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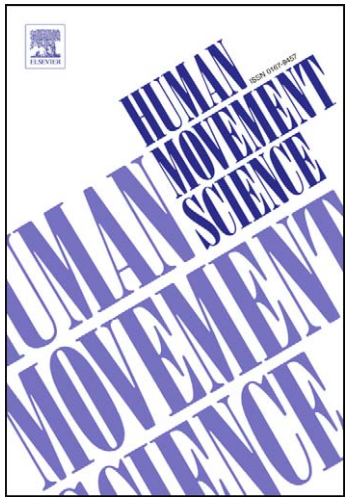

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Summary

The aim of this study was to examine the validity of the Bruininks-Oseretsky Test of Motor Proficiency – Short Form (BOTMP-SF) (Bruininks, 1978) for the assessment of preschool aged children. Three hundred and eighteen children 48-71 months old (M = 58.97 months, SD = 6.73) participated in the study. For the data analysis both an ANOVA and a MANOVA were applied with the total battery score and the 14 item scores being the dependent variables, respectively. Age was found to have a significant effect on both children's total battery score ($F(3, 314) = 110.65$, $p < .001$, $\eta^2 = .68$) and 13 item scores (minimum $F(3, 314) = 8.75$, $p < .001$, minimum $\eta^2 = .145$). Although the aforementioned results represent an evidence for the validity of the BOTMP-SF, a closer study on the score of each item revealed a high percentage of zero scores on four items. Task difficulty has caused a floor effect, constituting a threat to the validity of the preschoolers' motor assessment with the above battery. A modification of the battery items is suggested, so that the BOTMP-SF will give valid results for children 4-6 years old.

Key words: *preschool age, motor assessment, BOTMP-SF, validity.*

1. Introduction

Motor assessment of preschool – aged children is thought to be both necessary and valuable (Payne & Isaacs, 1998; Zimmer, 2004) for three major reasons. To begin with, during infancy and preschool age, movement is an integral part of children's life. In that period, children use movement in order to discover themselves and the world (Zimmer, 2004). Consequently, the study of a child's motor development is a prerequisite for the full understanding of his or her whole development (Payne & Isaacs, 1998). Moreover, planning, implementation, and evaluation of developmentally adequate movement programs depend on proper and sound diagnosis of the child's level of motor development (Zimmer & Circus, 1993). Finally, the identification of children that may have developmental delays is the first step to impede later difficulties. An intervention in preschool years is both cheaper and more effective than a therapy in older age, narrowing (and in some cases minimizing) problems that associate with developmental delays (Berk & DeGangri, 1979; McIntosh, Gibney, Quinn, & Kundert, 2000).

Many instruments are available for children's motor assessment. The Bruininks - Oseretsky Test of Motor Proficiency (BOTMP) (Bruninks, 1978) is one of the most popular batteries for children between 4½ and 14½ years old (Burton & Miller, 1998; Miles, Nierengarten, & Nearing, 1988). The complete form of the battery (BOTMP-LF) consists of 46 items that are grouped into 8 subtests, and according to Bruininks (1978), "provides a comprehensive index of motor proficiency as well as separate measures of both gross and fine

motor skills" (p. 11). Nevertheless, when the examinee is very young the battery should be administered in two sessions of about 20 to 30 minutes each. In addition to the long form there is a short form of the battery (BOTMP-SF) that consists of 14 items (selected from the BOTMP-LF) and provides a brief survey of the motor proficiency.

The use of the SF is recommended for the occasions in which a brief, screening picture of motor proficiency is required (Bruininks, 1978; Payne & Isaaks, 1998), and it has been widely used in typical school environments (Hay & Missiuna, 1998; Plimpton & Regimbal, 1992; Reeves, Broeder, Kennedy-Honeycutt, & East, 1999), with mentally retarded children (Broadhead & Church, 1984), with mildly handicapped children (Roswal & Frith, 1983), and with deaf children (Brunt & Broadhead, 1983). Furthermore, Hattie and Edwards (1987) recommend the SF for the motor assessment of children with attention deficit problems. According to the relevant research findings, the SF is valid enough to differentiate various age groups and it provides satisfactory information about the motor proficiency of children (Beitel & Mead, 1980; 1982; Broadhead & Bruininks, 1982; Hassan, 2001; Kambas & Aggeloussis, 2006).

Nevertheless, only a few researchers have examined the suitability of BOTMP-SF for preschool aged children exclusively and their findings do not provide sufficient evidence for the technical adequacy of the battery for that particular age. Specifically, Moore, Reeve, and Boan (1981) investigated the reliability of the BOTMP-SF with 32 5-year-old children and concluded that

many of the 14 items of the BOTMP-SF lack reliability. Venetsanou, Kambas, Aggeloussis, Serbezis, and Taxildaris (2007) also compared the consistency of the SF and LF of the BOTMP in identifying 5-year-old children with motor impairment, using the scores of 144 children. According to their results the BOTMP-SF does not appear to be a valid test of the aforementioned purpose of motor assessment, as it displays low sensitivity and negative predictive value in identifying motor impairment, compared to the BOTMP-LF. The only study that gives support to the suitability of BOTMP-SF for preschoolers is that of Beitel and Mead (1980, 1982), in which the BOTMP-SF was administered to children aged 3-5 years and it was found viable for that age. However, those findings can hardly be generalized, because of the very small sample (n = 24).

Taking into consideration the importance of preschool age for the human motor development (Gallahue & Ozmun, 1998), a focus on the validity of the BOTMP-SF for that particular age is worthwhile. The aim of the present research was the preliminary study of the validity of the BOTMP-SF for the assessment of children 4-6 years old, examining the effect of age on the children's BOTMP- SF scores.

2. Methods

2.1. Participants

Three hundred and eighteen children (158 boys and 160 girls) 4-6 years old (M = 59.09 months, SD = 6.64) without an identified neurological, sensory, or

motor problem, attending kindergartens in Greece, participated in the study. The children were divided in four age-groups [48-54 months (n = 70), 54-59 months (n = 88), 60-65 months (n = 84) and 66-71 months (n = 76)]. Although, the BOTMP is designed for the assessment of children 4½ - 14½ years old, according to Beitel and Mead's findings (1980, 1982), BOTMP-SF is a viable measure of motor proficiency in children 3 to 5 years of age. Taking into consideration both the aforementioned findings and the fact that kindergarten students in most European countries are younger than 4½ years, children aged 48-53 months were included in the sample of the present study.

The method of stratified sampling was used to select the participants of the study from a number of randomly selected public schools, using sex and nationality as the stratification variables. All the participants were required to bring a consent form written and signed from their parents prior to their participation in the study. The study was approved by the Ethics Committee of the Department of Physical Education and Sport Science, Democritus University of Thrace, Greece. Twelve children of the initial sample (n = 330) were not allowed by their parents to be tested, leading to a 96.4% response rate.

2.2. Measures

The BOTMP-SF (Bruininks, 1978) was used for the motor assessment of children. The battery consists of the following 14 items, drawn from the eight subtests of the BOTMP-LF: *Running speed and agility, Standing on preferred leg*

on balance beam, Walking forward heel-to-toe on balance beam, Tapping feet alternately while making circles, Jumping up and clapping hands, Standing broad jump, Catching a tossed ball with both hands, Throwing a ball to a target, Response speed, Drawing a line through a straight path, Copying a circle, Copying overlapping pencils, Sorting cards and *Making dots.* The administration of the battery takes approximately 15-20 minutes.

A child's performance on the BOTMP – SF can be scored in several ways. Raw scores, such as the number of seconds taken to complete a task, the number of dots made, etc. are noted. These raw scores are then converted into a numerical point score that compile the total battery composite. Normative data on children from 4½ to 14½ yeas of age is provided in the manual and composite scores can be expressed in the form of percentile rank, *z*-score, *T*-score, stanine, and age-equivalent. For the purposes of this study, both the total point battery score and the raw scores of the 14 items were used.

As far as the suitability of the BOTMP- SF for the preschool aged children is regarded, Beitel and Mead's study supports (1980, 1982) its validity. However, Moore et al. (1986) found that many of the 14 items of the BOTMP-SF lack reliability, while Venetsanou et al. (2007) raise concerns about the validity of the above battery to identify motor impairment in 5-year-old children.

2.3. Procedure

The children were individually assessed in an indoor facility, according to the test guidelines (Bruininks, 1978). The duration for the administration of

the test was 15-20 minutes per child. The examiner was a doctoral student experienced with BOTMP administration and familiar with motor assessment in general. Intra-rater reliability had been examined before the study. Videotapes were made of 35 children, aged 54-60 months, while they were tested. With an interval of one month, these videotapes were scored again by the same examiner. Intraclass correlation coefficient (3.1) were used for statistical analysis and found to be excellent (r = .91).

In order to facilitate the administration of the test, the translated datasheets and guidelines from Kambas and Aggeloussis's study (2006) were used. The translation had been from English to Greek and the precision and the reliability of the translation had been tested by three examiners.

2.4. Statistical analyses

First, an ANOVA was employed to test the effect of age on the total battery score. As the BOTMP manual does not provide norms for children aged 48-53 months, the total point score of the participants was used for the analysis. Then a MANOVA, with the raw scores of the 14 BOTMP-SF items being the dependent variables, was applied. Post hoc comparisons were made using the Bonferroni test, with alpha set at .05.

In addition to p values, effect sizes as measured by Eta Squared (η^2) values were also used for data interpretation. According to Cohen (1988), only η^2 of $\geq$ .14 are considered sufficiently large to be of any consequence.

3. Results

The results of the ANOVA showed that age had a significant effect on the total battery scores ($F(3, 314) = 110.65$, $p < .001$, $\eta^2 = .68$). According to the results of the Bonferroni test, the mean total short form score of the group aged 66-71 months was significantly greater than the total scores of all the younger groups. Moreover, the group of 60-65 months had a significantly higher mean total short form score than the groups of 48-53 and 54-59 months. Conversely, the performance of the 54-59 months group was not significantly different to the performance of the 48-53 months group, even though it was higher (Table 1).

Table 1, approximately here

The MANOVA also revealed a significant effect of age (Wilks' Lambda = .097, $p < .001$, $\eta^2 = .54$). When the 14 item scores were examined individually, age had a significant effect on 13 items (minimum $F(3, 314) = 8.75$, $p < .001$, minimum $\eta^2 = .145$ for the item *Throwing a ball to a target*). The only item in which age groups did not have significantly different scores was *Tapping feet alternately while making circles* ($F(3, 314) = 2.18$, $p = .092$).

Table 2, approximately here

The rate of differences between age groups was not consistent for all items as indicated by the group means. Namely, on some items younger age groups did better than older ones [e.g.. on *Sorting cards*, 60-65 months group had a higher mean than the 66-71 months group (mean = 17.87 and mean = 17.84 respectively)]. Nevertheless, according to Bonferroni's results, in those cases the differences between the groups were not statistically significant (Table 2).

However, a detailed examination of the participants' scores revealed marked floor effects on four test items (Table 3).

Table 3, approximately here

The most difficult item was found to be *Tapping feet alternately while making circles*. Only four children of the 66-71 months group managed to have a "pass" score on that item, while the children of the other three age groups had a 100% shortfall. A high percentage of total failure was also revealed on *Copying overlapping pencils*. Ninety four percent of the 48-53 months age group could not copy those particular shapes, while older children had a slightly better performance (89% failure for 54-59 months group, 83% and 60% for 60-65 months and 66-71 months, respectively). *Catching a tossed ball with both hands* was difficult for the two younger groups too. Ninety four percent of the 48-53 months group and 50% of the 54-59 months group did not manage to catch the ball even once. Finally, 89% of 48-53 months group, 75% of the 54-59 months group and 60% of the 60-65 months group, failed to walk forward heel-to-toe on balance beam.

4. Discussion

In this study, the validity of BOTMP-SF for the motor assessment of children 4-6 years old was investigated. Even though the battery is designed for children older than 53 months, preschoolers aged 48-53 months were included in the sample, in order to examine the applicability of Beitel and Mead's (1980, 1982) findings, according to which, BOTMP–SF is a viable measure for children aged 3-5 years old.

The ANOVA that was applied to the total battery score showed a significant effect of age on children's total score with $\eta^2 = .68$ meeting Cohen's (1988) criteria for acceptability. Additionally, the MANOVA, in which the 14 item scores were used as depended variables, showed a significant effect of age on children's performance too. In most cases, the effect size exceeded .14 qualifying for Cohen's (1988) acceptability criteria. The only exception was the item *Tapping feet alternately while making circles* in which no significant differences among age groups were registered. The aforementioned results indicated positive and statistically significant differences across age groups. That finding is consistent among researches that regard either preschool aged children (Atwater & Wilmore, 1982; Beitel & Mead, 1980, 1982; Lam, Ip, Lui, & Koong, 2003; Morris Williams, Oja & Jurimäe, 1997; Toriola & Igbokwe, 1986) or a wider age range (Broadhead & Bruininks, 1982; Hassan, 2001; Kambas &

Aggeloussis, 2006) and suggests that the BOTMP-SF is valid enough to differentiate the age groups of 4 to 6 years.

However, examining the descriptive statistics of the 14 test items, it was noted that performance of four items was very close to the floor, especially for the 48-53 and 54-59 months age groups. Regarding the youngest age group, almost all children had a zero score on *Walking forward heel-to-toe on balance beam*, *Tapping feet alternately while making circles*, *Catching a tossed ball with both hands,* and *Copying overlapping pencils*. That finding is in contrast with the conclusion of Beitel and Mead (1980, 1982) that BOTMP-SF is a viable measure for children aged 3 to 5 years. As four of the fourteen test items of the BOTMP-SF do not provide any information about the performance of 48-53 months age group, concerns arise about the validity of that battery for the assessment of that particular group. In Beitel and Mead's study only the total SF- and the subtests LF- scores were examined. Consequently, in that study the floor effects may have been overshadowed by the total point score that was used.

In the present study, children aged 54-71 months had a high percentage of zero scores too. *Tapping feet alternately while making circles* was found to be the most difficult task with a failure rate exceeding 95%, followed by C*opying overlapping pencils* (75% -65% failure). On *Walking forward heel-to-toe on balance beam* item also, many children aged 54-65 months were not able to achieve any correct step and half of the 54-59 months children did not manage to catch the tossed tennis ball. Examining the descriptive statistics of previous

studies in which five and six year old children performed the BOTMP-SF (Broadhead & Bruininks, 1982; Kambas & Aggeloussis, 2006; Moore, Reeve, & Boan, 1986), low mean values of those age groups on the four aforementioned items were registered. It is possible that those low mean values represent a high percentage of children with zero scores. As has already been noted, one issue to be considered in this context is the failure of these tasks to give valid information about the motor performance of preschool aged children.

The BOTMP-SF in its current form may meet the need for the motor assessment of a wide age range. However, those items that are the same for the broad range from 4½ to 14½ years do not seem to give valid information for younger children. *Copying overlapping pencils*, for example, is undoubtedly easy for a 14 year old child, but a difficult task for a 5 year old child.

Therefore, it is suggested that the authors of the BOTMP-SF should create an alternative form of the instrument, with several adjustments to the test items, in order to improve its validity for the assessment of preschool aged children. The use of a bean bag instead of the tennis ball, for example, may improve younger children's scores on *Catching a tossed ball* item and *Walking on a balance beam* could be replaced by *Walking along a line*.

Another important issue to be discussed is the BOTMP-SF's ecological validity. According to Bailey and Wolery (1989), the unique characteristics of the preschool child indicate that a motor assessment should be ecologically valid. The instrument should be sensitive to the child's testing environment and level of comfort. Ecological validity is maximized by using familiar

materials and collecting data in familiar environments. Attending to these key features ensures that more accurate information regarding functional skill level is collected (Bricker, 1989). The measurements in the present study were conducted in municipal gymnasiums, because a 16.4 meter straight line is required for the administration of the battery. Most of the kindergartens, not only in Greece but in many European countries as well, are located in the ground floors of apartment buildings and do not have adequate space either inside or outside, rendering measurement at the schools impossible. Taking into consideration that the absence of space required for the BOTMP-SF's administration is common for kindergartens, it is concluded that, in many countries, it is particularly difficult to apply the battery at kindergartens.

In conclusion, BOTMP–SF does not seem to be valid enough to test the motor proficiency in 4-6 years old children. In spite of the significant effect of age on both the total battery score and on 13 of the 14 test items, a fact that represents an evidence for the validity of a developmental assessment tool, a closer study on the score of each item gave a different picture, revealing that on four items children had a zero score. Item difficulty has caused a floor effect, constituting a threat for the validity of the preschoolers' motor assessment with the above battery. Moreover, a threat for the ecological validity of the battery arises as the measurement cannot take place in the familiarity of the school environment, due to the absence of sufficient measurement conditions in most kindergartens.

When adding to the present results the findings of our previous study according to which BOTMP-SF does not appear to constitute a valid test for the identification of MI in 5-year-old children (Venetsanou et al., 2007), it is concluded that the suitability of the aforementioned battery for preschool age is questionable.

However, validation process should not be limited to one approach. Evidence of validity should be provided by using multiple techniques and evidence to argue the appropriateness of a decision (Yun & Ulrich, 2002). Further research, both in Greece and all other countries where the test of interest is utilized, including a larger sample of preschool aged children, is required, in order to accumulate sound evidence about the validity of the BOTMP- SF for the motor assessment of children in that important stage of human life.

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Tables

Table 1. Means, Standard Deviations and F Ratios for total score and each item of BOTMP-SF by age group

Battery items	Age groups								
	48-53 months (n = 70)		54-59 months (n-88)		60-65 months (n = 84)		66-71 months (n = 76)		Univariate
	M	*SD*	M	*SD*	M	*SD*	M	*SD*	$F_{3,314}$
Total point score	18.03	4.22	18.21	6.13	27.00	4.46	36.97	4.49	110.65
Running speed & agility (time)	11.20	1.46	11.13	1.69	9.80	0.92	8.93	0.68	29.17
Standing on preferred leg on balance beam (time)	1.95	1.87	2.87	2.49	5.75	2.97	8.94	2.69	57.51
Walking forward heel-to-toe on balance beam (number of correct steps)	0.20	0.71	0.72	1.56	1.14	1.63	2.86	1.64	23.44
Tapping feet alternately while making circles (pass/fail)	0.00	0.00	0.00	0.00	0.00	0.00	0.005	0.22	2.18
Jumping up and clapping hands (pass/fail)	0.97	0.29	1.04	0.42	1.14	0.41	1.78	0.41	34.07
Standing broad jump (distance)	3.25	0.95	3.25	1.48	4.52	1.17	6.10	0.89	52.00
Catching a tossed ball with both hands (correct catches)	0.79	1.51	1.19	1.54	2.22	1.55	3.10	0.72	22.60
Throwing a ball to a target (correct throws)	0.77	1.00	0.90	0.98	1.07	1.11	1.94	1.29	8.75
Response speed (response speed stick number)	1.65	1.23	2.13	1.21	2.90	1.03	4.18	0.86	38.09
Drawing a line through a straight path (number of errors)	4.31	2.36	3.40	1.80	2.16	1.51	1.89	2.32	12.64
Copying a circle (points)	1.35	0.89	1.68	0.60	1.88	0.45	1.86	0.34	25.81
Copying overlapping pencils (points)	0.005	0.23	0.11	0.32	0.21	0.52	0.68	0.90	10.10
Sorting cards (number of cards)	3.97	5.41	8.88	4.26	9.92	3.76	11.55	2.92	22.33
Making dots (number of dots)	10.40	4.47	14.52	3.11	17.88	3.56	17.84	4.82	28.99

* $p < .001$ for all variables except *Tapping feet alternately while making circles* ($p = .092$)

Table 2. Significant Differences in item scores between means of age groups as tested by Bonferroni Test.

Items

Age groups	Running speed & agility				Standing on preferred leg on balance beam				Walking forward heel-to-toe on balance beam				Tapping feet alternately while making circles			
	48-53	54-59	60-65	66-71	48-53	54-59	60-65	66-71	48-53	54-59	60-65	66-71	48-53	54-59	60-65	66-71
48-53			*	*			*	*			+	*				
54-59			*	*			*	*				*				
60-65	*	*		+	*	*		*	+			*				
66-71	*	*	+		*	*	*		*	*	*					

Age groups	Jumping up and clapping hands				Standing broad jump				Catching a tossed ball with both hands				Throwing a ball to a target			
	48-53	54-59	60-65	66-71	48-53	54-59	60-65	66-71	48-53	54-59	60-65	66-71	48-53	54-59	60-65	66-71
48-53				*			*	*			*	*				*
54-59				*			*	*			+	*				*
60-65				*	*	*		*		+		+				+
66-71	*	*	*	*	*	*	*		*	*	+		*	*	+	

Age groups	Response speed				Drawing a line through a straight path				Copying a circle			
	48-53	54-59	60-65	66-71	48-53	54-59	60-65	66-71	48-53	54-59	60-65	66-71
48-53			*	*			*	*		*	*	*
54-59			+	*				*	*			
60-65	*	+		*					*			
66-71	*	*	*		*	*			*			

Age groups	Copying overlapping pencils				Sorting cards				Making dots			
	48-53	54-59	60-65	66-71	48-53	54-59	60-65	66-71	48-53	54-59	60-65	66-71
48-53				*		*	*	*		*	*	*
54-59				*	*			+	*		*	*
60-65				+	*				*	*		
66-71	*	*	+		*	+			*	*		

*$p < .001$
+ $p < .05$

Table 3. Items with high percentage of zero raw-scores.

Battery items	Age groups							
	48-53 months		54-59 months		60-65 months		66-71 months	
	n	%	n	%	n	%	n	%
Walking forward heel-to-toe on balance beam	62	89	66	75	52	62	12	16
Tapping feet alternately while making circles	70	100	88	100	84	100	72	95
Catching a tossed ball with both hands	66	94	44	50	20	24	-	-
Copying overlapping pencils	66	94	78	89	70	83	46	60