SOME PROBLEMS AND SUGGESTIONS IN MEASURING MOTOR BEHAVIOUR OF PRE-SCHOOL CHILDREN

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NEKATERE TEŽAVE IN NAPOTKI ZA MERJENJE MOTORIČNEGA OBNAŠANJA PREDŠOLSKIH OTROK

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ABSTRACT

A battery of tests for evaluation of motor behaviour of adults has been modified and applied to a group of pre-school children. The analysis proved good reliability of the composite tests. Suggestions for applying the battery in practice and in future research of motor behaviour of pre-school children are provided.

Key words: pre-school age/ motor behaviour/ motor test/ reliability

IZVLEČEK

Skupina merskih inštrumentov za ugotavljanje motoričnega obnašanja odraslih je bila prirejena za merjenje predšolskih otrok. Analiza podatkov zbranih na izmerjeni skupini otrok je pokazala dobro zanesljivost prilagojenih testov. V študiji so podani tudi nekateri napotki za uporabe teh testov v praksi in nadaljnjemu raziskovanju motoričnega obnašanja predšolskih otrok.

Ključne besede: predšolski otroci/ motorično obnašanje/ motorični testi/ zanesljivost

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INTRODUCTION

When discussing the motor skills of young children, motor behaviour is a much more appropriate term. Motor behaviour of young children includes motor activity of children at play, during sport or recreation, and during everyday activities at home or in the kindergarten. Motor behaviour of young children is quite broad (general type), without clear sex differentiation (Bala, 1981; Nićin, J. Kalajdžić, Bala, 1997; Bala, Nićin, 1997; Strel, Šturm, 1981; Rajtmajer, 1997). It can be seen as a resultant of: a) development of potential motor skills, b) development and number of motor habits.

The space of motor abilities of young children is arranged differently than the spacethat of the older children or adults. The research evidence for this is mostly quantitative, with very little qualitative data which could point to the real structure of the space of motor behaviour at of young children (Bala, 1981; Strel, Šturm, 1981; Nićin, J. Kalajdžić, Bala, 1997; Bala, Nićin, 1997; Rajtmajer, 1997; Bala, 1999). Nevertheless, there is plenty of evidence from the experts who work with young children and also from everyday experience. They all point to the fact that young children react with their entire bodies and minds, as well as with all their motor abilities. This agrees with the theory of »integrated development« of young children (Ismail and Gruber, 1971) which points to the low correlation between motor, intellectual and emotional development of young children. The correlation decreases with age, which indicates an enormous possibility to positively influence a child's intellectual and emotional behaviour through the development and enhancement of their motor behaviour.

There are a number of problems in researching human motor behaviour. There are even more problems when researching motor behaviour of young children. There will be no discussion of such problems in this paper. The accent will be on the possibility of analogue use of motor tests for older children on pre-school subjects. This possibility is directly connected with the problem of reliability of the tests for young children.

To solve this problem, we first have to select the tests on the basis of their validity and reliability in the motor space of older children and then modify the conditions in which they are performed, therefore modifying the standardisation of the tests. Secondly, it is necessary to make these tests composite, so their reliability can be logically and simply defined. In most research, the motor tests consisted of only singular tasks, which, according to psychometric beliefs, applied corresponded to the items. In order to consider such tests composite, it is necessary to repeat the activity two, three or more times, with an appropriate rest time between each performance.

It is quite important to emphasise that a reliable test for a certain motor ability of adults can not be used to measure the same ability for small children. One such example is the »Standing broad jump« test, used to measure an adult's explosive strength of the legs. In the case of young children, the main problem in performing this task is connecting the simple movements of arms and legs for take take-off. However, this test can be used for measuring co-ordination of young children. Another such test is »Arm plate tapping«, which estimates an adult's speed of alternate hand movements (speed frequency of hand movement). In the case of small children, this test should be used to measure also co-ordination. These claims are the result of this author's work with young children over a number of years.

There is also no evidence that the abilities in question are »motor abilities« (the term used as in the previous research papers discussing the motor abilities of other ages). Thompson's sampling theory applies well when discussing motor behaviour of young children. It indicates that there is one general ability that is a combination of elementary abilities. In the case of young children these elementary motor abilities should be seen as potential abilities. Therefore the author uses the more appropriate term when discussing young children - motor behaviour.

METHODS

The sample of motor tests

The motor behaviour of small children has a general character but we are familiar with the names of motor abilities which we use for older children and adults. For this reason in this research the sample of motor tests is selected based on the model of motor abilities of youth (Kurelić, Momirović, Stojanović, Šturm, Radojević and Viskić-Štalec, 1975; Gredelj, Metikoš, Hošek and Momirović, 1975), even though this model is not suitable for pre-school children.

A) MECHANISM FOR MOVEMENT STRUCTURING
   I Functional co-ordination of primary motor abilities
      1) Test »Obstacle course backwards«
B) MECHANISM FOR TONUS AND SYNERGETIC REGULATION
   II Frequency of simple movements
      2) Test »Arm plate tapping«

III Flexibility
3) Test »Forward bend and touch on a bench«

C) MECHANISM FOR REGULATION OF EXCITATION INTENSITY
IV Explosive strength
4) Test »Standing broad jump«

D) MECHANISM FOR REGULATION OF EXCITATION DURATION
V Repetitive strength of the trunk
5) Test »Crossed-arm sit-ups«
VI Static strength of arms
6) Test »Bent arm hang«.

These motor tests are routinely used on older children, but they need to be modified before they can be applied to young children. The modifications occurred in the following tests:

1. *Arm plate tapping*. The height of the table and the chair is adjusted for comfortable seating of young children (if the seat is not made for children, this is accomplished by putting an additional layer on the chair as well as under the child's feet). The inside distance between the spaces that hands touch is 51 cm (61 cm for adults), although that distance should be even smaller.
2. *Forward bend and touch on a bench*. The children perform the deep bow to a large straight-angle ruler, so that it doesn't hurt the child.
3. *Bent arm hang*. The bar has a smaller radius than the regular bar, so the child can grip the bar firmly when holding a pull-up.

A short description of the motor tests follows, with the appropriate numbers and codes that occur later in the tables. A more detailed description with the entire standardisation of tests can be found in the book »Sport School For Children – the development of motor behaviour of children« (Bala, 1996).

1. Obstacle course backwards (OBSTACLE)

The child has to walk backwards on all fours and cover the distance of 10m, climb the top of Swedish bench and go through the frame of the bench. The task is measured in tens of a second and is repeated twice, with an appropriate rest time in between.

2. Arm plate tapping (TAPPING)

For fifteen seconds the child has to tap alternately two plates on the tapping board with his dominant hand, while holding the other hand in between the two plates. The result is the number of alternate double hits. The task is performed twice, with an appropriate rest in between.

3. Forward bend and touch on a bench (FORWBEND)

The child stands on a bench and bows as deep as possible. A straight-angle ruler which points down with the 40 cm mark at the child's feet, and 40 cm below it, is next to him/her. The result is the depth of the reach measured in cm. The task is performed three times without any rest.

4. Standing broad jump (STANJUMP)

The child jumps with both feet from the reversed side of Reuter bounce board onto a carpet which is marked in cm. The result is the length of the jump in cm. The task is performed three times without rest.

5. Crossed-arm sit-ups (SIT-UPS)

The child lies on his/her back with his/knees bent and arms crossed on the opposite shoulders. He/she raises into a seated position and returns into the starting position. The instructor's assistant holds the child's feet. The result is the number of correctly executed raises to the seated position (no longer than 60 seconds). The task is repeated twice, with a rest in between.

6. Bent arm hang (ARMHANG)

The child under-grips the bar and holds the pull-up as long as he/she can (chin above the bar). The result is the time of the hold measured in tens of a second. The task is repeated twice with a rest in between.

This battery of tests has been using used for several years in the training process at »Munchkin Sport School« in Novi Sad (Vojvodina) and it is very similar to the battery of tests in the expert system »Talent« in Slovenia (Leskošek, Bohanec, Kapus and Rajkovič, 1997).

The validity of these tests were obtained in another research on very similar sample of subject (Bala, 1999). The entire analysis was made on the basis of these procedures of result registration in motor testing of the same test: 1) in every test the result was the first one of two or three repetitions, 2) the best result of two or three repetitions, 3) the sum of the results of two or three repetitions, 4) the factor scores of the principal component of the correlation matrix of every repetition result. In all four analyses, promax transformation of the principal components of the corresponding correlation matrix was applied.

Table 1. PATTERN MATRICES OF THE MOTOR FACTORS

Variable	First Repetition		Best Repetition		Sum of repetitions		Principal components	
	F1	F2	F1	F2	F1	F2	F1	F2
OBSTACLE	–.85	–.01	–.82	–.04	–.85	–.03	–.85	–.03
TAPPING	.85	–.07	.82	.00	.86	–.04	.85	–.02
FORWBEND	–.10	.96	–.08	.97	–.11	.97	–.10	.97
STANJUMP	.76	–.00	.82	–.07	.84	–.07	.84	–.08
SIT-UPS	.77	–.11	.81	–.15	.81	–.11	.81	–.11
ARMHANG	.55	.40	.58	.36	.58	.40	.57	.40

The correlations between promax factors were not statistically significant, so it was concluded that the two factors obtained for small children (general motor factor and flexibility) were independent.

Sample of the subjects

The subjects were 54 pre-school boys and 30 girls with ages between 4-7 (average 5.83 years). The children attended a special training program on the development of motor behaviour in »Munchkin Sport School« in Novi Sad. The sample was consisted of all 84 children, because additional analyses of subgroups of boys and girls showed that there were no significant differences in the reliability of the tests, according to age or gender, therefore the children were all analysed together.

Data analysis

In the case of true composite tests (consisting of at least three items), and the two item tests, the following procedure was applied:

1) means (AS) and standard deviations (SD) were calculated for each item (repetition);

2) range of the results was measured (minimum (MIN) and maximum (MAX));

3) symmetry (skewness – SKEW) and homogeneity (kurtosis – KURT) of distribution for each item;

4) correlation coefficients between the items was calculated. In the case of the three item tests, average correlation of each items with the other two (R) was calculated;

5) correlation coefficients of each item with the first principal component (common object of measurement) with the appropriate motor test (H1);

6) Cronbach coefficient of the generalisation of the first principal component item re-scaled to anti-image metrics (α) was calculated.

RESULTS

The results are presented in tables 2 and 3. The first table shows the number of the items in every test (n), results of the reliability, based on the average correlation coefficients among the items in every test (R) and Cronbach's coefficient of reliability (α).

Table 2. RELIABILITY OF COMPOSITE MOTOR TESTS ON PRE-SCHOOL CHILDREN

TEST	N	R	α
1. OBSTACLE	2	.91	.947
2. TAPPING	2	.85	.915
3. FORWBEND	3	.97	.988
4. STANJUMP	3	.87	.951
5. SIT-UPS	2	.83	.907
6. ARMHANG	2	.85	.921

Table 3 shows the following for every item in each test: mean (AS), standard deviation (SD), minimal (MIN) and maximal (MAX) results of testing, skewness (SKEW), kurtosis (KURT) and correlation coefficients of composite motor tests with the first main object of the test measurements (H1).

DISCUSSION

The real indicators of reliability of motor tests (table 2) are results which are above those usually regarded as acceptable in psychometrics. Therefore, it is

Table 3. STATISTICAL CHARACTERISTICS OF THE MOTOR TESTS

TEST	ITEM	AS	SD	MIN	MAX	SKEW	KURT	H1
1. OBSTACLE (0.1s)	1	288.6	101.2	124	595	.85	.50	.98
	2	251.8	85.6	116	571	1.04	1.66	.98
2. TAPPING (freq.)	1	13.3	3.7	6	22	.14	-.79	.96
	2	15.1	4.4	7	26	.30	-.39	.96
3. FORWBEND (cm)	1	42.4	4.6	27	54	-.10	1.53	.98
	2	43.0	4.7	28	55	.15	.89	.99
	3	43.4	4.9	28	56	.15	1.04	.99
4. STANJUMP (cm)	1	108.3	18.8	70	149	-.08	-.49	.95
	2	109.4	19.2	72	150	-.04	-.78	.97
	3	111.7	21.5	58	158	-.12	-.43	.95
5. SIT-UPS	1	15.4	8.9	0	39	.50	-.34	.96
(freq.)	2	13.3	8.8	0	36	.63	-.21	.96
6. ARMHANG	1	99.4	86.9	0	368	1.28	1.14	.96
(0.1s)	2	95.5	82.4	0	332	1.31	1.14	.96

safe to conclude that all analysis of reliability of motor tests are quite reliable.

The test »Forward bend and touch on a bench« is the most reliable one. It is followed by »Obstacle course backwards« and »Standing broad jump«. It is interesting that »Arm plate tapping« is the least reliable. This indicates that the desk for tapping should be modified, as well as the time allowed for testing, since children get tired after the tenth second of testing.

The tests for estimation of repetitive strength of the trunk (Crossed-arm sit-ups) and static strength of arms and shoulders (Bent arm hang) are the least reliable, yet satisfactory in the whole group of tests.

The analysis of the means and standard deviations of all items in each test (table 3) shows that the second and third performance of the task gave better results, except for the tests for the estimation of duration of excitation (strength). We can conclude that the children were learning how to perform the task during the first performance, and actually performed it during the second and third performance. When performing the tests of maximal strength (Crossed-arm sit-ups and Bent arm hang) the children had not recovered from the previous repetition, although theoretically there was enough time, and therefore did not perform to the maximum of their ability. The children also need to be motivated to perform the same task again with the maximum strive. Variability of the second and third performance of each motor task is practically proportional to the change in the mean of the first performance. This indicates the relative stability in the performance of these motor tasks on the entire sample of the young children.

According to the characteristics of distribution of the results of each performance in every test (table 3), it could be concluded that all tests had slightly asymmetric (skewness) and not so homogeneous (kurtosis) distribution. The test »Obstacle course backwards« was easy for most of the children. However, there were some children that had a lot of trouble solving this task. The tests »Arm plate tapping« and »Forward bend and touch on a bench« had relatively normal distributions of the results in each performance. The difficult tests for the children were »Crossed-arm sit-ups« and »Bent arm hang«. In the case of the test «Standing broad jump«, the children mostly learned the technique of synchronising hand movements with the take-off in the attempts, and the distribution of the results relatively stable and reached a shape closer to the normal distribution.

Based on the correlation coefficient with the first principal component (the main object of measurement of each test), the second performance gave the most stable and even results. Therefore, it is necessary and sufficient to perform each test twice when measuring young children. In practical terms, it is necessary to create the situation where each child tries the motor test once or twice in order to understand and warm up for the performance when the result is measured. This method of testing is suitable for prac-

tical use in kindergarten, and only one item then would be used for analysis.

CONCLUSION

The applied motor tests had very good reliability. They should be used in the modified form described above when testing pre-school children. For practical purposes, it is also necessary to give the children adequate instructions for the performance of each test, build up their motivation and give them a practice run of each test. For further research, it is necessary to try out some more modifications of these tests, as well as on the tests which proved reliable for adults. Such research provided on larger samples of pre-school children divided into age subgroups (3, 4, 5, 6, 7 year). The construction of some new and reliable motor tests for pre-school children is a special problem which should be addressed more when studying motor behaviour of pre-school children.

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