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MOTOR ABILITIES OF SIX YEARS OLD CHILDREN

(Original scientific paper)

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Abstract

Knowledge about the motor abilities, their manifestation, development, conditionality and possibilities for improvement in every age period especially in the pre – school and early school period are one of the key issues in kinesiology. This is especially important from the aspect of PE teaching process and requirements for adaptation of PE contents to children`s individual possibilities. Therefore, the aim of this paper is to determine the structure of motor space of 6 year old children. The research was conducted at a sample of 123 six year old children, pupils in first grade in four primary schools in Skopje. The structure of motor space was determined using 33 motor tasks applied for estimation of nine motor abilities. Using factor analyses, following 10 latent dimensions were isolated: speed, coordinated and explosive movements, realization of fast movements with legs, static balance, strength of the front parts of the trunk, arms and shoulders, preciseness with leading, flexibility, strength of the back parts of the trunk, arms and shoulders, preciseness with throwing and one undefined factor. Isolated factor and their manifestation are highly influenced by the development characteristics and changes specific for the researched period of age.

Keywords: *motor abilities, development characteristics, factor analyses, Physical Education, male children, motor tests,*

INTRODUCTION

Successful performance of any motor movement is conditioned by the level of development of motor abilities. They represent the essence of human motoric, which as a complex characteristics are manifeseted differently dependin from movement characteristics and development of individual potentials (Jovanovski, (Јовановски), 2013). The level of development of motor abilities is highly related with acquisition of different motor skills and habits respectively with the realization of PE contents, but also are closely related with possibilities to follow and estimate the effects of PE teaching process. From the aspect of physical and health education process, development of motor abilities is defined as one of the main goals in national curriculum for primary school education (Conception for nine years educational system in Republic of Macedonia, 2007). Regarded the evaluation of effects of teaching process and evaluation of children's` achievements, measurement and evaluation of motor abilities is rising up not just as an objective parameter for designing the final grade, but also as a manner for following of individual improvement of every child, and manner for determination of the efficiency of PHE teaching process.

According to the Conception for nine years educational system in Republic of Macedonia (Conception for nine years educational system in Republic of Macedonia, 2007), respecting the individual possibilities of every child, respectively the adjustment of educational contents of children's real possibilities and needs is one of the basic principles in educational work with children as well as in the realization of PE teaching process. These emphasize the need for separate and detailed studies for determination of structure of motor space of children in every period of age during the childhood, designing a valid tests for following and evaluation of children's` improvement regarded PHE teaching process. All these issues regarded the period of pre – school and early school period are subject of research in the studies of many researchers (Bala, 1981, 2002; Rajtmajer & Proje, 1990; Perić, 1991; Rajtmajer, 1993, 1997; Zurc, Pišot & Strojnik, 2005; Sabo (Сабо), 2002; Popeska (Попеска), 2009), as well as their relations with other segments of human anthropological status, mainly the relations with morphologic space (Bala, 1999, 2007; Strel, & Šturm, 1981; Dukovski, 1984; Rausavljević, 1992; Bala, Sabo & Popović, 2005; Pisot & Planinsec, 2005; Popeska (Попеска), 2011).

Separate studies for motor abilities and structure of motor space in children are especially important in the period of pre – school and early school age where development changes are very intensive and continuous (Haywood, & Getchell, 2004; Jürimäe, T. & Jürimäe, J, 2001; Malina, Bouchard & Bar – or, 2004). Knowledge

for children's development characteristics is especially emphasized when it refers to physical education teaching process, because the segment of motor development is closely related and influence to all other development domains (Malina et al, 2004). Considering all previously mentioned notes, supported by information obtained from the previouse studies (Bala, 1981, 1999, 2002; Dukovski, 1984; Rajtmajer & Proje, 1990; Perić, 1991; Rajtmajer, 1997; Bala, et al., 2005; Pišot & Planinšec, 2005; Popeska (Попеска), 2009, 2011), leads to the conclusion that the structure of motor space of children in the early school period, including six years old children, is not clearly determined and not precisely defined. Regarded this, the aim of this study is to determine the structure of motor space of 6 years old children.

The structure of motor space of children was studied applying two researching models: the structured model (Metikoš, Prot, Hofman, Pintar, & Oreb, 1989) and the functional model, or model of hierarchic structure (Kurelić, et al., 1975). The structure model suggested by Metikos et al., (1989) on a sample of children is applied in the studies conducted by Dukovski, 1984; Rausavljević, 1992; Perić, 1991; Rajtmajer & Proje, 1990; Pisot & Planinsec, 2005; Popeska, (Попеска), 2009, 2011. Results from these researches point out on existence of multiple motor abilities, which have not yet been clearly differenced, which are representative of several potential abilities that have a tendency to be isolated as separate independent abilities in the following periods of development. Results obtained using the functional model, applied in the researches of Bala, 1981, 2002; Bala & Nićin, 1997; Zurc & Strojnik., 2005; Lasan, Pažanin, Pejčić & Katić, 2005, indicates to the existence of general structure of motor space or existence on one general motor factor and several others factors from second and third row. This structure is defined based on regulatory mechanisms represented by a small number of isolated factors. In this research, we use the structural model as a starting point in defining the structure of motor abilities, while in the interpretation and discussion of results, it is complemented by findings and results obtained with functional hierarchical model. This approach gives a clear view of children's motor abilities and their development tendencies as well as the possibilities of PHE teaching process.

METHODS

The aim of this study is to determine the structure of motor space at 6 years old children. Therefore, we conducted a research as a part of larger study (Popeska (Попеска), 2011) realized on a sample of 123 examinees, six years old male children, pupils in the second grade in four primary schools in Skopje, Republic of Macedonia. Motor abilities were determined applying 33 motor tests, used for estimation of nine motor abilities.

Following motor tests were used: *[1] CO – ORDINATION*: Co – ordination with stick (KOPAL), Obstacle course backwards (KOPON), Two balls slalom rolling (KOSL2), Rolling with ball on floor (KOTRT); [*2] SPEED OF RUNNING*:10m running from flying start (BT10LS), running 4 x 10(BT4x10), Cries – cross running 4 x 5м (BTZMT); [*3] FREQUENCY OF MOVEMENT*: Arm plate – tapping (BSTAR), One foot - tapping(BSTAN), Both feet – tapping on wall (BSTNZ); *[4] EXPLOSIVE STRENGTH*: Standing broad jump (ESSDM), Throwing medicine ball 1 kg from standing position (ESFMST), Throwing medicine ball 1 kg from sitting position (ESFMG) и 20m dash running (ES20VS); *[5] REPETITIVE STRENGTH*: Modified pushups (RSSKL), Sit-ups(RSPTR),Trunk lift (PSITR),Hands pulling over the diagonal Swedish bench (RSVKK); *[6] STATIC STRENGTH*: Bent arms hang (SSVZG), Horizontal hold lying on stomach (SSZLM), Horizontal hold lying on back (SSZLG); [*7] FLEXIBILITY*: Deep bend on bench (FLDPK), Both legs extension lying on bag (FLRLG), Legs extended forward bend on floor (FLPRP); *[8] BALANCE*: Walking on upturned Swedish bench (RAOSK), Standing on bench in width (RASKS), Standing on bench in length (RASKD) and [*9] PRECISENESS*: Throwing circles on stick (PIOBS),Throwing tennis ball in vertical goal with arm (PITET), Throwing ball in horizontal goal with arm (PITHC), Throwing ball in vertical goal with leg (PIVCN), Leading with short stick (PVGKS),Leading with short stick (PVGKD). Tests characteristics for these battery of tests were determined in a separate study. All applied tests have shown good test characteristics: validity, discrimination, reliability and representativeness (Popeska, Jovanova, & Mitkovska, 2014).

All applied tests were previously used with six years old children in the studies conducted by Perić, 1991; Dukovski, 1984; Pišot & Planinšec, 2005; Bala, 1981, 1999; Popeska (Попеска), 2009, 2011. Their recommendations were implemented in the research procedure. Applied tests were modified and adapted for children, or specially designed based on children's age and possibilities. Requirements in new designed tests are similar to the contents of PE curricula.

Results of motor tests were calculated using basic descriptive parameters. Correlation between tests results was determined using Persons coefficient of correlation (r). The structure of motor space is determined using factor analysis. The intercorelation matrix of applied motor tests is factorized using the Hotteling procedure. Significant roots were isolated applying Gutman – Kaiser criteria (roots values higher than 1.0 are considered significant). Results obtained from the main components are further rotated applying varimax, oblimin and promax rotation. In further interpretation of the results, we used the factor analysis obtained in promax rotation.

RESULTS AND DISCUSSION

Based on the obtained results, the structure of motor space of six years old children is defined with the existence of ten latent dimensions. These ten dimensions

explain the variability of children's motor space with 64,24%.From the total variability of the applied system of motor tests, only 17,20 % are explained by the first main component. Separately, other isolated main components explains the variability of the system from in values for 9,24% for the second up to 3.27% for the last, tenth component.

Obtained results of applied factor analyses, Promax procedure, are presented in Table 1. According the projections of applied motor tests on isolated factors, we defined following ten factors: F1 -speed, F2 - coordinated and explosive movements, F3 - realization of fast movements with legs, F4 - static balance, F5 - strength of the front parts of the trunk, arms and shoulders, F6 - preciseness with leading, F7 - flexibility, F8 – undefined factor, F9 - strength of the back parts of the trunk, arms and shoulders and F10 - preciseness with throwing.

The analyses of isolated and defined factor sugests on existance of clearly isolated and defined factors (F1, F4, F6, F7, F10), factors that are defined by topologic criteria based on the dominant body parts included in realization of movements (F3, F5, F9) and factor which manifests an integration of two motor abilities (F2). Obtained results suggest on existance of speed, static balance, precissenes with leading, flexibility and precissenes with throwing as clearly defined and undepended factors. Compared with other studies realized at the sample of 6 years old children, similiar results are obtained. At the sample of six years old children, the speed is isolated as independed factor in the studies of Dukovski (1984), named as running speed and in the study of Pišot & Planinšec (2005), named as speed of alternative movements. Static balance as independed factor is also ispolated in the research of Rajtmajer (1997), Perić (1991), Planinšec & Pišot, (2005), Popeska (Попеска), (2009). Related to manifestation of balance, in a sense of development changes it is noted a tendency to maintain static balance and after that in the later periods of development dynamic balance as well (Pišot & Planinšec, 2005). The examineers group involved in our research, was lately followed and measured a year later, at the age of seven (Popeska, Jovanovski & Mitevski, 2013). They isolated the existence of dynamic balance as one of the factors that defines the structure at the age of seven. These confirms the findings of Pišot & Planinšec (2005) for changes in balance regarded the development process.

In this study, preciseness was also isolated as separate factors named as preciseness with leading and preciseness with throwing. Existance of precisseness with leading is also confirmed in the research of Popeska (Попеска), (2011), while in the study of Perić (1991) precissenes is defined as a specific motor factor named as fine motorics, regulated by the mechanisam for sinergethic regulations.

Flexibility as separate factor is also isolated in the research of Bala (2002), Vlahović, Bavčević & Katić (2007), Rajtmajer (1993). In researches where a smaller number of tests is used and where the structure is defined with one general motor factor, flexibility is always isolate as a seperate ability, undepended from the general motor ability (Bala, 2002). These could be explained with the physiological mechanisams that defines the flexibility and it`s manifestation.

Results from factor analyses also suggest on existance of a factor which is an integration of two motor abilities, or the factor for coordinated and explosive movements (F2). Relations between explosive strength and coordination is previousely determined in some studies (Kukolj, 2006; Perić, 2006; Jovanovski (Јовановски), 2013) upon which authors determined a high correlation between explosive strength, speed and coordination. They are fulfilling each other and "helping" one another in realization of the movements. Similar factor is isolated in the research of Strel & Šturm, 1981; Rajtmajer,1993; Perić, 1991; Popeska (Попеска), 2009. Existence of motor factor defined by two motor abilities could be explained with development changes specific for the children. The characteristic of motor development manifested as a tendency of elimination of movements, respectively the characteristics that refers to the direction of manifestation of motor development from general, overall motor behavior and continues toward differenced and specific behavior is likely to be the reason for isolation of mixed factors that are not yet clearly defined. These dimensions are manifested as integrated factors and are named as precise and explosive movements (F4), and coordinated fast movements with legs and trunk (F5). These two latent dimensions are defined based on significant projections of several latent dimensions. This tendency is also confirmed in other similar studies several where such factors are mainly named as a general motor factor (Strel & Šturm, 1981; Bala, 1981, 2002; Rausavljević, 1992; Pišot & Planinšec, 2005). In this since, researchers suggest on general functioning of motor abilities, which is understood as function of highest integrative and regulatory mechanisms in CNS when resolving some motor task.

Other three factors: realization of fast movements with legs (F3), strength of the front parts of the trunk, arms and shoulders (F5) and strength of the back parts of the trunk, arms and shoulders (F9) are defined based on the activation of different body parts, or appling the thopolocic criteria. Similiary definated factors are isolated in the researches of Rajtmajer (1993), Pišot & Planinšec (2005), Popeska (Попеска), (2009), Delas, Miletić & Miletić (2008), Vlahović, Bavčević & Katić (2007). These abilities that mainly depends form the intensity of energetic outputs (explosive and repetitive strength, static power) are mainly defined by the topologic criteria, probably because of the insufficient synchronization of movements with arms, legs and trunk. Upon this, several longitudinal studies, noted a tendency of differentiation in the following periods of growth and manifestation of separate, clearly motor dimensions (Strel & Šturm, 1981; Rajtmajer, 1993; Perić, 1991; Bala, 2002; Pišot & Planinšec, 2005)

Following tests: One foot – tapping (BSTAN),

Table 1. Factor analysis of results from motor tests applied at six years old children – Promax procedure

Variables	FP1	FP2	FP3	FP4	FP5	FP6	FP7	FP8	FP9	FP10	h^2
KOPAL	0,13	0,07	0,98	0,12	-0,06	-0,03	-0,10	0,00	0,02	-0,09	0,94
KOPON	0,25	-0,60	-0,03	0,10	0,02	-0,07	0,07	-0,18	-0,05	-0,03	0,59
KOSL 2	0,23	-0,43	0,09	-0,31	-0,10	0,16	0,11	0,25	0,09	-0,12	0,63
KOTRT	-0,36	-0,57	0,01	-0,14	-0,03	-0,07	0,19	-0,05	-0,05	-0,25	0,51
BT10LS	0,12	0,05	0,99	0,11	-0,07	0,01	-0,09	-0,02	0,02	-0,07	0,94
BT4X10	0,77	0,12	0,13	-0,13	-0,12	-0,02	-0,04	-0,12	-0,10	0,16	0,77
BTZMT	0,77	0,02	-0,01	0,27	-0,01	-0,16	0,07	0,15	0,22	-0,17	0,74
BSTAR	0,96	0,21	0,06	0,11	-0,01	0,17	-0,18	0,02	-0,03	0,08	0,79
BSTAN	-0,10	0,34	0,01	-0,17	0,34	0,49	-0,12	0,09	-0,02	-0,14	0,60
BSTNZ	-0,17	0,05	-0,18	0,05	-0,07	0,08	-0,15	0,67	0,04	0,02	0,65
ESSDM	-0,30	0,42	0,04	0,09	-0,15	-0,04	0,16	0,13	0,16	0,05	0,62
ESFMST	0,20	0,92	0,01	-0,19	-0,05	0,01	0,11	-0,02	0,03	-0,17	0,69
ESFMG	0,17	0,64	0,18	-0,10	0,23	-0,07	0,17	-0,05	-0,03	0,02	0,55
ES20VS	0,52	0,05	0,15	-0,27	0,07	-0,05	0,22	-0,06	0,02	-0,01	0,58
RSSKL	-0,13	-0,04	-0,07	0,17	0,45	-0,02	-0,07	0,47	-0,09	0,08	0,58
RSPTR	-0,20	-0,02	0,09	-0,10	0,63	-0,09	-0,06	0,11	0,24	0,03	0,55
RSITR	-0,10	-0,16	0,21	-0,15	0,17	0,11	-0,28	-0,13	0,80	0,18	0,68
RSVKK	0,33	-0,19	0,04	-0,18	0,33	0,06	-0,14	-0,01	-0,23	0,00	0,52
SSVZG	0,09	0,21	-0,13	-0,06	-0,02	-0,02	0,10	-0,22	0,81	-0,07	0,70
SSZLM	0,08	-0,02	-0,07	0,17	0,39	0,02	0,13	-0,14	0,22	0,25	0,37
SSZLG	0,13	0,07	-0,17	0,04	0,76	-0,05	0,00	-0,28	-0,12	-0,01	0,67
FLDPK	-0,12	-0,03	-0,12	0,19	0,15	0,12	-0,01	-0,87	0,31	-0,12	0,70
FLRLG	-0,20	0,23	-0,14	0,09	0,21	0,01	0,65	-0,02	-0,10	-0,13	0,61
FLPRP	0,01	-0,03	-0,10	-0,06	-0,16	0,18	0,87	-0,10	-0,01	0,21	0,73
RAOSK	0,22	-0,09	0,10	-0,02	0,15	-0,05	0,15	0,08	0,14	-0,59	0,58
RASKS	0,04	-0,20	0,09	0,81	0,06	0,05	0,03	-0,15	-0,21	0,05	0,79
RASKD	0,03	0,01	0,15	0,82	-0,05	0,08	-0,03	0,06	0,09	-0,05	0,72
PIOBS	-0,23	0,13	0,20	0,10	0,06	-0,20	0,13	0,14	-0,04	0,30	0,41
PITET	-0,31	-0,03	0,27	-0,09	0,09	0,09	0,35	-0,03	-0,03	0,46	0,58
PITHC	0,32	-0,11	-0,19	0,02	0,16	-0,04	0,15	0,24	0,18	0,77	0,64
PIVCN	0,01	-0,06	0,21	0,23	0,10	0,20	0,27	0,19	-0,15	-0,15	0,30
PVGKS	0,26	0,04	-0,14	0,04	-0,13	0,81	0,17	0,12	-0,03	0,14	0,74
PVGDS	-0,10	-0,09	0,11	0,14	-0,05	0,87	0,14	-0,18	0,10	-0,08	0,72
Lambda	4,36	3,83	2,72	3,34	2,31	1,97	1,99	2,30	2,51	2,40	
%	17,20	9,24	7,08	5,60	5,22	5,03	4,28	3,97	3,36	3,27	
Cum.%	17,20	26,44	33,52	39,11	44,33	49,36	53,64	57,61	60,97	64,24	

Modified pushups (RSSKL) and Deep bend on bench (FLDPK) have significant projections of the eight latent dimensions. All three tests are applied for estimation of different motor ability. Therefore, there is now possibility for methodologically, professional and logical definition of this factor. Because of these, the eighth factor is undefined.

All these manifesations could be explained with the development changes that occures at this age period. Namely, the early school period in general is character-

ized with very different individual tempo of growth and development between childrena at the same age. This affects on variaty of manifestations regarded motor abilities. Unfinished cephalic – caudal andcproximal - distal development where movements are complicated, general and with luck of preciseness. Other ontogenetic characteristics, such as intemitented development, or development process when certain manifestation of movements appears and disappear is also one of the reasons for great variety on manifestation of motor abilities in children. Time of appearing and disappearing is very individual for every child and decrease during the time. Changes of motor functions, or their appearance and disappearance are the reason why motor manifestations should be studied and analyzed together. The tendency for elimination as development characteristics suggest manifestation of movement which begins from general, massive motor behavior and continuous towards differenced and specific behavior. Related to this specifics are findings of numerous studies where such isolated factors are defined as general motor factor (Strel & Šturm, 1981; Bala, 1981; Rausavljević, 1992; Pišot & Planinšec, 2005).

Analyzing the structure of motor space obtained for six years old children, it could be noted that only coordination, regulated by the mechanism for structuring of the movements, was not was not isolated as a separate ability. It is isolated as integrative ability, together with explosive strength. This could be explained with following arguments: (1) coordination requires solving movement tasks with complex structure which means synchronization of movements with all body parts as well as their localization in space; (2) Development of coordination in early periods of age means acquisition of complex movement structures that are foundation for future development of strength and speed; (3) Small number of tests applied for estimation of coordination; (4) The nature of tests applied for estimation of coordination; (5) Changes in the functioning of CNS as a result of development process that able more efficient manifestation of coordination. In the period of early school period, manifestation of other motor abilities (speed, strength, balance, preciseness) depends from level of development of coordination, or these movements could be possible to be realized only if the coordination is developed on a higher level.

CONCLUSION

Obtained results in this study suggest a complicated and not clearly defined structure of motor space of six years old children. Results from applied factor analyses point out on motor space defined with ten latent dimension, named by the significant projections of motor tests on isolated factor. Based on this, following factors were defined: speed, coordinated and explosive movements, realization of fast movements with legs, static balance, strength of the front parts of the trunk, arms and shoulders, preciseness with leading, flexibility, strength of the back parts of the trunk, arms and shoulders and preciseness with throwing and one undefined factor.

Analyzing their structure, it could be noted that four clear and independed factors were isolated (speed, balance, flexibility and precissenes). Three factors were isolated according activation of certain body parts or appying topologic criteria. This is a result of development changes noted as unsuficient singhronisation of the movements with legs, arms and the trunk, These factors are regulated by the mechanisam for energethic regulation of the movements and have a tendency for differentiation in future stages of development and manifestation as independed factors. The factor named as coordinated and explosive movements is a factor which is an integration of two motor abilities. Existence of such factor could be explained with development changes specific for the children, mainly with the tendency of elimination of movements, respectively the characteristics that refers to the direction of manifestation of motor development from general, overall motor behavior and continues toward differenced and specific behavior. This factor also have a tendency to be isolated as a separate in the following stages of development.

The analyses of isolated latent dimensions suggests that motor abilities in children are potential and connected. Regarded this, all 10 isolated factors could be grouped in two dimensions: first latent dimension regulated by the mechanism for energetic regulation (explosive and repetitive strength, static power and speed) and the second dimension is regulated by the mechanism for synergetic regulation and regulation of muscle tonus (preciseness and balance). Obtained structure is highly determinate by the development changes and characteristics. Because of these, it is needed to determine the structure of motor space in every single age in the childhood as well as to design test according children's possibilities in the certain period.

All these is especially important from the aspect of PHE teaching process. Information about children possibilities, what they can do and what are they able to do, which motor abilities they have as a potential and how do they change in every single period of age is especially important for effective teaching process. This information is the starting point for correct choice of PHE contents, based on a national PHE curriculum. On the other hand, development of motor ability is one of the goals of PHE teaching process and it could give us information about individual progress and improvement of every child. Well known and determined structure of motor space in every age period could be also a starting point for innovation of current PHE curricula and designing a new one, according children real possibilities.

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