Comparison of the results of children with psychiatric disorders on two tests measuring motor abilities

AFRODITI THEOFILI & JOHAN SIMONS

Abstract

The relationship and the differences with respect to the norms between two popular motor tests in children with psychiatric disorders aged 4, 6 to 14, 11 years were investigated. A group of 85 children with psychiatric disorders completed the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP) and Körperkoordinationstest für Kinder [Body Co-ordination Test for Children] (KTK). The participants were 55 boys and 30 girls with mean age 9.91 years (SD = 3.05 years). The Pearson product moment coefficient of correlation between the total scores of BOTMP and the total scores of KTK was r = .75. Significant statistical differences were found between the performance of the participants and the norm group in both tests on the 1-% level of significance. No significant differences between boys and girls were found.

Key words: motor test, psychiatric disorder, BOTMP, KTK

In the literature a variety of definitions and explanations concerning the terms "motor ability" and "motor skills" can be found. The term provided here by Burton and Miller (1998), says that motor abilities are the general characteristics and capacities of an individual, which determine the performance of that individual in various motor skills. In contrast, motor skills are specific goal-directed movement patterns (Sherrill, 1998). Motor abilities are not easily modified, but improving the movement skills (Burton & Miller, 1998) can influence them.

Motor tests are developed to screen the motor performance of children by measuring the motor skills and identifying the motor abilities in order to find out motor problems not related to obvious neurological disorders. But when an instrument can be called "motor test"? As Sherrill (1998) mentions, if the scores of an instrument can be interpreted beyond the specific skills included in the test, then easily that instrument can be enlisted to the motor ability tests. In the recent years there is an arising interest in motor tests. This appears as a result of the usefulness of tests in a great variety of groups: clinicians, psychologists, educators, researchers and lately medical doctors.

The multidimensional character of tests made that they have been used frequently during the last decades. Tests serve more than one purpose. One of the most important purposes is that they provide information and help to make an assessment about the motor abilities of an individual and to diagnose various developmental problems (Burton & Miller, 1998). That information can be used to make an intervention programme to improve the motor skills of an individual and also to take decisions about placement in educational settings (Düger, Bumin, Uyanik, Aki & Kahiyan, 1999). Last but not least, instruments are developed to provide an es-

timation of the future status of the child and an evaluation of the changes in function over the years or after an intervention programme or treatment (Katelaar & Vermeer, 1988).

One of the most commonly used tests in the assessment of children with movement difficulties is Bruininks-Oseretsky Test of Motor Proficiency (BOTMP; Bruininks, 1978). In 1990 Riggen, Ulrich and Ozmun state that "... the Bruininks-Oseretsky Test of Motor Proficiency has gained wide popularity since publication" (p. 250). Also in a review of the eleven most frequently used assessment instruments in Adapted Physical Education, by Miles, Nieregarten and Nearing (1988) it is reported that BOTMP is the most reliable instrument. For the same purpose, Körperkoordinationstest für Kinder (KTK [Body co-ordination Test for Children]; Kiphard & Schilling, 1974) is used on a smaller scale by European researchers (Smits-Engelsman, Henderson & Michels, 1998). BOTMP was published in 1978 and it is one of the many adaptations on Oseretsky's Test of Motor Proficiency (Doll, 1946; Holbrook, 1953; Sloan, 1955) which was initially introduced in Russia in 1923 (Hattie & Edwards, 1987). Bruininks seemed to ignore the later adaptations, he revised Doll's adaptation and provided his own instrument (Beitel & Mead, 1980). BOTMP has obtained such high acceptance through time, because the skills it measures, are important for the children' development and also, till recently only a few other tests existed for school-aged children (Wilson, Kaplan, Crawford & Dewey, 2000).

KTK is a German test, which was first presented in 1968 by Kiphard and Schilling and reached its latest form in 1974. The test is a result of research by Kiphard (1967) and Hünnekens, Kiphard and Kesselman (1967) in order to establish a new reliable and valid motor test, which would be easier and better to be applied than the Oseretsky Test of Motor Proficiency in order to assess children with brain damage and brain dysfunction (Schilling & Kiphard, 1975). Schilling's and Kiphard's instrument found extensive use in the psychomotor approach, called motopedagogy/mototherapy in Germany (Doll-Tepper, 1989).

In a first look, it seems that the two tests have many similarities. Both tests have been developed to categorise children and to make an assessment of the motor performance (Simons, 1997). In order to make that assessment, quantitative criteria are used (Steffens, Semmes, Werder & Bruininks, 1987). Moreover, both tests are trying to assess the contemporary level of ability, using a variety of behavioural events (Gallahue, 1983). These similarities provide a motive for this study. Since both tests are used for the same purposes, two questions are coming up: do they measure the same motor aspects and can they be used as equivalent to each other? The last question is of great importance because in time speaking, a child needs only 20 minutes to complete KTK, while for the BOTMP that time is extended to a total of 45-60 minutes. In the clinical and the educational settings where the time constrains are enormous, we can easily understand the gains if we can use KTK instead of BOTMP.

In previous research in psychiatric populations contradictory results were found. In 1984 Van Coppenolle and Simons found a total correlation of $\underline{r} = .59$, while Vanderheyden and Simons (1984) found a rather high correlation of $\underline{r} = .80$ ($n = 123$). Also in 1993 by Simons, a lower but still high correlation of $\underline{r} = .76$ was found. In our opinion, because of these contradictory results further research was necessary. The present study had following objectives: 1) comparing the scores on the KTK and BOTMP of a test group of children with psychiatric disorders with those of the norm groups, 2) comparing scores of boys and girls, assuming that there are significant sex differences, and 3) examining the relationship between both tests. That psychiatric problems in children influence their motor performances was argued in several studies by Walker and Green (1982), Vanderheyden and Simons (1984), Humphries et al (1985), Gruber et al (1989), Miyahara (1994), and Simons (1993, 1997). The hypothesis of this study is that both tests are linked closely and that psychiatric children score lower than the norm group on both BOTMP and KTK.

Method

Research participants

A group of 85 children (55 males and 30 females) composed the sample. They had a mean chronological age of 9,7 years with a range of 5,2 to 14,8 years and standard deviation of 3,05 years (Table 1). The subjects were in- and outpatients at the Department of Child's and Adolescent Psychiatry of the University Hospital of Gasthuisberg (U.H.G) in Leuven (Belgium).

Table 1
Mean age and standard deviation of the group sample

	n	M	SD	Range
Males	55	9. 91 (years)	3. 07 (years)	5,2-14,8 years
Females	30	9. 27 (years)	3. 01 (years)	5,8-14,3 years
Total	85	9. 69 (years)	3. 05 (years)	5,2-14,8 years

No significant difference was found between the mean age of males and females ($t(83) = -.931$, $p = .354$). The sample covered a wide spectrum of different psychiatric diagnosis such as social phobia, post traumatic stress disorder, reactive attachment disorder, depression... A multidisciplinary team which, among others, consisted of psychologists, psychomotor therapists and medical doctors in the University Hospital of Gasthuisberg in Leuven conducted the diagnosis.

Measures

To assess the motor performance and especially the various characteristics of gross and fine motor proficiency, the long form of Bruininks-Oseretsky Test of Motor Proficiency [BOTMP] (Bruininks, 1978) was used. BOTMP is a standardised test for the assessment of motor performance in children between 4,6 and 14,5 years old. The long form consists of 46 tasks, organised in 8 subtests: four measure gross motor performance, three measure fine motor skills and one measures both gross and fine motor performance. The combination of all subtests provides a clear picture of a child's motor performance. There is also a shorter version of BOTMP. In a research by Bruininks and Broadhead (1983), it was reported that even though the short form cannot be as precise as the long form, it provides useful information about the motor abilities of an individual. The long form needs 45-60 minutes to be administered, while the short form needs only 15-20 minutes. But when the long form of BOTMP is administered to children with severe motor problems, then the time requirements are longer: one to two and a half-hours are required (Verderber & Payne, 1987).

The eight sub tests are:

1) Running speed and agility (one item). It measures running speed during a shuttle run.
2) Balance (eight items). Three items assess static balance by requiring the subject to maintain balance while standing in on leg. Five items assess performance balance by requiring the subject to maintain balance while executing various walking movements.

3) Bilateral motor co-ordination (eight items). Seven items assess sequential and simultaneous co-ordination of the upper limbs with the lower limbs. One item assesses co-ordination of upper limb only.
4) Strength (three items). These items assess arm and shoulder strength, abdominal strength and leg strength.
5) Upper-Limb co-ordination (nine items). Six items assess co-ordination of visual tracking with movements of arms and hands. Three items assess precise movements of arms, hands or fingers.
6) Response speed (one item). It measures the ability to respond quickly to a moving visual stimulus.
7) Visual-motor control (eight items). These items measure the ability to co-ordinate precise hand and visual movements.
8) Upper-limb speed and dexterity (eight items). These items measure hand and finger dexterity, hand speed and arm speed (Bruininks, 1978).

Each item is scored in raw scores, which are expressed in terms of time, number of units completed, number of errors and pass or fail. The subtests point scores ($\underline{M}$ = 15, $\underline{SD}$ = 5) can be converted to standard scores and then the sums to composite standards scores ($\underline{M}$ = 50, $\underline{SD}$ = 10), percentiles, age equivalents and stanines.

Internal consistency reliability based on test-retest reliability coefficients for all the components, examined with children without disability, is quite satisfactory. For the complete battery r_{tt} = .87 and for Gross motor composite and Fine motor composite r_{tt} = .81 and r_{tt} = .80, respectively. All the subtests have coefficients above .70 except the subtests Balance ($\underline{r}$ = .56), Upper-limb co-ordination ($\underline{r}$ = .61) and Response speed ($\underline{r}$ = .60).

Factor analysis of the 46 items in relation with the 8 subtests was used to clarify the structure of the test.

The Körperkoordinationstest für Kinder (KTK [Body Co-ordination Test for Children]; Kiphard and Schilling, 1974) is designed to evaluate the overall body co-ordination and control of children from 5 to 14,11 years old. It includes four items: 1) Walking backwards on a balance beam 6, 4.5 and 3 cm broad and 5 cm high. The number of successful steps are recorded, 2) Hopping over obstacles. The child jumps on one foot over plastic blocks (5 cm high each), with maximum height of 60 cm long, 3) Jumping laterally as fast as possible for 15 seconds. The number of jumps is recorded, 4) Moving the body sideways with the help of two little boxes for 20 seconds as quickly as possible.

KTK is a normative test and a number of different estimates of performance are available. For each item a raw score and a scaled score are recorded. Furthermore separate values for boys and girls are presented. Finally, total Motor Quotient (MQ) ($\underline{M}$ = 100, $\underline{SD}$ = 15) percentiles, and motor age can be estimated per item as well as for the global test. The MQ can be compared with the IQ of intelligent tests (Undeutsch, 1978) and a result lower than 85 indicates a serious co-ordination disturbance (Schilling & Kiphard, 1977). The test manual provides normative date for four reference-groups: normal children, children with learning disabilities, children with behavioural problems and children with brain damage/brain dysfunction.

Internal consistency reliability based on test-retest reliability coefficients, for each item, ranges from .80 to .96; for balance r_{tt} = .80, jumping on one foot r_{tt} =.96, jumping sideways r_{tt} = .95 and moving sideways r_{tt} = .95 and for the total test r_{tt} = .97.

Factor analysis evidenced that the test measures global dynamic co-ordination. Results in a comparison group, consisting of children with brain damage/brain dysfunction, children with learning difficulties, and children with behavioural problems, were significantly lower than the results in the norm group.

Procedures

The data were derived from existing file folders of the years 1990-2000 in the University Hospital of Leuven (U.H. Gasthuisberg), in the Department of Child and Adolescent Psychiatry. The files met the following criteria: they all comprised both the Bruininks-Oseretsky test of Motor Proficiency and the Körperkoordinationstest für Kinder in the age span of 4,6 to 14,11 years.

Data analysis

To analyze the data, parametric statistics was used. Means and standard deviations for age and the standard scores of both tests were calculated. The first step was to use t-tests to test if there were differences between the test group and the norm group. T-tests were also used to test differences between boys' and girls' performances.
Next, the Pearson product moment coefficient of correlation was used to determine the relationship between the scores of the two tests. Total scores on the BOTMP were correlated with the total MQ scores on the KTK. Next, the standard scores of each composite of the BOTMP were correlated with the scores of each of the four items of KTK. Finally, the scores of the eight subtests were correlated with the scores of each item of KTK. The level of significance was determined at $p < .01$.
Since there was a wide spectrum of diagnoses, it was impossible to divide the sample into subsamples of children having a similar diagnosis.

Results

Table 2 presents the means and standard deviations for BOTMP's motor composites, complete battery's scores and KTK's total MQ scores.
Table 3 presents the means and standard deviations of BOTMP subtests scores and also the KTK's item scores.
There were no significant differences between the test group and the norm group (in the norm group $M = 50$, $SD = 10$), neither on the total score, nor on the composite scores.
Table 4 shows the results of the comparison of BOTMP's subtest scores between the test and the norm group (in the norm group $M = 15$, $SD = 5$). Significant differences were found only on the subtests Running Speed and Agility, Balance and Upper-limb co-ordination.
As Table 5 shows, significant differences were found between both groups on the KTK's total MQ and the item scores (in the norm group $M = 100$, $SD = 15$).
Neither on the BOTMP (total score, composite and subtest scores) nor on the KTK (total MQ, item scores), significant differences between boys and girls were found.
The Pearson product moment coefficient of correlation between the total scores of the BOTMP and the MQ of KTK was .75 ($p < .01$), the correlations between the MQ scores of KTK and the scores on the Gross and Fine motor composite of BOTMP were .76 and .47, respectively (in both cases $p < .01$).
The Pearson product moment coefficient of correlation between the scores of each subtest of BOTMP and the scores of the four items of KTK are shown in Table 6. All correlations were significant ($p < .01$) except the correlations between Visual motor control and Hopping obstacles (for $r = .14$) and between Visual motor control and Jumping laterally ($r = .20$).

Table 2
Descriptive statistics for BOTMP's composites, total Scores and KTK's MQ (N = 85)

	M composite score	SD
BOTMP		
Total battery	46.24	14.16
Gross motor	46.29	13.22
Fine motor	50.41	17.58
KTK		
Total MQ	83.01	19.73

Table 3
Descriptive statistics for BOTMP's subtests scores and KTK's items scores (N = 85)

	M subtest point score	SD
BOTMP		
Running speed and agility	12.35	7.17
Balance	12.85	6.09
Bilateral co-ordination	15.08	5.50
Strength	14.32	6.23
Upper-limb co-ordination	12.18	5.42
Response speed	14.36	6.10
Visual-motor control	14.88	6.61
Upper-limb speed	14.48	5.19
KTK		
Backwards balance	86.64	16.15
Hopping obstacles	80.63	20.13
Jumping laterally	90.36	19.14
Sideways moving	89.25	18.68

Table 4
Comparison of BOTMP's subtests scores with the norm group scores

	Test group	N = 85	Norm group	N = 765	t-value	p-value	ES
	M	SD	M	SD			
Running speed and agility	12.35	7. 17	15	5	-3.402	.001	-.50
Balance	12.85	6. 09	15	5	-3.241	.007	-.42
Upper-limb co-ordination	12.18	5. 42	15	5	-4.778	< .0001	-.58

Table 5
Comparison of KTK's MQ and composite scores with the norm group scores

	Test group M	N = 85 SD	Norm group M	N = 1228 SD	t-value	p-value	ES
M.Q. total	83.01	19.73	100	15	-7.937	< .0001	-1.11
Backward balance	86.64	16.15	100	15	-7.620	< .0001	-.89
Hopping obstacles	80.63	20.13	100	15	-8.869	< .0001	-1.26
Laterally jumping	90.36	19.14	100	15	-4.641	< .0001	-.63
Sideways moving	89.25	18.68	100	15	-5.299	< .0001	-.70

Table 6
Correlation of BOTMP subtests with KTK's items (N = 85)

	Walking backwards	Hopping obstacles	Jumping laterally	Sideways moving
Running speed and agility	.35	.55	.58	.41
Balance	.45	.47	.35	.39
Bilateral Co-ordination	.40	.52	.42	.47
Strength	.29	.62	.61	.44
Upper-limb Co-ordination	.38	.36	.45	.35
Response Speed	.28	.45	.39	.30
Visual-Motor Control	.36	.14	.20	.29
Upper-Limb Speed	.53	.55	.65	.57

Discussion

The high correlation between BOTMP total and KTK total MQ scores supports the results of Vanderheyden and Simons (1984), who reported an even higher correlation between both measures (r = .80). Fifty-six percent of the performance in one test is associated and explained by the factors involved in the performance of the other. But what about the 44% of the unexplained variance? Although it cannot be fully explained, an important factor could be the differences in the administration of both tests. KTK is a fairly dynamic test and children need to try hard in order to complete the test. BOTMP has not the same level of intensity and the therapist can provide a variety of activities to keep the interest of the child. At least a part of the unexplained variance may be due to: a) children's lack of motivation to perform at their best in tests (unlike adults), b) a fatigue factor (the KTK has a rather dynamic character) and c) the unidimensional direction of the KTK. This result indicates strong relationships between the total scores of the two tests.

As expected, a significant positive intercorrelation was found between the gross motor composite and the MQ scores of the KTK. This finding supports the results reported by Simons

(1993). The intercorrelation between the scores of the fine motor composite and the total MQ scores of the KTK was moderate. However, even a lower correlation could be expected, because the KTK does not include separate items measuring fine motor performance. Van Coppenolle and Simons (1984) also reported a moderate correlation (r = .57) in a group of 78 psychiatric children. In their study, a surprisingly low (but significant) intercorrelation was found between the balance items of the two tests (r = .45).

Between the BOTMP Balance subtest and the KTK total MQ a low, but significant correlation was found. This can be explained by the many problems that many researchers have indicated through the years, regarding the eight items of the subtest of Balance in BOTMP. In particular, in an earlier review of BOTMP, Hattie and Edwards (1987) concluded that the Balance subtest was not consistent over time. In addition, Burton and Davis (1992) indicated that the test-retest reliability coefficients for the Balance subtest were low. They reported coefficients ranging from .45 to .73 for boys and for girls from .46 to .54.

Furthermore, in order to assess balance, both tests use items that demand and emphasize conscious control, while most everyday movements are automatized (Woollacott & Shumway-Cook, 1986). Effgen (1981) commented that balance should be manipulated at the automatic level and exercises like "standing on preferred foot" cannot provide sufficient information about the real ability of an individual in balance. A large part of the Balance subtest in BOTMP consists of these kinds of exercises. Another justification for the low correlation can be that the subtest of KTK requires only backward movements, while the subtest of BOTMP requires mostly feed forward movements. So, even though the object is the same: to assess balance, the two tests use different ways to measure it. Burton (1992) mentioned the importance of the backward balance and suggested that it would be better if the BOTMP included some items to assess the backward movements. The aforementioned reasons prove that the area of balance is rather problematic and these problems probably are reflected in the two tests. Another reason to take into account is that in BOTMP's exercises children are not allowed to use their hands in order to obtain better balance. This is not the case on the KTK.

Another unexpected result was the high correlation between the BOTMP subtest Upper-limb Speed and Dexterity and the KTK's total MQ and the KTK's items. Reasonably, a lower correlation would be expected, because the KTK is not including separate exercises for the upper-limb co-ordination. An explanation can be that the speed and dexterity of the upper limbs are basic elements in the successful completion of KTK's exercises. In particular, upper limbs' speed plays an important role in the KTK's item "Jumping laterally".

Another issue for consideration is that researchers have raised questions about the validity of norm-referenced tests when they are applied in children with intellectual impairments (Thorpe & Werner 1974; Ulrich, 1984). Furthermore, Gowland et al. (1991) noted that the assumption that reliability and validity in a motor test is the same for children with motor problems, should not be easily made. In case that a child is severely impaired, assessment with a norm – referenced test should not be applied (Miles et al, 1988). While these considerations are reflected in BOTMP, this may not be the case in KTK. The German test was introduced as an instrument to assess the motor problems of children with brain damage and brain dysfunction. It was specifically designed for children with an impairment and not for non-disabled children. In that case, KTK is probably more reliable than BOTMP, when it is used in children with some kind of impairment. On the other hand, the KTK has insufficient accuracy to assess fine motor skills. It sounds unlikely to use this instrument to detect deficits in a child with problems in the graphomotor domain (Smits-Engelsman et al, 1998). The BOTMP is more reliable for this purpose, since it contains a composite designed to measure aspects of fine motor performance. The results indicate that the BOTMP and the KTK measure different aspects of motor performance. This is important to remember, because in clinical practice some people use the KTK as interchangeable for the BOTMP.

Another objective of this study was to examine whether there was a difference between the scores of psychiatric and non-psychiatric children in BOTMP and KTK. Compared to published norms significant differences were found only on three subtests of BOTMP: Running

Speed and Agility, Balance and Upper-limb Co-ordination, while for KTK statistical differences were found on all four items and also on the MQ scores. Bruininks (1978) indicated that non-handicapped children may have an advantage over children with learning disabilities and children with intellectual impairments and maybe this is the explanation of the differences. The psychiatric problems these children face are also visible in their motor performance and reveal a motor delay in contrast with the non-psychiatric children (Gruber et al, 1989; Humphries et al, 1985; Miyahara, 1994; Simons, 1993, 1997; Vanderheyden & Simons, 1984; Walker & Green, 1982). This is interesting because further research could be done to investigate differences between several psychiatric diagnostic categories. In this way psychomotor tests could help to find some arguments for diagnostic categories.

Another interesting aspect of this study was the lack of gender differences. This was contrary to expectations based on findings from earlier research. Gender differences were expected in the subtests Strength, Running Speed and Agility (BOTMP) and Balance (BOTMP and KTK). Furthermore, on the KTK, differences were expected between the performances of males and females with regard to speed and strength. Düger et al (1999) mentioned that males were traditionally stronger than girls and performed better in a variety of gross motor skills. Further, higher scores in boys as compared to girls were expected, because boys tend to play more aggressive games and to do more sports (Tauber, 1979), both activities with a high level of motor activity. With regard to balance, it is interesting to note that girls were expected to score higher than boys (Plimpton & Regimbal, 1992) and to perform better in gymnastic type exercises (like the exercises on balance included in the KTK). However, it has to be considered that the size of the sample group was rather small. But in the case of KTK the results were derived from the standard scores. So, any existing differences between the performances of males and females could be visible only in the raw scores before their standardised conversion. Maybe it is necessary to build up new reference data providing separate information on boys and girls.

Furthermore, it should be considered that the BOTMP does not provide separate normative data for boys and girls (Broadhead & Bruininks, 1982). The KTK does provide such data, except for the item "Walking backwards on a balance beam". In the case of the BOTMP this is interpreted as a reduction of the sensitivity of the items.

In conclusion, the strong intercorrelation between BOTMP and KTK supports the findings reported by Vanderheyden and Simons (1984) and Simons (1993) but contradicts the findings reported by Van Coppenolle and Simons (1984). The comparison between the participants and the norm group showed that psychiatric children scored lower on both instruments. The lower performances reflect the psychiatric disorders these children manifest. There were no differences between girls' and boys' performances, but since the sample size was rather small, more research on this topic is necessary. Although the BOTMP provides a large amount of information on the motor performance of an individual, researchers question the reliability of this instrument. On the other hand, KTK seems to be more reliable but provides limited information, in particular on fine motor skills. Finally, there are no fully reliable or valid methods or instruments. So, why should practitioners hesitate to rely on the BOTMP and the KTK when preparing interventions and therapeutic programmes?

References

BEITEL, P.A., & MEAD, B.J. (1980). Bruininks-Oseretsky Test of Motor Proficiency: A viable measure for 3- to 5-year old children. *Perceptual and Motor Skills, 51*, 919-923.

BROADHEAD, G.D., & BRUININKS, R.H. (1983). Factor structure consistency in the Bruininks-Oseretsky Test of Motor Performance – Short Form. *Rehabilitation Literature, 44* (1-2), 13-18.

BROADHEAD, G.D., & BRUININKS, R.H. (1982). Childhood motor performance traits on the short form Bruininks-Oseretsky Test. *Special Populations*, 149-155.

BRUININKS, R.H. (1978). *The Bruininks-Oseretsky Test of Motor Proficiency*. Circle Pines. MN: American Guidance Service.
BURTON, A., & DAVIS, W. (1992). Assessing balance in adapted physical education: fundamental concepts and applications. *Adapted Physical Activity Quarterly, 9*, 14-46.
BURTON, A., & MILLER, D. (1998). *Movement Skill Assessment*. Champaign, IL: Human Kinetics.
DOLL, E.A. (1946). *The Oseretsky Tests of Motor Proficiency*. Circle Pines, MN: American Guidance Service.
DOLL-TEPPER, G. (1989). Children with special needs – motodiagnostic test procedures and Kiphard's mototherapeuic approach. *Adapted Physical Activity Quarterly, 6*, 170-175.
DÜGER, T., BUMIN, G., UYANIK, M., AKI, E., & KAYIHAN, H. (1999). The assessment of Bruininks-Oseretsky test of Motor Proficiency in children. *Paediatric Rehabilitation, 3*, 125-131.
EFFGEN, S.K. (1981). Effect of an exercise programme on the static balance of deaf children. *Physical Therapy, 61*, 873-877.
GALLAHUE, D. (1983). Assessing motor development in young children. *Studies in Educational Evaluation, 8*, 247-252.
GOWLAND, C., KING, G., KING, S., LAW, M., LETTS, L., MAC KINNON, L., ROSENBAUM, P., & RUSSEL, D. (1991). *Review of selected measures in neurodevelopmental rehabilitation*. Ontario: Neurodevelopmental Clinical Research Unit.
GRUBER, J.J., HALL, J., KRYSCIO, R., & HUMPHRIES, L. (1984). Performance of older adolescents on the Bruininks-Oseretsky Test of Motor Proficiency: A prelude to normative data. *American Corrective Therapy Journal, 38*, 119-121.
HATTIE, J., & EDWARDS, H. (1987). A review of the Bruininks-Oseretsky Test of Motor Proficiency. *British Journal of Educational Psychology, 57*, 104-113.
HOLBROOK, S.F. (1953). *A study of the development of motor abilities between the ages of 4 and 12, using a modification of the Oseretsky scale*. Unpublished doctoral dissertation, University of Minnesota.
HUMPHRIES, L., GRUBER, J., HALL, J., & KRYSCIO, R. (1985). Motor proficiency in depressed adolescent inpatients: Biochemical and clinical diagnostic correlates. *Journal of Developmental & Behavioral Pediatrics, 6*, 259-262.
HÜNNEKENS, H., KIPHARD, E.J., & KESSELMANN, G. (1967). Untersuchungen zur Motodiagnostik im Kindesalter. *Acta Paedopsychiatrica, 34*, 17-27.
KATELAAR, M., & VERMEER, A. (1988). Functional motor abilities of children with cerebral palsy: A systematic literature review of assessment measures. *Clinical Rehabilitation, 12*, 369-380.
KIPHARD, E.J. (1967). Beitrag zur Diagnostik zentralmotorischer Störungen. *Zeitschrift für Heilpädagogik, 18*, 33-38.
KIPHARD, E.J., & SCHILLING, F. (1974). *Körperkoordinationstest für Kinder, KTK: Test Manual* [Body Coordination Test for Children]. Weinheim, Germany: Beltz Tests.
MILES, B., NIERENGARTEN M., & NEARING, R. (1988). A review of the eleven most often-cited assessment instruments used in adapted physical education. *Clinical Kinesiology*, 33-41.
MIYAHARA, M. (1994). Subtypes of students with learning disabilities based upon gross motor functions. *Adapted Physical Activity Quarterly, 11*, 368-382.
PLIMPTON, C., & REGIMBAL, C. (1992). Differences in motor proficiency according to gender and race. *Perceptual and Motor Skills, 74*, 399-402.
PORTER, R.E. (1989). Normal development of movement and function: child and adolescent. *Physical Therapy*, 83-98.
RIGGEN, K., ULRICH, D., & OZMUN, C. (1990). Reliability and concurrent validity of the test of Motor Impairment – Henderson Revision. *Adapted Physical Activity Quarterly, 7*, 249-258.
SCHILLING, F., & KIPHARD, E. (1975). Der KTK – ein neuer motorische Entwicklungstest [KTK – a new motor development test]. *Zeitschrift für Heilpädagogik, 26*, 447-452.
SCHILLING, F., & KIPHARD, E. (1977). Ziele und differentialdiagnostische Möglichkeiten des Körper-Koordinationstests für Kinder (KTK). [Goals and differential – diagnostic possibilities of KTK]. *Psychomotoric, 2*, 148-147.

SHERRILL, C. (1998). *Adapted Physical Activity, Recreation and Sport: Crossdisciplinary and Lifespan*. Fifth Edition. Washington: WBC/McGraw – Hill.
SIMONS, J. (1993). Psychomotor diagnostics in psychiatrically disturbed children. *Issues in Special Education and Rehabilitation, 8*(2), 17-21.
SIMONS, J. (1997). *Introductie tot de psychomotoriek* [Introduction in psychomotor therapy], Leuven, Belgium: Garant.
SLOAN, W. (1955). The Linkoln-Oseretsky Motor Development Scale. *Genetic Psychology Monographs, 51*, 183-252.
SMITS-ENGELSMAN, B., HENDERSON, S., & MICHELS, C. (1998). The assessment of children with Developmental Coordination Disorders in the Netherlands: The relationship between the Movement Assessment Battery for Children and the Körperkoordinationstest für Kinder. *Human Movement Science, 17*, 699-709.
STEFFENS, K., SEMMES, R., WERDER, J., & BRUININKS, R. (1987). Relationship between quantitative and qualitative measures of motor development. *Perceptual and Motor Skills, 64*, 985-986.
TAUBER, M. (1979). Parental socialisation techniques and sex differences in children's play. *Child Development, 50*, 225-234.
THORPE, H.S., & WERNER, E.E. (1974). Developmental screening of preschool children: A critical review of inventories used in health and educational programmes. *Paediatrics, 53*, 362-370.
ULRICH, D.A. (1984). The reliability of classification decisions made with the Objectives – Based Motor Skill Assessment Instrument. *Adapted Physical Activity Quarterly, 1*, 52-60.
UNDEUTSCH, B. (1978). Körperkoordinationstest für Kinder [Body Coordination Test for Children]. *Kinderarzt, 9*, 1195-1199.
VAN COPPENOLLE, H., & SIMONS, J. (1984). *Psychomotorische observatie en therapie bij kinderen* [Psychomotor observation and therapy in children]. Leuven, Belgium: Acco.
VANDERHEYDEN, V., & SIMONS, J. (1984). Onderzoek van de algemeen psychomotorische ontwikkeling en de dynamische coordinatie bij leer- en gedragsgestoorde kinderen. [Evaluation of the psychomotor development and bodily co-ordination in children with learning and behavior disabilities]. *Vlaams Tijdschrift Psychomotorische Therapie, 11*(4), 92-99.
VERDERBER, J.M., & PAYNE, G.V. (1987). A comparison of the long and short forms of the Bruininks-Oseretsky Test of Motor Proficiency. *Adapted Physical Activity Quarterly, 4*, 51-59.
WALKER, E., & GREEN, M. (1982). Motor proficiency and attentional-task performance by psychotic patients. *Journal of Abnormal Psychology, 91*, 261-268.
WERDER, J., & BRUININKS, R. (1987). Relationship between quantitative and qualitative measures of motor development. *Perceptual and Motor Skills, 64*, 985-986.
WILSON, B., KAPLAN, B., CRAWFORD, S., & DEWEY, D. (2000). Interrater reliability of the Bruininks-Oseretsky Test of Motor Proficiency – Long Form. *Adapted Physical Activity Quarterly, 17*, 95-110.
WOOLLACOTT, M.H., & SHUMWAY-COOK, A. (1986). The development of the postural and voluntary motor control systems in Down's syndrome children. In M.G. WADE (Ed.), *Motor Skill acquisition of the mentally handicapped: Issues in research and training* (pp. 45-71). Amsterdam: North Holland.

Author note

Afroditi Theofili and **Johan Simons**, Department of Rehabilitation Sciences, Katholieke Universiteit Leuven, Belgium.
Correspondence concerning this article should be addressed to: Johan Simons, PhD, Faculty of Physical Education and Physiotherapy, Department of Rehabilitation Sciences, Tervuursevest 101, B-3000 Leuven (Belgium). Tel ++32-16-329140, Fax ++32-16-329196.
E-mail: johan.simons@flok.kuleuven.ac.be