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VISUAL-MOTOR STATUS OF GRADE 1 LEARNERS IN THE NORTH-WEST PROVINCE OF SOUTH AFRICA: NW-CHILD STUDY

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ABSTRACT

The aims of this study were firstly, to determine whether gender differences influence visual-motor status and secondly, if visual-motor integration, visual perception and motor coordination of Grade 1 learners correlate in the North-West Province of South Africa. A cross-sectional design was used. The subjects consisted of 816 (419 boys and 397 girls) Grade 1 learners with a mean age of 6.78 years. The Developmental Test of Visual-motor Integration (4th ed.) was used to evaluate the children's visual-motor integration, visual perception and motor coordination. The results indicate that there were no statistically significant differences between the boys and the girls regarding visual-motor integration, visual perception or motor coordination. In addition, the results indicated that most of the learners experienced problems with visual perception, with 33% classed as below average and 26% as far below average. There was a correlation between gender and visual-motor integration. Correlations with moderate practical significance were found between visual-motor integration and visual perception (r=0.36; r=0.35), visual-motor integration and motor coordination (r=0.41), and visual perception and motor coordination (r=0.37; r=0.41 and r=0.39) for the boys, girls and the whole group separately.

Key words: Visual-motor integration; Visual perception; Motor coordination; Motor development; Gender.

INTRODUCTION

Visual-motor skills, such as visual-motor integration, visual perception and motor coordination, are necessary to plan and execute movement effectively in the environment. These visual-motor skills are, furthermore, important for academic and sport development and performance (Willoughby & Polatajko, 1995; Cheatum & Hammond, 2000; Winnick, 2005). According to Taylor (1988), during the first two years of formal schooling the development of visual-motor skills is a prerequisite for good academic progress.

Visual-motor integration can be identified as the integration of visual, perceptual and motor skills (Tseng & Chow, 2000; Exner, 2005), and is the ability to integrate visual processing abilities and fine motor abilities (Aylward & Schmidt, 1986). It requires intact visual perception and hand-eye coordination (Weil & Cunningham-Amundson, 1994), and is controlled by different areas and structures in the brain (Schultz *et al*., 1998). Bonifacci (2004) also found that there were significant differences in visual-motor integration in children with good and poor gross motor abilities.

The literature indicates a strong relationship between visual-motor integration and a variety of different learning disabilities (Kulp, 1999; Bonifacci, 2004; Lotz *et al.*, 2005; Van Hoorn *et al.*, 2010), and that poor visual-motor integration can lead to poor academic performance (Kulp, 1999; Sortor & Kulp, 2003; Tekok-Kiliç *et al.*, 2010). Several studies have shown that visual-motor integration is one of the most important activities in preparing children to learn writing skills (Gombert & Fayol, 1992; Weil & Cunningham-Amundson, 1994; Daily *et al.*, 2003; Bezrukikh & Kreshchenko, 2004; Volman *et al.*, 2006). Reading and writing problems during the initial phase of learning could be influenced by inadequate visual-motor integration (Bezrukikh & Kreshchenko, 2004).

In this regard, Lotz *et al*. (2005) reports that a group of South African children in Grades 1 and 2 achieved one standard deviation below the mean during visual-motor integration. This suggests that the visual-motor skills of these children were at a below-average level when entering school. Research by Ratzon *et al.* (2009) on writing skill problems in pre-primary schools found that children with these impairments also had problems with visual-motor integration, visual perception, motor coordination, fine motor coordination and cognitive planning, as well as self-esteem (Khalid *et al.*, 2010). Poor writing skills in these children showed a strong relationship with deficiencies in visual-motor integration, visual perception and motor coordination (Volman *et al.*, 2006; Ratzon *et al*., 2009).

Visual perception is a learnt process that converts the image obtained through visual acuity and/or sight into significant and useful information. It is also an important part of extracting and organising information from the environment (Sortor & Kulp, 2003). In other words, it is making sense of the visual stimuli that is received from the environment, and for interpreting and understanding it (Cheatum & Hammond, 2000; Sherrill, 2004). Winnick (2005) states that visual perception is important for writing, drawing, reading, spelling and mathematical skills, as well as the fundamental movement skills such as throwing, kicking, catching and hitting. Inadequacy in these skills can contribute to deficiencies in gross muscle control (Bouchard & Tetreault, 2000; Reimer *et al.*, 2000), which in turn is needed to perform the necessary motor skills to promote motor development (Willoughby & Polatajko, 1995; Cheatum & Hammond, 2000). According to Tekok-Kiliç *et al*. (2010), defects in a child's visual perception skills not only cause academic problems, but also have debilitating effects on the performance of daily activities. The literature further indicates that there is a positive relationship between visual perception skills and academic skills such as reading, writing and mathematics (Solan, 1987; Willows, 1998; Kulp, 1999; Sortor & Kulp, 2003).

Motor coordination has been defined as the ability to coordinate vision with body movement (Lane, 2005; Winnick, 2005). In sport it contributes to the correct information being provided to the body, for instance when and how to catch or hit a ball. Motor coordination plays an important role in gross motor skills, such as hand-eye coordination and foot-eye coordination, as well as fine motor skills such as cutting, drawing, colouring-in and writing (Desrochers, 1999; Winnick, 2005). According to Erhardt *et al.* (1988) and Arter *et al.* (1996), it appears that if any problems are experienced with motor coordination, hand-eye coordination and fine motor skills will be influenced adversely, which in turn could result in motor as well as academic problems. Research by Martins *et al.* (2008) on writing and perceptual motor skills found that good motor coordination and hand-eye coordination contributed most to the readability of children's handwriting. Sufficient visual analysis abilities are important in children who are learning to read, allowing them to differentiate between letters such as b and d or p and q and homonyms, such as fair and fare (Case-Smith, 2002).

Children must furthermore be able to differentiate between figures and mathematical signs and then to break down problems into simpler components. Some aspects of mathematical ability correlate with spatial orientation (Fias & Fischer, 2005). According to various researchers (Kulp, 1999; Kurdek & Sinclair, 2001; Mazzoco & Myers, 2003), a relationship between mathematics and visual skills, such as visual perception and motor integration, are found in the early school years.

There is still controversy in the literature regarding the role of gender in these matters. Only a few studies related to gender differences in visual-motor integration could be found. A study conducted by Singh *et al.* (2010) on 100 Indian children (50 boys and 50 girls), between 2 and 3 years old, evaluated their visual-motor skills. These researchers found that regarding visual-motor integration skills, the boys were significantly better than the girls. Another study by Makhele (2005) conducted on a group of nine-year-olds in the Free State Province of South Africa also revealed that the boys performed better in visual-motor skills than the girls. A study by Lotz *et al.* (2005) involving 339 children, between six and 15 years (171 boys and 168 girls) in the Western Cape Province of South Africa, with a mean age of 8.10 years, found that the boys once again performed significantly better than the girls in respect of visual-motor skills. Reasons provided for these differences were that boys seemed to be socialised earlier in life at home or on farms, and that the nature of the tasks given to them may be the reason for their advantage in developing visual-motor skills (Lotz *et al*., 2005).

In several international studies, girls performed better than boys in visual-motor integration skills (Harris, 1963; Aylward & Schmidt, 1986; Brown, 1990), while in other studies no gender differences were found between boys and girls in these skills (Aylward & Schmidt, 1986; Weil & Cunningham-Amundson, 1994; Beery, 1997; Tekok-Kiliç *et al.*, 2010). This indicates uncertainty about gender differences. While several studies could be found that examined gender differences in visual-motor integration, none was available that examined gender differences in visual perception and motor coordination.

This study, therefore, focused on gender differences of Grade 1 learners (6- & 7-year-olds) in the North-West Province of South Africa, because of the uncertainty in the literature about gender differences in visual-motor integration, visual perception and motor coordination. Children usually start their schooling at this age, and it is, therefore, important for their visual-motor skills to be intact, otherwise it could be problematic for their motor development and academic performance.

In terms of the different phases of a child’s development, Lotz *et al.* (2005) indicated that visual-motor skills play an important role in aspects that include academic skills, motor development and emotional well-being. The literature clearly indicates a significant relationship between visual-motor integration and reading, mathematics, writing and spelling ability (Kulp, 1999; Sortor & Kulp, 2003; Bonifacci, 2004; Son & Meisels, 2006; Volman *et al.*, 2006; Mayes *et al.*, 2008), as well as visual perception and academic skills such as reading and mathematics. Moreover, the literature points out that motor coordination also shows a relationship with reading and mathematics (Solan, 1987; Kulp, 1999; Sortor & Kulp, 2003). It is, therefore, important to assess children as early as possible, because early detection can lead to implementation of the correct intervention programme to reduce the incidence of scholastic and motor development problems (Lotz *et al.*, 2005).

There is a clear gap in the literature with regard to the effect of gender on the visual-motor integration, visual perception and motor coordination of Grade 1 learners, and the relationship between visual-motor integration, visual perception and motor coordination. Investigating these relationships could shed light on the potential role that these skills could have on academic outcomes and sport performance of children, and may contribute to a better understanding among teachers as to how to improve these skills. Thus, the purpose of this study of a group Grade 1 learners was to determine, firstly, whether gender differences influenced visual-motor status and secondly, whether there were correlations among visual-motor integration, visual perception and motor coordination in Grade 1 learners in the North-West Province of South Africa.

METHOD

Research design

A one-way cross-sectional design was used for the collection of the baseline information in 2010.

Participants

The research was part of the NW-CHILD (Child-Health-Integrated-Learning and Development) study. The target population for this study was Grade 1 learners in the North-West Province. The total number of participants identified for the study was 880 Grade 1 learners (N=880). The research group was selected by means of a stratified random sample in conjunction with the Statistical Consultation Services of the North-West University.

To determine the research group, a list of names of schools in the North-West Province was obtained from the Education Department of the North-West Province. This list of schools was grouped into 4 educational districts, each representing 12 to 22 regions with approximately 20 schools (minimum 12, maximum 47) per region. Regions and schools were randomly selected with regard to population density and school status (quintile 1=schools from poor economic sectors, to quintile 5=schools from high economic sectors).

Boys and girls in Grade 1 were then randomly selected from each school. A total of 20 schools were involved in the study, from 4 districts with a minimum of 40 children per school and with an even gender distribution. The final total group consisted of 816 learners (419 boys and 397 girls) with a mean age of 6.78 years. Thirteen parents (1.5%) did not consent to participation, whereas 35 (4.0%) of the selected participants were absent on the day of testing or had to be excluded because of incorrect ages that were provided by the schools.

Ethical issues

Ethical approval was obtained from the Ethics Committee of the North-West University, Potchefstroom Campus (No. NWU-0070-09-A1), and permission to perform the study in the schools was obtained from the Education Department of North-West Province. A formal meeting was organised with each principal to explain the aim and protocol of the study and to request permission for collecting data during school hours.

At each school 60 Grade 1 learners were randomly selected and received informed consent forms that had to be completed by their parents. This was done to ensure that consent would be granted by the parents of a minimum of 40 learners who needed to be tested at each school. Each participant's parents were requested to give informed consent before any tests were done. The purpose of this study was verbally explained to all the participants, and each participant had the chance to ask any questions about the research procedures. The children, whose parents gave consent, were evaluated to determine their visual-motor integration, visual perception and motor coordination skills. Trained interpreters were used to convey the instructions of the evaluators to the subjects, if English was not their first language.

Measuring instruments

Developmental Test of Visual-Motor Integration 4th edition –Test battery (VMI-4)

The Developmental Test of Visual-Motor Integration [4th edition] (VMI-4) (Beery, 1997), consists of 3 subtests, which include visual-motor integration, visual perception and motor coordination. The aim of the VMI-4 is to identify children who need special assistance by means of early detection. The visual-motor integration subtest consists of 3 practice geometrical shapes and 24 increasingly complex geometrical shapes. The participants are required to copy a geometric figure with a pencil without using an eraser, and only 1 attempt is permitted for each figure. This test allows 10 minutes for completion, or is stopped after 3 consecutive mistakes are made. The complete 27-item VMI can be administered individually or in groups, takes about 10 to 15 minutes to complete and can be used for all age groups, from pre-school children to adults.

The 18-item short form edition can be used to test 3- to 7-year-old children. The visual perception subtest requires matching shapes with each other and takes 3 minutes to complete or is stopped after 3 consecutive mistakes are made. The last subtest, motor coordination, involves completing dots in a shape and takes 5 minutes to complete. The criteria for awarding marks in the VMI-4 are as follows: a "0" is awarded for figures that are wrong and a "1" is awarded for the correct figures. The test is stopped after 3 consecutive mistakes are made or when time is up, except for the motor coordination section which has a specified time limit; the test is stopped when the time elapses.

The data is read in under 3 categories: VMI; visual perception; and motor coordination. The raw score is converted to a standard score and then to a percentile. Using the standard score, children can be grouped into 5 different classes, ranging from very high (133−160) to very low (40−67). The VMI-4 was developed to measure the extent to which an individual can integrate his or her visual and motor capabilities. Poor results in the VMI-4 could be ascribed to the inability to integrate visual-perceptual and motor abilities and not necessarily to inadequate abilities. Beery (1997) reported a validity of 0.92, 0.91 and 0.89 for the VMI-4 test battery.

Statistical analysis

The *Statistica* software package (StatSoft, 2010) of the North-West University was used to analyse the data. Data was analysed for descriptive purposes based on means (M), standard deviations (SD) and minimum and maximum values. The independent t-test was applied to determine gender differences with regard to visual-motor integration, visual perception and visual-motor coordination. The level of statistical significance was set at $p \leq 0.05$. Spearman rank order correlation was used to determine the correlations among visual-motor integration, visual perception, and motor coordination with the girls, boys and the whole group separately. The strength of the correlations is given with r≥0.1 indicating a small effect, r≥0.3 a medium effect and r≥0.5 a large effect.

Furthermore, use was made of a Two-way frequency table to compare the classifications of the boys and girls. The Pearson Chi-square served to indicate the significance of the results and the accepted level of statistical significance was set at p≤0.05. The strength of the correlations are represented by the phi-coefficient with w>0.1 indicating a small effect, w>0.3 a medium effect and w>0.5 a large effect (Steyn, 2002). Effect sizes (d) were calculated to determine the practical significance of the results by dividing the differences in the mean by the largest standard deviation of the test. For the interpretation of practical significance, the following guidelines were used: d≥0.2 indicated a small effect, d≥0.5 a medium effect and d≥0.8 a large effect (Cohen, 1988).

RESULTS

Table 1 shows the composition of the study population by gender and age. A total of 816 Grade 1 learners (419 boys and 397 girls) were identified as subjects for this project. The group had a mean age of 6.78 years (SD=0.49); the mean age of the boys was 6.81 years (SD=0.49), which was slightly higher than the girls' 6.74 years (SD=0.48).

***TABLE 1*: COMPOSITION OF RESEARCH GROUP ACCORDING TO GENDER AND AGE**

		Age (years)			
Group	**n**	**Mean**	**SD**	**Minimum**	**Maximum**
Boys	419	6.81	0.49	6.00	7.80
Girls	397	6.74	0.48	6.00	7.80
Total	816	6.78	0.49	6.00	7.80

***TABLE 2*: BOYS' AND GIRLS' SCORES FOR AND DIFFERENCES BETWEEN VISUAL-MOTOR INTEGRATION, VISUAL PERCEPTION AND VISUAL-MOTOR COORDINATION**

	Boys (n=419)		**Girls** (n=397)		**Group** (N=816)		**Significance of differences**			
Variables	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**t-value**	**df**	**p**	**d**
VMI	92.0	13.9	91.0	13.7	91.5	13.8	1.07	815	0.29	0.07
VP	80.0	23.3	78.7	22.8	79.4	23.0	0.81	815	0.42	0.06
MC	93.4	14.0	92.6	15.3	93.0	14.67	0.69	815	0.49	0.05

VMI= Visual-motor integration VP= Visual perception MC= Motor coordination
SD= Standard deviation df= degrees of freedom;
Significance accepted: * p≤0.05; * d≥0.2; ** d≥0.5; *** d≥0.8

Table 2 indicates the *visual-motor integration*, *visual perception* and *motor coordination* of the total group (N=816; 419 boys and 397 girls). The statistical and practical significance of the results for the 2 subgroups are also presented in Table 2.

With regard to *visual-motor integration*, the boys exhibited a slightly higher mean (92.0) than the girls (91.0), although there was no statistical or practical significance ($p \leq 0.29$; d=0.07) to distinguish the groups. The same tendencies were observed for *visual perception*. The mean value for the boys was also slightly higher than that for the girls (80.0 and 78.7 respectively). There was no statistical or practical difference between the genders ($p \leq 0.42$; d=0.06). The same pattern was observed for *motor coordination*. The mean value for the boys was slightly higher than the girls (93.4 and 92.6 respectively), although there was no statistical or practical significance to distinguish the 2 groups ($p \leq 0.49$; d=0.05) (Table 2).

***TABLE 3*: CORRELATION BETWEEN VISUAL-MOTOR INTEGRATION, VISUAL PERCEPTION, AND VISUAL-MOTOR COORDINATION OF BOYS (n=419), GIRLS (n=397) AND GROUP (N=816)**

Variable	VMI	VP	MC
Boys			
VMI	–	0.36*	0.41*
VP	0.36*	–	0.37*
MC	0.41*	0.37*	–
Girls			
VMI	–	0.35*	0.41*
VP	0.35*	–	0.41*
MC	0.41*	0.41*	–
Group			
VMI	–	0.35*	0.41*
VP	0.35*	–	0.39*
MC	0.41*	0.39*	–

VMI= Visual-motor integration; VP= Visual perception; MC= Motor coordination
* $r \geq 0.3$

A Spearman rank order correlation was used to determine the correlations among visual-motor integration, visual perception, and motor coordination with the girls, boys and whole group separately. The results in Table 3 indicate that the boys demonstrated only slightly higher correlations with a moderate practical significance regarding *visual-motor integration with visual perception* (r=0.36) than the girls (r=0.35) or the whole group (r=0.35). Furthermore, the girls demonstrated a slightly higher correlation with a moderate practical significance than the boys (r=0.37) or the whole group (r=0.39) during *visual perception with motor coordination* (r=0.41). The boys, girls and the whole group showed the same correlation with a moderate practical significance for *visual-motor integration with motor coordination* (r=0.41).

Table 4 shows the *visual-motor integration*, *visual perception* and *visual-motor coordination* of the Grade 1 learners in the various categories as a total group, as well as boys and girls separately. The largest percentage of boys (74.9%), as well as girls (73.1%), fell within Class

3 (average class) in the *visual-motor integration* test. The subtest, *visual perception*, exhibited the same tendencies with the greater percentage of boys (36.3%) and girls (36.0%) in Class 3 (average class). For the *motor coordination* subtest, the largest percentage of boys and girls also fell within Class 3 (average class), with percentages of 80.4% and 80.6%, respectively.

***TABLE 4*: PERCENTAGE OF VISUAL-MOTOR INTEGRATION, VISUAL PERCEPTION AND VISUAL-MOTOR COORDINATION FOR BOYS, GIRLS AND GROUP**

Variables and study population	**Class 1**		**Class 2**		**Class 3**		**Class 4**		**Class 5**	
	%	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**
Visual-motor integration (VMI)										
Boys (n=419)	0.2	1	1.9	8	74.9	314	18.4	77	4.5	19
Girls (n=397)	0.5	2	3.5	14	73.1	290	18.6	74	4.3	17
Group (N=816)	0.4	3	2.7	22	74.0	604	18.5	151	4.4	36
Visual perception (VP)										
Boys (n=419)	0.5	2	4.1	17	36.3	152	31.5	132	27.7	116
Girls (n=397)	0.5	2	4.3	17	36.0	143	34.8	138	24.4	97
Group (N=816)	0.5	4	4.2	34	36.2	295	33.1	270	26.1	213
Motor coordination (MC)										
Boys (n=419)	0.0	0	1.2	5	80.4	337	13.6	57	4.8	20
Girls (n=397)	0.5	2	2.0	8	80.6	320	11.3	45	5.5	22
Group (N=816)	0.3	2	1.6	13	80.5	657	12.5	102	5.2	42

Class 1= Far-above-average; Class 2= Above average; Class 3= Average; Class 4= Below-average; Class 5= Far-below-average;
VMI ($p<0.64$ & phi>0.05); VP ($p<0.83$ & phi>0.04); MC ($p<0.40$ & phi>0.07)

There was no statistical or practical significant difference between boys and girls in the *visual-motor integration* ($p<0.64$ & $w>0.05$), *visual perception* ($p<0.83$ & $w>0.04$), or *motor coordination* ($p<0.40$ & $w>0.07$) tests. Both boys and girls performed best in the *motor coordination* exercise and the greatest difference between the genders was observed in *visual-motor integration*. It appears (Table 4), that most Grade 1 learners generally fared poorest in the *visual perception* subtest, although the girls exhibited a slightly lower percentage (24.4%) than the boys (27.7%).

With regard to the total group's *visual-motor integration*, *visual perception* and *motor coordination*, the largest proportion of the subjects fell within Class 3 (average group). It is also apparent from Table 4 that only a small percentage of the subjects fell within Class 1 (far above average) in the various sections (0.4%, 0.5% and 0.3%). It can further be noted that the largest percentage of the group fell in Class 5 (far below average) (26.1%) in the *visual perception* subtest.

DISCUSSION

The aims of this study were to determine whether gender influenced visual-motor status and whether there were correlations among visual-motor integration, visual perception and motor coordination in a group of Grade 1 learners in the North-West Province of South Africa.

The results indicate that there were slight differences between the boys and the girls in visual-motor integration, visual perception and motor coordination, although the differences were not significant. This supports the findings of Aylward and Schmidt (1986), Weil and Cunningham-Amundson (1994), Beery (1997) and Tekok-Kiliç *et al.* (2010), who found no gender differences between boys and girls in visual-motor integration skills. These results, however, contrast with the findings of other researchers (Lotz *et al.*, 2005; Makhele, 2005; Singh *et al.*, 2010), where the boys performed significantly better than the girls, and other studies in which the girls performed significantly better than the boys (Harris, 1963; Aylward & Schmidt, 1986; Brown, 1990) in visual-motor integration. No literature was found that reported gender differences for visual perception and motor coordination.

Significant correlations were found in this study between: visual-motor integration and visual perception; visual-motor integration and motor coordination; and visual perception and motor coordination between the boys and girls, as well as in the group as a whole. The results indicate, furthermore, that the boys demonstrated a slightly higher correlation with visual-motor integration and visual perception than the girls. A possible reason for this difference is that boys start to socialise earlier in life than girls, and that the nature of the tasks given to them at home and elsewhere may give them an advantage in developing visual-motor skills (Connor *et al.,* 1978; Lotz *et al*., 2005). Research by Kulp (1999) found a strong relationship between visual-motor integration, visual perception and motor coordination and academic skills such as reading, mathematics, writing and spelling in 7- to 9-year-olds.

In certain aspects this study's results were similar to the findings of Lotz *et al.* (2005) regarding the visual-motor integration scores. The results of this study indicated that the largest percentage of boys (74.9%) and girls (73.1%) fell within the average class for visual-motor integration, whereas 22.9% of the whole group fell in the below-average and far-below-average classes. Lotz *et al.* (2005) reports that the visual-motor integration score for the Grade 1 and 2 learners in their study were at least one standard deviation below the mean, which indicated that these learners performed between average and low visual-motor functions. Problems that may occur as a result of deficiencies in visual-motor integration involve motor development (Mon-Williams *et al.*, 1996; Bonifacci, 2004; Van Waelvelde *et al.*, 2004; Lotz *et al.,* 2005) and academic ones (Kulp, 1999; Sortor & Kulp, 2003; Bonifacci, 2004; Son & Meisels, 2006; Volman *et al.*, 2006; Mayes *et al.*, 2008).

The visual perception subtest results show that 59.2% of the boys and girls fell in the below-average and far-below-average classes. The results further indicated that most of the learners struggled with visual perception, with 270 learners in the below-average class (33.1%) and 213 learners in the far-below-average class (26.1%). According to Holle (1976), visual perception, which includes shape perception, directional space and visual memory, needs a certain degree of development to enable an individual to distinguish clearly between the fore- and background.

This study's results revealed that the group's visual perception was at a lower than average level and can be ascribed to the possibility that the visual skills of these children were not fully developed when entering school. This could be a reason why this group of boys and girls performed relatively poorly in the visual perception subtest. According to Aylward and Schmidt (1986), Solan (1987), Griffin *et al.* (1993), Papavasiliou *et al.* (2007) and Tekok-Kiliç *et al.* (2010), visual perception deficiencies contribute to reading problems. Children need more complex visual perception to be able to read, because they have to connect the words and letters that they see on the black board or on their books to the words they hear and to the meanings attached to them (Griffin *et al.*, 1993; Cheatum & Hammond, 2000; Papavasiliou *et al.*, 2007). In this manner visual perception problems lead to reading and learning problems (Cheatum & Hammond, 2000).

Visual perception also includes comprehension of the differences between various forms, as well as understanding where to place the answers to mathematical questions (Cheatum & Hammond, 2000). Winnick (2005) is of the opinion that a child's faulty visual perception can also contribute to deficiencies in fundamental movement skills such as throwing, kicking, catching and hitting.

In the case of the motor coordination subtest, only 17.7% of the children fell into the below-average and far-below-average classes. Various researchers have found that if children experience problems with this skill, it could lead not only to motor deficiencies, such as coordination (hand-eye and foot-eye), spatial orientation and balance, but also to fine motor deficiencies, which could influence a child's academic as well as sporting skills (Desrochers, 1999; Winnick, 2005). Nothing could be found in the literature that indicates gender differences with motor coordination as evaluated by the VMI-4 test. Further research in this area is recommended. Answering this would help teachers to have a better understanding of how to work with boys and girls with motor coordination problems, and which remedial programme to use for these children.

CONCLUSION

The results of this study indicated that there were limited gender differences in visual-motor integration, visual perception and motor coordination, although the differences were not significant. Relationships with practical significance were found between visual-motor integration and visual perception, visual-motor integration and motor coordination and, lastly, visual perception and motor coordination. According to the literature, if any deficits are present in a child's visual-motor skills when entering school, poor motor development and academic performance could occur.

LIMITATIONS AND RECOMMENDATIONS

The study did, however, demonstrate several limitations, which could be overcome with a view to further research. The different ethnic groups and their socio-economic circumstances were not recorded in this study, thus further longitudinal research is recommended to determine the relationship between race and socio-economic conditions with visual-motor integration, visual perception and motor coordination. Given the importance of the first two years of formal education in which the visual-motor skills are important for scholastic and motor development, assessment and early detection of visual-motor integration, visual perception and motor coordination deficits are especially important and useful. To reinforce the recommendations of Lotz *et al.* (2005), it is important to detect visual-motor skills deficits as early as possible, because without the development and implementation of appropriate intervention programmes that focus on the improvement of visual-motor skills, the number of scholastic problems and motor development difficulties will increase in the future. These intervention programmes could further be implemented by teachers, to help with the improvement of visual-motor skills deficits, which in turn could improve the children's academic and sport performance.

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