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Hypothetical Model in Testing Integrated Development of Preschool Children

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A B S T R A C T

This paper provides systematic presentation of the issues related to methodology, and offers some possible solutions for analysis of different aspects of child development, especially preschool age. These issues are related to the definition, acceptance and preparation of the existing theories on development, which include analysis of the whole child's self, his/her surroundings, and his/her activities. In addition, this analysis also includes some methodological problems related to sexual dimorphism, heritage-bound and surroundings-bound development, definition of the model of constructs affecting the selection of variables for evaluation of integral development, definition of the population and selection of the subject sample, determination of manifest characteristics and abilities, selection or construction of measuring instruments for their evaluation, appropriateness of the model and method of data analysis, as well as the possibility of designing the potential model of integrated development of preschool children.

Key words: *integrated development, sexual dimorphism, constructs model, measuring instruments, preschool children*

Introduction

The theory of integrated development points out that all human abilities and characteristics in the process of development are inter-related. This has been scientifically demonstrated, especially in the studies of relations among particular dimensions of the psychosomatic status[1–5].

Previous studies have demonstrated the existence of positive correlation between intelligence and performance of complex motor tasks[1–3, 6–7], and thus also with specific motor knowledge in various sports. This correlation is explained by the general speed of information flow as well as by the role of cognitive processes in motor activity.

On considering numerous methodological problems in the analysis of various aspects of child development, it is necessary to know the **theory of integrated development** as conceived and defined by Ismail and Gruber (1971)[8] and Ismail (1976)[9], as well as some aspects that would help extend and improve the solution of the problems depicted by this theory (e.g., Bandura, 1986, 1989)[10,11]. In addition, due attention should also be paid to defining and solving the following major issues:

- sexual dimorphism,
- heritage-bound and surroundings-bound development,
- definition of the model of constructs affecting the selection of variables for evaluation of integral development,
- definition of the population and selection of the subject sample,
- determination of manifest characteristics and abilities, selection and/or construction of measuring instruments for their evaluation,
- appropriateness of the model and method of data analysis, and
- designing the potential model of integrated development.

On the Theory of Integrated Child Development

Integrated development is understood as biological, psychological and social child growth and development. The study of integrated development implies analysis of the child's body status where all his/her functions work harmoniously and in line with all his/her anthropological characteristics and abilities. Thus, the child has to be perceived as a whole, as thoroughly as possible, depend-

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ing on the study problem, methodological knowledge, and researcher's financial and organizational resources.

When referring to the bio-psycho-social self, the studies address the problems related to the conditions, growth/development and relations of the following child anthropological characteristics and abilities: health status, morphological body characteristics, functional abilities, cognitive (intellectual) abilities, conative characteristics (personality features), values and attitudes, microsocial status, and social status.

Thus, the theory of integrated development encompasses the states, growth and development, as well as inter-relations of anthropological characteristics and abilities related to the child and his/her physical and social environment. However, the child's activities that are in function of his/her behavior in different situations and the possibilities for the child's activities to potentially contribute, directly or indirectly, to the development of his/her own anthropological characteristics and abilities are inadequately considered in this theory. Accordingly, the results of the child's behavior yield a feedback upon his/her bio-psycho-social self. Of course, these processes primarily depend on the child's maturation, experience, motivation and willful activity aimed at appropriate behavior. Such an expanded concept of integrated development could be further upgraded and explained by Bandura's socio-cognitive theory (1986, 1989)[10,11], which can also be applied in solving kinesiologic problems not only in children but even more in adults, athletes in particular.

Sexual Dimorphism

In the early childhood, preschool age in particular, children are differentiated by biological sex into male and female. In preschool children, sex cannot be defined on the basis of external characteristics such as body built, hairiness, or adipose tissue. Later in life, with growth and development, these characteristics are differentiated into specific external sex characteristics. However, the child's particular sex role is more significantly manifested through his/her behavior, interests, attitudes, and various activities within the family, in kindergarten, at playground, in the street and in other situations, as considered typical for either sex. The feminine, masculine, androgynous (combinations of feminine and masculine) as well as undifferentiated sex roles can already be identified at this age. Such differences can be due to the impact of a single or a number of the following reasons:

- biological (genetic),
- extrinsic, environmental (sociocultural), and
- neurophysiologic (mostly due to cerebral lateralization).

Comprehending and explaining sex differences by only one characteristic cannot yield correct information on the real causes of differences in anthropological characteristics and abilities of children. This can only be achieved by comprehending all these causes and analyzing their interaction. This in turn requires the age and rate of maturation in male and female children as well as their passive socioeconomic status to be taken into account. The socioeconomic status of the parents and the family at large plays a major role in the development and interaction of a number of anthropological characteristics and abilities in preschool children when analyzing sexual dimorphism, i.e. sex differences in various dimensions of the overall anthropological status.

Men and women differ not only by their physical characteristics and reproductive function, but also in the way of solving various problems, e.g., intellectual, motor, etc. These variations are usually considered to be minimal, which can be attributed to different experiences during development. However, a large body of evidence indicates that the effects of sex hormones on brain structure occur in early childhood, through the environment influencing the variedly organized system of connections in male and female children. It is therefore almost impossible to assess the effects of experience independently from psychological predisposition. Behavioral, neurological and endocrine studies have elucidated the process by identifying sex differences within the brain. In addition, studies of hormone effects on cerebral functions during lifetime indicate that evolutional pressures canalizing these differences still permit some level of flexibility in the cognitive ability between the sexes.

Sex differentiation is established by estrogen and androgen (male hormones, testosterone as the main one) functions in early childhood. The child's personality may depend on his/her previous, intrauterine exposure to certain hormones. A difficult or very stressful pregnancy may reflect in anxious or irritant mood of the newborn. Testosterone (a male sex hormone) is also of major importance because female fetuses at a higher intrauterine exposure to this hormone may later grow into »mannish« girls.

The role of sexes is imposed upon the individual by the society and implies behavioral rules characteristic of men and women, derived from their biological differences. The individual's attitudes are subconsciously tailored by different sex roles from early childhood. The sex based division is being gradually rooted into the individual's character as early as in childhood, when the child learns about it watching the men and women behaving at home, through mass media and in the community. Between the age of 5 and 11, male and female children are very differently treated. At this age, children have to decide on joining some groups, depending on their activities. In most industrialized countries, male and female children have nearly identical opportunities, however, in many traditional societies the tasks conferred to male and female children will differ significantly. Male children are stimulated to take part in tougher games than female children, to play outdoor and perform physical activities, whereas female children are generally directed towards housework and indoor tasks such as taking care of younger siblings, cleaning, cooking, etc. Traditional societies mostly emphasize the protective role of men,

while women are those to be protected and can manifest emotions to a greater extent than men. There are situations in which some individuals do not agree with the role imposed upon them by the society, whereas others may feel this role does not fit completely.

The term »sexual dimorphism« is defined as »the existence within a species of males and females that differ distinctly from each other in form«[12]. The issue of precise definition of the subjects' sex, especially in children, has not been paid due attention, and the problems of sexual dimorphism in children in the spaces of anthropological variables have been solved by formal subject division into male and female children. The issue of sexual dimorphism in the elderly has been tackled by Momirović, Hošek and Popović (2007)[13] in their studies collected in the monograph entitled Sexual Dimorphism. The monograph considers only one segment of the anthropological space in man, i.e. cognitive abilities and conative characteristics as well as aberrant behavior and their inter-relations. These studies may point to certain differences and problems in sexual dimorphism in adults, which can be only indirectly used to explain sexual dimorphism in children.

The Heritage-Bound and Surroundings-Bound Development

The unity of anthropological dimensions and the child's interactions with his/her close and broad environment determine the modality and intensity of his/her behavior in particular situations. Some of these dimensions are influenced by the genetic material inherited from the parents and ancestors, whereas others are more prone to the impact of the surroundings in which the child's growth, development, education and other activities take place.

It is believed that some morphological dimensions are predominantly inheritable traits (e.g., skeleton longitudinal dimensionality) whereas some others are by far less determined by inheritance (e.g., body mass and volume, subcutaneous adipose tissue). Child motoricity shows a similar pattern, although specific and relatively independent motor abilities cannot be differentiated in early childhood. Yet, a relationship between good parental motoricity in general or particular motor abilities and good motoricity in their child can already be observed in early childhood. In the domain of intellectual abilities, the genetic impact of parents on their child's cognitive functioning is even more pronounced. These relations are considerably less pronounced in the space of conative characteristics of parents and their children, suggesting their greater influence on the child's behavior and transformation of a behavioral modality or intensity into another one.

The character (personality traits), which also determines the individual's behavior to a great extent, is a resultant of all his/her experiences. Studies have revealed monozygotic twins to show identical behavior in the same situations, indicating that the impact of the environment is a predominant factor in building the man's character. Family relations influence the child from his/her birth. Later, the child is increasingly influenced by the relations with his/her peers and overall circumstances in the society. Considering child's behavior, the roots of aggressiveness should be identified. Some children are exposed to aggression in their families. They would yell and beat other children to get what they want because they have witnessed such behavioral pattern at home. There is clear association between aggressive behavior of children and their parents. Pain and uneasiness may also lead to aggressiveness. Sickly children will probably exhibit aggressive behavior in adulthood. Genetics also plays a major role in aggressive behavior. Adopted children frequently behave like their biological parents.

The child's self-esteem and support from the people close to him/her add to his/her chances for success. Those from inferior social groups in a particular society show lower school performance. When moving to a setting where he/she need not feel inferior anymore, the individual will probably achieve better results.

The process of the child's learning how to get integrated in the society (socialization) begins with relations with his/her peers, regular attendance of preschool institutions (day-care) and school. While growing up, the child learns about the social rules of conduct, which contributes to the formation of socially acceptable behavior.

People's living next to each other always results in social divisions, disintegration and conflict of interest, thus the rules will not be respected by all members of the society. For example, young people may tend to aggressive behavior and joining »antisocial« groups such as street gangs coming in conflict with social environment. Such a sequence of events may also be supported by the early aberrant behavior that is not fully consistent with the child's development nor is socially acceptable, but cannot be qualified as delinquent behavior.

Various stressful life events such as disease, death of a close person, transfer to another school, etc. have variable effects in different periods of life (for example, the impact of the loss of parents is different at age 5 and 15). Even the events occurring during intrauterine life may influence the development of the child's personality. As the man and thus the child is a societal organism, other people's behavior and attitudes also exert considerable influence upon his/her personality. This influence may be direct, e.g., being rewarded for good deeds or punished for misdeed, or indirect when other people's behavior influences his/her self-esteem or some other personality trait.

According to behavioristic principles, behavior is almost completely determined by the environment and fully learned, with only little contribution of inherited mechanisms; the general learning and raising abilities play a major role. Other theoreticians believe that the behavior is determined by personal factors such as personality traits. According to Bandura (1986, 1989)[10,11], these attitudes are too »simple and shallow«, therefore he advocates the concept of triple reciprocal causality. The

main idea underlying this causality is that personal factors (cognitive and emotional), the environment and behavior influence each other. For instance, our behavior and our motives frequently influence the environment where we feel to belong. Bandura strongly advocates that the people's conduct can only be predicted by taking into account the overall situation and context surrounding the particular individual.

Four classes of factors potentially determining the »innate« and the »inherited« should be considered on assessing the causality, i.e. the impact of heredity and environment on the child anthropologic characteristics and abilities (Zarevski, 2000)[14]:

1. inherited – predictable parental contribution,
2. innate – gene mutations and segregations,
3. constitutional – variability in body built and functioning, and
4. congenital – acquired during intrauterine development.

The impact of heredity and environment on a particular anthropologic ability can be determined by defining the variance of a variable (usually results of motor and cognitive abilities testing and conative characteristics) by the proportions of hereditary and environmental influence, thus partializing (neutralizing) respective relations by some of these impacts. Accordingly, genetic impact can be neutralized by taking genetic similarity (monozygotic twins) a constant, therefore environmental impact (which is variable) on the ability or characteristic observed can be analyzed. Or *vice versa,* choosing the same environment and subjects of different genetic composition enables analysis of the impact of genetics and inheritance on the child's ability or characteristic observed.

Experience has shown that such methodological requirements are difficult, and some of them impossible to perform in practice. The usual and even classic comparisons of monozygotic twins with the identical genetic potential and with identical or different raising conditions (housing, economic and educational conditions, intellectual surrounding, etc.) are not fully reliable because twins are not identical, as it used to be believed, because of congenital effects during their intrauterine development. However, it should be taken in consideration that environmental and hereditary factors influence the child growth and development interactively rather than independently, resulting in the integral growth and development in childhood as well as later in life. This means that genetically »better« (e.g., intelligent) parents will create better environment for their children (in terms of contents, value system, stimulation, etc.) than some other will do. Also, children with »better« genes will be more curious and successful in the creation and selection of their environment, with the help of their parents, than children with »poor« genes.

In practice, experiments with families and adopted children are usually performed, allowing for the following assessments to make:

- assessment of environmental effects on the »heredity-environment« interaction, based on resemblance between adopted children and adoptive parents according to the abilities and/or characteristics analyzed; and
- assessment of the genetic component effect on the »heredity-environment« interaction, based on resemblance between adopted children and their biological parents according to the abilities and/or characteristics analyzed.

Studies based on these assessments (Zarevski, 2000)[14] mostly analyzed cognitive functioning of children in different families. Results of these studies point to a greater impact of heredity (adopted children show significantly greater resemblance with their biological parents than with adoptive parents). However, in early childhood environmental effects, education and parental social status in particular, as well as the child's activity are also very important, therefore the hereditary component that plays a major role in the child growth and development is not so predominant that it could not be »built up« or »impaired«.

When analyzing integrated development in large samples of children, it is very difficult to clearly distinguish the segment related to heredity from the segment received from the environment and the segment created by the children themselves through their activities performed during the process of the overall personal, integrated development. That is why the studies do not address partial contribution of each of these segments but the respective state of child development is taken as the integral product of all those factors within the spaces of the child anthropologic characteristics and abilities analyzed.

Defining the Factor Model to Serve as a Basis for the Choice of Variables for Assessment of the Child Integrated Development

Determination and definition of the status at a certain level of development of the child abilities and characteristics requires previous setting up of a more or less hypothetical model. The instruments for measuring the planned abilities and characteristics can only be chosen on the basis of a model actually serving as the study subject. The model can be very simple, containing a single ability or characteristic (which is, however, rarely used in kinesiologic studies), or multidimensional, either within a single space of the child anthropologic status, or implying analysis of combinations of multiple spaces.

Each study model is composed of one or more factors or latent dimensions of lower or higher order. Factor is a feature attributed to at least two objects as the result of scientific observation and comparison, and it represents the respective concept, formally proposed, with appropriate definition and limitations strictly associated with empirical data from which it has been derived. This indicates that measuring data based on some explicit mathematical or cybernetic model of the study system structure

and functions are necessary to identify the generation of a state or relations. It will lead to confirmation (or rejection) of the hypotheses the integration of which can define the respective theory.

The model of the human anthropological status structures implies an array of dimensions, i.e. factors (characteristics and abilities) which vary to such an extent that they allow for depicting differences among people and identifying each individual's status. The anthropological status factors are as follows (Hošek, 2004)[15]: body morphological characteristics, functional abilities, motor abilities, cognitive (intellectual) abilities, conative characteristics (personality traits), values and attitudes, microsocial status, social status, and health status.

Each of these factors is known to be liable to developmental regularity and to contribute to defining the general anthropological status of each individual with an appropriate, lesser or greater coefficient of participation. Of course, a model with a limited number of factors, including those that define the most recognizable part of man as a bio-psycho-social organism, which have been most widely investigated to date, is presented here. Such a model of anthropologic dimensions may not always be suitable for use in children because children undergo continuous changes (biological growth and development, motor and mental development, etc.) in different conditions and circumstances than those found in adults.

On establishing a model of a single or multiple segments of the presented anthropological status in a study to be carried out in children, it should be taken in consideration that some factors cannot be adequately assessed in children as in adults or they have to be modified. The issue is also related to the choice of measuring instruments, the number of which should be reduced, and most of them should be modified relative to the choice of measuring instruments used in adults.

The generally adopted four-dimensional model cannot be established for assessment of morphological dimensions in children because children undergo the process of growth and development, therefore a reduced number of latent, thus manifest variables will suffice to define their morphological status. In this period of life, the morphological and constitutional types can hardly be considered at all.

The fast growth and development of organ systems in children make the assessment of their functional abilities uncertain since they rarely employ the real (potentially possible) capacity to manifest these abilities on testing. Due to the lack of physical activity in both urban and rural settings, increasingly sedentary lifestyle and upbringing, many children will never even nearly achieve their maximal functional potential.

Due to the general character of the child motor development, the model of differentiated motor abilities cannot be studied in total in small children. This fact in turn influences the choice of the sample of standard motor measuring instruments, which mostly have to be modified or substituted by some more suitable ones. The same also applies to the assessment of the child cognitive functioning.

Assessment of the child conative characteristics is associated with some specific requirements in terms of numerous reductions and modifications in both the establishment of the study model and in construction of the sample of measuring instruments. The child conative characteristics may contribute to the formation of a system of values and attitudes that are frequently quite variable, but may also influence the child microsocial status at preschool and school institutions, in the street, in sports clubs, etc.

In addition to genetic factors, the components of parental social status conferring the child a particular passive social status from the birth certainly contribute considerably to the segments of the overall model of the child anthropological characteristics and abilities described above. The child health status is crucial for correct functioning of the overall anthropological status in children, its role probably being by far more relevant in children than in adults. The study of these segments of the child anthropological status is also highly specific and cannot be addressed by the same methodology as in adults.

Definition of the Child Population and Selection of Subject Sample

The choice of the child population, preschool children in particular, and the method of subject sampling influence the confirmation or rejection of the theoretical model of anthropological dimensions analyzed. Although the characteristics of the study population of children, including geographical, climatic, racial, sociopolitical, economic, cultural, etc. do make a difference, they are inadequately addressed or not addressed at all in most studies, simply characterizing the subject sample by their sex and age data; occasionally even these data are lacking.

The study of the child anthropological characteristics should be viewed in the context of their parental social status as well as of the socioeconomic conditions in their close or broad environment, which can exert significant impact on the study results, longitudinal studies in particular. Analyzing population differences that prevent or considerably hamper generalization of the results obtained in social status studies, Hošek (2004)[15] identifies several sources of these differences. These sources may also have considerable influence on the results of studies investigating the child anthropological characteristics, and even more on the results of studies of the child integrated development. Some sources relevant for the studies of the child integrated development are presented below.

The first source of population differences is the period of time to which a theory or analytical results may apply. As parental status is taken in consideration in the analysis of children, the role of various status indicators varies with different periods of social development, and constellation of these indicators differs among different time periods (Hošek and Momirović, 1985)[16]. This may not have

great impact on the child anthropological dimensions of biological character, but are very likely relevant for correct assessment of the child behavior, which depends on his/her motor and intellectual abilities, personality traits, microsocial status, and system of values and attitudes. Although the child behavior is assessed in various circumstances by the respective professionals, the majority of behavior indicators, of aberrant behavior in particular, come from the parents. Assessment of these indicators is highly subjective and frequently depends, wittingly or not, just on the parental socioeconomic status, whereby the parents make these assessments according to actual circumstances, or quite often based on their wish for their child to assume a certain behavioral pattern, weighing their actual and desired socioeconomic status. Besides these characteristics, chronological age of the study subjects should also be noted. On selecting the population and appropriate study sample, care should be taken for the study subjects to be as homogeneous as possible according to age, i.e. the age range should not be too large. It is important because children are in the constant process of growth and development, which can be viewed as group or individual age. The rate of growth and development depends on the above mentioned characteristics of the environment where the children live, grow and receive education. Some segments of the anthropological status show faster development at some age and slower at another age. Therefore, frequent measurements are recommended, twice a year at least, when a single generation of children is being monitored. In case of transverse measurements, study samples should so selected as to span at least a half-year age range. A more accurate assessment of chronological status is obtained by expressing it in decimal years (defining difference between the date of measurement and date of the child's birth according to respective table from the International Biological Program). Besides their use as simple grouping variables, thus defined differences can also be used as analytical variable.

The issue of sample selection is frequently approached uncritically and incorrectly, even in case of properly defined population, and such an approach must have unfavorable reflection upon the possibility of reliable generalization of study results.

Randomized selection of subject samples, giving the small study subjects equal chances to be selected, is only rarely employed, although the samples thus selected entail high validity of the kinesiologic study results. Inappropriate size of the study sample is found in many studies, occasionally with excessive number and more frequently inadequate number of study subjects relative to the preset study problems. The optimal sample(s) size is known to depend on the type of study problem. A study phenomenon of high variability requires a large sample of children; in the opposite case such as the phenomena under major genetic influence, a smaller sample is sufficient.

In kinesiologic studies tackling the problems of relations among the sets of anthropological variables or problems of differences within the sets of such variables between the samples representative of particular subpopulations of the child population, large samples implying an effective number of at least 100 entities should be included. In this way, external validity of the study, i.e. generalization of the study results is ensured.

Determination of the Manifest Characteristics and Abilities of the Child Integrated Development and Choice or Construction of Measuring Instruments for their Assessment

Upon establishing the study model of the child anthropological dimensions for integrated development assessment and after correct or appropriate, i.e. available definition of children samples, the problem is faced of the choice of manifest characteristics and abilities to be measured by validated and reliable measuring instruments and then assessed.

Every choice of variables resulting from the use of appropriate measuring instruments in the subject sample depends on the previously defined mathematical or cybernetic model of integrated development or its segments. In children these models differ from those used in adults both quantitatively and qualitatively as well as by the modality of latent dimensions constituting them. These are mostly latent dimensions of general character (e.g., growth and development, motor and cognitive functioning, and behavior) that have not yet been fully explored. There are partial studies of particular anthropological status segments or even dimensions, however, few studies have analyzed integrated development with a great number of anthropological dimensions.

Attention and its duration and maintaining »working« and »behavioral« discipline of the small study subjects during measurement and testing pose a specific problem on choosing measuring instruments and especially during the course of measurement and testing. Therefore, measuring instruments should be so chosen as to prove attractive and short-lasting when applied. Of course, these measuring instruments should be correctly validated and reliable, based on the analysis of metric characteristics of respective small samples of children, or preferably in the sample analyzed; respective experiences acquired in older or adult subjects should by no means be used.

Determination of the number of indicators and measuring instruments for assessment of an anthropological dimension poses a problem because it cannot be boiled down to a single indicator. It is well known that successful assessment of a dimension should be done by use of multiple indicators (manifest variables). On assessing motor, functional and intellectual (cognitive) abilities in children, measurements employing multiple indicators are both difficult to perform and unreliable due to the reasons mentioned above (they are time-consuming and similar, thus being unattractive to children, they cannot understand why they have to repeat the same actions, etc.). Therefore, the preset mathematical or cybernetic model is frequently difficult to perform and hypotheses

difficult to check, while occasionally the results obtained may raise doubts about the existence of some abilities presumed by the model (e.g., in motor space), just because of the small or excessive number of the variables analyzed. Quite frequently, an excessive number of variables may yield an illogical and unrealistic mathematical-statistical picture.

Measuring scales used to obtain measurement results pose an additional problem. Scales of the nominal and ordinal type are very frequently used for assessment of some characteristics, abilities or behaviors in studies that include children. However, in these studies proportional or interval scales need to be employed to obtain reliable information and more correct study results.

The use of ordinal scales may in some cases be expected to yield results in the form of semi-ordinal variables, which will considerably reduce the possibility of correct perception of the state, difference or relations of such variables against the others. For correct use of ordinal variables in the analysis of relations of anthropological dimensions in children, they should be transformed into a higher form of measuring scales. It is generally done by the Blom procedure (in the SPSS statistical software), transforming the ordinal scale data by appropriate monotonous transformation into a scale of interval characteristics, thus yielding interval variables suitable for multivariate data processing. This results in such a variable distribution that does not deviate significantly from the normal, as an additional benefit of this transformation. However, it should be noted that in large subject samples ordinal scales can often be processed by parametric statistical methods without previous transformation. This procedure will not yield absolutely accurate results, yet the results obtained do not differ significantly from those recorded with previous transformation.

Apart from these, problems are also encountered in the selection and definition of valid and reliable measuring instruments for testing in children. Problems are mostly encountered on measuring motor abilities and motor behavior in small children. For a number of measuring instruments (tests), logical validity has been established on the basis of conclusion on the contents and sequence of motor activities expected to be done by the small study subject on motor test performance. Another way of defining motor test logical validity implies validity extrapolation from the same or similar tests intended for older subjects. However, on doing this errors in the assessment of validity are quite frequent because the motor space is differently structured in children as compared with older and adult subjects. Therefore, the validity of measuring instruments should be defined by the procedure of factor analysis, which produces appropriate factor validity. Information on the prognostic value of motor tests may frequently prove useful, helping in various orientations and selection of children according to some kinesiologic and in particular sports activities.

The issue of reliability of the motor measuring instruments is mostly solved by the construction of composite tests. These tests for children are generally composed of 2–3 elements that simply represent replications of the same motor task, with an adequate break to allow the body to recover until the next performance. Among a number of procedures used to define motor test reliability, Cronbach's alpha coefficient contained in statistical softwares for data processing is most frequently employed. Another method to define reliability is calculation of the correlation coefficient between the results of two performances of the same test at a different, not too long, time interval. The former method is obviously faster, less expensive and more correct.

All these issues have to be taken in consideration, either employing the existing measuring instruments or constructing new ones. On constructing new instruments, factor validity in the space of the previously demonstrated valid motor tests and their reliability need to be checked.

Similar is the situation with measuring instruments for assessment of cognitive functioning in children. Although psychologists possess measuring instruments for such assessment, they are intended for individual application and cannot be used in very large samples. The choice of standardized and valid cognitive measuring instruments for group utilization in children is very small. In spite of a number of handbooks and recommendations as well as respective standards, achievements reported with the use of these measuring instruments need to be tested through statistical and metric characteristics obtained in the samples of children analyzed because these measuring instruments may be specific, inappropriate, or even obsolete.

Identification or construction of a measuring instrument for assessment of child behavior to be used in large subject samples is a major problem. Taking poll among parents and educators appears to be efficient in this case. Yet, it may pose another problem because each of them will assess the child behavior in different settings and activities, and even in different time of the day. Such measuring instruments should be submitted to appropriate analysis to ensure their validity and reliability.

Appropriateness of the Model and Methods of Data Analysis

Data collected for analysis and explanation of the child integrated development are obtained from several different anthropological status areas by use of different methods and techniques, and on different measuring scales. One arm of such data collection employs transverse analysis over a short period of time, presenting the state recorded in various generations of children in a single period of time. The other arm is based on collecting such data on a single generation of children at several time points. This methodology provides information on the secular trends of growth and development as well as on other characteristics and abilities, motor, functional and cognitive abilities in particular. These data may point to the presence of secular trend (favorable or unfavorable), or to the absence of this phenomenon. Besides the phenomenon of accelerated growth and development,

maturation and body size, a favorable or unfavorable secular trend is also observed in both motor (mild development, sensitive or stable periods) and cognitive development as detected by Flynn's effect (Flynn, 1984, 1987, 2007)[17–19].

In either case, the data collected can be analyzed and processed by univariate and multivariate statistical methods. The use of mathematical models, multivariate methods and techniques employed for transformation and condensation of information is considered more suitable for the study of regularities and tendencies of the child integrated development. However, problems emerge when using these mathematical models, methods and techniques, depending on anthropological characteristics and abilities to be analyzed within the frame of the overall child integrated development. Namely, a variety of modified methods, techniques and even models are available for the analysis of biological, motor and mental development, as well as for the analysis of close and broad ecologic, social and economic environment, i.e. of the respective socioeconomic status.

The usual mathematical models used to analyze relations of anthropological dimensions in search for correlation or causal relations to better define integrated development implied linear and even symmetrical associations between manifest and latent variables. Such a general linear model implied correlation, factor, regression, canonical, discriminative and taxonomic methods of data processing. Of course, the criterion and predictor variables had to be strictly predefined because completely symmetrical relations between anthropological dimensions do not exist; instead, the proportion of participation of each dimension sub-space in the common variability of the overall space of anthropological dimensions analyzed has to be determined. For the time being, it has been done by so-called redundant analysis, usually on using canonical analysis of correlations or covariants of the predictor and criterion variables applied. All these methods allow for various problems in the scope of the child integrated development to be relatively easily solved.

The methods of data processing described above imply monotonous and symmetrical relation of the anthropological dimensions analyzed. However, it has been suggested that some of these relations in particular anthropological dimensions are not linear but curvilinear, therefore they are not symmetrical (e.g., Bala, 1999)[20]. Yet, distribution of the anthropological status dimensions, at least those referring to biological, motor and mental development, appears to show no significant differences from normal (which does not mean that it is normal), whereas their relations are linear with multivariate normal distribution in the majority of cases. Therefore, the linearity of variables should be analyzed prior to employing any multivariate statistical method. Of course, this analysis should include testing for alinearity and asymmetry of variable relations. Some of the methods for non-linear model should only be employed when the relations are proved to be non-linear. However, it should be done with caution because these methods (non-linear factor, canonical, discriminative and regression analyses) are inadequately tested, thus it may be preferable to use classical methods and linear model.

Accordingly, it appears that, at least for the time being, it is reasonable to use linear model and appropriate multivariate mathematical-statistical methods for data (information) condensation and transformation in order to test the operationally set study hypotheses and to solve the kinesiologic problem under study, in this case within the scope of the child integrated development. On doing this, the problem of defining the number of significant latent dimensions extracted is encountered and can be simply settled by using different criteria to retain significant dimensions (factors). The best known Guttmann-Kaiser (GK) criterion may frequently lead to hyperfactorization of the anthropological space analyzed, therefore the graphic screen-test (Cattell) available in statistical softwares should also be used; however, there are other tests that can be implemented in the respective parts of these softwares. In addition, various methods for data condensation and transformation (usually factor analysis) as well as those that will not produce so-called orthogonal solutions or factors showing no correlation should be employed. Considering transformation methods proved to be more realistic, direct oblimin and promax are available in statistical packages. Based on some studies (e.g., Bala, 1999, 2000; Bala and Ambrožič, 2002)[21–23], the promax method is preferred.

The methods described are very important for defining various problems of the child integrated development because they yield latent dimensions (as a linear combination of the manifest variables analyzed), which are highly relevant in kinesiologic scientific disciplines and which can be further analyzed by other multivariate mathematical-statistical methods.

However, it should be noted that the very choice and use of the latest mathematical-statistical models cannot solve the problems described. Instead, it is of utmost importance to properly design the sample and to construct appropriate and reliable measuring instruments, and to select competent measurers that will strictly comply with the standardized measuring conditions, which should result in a correct matrix of rough data (Bala, 2003)[24]. On doing this, care should be taken that all measurements are performed in line with a correct research and experimental design. Respective data processing can only be done when all these basic preconditions are met.

Designing a Potential Model of the Child Integrated Development

It is not possible to design a complete model of the child integrated development that would subsequently be extrapolated to a complete anthropological status of characteristics and abilities of adults (simply called anthropological dimensions). Every age, sex, nation, race, socioeconomic environment and other phenomena have their own specificities, and thus some specific characteristics and abilities (mental, attitudes and interests, social status, activities, etc.) along with the relatively general

ones (morphological features, body built, motor and functional abilities). Therefore, an attempt at defining and designing a potential model of the child integrated development is presented below.

The model of the child integrated development was based on the fact that children differ according to all anthropological characteristics and abilities, and that these differences can be detected for each individual child by their environment. These differences are observed in each individual child, therefore interindividual differences are analyzed, or differences between particular groups of children, composed on the basis of differences and resemblances among children according to the characteristics and/or abilities analyzed. Of course, these differences or resemblances vary in the level of significance, depending on the anthropological dimensions analyzed.

Besides these, designing a model of the child integrated development also relies on the fact that there is no anthropological dimension the variability of which would be influenced solely by an exogenous factor. On the other hand, the current state-of-the-art does not allow us to state that some dimensions are exclusively, or to what extent, influenced by endogenous factors. Accordingly, anthropological dimensions generated by endogenous and exogenous influences as well as those that can be obtained by the child's willing activity to modify his/her close social environment, or even to activate some potential anthropological dimensions to a certain extent, should be introduced in the model.

Designing a model of the child integrated development poses a problem due to the obvious fact that the term of anthropological dimensions in adults can hardly be used in children, preschool children in particular. However, keeping the terms of anthropological dimensions in adults and their use in the studies, analysis and result interpretation in children appears to be unavoidable for the time being. The problem does not only refer to the quantity and the level of existence, but also to the modalities (structure) of these dimensions, and in particular to their inter-relations. In order to obtain as complete as possible information on the child integrated development, as many of their characteristics, abilities, behavior and various activities as possible should be included. This means that assessment of the child development and status based on a single segment of the anthropological space should be avoided, and as many as possible segments and anthropological dimensions should be considered on analysis. It is necessary for the supra-summation effect of the relations of these dimensions in the overall anthropological space.

A model of the child integrated development should have the following main characteristics:

- manifestations of anthropological dimensions should be quantifiable on a measuring scale that is sensitive enough to observe interindividual differences among children; and
- allowing for assessment of relations within and between the anthropological space segments (systems) and between different sets of variables for their assessment.

The entire anthropological space is of a stochastic but not completely causal character. This means that correlations among anthropological dimensions need not be generated by the quality and intensity of some other child dimensions or behavior. However, the analysis should start with determination of correlations among manifest variables in order to establish some tendencies or even regularities during the growth and development and in the child behavior. On doing this, a situation should be created that would also enable partial assessment of anthropological dimensions, thus allowing for the best possible analysis of the subsystem of particular variables. Upon such an analysis establishing the factors and possibly the generators of these dimensions, the intensity and direction of relations among the subsystems of anthropological dimensions should be determined. Studies attempting to design a complete model of the child integrated development are also faced with some methodological and especially material limitations. Therefore, researchers decide to restrict their studies to a minor number of subsystems, usually two or three, with a relatively small number of indicators *per* subsystem. It is dictated by the impossibility of measuring and testing small children by a large battery of tests and measures, both for the limited time available in appropriate circumstances, and even more for the lack of attention and collaboration of the small study subjects in case of prolonged measurement and testing (more than 45–60 minutes). Note should also be made of the issue of the consent to be obtained from the parents, institutions and children themselves for the planned testing and measurements, along with the limited time to obtain it.

The model of the child integrated development definitely has a hierarchical character and each subsystem tends to generality in preschool children. Because of the incomplete development of the central nervous system and various sensitive stages of growth and development in this period, it is difficult to speak of the model of the child integrated development as a functional model, and probably it should be more appropriate to design it as a structural model liable to exogenous factors from the parents and family, and later from contacts and spending time with other children and educators (socialization), and from activities performed at preschool institutions.

The real structure of the model of integrated development could only be defined on the basis of identification of anthropological segments (subsystems, subspaces) and respective dimensions, and their inter-relations; however, an initial model has to be chosen on the basis of experiences acquired with adults, i.e. with subjects of relatively stable anthropological characteristics and abilities (dimensions).

As the child integrated development includes the biological, motor, mental (psychological) and social development, which define – by their supra-summation effects – the efficiency of activities and communication in childhood, the respective components should be introduced in the model. Each component carries a certain genetic potential and the ability to transform according to some ex-

ogenous factors. Each of these components follows its own trend of growth and/or development, contributing in various ways to the formation of anthropological dimensions and the entire anthropological status and integrated development of children. Each component contains so-called primary factors that are assessed by the respective measuring instruments (indicators, measures and tests). These components can be further divided into the following secondary components (factors, constructs): health status, morphological characteristics, functional abilities, motor abilities, cognitive (intellectual) abilities, personality traits, values and attitudes, microsocial status, social status, and activities.

Based on the inter-relations of secondary components, the existence of the following constructs can be predicted at the third level of this model:

- morphological-functional-motor structures (health status, morphological characteristics, functional and motor abilities);
- socio-cognitive structures (intellectual abilities, personality traits, values and attitudes, microsocial and social status); and
- behavior (in line with social standards and aberrant behavior as the result of activities according to the morphological-functional-motor and socio-cognitive structures).

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HIPOTETSKI MODEL U ISPITIVANJU INTEGRIRANOG RAZVOJA PREDŠKOLSKE DJECE

SAŽETAK

U radu su sustavno prikazani problemi metodološke naravi, kao i moguća rješenja u istraživanju raznih aspekata razvoja djece, osobito one predškolske dobi. Ti problemi tiču se definiranja, usvajanja i pripreme postojećih teorija razvoja koje obuhvaćaju analizu djece u cjelini njihovog bića, njihove okoline, ali i njihove aktivnosti. Uz to, obrađeni su i metodološki problemi vezani za seksualni dimorfizam, uvjetovanosti razvoja naslijeđem i okolinom, definiranje modela konstrukata (faktora) na osnovi kojeg se provodi izbor varijabla za procjenu integralnog razvoja, definiranje populacije i način izbora uzorka ispitanika, određivanje manifestnih značajki i sposobnosti, te izbor ili konstrukcije mjernih instrumenata za njihovu procjenu, primjerenost modela i metoda za analizu podataka, kao i mogućnost izrade mogućeg modela integralnog razvoja predškolske djece.