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Original Article

Model of Socio-Psychological Adaptation of Humans with Different Temperament

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Abstract

We considered the process of socio-psychological adaptation when a person gets in a new environment. The socio-psychological adaptation involves communion of an individual to the new groups, as well as the types of activities that take place in the society. Its essence is the combination of stability and variability, which is carried out at the level of its interaction methods with the environment and at the level of adaptive mechanisms. We singled out the main social and psychological aspects influencing the adaptation process. At that, we took into account the extreme states of the adaptation process – adaptability and disadaptability. We considered the most studied classical types of temperament: sanguine, choleric, phlegmatic and melancholic. We singled out the adaptation process features for the specific types of temperament. We offered a mathematical model of socio-psychological adaptation, taking into account the features of the personality's behavior in the extreme states of adaptation process. The model is a Cauchy boundary problem for an ordinary first-order differential equation. The equation has two main parameters that determine the person's behavior in a depressed state and a state of complete adaptation. We chose the individual model parameters for each individual's temperament. We gave the graphs of adaptation dynamics in the absence of external stimuli. We analyzed the adaptation process of various temperaments, taking into account the 28-day biological cycle.

Key words: Socio-psychological adaptation, Temperament, Mathematical model

INTRODUCTION

The person's adaptation to the environmental factors is a polystructural and multifunctional phenomenon. The term "adaptation" should mean the interaction process between the individual and the environment. The individual's adaptation result is determined by the individual's adaptability. Adaptability is based on relatively constant personality characteristics, which constitute a system of adaptively important qualities [1]. The congenital bases of adaptability include physical indicators of the body state, temperament, body tympanum, emotions, congenital inclinations of intellect and abilities [2].

The socio-psychological adaptation, as one of the adaptation types, is especially relevant in the active social contact of people with different cultures and world views [3-5]. Social adaptation should take into account the various psychological aspects of the individual [6, 7], including temperament. Our work takes into account the influence of the temperament type on the socio-psychological adaptation.

The disadaptation development in different people passes individually and depends, inter alia, on the type of nervous system that forms the basis of temperament. The importance of temperament properties is more represented in the development of neurotic and psychosomatic disorders [8, 9].

Despite a variety of studies related to adaptation, there are no works describing adaptation as a mathematical model. The purpose of this work is to fill this gap and to build a simple mathematical model of the socio-psychological adaptation. When constructing the model, we consider four classical types of temperament.

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SOCIO-PSYCHOLOGICAL ADAPTATION

Let us consider the concept of socio-psychological adaptation in more detail. The socio-psychological

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adaptation involves communion of a personality to the new groups, as well as the types of activities taking place in the society. This adaptation type is understood as a result of the process of various changes, in particular social, socio-psychological, moral-psychological, etc.

The essence of socio-psychological adaptation is the combination of stability (preservation of body identity to itself) with variability (achievement of new states), which is carried out at the level of ways of its interaction with the environment and at the level of adaptive mechanisms.

The main indicator of socio-psychological adaptation is the state of a person's mental health. It means that the adaptation indicator determines, first of all, the viability and survival ability of the individual. The indicators associated with rethinking of a situation and effectiveness of solving the difficult situations are less significant and are often not considered.

In this work, we used the methodology for estimating the adaptation level, that is, the health, activity and mood (HAM) express-method. The method is based on using a questionnaire containing 30 pairs of bipolar scales, which are grouped into three categories (indicators): health, activity and mood. The examinee identifies the degree of manifestation of each of these three indicators. The mean mark of the scale is 4.0. A value of an indicator (health, activity or mood) exceeding 4.0 corresponds to a favorable state of a person and a value smaller than 4.0 corresponds to an unfavorable state. Normal state values lie in the range of 5.0–5.5. The negative pole's extreme value equals to 1.0, whereas the positive pole's extreme value equals to 7.0. It is noteworthy that, in analyzing a functional state, not only the values of three separate indicators should be taken into account; ratios of three values are also important. A detailed description of the questionnaire as well as of the HAM method, as a whole, is given in [10].

The extreme (opposite) adaptation states are adaptability and disadaptability, which mean the adaptation process result in terms of the success of its completion. Social adaptation assumes that the subject has certain skills and ways of interaction with the social environment. Such skills include free possession of the social interaction means; awareness of the social environment; a person's ability to realize his/her own stereotypes in the perception of other people; an individual's ability to cope with the emerging stressful situations by his/her own; settings for active interaction with the social environment; adoption of a social role [11]. In addition, the skills and methods of adaptive behavior include the ability to constructively resolve conflict and tense situations, as well as the ability to take responsibility for the actions, manifestations.

Disadaptability often leads to the formation of pathological complexes, neuroses, as well as to any form of "flight into illness", constant frustration that leads to the use of pathological defense mechanisms, resulting in neuroses. Disadaptation is expressed in the presence of long-term external and internal conflicts in the absence of psychic mechanisms and behaviors to resolve them with the individual [12]. Thus, at a certain stage, the disadaptation state can be associated with depressive states.

ADAPTIVE FEATURES OF DIFFERENT TYPES OF TEMPERAMENTS

At all stages of adaptation, the temperamental features significantly influence the formation of a variety of adaptive strategies, as well as the situationally conditioned disadaptive shifts. Temperament is the most important regulator of a functional state under stress, considered as a nonspecific reaction of a person to any, including extreme, impact.

The modern science has accumulated a large number of experimental data on the influence of temperament features on the processes of individual's adaptation to the varied environmental conditions: in terms of educational and pedagogical – building relationships with others [13, 14]. A large number of works are devoted to the temperament study in the adaptation process of foreign students to new living conditions [15], to profession choice, to professional activity [16]. Also, it is investigated the relationship between the properties of temperament and the parameters of biological and socio-psychological adaptation in the extreme conditions among military personnel and employees of emergency services [17].

As the medical literature analysis has shown, the temperament is studied in the framework of affective, neurotic and psychosomatic disorders: relationship of depression type and temperament type in patients with unipolar nonpsychotic depression, as a cause of stutter development [18].

Different temperaments differ in depressive states [19]. It is possible to distinguish differences in depressive states primarily between melancholic and other temperaments [20]. The most pronounced depressive states are in melancholic persons [21].

However, as the analysis of available studies has shown, it is mainly studied the individual temperament indicators (plasticity-rigidity, extravertibility-introvertibility), but there are no works in which a full-fledged relationship of temperament type and adaptation are considered.

Therefore, when constructing the model, we will rely, first of all, on features inherent to certain classical types of temperaments.

SOCIO-PSYCHOLOGICAL ADAPTATION MODEL

We begin the model construction by establishing a connection between the rate of socio-psychological adaptation du/dt and the adaptation itself $u = u(t)$, taking into account the individual's temperament. First of all, we take into account the features manifested in the states close to disadaptation ($u \to 1 + 0$) and the states close to full adaptation ($u \to 7 - 0$). To do this, we represent this relationship in the following form:

$$\frac{du}{dt} = A(u-1)^{\alpha}(7-u)^{\beta} \quad (1)$$

Where A is the adaptation rate ratio, which conditionally shows how fast the nervous system reacts to the stimulus. This ratio is most often a function of time t and a state of adaptation $u(t)$. We should also note that A, in the most general case, may also be the adaptation rate function: $A = A(u, du/dt; t)$. The values A may be either positive, indicating positive adaptation dynamics, and negative, indicating a decrease in the adaptation level.

The parameter α characterizes how difficult it is for an individual to leave a state close to disadaptation. A larger value of this parameter indicates a lower rate of change in the adaptation state at values u about one. We assume that the values α coincide for the sanguine and choleric persons $\alpha = 2$, and the values α coincide also for the phlegmatic and melancholic persons, they have $\alpha = 4$.

The parameter β shows how much the personality is difficult to remove from the adaptation state. Also, as in the case of parameter α, larger values β correspond to a more stable state of psyche, and, correspondingly, a lower rate of change in the vicinity $u = 7$. We will assume that a sanguine person has the most stable temperament ($\beta = 5$), then – choleric and phlegmatic persons ($\beta = 2$). And, finally, the least stable temperament is melancholic: $\beta = 1$.

We should note that the function du/dt, defined by equation (1), has one maximum $u = (7\alpha + \beta)/(\alpha + \beta)$ at equal to

$$\left(\frac{du}{dt}\right)_{\max} = A a^{a} \beta^{\beta} \left(\frac{6}{a+\beta}\right)^{a+\beta} \quad (2)$$

Fig. 1 shows the graphs of normalized (selected $A = (du/dt)^{-1}_{\max}$) dependencies of adaptation rates on adaptation for classical temperaments. The solid line indicates the dependence graph of the adaptation rate for a sanguine person. Our model shows that the sanguine rate has larger values even at small $u < 3$. In fact, this means that an individual with this temperament is trying to quickly get out of the disadaptation state. At values $u > 3$, when the adaptation state is normalized, the adaptation rate decreases, becoming practically zero at values of $u > 6$. This indicates that it is difficult to remove a sanguine person from a "comfortable" state.

The melancholic person has different situation (the dot-dashed line in Fig. 1). It is difficult for melancholic to get out of a "bad" state (the adaptation rate is practically equal to zero at $u < 2$), but it has a high adaptation change rate at large values of u. The dependence curve for phlegmatic is symmetrical (dashed line) and has the same behavior for the adaptation change rate in the vicinity of $u = 1$ and $u = 7$.

We should note that equation (1) in the particular case, at $\alpha = \beta = 1$, takes the form of the Bernoulli equation. The Bernoulli equation describes various limited processes (in our case $1 < u < 7$). For example, the information placement model is described by this equation in the work [22]. We should also note that the Bernoulli equation admits an analytic solution. For arbitrary values of α and β, the equation (1) should be solved numerically.

NUMERICAL RESULTS

Using equation (1), we calculate the adaptation dynamics for given values of the equation parameters. As an initial

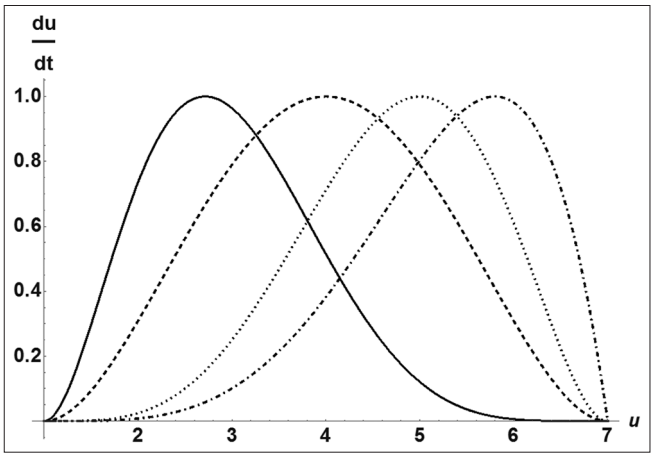

Figure 1: Dependence of the adaptation rate on adaptation for various classical temperaments. Solid line is for sanguine person ($\alpha = 2$, $\beta = 5$), dashed line is for choleric ($\alpha = 2$, $\beta = 2$), dotted line is for phlegmatic ($\alpha = 4$, $\beta = 2$), dot-dashed line is for melancholic ($\alpha = 4$, $\beta = 1$)

condition, we choose the value $u(0) = 1.8$. Thus, we obtain the initial boundary problem. Its solutions for four sets of parameters are shown in Fig. 2. The solid line shows the adaptation dynamics curve inherent to a sanguine person, which adapts quickly, in fact, in the first forty-five days. We should note that the rapid adaptation of sanguine person, from the point of view of the proposed model, is affected by a small parameter value of $\alpha = 0.8$ and a high rate of the nervous system response: $A = 0.25$. The phlegmatic person, having a bit worse parameter values for the speedy adaptation, is next adaptive: $\alpha = 1.1$ and $A = 0.15$.

Let us consider in more detail the dependence for an individual who bears the features of a melancholic person. In Fig. 2 the graph corresponding to this temperament is indicated by a dot-dashed line. The graph shows that the state of maximum adaptation in melancholic persons is reached only by 14th week. This confirms that the melancholic person is the most slowly adapting psychotype.

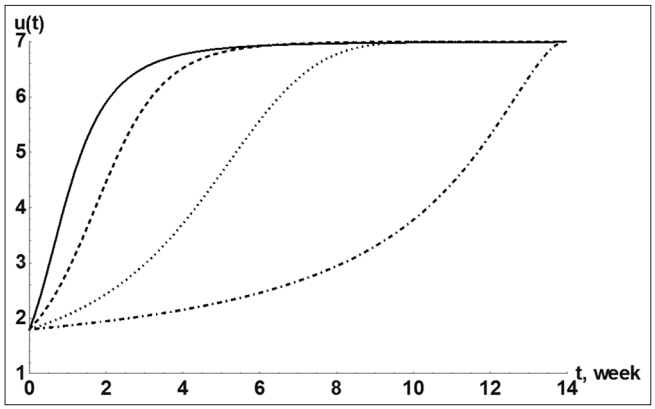

Figure 2: Adaptation dynamics graph for a constant value of *A*. Solid line is for $A = 0.25$, $\alpha = 0.8$, $\beta = 1.3$, dashed line is for $A = 0.15$, $\alpha = 1.1$, $\beta = 1.1$, dotted line is for $A = 0.08$, $\alpha = 1.4$, $\beta = 0.8$, dot-dashed line is for $A = 0.05$, $\alpha = 1.9$, $\beta = 0.4$

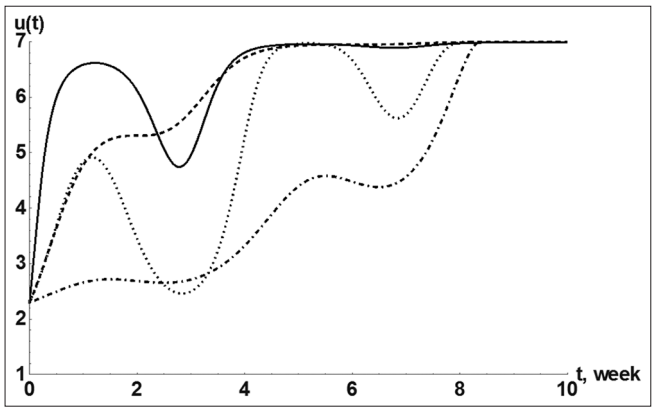

Figure 3: The graph of adaptation dynamics taking into account the four-week biological cycle: $A = B(1 + C\cos(\pi t/2))$. Solid line is for $B = 0.25$, $C = 3$ $\alpha = 0.8$, $\beta = 1.3$, dashed line is for $B = 0.15$, $C = 1$ $\alpha = 1.1$, $\beta = 1.1$, dotted line is for $B = 0.08$, $C = 4$ $\alpha = 1.4$, $\beta = 0.8$, dot-dashed line is for $B = 0.05$, $C = 1.4$ $\alpha = 1.9$, $\beta = 0.4$.

In our model it corresponds to the values $A = 0.05$ and $\alpha = 1.9$.

Above we have considered the cases when a parameter A is constant. However, as indicated above, it is a function of time. Let us take into account the biological cycles having a period of 28 days in the model. To this end, let us consider the adaptation rate of the form of $A = B(1 + C\cos(\pi t/2))$. Such a representation assumes that the normal state, in which the adaptation rate is described by a parameter B, is affected by the biological cycle with a period of 4 weeks. And the amplitude BC with cosine shows how strong the effect of this cycle is.

Timelines for changing the adaptation state in time for the parameters used in constructing the graphs in Fig. 2, taking into account the biological cycle are shown in Fig. 3. Here the initial adaptation value is $u(0) = 2.3$. Analysis of the graphs in Fig. 3 shows that the dotted line describing a choleric person has the greatest bursts, which is due to a strong dependence on the mood ($C = 4$). The graphs for a phlegmatic and a melancholic person have an almost monotonic time dependence, which follows from the low values of parameter C.

It should be noted that the graphs in Fig. 3 correspond to examples where the adaptable temperament has a rise in terms of biorhythms. If we choose that there will be a decline at the initial time, then the adaptation process will be somewhat slowed down. Setting the biorhythm phase is achieved by selecting an additional parameter φ in expression of $A = B(1 + C\cos(\pi t/2 + \varphi))$.

CONCLUSIONS

We constructed a mathematical model of socio-psychological adaptation in the form of a Cauchy boundary problem for an ordinary first-order differential equation. We chose the pair of parameters contained in the model for each individual temperament. We created the graphs of adaptation dynamics in the absence of external stimuli. We analyzed the adaptation process of various temperaments, taking into account the 28-day biological cycle.

SUMMARY

We constructed a mathematical model of socio-psychological adaptation, taking into account the main features of person's temperament types. We gave the graphs confirming the model adequacy. In the future, the model may be improved by considering the less significant features inherent to the temperament types and an individual.

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