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MATHEMATICAL MODELING OF PARENTAL MOTIVATION

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Abstract

The article suggests a mathematical model of parental motivation based on factor analysis and dispositional theory of personality. It is supposed that parental motivation is a combination of interaction between subject and conditions of parenthood. The external conditions are given as a complex of variables on macro- meso- and microlevel of parenthood realization. Features of the subject of parenting are described through functionally objective and subjective characteristics of personality. The child, as a participant in the parenting process, which determines the factors of the parenting conditions (its tension, complexity, etc.), is included in the variable of the conditions of parenthood to verify the adequacy of the proposed model on real sociological data.

Keywords: Parenting, mathematical modelling, parenting factors, parental motivation, demography.

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1. Introduction

In recent years, the possibility of predicting social processes using mathematical modeling and statistical analysis has increasingly attracted interest. The theoretical and methodological foundations for the construction of sociological and mathematical models of social processes were laid by V.M. Alekseev, Yu.A. Levada, A.A. Samarsky, V.V. Fedoseev, V.A. Shvedovsky and others. Several studies of modeling processes in socio-economic systems were awarded the Nobel Prize (The Official Web Site of the Nobel Prize 2017).

The acute demographic problems in modern Russia predetermine the high relevance of research into parental behavior. Traditionally, the use of modeling methods in human capital reproduction is reduced to making demographic projections (Bergaglio 2017; Coste, Austerlitz, & Pavard, 2017). Even a conventional construction of parenting models using precise mathematical methods is difficult due to the multitude of factors influencing human activities. At the same time, there are a number of studies analyzing the general factors and determinants of parental behavior and its key element - reproductive behavior. Thus, it has been substantiated that the factors affecting parenting are the socio-demographic characteristics of the parenting subjects (Hubel, Rostad, Self-Brown, & Moreland, 2018), the psychological climate in the social group and the support of the environment (Seo et. al., 2018), the socio-cultural environment (Gonzalez & Méndez-Pounds, 2018), the material and living conditions (Sim, Fazel, Bowes, & Gardner, 2018), etc.

2. Problem Statement

It is known that motivation is formed through the interaction of the subject and the situation where its capabilities are implemented. Then the motivation for parenting is born when the parental subject encounters specific conditions for the realization of this type of activity at various levels of social organization. Social and socio-psychological processes are usually difficult to be measured directly. However, the mathematical and computer simulation of social processes can improve the precision and impact of targeted activities of demographic and social support that are developed for parenthood and parental labor.

Thus, we need to develop the general principles of simulation of parental labor motivation. These principles should take into account the personality of the parent, the personality of the child, as well as the social and material conditions of parental labor.

3. Research Questions

This paper considers two basic research questions. First, we try to mathematically evaluate the interaction between the different factors of parental labor: the characteristics of the subject of parental labor, the features of the object of parental labor and the socio-economic conditions of parental labor. The second point is to show by a simple mathematical model where the parental labor can become more motivated, and where the motivation decrease.

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4. Purpose of the Study

The purpose of this study is to develop a mathematical model for parental labor motivation taking into account the characteristics of the subject of parental labor (the parent), the features of the object of parental labor (the child) and the socio-economic conditions of parental labor (the society)

5. Research Methods

The dispositional theory (Yadov, 2013) suggests the following scheme for any specific human action: 1) a certain "configuration" of external and internal conditions (for the cognitive component of the disposition structure there should be enough information, for the emotional component - the correlation of knowledge and need etc.); 2) actualization of dispositions; 3) a behavioral act. The specific ways to satisfy the needs of parenting are determined by the activity conditions at three levels of societal organization: micro-, meso- and macrolevel. At the macrolevel, these conditions include the institutional foundations of parenthood as a social institution; at the mesolevel it is a complex of social interactions; at the microlevel we consider the individual's physical and mental activity in the sphere of parenthood. Let us study these aspects in more detail.

6. Findings

6.1. Macrolevel

The macrolevel of parenting includes several stable types of conditions in different social spheres:

- political conditions are the state regulations of family and demographic sphere, organizational and legal standards for parenting, etc. In the model of parental motivation, this group of conditions will be designated by 'o' (organization);
- economic conditions are availability of financial and material support measures, state of infrastructure and social stability. The economic conditions will be designated by 'e' (economy);
- informational and cultural conditions are the traditions, ideals, norms and values broadcasted in the society's mass media. The informational and cultural conditions will be designated by 'c' (culture).

6.2. Mesolevel

The mesolevel of parenting organization includes stable conditions for group communication and infrastructural support at the direct level of parenting in particular cases. The mesolevel conditions are undoubtedly connected with the macrolevel conditions of social organization, but this connection is not always unambiguous. This concerns the differentiation of the material and social status of various societal groups and strata. The same applies to the individual's social environment - it can vary significantly, depending on the subject's belonging to a particular social group or individual preferences in communication. Therefore, the direct material conditions for the realization of a particular subject's

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parental functions will be denoted as 'm', and the direct social conditions for the realization of parental functions - as 's'.

6.3. Microlevel

The microlevel of parenting organization includes the conditions of parental behavior in volatile situations, depending on the characteristics of the parenting subject considered below. Schematically, the conditions for implementing parental procedures (C) can be expressed as a function of the above parameters at the macro- and mesolevel:

$$C = f_1(o + e + c + m + s) \quad (1)$$

where C - parenting conditions; o – political conditions; e – economic conditions; c – informational and cultural conditions; m – material conditions; s – social conditions of parenting.

Let us introduce quantitative coefficients for each argument of function (1). These coefficients are based on empirical data and allow us to evaluate the specific conditions for the realization of parenthood, depending on regional, demographic, temporal or other differences.

In this case the formula is as follows:

$$C = f_1(o \times a_1 + e \times a_2 + c \times a_3 + m \times a_4 + s \times a_5) \quad (2)$$

Limits for weights can be set by the researcher using the assessment scale in the empirical data collection tools. Thus, the respondents will be able to assess the level of certain conditions for the realization of parenthood according to a given scale. At the same time, the researcher can vary the number of arguments of the function depending on the specifics and objectives of the study.

The complex of objective conditions for parenting, along with the society's attitude to it, is individually reflected in each person's psyche at the microlevel.

The individual's perception at this level depends on two groups of personality parameters:

1) functional-objective parameters:
   - biological features: gender, age, health, psycho-physiological characteristics, denoted as 'bio'.
   - social characteristics: subject's own experience with his parents, his parenting experience, the stage of parenting, the level of education, involvement in social relations, etc. Let us designate these characteristics as 'socio'.
2) subjective personal characteristics, which include the individual's system of values and beliefs:
   - the system of needs (nd – needs);
   - personal interests (int –interests);
   - values and orientations (v –values).

Subjective personality characteristics form the core of motivation for parenting, along with reflection (its rational and emotional aspect), individual motives and the system of the individual's dispositions.

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The integral designation of the parenting subject can be expressed as a function of their biosocial and personal characteristics:

$$S = f_2(\text{bio+socio+nd+int+v}) \qquad (3)$$

where S – is the parenting subject; bio – psychical and physiological characteristics of the parenting subject; socio – social characteristics of the parenting subject; nd – the parenting subject's system of needs; int – personal interests of the parenting subject; v - the parenting subject's values and orientations.

Similar to the description of the child's features and the conditions for the realization of parenting, we can introduce the weighting coefficient c_n for each variable on the basis of its estimate, and the formula will take its final form:

$$S = f_2(\text{bio}\times b_1 + \text{socio}\times b_2 + \text{nd}\times b_3 + \text{int}\times b_4 + \text{v}\times b_5) \qquad (4)$$

The interaction between the subject's characteristics and parenting conditions is shown in the table below.

Table 01. Interaction between the Subject's Characteristics and Parenting Conditions

Levels	**Conditions**		
Macrolevel	Political (procedural and regulatory)	Economic	Socio-cultural
Mesolevel	Material	Social (approval of the social group)	
The subject's characteristics			
Microlevel	Functional-objective psycho-physiological characteristics		Subjective personality traits

Let us describe the interaction of the components of motivation for parenting presented in the table in terms of mathematics.

In the above expressions, f_1 and f_2 – some non-linear functions – are used to designate the components of parental motivation. The linear function does not ensure the unevenness of the function values relative to the argument, which virtually cannot be found in real models. The coefficients 'a' and 'b' are determined in accordance with the sample under study based on the statistical analysis of the respondents' answers. In view of the insufficient identification of mathematical models for motivation components, in this study these functions are linearized to a simple algebraic sum of weighted operands.

With all the three components of parental motivation expressed by a formula the following equation is obtained:

$$M = \frac{a + bC + cS + dCS}{e + fC + gS + kCS} \qquad (5)$$

where: M – motivation for parenting; S – parenting subject's characteristics; C – the complex of parenting conditions; a, b, c, d, e, f, g, k – rational function approximation coefficients.

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Formula (5) is a linear function with a set of weighting coefficients, which is a linear interpolation of theoretical and empirical data on parental motivation. Let us construct a three-dimensional graph of the surface graphically interpreting the phase space of the mathematical model of parental motivation based on situational approach.

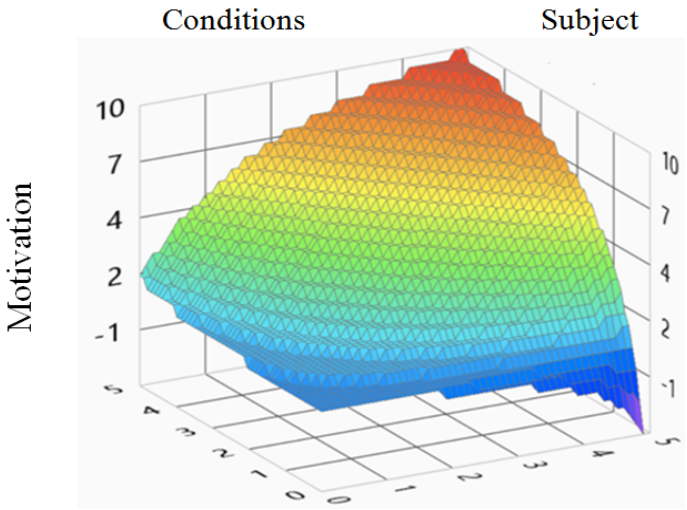

Figure 01. Dynamical space of the parental motivation model based on situational approach graded by levels

The X-axis of the graph in the Cartesian coordinate system shows the level of the subject's interest in parenting, the Y-axis represents the quality of parenting conditions. Each of the scales has 5 conventional divisions. The evaluation of parental motivation (Z-axis) has a scale from 1 to 10. The developed toolkit allows for flexible grading of scales depending on the chosen approach. When the number of measured indicators is increased, the resolution of the model phase space also increases. To make it more visual, the areas of the parental motivation graph are indicated by different colours of the spectrum: from violet (very low level of parental motivation) to red (very high level of motivation).

The resulting graph describes all the possible types and levels of parental motivation, showing their dependence on the characteristics of the subject and the specific conditions for its implementation. The developed model is not exhaustive, but is highly adequate.

7. Conclusion

When constructing a model of parental motivation, an important, but relatively independent variable should be mentioned: the child. In the system of determining the motivation for parenting, a child cannot be unequivocally attributed to the conditions for the realization of parental functions, since he himself is an independent personality and a subject of action. On the other hand, the individual characteristics of the child influence the outcome of parenting and the parent's reflection on their achievements in this area, and hence the attitude towards parenthood in general. But for testing this model on real sociological data, at the first stage of the verification it needs to be simplified, on the assumption

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that the child as an independent variable can be hypothetically included in the variable of parenting conditions (C).

This is possible for two reasons. First, mass sociological evaluation of the child's parameters is difficult due to the high level of subjectivity of the evaluations obtained (in particular, if they are given by parents). To obtain more objective data, it is essential to conduct a deep psychological analysis of each child for an adequate evaluation of all personality substructures.

Secondly, the child, in terms of situational approach to studying parental motivation, is an agent external to the parenting subject, that is, in a broader sense, part of external conditions (including social ones).

The child has a certain relationship with the parent, based on the personality traits of both sides. Depending on this, there is a level of mutual understanding, communication, social and psychological climate in the family, which creates an environment for the implementation of parental functions, directly related to parenting conditions. In addition, anthropologists have proved that cultural and social conditions can influence the implementation of parental functions, depending on the number of children, their rank in terms of birth order and gender (Butovskaya 2013). These characteristics relate to the conditions of parenting, rather than to the child's subjective characteristics or actions.

Given the complex, dynamic and multidimensional personality characteristics of the child and parent as parenting subjects, the introduction of the child will provide for a more detailed formula for constructing a mathematical model of parental motivation. However, at this stage, it can be conventionally attributed to the variable parenting conditions or left outside the brackets to be clarified in future studies.

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References

Bergaglio, M. (2017). "The contemporary illusion: population growth and sustainability". *Environment, Development and Sustainability*. 19(5), 2023-2038.

Butovskaya M.L. (2013). *Anthropology of gender*. Moscow.

Coste, C.F.D., Austerlitz, F., Pavard, S. (2017). "Trait level analysis of multitrait population projection matrices". *Theoretical Population Biology.* No 116, 47-58.

Gonzalez, N., Méndez-Pounds, J. (2018). "The Impact of Acculturation and Cultural Values on Hispanic Immigrants' Parenting". *Contemporary Family Therapy,* 40(1), 56-67.

Hubel, G.S., Rostad, W.L., Self-Brown, S., Moreland, A.D. (2018). "Service needs of adolescent parents in child welfare: Is an evidence-based, structured, in-home behavioral parent training protocol effective?" *Child Abuse and Neglect,* 79, 203-212.

Seo, Y.J., Cheah, C.S.L., Özdemir, S.B., (...), Leung, C.Y.Y., Sun, S. (2018). "The Mediating Role of Korean Immigrant Mothers' Psychological Well-Being in the Associations between Social Support and Authoritarian Parenting Style". *Journal of Child and Family Studies*. No 27(3), 979-989.

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Sim, A., Fazel, M., Bowes, L., & Gardner, F. (2018). "Pathways linking war and displacement to parenting and child adjustment: A qualitative study with Syrian refugees in Lebanon". *Social Science and Medicine.* 200, 19-26.

The Official Web Site of the Nobel Prize. Lists of Nobel Prizes and Laureates. Retrieved from: https://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/ (Retrieved on: 1.11.2017).

Yadov, V.A. (2013). Self-regulation and predicting an individual's social behavior: dispositional theory. Moscow.