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Motor competence assessment in children: Convergent and discriminant validity between the BOT-2 Short Form and KTK testing batteries

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ABSTRACT

This study investigated convergent and discriminant validity between two motor competence assessment instruments in 2485 Flemish children: the Bruininks-Oseretsky Test of Motor Proficiency 2 Short Form (BOT-2 Short Form) and the KörperKoördinationsTest für Kinder (KTK). A Pearson correlation assessed the relationship between BOT-2 Short Form total, gross and fine motor composite scores and KTK Motor Quotient in three age cohorts (6–7, 8–9, 10–11 years). Crosstabs were used to measure agreement in classification in children scoring below percentile 5 and 15 and above percentile 85 and 95. Moderately strong positive ($r = 0.44–0.64$) associations between BOT-2 total and gross motor composite scores and KTK Motor Quotient and weak positive correlations between BOT-2 Short Form fine motor composite and KTK Motor Quotient scores ($r = 0.25–0.37$) were found. Levels of agreement were fair to moderate. Therefore, some proof of convergent and discriminant validity between BOT-2 Short Form and KTK was established in this study, underlining the notion that the evaluation of motor competence should not be based upon a single assessment instrument.

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1. Introduction

The ability to execute a wide range of motor acts, often described as motor competence, is a prerequisite for enjoyable and successful participation in leisure and sports activities from childhood into adulthood (Barnett, van Beurden, Morgan, Brooks, & Beard, 2009; Cools, De Martelaer, Vandaele, Samaey, & Andries, 2010). Within a general pediatric population, there is great variation in motor competence levels. Children who possess low levels of motor competence perform below average for their age and/or gender on different components of physical fitness (Cairney, Hay, Faught, Flouris, & Klentrou, 2007; Hands & Larkin, 2006; Schott, Alof, Hultsch, & Meermann, 2007) and show a greater decrease in physical fitness levels over time (Hands, 2008). Hence, they are unlikely to catch up with their more competent peers with age (Hands, 2008) and might be at risk of having a compromised physical fitness throughout adulthood (Stodden, Langendorfer, & Robertson, 2009).

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Therefore, an early detection and continuous monitoring of children with low motor competence levels relative to their peers and/or normative standards is important.

In order to profile motor competence levels in children, different assessment tools have been used (Cools, De Martelaer, Samaey, & Andries, 2008). Research on the assessment of motor skill competence in children has mainly focused on discriminating atypically developing children from their normally developing peers (Yoon, Scott, Hill, Levitt, & Lambert, 2006). Therefore, most assessment tools have the specific goal of identifying children with motor problems (Cools et al., 2010). The Bruininks-Oseretsky Test of Motor Proficiency second edition (BOT-2; Bruininks & Bruininks, 2005) for example, is used to identify individuals aged 4–21 years with mild to severe motor coordination problems. The BOT-2 testing battery measures fine and gross movement skill using 53 test items in eight subtests: fine motor precision (seven items), fine motor integration (seven items), manual dexterity (five items), bilateral coordination (eight items), balance (nine items), running speed and agility (five items), upper limb coordination (seven items) and strength (five items). The BOT-2 Short Form (Bruininks & Bruininks, 2005) is a motor competence testing battery originally designed to identify 4–21 year old individuals with mild to severe motor problems. It is derived from the BOT-2 and is shorter and easier to administer and features a total 14 items, with at least one from each of the BOT-2 subtests. A second movement skill assessment tool of interest to this study is the KörperKoördinationsTest für Kinder (KTK, Kiphard & Schilling, 1974, 2007).

The KTK consists of four subtests measuring gross motor coordination and was also developed with the main goal of identifying 4–15 year old children with mild to severe motor problems. Previous research has been shown that the KTK also measures physical fitness to some extent (Vandorpe, Vandendriessche, Lefevre, et al., 2011), making it an ideal motor competence assessment instrument. In contrast to the BOT-2, the KTK has also been used to identify children at the other end of the continuum, i.e., for talent detection and identification purposes (Vandorpe, Vandendriessche, Vaeyens, et al., 2011; Vandendriessche et al., 2012).

To assess motor competence in children, there is a need for reliable and valid instruments. For the BOT-2 Short Form including knee-push ups, a very high inter-rater reliability of $r = .98$ and a test–retest reliability over a time interval of 7–42 days of $r \geq .80$ were found as well as a good ($r \geq .80$) internal consistency in 8–12 year old children. Also, content validity was shown by a high correlation ($r = .80$) between the BOT-2 Short Form and the BOT-2 Complete Form (Bruininks & Bruininks, 2005; Deitz, Katrin, & Kopp, 2007). For the KTK, the scores on each subtest had a test–retest reliability of $.80 \geq r \leq .96$ and the raw total score on the test battery had a test–retest reliability of .97. Furthermore, the KTK showed good internal consistency by showing strong significant relationships ($.60 \geq r \leq .81$) between test items (Kiphard & Schilling, 1974, 2007). To establish validity of the KTK; different aspects of construct validity were used. Construct validity is the evaluation of the extent to which a measure assesses the construct it means to measure and consists of content, internal structure, convergent and discriminant validity (Strauss & Smith, 2009). Content and internal structure validity were respectively shown by a high explained variance on total KTK scores by the KTK subtests (explained variances ranged from 81% at 6 years to 98% at age 9) and by a factor analysis where all test items load on the same factor. The ability to differentiate between typically and atypically developing children (91% were correctly labeled as having brain injury) showed good concurrent validity. However, convergent and discriminant validity for both testing batteries has not been thoroughly established.

Convergent validity refers to the extent to which different measures of the same construct are in fact related while discriminant refers to how different measures of different constructs are not related (Portney & Watkins, 2009, chap. 6). A high convergent validity between two test batteries should result in a high agreement of classification based on both measurement instruments (Cools et al., 2010). However, no recent studies have established convergent and discriminant validity between the KTK and BOT-2 Short Form specifically, or between KTK or BOT-2 Short Form and any other popular motor assessment battery in general. The assessment of convergent and discriminant validity between these two motor competence testing batteries in particular is interesting since both testing batteries have frequently been used in research on motor competence (deficits) in children (Barnett, 2008; Vandorpe, Vandendriessche, Lefevre, et al., 2011). Therefore, the aim of this study is to assess convergent and discriminant validity between the KTK and BOT-2 Short Form by assessing relationships between KTK Motor Quotient, BOT-2 Short Form standardized score, BOT-2 Short Form gross and BOT-2 Short Form fine motor composite score in a representative sample of 6–12 year old children. In order to measure the level of agreement of classification between both testing batteries at different ends of the motor competence, the agreement in classification between both batteries was assessed. It is hypothesized that stronger correlations will be visible between KTK and BOT-2 Short Form total and gross motor composite scores, than between KTK and BOT-2 Short Form fine motor composite scores. Furthermore, since KTK and BOT-2 Short Form aim to identify children with mild to severe motor problems, the agreement of classification between both testing batteries would be highest in the P5 and P15 categories.

2. Materials and methods

2.1. Participants

A total of 2485 children (i.e., 1300 boys and 1185 girls) between 6 and 12 years participated in this study with a cross-sectional design. These children were recruited from 26 primary schools for general education located throughout the Flemish region of Belgium. To obtain a representative sample of the Flemish elementary school population, schools were randomly selected from all five Flemish provinces and the Brussels Capital Region and were situated in both rural and city areas.

2.2. Procedures

All children completed the BOT-2 Short Form and KTK assessments in a three-month time span in 2007 and all testing was conducted by trained supervisors in an indoor facility. Written informed consent was obtained from the children's parent(s) or guardian(s). The local Ethics Committee of the Ghent University Hospital granted permission for this study.

2.3. Measuring Instruments

2.3.1. Bruininks-Oseretsky Test of Motor Proficiency 2 (BOT-2)

The BOT-2 Short Form consists of 14 test items from 8 subtests: (1) Fine motor precision: drawing line through crooked paths + folding paper; (2) Fine motor integration: copying a square + copying a star; (3) Manual dexterity: transferring pennies; (4) Bilateral coordination: jumping in place – same side synchronized + tapping feet and fingers – same side synchronized; (5) Balance: walking forward on a line + standing on one leg on a balance beam – eyes open; (6) Upper limb coordination: dropping and catching a ball with both hands + dribbling a ball with alternating hands; (7) Strength: knee push-ups + sit ups; (8) Speed and Agility: jumping on one leg (Bruininks & Bruininks, 2005). The total score for the BOT-2 Short Form was calculated by comparing the sum of the standard numerical scores on the different subtests to normative data of 1520 children living in the US in 2004–2005. To obtain a gross and fine motor composite scores, the sum of the standard numerical scores of their respective items were used. Table 1 shows the subdivision made by a two-factor analysis performed on the point scores for each item of the BOT-2 Short Form to acquire a gross and a fine motor factor.

2.3.2. KörperkoördinationsTest für Kinder (KTK)

The KTK consists of 4 subtests: (1) walking backwards along a balance beam, (2) moving sideways on boxes, (3) hopping for height on one foot and (4) jumping sideways (Kiphard & Schilling, 1974). From these four subtests, an age- and gender-specific motor quotient (MQ) was calculated based on normative data of 1128 normally developing German children (Kiphard & Schilling, 1974). The KTK and BOT-2 were administered during the same day and all children were given sufficient rest between different subtests.

2.4. Data analysis

All data were analyzed using SPSS 20 for windows. To assess convergent and discriminant validity between the BOT-2 and KTK, Pearson correlations were calculated between total BOT-2 Short Form score, BOT-2 Short Form gross motor composite scores (balance + upper limb coordination + strength + speed and agility), BOT-2 Short Form fine motor composite scores (fine motor precision + fine motor integration + manual dexterity) and KTK Motor Quotient and were used for the total age range (6–12 years) and for three age groups separately (6–7 years, 8–9 years, 10–11 years). Since this study means to portray the amount and percentage of children that were classified into categories based on percentile scores, the following groups were constructed for both testing batteries: lower than percentile 5 (P5) and percentile 15 (P15), or higher than percentile 85 (P85) and percentile 95 (P95). In order to determine the agreement in the classification for the amount of children classified in these categories for the BOT-2 Short Form and KTK Motor Quotient, cross-tabs between both tests were used and Pearson Chi-Square (Chi^2) and Cohen's Kappa (κ) values were calculated. According to Landis & Koch (1977) a Cohen's Kappa between .21 and .40 is considered fair, between .41 and .60 moderate, between .61 and .80 substantial and Cohen's Kappa bigger than .81 is considered an almost perfect agreement. Significance levels were set at .05.

3. Results

Means and standard deviations for all subtests of the BOT-2 Short Form and KTK, the BOT-2 Short Form total score and KTK Motor Quotient for boys and girls from 6 to 11 years can be found in Table 2.

Table 1
Subtests used in the gross motor and fine motor coordination composite scores for the Bruininks-Oseretsky Test of Motor Proficiency 2 Short Form (BOT-2 SF).

BOT-2 Short Form		KTK
Gross motor coordination composite score	Fine motor coordination composite score	
Walking forward on a line	Drawing lines through crooked paths	Walking backwards along a balance beam
Standing on one leg on a balance beam (eyes open)	Folding paper	Moving sideways on boxes
Dropping and catching a ball with both hands	Copying a square	Hopping for height on one foot
Dribbling a ball with alternating hands	Copying a star	Jumping sideways over a slat
Knee push ups		
Sit ups		
Jumping on one leg		
Tapping feet and fingers same side synchronized		
Transferring pennies		

Table 2
Means and standard deviations for KTK and BOT-2 Short Form subtests and total standardized scores.

Variable	6 years (*n* = 304)	7 years (*n* = 424)	8 years (*n* = 486)	9 years (*n* = 557)	10 years (*n* = 363)	11 years (*n* = 352)
KTK Motor Quotient						
Boys (*n* = 1300)	97.1 (11.7)	100.7 (14.4)	96.2 (15.2)	97.3 (14.0)	94.1 (13.7)	97.8 (17.4)
Girls (*n* = 1185)	92.3 (14.4)	95.8 (14.8)	98.1 (13.8)	91.6 (15.7)	89.2 (14.0)	96.5 (15.6)
Group (*n* = 2485)	94.4 (13.4)	98.4 (14.7)	97.2 (14.6)	94.5 (15.1)	92.1 (14.0)	97.2 (16.6)
Walking backwards						
Boys (*n* = 1300)	24.1 (12.0)	31.0 (13.2)	35.9 (13.2)	35.9 (14.2)	40.5 (13.3)	46.8 (14.1)
Girls (*n* = 1185)	27.2 (11.2)	34.8 (11.7)	39.4 (12.4)	43.6 (13.9)	46.0 (12.7)	50.8 (13.8)
Group (*n* = 2485)	25.8 (11.6)	32.7 (12.6)	37.6 (13.5)	42.1 (13.7)	44.3 (13.1)	48.5 (14.6)
Jumping sideways						
Boys (*n* = 1300)	35.0 (8.4)	44.1 (10.3)	49.7 (11.3)	57.2 (11.1)	61.3 (10.9)	67.5 (11.4)
Girls (*n* = 1185)	35.3 (9.5)	43.9 (11.1)	51.6 (10.3)	56.7 (11.5)	60.9 (11.1)	66.7 (10.1)
Group (*n* = 2485)	35.2 (9.0)	44.0 (10.7)	50.6 (10.9)	57.0 (11.3)	61.1 (11.0)	67.2 (10.9)
Moving sideways						
Boys (*n* = 1300)	28.6 (4.9)	33.8 (5.6)	36.4 (5.8)	39.7 (6.8)	41.7 (5.7)	44.2 (7.4)
Girls (*n* = 1185)	29.7 (5.5)	32.4 (5.4)	37.1 (5.4)	39.7 (6.5)	42.2 (5.8)	45.1 (6.9)
Group (*n* = 2485)	29.2 (5.3)	33.1 (5.5)	36.7 (5.6)	39.7 (6.7)	41.9 (5.7)	44.6 (7.2)
Hopping for height						
Boys (*n* = 1300)	32.2 (10.3)	41.8 (11.8)	49.2 (12.6)	57.5 (12.5)	62.2 (12.5)	65.8 (13.5)
Girls (*n* = 1185)	30.7 (11.5)	38.7 (12.0)	47.2 (12.2)	52.2 (13.3)	56.5 (11.9)	63.4 (11.6)
Group (*n* = 2485)	31.4 (11.0)	40.4 (12.0)	48.2 (12.4)	54.8 (13.2)	59.9 (12.5)	64.7 (12.7)
BOT-2 Short Form						
Boys (*n* = 1300)	52.8 (6.9)	54.2 (7.8)	51.6 (8.6)	52.4 (7.5)	51.7 (7.2)	54.4 (8.0)
Girls (*n* = 1185)	48.9 (7.7)	51.2 (8.7)	52.5 (8.5)	51.8 (8.3)	52.0 (7.1)	53.1 (7.4)
Group (*n* = 2485)	50.6 (7.6)	52.8 (8.4)	52.0 (8.6)	52.1 (7.9)	51.8 (7.2)	53.8 (7.8)
Drawing lines						
Boys (*n* = 1300)	2.0 (2.1)	1.5 (2.7)	1.0 (2.1)	0.5 (1.2)	0.3 (1.0)	0.2 (0.8)
Girls (*n* = 1185)	1.5 (2.4)	1.6 (4.0)	0.7 (1.6)	0.5 (1.0)	0.2 (0.6)	0.1 (0.5)
Group (*n* = 2485)	1.7 (2.3)	1.5 (3.3)	0.8 (1.9)	0.5 (1.1)	0.3 (0.9)	0.2 (0.7)
Folding paper						
Boys (*n* = 1300)	6.1 (3.9)	8.3 (3.4)	9.1 (3.3)	10.4 (2.6)	11.1 (1.9)	11.3 (1.7)
Girls (*n* = 1185)	8.2 (3.3)	9.4 (2.9)	10.6 (2.2)	11.1 (1.9)	11.6 (1.1)	11.7 (0.9)
Group (*n* = 2485)	7.3 (3.7)	8.8 (3.2)	9.9 (2.9)	10.7 (2.3)	11.3 (1.6)	11.5 (1.4)
Copying square						
Boys (*n* = 1300)	2.4 (0.8)	3.0 (0.9)	3.0 (0.9)	3.4 (0.9)	3.4 (0.8)	3.7 (0.8)
Girls (*n* = 1185)	2.7 (1.0)	3.2 (1.0)	3.2 (0.8)	3.4 (0.9)	3.5 (0.8)	3.5 (0.8)
Group (*n* = 2485)	2.6 (0.9)	3.1 (1.0)	3.1 (0.9)	3.4 (0.9)	3.4 (0.8)	3.6 (0.8)
Copying star						
Boys (*n* = 1300)	1.5 (1.2)	2.1 (1.1)	2.3 (1.1)	2.8 (1.2)	2.8 (1.0)	3.2 (0.9)
Girls (*n* = 1185)	1.7 (1.2)	2.3 (1.2)	2.6 (1.1)	2.9 (1.1)	2.9 (1.1)	3.1 (1.0)
Group (*n* = 2485)	1.6 (1.2)	2.2 (1.2)	2.4 (1.1)	2.8 (1.1)	2.9 (1.1)	3.2 (1.0)
Jumping in place						
Boys (*n* = 1300)	4.0 (1.5)	4.5 (1.2)	4.7 (1.0)	4.6 (1.0)	4.8 (0.8)	4.9 (0.4)
Girls (*n* = 1185)	4.5 (1.2)	4.7 (1.0)	4.8 (0.8)	4.8 (0.6)	4.9 (0.4)	5.0 (0.2)
Group (*n* = 2485)	4.3 (1.3)	4.6 (1.1)	4.7 (0.9)	4.7 (0.9)	4.9 (0.7)	5.0 (0.3)
Tapping feet and fingers						
Boys (*n* = 1300)	7.8 (3.2)	9.1 (2.2)	8.9 (2.4)	9.3 (1.8)	9.3 (1.9)	9.9 (0.7)
Girls (*n* = 1185)	8.6 (2.5)	9.1 (2.2)	9.4 (1.8)	9.6 (1.5)	9.7 (1.1)	9.8 (0.9)
Group (*n* = 2485)	8.3 (2.9)	9.1 (2.2)	9.1 (2.1)	9.4 (1.7)	9.5 (1.7)	9.9 (0.8)
Transferring pennies						
Boys (*n* = 1300)	9.3 (2.1)	10.7 (2.1)	11.6 (2.0)	12.4 (2.0)	12.9 (2.1)	14.3 (2.0)
Girls (*n* = 1185)	9.9 (2.1)	10.9 (2.0)	12.4 (2.1)	13.0 (2.1)	14.2 (2.0)	14.9 (2.3)
Group (*n* = 2485)	9.6 (2.1)	10.8 (2.1)	12.0 (2.1)	12.7 (2.1)	13.4 (2.2)	14.5 (2.2)
Walking on line						
Boys (*n* = 1300)	5.7 (0.8)	6.0 (0.2)	5.9 (0.4)	5.9 (0.4)	6.0 (0.3)	6.0 (0.2)
Girls (*n* = 1185)	5.9 (0.5)	6.0 (02)	6.0 (0.2)	6.0 (0.3)	6.0 (0.1)	6.0 (0.0)
Group (*n* = 2485)	5.8 (0.6)	6.0 (0.2)	6.0 (0.3)	6.0 (0.2)	6.0 (0.2)	6.0 (0.3)
Standing on one leg						
Boys (*n* = 1300)	6.3 (3.3)	7.6 (3.2)	8.1 (2.9)	8.8 (2.4)	9.0 (2.2)	9.4 (1.7)
Girls (*n* = 1185)	7.1 (3.3)	8.5 (2.8)	9.0 (2.3)	9.1 (3.3)	9.4 (1.8)	9.5 (1.6)
Group (*n* = 2485)	6.7 (3.4)	8.0 (3.0)	8.5 (2.7)	8.9 (2.3)	9.3 (2.1)	9.4 (1.7)

Table 2 (*Continued*)

Variable	6 years (n = 304)	7 years (n = 424)	8 years (n = 486)	9 years (n = 557)	10 years (n = 363)	11 years (n = 352)
Catching ball						
Boys (n = 1300)	4.0 (1.5)	4.5 (1.0)	4.5 (0.9)	4.8 (0.7)	4.8 (0.7)	4.9 (0.5)
Girls (n = 1185)	3.5 (1.7)	4.2 (1.3)	4.3 (1.1)	4.7 (0.8)	4.8 (0.6)	4.7 (0.8)
Group (n = 2485)	3.8 (1.7)	4.4 (1.1)	4.4 (1.0)	4.7 (0.8)	4.8 (0.6)	4.8 (0.7)
Dribbling ball						
Boys (n = 1300)	4.7 (2.7)	6.9 (2.9)	7.8 (2.8)	8.8 (2.1)	9.0 (1.9)	9.4 (1.5)
Girls (n = 1185)	3.5 (2.2)	5.2 (2.8)	6.5 (2.9)	7.6 (2.8)	8.4 (2.4)	8.7 (2.2)
Group (n = 2485)	4.0 (2.5)	6.1 (3.0)	7.2 (2.9)	8.2 (2.5)	8.8 (2.1)	9.1 (1.9)
Knee push ups						
Boys (n = 1300)	19.0 (5.2)	20.9 (5.9)	23.4 (6.3)	24.3 (6.0)	27.5 (6.0)	28.4 (7.5)
Girls (n = 1185)	17.0 (6.0)	18.8 (5.7)	21.4 (5.7)	21.7 (6.0)	23.3 (7.0)	24.2 (8.2)
Group (n = 2485)	17.9 (5.7)	19.9 (5.9)	22.4 (6.1)	23.0 (6.2)	25.8 (6.8)	26.6 (7.3)
Sit-ups						
Boys (n = 1300)	11.4 (6.9)	16.2 (7.8)	18.6 (7.4)	20.9 (6.4)	22.6 (6.5)	25.6 (6.5)
Girls (n = 1185)	12.4 (6.9)	16.2 (6.5)	20.1 (6.9)	20.7 (6.3)	22.3 (7.3)	24.2 (5.9)
Group (n = 2485)	12.0 (7.0)	16.2 (7.2)	19.3 (7.2)	20.8 (6.4)	22.5 (6.8)	24.9 (6.3)
One leg hop						
Boys (n = 1300)	39.4 (6.9)	41.0 (7.6)	43.5 (6.7)	45.1 (7.0)	46.9 (6.1)	46.9 (5.8)
Girls (n = 1185)	37.0 (7.6)	40.2 (6.9)	43.1 (7.1)	44.1 (7.1)	45.4 (5.9)	46.3 (6.5)
Group (n = 2485)	38.0 (7.4)	40.6 (7.3)	43.3 (6.9)	44.6 (7.0)	46.3 (6.1)	46.6 (6.1)

Correlation coefficients and confidence intervals for KTK and the BOT-2 Short Form total score, gross motor coordination composite score and the fine motor coordination composite score and KTK Motor for the total sample and the sample split by age group (6–7, 8–9, 10–11 years) are presented in Table 3. For the total sample, the strongest correlations between BOT-2 Short Form and KTK were found between total BOT-2 Short Form score ($r = 0.61$, $p < 0.001$) and KTK Motor Quotient and BOT-2 Short Form gross motor composite score ($r = 0.44$, $p < 0.001$) and KTK Motor Quotient. A weaker but significant correlation ($r = 0.25$, $p < 0.001$) emerged between BOT-2 Short Form fine motor composite score and KTK Motor Quotient. When analyzing each age cohort separately, significant correlations ($0.60 \geq r \leq 0.64$, $p < 0.001$) between BOT-2 Short Form total and gross motor composite scores and KTK were also found for each age group separately. For the correlations between BOT-2 Short form fine motor composite scores and KTK Motor Quotient, significant correlation coefficients of $0.30 \geq r \leq 0.37$ ($p < 0.001$) were found for each age group.

Crosstabs showed fair associations and moderate levels of agreement between BOT-2 Short Form and KTK at the P5 ($Chi^2 = 237.5$; $\kappa = .31$, $p < 0.001$), P15 ($Chi^2 = 412.6$; $\kappa = .42$, $p < 0.001$), P85 ($Chi^2 = 265.7$; $\kappa = 0.33$, $p < 0.001$) and P95 ($Chi^2 = 222.4$; $\kappa = 0.30$, $p < 0.001$). The total number of participants classified in each percentile category by both tests and the percentage boys and girls classified in each group per age group can be found in Tables 4 and 5. Thirty-two percent of children classified in the ≤P5 category by the BOT-2 Short Form, were also classified in ≤P5 using the KTK. Thirty-eight percent of children with KTK scores below the fifth percentile were also classified as such by the BOT-2 Short Form. Fifty percent of children classified in the ≤P15 category by the BOT-2 Short Form, were also classified ≤P15 in using the KTK and vice versa. Forty-one percent of children classified in the ≥P85 category by the BOT-2 Short Form, were classified ≥P85 in using the KTK. Forty-eight percent of children with KTK Motor Quotients ≥P85 were also categorized ≥85 by the BOT-2 Short Form. Thirty-three percent of children classified in the P95 category by the BOT-2 Short Form, were classified as scoring ≥P95 by the KTK. Thirty-six percent of children scoring ≥P95 on the KTK were also classified as such by the BOT-2 Short Form. The percentage of total children for whom there was an agreement in classification between the BOT-2 Short Form and KTK was 2.1%, 7.8%, 8.1% and 4.2% for the ≤P5, ≤P15, ≥P85 and ≥P95 categories.

4. Discussion

The present study aimed to assess convergent and discriminant validity between the BOT-2 Short Form and KTK in 2485 children aged 6–12 years. Moderately strong positive associations between BOT-2 total and gross motor composite scores and KTK Motor Quotient and weak positive correlations between BOT-2 Short Form fine motor composite scores and KTK Motor Quotient were found. Furthermore, levels of agreement between both movement assessment batteries in terms of classification were fair to moderate for P5, P15, P85 and P95.

The moderately strong associations between total scores for the BOT-2 Short Form and KTK show that both tests mainly measure the same construct, being general motor competence. The strength of the correlation between the BOT-2 Short Form and KTK is in accordance with previous research by Smits-Engelsman and colleagues (Smits-Engelsman, Henderson & Michels, 1998) who found a correlation coefficient of .62 between the Movement Assessment Battery for Children (M-ABC; Henderson & Sugden, 1992) and KTK. However, Van Waelvelde and coworkers (Van Waelvelde, Peersman, Lenoir & Smits-Engelsman, 2007) mentioned that test scores can only be interpreted in relation to the specific tasks used in the assessment

Table 3
Pearson correlation coefficients (*r*) and 95% confidence intervals (lower limit–upper limit) between Bruininks-Oseretsky Test of Motor Proficiency 2 Short Form (BOT-2 Short Form) standard score, gross and fine motor composite scores and KörperKoördinationsTest für Kinder (KTK) motor quotient in 6–7, 8–9 and 10–11 year old boys and girls.

	BOT-2 Short Form								
	Boys (*n* = 1300)			Girls (*n* = 1185)			Girls (*n* = 1185)		
	Fine motor coordination	Gross motor coordination	Total score	Fine motor coordination	Gross motor coordination	Total score	Fine motor coordination	Gross motor coordination	Total score
Total sample (N = 2485)									
Motor Quotient (points)	.27 (.22–.33)	.43 (.38–.46)	.62 (.58–.65)	.26 (.21–.32)	.45 (.40–.49)	.61 (.57–.64)	.25 (.22–.29)	.44 (.41–.47)	.61 (.58–.63)
6–7 years (N = 728)									
Motor Quotient (points)	.37 (.29–.45)	.61 (.56–.67)	.57 (.50–.64)	.32 (.22–.41)	.60 (.53–.66)	.58 (.51–.65)	.30 (.24–.37)	.62 (.57–.66)	.60 (.55–.64)
8–9 years (N = 1042)									
Motor Quotient (points)	.43 (.36–.51)	.60 (.54–.66)	.64 (.58–69)	.34 (.25–.42)	.58 (.52–.63)	.65 (.59–70)	.37 (.31–.42)	.61 (.57–.65)	.63 (.58–67)
10–11 years (N = 715)									
Motor Quotient (points)	.34 (.24–.41)	.64 (.58–.70)	.63 (.57–.68)	.30 (.17–.42)	.65 (.58–.72)	.60 (.51–.67)	.31 (.23–.38)	.61 (.60–.69)	.64 (.56–.66)

Note: Gross Motor Composite score BOT-2 Short Form = Balance + Upper Limb Coordination + Strength + Speed and Agility + manual dexterity; Fine Motor Composite score BOT-2 Short Form = Fine Motor Precision + Fine Motor Integration.

Table 4
Crosstabs showing the number of participants and the percentage of the total population scoring above or below P5, P15, P85 and P95 on the Bruininks-Oseretsky Test of Motor Proficiency 2 Short Form (BOT-2 SF) and KörperKoordinationsTest für Kinder (KTK).

		KTK					
		≤P5	% of total cases	>P5	% of total cases	Total	% of total cases
BOT-2 SF	≤P5	53	2.1	111	4.5	164	6.6
	>P5	86	3.5	2235	89.9	2321	93.4
	Total	139	5.6	2346	94.4	2485	100
		≤P15	% of total cases	>P15	% of total cases	Total	% of total cases
BOT-2 SF	≤P15	194	7.8	192	7.7	386	15.5
	>P15	196	7.9	1903	76.6	2099	84.5
	Total	390	15.7	2095	84.3	2485	100
		<P85	% of total cases	≥P85	% of total cases	Total	% of total cases
BOT-2 SF	<P85	1819	73.2	202	8.1	2221	81.3
	≥P85	276	11.1	188	7.6	264	18.7
	Total	2095	74.3	390	25.7	2485	100
		≤P95	% of total	≥P95	% of total	Total	% of total cases
BOT-2 SF	<P95	2243	90.2	90	3.6	2333	93.8
	≥P95	104	4.2	50	2.0	154	6.2
	Total	2347	94.4	140	5.6	2485	100

Note: Gross Motor Composite score BOT-2 SF = Balance + Upper Limb Coordination + Strength + Speed and Agility + Manual Dexterity; Fine Motor Composite score BOT-2 SF = Fine Motor Precision + Fine Motor Integration; Chi^2 P5 = 237.5; $\kappa = .31$, $p < 0.001$, Chi^2 P15 = 412.6; $\kappa = .42$, $p < 0.001$, Chi^2 P85 = 265.7; $\kappa = 0.33$, $p < 0.001$, Chi^2 P95 = 222.4; $\kappa = 0.30$, $p < 0.001$.

since a correlation of this magnitude between variables does not allow for a complete (100%) explained variance, and thus the variance in one variable is partly explained by other variables. Additionally, Vandorpe, Vandendriessche, Lefevre, et al. (2011) hypothesized that the difference in physical fitness between boys and girls might explain gender differences in KTK Motor Quotient scores highlighted by their results. Hence, the fact that not only motor competence, but also physical fitness was measured to a different degree in both tests, might in part explain the occurrence of moderately strong rather than strong correlations between BOT-2 Short Form and KTK.

Proof of convergent and discriminant validity between these two testing batteries is provided to some extent through the moderately strong significant association between BOT-2 Short Form and KTK gross motor composite scores and the weak significant relationship between BOT-2 Short Form fine motor composite score and KTK. These findings are in accordance with studies by Van Waelvelde and colleagues (2007) on the relationship between M-ABC (Henderson & Sugden, 1992) and Peabody Developmental Motor Scales (Folio & Fewell, 1974) and Cools et al. (2010) on the relationship between Motoriktest für Vier- bis Sechsjärige Kinder (MOT 4–6; Zimmer & Volkamer, 1984) and the M-ABC (Henderson & Sugden, 1992), where higher correlation coefficients were found between gross or fine motor composite scores of each battery, than between gross motor composite scores of one and fine motor composite scores of the other.

In the current study, convergent and discriminant validity was assessed in three age cohorts (6–7 years, 8–9 years, 10–11 years) and per gender separately. Moderate to strong significant correlations between total and gross motor composite scores for the BOT-2 Short Form and KTK Motor Quotient were found in all age cohorts and there seemed to be no differences between boys and girls. Hence, in each age group separately, convergent validity was better and discriminant validity was worse than in the total sample. These results might demonstrate that when using the BOT-2 Short Form and KTK, the use of age cohorts is advised.

The levels of agreement between both movement assessment batteries in terms of classification were fair to moderate for P5, P15, P85 and P95 and did not seem to be different for boys and girls. However, for P5, P85 and P95 the level of agreement was lower ($\kappa = 0.31$, $\kappa = 0.33$, $\kappa = 0.30$, respectively), than for P15 ($\kappa = 0.42$). This means that agreement of classification (and convergent validity) for both testing batteries is moderate when KTK and BOT-2 Short Form are used to discriminate children with a relatively poor motor competence from those with average to good motor competence but only fair when trying to classify children with relatively high or very poor motor competence. Indeed, the results of this study showed that (only) 50% of the children that were categorized below the 15th percentile by the KTK were likewise categorized by the BOT-2 Short form and vice versa. Since both testing batteries were designed with the aim of identifying children with mild to severe motor problems (Bruininks & Bruininks, 2005; Deitz et al., 2007; Kiphard & Schilling, 1974), these findings are not surprising. However, because of the only fair to moderate agreement between both testing batteries, practitioners and researchers should keep in mind the potential wrongful categorization of individuals when using either the BOT-2 Short Form or the KTK to assess motor competence alone. Therefore, it is advised to use at least two testing batteries when assessing motor competence.

The main strength of this study is firstly its large sample size. Comparable studies (Cools et al., 2010; Smits-Engelsman et al., 1998; Van Waelvelde, Peersman, Lenoir, & Smits-Engelsman, 2007) had a sample size of 31, 48 and 208 participants respectively, while the present study has a sample size of 2485 children, representative for the Flemish elementary school

Table 5
Crosstabs showing the number of participants and the percentage of boys and girls separately scoring above and below P5, P15, P85 and P95 on the Bruininks-Oseretsky Test of Motor Proficiency 2 Short Form (BOT-2 SF) and KörperKoordinationsTest für Kinder (KTK).

		BOT-2 Short Form											
		Boys (n = 1300)						Girls (n = 1185)					
		≤P5	% of total cases	>P5	% of total cases	Total	% of total cases	≤P5	% of total cases	>P5	% of total cases	Total	% of total cases
6–7 years	≤P5	3	0.8	7	1.9	10	2.7	8	2.2	17	4.7	25	6.9
	>P5	7	1.9	347	95.3	354	97.3	16	4.4	323	88.7	339	93.1
	Total	10	2.7	354	97.3	364	100.0	24	6.6	340	93.4	364	100.0
8–9 years	≤P5	15	2.9	11	2.1	26	4.9	12	2.3	18	3.5	30	5.8
	>P5	17	3.2	483	91.8	500	95.1	20	3.9	466	90.3	486	94.2
	Total	32	6.1	494	93.9	526	100.0	32	6.2	484	93.8	516	100.0
10–11 years	≤P5	10	2.4	11	2.7	21	5.1	5	1.7	12	4.0	17	5.6
	>P5	20	4.9	370	90.0	390	94.5	10	3.3	276	91.1	286	94.4
	Total	30	7.3	381	92.7	411	100.0	15	5.0	288	95.0	303	100.0
6–7 years	≤P15			>P15		Total		≤P15		>P15		Total	
	≤P15	20	5.5	25	6.9	45	12.4	31	8.5	32	8.8	63	17.3
	>P15	25	6.9	294	80.8	319	87.6	41	11.3	260	71.4	301	82.7
	Total	45	12.4	319	87.6	364	100.0	72	19.8	292	80.2	364	100.0
8–9 years	≤P15	50	9.5	39	7.4	89	16.9	44	8.5	50	9.7	94	18.2
	>P15	43	8.2	394	74.9	437	83.1	35	6.8	387	75.0	422	81.8
	Total	93	17.7	433	82.3	526	100.0	79	15.3	437	84.7	516	100.0
10–11 years	≤P15	28	6.8	24	5.8	52	12.7	26	8.6	28	9.2	54	17.8
	>P15	42	10.2	317	77.1	359	87.3	22	7.3	227	89.0	249	82.2
	Total	70	17.0	341	83.0	411	100.0	48	15.8	255	84.2	303	100.0
6–7 years	<P85			≥P85		Total		<P85		≥P85		Total	
	<P85	249	68.4	59	16.2	308	84.6	271	74.5	34	9.3	305	83.8
	≥P85	28	7.7	28	7.7	56	15.4	37	10.2	22	6.0	59	16.2
	Total	277	76.1	87	23.9	324	100.0	308	84.6	56	15.4	364	100.0
8–9 years	<P85	397	75.5	44	8.4	441	83.8	385	74.6	49	9.5	434	84.1
	≥P85	49	9.3	36	6.8	85	16.2	37	7.2	45	8.7	82	15.9
	Total	446	84.4	80	15.2	526	100.0	422	81.8	94	18.2	516	100.0
10–11 years	<P85	289	70.3	44	10.7	333	81.0	206	68.0	45	14.9	251	82.8
	≥P85	40	9.7	38	9.2	78	19.0	21	6.9	31	10.2	52	17.2
	Total	329	80	82	20	411	100.0	227	74.9	76	25.1	303	100.0
6–7 years	≤P95			≥P95		Total		≤P95		≥P95		Total	
	<P95	327	89.8	17	4.7	344	94.5	334	91.8	13	3.6	347	95.3
	≥P95	12	3.3	8	2.2	20	5.5	12	3.3	5	1.4	17	4.7
	Total	339	93.1	25	6.9	364	100.0	346	95.1	18	4.9	364	100.0
8–9 years	<P95	480	91.3	22	4.2	502	95.4	474	91.9	18	3.5	492	95.3
	≥P95	14	2.7	10	1.9	24	4.6	15	2.9	9	1.7	24	4.7
	Total	494	93.9	32	6.1	526	100.0	489	94.8	27	5.2	516	100.0
10–11 years	<P95	367	89.3	19	4.6	386	93.9	269	88.8	17	5.6	286	94.4
	≥P95	18	4.4	7	1.7	25	6.1	13	4.6	4	1.3	17	5.6
	Total	385	93.7	26	6.3	411	100.0	282	93.1	21	6.9	303	100.0

Note: Gross Motor Composite score BOT-2 SF = Balance + Upper Limb Coordination + Strength + Speed and Agility + Manual Dexterity; Fine Motor Composite score BOT-2 SF = Fine Motor Precision + Fine Motor Integration.

population. A second strength of this study is assessing children in a six-year age band (6–12 years). In this age cohort, the development of motor competence contributes highly to the successful engagement in everyday physical activity and organized sports (Barnett, 2008). Therefore, using reliable and valid motor competence assessment tools in this particular age group is paramount toward the early detection of poor (or outstanding) motor competence. To do so, normative values as represented in Table 2 are paramount. A limitation to the study is the use of point scores for the gross and fine motor constructs of the BOT-2 Short Form because the absence of standardized values for the BOT-2 Short Form gross and fine motor composite scores.

5. Conclusion

In conclusion, the aim of this study was to establish convergent and discriminant validity between BOT-2 Short Form and KTK. Moderately high correlations between the total and gross motor composite score of the BOT-2 and KTK Motor Quotient, weak correlations between BOT-2 Short Form fine motor composite score and KTK Motor Quotient and fair to moderate levels of agreement in the classification of children in motor competence groups based on percentile scores on both tests show reasonable proof of convergent and discriminant validity. However, because of the relatively low agreement, especially in children with relatively high and relatively low motor competence, there is a need the use of at least two motor competence assessment instruments when assessing children in the lower (or higher) spectrum of motor competence.

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