of a kindergarten in Luxembourg is similar to the visual-motor development of pre-school children in the United States. The research also aims to confirm the validity of the norms for a sample of children in Luxembourg.

Aim of the study

First of all the data will be controlled for normal distribution; if so parametric statistics can be used.

The influence of the interaction of the different variables (sex, school, and age category) with the results of the Beery VMI, Beery VP, and Beery MC was controlled. To control the construct validity, the correlation of the results of the visual-motor integration test, the visual perception test, and the motor coordination test were analyzed.

The test-retest reliability will be checked. In a last step the difference between the standard mean of each test and the reference constant was controlled.

Methods

Participants

In total, 68 children, aged between 53 and 81 months old, $\underline{M}_{age}$ ($mean_{age}$) = 64.09 months, <u>SD</u> (standard deviation) = 7.49 months, participated in the Developmental Test of Visual-motor Integration and its supplemental tests of visual perception and motor coordination. The group is formed of 33 boys, $\underline{M}_{age}$ = 64.45 months, <u>SD</u> = 7.15 months, and 35 girls, $\underline{M}_{age}$ = 63.74 months, SD = 7.89 months old. The children were inscribed to two kindergartens in Luxembourg-city. In each kindergarten, three classes were involved in the test. The inclusion criteria were the following: the child had to be aged between 4 and 7 years, have lived in Luxembourg for at least 2 years and have a good control of Luxembourgish, to understand the instructions given before and during the tests. All of the children except of two answered these criteria. The data of the two children who didn’t correspond to the criteria were excluded from the sample. The exclusion criteria were the following: the results of children with a physical or mental disability were excluded from the sample, because the norms of the Beery VMI manual (Beery & Beery, 2004) have been established on a group of non disabled children. In one class there were two children with a mental disability. The two children had a special teacher in the class who helped them to follow the guidelines of the class teacher. Although both children were allowed to participate in the tests with the rest of the class, the data of the two children with a mental disability were excluded from the sample. Before administering the test to the children, we requested and obtained authorization from the Ministry of Education in Luxembourg-city. Parents had to give informed consent before the children were allowed to participate in the test. In one class, two children did not participate in the test because their parents had not given the permission for the child to participate. The children were divided in different age groups. To facilitate the manipulation of the variables, an age code was created (Table 1).

Table 1: Age code for the sample of children of two pre-schools in Luxembourg-city

Category	Age in months	Frequency	Number of children in school 1	Number of children in school 2	Percent	Cumulative percent
1	52-53	2	1	1	2.94	2.94
2	54-55	7	5	2	10.29	13.23
3	56-57	9	5	4	13.23	26.47
4	58-59	8	7	1	8.82	38.23
5	60-61	2		2	2.94	41.17
6	62-63	6	4	2	8.823	50.00
7	64-65	5		5	7.36	57.35
8	66-67	4	2	2	5.882	63.23
9	68-69	4	3	1	5.882	69.12
10	70-71	8	1	7	11.765	80.88
11	> 72	13	5	8	19.118	100.00

Instrument

The Beery-Buktenica Developmental test of Visual-motor Integration (Beery VMI, 5th edition, by Beery & Beery, 2004) was used, which is a developmental sequence of forms to be copied with paper and pencil. The Beery VMI (Beery & Beery, 2004) is designed to assess the extent to which individuals can integrate their visual and motor abilities (eye-hand coordination). The Full Form 30-item Beery VMI can be either group or individually administered in about 10 to 15 minutes and is used in individuals aged 2-18 years. We used the shorter 21-item version, aimed for children 2 through 7 years. The Beery VMI is virtually culture free. Because children of different backgrounds often have widely varying degrees of experience with alphabets and numbers, geometric forms are used in the Beery VMI rather than letter or numeric forms. Norms for the visual-motor integration test are provided in two months intervals.

For measurement of visual perception, we used the visual perceptual subtest of the Beery Developmental test of visual-motor integration (Beery & Beery, 2004). The first three items of the test require very young children to identify parts of their bodies, picture outlines, and parts of a picture. For the remaining 27 items, one geometric form that is exactly the same as each stimulus is to be chosen from among others that are not exactly the same as the stimulus. During a three minute period, the task is to identify the exact match for as many of the 27 stimuli as possible. To make this as much a visual perceptual task as possible, the motor requirements of the task are reduced to a minimum by having the child simply make a circle round his choice. Examiners should be alert for possible visual problems.

Motor coordination was evaluated by the motor coordination subtest of the Beery VMI (Beery & Beery, 2004). The first three items of the test require very young children to climb on a chair, to hold a pencil with their thumb and finger and to hold the paper as they mark it. For the remaining 27 items, the task is to simply trace the stimulus forms with a pencil without going outside double-lined paths.

Norms for the latter two tests are provided in 3 months intervals. The three tests must be administered in the same order to obtain valid results: first the visual-motor integration test, followed by the visual perceptual test, the motor coordination test is administered last.

Reliability and validity of the Beery Developmental Test of Visual Motor Integration were well established according to the manual (Beery& Beery, 2004).

Procedure

The children were administrated the Beery-Buktenica Developmental Test of visual-motor integration, 5th edition, 2004. The administration of the visual-motor integration test was followed by its two supplemental tests, the visual perception test (Beery VP) and the motor coordination test (Beery MC). The shorter form of 21 items was used to measure visual-motor integration. The tests were administered following the guidelines in the Beery VMI manual, 5th edition, 2004. The tests were administered in Luxembourgish, the language spoken officially in the pre-schools. For the visual-motor integration test, time is unlimited. Scoring was stopped after three consecutive errors. According to the manual, the visual perceptual test and the motor coordination test end after three and five minutes respectively. Scoring is based on the score-no score criteria. Following the scoring criteria in the manual, the students are attributed either a “1” for pass or a “0” for failure. As the teachers stated that all of the children are able to draw, the participants didn’t perform the first six forms of the test (which consist of scribbling in imitation of the examiner); the six points were added to each participant’s total VMI score. According to the manual, the visual-motor integration test and the visual perceptual test were administered in group. The children executed the motor coordination test individually. One part of the participants (30 children belonging to three classes of one kindergarten) did a retest (visual-motor integration, visual perception, motor coordination) after one week. The test-retest correlation allows controlling for reliability.

Statistical analyses

An α-level of .05 to evaluate significance for all the tests (Thomas, Nelson, & Silverman, 2005) was used. A Kolmogorov-Smirnov test (KS) to evaluate if the results are distributed normally was used. Univariate tests of significance (ANOVA) were used to see if there is an interaction effect Sex × School × Age category, School × Age category, Sex × Age category, or Sex × School, on the results of the Beery VMI, Beery VP, and Beery MC. If a statistical difference was found, a Tukey post hoc test was used to find out which scores differed significantly from one another. When no interaction effects were found, the main effects were controlled. By calculating the Pearson coefficient of correlation (Pearson r) was evaluated if the visual-motor integration test, the visual perceptual test, and the motor coordination test are related to each other. The coefficient of determination was calculated to determine how much of the variability of one test accounts for the variability of the other test. By an independent t test is controlled if there is a significant difference between the test-retest results of the children, and we computed the Pearson coefficient of correlation for each test and its retest. By a t test against reference means was calculated if there is a statistical difference between each of the three tests with the reference means (100).

Results

For all of the tests (raw scores and standardized scores), except of the motor coordination test (raw scores), the Kolmogorov-Smirnov test indicates that the results are distributed normally ($p > .20$). The motor coordination test has a $p < .10$. As p is not statistically significant for most of the tests, we consider our data normally distributed and use parametric statistics for the following tests.

For the Beery VMI, the ANOVA revealed no significant effect for the interaction Sex × School × Age category, nor for the interaction School × Age category, nor for the interaction Sex × Age category. In order, F (2, 37) = .06, p = .94; F (2, 37) = .51, p = .61; F (2, 37) = 1.75, p = .19. The interaction Sex × School has no effect on the results of the Beery VMI, however the Beery VMI scores resulted in a significant effect for age categories, with F (2, 37) = 3.86, p = .03. The Tukey post hoc test indicates that there is a significant difference between the scores of children of age category 2 and 9 (p = .04), 4 and 8 (p = .03), 4 and 9 (p = .01), and 4 and 11 (p = .02) (Table 2).The Beery VMI raw scores correlated significantly at r=.43 with the age of the children.

For the Beery VP test, the ANOVA revealed no significant effect for the interaction Sex × School × Age category, nor for the interaction School × Age category, nor for the interaction Sex × Age category. In order, F (2, 37) = .03, p = .97; F (2, 37) = .21, p = .81; and F (2, 37) = 2.40, p = .10. Sex and school have no influence on the results of the Beery VP, however the Beery VP scores resulted in a significant effect for age categories, with F (2, 37) = 5.13, p = .01. The Tukey post hoc test indicates that there is an overall statistically significant difference for the age categories but no difference between the results of two different age categories (Table 2). The Beery VP raw scores correlated significantly at r=.38 with the age of the children.

For the Beery MC test, the ANOVA revealed no significant effect for the interaction Sex × School × Age category, F (2, 37) = .03, p = .97. However, the results of the Beery MC resulted in a significant School × Age category result, with F (2, 37) = 4.45, p = .02. The Tukey post hoc test indicates that for the School × Age category effect there is a significant difference between school 1 × age category 3 and school 1 × age category 11 (p = .048); school 1 × age category 4 and school 1 × age category 11 (p = .03); school 1 × age category 11 and school 2 × age category 2 (p = .04); school 1 × age category 11 and school 2 × age category 6 (p = .00). The interaction effect Sex × Age category was not significant, F (2, 37) = 1.21, p = .31, nor was the interaction effect Sex × School. Neither sex, nor school has a significant effect on the results of the Beery MC test. However, Beery MC scores resulted in a significant age category effect, with F (2, 37) = 7.93, p = .00. The Tukey post hoc test for the interaction effect of age indicates that there is a significant difference for the scores of children of age categories 6 and 11 (p = .03) (Table 2). The Beery MC raw scores correlated significantly at r=.38 with the age of the children.

Table 2: Analysis of variance for the age categories on the visual-motor integration test, the visual perceptual test, and the motor coordination test

test	$F_{2, 37}$	p	1	2	3	4	5	6	7	8	9	10	11	Tukey contrast
			Age code											
Visual-Motor Integration														
M	3.86	.03	15.00	13.86_a	14.44	$13.25_{b,c,,d}$	16.50	13.83	15.40	17.25_b	$17.75_{a,c}$	15.87	16.31_d	2 – 9* 4 - 8 * 4 – 9*
SD			.00	1.57	1.24	1.49	2.12	2.86	1.52	.96	2.50	2.53	2.21	4 – 11*
Visual Perception														
M	5.13	.01	17.00	18.71	18.00	16.37	17.50	15.00	19.40	20.50	20.50	21.00	21.38	
SD			.00	4.71	3.60	3.89	.71	5.55	4.33	3.32	4.20	3.16	3.73	
Motor Coordination														
M	7.93	.00	16.50	16.28	16.22	15.75	16.00	14.67_a	17.80	18.25	17.75	18.00	19.08_a	6 – 11*
SD			2.12	3.35	2.86	1.67	2.83	3.93	3.27	.96	2.06	1.77	2.98	

$_{a,, b, c, d}$ means having the same subscript are significantly different at $p < .05$ at the Tukey honestly significant difference comparison, $*p < .05$

Considering the results of the whole group of children (68 children), the results of the visual-motor integration test and the results of the visual perception correlated at $r = .66$, $r^2 = .44$, $p = .00$. The results of the visual-motor integration test and results of the motor coordination test signed a coefficient of correlation of $r = .54$, $r^2 = .29$, $p = .00$, and the results of the visual perception test and the results of the motor coordination test signed a correlation of $r = .52$, $r^2 = .27$, $p = .00$. All the correlations are significant for our designated α level of .05 (H4). The test-retest correlations of the 30 children who performed a retest after one week are the following: for the VMI test-retest the Pearson $r = .65$, for the VP test-retest the Pearson $r = .70$, for the MC test-retest the Pearson $r = .51$.

The results of the dependant t test show that for the 30 children who performed a retest after one week, there was a significant test-retest difference for the motor coordination test (raw scores), but not for the visual-motor integration test and the visual perception test (Table 3).

Table 3: Dependant t test measuring the difference between each test and its retest, effectuated by thirty children

	test		retest			
	M	SD	M	SD	t-value	p-value
Visual-motor Integration	15.20	2.25	14.97	2.01	0.71	0.48
Visual Perception	18.87	4.43	19.80	4.58	-1.47	0.15
Motor Coordination	17.27	2.89	15.80	3.04	2.74	0.01*

* $p < 0.05$

The standardized scores of the three tests differ significantly from the reference constant: VMI, $n = 68$, $M_{standard\ score} = 104.62$ scores, $SD_{standard\ score} = 12.36$ scores, $t(67) = 3.08$, $p = .00$; VP, $n = 68$, $M_{standard\ score} = 115.37$ scores, $SD_{standard\ score} = 22.60$ scores, $t(67) = 5.61$, $p = .00$;

MC, n = 68, $M_{standard\ score}$ = 105.82 scores, $SD_{standard\ score}$ = 13.27 scores, $t\ (67) = 3.62$, $p = .00$. (H7).

Discussion

It was hypothesized that on the three tests the results of the boys do not differ significantly from the results of the girls. Our data confirm this hypothesis. The data indicate no significant difference between the scores of boys and girls. Thus, our data analysis reveals no influence of sex on the test results. This confirms the statement of Beery and Beery (2004) and Vorster and Brand (1995).

The second hypothesis stated that the performances of the children from both pre-schools don't differ significantly. Our data sign indeed that the results of the two schools don't show any significant differences. Our results agree with the report of Beery and Beery (2004) that residence doesn't influence test results. Considering that one pre-school is situated in an area where a lot of families have a high socioeconomic level, we could support Beery and Beery's (2004) argument that socioeconomic level does not influence the test results.

It was expected that older children would perform better on the tests than younger children and, that the test results would be related to the age of the children. The data in table 2 show that the results of the children differ following the age of the children. However the scores of the three tests don't increase gradually with the age. The results of the tests correlated at r=.43 for the Beery VMI, r=.38 for the Beery VP, and r=.38 for the Beery MC with the age of the children. Although all three correlations were significant, they were lower than the correlations found by Beery and Beery (2004). The authors found correlations for the total standardization sample between chronological ages and the Beery VMI, Beery VP, and Beery MC of .89, .84, and .84, respectively, all of which were significant beyond the .01 level of confidence. Demsky, Carone, Burns, and Sellers (2000), and Preda (1997) found lower correlations between the age and the test scores than Beery and Beery (2004). Preda (1997) administered the Beery VMI to a group of 103 children, including 12 children with learning disabilities, aged between 7.2 and 11.7 years old. She found a coefficient of correlation for Beery raw scores with age of .42 ($p < .001$) for children without learning problems, and a coefficient of correlation of .64 ($p < .05$) for children with learning disabilities. The fact that the results of the three tests don't increase gradually with the age could be explained by too small age groups. Indeed, most of the age categories contain a rather small number of children. These small categories don't allow to drawing a valid conclusion. The developmental stage from 2-6 years is called "early childhood" or "pre-school period". During this stage, cognitive and physical-motor abilities develop considerably (Dunn, 2001). Some of the younger children may have been further along their cognitive and physical-motor stage of development and show better results than some older children who developed more slowly.

The abilities measured by the visual-motor integration test and its supplemental tests are expected to be at least moderately related to each other, because each supplemental test measures a part of what the Beery VMI measures (Beery & Beery, 2004). The data confirmed this. However, the founded coefficients of correlation are higher than the coefficients of correlation reported in the manual of Beery and Beery (2004) (.66 versus .35 for the visual-motor integration test against the visual perceptual test, .54 versus .28 for the visual-motor integration test against the motor coordination test, and .52 versus .41 for the visual perception test against the motor coordination test). When administering the Beery VMI and its supplemental tests to a group of 193 children (aged 7-10 years old), Kulp and Sortor (2003) also found higher correlations between the three tests than did Beery and Beery (2004): .54 for the visual-motor integration test and the visual perception test, .58 for the visual-motor integration test and the motor coordination test, and .50 for the visual perception test and the motor coordination test. Kulp and Sortor (2003) suggested that children should always be administered the three tests to control for eventual problems in all three domains, even if they score adequately on the visual-motor integration test. We can conclude that our data proof the high construct validity of the Beery VMI and its supplemental tests.

As a part of the reliability the test-retest correlation was checked. The coefficients of correlation of each test with its retest are low (.65 for the VMI and the retest, .70 for the Beery VP, and .51 for the Beery MC), compared to the coefficients of correlation of the Beery test manual (Beery & Beery, 2004) (.89 for the VMI and the retest, .85 for the Beery VP, and .86 for the Beery MC), and compared to the results of Graf and Hinton (1997). Graf and Hinton (1997) found test-retest reliabilities ranging from .92 over a 2 week-period to .63 over a 7 months period when administering the Beery test of visual-motor integration to a sample of 5,824 children aged between 2 years 6 months to 19 years in the USA. The low test-retest correlations of our results mean that the test-retest relation is not highly significant, or highly reliable (Thomas, Nelson, & Silverman, 2005). As the coefficient of determination is defined by the square of the coefficient of correlation, the coefficients of determination are also low. This means that the test-retest relation is not very meaningful (Thomas, Nelson, & Silverman, 2005). However, the authors state that it is complicated to interpret the correlation coefficient, because whether a correlation is “good” or “inadequate” depends on the purpose of the correlation. To be considered a valid measure, a test must first be reliable, or consistent in its measurement (Beery & Beery, 2004; Thomas, Nelson, & Silverman, 2005). We concluded that the low reliability of our tests is in contrast to the high levels of reliability found by Beery and Beery (2004). The following factor could have influenced the levels of reliability and validity of our scores: Beery and Beery (2004) stated that the interrater reliability, in particularly for inexperienced scorers, seems to depend on the preparation of the scorers. Pryzwansky (1977), cited in Beery and Beery (2004) reported a correlation of .73 between scoring by a group of learning disability teachers and a psychology extern. After a follow-up workshop the correlation was increased to .98. Beery and Beery (2004) also cited Pryzwansky and Lepkin (1983), who recommended structured workshops (3 hours’ preparation) for scorers. A lack of experience in administering and scoring the Developmental Test of Visual-motor integration and its supplemental tests can have influenced the results and be one of the causes of the variability and inconsistency of the results. To measure the reliability of the tests, we also compared the difference of the results of each test and its retest. We found no statistically significant difference for the visual-motor integration test and its retest, nor for the visual perception test and its retest, $\underline{M}_{VMI}$ = 15.20 scores, $\underline{SD}$ = 2.25 scores, $\underline{M}_{RVMI}$ = 14.97 scores, $\underline{SD}$ = 2.01 scores, $\underline{p}$ = 0.48, and $\underline{M}_{VP}$ = 18.87 scores, $\underline{SD}$ = 4.43 scores, $\underline{M}_{RVP}$ = 19.80 scores, $\underline{SD}$ = 4.58 scores, $\underline{p}$ = 0.15 respectively. However, the difference between the scores of the motor coordination test and its retest was statistically significant, $\underline{M}_{MC}$ = 17.27 scores, $\underline{SD}$ = 2.89 scores, $\underline{M}_{RMC}$ = 15.80 scores, $\underline{SD}$ = 3.04 scores, $\underline{p}$ = .01. This could be explained as followed: the children, remembering the course of the events of the tests they had performed one week before, tried to hurry to be able to finish all the items of the motor coordination test. Indeed, most of the children hadn’t had enough time to finish the motor coordination test in the five minutes’ time given for this test. It may be proposed that the children tried to be faster than at the first evaluation, they paid less attention to drawing precisely, and consequently they passed the boarder of the road more often than the first time, which lowered their scores.

Finally, it is checked is the United States norm tables could be used therefore no significant difference could exist between the standard score of each test and the reference norm (M=100). For all of the three tests, the results of the pre-school children in Luxembourg differed significantly from the age related norms established in the United States. The norms for the Beery test show that a higher raw score for older age is required to achieve the same standard score of 100 (Demsky, Carone, Burns, & Sellers, 2000). For the same age, the results of the pre-school children in Luxembourg were statistically different of the results of the pre-school children in the United States. The children in Luxembourg scored higher than the children of the same age in the United States. The difference between the results of our sample and the USA norms was most pronounced for the visual perceptual test. Even though it was statistically significant, the difference between the standard scores obtained in Luxembourg and the USA norms was low for the visual-motor integration test and the motor coordination test. Preda (1998) found on a sample of 71 children (mean age 9 years) in Italy a standard score of 103.7 ($SD = 12.4$, $t = 6.2$, $p < .0001$) on the Beery VMI. This score is also higher than the reference constant. When dividing the group of children in age categories, we decided to create age classes of two months, as indicated in the Beery administration manual (Beery & Beery, 2004) for the VMI test. However, in the beery administration manual (Beery & Beery, 2004), the norms for the beery VP and MC were established on age categories of 3 months. The fact that we used the 2 months age categories to compute the difference of our standard scores and the reference means could have influenced the results.

A limitation is that we did not control if the socio-economic status of the family influences the results on the Beery VMI and its supplemental tests. Although Beery and Beery (2004) stated that the socioeconomic status of the family does not influence test results, Dunn (2001), performing the Beery Developmental test of visual-motor integration with a sample of multiethnic pre-school children in South Africa found an influence of the socioeconomic status on the results of the children. But as the socioeconomic differences are extremely high in South Africa, the effect of socioeconomic influence, even though it is present in this multiethnic country, may be negligible in other places where the socioeconomic differences are less pronounced.

In summary, the Developmental test of visual-motor integration and its supplemental tests of visual perception and motor coordination are frequently used cross-culturally. However, when controlling for the reliability and validity of the tests in a sample of pre-school children in Luxembourg, we found that the level of reliability and therefore also the level of validity were lower than in the Beery manual (Beery & Beery, 2004).

References

Aylward, E. H., & Schmidt, S. (1986). *An examination of three tests of visual-motor integration. Journal of Learning Disabilities, 19, 6,* 328-330.

Baard, M. L. (1998). *Expressive movement and the perceptual-motor development of young children from disadvantaged communities.* Unpublished doctoral dissertation, University of Stellenbosch, Stellenbosch, South Africa.

Beery, K. E., & Beery, N. A. (2004). *The Beery-Buktenica Developmental Test of Visual-Motor Integration (Beery-VMI) with supplemental Developmental tests of Visual Perception and Motor Coordination and Stepping Stones Age Norms from Birth to Age Six.* 5th edition, Pearson Assessments, Minneapolis.

Demsky, Y., Carone, D. A., Burns, W. J., & Sellers, A. (2000). Assessment of visual-motor coordination in 6 - to 11 – yr. – olds. *Perceptual and Motor Skills, 91,* 311-321.

Dunn, M. (2001). *The validity of the Developmental test of visual-motor Integration in a selected pre-school sample in the south african context.* Unpublished master's thesis, University of Stellenbosch, Stellenbosch, South Africa.

Graf, M., & Hinton, R. H. (1997). Correlations fort the Developmental visual-motor integration test and the Wechsler intelligence scale for children-III. *Perceptual and Motor Skills, 84, 2,* 699-702.

Krapp, C. & Wilson, J. (Eds.). (2005). Visual-motor integration. In Encyclopedia of Children's Health. Thomson Gale. Retrieved February 15, 2009, from google: http://health.enotes.com/childrens-health-encyclopedia/hand-eye-coordination.

Kulp, M. T., & Sortor, J. M. (2003). Clinical value of the Beery Visual-motor integration supplemental tests of visual perception and motor coordination. *Optometry and Vision Science, 80, 4*, 312-315.

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,* 661-669.

Preda, C. (1997). Test of visual-motor integration: construct validity in a comparison with the Beery-Buktenica Developmental Test of Visual-Motor Integration. *Perceptual and Motor Skills, 84,* 1439-1443.

Preda, C. (1998). Partial cross-validation of low correlation for scores on the Test of Visual-Motor Integration and the Beery-Buktenica Developmental Test of Visual-Motor Integration. *Perceptual and Motor Skills, 86,* 224-226.

Pryzwansky, W. B. (1977). The use of the Developmental Test of Visual-motor Integration as a group screen instrument. *Psychology in the Schools, 14,* 419-422.

Thomas, J. R., Nelson, J. N., & Silverman, S. J. (2005). *Research Methods in Physical Activity, (5th ed).* Champaign: Human Kinetics.

Vorster, M. H., & Brand, H. J. The validity of the Developmental test of Visual-motor Integration in the South African context: A pilot study. *The South African Journal of Occupational Therapy, 25, 2,* 28-33.

ISSN 1791-3837