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Modelling of Adaptation Strategies for Different Entities

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Abstract

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Traditional methods for studying human adaptation characteristics allow us to estimate the dynamics of the individual parameters of the body and under the influence of a large number of unaccounted factors that give reliable results only if significant gross abnormalities. For quantitative characteristics of the adaptation process in the paper considers the entropy indicators of biosystems that allow to estimate not the absolute values of the physiological (or any other) characteristics of the condition of the body, and the tendency of their changes under the influence of external factors or conditions. The authors consider the possibility of applying this approach to the studies of the students' adaptation to training in high school. In this paper also we attempt to build models of adaptive processes stakeholders.

Keywords: Adaptation, the entropy approach, adaptation strategies, integrated indicatore.

1. Introduction

Nowadays, the issue to study the factors that influence the adaptation of entities is up-to-the-minute. However, the majority of works devoted to this issue consider, as a rule, some individual specific aspects of adaptation. As a matter of fact, there are not scientific works where the process of social, physiological and psychological adaptation of entities is considered as a whole. In this paper we attempt to build some models of adaptation strategies for entities.

2. Information-entropy approach

Biological and social systems exist, adjust and develop due to the power, substance and information interchange with the external environment. These systems are called open. One of the most perspective avenues in these systems research is based on the entropy concept. Unlike the classic physics where deterministic and reversible processes are studied, open systems, and it is common for living systems, can demonstrate the steady imbalance.

It is known that the entropy represents the probability degree of the system being in this state. It emerged that the entropy is one of the fundamental properties of any system with probabilistic behavior that provides new levels of understanding in information encoding, system analysis, linguistics, biology, image processing and etc. The external information influence on the system can be considered through the entropy change of the system state. When the system reaches the steady-state condition, the total entropy change can be considered as approximately equal to zero that corresponds to the cancellation of all processes connected to the substance, energy and information input, removal and transformation (Williams, 1993).

As for the organism disorders, they are connected to the extra energy consumption to compensate for acquired or elf-marked defects and to the entropy growth.

The dynamic system can have several steady-state conditions that differ by the entropy playback level. Biological system is in operation and in coordination with the external environment follows every exogenous and endogenous exposure. It is possible to observe the processes that deal with fluctuation, energy dissipation, information and energy interchange, and finally, with building-up of new dynamic conditions that we are used to name the adaptation strategies.

Traditional research methods of human adaptation properties allow evaluating the dynamics of certain organism parameters and under conditions of a big amount of unaccounted factors, diversity of n parameters, and a low accuracy of non-invasive methods produce a reliable result only when deviations are significant and rough. As a rule, it is almost impossible to take into consideration the nature and tendency of organism condition change or it can be done at the level of verbal statements.

To get the adaptation process quantity characteristics we introduced the entropy parameters of bio-system state that allow evaluating the tendency of physiological (or any other) properties change under the influence of external factors and conditions and not their absolute values.

3. Information criterion I

Information criterion I allows to evaluate the deviation degree of the object current state from the “preferential” (or reference state) taking as a “preferential” object state the state when the values of all state variables are equal to the average values of the physiological range (for homogenous groups of respondents) (Berestneva, 2015):

$$I = \sum_{j=1}^{n} P_{0j} \ln \frac{P_{0j}}{P_{1j}}, \quad (1).$$

where

n – numberofaccountablecharacteristicsthatoutline the object state;

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P_{0j} – prior probability that characterizes the “preferential” probability of the object state;

P_{1j} – posterior probability.

Theprobabilitythatthevalueofcharacteristic*X*iscorrespondingtothe “norm” can be determined as follows [3]:

$$P_{ij} = P(|X - a| < \delta) = 2\Phi\left(\frac{\delta}{\sigma}\right) - 1, \qquad (2)$$

where a –probabilistic average of characteristicx_j;

δ –deviation amount of actual value$x_j$from*a*;

σ –dispersion of characteristic x_j;

Φ – standard function of Gauss distribution.

4. Characteristic property of students’ adaptation to higher learning

The practical utility of contact issue between the organism and environment actually resides in fact that the knowledge of its mechanisms allows solving a range of important issues of human physiology and ecology. One of these issues is an optimization of students’ academic activity taking into account social-psychological and psycho-physiological features of an individual.

Over the past few years this issue was covered in many works. The authors of this works (Zamyatina, 2013,2015) study the issues of human adaptation to operational activity. They attempt tosolvetheproblemofquality assessment of automated control system operatortraining taking into account his psycho-physiological characteristics. To solve this problem, the authors use the operator activity research method in terms of functionality parameters of the operator. They carried out an operator psycho-physiological characteristics analysis to choose the most appropriate functionality parameter. As a result, the parameter of operator’s functional efficiency and the psycho-physiological tension parameter that allow evaluating the operator’s commitment to long-term performance with specified quality were obtained. The method of quality assessment of automated control system operatortraining was developed on the basis of operator activity experimental studies.

The method of adaptation strategies modeling that was developed by the authors was used to study the characteristic properties of students’ adaptation to the academic activity. In this case, the adaptation function is an integral index value I_{adapt} at time periods t_1, t_2 … t_k (integral index value at discrete time periods. This approach was successfully applied earlier by A.V. Rotov, I.G. Svarovskaya,V.F.,Tsoy, O.M. Gerget (Gerget, 2014) and others to study the adaptive behavior characteristic properties of oilfield workers and timber loggers under conditions of shiftwork, of pregnant women, of newborn babies during an early neonatal period, of obstructive jaundice patients in postoperative period.

When the integral index$I_{adapt}$is used, it is supposed that there is some “reference” (“preferential”) state of the bio system and the deviation degree from this state in real time allows evaluating *I*-criterion.

For instance, if *I*-criterion is used to evaluate "the health level", the physiological standard values for every state variable are taken as reference. Moreover, when the problems of state dynamics assessment are solved, the co-called "background" state (e.g. the students' state for the initial few days of the term, i.e. before the academic activity) is taken as "reference". In the latter case, the "work expectations" state is specified and on its basis, the dynamic studies are carried out taking into account the Wilder's "reference values law".

The studies of adaptation characteristic properties of first-year students to the academic activity that were carried out by the authors showed that in this case there are four main types of organism excitation response (fig. 1-4). These types ("adaption strategies") were revealed earlier by other authors when they studied the adaptive behavior characteristic properties of workers under conditions of shiftwork, of pregnant women, of newborn babies during an early neonatal period, of patients in postoperative period and others.

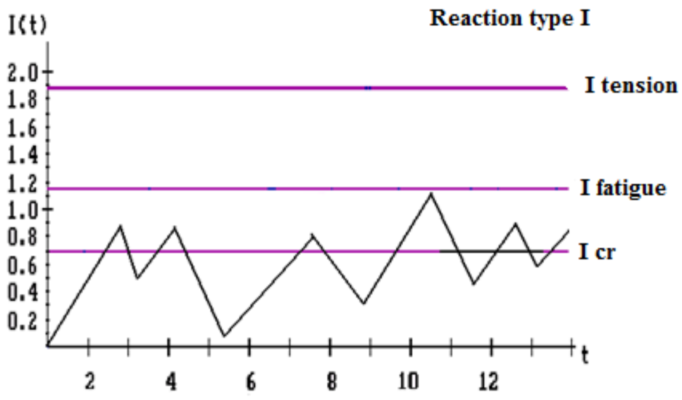

Fig. 1. Adaptive reaction type (1)

The first type of reaction (*I*) is characterized by fluctuations $I(t)$ relating to I_{cr} absent the tension (tension degree (TD) <0,2). The students with the first type of reaction (*I*) in fact do not have major breakthroughs of functionality. Therefore, this type of reaction can be considered adaptive, as the function values do not exceed "standard limits" during the whole period of object observation.

On the second type of reaction (II) the value $I(t)$ grows at a certain period of time and then levels off at a new level. This type of reaction of the functional system to socio-productive factors is determined as an adaptive compensatory reaction.

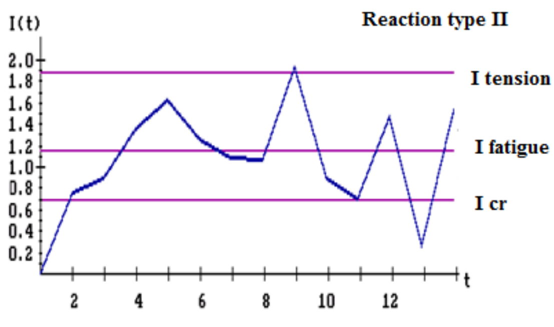

Fig.2. Adaptive compensatory reaction type

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On the third type of reaction at a certain period of time (III) the value $I(t)$ starts to grow gradually to a certain level that significantly exceeds I_{cr}, and then decreases steadily and reaches the initial level that characterizes this reaction type as compensatory. In this case, the organism functional back-ups at the academic activity period fully recompense some tension of the functional system.

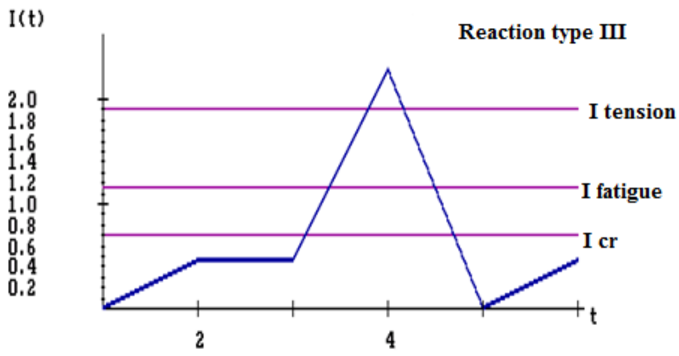

Fig.3. Compensatory reaction type

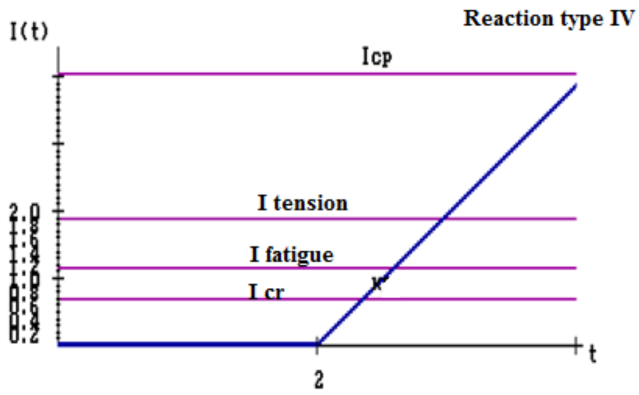

Fig.4. Maladaptive reaction type

The fourth reaction type (IV) is characterized by the steady rise of function $I(t)$ at a certain period of time that witnesses the disruption of all studied organism systems. Therefore, this type of reaction is common for adaptive compensatory mechanisms tension and can be determined as maladaptive.

The adaptive compensatory type (II) (table 1) is the most widespread one i.e. if you are a first-year student, the adaptive mechanism over-tension does not arise as a rule, but the re-establishment of the organism balance takes place at values that are different from the baseline ones. If the adaptation is sufficient, the person adjusts to the academic activity without any changes in state. Through the mechanism of fatigue, the organism guards against the after-effects of stress (Mokina, 2005).

Table 1. Allocationofadaptationstrategytypesinexperimentalgroups

Group	Samplesize	Allocation of adaptation strategies	
1. Skiers	31	1 - 76% 2 - 18%	3 - 6% 4 - –
2. Fourth-year students	44	1 - 23% 2 - 31%	3 - 44% 4 - 2%

Group	Samplesize	Allocation of adaptation strategies	
3. Aerobics group students	57	1 - 32% 2 - 32%	3 - 26% 4 - 10%
4. Therapeutic group students	48	1 - 12% 2 - 36%	3 - 20% 4 - 32%

The diagnosis of adaptation strategy types was carried out with the help of "STRATEG" program (Berestneva, 2013).

Table 2 displays the data allocation of adaption strategy types in our experimental groups. The further studies showed that there is an interconnection between the adaptation behavior types and the physical health level assessment, and between the psychological qualities and adaptation strategy types.

Table 2.Allocationofadaptationstrategytypesintermsofthestudents' physicalhealthlevel

Adaptation strategy type	Physical health level assessment			
	excellent	good	satisfactory	bad
I	30	45	-	-
II	21	17	39	28
III	42	30	15	18
IV	7	8	46	54

Taking into account the criteria based on our parameters, we discovered the testees (among examined students) with different adaptation degrees that reflect health scales. The psycho-physiological and academic activity parameters analysis results showed that sportsmen, fourth-year and first-year students have all four types of organism reaction given in (Berestneva, 2004).

5. Conclusion

Therefore, it is possible to make a conclusion that there are four main types of students' adaptation to the academic activity. It is worth mentioning that the group distribution according to the adaptation level has an important practical value and is devoted to organize the pastoral and psycho-correctional work with students in a risk group.

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