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DEPENDENCE OF THE MOTOR DIMENSION DEFINITION ON THE MODE OF RESULT REGISTRATION PROCEDURE OF MOTOR TEST PERFORMANCE

ODVISNOST OPREDELITVE MOTORIČNIH RAZSEŽNOSTI OD NAČINA IZRAČUNA REZULTATA PRI MOTORIČNIH TESTIH

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Abstract

On a sample of 260 first and second year students of the Faculty of Physical Education in Novi Sad - Yugoslavia, four factor analyses were applied on the correlation matrices with 21 variables, obtained on the basis of different result registration procedures of motor test performance. It was concluded that the best-fitted and most parsimonious solution was the case when the test results were the factor scores of first principal component of the correlation matrix of every repetition result in every motor test.

Keywords: result registration, motor test, motor abilities, factor analysis, metric characteristics

Izvleček

Na vzorcu 260 študentov prvega in drugega letnika Fakultete za telesno vzgojo v Novem Sadu (Jugoslavija), je bila izvedena primerjava štirih faktorskih analiz korelacijskih matrik 21 kompozitnih motoričnih testov, dobljenih z različnimi načini izračuna končnih rezultatov merjencev iz posameznih ponovitev merjenja. Ugotovljeno je bilo, da je bila dobljena najbolj racionalna in ustrezna rešitev, ko so bili končni rezultati merjencev faktorske vrednosti prve glavne komponente korelacijske matrike vseh ponovitev vsakega testa.

Ključne besede: motorični test, način izračuna rezultata, motorične sposobnosti, faktorska analiza, merske značilnosti

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INTRODUCTION

Motor tests measure very complex human abilities. These abilities, which are called »motor abilities«, can't be measured directly, but we must make conclusions about them on the basis of a larger number of indicators (motor tests), which never show the exact level of the measured abilities, with equal reliability and validity. For these reasons, motor tests should be constructed from a larger number of items; usually they are the same motor tasks, which the subjects need to perform several times successively, without or with a short pause. Such realised motor tests with several items are called »composite motor tests«.

With the composite motor test, there are problems about: the definition of internal metric characteristics of the motor test as a whole, as well as the definition of metric characteristics of items, from which the motor test is composed. Beside those problems, it is necessary to define the result registration procedures of motor test performance, with the intention to get good measure exactness. Solving all these problems, we can get information about the reliability, representativeness, homogeneity, and validity of the used items, as well as about the reliability, representativeness and homogeneity of the total result in the motor test. Validity of the total result in the motor test should be defined on the basis of external metric characteristics (factor and pragmatic validity). The reader can find more on measurement instruments in Momirović, Wolf and Popović (1999).

The aim of this paper is to analyse the factor validity of the motor tests, with regard to the pattern and structure of entire analysed motor space, on the basis of different testing results of the same motor test, being repeated several times.

METHODS

Subject sample

The sample of subjects consisted of 260 first and second year students of the Faculty of Physical Education in Novi Sad – Yugoslavia, 18-22 years of age, which were selected according to their biological, health, motor and psychological development; and were tested at the entrance examination and during the school year.

Motor test sample

The sample of motor variables was obtained on the basis of the motor model according to Kurelić et al. (1975); and Gredelj, Metikoš, Hošek and Momirović (1975):

A) MECHANISM FOR MOVEMENT STRUCTURING

I Functional co-ordination of primary motor abilities

1 The test »Agility on the floor« (CAGFLOOR)

2 The test »Dragging and jumping over« (CDRAJUMP)

3 The test »Co-ordination with stick« (CCOSTICK)

4 The test »Figure-8 duck« (CFI8DUCK)

B) MECHANISM FOR TONUS AND SYNERGETIC REGULATION

II Balance

5 The test »One foot cross balance-eyes open« (B1CROPEN)

6 The test »One foot length-wise balance-eyes open (B1LEOPEN)

7 The test »Flamingo« (BFLAMING)

III Frequency of simple movements

8 The test »Two foot tapping« (F2FOOTTA)

9 The test »Arm plate-tapping« (FTAPPING)

10 The test »One foot-tapping« (F1FOOTTA)

III Flexibility

11 The test »Toe touching-sitting straddle« (FLTOESIT)

12 The test »Toe touching-standing« (FLTOESTA)

13 The test »Push off one leg-lying on the side« (FLPUSH1L)

C) MECHANISM FOR EXCITATION INTENSITY REGULATION

IV Explosive strength

14 The test »Standing broad jump« (ESTANJUM)

15 The test »20m dash« (E20MDASH)

16 The test »Spring forward from front support on the floor« (EREFLOOR)

D) MECHANISM FOR EXCITATION DURATION REGULATION

V General strength

17 The test »Bent arm hang« (SARMHANG)

18 The test »Pull-ups« (SPULLUPS)

19 The test »Horizontal hold laying on the back« (SHORHOLD)

20 The test »Sit-ups« (SSIT-UPS)

21 The test »Hand grip« (SHANDGRI).

The coding of the motor tests was as follows: the first letter in the code name was according to the hypothetical motor factor and the others according to the names of the tests. The reason for that was to make interpretation of analysed factors easier. This means that the first letter in the code name C was for co-ordination, B for balance, F for frequency of simple movements, FL for flexibility, E for explosive strength and S for general strength.

The conditions and techniques of measuring for most of the tests were according to Metikoš, Prot, Hofman, Pintar and Oreb (1989); except the tests »Flamingo« (Moravec, 1996), »Push off one leg-lying on the side« and »Spring forward from front support on the floor« (Madić, 1995; Madić, 2000). Every test was performed three times, so each of them was a composite test of three items.

The entire analysis of motor space were made on the basis of these procedures of result registration in motor testing of the same test:

1 in every test the final result was the first one of three repetitions;
2 the best result of the three repetitions;
3 the mean (or sum) of the results of the three repetitions;
4 the factor scores of the first principal component of the correlation matrix of every repetition result.

Data analysis

In all four analyses, promax transformation of the principal components of the corresponding correlation matrix was applied. The number of statistical significant principal components was obtained on the basis of the Guttman-Kaiser criterion.

RESULTS

The reliabilities of these tests were computed as Cronbach's α-coefficient (α). The values of the reliabilities are shown in Table 1.

It is obvious that all the motor tests have quite good reliabilities, except the tests SARMHANG (Bent-arm hang) and B1CROPEN (One foot cross balance-eyes open).

In the analysis of the complete motor space of 21 variables, the most important results of the promax transformation of principal components of the four inter-correlation matrices were used. The obtained information is given in the tables that follow. The communalities and the principal components are not shown due to the restricted length of papers.

Table 1. RELIABILITIES OF THE MOTOR TESTS

TEST	α	TEST	α
1. CAGFLOOR	.92	12. FLTOESTA	.94
2. CDRAJUMP	.93	13. FLPUSH1L	.99
3. CCOSTICK	.88	14. ESTANJUM	.94
4. CFI8DUCK	.89	15. E20MDASH	.91
5. B1CROPEN	.76	16. EREFLOOR	.95
6. B1LEOPEN	.90	17. SARMHANG	.62
7. BFLAMING	.92	18. SPULLUPS	.95
8. F2FOOTTA	.92	19. SHORHOLD	.97
9. FTAPPING	.85	20. SSIT-UPS	.92
10. F1FOOTTA	.87	21. SHANDGRI	.95
11. FLTOESIT	.93		

It is obvious from Table 2, that the first three procedures produced seven motor factors and when the test result was the factor score of the first principal component of the correlation matrix of every repetition result, the significant number of motor factors was reduced to six. It seams that this procedure produced a simpler solution than the others, especially the procedures with only one repetition (the first and the best repetition). Such information can be seen from the proportion of variance of every isolated principal component and the cumulative percentage of all isolated principal components.

When the factor analysis of motor space was made on the basis of procedures of result registration taking in

Table 2. EIGENVALUES (λ), % OF VARIANCE AND CUMULATIVE % OF PRINCIPAL COMPONENTS OF CORRELATION MATRICES OBTAINED ON THE BASIS OF DIFFERENT RESULT REGISTRATION PROCEDURES

	λ				% of Variance				Cumulative %			
	A	B	C	D	A	B	C	D	A	B	C	D
1	4.08	4.21	4.60	4.66	19.42	20.05	21.94	22.19	19.42	20.05	21.94	22.19
2	1.67	1.78	1.71	1.73	7.95	8.48	8.15	8.26	27.38	28.54	30.09	30.46
3	1.53	1.58	1.58	1.57	7.30	7.52	7.54	7.48	34.68	36.06	37.63	37.94
4	1.45	1.41	1.40	1.41	6.92	6.75	6.69	6.75	41.61	42.82	44.33	44.70
5	1.22	1.25	1.21	1.19	5.84	5.98	5.78	5.67	47.45	48.80	50.11	50.38
6	1.08	1.12	1.13	1.12	5.15	5.36	5.41	5.35	52.61	54.16	55.53	55.73
7	1.05	1.02	1.01		5.04	4.87	4.84		57.66	59.04	60.37	

A – the first one of three repetitions;
B – the best result of three repetitions;
C – the mean (or sum) of the results of three repetitions;
D – the factor scores of first principal component of the correlation matrix of every repetition result

Table 3. PATTERN AND STRUCTURE MATRICES OF FIRST REPETITION

	Pattern Matrix							Structure Matrix						
VARIABLES	1	2	3	4	5	6	7	1	2	3	4	5	6	7
CAGFLOOR	.13	-.10	.80	.13	-.04	-.01	-.08	-.19	-.13	.71	-.15	-.13	.09	-.12
CDRAJUMP	-.38	-.01	.27	.05	-.03	.01	-.24	-.52	-.17	.41	-.14	-.19	.11	-.32
CCOSTICK	-.04	-.11	.83	.19	-.06	-.01	.07	-.34	-.16	.78	-.15	-.15	.12	.00
CFI8DUCK	-.26	.08	.38	-.05	.30	.29	-.07	-.39	-.03	.49	-.22	.18	.41	-.08
B1CROPEN	.48	-.05	.22	.12	.44	.03	-.04	.50	.10	-.07	.23	.53	.00	.09
B1LEOPEN	.02	.02	-.05	-.18	.87	-.07	-.18	.18	.09	-.13	.05	.81	-.02	-.02
BFLAMING	.04	-.02	.09	-.09	-.69	.05	-.16	-.20	-.14	.24	-.28	-.75	.06	-.28
F2FOOTTA	.70	-.06	-.08	-.04	-.06	-.07	-.07	.70	.10	-.32	.13	.07	-.18	.02
FTAPPING	.74	.02	.04	.03	.03	-.05	-.06	.74	.20	-.26	.19	.18	-.16	.06
F1FOOTTA	.54	.13	.14	.03	.07	-.06	.22	.58	.31	-.11	.13	.22	-.15	.33
FLTOESIT	-.05	.87	-.06	.12	-.02	-.12	-.06	.21	.87	-.16	.22	.09	-.24	.08
FLTOESTA	-.04	.85	-.16	.00	.08	.02	-.02	.24	.85	-.22	.15	.19	-.10	.13
FLPUSH1L	.40	.55	.04	-.02	-.08	.22	.07	.48	.62	-.11	.06	.08	.09	.20
ESTANJUM	-.12	.10	-.02	.23	.06	-.78	.02	.09	.19	-.20	.34	.07	-.80	.07
E20MDASH	-.27	.08	-.03	.14	-.08	.76	.08	-.33	-.06	.15	-.02	-.05	.76	.00
EREFLOOR	.00	.04	.14	.49	-.02	-.09	.13	.09	.10	-.07	.45	.09	-.15	.12
SARMHANG	.04	-.04	-.05	.06	-.06	.05	.88	.17	.11	-.10	.06	.11	-.01	.87
SPULLUPS	-.06	-.16	-.31	.53	.21	.07	.21	.20	-.05	-.50	.65	.38	-.03	.21
SHORHOLD	.15	.02	.10	.69	-.06	.08	-.03	.24	.09	-.19	.66	.11	-.02	-.03
SSIT-UPS	.15	-.05	-.34	.45	-.02	.11	-.41	.28	-.03	-.53	.59	.09	.00	-.40
SHANDGRI	-.14	.13	.23	.71	-.08	-.12	-.05	-.05	.14	.01	.60	.01	-.18	-.07

every test the result of first of three repetitions, the final solutions are in Table 3 and Table 4.

Table 3 shows the pattern and structure matrices after promax rotation of the principal components, with grey boxes for the values of the variables, which were involved significantly in defining the motor factors. The pattern coefficients are the validities of applied motor tests in this research. According to these coefficients, as well as structure coefficients and correlation coefficients between the factors, in this analysis, the obtained motor factors were interpreted as:

1 Frequency of simple movements (FREQUENCY)
2 Flexibility (FLEXIBILITY)
3 The speed of solving complex motor problems (COORDINATION)
4 Continuous regulation of muscle force (FORCE-REGUL)
5 Balance (BALANCE)
6 Dual factor, defined by explosive strength (EXPLOSIVE)
7 Single factor, defined by variable of absolute isometric strength of upper extremities (ISOMETRIC).

Table 4. CORRELATION MATRIX OF FACTORS OF FIRST REPETITION

FACTORS	1	2	3	4	5	6	7
1. FREQUENCY	1.00	.24	-.38	.22	.22	-.15	.15
2. FLEXIBILITY	.24	1.00	-.07	.09	.11	-.12	.17
3. COORDINATION	-.38	-.07	1.00	-.38	-.15	.16	-.04
4. FORCE-REGUL	.22	.09	-.38	1.00	.22	-.14	-.01
5. BALANCE	.22	.11	-.15	.22	1.00	.04	.17
6. EXPLOSIVE	-.15	-.12	.16	-.14	.04	1.00	-.05
7. ISOMETRIC	.15	.17	-.04	-.01	.17	-.05	1.00

All correlation coefficients, which are greater than 0.11, are statistically significant with a 1% error level and those greater than 0.15 with a 5% error level. These point to a real relationship of motor factors (abilities) (grey boxes in Table 4).

The final solution of factor analysis in the case, when the best result of three repetitions was the test score, is given in Table 5 and Table 6.

1 The speed of solving complex motor problems (COORDINATION)
2 Frequency of simple movements (FREQUENCY)
3 Flexibility (FLEXIBILITY)
4 Absolute strength of upper extremities and trunk (STRENGTH)

Table 5. PATTERN AND STRUCTURE MATRICES OF BEST REPETITON

VARIABLES	Pattern Matrix							Structure Matrix						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
CAGFLOOR	.78	.18	-.06	.07	.01	-.08	-.09	.69	-.11	-.13	-.18	-.13	-.15	-.08
CDRAJUMP	.52	-.19	-.04	-.10	.02	.12	.02	.62	-.44	-.15	-.34	-.16	.05	.12
CCOSTICK	.81	-.01	-.10	.31	-.09	-.13	-.12	.73	-.26	-.21	-.06	-.22	-.17	-.10
CFI8DUCK	.43	-.15	.04	-.31	.37	-.10	.21	.54	-.38	-.06	-.46	.17	-.16	.28
B1CROPEN	.08	.30	-.04	.11	.57	-.12	-.06	-.21	.42	.08	.30	.63	-.09	-.12
B1LEOPEN	.03	.04	-.01	-.09	.81	.01	.00	-.14	.15	.08	.12	.79	.01	.02
BFLAMING	.10	.07	-.07	-.11	-.65	-.14	.02	.28	-.16	-.17	-.32	-.69	-.20	.00
F2FOOTTA	-.04	.88	-.10	-.27	.00	.10	.22	-.27	.74	.10	.04	.11	.09	.09
FTAPPING	.08	.76	.05	.05	.06	.10	.12	-.26	.75	.25	.31	.21	.15	.00
F1FOOTTA	.11	.57	.06	.16	.12	.08	-.33	-.25	.68	.22	.39	.25	.10	-.42
FLTOESIT	.04	.00	.85	.11	-.04	.10	.06	-.11	.21	.87	.20	.08	.24	.08
FLTOESTA	-.16	-.13	.84	.02	.08	.00	-.05	-.25	.17	.85	.17	.19	.13	-.03
FLPUSH1L	-.10	.35	.57	-.08	-.04	-.27	.03	-.25	.48	.62	.08	.08	-.18	-.06
ESTANJUM	-.07	.01	.07	.03	.05	.80	.10	-.17	.09	.20	.24	.11	.84	.19
E20MDASH	.09	-.24	.09	.07	.01	-.72	.13	.22	-.28	-.06	-.20	-.05	-.69	.09
EREFLOOR	.12	-.09	.04	.58	-.01	.02	.13	-.06	.05	.08	.50	.10	.15	.11
SARMHANG	-.13	-.15	.01	.63	.22	.02	-.16	-.38	.19	.09	.70	.37	.14	-.19
SPULLUPS	-.35	-.01	-.21	.46	.14	-.06	.37	-.49	.19	-.10	.56	.31	.09	.30
SHORHOLD	.19	.04	.07	.75	-.07	-.07	.30	-.08	.17	.14	.65	.10	.12	.24
SSIT-UPS	-.29	.14	-.03	.16	.01	-.13	.75	-.33	.17	.06	.23	.15	.02	.67
SHANDGRI	.22	.06	.11	.33	-.09	.24	.57	.10	.00	.16	.26	-.02	.38	.58

5 Balance (BALANCE)
6 Dual factor, defined by tests of explosive strength (EXPLOSIVE)
7 Dual factor, defined by variables of trunk strength and maximal force of attempted movements of hand (STRE-FORCE)

When the mean (or sum) of the results of three repetitions was the result registration procedure of motor test performance, the factor analysis solution is shown in Table 7 and Table 8.

1 The speed of solving complex motor problems (COORDINATION)

Table 6. CORRELATION MATRIX OF FACTORS OF BEST REPETITION

FACTORS	1	2	3	4	5	6	7
1. COORDINATION	1.00	-.40	-.14	-.39	-.23	-.09	.08
2. FREQUENCY	-.40	1.00	.24	.34	.19	.03	-.18
3. FLEXIBILITY	-.14	.24	1.00	.12	.11	.13	.01
4. STRENGHT	-.39	.34	.12	1.00	.25	.21	-.08
5. BALANCE	-.23	.19	.11	.25	1.00	.03	.02
6. EXPLOSIVE	-.09	.03	.13	.21	.03	1.00	.12
7. STRE-FORCE	.08	-.18	.01	-.08	.02	.12	1.00

2 Flexibility (FLEXIBILITY)
3 Frequency of simple movements (FREQUENCY)
4 Continuous regulation of muscle force (FORCE-REGUL)
5 Balance (BALANCE)
6 Dual factor, defined by two tests of explosive strength (EXPLOSIVE)
7 Single factor, defined by variable of absolute isometric strength of upper extremities (ISOMETRIC).

And finally, when the factor analysis of motor space was made on the basis of procedures of result registration taking in analysis of the factor scores of first principal component of the correlation matrix of every repetition result, the final solution is in Table 9 and Table 10.

1 Balance (BALANCE)
2 The speed of solving complex motor problems (COORDINATION)
3 Flexibility (FLEXIBILITY)
4 Continuous regulation of muscle force (FORCE-REGUL)
5 Frequency of simple movements (FREQUENCY)
6 Dual factor, defined by two variables of explosive strength (EXPLOSIVE).

Table 7. PATTERN AND STRUCTURE MATRICES OF MEANS OF REPETITIONS

VARIABLES	Pattern Matrix							Structure Matrix						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
CAGFLOOR	.79	-.07	.12	.06	.02	-.03	-.04	.74	-.14	-.19	-.17	-.17	-.17	-.21
CDRAJUMP	.40	.00	-.15	.05	.03	.00	-.37	.52	-.16	-.41	-.08	-.20	-.16	-.51
CCOSTICK	.81	-.13	.00	.18	-.10	-.05	.11	.79	-.22	-.31	-.10	-.27	-.18	-.14
CFI8DUCK	.39	.03	-.12	-.03	.23	-.32	-.32	.51	-.14	-.36	-.16	-.02	-.46	-.45
B1CROPEN	.10	-.13	.22	-.09	.63	.07	.13	-.15	.04	.35	.06	.66	.15	.34
B1LEOPEN	-.05	.02	.05	-.09	.85	.00	-.15	-.23	.12	.23	.14	.82	.07	.12
BFLAMING	.09	-.09	.14	-.10	-.65	.04	-.17	.29	-.20	-.13	-.28	-.72	-.09	-.34
F2FOOTTA	-.01	-.07	.85	-.02	.04	.11	-.14	-.30	.13	.81	.06	.20	.21	.16
FTAPPING	.06	.05	.77	.17	.03	.00	-.01	-.29	.26	.78	.22	.25	.16	.26
F1FOOTTA	.14	.17	.41	-.06	.14	.01	.42	-.15	.36	.57	-.01	.33	.17	.60
FLTOESIT	.01	.83	-.03	.12	-.03	.13	-.02	-.14	.85	.20	.22	.12	.28	.16
FLTOESTA	-.19	.84	-.10	-.04	.03	-.01	.01	-.26	.84	.19	.10	.17	.14	.20
FLPUSH1L	-.02	.57	.34	-.02	-.02	-.21	.07	-.18	.63	.47	.02	.14	-.06	.25
ESTANJUM	-.04	.10	-.08	.13	.06	.80	-.09	-.21	.22	.09	.32	.16	.83	.09
E20MDASH	.06	.09	-.18	.11	.01	-.75	-.02	.23	-.07	-.30	-.06	-.10	-.76	-.22
EREFLOOR	.10	.07	-.23	.46	.07	.07	.29	-.06	.13	-.09	.45	.20	.19	.24
SARMHANG	.02	-.01	-.13	.17	.02	-.06	.83	-.18	.14	.14	.16	.25	.12	.78
SPULLUPS	-.28	-.22	-.04	.47	.21	.00	.24	-.49	-.06	.17	.58	.42	.18	.31
SHORHOLD	.13	.02	.14	.80	-.15	-.12	.21	-.15	.12	.16	.71	.09	.07	.18
SSIT-UPS	-.43	-.04	.20	.55	-.01	-.14	-.32	-.55	.03	.25	.65	.17	.02	-.18
SHANDGRI	.27	.11	.06	.59	.03	.29	-.19	.04	.16	.02	.59	.11	.35	-.14

Table 8. CORRELATION MATRIX OF FACTORS OF MEANS OF REPETITIONS

FACTORS	1	2	3	4	5	6	7
1. COORDINATION	1.00	-.13	-.37	-.30	-.26	-.19	-.24
2. FLEXIBILITY	-.13	1.00	.25	.10	.15	.16	.21
3. FREQUENCY	-.37	.25	1.00	.07	.25	.17	.33
4. FORCE-REGUL	-.30	.10	.07	1.00	.24	.21	.01
5. BALANCE	-.26	.15	.25	.24	1.00	.11	.28
6. EXPLOSIVE	-.19	.16	.17	.21	.11	1.00	.20
7. ISOMETRIC	-.24	.21	.33	.01	.28	.20	1.00

DISCUSSION

The obtained pattern and structure matrices showed that in every case, there were six factors named in the same way, and their patterns and structures are similar, but not the same. The first three cases produced seven factors, and the seventh factor in every case was a single or dual factor. In the case, where a motor test result was the score on the first principal component, the factor analysis produced six quite well defined factors. At first sight it is obviously that in this case the applied factor analysis produced a more parsimonious solution than in the other cases. Advantage of the last result registration procedure was obtained also in the research with pre-school children (Bala 1999).

Frequency of simple movements was best defined, when all items are considered in the test, which really measure this ability. Even one item is good, but it must be the best test score of the three performed items. But as the pattern and the structure coefficients of this factor showed in every case (Table 3, 5, 7 and 9), the motor test »One foot tapping« is a poor estimator of frequency of simple movements. This means that this test had very poor validity. This group of variables (Two-foot tapping – F2FOOTTA, Arm plate tapping – FTAPPING and One foot tapping – F1FOOTTA) had the lowest communalities in the entire motor space, and »One foot tapping« had the lowest value in this group.

Flexibility is quite a well-defined factor in every analysed case. Similarity of performance of the test »Toe touching-sitting straddle« (FLTOESIT) and »Toe touching-standing« is obvious, so their variables had literally the same projections on this factor. It is very interesting that this factor had no statistically significant correlations with the other four motor factors, in the case when only one item – first or best repetition – is taken in the analysis. These two tests had very good validities of obtained factors named »flexibility«. The

Table 9. PATTERN AND STRUCTURE MATRICES OF FIRST PRINCIPAL COMPONENT OF THE CORRELATION MATRIX OF EVERY REPETITION RESULT

VARIABLES	Pattern Matrix						Structure Matrix					
	1	2	3	4	5	6	1	2	3	4	5	6
CAGFLOOR	.06	.80	-.06	.06	.09	-.05	-.23	.75	-.15	-.15	-.16	-.20
CDRAJUMP	-.25	.40	-.02	.19	-.12	-.14	-.44	.52	-.21	.02	-.35	-.29
CCOSTICK	.04	.80	-.11	.11	-.03	.01	-.27	.78	-.23	-.09	-.29	-.17
CFI8DUCK	.02	.42	-.01	.08	-.08	-.45	-.28	.52	-.20	-.10	-.26	-.54
B1CROPEN	.68	.12	-.07	-.04	.22	-.07	.65	-.16	.12	.03	.36	.09
B1LEOPEN	.72	.06	-.06	.02	.12	-.16	.67	-.20	.10	.11	.27	.03
BFLAMING	-.72	.04	-.06	-.08	.10	.08	-.71	.28	-.20	-.22	-.12	-.14
F2FOOTTA	-.04	-.04	-.09	.05	.82	.14	.24	-.30	.15	.04	.81	.21
FTAPPING	.04	.03	.07	.19	.74	.06	.32	-.28	.29	.18	.76	.20
F1FOOTTA	.37	.10	.21	-.16	.37	.14	.51	-.17	.41	-.10	.52	.29
FLTOESIT	-.07	.01	.85	.17	-.04	.08	.18	-.14	.85	.20	.15	.30
FLTOESTA	.00	-.17	.86	.00	-.11	-.06	.24	-.26	.84	.07	.16	.18
FLPUSH1L	.04	-.04	.60	-.03	.29	-.19	.24	-.19	.65	-.03	.45	.01
ESTANJUM	-.09	-.01	.04	.23	-.02	.75	.17	-.20	.21	.34	.05	.77
E20MDASH	.07	.03	.13	.06	-.21	-.78	-.18	.20	-.11	-.05	-.26	-.75
EREFLOOR	.29	.12	.09	.33	-.22	.16	.31	-.05	.14	.39	-.15	.26
SARMHANG	.57	-.10	.03	.02	-.23	.17	.60	-.29	.18	.19	-.01	.34
SPULLUPS	.39	-.29	-.20	.39	-.05	.04	.52	-.51	-.04	.54	.10	.22
SHORHOLD	.15	.11	.06	.68	.08	-.02	.27	-.15	.13	.67	.08	.13
SSIT-UPS	-.11	-.41	-.05	.62	.20	-.21	.14	-.54	.00	.66	.23	-.04
SHANDGRI	-.14	.24	.11	.69	.10	.20	.01	.03	.14	.63	.01	.26

Table 10. CORRELATION MATRIX OF FACTORS OF FIRST PRINCIPAL COMPONENT OF THE CORRELATION MATRIX OF EVERY REPETITION RESULT

FACTORS	1	2	3	4	5	6
1. BALANCE	1.00	–.37	.26	.18	.29	.28
2. COORDINATION	–.37	1.00	–.15	–.26	–.30	–.22
3. FLEXIBILITY	.26	–.15	1.00	.04	.26	.26
4. FORCE-REGUL	.18	–.26	.04	1.00	–.04	.16
5. FREQUENCY	.29	–.30	.26	–.04	1.00	.12
6. EXPLOSIVE	.28	–.22	.26	.16	.12	1.00

third one had poor validity and should not be used to measure general flexibility (maybe specific flexibility for some specific kinesiological activities, for instance: artistic and rhythmic gymnastics, artistic skating, karate, kick-boxing etc.).

Independence of the flexibility factor from most of the other motor factors pointed to the existence of the problem linked to the nature of flexibility.

The speed of solving complex motor problems (co-ordination) is the factor, which had very high projections of two variables (test »Agility on the floor« – CAGFLOOR and test »Co-ordination with stick« – CCOSTICK), and much smaller projections of the variables »Figure-8 duck« (CFI8DUCK) and »Dragging and jumping over« (CDRAJUMP). The best result was obtained in the case, when a motor test result was the factor score of the first principal component of the correlation matrix of every repetition (item) in the corresponding test. In that case, the correlation coefficients between this factor and all other motor factors were statistically significant. Validity of the applied motor tests for such co-ordination was very good for »Agility on the floor« and »Co-ordination with stick«, but very poor for the other two tests.

Continuous regulation of muscle force is the factor which had a very similar pattern and structure in all cases of the analysed result registration procedures, except when the result was the score of the best repetition. The hypothetical sample of motor variables which should estimate general strength, was divided into two groups and defined two factors: 1) continuous regulation of muscle force, and 2) dual factor, defined by variables of trunk strength and maximal force of attempted movement of hand – when the best repetition of every test was analysed.

In other analyses, hypothetical general strength was defined by almost all the variables mentioned above, which were named as continuous regulation of muscle force. The exception was the variable SARMHANG (Bend arm hang), which made a »single factor, defined by the variable of absolute isometric strength of upper extremities«.

Balance is a motor factor, which was defined well in all four cases, but the most homogenous solution was obtained, when the motor test result was considered as a first principal component of the correlation matrix of every repetition. This factor had statistically significant correlations with all other factors in the mentioned case and when the result of test was the average (or sum) of repetitions in every motor test. In the other two cases, there were no significant correlations with flexibility and explosive strength (Table 4) and flexibility, explosive strength and dual factor, defined by variables of trunk strength and maximal force of attempted movements of hand (Table 6). The test »One foot length-wise balance-eyes open« (B1LEOPEN) had the best validity and the test »Flamingo« (BFLAMING) a lower one. Balance test with the lowest validity was »One foot cross balance-eyes open« (B1CROPEN).

Explosive strength was defined very well only by two variables (»Standing broad jump« – ESTANJUM and »20m dash« – E20MDASH), but the third hypothetical explosive variable (»Spring forward from front support on the floor« – EREFLOOR) had validity too low to be taken as a measure of this motor ability.

Isometric strength was obtained in two cases as a single factor, with very high validity of the variable »Bent arm hang« (SARMHANG), or in combination with the variable to estimate the absolute strength of upper extremities and trunk, or even to estimate balance, which has in common excitation duration regulation (tonus and synergetic, but also strength regulation).

CONCLUSIONS

When the test results are used for scientific purposes, from a strictly theoretical point of view, in order to obtain good motor test results, the researchers should use composite motor tests with several items in every test. The items are the same motor tasks, which the subject needs to perform several times successively, without or with a short pause. Of course, standardised performance instructions of every test must be fully respected. Preference should be given to the procedure that assumes computing the factor scores of the first principal component of the correlation matrix of every performance of the same test. In that way the metric characteristics of motor tests should be adequate.

Certain preference should be given also to the sum-results registration procedure of all repetitions of the same test. But it is also worthwhile to take into consideration the best result among more repetitions of the same test.

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