ORIGINAL ARTICLE

The relation between basic movement skills and perceptual-motor skills in 5 to 7 years old children

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Abstract
The main purpose of this study was to examine the correlation between basic movement skills and perceptual motor skills of children using the Test of Gross Motor Development (TGMD) developed by Ulrich (1985) and the Movement Assessment Battery for Children (M-ABC) developed by Henderson and Sugden (1992). Therefore we firstly excluded gender effects. Thirdly we looked for differences in results according to the age. A total of 40 children (11 boys and 29 girls), 5 to 7 years of age participated. We found an interaction effect of age on the results of TGMD but the results of the M-ABC showed no interaction effect. The Pearson's correlation between Gross Motor Developmental Quotient of the Test of Gross Motor Development and Total Impairment Score of the M-ABC was low (r=0.36, p=.000003). In this study it was found that there was no gender effect on the results of TGMD and the results of the M-ABC on the repeated ANOVA results. The correlation between the results of both tests became lower as the age increased.

Keywords: *Motor development, children*

Introduction

In 1998 Burton and Miller presented their taxonomy of the concept of general motor ability. The definitions indicated that the different concepts could be placed in a theoretical hierarchy, with movement skills at the highest level, motor abilities at the next and gross motor abilities at the basic level. Burton and Rodgerson concluded in 2001 that there was a lot of inconsistent use of the different terms and constructs in this area, and that the within-task correlations between different assessment instruments were low. Therefore they build up a new taxonomy of movement skills and general motor ability (Burton & Rodgerson, 2001). The new taxonomy consists of four primary levels: movement skills, movement skill sets, movement skill foundations, and general movement abilities. Movement skills are defined as a group or class of movements that have a similar movement form or function, which can be modified by practice and experience (Burton & Miller, 1998; Schmidt & Lee 1999). The movement skills clustered together into subtests in an assessment instrument are considered to be movement skill sets in the new taxonomy (Burton & Rodgerson, 2001). For example the locomotor and object control skills in the Test of gross motor development (Ulrich, 1985)

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meet this standard. In the Movement Assesment Battery for children (Henderson & Sugden, 1992) the three different skill sets are manual dexterity, aiming and catching and balance. However they question the use of a summed composite score to represent competency of proficiency as is done in de Gross Motor Quotient of the TGMD and in the total impairment score of the MABC-test. For years professionals have emphasized the interrelatedness of the developmental domains. On this basis it is expected to find at least a moderate correlation between the different movement skills and it is further hypnotized that the correlations between the different movement skills will be higher than the correlations with the sum of the skills.

It is generally accepted that development of basic movement skills occurs in an orderly and sequential manner (Branta, Haubenstricker & Seefeldt, 1984; Walkley, Holland, Treloar, & Probyn-Smith, 1993; Adrian & Scott, 1994) and in a similar way to the other parameters of the child such as intellectual capacity, physical growth and psycho-social skills (Gabbard, 2004). In addition, a child's level of movement skill performance normally improves with age (Espenschade & Eckert, 1980; Rarick, 1981). The development and mastery of basic movement skills should occur during the preschool and elementary years (Gabbard, 2004). Children develop the basic movement skills from 2 to 7 years old and specialized movement skills are developed from 7 years old (Gallahue & Ozmun, 2006). Keogh and Sugden (1985) argue that children between the ages of 2 and 7 years achieve all of the fundamental skills he or she will ever develop naturally. Children do not naturally develop any new skills after this age (Keogh & Sugden, 1985). This period of childhood is a proper time of development of movement skills. Learning perceptual-motor skills is an appropriate physical education goal for children from 2 to 7 years old (Sherrill, 2004). In this paper the progressive characteristics of the development of basic movement skills and perceptual-motor skills of typically developing children are evaluated. It was hypothesized that the children would show improvement on basic movement skills and on perceptual-motor skills over age.

According to Malina and Bouchard (1991) girls are superior in fine motor abilities, and boys in throwing skills, running and jumping skills. Ikeda and Aoyagi (2009) just found the opposite. On the other hand it is remarkable that most of the assessment instruments for motor skills don't provide separated norm tables according to gender.

The main purpose of this study was to analyze the relation between the basic movement skills and specialized movement skill of young children. However we firstly checked for gender effects, because if so we have to split out

the analyzes according to gender. A secondary focus of the research was the development of basic movement skills and perceptual motor skills according to their age. We expected that the older they got the higher the results on basic movement skills would be and lower on perceptual motor skills.

Method

Participants

A total of 40 children were recruited from a single preschool located in rural region of Belgium. The children's age ranged from 5 to 7 years (5 years old, M=65.65, SD=3.27, 6 years old, M=79.41, SD=3.46, 7 years old, M=91.44, SD=3.30). All children were tested three times, in a time period of 3 consecutive years, once a year, from January to February. All children were without obvious intellectual, neurological or physical disturbances. None of the participants had any known motor or neurological disorder or any developmental or learning problem. Written informed consents were given by parents and participants.. The number and gender of children in each age group are displayed in Table 1. There were no significant differences between boys and girls regarding age, $F_{2,76}$=.62, p=.53.

Table 1. The mean age of participants

Age	Boy (n=11)		Girl (n=29)		Total (n=40)	
	M	SD	M	SD	M	SD
5 years old	65.51	3.48	65.92	2.92	65.65	3.27
6 years old	79.24	3.62	79.78	3.21	79.41	3.46
7 years old	91.37	3.44	91.57	3.10	91.44	3.30

Note. The age was reported in months.

Instruments

The Test of Gross Motor Development (TGMD), developed by Ulrich (1985), was selected to assess the Basic movement skills (Ulrich, 1985) evaluates the gross motor functioning of children 3-10 years old. The TGMD includes two subtests. Seven skills comprise the locomotor subtest (run, gallop, hop, leap, jump, skip, and slide), with five skills for the object control subtest (two hand strike, stationary bounce, catch, kick, and overhand throw). The total subtest raw scores for locomotor skills ranged from 0-26 points and 0-19 points for object control skills. The raw scores are converted to standard score, and then

they are added and converted to quotients. The TGMD locomotor and object control subtest standard scores range from 1 to 20 (M=10, SD=3). Both subtests are then used to determine the Gross Motor Development Quotient (M=100, SD=15). Evidence of the instrument's validity and reliability for children ages 3 to 10 years is reported in the test manual (Ulrich, 1985).

The Movement Assessment Battery for Children (M-ABC), developed by Henderson and Sugden (1992), is designed to assess perceptual motor skills in children aged 4 to 12 years old. A total of 32 items are divided into four sets of eight, each intended for use with children of specific ages. Age Band 1 (AB1) is designed to be used with children age 4 through 6 years, Age Band 2 (AB2) is designed for 7 and 8 year olds, Age Band 3 (AB3) is designed for 9 and 10 year olds, and Age Band 4 (AB4) is designed for those of 11 years and older. In this study, the AB1 and AB2 were used. For each age band, the M-ABC has eight test items grouped under the headings Manual dexterity (three items), Ball skills (two items), and Balance (three items). Each item is scored from 0 to 5. The maximum total impairment score (TIS) is 40, with the higher scores indicating lower perceptual motor skills. The test has age related norms and two cut-off points. The TIS can be converted into percentile. The TIS at the 5th percentile or less should be considered as indicating definite motor difficulties. Score between the 5th and 15th percentiles indicate borderline motor difficulties. Reliability and validity data can be found in the M-ABC manual and Henderson and Sugden (1992) as well as in more recent published studies (Croce, Horvat, & McCarthy, 2001; Chow & Henderson, 2003).

Procedure

One physical education teacher, who was trained and familiar with the testing and scoring procedures, administered both tests. All participants were individually assessed in a quiet room at the school. Encouragement was given in order to maximize the child's efforts. The same equipment was used for all children. Children were asked to wear soled shoes and sports clothes. The analysis of the data was done by one of the researchers.

Data Analysis

Pearson's correlations were used to examine the relationships between results of the TGMD and those of the M-ABC. Alpha was set at the .05 level. A repeated ANOVA measurement with post-hoc Scheffé test design was carried out to test the basic movement skills on the TGMD and perceptual motor skills on the M-ABC for gender and age. The variables used in the analyses were the three subtests of the

Movement ABC (manual dexterity, ball skills, balance) and the two subtests of the TGMD (locomotor skills, object control skills).

Results

Gender Effect

Repeated measures ANOVA regarding TGMD (basic movement skills) and M-ABC variables (perceptual motor skills) showed no significant main and interaction gender effects. Therefore the correlation between the basic movement skills and the perceptual motor skills will be calculated on the whole group.

Correlation between basic movement skills and the perceptual motor skills

Table 2 shows the Pearson's correlation coefficients between TGMD and the M-ABC. The correlation coefficients between the GMDQ and TIS were significant but rather low, r=-0.36, p=.001.

Table 2: Change of the Test of Gross Motor Development (TGMD) according to age

Variables	5 years old (A)		6 years old (B)		7 years old (C)		F	p	Scheffé test
	M	SD	M	SD	M	SD	(2,76)		
Locomotor[a]	18.52	4.08	20.45	4.54	21.82	3.24	11.55	.001	B=C>A
Object Control[a]	9.58	3.90	11.06	3.63	13.07	3.00	13.97	.001	C>B>A
GMDQ[b]	109.22	13.55	105.45	17.42	100.37	11.04	5.66	.005	A>B=C

[a]TGMD for Locomotor and object control score raw scores were used. [b]GMDQ is the gross motor development quotient

The correlation coefficients between the GMDQ and TIS were significant, for 5 year old children r=-.50 (p=.001), and for 6 year old children r=-0.417 (p=0.008), for 7 year old children r=-0.34 (p=0.031). The correlations between GMDQ and TIS ranged from moderate to low. The correlation became lower as the age increased.

Age effects

Table 3 shows the mean scores and standard deviation by group on the TGMD. The repeated ANOVAs regarding TGMD variables showed that there were significant differences between age groups for locomotor skills ($F_{2,76}$=11.52, p=.001). There was significant improvement for object control skills on the result of the repeated ANOVA ($F_{2,76}$=13.97, p=.001), and the results of post hoc Scheffé test also revealed a significant improvement. The GMDG showed a slight decline on the result of the repeated ANOVA ($F_{2,76}$=5.66, p=.005), but the GMDQ result of post hoc Scheffé test showed no significant decrease between 6 and 7 years olds (p=.09). The locomotor, and the object control raw scores became higher from 5 to 7 years olds but the GMDQ became lower. The result of post hoc Scheffé test showed a non-significant improvement for the locomotor skills between 6 and 7 years olds (p=.09).

Table 4 shows the means scores for Manual dexterity, Ball skills, Balance Score and the Total impairment Score (TIS) of comparison groups on the M-ABC. ANOVAs on the M-ABC test scores showed that there were no significant differences between groups for Ball skills ($F_{2,76}$=1.33, p=.26). There were significant differences for Manual dexterity ($F_{2,76}$=18.52, p=.00) and TIS ($F_{2,76}$=15.83, p=.001), and the results of the post hoc Scheffé test also revealed significant differences for Manual dexterity. There were significant improvements for Balance ($F_{2,76}$=4.15, p=.01), but the results of the post hoc Scheffé test showed no significant improvement for Balance between 5 and 6 years olds (p=.39). There is a tendency that the results of the 6 years old ones are lower than the results of the 5 years old ones. This means that they improved. But the 7 years old ones had most of the higher results time than the 6 years old ones.

Table 3. Change of the Movement Assessment Battery for Children (M-ABC) according to Age

Variables	5 years old (A)		6 years old (B)		7 years old (C)		*F*	*p*	Scheffe test
	M	SD	M	SD	M	SD	(2,76)		
Manual dexterity	3.93	2.62	1.72	1.80	2.94	2.40	18.52	.00	A>C>B
Ball skills	1.19	1.98	1.70	1.81	2.22	2.19	1.33	.26	A=B=C
Balance	1.18	2.41	0.81	1.55	0.46	0.94	4.15	.01	A=B>C
TIS[a]	7.00	4.88	4.25	3.42	5.62	4.00	15.83	.001	A>C>B

[a]TIS is total impairment score.

Table 4. Correlation between the Test of Gross Motor Development (TGMD) and the Movement Assessment Battery for Children (M-ABC)

		M-ABC			
		Manual dexterity	Ball skills	Balance	TIS[a]
TGMD	Locomotor Raw Score	-0.35 p=.000004	-0.10 P=.18	-0.33 p=.001	-0.37 p=.001
	Object Control Raw score	-0.10 p=.20	-0.39 p=.00	-0.27 p=.001	-0.34 p=.001
	GMDQ[b]	-0.21 p=.006	-0.29 p=.001	-0.27 p=.0003	-0.36 p=.001

[a]TIS is total impairment score. [b]GMDQ is the gross motor development quotient

Discussion

No gender interaction effect was found for the results on the TGMD and the results on the M-ABC tests. In the TGMD, Ulrich (1985) also found no significant differences between boys and girls in mean performances on locomotor and object-control subtests and consequently used the same conversion tables for both sexes. Langendorfer (1986), in a review of the TGMD, argued that this decision should be questioned because of previous literature showing sex differences in both product and process for some of the skills in the test, such as throwing, striking, hopping, and jumping. Ulrich (1985) states that differences in the means between boys and girls in the standardization sample were not significant at the .01 level, but he does not provide any means or standard deviations for examination or indicate the nature of statistical analysis. Gender differences were found between boys and girls in object control skills by others (Berkeley, Zittel, Pitney & Nichols, 2001; Goodway, Crowe & Ward, 2003). In M-ABC, researchers have found that gender differences were apparent in the development of perceptual motor skills (Maeland, 1992; Sigmundsson & Rostoft, 2003). On the total score and in two of the three sections (manual dexterity and balance) the results of the boys were significantly worse than the results of the girls in the study of Sigmundsson and Rostoft (2003). These findings were in line with the results of Maeland (1992), who showed in her study on 10 year old Norwegian children that the girls had a slight but not significant advantage on the mean total scores of Test of Motor Impairment.

The main aim of the present study was to analyze the correlation between basic movement skills on the TGMD and perceptual motor skills on the M-ABC tests. The correlation was statistically significant at the 5% level. It seems that basic movement skills and perceptual motor skills are related to each other but the correlation is low (r=-0.36, p=.001). Basic movement skills are commonly considered the building blocks to more advanced movement skills (Seefeldt, 1980; Burton & Miller, 1998; Haywood & Getchell, 2001; NASPE, 2002; Payne & Isaacs, 2002). The correlation became lower as the age increased. This can be explained by the fact that the development of perceptual motor skills is modified with practice (Burton & Rodgerson, 2001). The perceptual motor skills are highly dependent upon opportunities for practice, encouragement, quality instruction, and the ecological context of the environment (Gallahue & Ozmun, 2006). Also the basic skills do not emerge rather they are the results of many ontogenetic factors that influence a child's motor skill development, including instruction (Newell, 1984, 1986; Haywood & Getchell, 2001; Goodway, Rudisill & Valentine, 2002; Gabbard, 2004). The correlation between the totals of both instruments was in the same height then the correlations among the subscales. This was in disagreement with the suggestions of Burton and Rodgerson (2001) because they suggested that the subtests referred to movement skill sets and the totals measured different things.

A third aim was to evaluate influence of age on the basic movement skills and perceptual motor skills. The influence of age and movement skills reported in this study we found an interaction effect of age on the results of TGMD. But the results of the M-ABC showed no interaction effect on age. In this study we found that the gross motor development quotient (GMDQ) became lower as age increases ($F_{2,76}$=5.66, p=.005) but the GMDQ result of the post hoc Scheffé test showed a non significant decrease of the results between 6 year old and 7 year old ones (p=.09). The locomotor and object control raw score seem to improve significantly in the TGMD. Aponte, French, and Sherrill (1990) found that TGMD total raw scores were significantly higher for 7 year old compared to 6 year old and significantly higher for 6 year old compared to 5 year old. It seems that locomotor and object control skills were developing steadily with increasing age but it was not as much as the GMDQ increase. Basic movement skills do not naturally "emerge" they rather are the result of many ontogenetic factors that influence a child's movement skill development, including instruction (Newell, 1984, 1986; Haywood & Getchell, 2001; Goodway, Rudisill, & Valentini, 2002; Gabbard, 2004).

The results of Ball skills in the M-ABC showed no significant differences between age groups. The Manual Dexterity, Balance Score and the Total Impairment Score (TIS) in M-ABC became lower between 5 year olds and 6 year old, and between 6 year olds and 7 year olds became higher. This can be interpreted in two ways. One possibility is that 5 year olds, and 6 year olds were tested using Age Band One (AB1), but 7 years old children were tested using Age Band Two (AB2) which is a higher level. The children may have felt it more difficult because it were totally different tasks as compared with age band one. Another possibility is that perceptual motor skills do not simply develop as a result of age and they must be instructed and practiced (Haywood & Getchell, 2001; Payne & Isaacs, 2002). Young children must establish a broad base of motor experiences for higher learning to develop properly.

Limitations of the study: A first limitation of this study is the selection of the children. All the children were recruited in one school which can induce problems of generalization of our findings. But for practical reasons, because the children were followed during several years, it was not possible to select a representative community sample. This was also why the research was done by means of the TGMD and the MABC while later new version of both instruments came on the market. The findings from this study suggest the followings:

First, future researches need to compare the basic and perceptual motor skills between group, which trains proper physical activity program, and control group. It will be necessary to prove how proper physical activity programs affect the basic movement skills and perceptual motor skills.

Second, future research should examine younger and older children because a limitation of this study was that we examined children from 5 to 7 years old. And, although the present study provided important results regarding the movement skills, the findings should be further replicated. The sample used in the present study consisted of children without disability. It would be valuable to extend the examination of basic movement skills and perceptual motor skills to children with intellectual, sensory-motor, and other disabilities. That is, it seems to need future researches through wide variety of research subjects.

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