**FACTA UNIVERSITATIS**
Series: **Physical Education and Sport** Vol. 14, N° 1, 2016, pp. 99 - 108

**Original research article**

# VIRTUAL SPACE OF THE BASIC MOTORIC STRUCTURES

*UDC 796.012.1*

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**Abstract**. *A battery composed of 18 composite motor tests, which were assumed to be proper indicators of 9 hypothetical motor dimensions, was analyzed based on the hypothetical model of motor dimensions. The tests were applied on a sample of 220 girls aged ten. By using the factor analysis, the previous predictions of the existence of 9 factors which can generally be used for explaining motor space on the applied sample have not been confirmed because a certain number of variables do not saturate those basic vectors which were thought to determine the assumed motor structures. The results of this paper disaffirm the present validation of structural theories of motor skills and confirm the opinion that at this level of physical education research it is not possible to define the unique model of basic structures which could be used to explain the motor space of the entire human population. Considering the specificities of the sample (maturation, gender, the achieved level of motor skills, cognitive, conative and other characteristics of the sample), there is a great number of hypothetical models which can be used to explain the structure of motor space.*

**Key words:** *measuring instruments battery, basic vectors, motor skills*

## INTRODUCTION

The idea to model motor space appeared during the middle of the last century. Numerous studies followed and they did not structure this latent antrophomotoric space which would fulfill all the scientific criteria. Several seemingly stable models have been recommended Kurelić et al. (1975), Bonacin & Blažević (2006), Mekota (2000), Šimunek (2006), Zaciorski (1975), but one universal taxonomy still has not been accepted. On the other hand, the opinion of Bala & Ambrožič (2002, 2013), Sturza-Milić (2009), Šekeljić, Stamatović, & Georgiev (2014) that all the possibilities of the scientific validation of the motor structures have not been used is more and more present. In Bala and Ambrožič's research (2013), based on the

Received December 25, 2015 / Accepted March 18, 2016
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application of the MUAD DIB program - version 2.0 designed by Momirović (2001) with the aim of obtaining information about a battery of measuring instruments, it has been ascertained that there is a need for restructuring the assumed motor space model and reconstruction of the applied battery of tests. Motor skills represent basic information in kinesiological research. This is the reason why the precise definition of motor dimensions and determining the validity of the measuring instruments used for their valuation is an existential/basic methodological problem. This research has been carried out to analyze the structure of motor space on the sample of 10-year-old girls, in order to observe the correlation between the characteristics and based on that, define the structure of basic vectors, the contribution of each factor to the characteristics and contribution of each characteristic to the factor, and finally, to define the position and the influence of each motor dimension in the new hypothetical model. It was possible to compare the model made in this way with the tested model determined by 9 latent dimensions.

## METHOD

### The sample of participants

The research included 220 girls aged ten.

### Measures

The assessment of 9 motor skills was made using the battery of 18 tests which were also used by Kurelić et al. (1975). Explosive power was assessed by the Standing Broad Jump Test (SBJ) and Medicine Ball Throw Test (MBT), repetitive force by Sit-Ups in 30 seconds Test (SU) and Torso Straightening Ups Test (TSU), the static force by Bent Arm Hang Test (BAH) and the Hand Dynamometry Test (HD). The sprint speed was assessed by the 20 m Run Test with a Flying Start (S20) and the 30 m Sprint Test With a High Start (S30), segmentary speed by Plate Tapping (PT) and Foot-Tapping Test (FT). Flexibility was assessed by the Sit-and-Rich Test (SR) and the Lateral Side-Bending Flexibility Test (LSB), balance by the Flamingo Balance Test (F) and Standing on One Foot on the Bench (SFB). Coordination was assessed by tests Transfer Stick Through The Legs (SP), and Ball Bouncing Against the Wall for 15 seconds (BB), precision by the tests of Hitting the Horizontal Target With a Ball (HHB), and the Darts Test (P).

### Statistical method

For the purpose of data processing the software SPSS version 11.0 was used, i.e. the method of Factor Analysis was used in the statistical data analysis.

## RESULTS

Factor analysis enables the determination of a small number of basic variables which explain the studied motor space.

Six vectors which provide the biggest amount of information about the variables were determined using the intercorrelation matrix, principal component analysis (table 1), and the Guttman-Kaiser Criterion according to which it is necessary to keep only those principal components whose characteristic root is equal or bigger than 1. This way it was deduced that the assumed model of 9 factors does not correspond to the six-vector structure which is more characteristic of this sample. This can be explained by the fact that this sample is characterized by the variables which have less specificity than the expected ones, which resulted in a smaller number of factors. This is the reason why the centroid method of the factor analysis grouped 18 variables around 6 factors.

**Table 1** Characteristic roots and the percentage of participation of each isolated component used in explanation of the overall variance

| n | root | % | sum | n | root | % | sum |
|---|---|---|---|---|---|---|---|
| 1 | 4.524 | 25.136 | 25.136 | 10 | .777 | 4.316 | 79.868 |
| 2 | 1.500 | 8.335 | 33.471 | 11 | .698 | 3.877 | 83.745 |
| 3 | 1.436 | 7.977 | 41.448 | 12 | .601 | 3.342 | 87.087 |
| 4 | 1.276 | 7.089 | 48.538 | 13 | .538 | 2.991 | 90.078 |
| 5 | 1.205 | 6.695 | 55.233 | 14 | .457 | 2.540 | 92.618 |
| 6 | 1.030 | 5.722 | 60.956 | 15 | .431 | 2.393 | 95.011 |
| 7 | .946 | 5.255 | 66.211 | 16 | .401 | 2.228 | 97.239 |
| 8 | .847 | 4.705 | 70.916 | 17 | .346 | 1.921 | 99.160 |
| 9 | .835 | 4.636 | 75.553 | 18 | .151 | .840 | 100.000 |

**Table 2** The structure of 6 selected principal components of the system and vectors of the manifest variables (qlt - communality; #F factor coordinate; cor - the contribution of the factor to the characteristic; ctr - the contribution of the characteristic to the factor)

| | J1 | qlt | 1#F | cor | ctr | 2#F | cor | ctr | 3#F | cor | ctr | 4#F | cor | ctr | 5#F | cor | ctr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SBJ | 586 | -672 | 452 | 100 | 277 | 76 | 51 | -51 | 3 | 2 | 196 | 39 | 30 | -129 | 17 | 14 |
| 2 | MBT | 656 | -647 | 419 | 93 | -134 | 18 | 12 | -460 | 212 | 148 | -76 | 6 | 5 | -34 | 1 | 1 |
| 3 | SU | 449 | -585 | 342 | 76 | 32 | 1 | 1 | 120 | 14 | 10 | -267 | 71 | 56 | 141 | 20 | 16 |
| 4 | TSU | 318 | -450 | 202 | 45 | -1 | 0 | 0 | 234 | 55 | 38 | 204 | 42 | 33 | -139 | 19 | 16 |
| 5 | BAH | 423 | -537 | 288 | 64 | 316 | 100 | 67 | 33 | 1 | 1 | 174 | 30 | 24 | -60 | 4 | 3 |
| 6 | HD | 521 | -431 | 186 | 41 | -467 | 370 | 196 | -283 | 80 | 56 | -182 | 33 | 26 | -56 | 3 | 3 |
| 7 | S20 | 772 | 708 | 501 | 111 | -457 | 209 | 139 | -38 | 1 | 1 | 9 | 0 | 0 | -246 | 60 | 50 |
| 8 | S30 | 780 | 705 | 497 | 110 | -389 | 151 | 101 | -104 | 11 | 8 | 48 | 2 | 2 | -345 | 119 | 99 |
| 9 | PT | 698 | -459 | 211 | 47 | -422 | 178 | 119 | 492 | 390 | 168 | -221 | 49 | 38 | -137 | 19 | 16 |
| 10 | FT | 293 | -383 | 147 | 32 | -142 | 20 | 13 | -41 | 2 | 1 | -229 | 53 | 41 | -267 | 71 | 59 |
| 11 | SR | 651 | -98 | 10 | 2 | 223 | 50 | 83 | -512 | 389 | 183 | -77 | 6 | 5 | -568 | 401 | 268 |
| 12 | LSB | 582 | -631 | 399 | 88 | -160 | 26 | 17 | -335 | 112 | 78 | -201 | 41 | 32 | -69 | 5 | 4 |
| 13 | F | 391 | -198 | 39 | 9 | -228 | 52 | 35 | -147 | 22 | 15 | 36 | 1 | 1 | 527 | 397 | 230 |
| 14 | SFB | 523 | -158 | 25 | 5 | 375 | 140 | 94 | 375 | 141 | 98 | -61 | 4 | 3 | -461 | 383 | 197 |
| 15 | SP | 579 | 434 | 188 | 42 | 299 | 89 | 80 | -515 | 388 | 184 | 164 | 27 | 21 | 102 | 10 | 9 |
| 16 | BB | 448 | -647 | 419 | 93 | -105 | 11 | 7 | -83 | 7 | 5 | -3 | 0 | 0 | 106 | 11 | 9 |
| 17 | HHB | 640 | -279 | 78 | 17 | -162 | 26 | 18 | -38 | 1 | 1 | 731 | 534 | 419 | -1 | 0 | 0 |
| 18 | P | 631 | -348 | 121 | 27 | -366 | 134 | 89 | 68 | 5 | 3 | 582 | 399 | 265 | -180 | 32 | 27 |
| | | | | | 1000 | | | 1000 | | | 1000 | | | 1000 | | | 1000 |

Note: all results shown in the tables are multiplied by 1000.

Based on the analysis of the data in table 2, it can be seen that a certain number of variables (those with core values smaller than 400) do not belong to any factor. These results can be explained by the fact that, besides the controlled variations, influences which cannot be controlled appear. According to Perić (2003), this happens because it is impossible to control the effect of all the influences in the research and it is impossible to control all the specificities of the sample and completely eliminate the mistakes in the measurement. This is the reason why it should be taken into consideration that in the factor analysis uniqueness is the result of the influence of the unexamined factors, the specificity of the variables and the mistakes in the measurement which can occur as a consequence of insufficiently standardized instruments, and other factors which make the research inconsistent. As a result, big deviations occur because of the big spans in the frequency distribution.

Overall participation of the first 6 factors in the explanation of the variance is 61%. The first two factors are the most significant because 33,5 % of them participate in the explanation of the variance. Considering the pattern matrix (table 1), it can be seen that the first principal component explains 25% of the total variance of the system. Factor one (table 3) consists of the motor exams which are assumed to assess speed, explosiveness, coordination and flexibility (table 3). It is obvious that in this factor the abilities with so-called myogenic output dominate, which means that the first factor consists of the variables which primarily depend on the contractile abilities of muscles. Thus this vector can be called myogenic. The variable BB, which should assess the coordination in the physical activities, showed a tendency to be one of the strength indicators of the upper and lower extremities.

**Table 3** The variables that constitute factor 1 - Myogenic factor

| Variables | cor |
|---|---|
| S20 | 501 |
| S30 | 497 |
| SBJ | 452 |
| MBT | 419 |
| BB | 419 |
| LSB | 400 |

This is not difficult to understand considering the fact that the motor task in the test is conceived as throwing the ball hard against the wall and its bouncing off the wall. The participant should quickly catch the ball and throw it again quickly against the wall. In order to fulfil the task, the participant is required to move fast left and right and that he/she has strong hand movements while throwing and catching the ball. In that case the lower and upper extremities are quite burdened. This set of variables in the first vector refers to the statement that there is a connection between the factors responsible for synergistic regulation, the regulation of muscle tone and the factors responsible for the structuring of movement.

**Table 4** The variables that constitute factor 2

| Variables | cor |
|---|---|
| HD | 370 |

Factor 2 (table 4), whose contribution to the explained variability is 8%, showed significant projections on only one variable - the hand dynamometry. In order for one factor to exist as an independent, it is necessary for it to be represented by at least two variables, thus this factor cannot be acknowledged. It is interesting that also in Bale and Ambrožić's paper (2002), the dinamometry test was not a proper indicator of static force, but it was a proper indicator of flexibility, which the authors interpreted by the involvement of the synergistic regulation factor and regulation of the muscle tone factor, which is, according to the hypothetical model, superordinate to flexibility in the dinamometry variance.

**Table 5** The variables that constitute factor 3 – the vector of fast hand manipulation

| Variables | cor |
|---|---|
| SP | 388 |
| PT | 390 |

Factor 3 (table 5) whose contribution to the explained variability is 8 % consists of two variables. The characteristic of these two tests for which they are thought to assess different segments in the motor space (coordination and segmentary speed) is that for its success, hand speed is very important. This is the reason why this factor can be called the fast hand manipulation factor.

**Table 6** The variables that constitute factor 4 - The vector of the precision

| Variables | cor |
|---|---|
| HHB | 534 |
| P | 389 |

The contribution of factor 4 to the explanation of the variability is 7% (table 6). This factor is simple because it consists of two variables which determine the precision. This is why it can be called the precision factor.

**Table 7** The variables which constitute factor 5 - The balance vector

| Variables | cor |
|---|---|
| SR | 401 |
| F | 397 |
| SFB | 383 |

Factor 5, whose contribution to the explained variability is 6,7% consists of 3 variables. One of them determines the flexibility, and the other two assess the balance (table 7).

Based on the hypothesized matrix structure of the motor factors, calculating the correlation matrix, and converting the hypothesized matrix structure into the Mahalanobis form, intercorrelations between latent motor dimensions were obtained. The information indicates that some variables which should assess the same motor skill are not significantly connected, whereas good connections were assessed in some subsets.

**Table 8** Correlation matrix and simple linear correlation coefficients between each of the 18 applied variables

| | SBJ | MBT | SU | TSU | BAH | HD | S20 | S30 | PT | FT | SR | LSB | F | SFB | SB | BB | HHB | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SBJ | 1000 | | | | | | | | | | | | | | | | | |
| MBT | 371 | 1000 | | | | | | | | | | | | | | | | |
| SU | 346 | 276 | 1000 | | | | | | | | | | | | | | | |
| TSU | 272 | 152 | 157 | 1000 | | | | | | | | | | | | | | |
| BAH | 440 | 259 | 315 | 181 | 1000 | | | | | | | | | | | | | |
| HD | 126 | 414 | 207 | 169 | 161 | 1000 | | | | | | | | | | | | |
| S20 | -518 | -336 | -361 | -311 | -344 | -135 | 1000 | | | | | | | | | | | |
| S30 | -373 | -381 | -439 | -258 | -381 | -116 | 798 | 1000 | | | | | | | | | | |
| PT | 116 | 192 | 284 | 255 | 104 | 234 | -147 | -220 | 1000 | | | | | | | | | |
| FT | 218 | 214 | 184 | 45 | 186 | 174 | -165 | -145 | 237 | 1000 | | | | | | | | |
| SR | 149 | 205 | 30 | 24 | 62 | 33 | -37 | 59 | -132 | 97 | 1000 | | | | | | | |
| LSB | 311 | 541 | 338 | 193 | 131 | 358 | -341 | -352 | 249 | 210 | 166 | 1000 | | | | | | |
| F | 15 | 169 | 66 | -35 | 61 | 103 | -82 | -153 | 94 | 37 | -34 | 95 | 1000 | | | | | |
| SFB | 121 | -9 | -29 | 85 | 186 | -92 | -146 | -169 | 187 | 45 | 112 | 43 | -74 | 1000 | | | | |
| SP | -241 | -114 | -354 | -199 | -114 | -142 | 156 | 166 | -435 | -178 | 74 | -154 | -86 | -129 | 1000 | | | |
| BB | 425 | 388 | 213 | 279 | 283 | 243 | -392 | -338 | 241 | 242 | 2 | 425 | 199 | 4 | -268 | 1000 | | |
| HHB | 222 | 152 | 65 | 152 | 151 | 26 | -100 | -107 | 38 | 70 | 5 | 119 | 166 | 0 | -91 | 123 | 1000 | |
| P | 212 | 205 | 63 | 185 | 163 | 203 | -102 | -124 | 237 | 68 | -35 | 159 | -8 | -24 | -149 | 174 | 342 | 1000 |

The largest correlation (798) (table 8) exists between the 20 m run test with a flying start (t20) and 30 m sprint tests with a high start (t30). Such a high correlation is expected considering the fact that both tests assess the same motor skill - sprint speed.

Significant correlations were established between:

- the Run Test with a Flying Start (S20) and the Standing Broad Jump Test (SBJ), (-518),
- the 30 m Sprint Test With a High Start (S30) and Torso Straightening Ups Test (TSU), (-439),
- the Ball Bouncing Against the Wall for 15 seconds (BB) and the Standing Broad Jump Test (SBJ), (425),
- the Ball Bouncing Against the Wall for 15 seconds (BB) and Medicine Ball Throw Test (MBT), (388),
- the tests for the assessment of explosive strength of the cranial and caudal part of the body (371) which were assessed by the Standing Broad Jump Test (SBJ) and Medicine Ball Throw Test (MBT),
- the Bent Arm Hang Test (BAH) and Standing Broad Jump Test (SBJ), (440),
- the tests of Hitting the Horizontal Target With a Ball (HHB) and Darts Test (P), which was used to assess precision (342).

Significant correlations exist between the Standing Broad Jump Test (SBJ) 20 m Run Test with a Flying Start (S20) and the 30 m Sprint Test With a High Start (S30). A negative sign appeared as a consequence of the measurement methodology, namely the explosive power of the lower extremities was assessed by the long jump test in which the values are higher if the result is greater. Speed of movement was assessed by the 20 m and 30 m Sprint Test in which the result is better if the values expressed in seconds are lower on the test. Such data is quite expected considering the connection between speed and explosive power which has already been confirmed many times.

Small correlations (157) were achieved between the Sit-Ups and Torso Straightening up Test, which were used for assessing the repetitive force of the torso. This can be explained by the fact that those are the tests which are used to assess the repetitive force of different muscle groups and they do not have to be equally developed.

The situation is similar with the tests (correlation - 161) the Bent Arm Hang Test (BAH) and the Hand Dynamometry Test (HD) which were used to assess the flexor of the elbow force and finger and carpus flexor force. According to Popović, Cvetković & Grujičić (2006), such findings are the result of the methodological nature of measurement and the metric characteristics of the tests which depend more on conative factors (fear, motivation). The research of Šekeljić, Stamatović, Marković, & Marković (2013) showed that the BAH does not contain the required sensitivity, satisfactory discrimination and that it is not sufficiently standardized. This is the reason why it is not surprising that such a test is not significantly connected to the hand dynamometry test, which instead of being an indicator of explosive power, explained the flexibility better in Bala & Ambrožič's research (2002).

A surprisingly small correlation (-74) was established between the tests used to assess balance: Flamingo Balance Test (F) and Standing on One Foot on the Bench (SFB). In Bala & Ambrožič's research (2002) it was ascertained that the variables for the assessment of balance do not properly assess the hypothetical factor of balance, but they perfectly assess the general strength factor. Poor discrimination of the balance tests in young school-aged children was ascertained in the papers of Šekeljić & Marković (2011). Balance is the ability to maintain body equilibrium in different movements and positions. It depends on information, visual analyzers, kinesthetic analyzers and vestibular apparatus. This is the reason why the best, but also the stable, results for this motor skill can be expected only after 12 years of age (Gajić, 1985). Besides, there is a difference between the abilities to maintain balance in the state of relative rest (static balance), and in the state of motion (dynamic balance). It is considered that there is a difference between the balance established and maintained in moments when eyesight is active and when it is not.

Physiological mechanisms that dominate in maintaining the balance are based on structuring the neuromuscular schemes. Panjan & Sarabon (2010), who dealt with the analysis of the majority of known tests for assessing balance, observed that the reliability of the tests is lower than 0.90 in their review. They explained this phenomenon by the maturation specificities of the population. This indicates that this motor skill cannot be explained by only one test. One of the conclusions is that dynamic balance is more complex for assessment than static balance. It requires better equipment and more advanced methods which are applied in some clinical cases and in more advanced research such as EquiTest and Balance System SD, and the application of so-called machine learning methods or the application of machine data tools.

A negative correlation (-268) was ascertained between two tests used for assessing coordination - Transfer Stick Through The Legs (SP) and Ball Bouncing Against the Wall for 15 seconds (BB). Perić (1994) indicated that linkage of individual movements into the complex motor continent require time, space and mechanical factors incorporated into the complex coordination structures to ensure timely neuromuscular synergies of motor units. This is the reason why the level of coordination of some motor task expressions depends on accuracy with regard to space, time and force and directly depends on the maturity, development and practice of the structures which participate in its manifestation. Šimunek (2006) thinks that there are seven basic abilities which can characterize coordination (kinesthetic, spatial, rhythmic, reaction speed, balance, reorganization of movement and the ability to learn new movements). Motor tasks in these two tests for assessing coordination are quite different, which suggests the possibility that success on these two tests depends on different structures of the motor space (strength, speed, explosiveness, balance) and typologically different muscle structures.

## Discussion

Motor development is an active consequence of developmental changes, thus they directly project the quantitative and qualitative characteristics of movement in a certain moment of the specificity of the neuromuscular and the overall motor system development (Kukolj, 2003). There is also an agreement that many factors influence the development and differentiation of motor skills. Some of them are hereditary, others are the consequence of the environment and activities. From the standpoint of developmental psychology, every human being has genetically determined abilities whose development can be expected within a broadly defined space which depends on the conditions of the environment and the activities of every individual. There are different opinions on the question when the differentiation and final defining of motor space start. The research of Rajtmajer & Proje (1990), Rajtmajer (1993), Planinšec (1995), conducted by using factor analysis, indicates that there is a significant differentiation of motor skills in children already starting at the age of 3, and that at the age of 8 motor skill structure is similar to the structure of adults. On the other hand, the research of Ismail (1976), Proje (1980), Gajić (1985), Gallahue (1987), Perić (2003), Bala & Krneta (2006), Bala, Popović & Sabo (2006) indicates that motor functioning in children until the age of 7, even until the age of 10, is general. This means that there are still no differentiated motor skills until that period. Luria (1976) explains the existence of general motoric factor and the absence of clearly differentiated skills in children by the insufficient functional formation of the secondary and tertiary motor areas of the cerebral cortex. Thus, the central nervous system must function integrally. Therefore, until the age of 7, the latent space of motor skills should be considered from the aspect of the unique IT component of motor expressions, which is almost identical in boys and girls. Differentiation begins at the age of 12, and in some cases even later. It is a consequence of neurophysiological development. This research confirms Bala & Krneta (2006) and Bala & Ambrožič's statement (2013) that our preconceptions about the nature of the indicators of motor dimensions are not always correct, nor are they correct on some specific sample of participants. Consequently certain tests can be adequate measuring instruments for a certain sample, whereas for other persons they are completely inadequate, and this is the reason why one should pay attention to using a battery of tests selectively.

## Conclusion

In this paper, the testing of a hypothesized structural model of motor dimensions has been carried out. The aim of this paper is to check the previously formulated hypothetical model of basic motor structures. The factor analysis applied on this sample did not confirm the previous predictions of the existence of 9 factors which could generally be used to explain the motor space of 10-year-old girls. It has been confirmed that a certain number of variables do not perform the saturation of those basic vectors, which were thought to determine the motor space. The results of this paper disaffirm the scientific validation of structural theories which assess the space of motor skills on the basis of hypothesized basic vectors. On the other hand, this research confirms those viewpoints which suggest that at this level of physical education research the unique model of basic structures which can be used to explain the motor structure of all possible samples cannot be defined. This research confirms the findings of some previous studies, e.g. Bala & Ambrožič (2013), Perić (2003), Šekeljić, Stamatović, & Georgiev (2014), that there is a larger number of hypothetical models of motor dimensions depending on the sample specificity and that this space can virtually be presented in an infinite number of ways. The existing speculative models, theories and conceptions on which they are based will hardly become valid in the near future for the simple reason that it is very difficult to reduce the latent multidimensional structures, such as motor skills, to the level of manifest motor kinesiological manifestations and based on them, perform a scientifically valid assessment of basic structures in the motor space.

## REFERENCES

Bala, G., & Ambrožič, F. (2002). Rekonstrukcija baterije motoričkih testova na osnovu hipotetičkih faktora (Reconstruction of the battery of motor tests on the basic of hypothetical factor). In: G. Bala, (Ed.), T*he tenth International Interdisciplinary Symposium "Sport, physical activity and health of young people")*, Proceedings, pp. 12-21. University of Novi Sad: Faculty of Physical Culture.

Bala, G., & Ambrožič, F. (2013). Internal metric characteristics of motor tests on physical education students. *Acta Universitatis Carolinae. Kinanthropologica*, 39 (1), 5-17.

Bala, G., & Krneta, Ž. (2006). O metrijskim karakteristikama motoričkih testova za decu (About metric characteristics of motor tests for children). In: G. Bala, (Ed.), *The Interdisciplinary Scientific Conference with International Participation "Anthropological status and physical activity in children and youth, Anthropological characteristics and abilities of preschool children"*), Proceedings, pp.13-21. University of Novi Sad: Faculty of Physical Culture. In Serbian

Bala, G., Popović, B., & Sabo, E. (2006). *Fizička aktivnost devojčica i dečaka predškolskog uzrasta (Physical activity of girls and boys of preschool age).* In: G. Bala, (Ed.), *The Interdisciplinary Scientific Conference with International Participation "Anthropological status and physical activity in children and youth, Anthropological characteristics and abilities of preschool children")*, Proceedings, 75-102. University of Novi Sad: Faculty of Physical Culture.

Bonacin, D., & Blažević, S. (2006). The avantgarde model of motor abilities. In: G. Bala, (Ed.), *The Interdisciplinary Scientific Conference with International Participation "Anthropological status and physical activity in children and youth, Anthropological characteristics and abilities of preschool children"*), Proceedings, pp.39-45. University of Novi Sad: Faculty of Physical Culture.

Gajić, M. (1985)*. Osnovi motorike čoveka (Basics of human motorics).* Novi Sad: Faculty of Physical Culture. In Serbian

Gallahue, D.A. (1987). *Development physical education for todey s elementary school children.* New York: Macmillian.

Ismail, A.H. (1976). Integralni razvoj: teorija i eksperimentalni rezultati (Integral development: Theory and experimental results). *Kineziologija*, 1 (2), 6-28.

Kukolj, M. (2003). *Razvoj motoričkih sposobnosti dece i omladine (Development of motor skills of children and youth).* In: B. Jevtić, J. Radojević, I. Juhas, & R. Ropert, Dečiji sport od prakse do akademske oblasti (Children's sport from practice to academic field), pp.102-118. University of Belgrade: Faculty of Sport and Physical Education. In Serbian

Kurelić, N., Momirović, K., Stojanović, M., Šturm, J., Radojević, Đ., & Viskić-Štalec, N. (1975). *Struktura i razvoj morfoloških i motoričkih dimenzija omladine* (T*he structure and development of motor dimension* in youth). Belgrade: Faculty of Physical Culture. In Serbian

Luria, A. R. (1976). *Osnovi neuropsihologije* (*Basics of neuropsychology*). Belgrade: Nolit. In Serbian

Mekota, K. (2000). Definice a struktura motorických schopností (Definition and structure of motor abilities). *Novější poznatky a střety názorů. Česká kinantropologie*, 4 (1), 59-69. In Czech

Momirović, K. (2001). *Program za konstrukciju ili rekonstrukciju baterija mernih instrumenata (Program for construction or reconstruction of measuring tool batteries).* Belgrade: Institute for Criminological and Sociological Research. In Serbian

Panjan, A., & Sarabon, N. (2010). Review of methods for the evaluation of human body balance. *Sport Science Review*, 19 (5-6), 131-163.

Perić, D. (2003). *Osnovi sportske lokomocije (Fundamentals of sports locomotion*). Belgrade: Self Edition of the Author. In Serbian

Planinšec, J. (1995). *Relacije med nekaterimi motoričnimi in kognitivnimi sposobnostimi petletnih otrok (Relationships between certain motor and cognitive skills of children five years).* Unpublished master's thesis, Ljubljana: Faculty for Sport. In Slovenian

Popović, B., Cvetković, M. & Grujičić, D. (2006). Trend razvoja motoričkih sposobnosti predškolske dece *(The trend of development of motor skills in preschool children).* In: G. Bala (Ed.), *The Interdisciplinary Scientific Conference with International Participation "Anthropological status and physical activity in children and youth, Anthropological characteristics and abilities of preschool children")*, Proceedings, pp.22-31. University of Novi Sad: Faculty of Physical Culture. In Serbian

Proje, S. (1980). *Prediktivna vrednost poligona u utvrđivanju opštih i specifičnih motoričkih sposobnosti u nižem školskom uzrastu u sportskoj gimnastici (The predictive value of polygons in determining general and specific motor abilities in the lower school age in gymnastics).* Unpublished doctoral dissertation, University of Belgrade: Faculty for Physical Education. In Serbian

Rajtmajer, D. (1993). Komparativna analiza psihomotorične strukture dečkov in deklic, starih 5-5,5 let (Comparative analysis of psycho motor skills of boys and girls aged 5-5, 5 years). *Šport,* 41 (4), 36-40. In Slovenian

Rajtmajer, D., & Proje, S. (1990). Analiza za neosetljivost in faktorska struktura kompozitnih tetsov za spremljenje in vrednotenje motorničega razvoja predškolskih otrok (Analysis of insensitive in factor structure of the composite tests for monitoring and evaluation of the motor development of preschool children). *Šport*, 38 (1-2), 48-51. In Slovenian

Šekeljić, G., & Marković, Ž. (2011). Metrijske karakteristike motoričkih testova za procenu ravnoteže (Metric characteristics of the motor tests for assessment of the balance). *Zbornik radova Učiteljskog fakulteta, Užice*, 13 (14), 257-268. In Serbian

Šekeljić, G., Stamatović, M., Marković, Ž., & Marković, J. (2013). Metric characteristics of the motor test used to estimate the force of arms and shoulders. *Facta Universitatis* series *Physical Education and Sport.* 11 (1), 115-124.

Šekeljić, G., Stamatović, M., & Georgiev, G. (2014). Problemi u definisanju hipotetičkog prostora motoričkih sposobnosti (Problems in defining a hypothetical motor skills). *Zbornik radova Učiteljskog fakulteta, Užice*, 17 (16), 109-122. In Serbian

Šimunek, J. (2006). *Model of development of coordination abilities in the long-term sports preparation in volleyball*. Oredea: Editura Universitation.

Sturza-Milić, N. (2009). *Identifikacija motorički darovitih učenika mlađeg školskog uzrasta* (*Identification of motor gifted pupils of younger school age).* Vršac: Higher School of Professional Studies for the Preschool Teachers "Mihailo Palov". In Serbian

Zaciorski, V. M. (1975). *Fizička svojstva sportiste (Physical properties of athletes).* Belgrade: Association for Physical Culture of Yugoslavia. In Serbian.

## VIRTUELNI PROSTOR BAZIČNIH MOTORIČKIH STRUKTURA

*Na osnovu hipotetičkog modela motoričkih dimenzija, analizirana je baterija od osamnaest kompozitnih motoričkih testova, za koje se pretpostavilo da su valjani indikatori devet hipotetičkih motoričkih dimenzija. Testiranje je sprovedeno na uzorku od 220 desetogodišnjih devojčica. Faktorskom analizom nisu potvrđena ranija predviđanja o postojanju devet faktora kojima se generalno može objasniti motorički prostor na primenjenom uzorku, jer određen broj varijabli ne vrši zasićenje onih bazičnih vektora za koje se mislilo da determinišu pretpostavljene motoričke strukture. Rezultati rada opovrgavaju postojeću validaciju strukturalnih teorija motoričkih sposobnosti i potvrđuju mišljenja Bale i Ambrožiča (2002, 2013), Perića (2003), Bonacina i Blaževića (2006), Šekeljića, Stamatovića i Georgieva (2014) da na ovom nivou nauke fizičke kulture nije moguće definisati jedinstven model bazičnih struktura kojima bi se mogao objasniti motorički prostor celokupne ljudske populacije. S sobzirom na specifičnosti uzorka (maturacije, pola, dostignutog nivoa motoričkih sposobnosti, kognitivnih, konativnih i drugih karakteristika uzorka) postoji veći broj hipotetičkih modela kojim se može objasniti struktura motoričkog prostora.*

Ključne reči: *baterija mernih instrumenata, bazični vektori, motoričke sposobnosti*