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Anthropological Studies of the Role of Temperament in Psychosomatic Correlations in Adults and children

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Currently, the actual problem of the study is the identification of the role of temperament, due to the individual characteristics of the nervous system, in the adaptation of the body to the environment. The available term «adaptation range» originates from assessment of functional system capability to change its characteristics to provide homeostasis during adaptation processes including the change of behavioral modes. The purpose of the article is to reveal and assess integrated indices of the efficiency of adaptive responses and the health reserve in young subjects and in junior schoolchildren with different temperamental features. This article contains the research results for heart rate variability, integrated index of health in young healthy persons and nonspecific resistance in junior schoolchildren with different temperamental feature manifestations. It has been determined that persons with different temperamental feature manifestations characterizing the behavioral activity have specific autonomic regulation of functions, which is a factor responsible for differences in the expression and efficiency of adaptive responses and, thus, for different health levels.

The results of the study demonstrate the relationship of personality temperament traits with the standard and reserve of health; identify the mechanisms underlying psychosomatic relations in children and adults.

Keywords: temperament; psychosomatic relations; nonspecific resistance; adaptive responses and conditions; heart rate variability; standard of health; young healthy persons; junior schoolchildren.

Research area: psychological sciences.

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Introduction

According to modern concepts, temperamental features are determined by differences in the excitability of brain systems that integrate not only the behavior and emotions of an individual, but also autonomic functions (Bardetskaya et al., 2016; Denissen et al., 2013; Porges, 1995). Temperament determines the «parsimony» of energy support of the life activity of an individual and, hence, the efficiency of adaptation to the environment. The amount of adaptive possibilities of the body determines the key difference of the normal state from pathology (Kolpakov et al., 1987; Lisova et al., 2017).

The close relation between temperament and basic biological processes forms individual psychophysiological constitution of an organism and in many respects determines «typogenic» characteristics of physiological processes and non-specific reactivity of an organism. In relation to this, the search of physiologic foundations and mechanisms determining the specifics of adaptive responses and parameters of non-specific responsiveness of a healthy organism in young healthy persons and junior schoolchildren, with different typological personal properties is becoming increasingly important (Karavayeva et al., 2011; Dzyatkovskaya, 2011; Garro, 2016). Consistent generalized dynamic-energetic characteristics (temperament) in human mind that are formed during activity on the basis of biological factors provide for adequate response to environmental disturbance (Petrosyan et al., 2009; Pintzinger et al., 2017). To our opinion, this constitutes in many respects the adaptive role of temperament.

Highly occurring deviations in junior schoolchildren's health today necessitate the research of the psychosomatic aspects of health formation during junior school.

Start of education is a powerful stress factor that changes a child's lifestyle, daily routine, exercise and rest regime. The change in a dynamic stereotype leads to adaptation mechanism tensioning and organism functional capabilities decreasing. Negative factors including those arising from the lifestyle aggravate the situation (Kulikov et al., 2001).

As the functional status of an organism is based on cortical-subcortical intermodulation relations, it is possible that the activity of cortical structures determining the typological specifics of neural activity including temperament can influence the expression of super-slow oscillatory processes in neural system and thus determine adaptive responses and organism conditions (Bornemann et al., 2016).

Complex neuroendocrine changes and the condition of vital organs and systems providing for adaptive responses may depend on typological specifics of

a child's higher nervous activity meaning that they must be reflected on the WBC differential.

For this reason, it is of apparent scientific interest to study the mechanism being the foundation of adaptive responses and organism conditions of in young healthy persons and junior schoolchildren with different temperamental traits.

Our study was aimed at revealing and assessing integrated indices of the efficiency of adaptive responses and the health reserve in young subjects and in junior schoolchildren with different temperamental features.

Methodology (materials and methods)

For determining temperamental features, we used a Russian variant of the Dimensions of Temperament Survey (DOTS) (Thomas et al., 1995) adapted by a research group from Novosibirsk (Kolpakov et al., 1987; Kolpakov et al., 1993).

The DOTS method includes the determination of the degree of expression, on a scale of one to four, of the following temperamental features:

(1) General activity level, the number of actions per formed by a person per unit time. It characterizes the motor component of behavior.

(2) Activity level during sleep. It characterizes motor activity during sleep. This index is considered to reflect the degree of dominance of the motor component of behavioral responses.

(3) Approach-withdrawal. It characterizes the first response of a person to new stimuli or situations. This feature is regarded as the resultant of the interaction of fear, avoidance, and the exploratory reflex in response to a new stimulus.

(4) Flexibility-rigidity. This feature characterizes the capacity for changing the behavior under the influence of external factors.

(5) Mood. It characterizes the ratio between positive and negative emotions during behavioral acts.

(6–8) Rhythmicity of sleep, eating, and habits. They characterize the stability of stereotypes resulting from individual experience.

(9–11) Task orientation, distractibility, and persistence. They characterize the ability to finish work once it is started despite external stimuli.

(12) Sensitivity, i. e., the threshold, the vulnerability, or the level of external stimulation necessary for changing the behavioral response.

(13) Intensity. It characterizes the energy level of behavioral responses irrespective of their sign (positive or negative), type, and orientation.

The possibility of precise quantitative characterization of temperamental features by this method permits demonstrating the presence or absence of a relation of the state of the body not only with the degree of manifestation of individual temperamental features, but also with their integrated manifestation. Taking into account fundamental parameters of the formal organization of human behavior, such as activity and flexibility or stability of behavior, which in many respects coincide with criteria of division of the higher nervous activity into types (the strength and mobility of cortical processes), temperamental features, according to the DOTS, are combined into groups related to the aforementioned properties. This method of distinguishing behavioral types of temperament has been patented in the Russian Federation (Savchenkov et al., 2005).

To determine behavioral types of temperament, we suggest two indices:

(1) the *index of behavioral expression* (IBE), which is equal to the sum of the values of general activity, sensitivity, intensity, and mood, and

(2) the *index of stability of behavioral stereotypes*, which is equal to the sum of the values of sleep rhythm, eating rhythm, rhythm of habits, and flexibility.

The calculation of the coefficients of correlation between the summary indices of activity and stability of stereotypes demonstrated that there were no significant correlations between them; each group exhibited a certain degree of independence, which justified their classification as separate significant factors of the overall temperament structure. A temperamental feature was considered to be pronounced if the average sum of points for the indices of activity or flexibility exceeded $M + 2/3\sigma$ and was considered poorly pronounced if this sum was less than $M - 2/3\sigma$. The remaining representatives of the population, whose scores were in the range $M \pm 2/3\sigma$, were assigned to the group with moderate expression of these behavioral features. In our studies, these values were 12.81 ± 0.92 for the index of activity and 9.7 ± 1.0 for the index of flexibility. Thus, according to the observed behavioral reactions, three gradations of expression (intense (In), adequate (Ad) and quiet (Qu)) and flexibility (labile, flexible and rigid) were distinguished.

In this study, when discussing interrelations of human temperament types with the integrated index of health and the type of the autonomic response, we consider only the IBE expression. The distribution of the studied population with respect to the IBE was close to the Gaussian distribution: intense (In) subjects accounted for 25.92 % of the sample; adequate (Ad) for 48.55 %; and quiet (Qu) for 25.53 %.

Because the universal indicator of adaptive responses of the body is the cardiovascular system, to assess the efficiency of adaptation responses, we studied

the heart rate variability (HRV) by tachography using a Valenta hardware-software system at rest and during a clinorthostatic test. Standard HRV indices were recorded and assessed. They included the heart rate (HR), index of stress of regulatory systems (stress index, SI), average power of the spectrum of the high-frequency component of HRV (rapid waves, RW), average power of the spectrum of the low-frequency component of HRV (slow waves, SW-2) and very low frequency component of HRV (slow waves 1, SW-1), number of pairs of RR intervals with a difference higher than 50 ms in percent of the total number of RR intervals in the array (pNN50), and index of centralization (IC).

The calculation of the integrated health reserve index (HRI) for the comprehensive health diagnosis was performed using the Khelmi-Test-2000 software package, into which we input the results of the objective examination of the subjects: height; weight; age, sex; HR and arterial pressure at rest, after the test (count), and during exercise (using a bicycle ergometer); Martinet's test; the assessment of trait anxiety according to the Spielberger-Khanin test; and the level of mental, physical, and social satisfaction according to Gundarov (Kulikov et al., 2000).

$$\text{HRI} = \{1/[1 + \exp(0.013 \text{ MOC} - 0.02 \text{ HR} + 0.132 \text{ SBP} + 0.0812 \text{ DBP} + 0.014 \text{ SR} + 0.005 \text{ SI1} - 0.037 \text{ R} + 0.091 \text{ MT} - 0.072 \text{ TA} - 0.03 \text{ PSL} - 0.001 \text{ SSL} - 0.01 \text{ MSL} + 0.084 \text{ IEI} - 13.94)]\} \times 100,$$

where MOC is maximal oxygen consumption (ml/(kg min)); HR is heart rate (beats/min); SBP and DBP are, respectively, systolic and diastolic blood pressure (mm Hg); SR is stress resistance; SI1 is the stress index at rest (arb. units); TA is trait anxiety (arb. units); PSL, SSL, and MSL are the levels of physical, social, and mental satisfaction (arb. units); and IEI is the integrated index of the efficiency of oxygen supply to the body (Kulikov et al., 2001).

We examined a total of 500 apparently healthy subjects (220 men and 280 women) aged 18–22 years.

Based on the assessment of functional system capability to change its characteristics to provide homeostasis during adaptive mechanism execution in particular by switching behavioral modes, we have performed a study of adaptive responses and organism conditions using the peripheral blood WBC differential in junior schoolchildren with different manifestation of temperamental features by V.A. Kopanev's method adapted for pediatrics by S.A. Vyborova (Kopanev et al., 1999; Vyborova, 2003).

The study incorporates 424 WBC differentials of healthy children permanently residing in Krasnoyarsk. It was taken into account that in the cyclical assessment

model of adaptive responses each of the response has a respective tension rank. The relationship between rank and organism resistance is inverse. All 9 ranks were categorized into four resistance levels: ranks 1–4 are “good” level; ranks 5–6 are “lowered” level; rank 7 is “low” level; ranks 8–9 are “very low” level. The discrete data of lymphocyte and segmented neutrophil count limits were used to categorized adaptive responses into adaptive conditions that formed five functioning blocks: I — Healthy (HF); II — Pathology Risk (PR); III — Compensated Pathology (CP); IV — Acute Stress (AS) and V — Chronic Stress (CS).

Results and discussion

On the basis of the HRV data, it was found that, at rest, intense (In) men were characterized by a higher SI and IC and a lower RW index as compared to adequate (Ad) men and especially to quiet (Qu) men (Fig. 1).

Such shifts, as is known, testify to the dominance of the activity of the central control loop over the autonomous loop. Taking into account the level of pNN50 and RW, in subjects with quiet (Qu) types of temperament (both men and women), the domination of the parasympathetic component of regulation over the sympathetic component is stronger than intense (In) subjects. The domination of the parasympathetic component indicates a more economic and efficient level of functioning of adaptation processes in these subjects (Baevskii et al., 2000; Baevskii et al., 2001).

The analysis of sex differences between data on cardiorythmography in the studied groups at rest demonstrated that SW-1 and the IC were considerably decreased and the SI was slightly increased in all women as compared to men (Fig. 2).

In the female group, among intense (In) subjects, the SI and IC were higher than in other groups and the SI even exceeded this index for men. As a whole, according to the HRV data, the activity of functional systems in the examined women displayed a higher stress of the regulation mechanisms; however, general sympathicotonia was not observed.

A functional load (the clinorhthostatic test) detected changes in several indices of the HRV and, hence, some differences in the mechanisms of heart rate regulation in subjects of different groups. In particular, the response to a load in quiet (Qu) and adequate (Ad) men and women was characterized by an increase in HR, IC, SI, and the intensity of SW-2 and a decrease in the power of RW and pNN50. Such a shift in the HRV parameters is generally assumed to indicate typical responses to a functional load involving an increase in the activity of central regulatory effects and an increase in the activity of the vasomotor center.

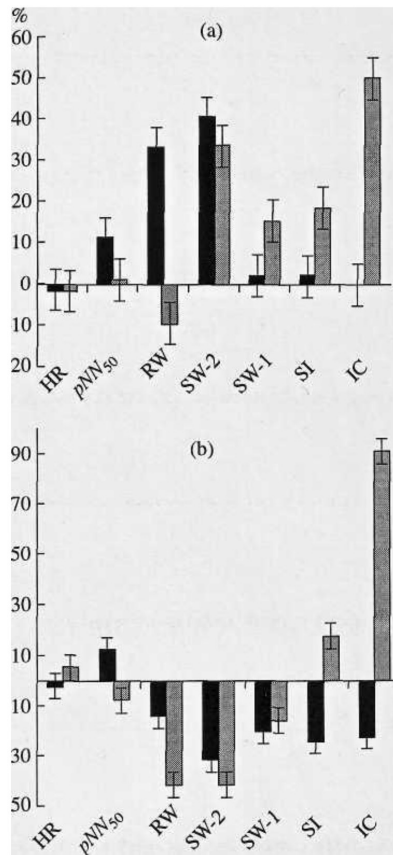


Fig. 1. Indices of HRV in quiet (Qu) (black columns) and intense (In) (gray columns) (a) women and (b) men as compared to adequate (Ad) subjects (taken to be 0%). Abscissa: studied indices (for explanations, see the text)

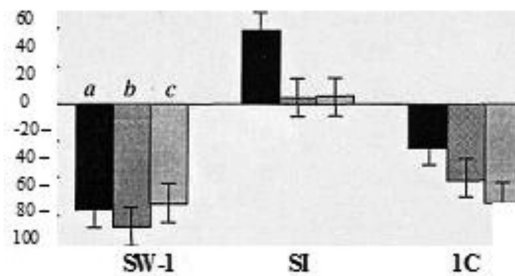


Fig. 2. Indices of HRV in (a) quiet (Qu), (b) adequate (Ad) and (c) intense (In) women as compared to the same groups of men (taken to be 0%)

At the same time, in intense (In) subjects, both men and women, such a dynamics was not observed. Apparently, this is accounted for by an initially more intense functioning of regulatory mechanisms in subjects with a pronounced component of intensity of behavioral responses. This may limit the adaptive possibilities of

Table 1. Initial autonomic tone (%) in men and women with different behavioral activities

Subjects	Sex	Eutonia	Sympathicotonia	Hypersympathicotonia	Vagotonia
Quiet (Qu)	Male	36.4	9.09	9.1	45.45
	Female	48.0	16.0	12.0	24.0
Adequate (Ad)	Male	34.38	18.75	15.63	31.2
	Female	55.0	25.0	5.0	15.0
Intense (In)	Male	43.3	11.1	27.8	17.8
	Female	45.0	17.1	26.3	7.9

regulatory mechanisms when the body is exposed to a wide spectrum of loads. Previously, we established that individuals characterized by a high intensity of behavioral responses have no sex differences in the response of slow fluctuations in hemodynamics to a functional load and, in the case of a high degree of stress of regulatory systems, cannot respond adequately because of their energy-deficient state (Savchenkov et al., 2017).

In our analysis of the initial autonomic tone in subjects with different behavioral activities, we obtained results indicating that, in quiet (Qu) subjects with a low IBE, especially in men, vagotonia dominates in a significantly higher percent of cases (table 1).

That is, in the studied group, subjects exhibiting differences in temperamental features also exhibited specific features of the autonomic regulation of functions, which might be responsible for differences in the expression (efficiency) of adaptive responses.

Comparison of the integrated index of health in the examined subjects demonstrated that all of them had a high HRI, which was to be expected since we examined apparently healthy young people. However, in quiet (Qu) men and women, the HRI was significantly higher than in intense (In) subjects (Fig. 3).

Organism functioning level study by WBC differential data from children with different manifestations of temperamental features showed that children with low resistance were the major part of all studied children (55 % male, 69 % female) regardless of temperament IBE or ISBS.

Moreover, a good resistance level was recorded much more frequently within the group of “quiet” children characterized by low behavioral manifestation especially among male children.

“Flexible” schoolchildren stood out among children with various stabilities of behavioral stereotypes during the analysis of rank characteristics. They were more often attributed to ranks 1–4 indicating good organism resistance.

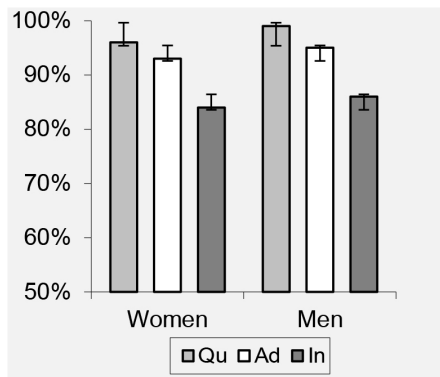


Fig. 3. Health indices in quiet (Qu), adequate (Ad) and intense (In) subjects

The analysis of functioning structure distribution showed that “quiet” schoolchildren had the highest HF and PR levels (20 % and 25 % respectively) and the lowest CP (51 %) and AS (4 %) levels in comparison to “adequate” (HF 19 %, PR15 %, CP 61 %, AS5 %) and “intensive” (HF 17 %, PR11 %, CP 66 %, AS6 %) children. The latter were not substantially different from each other. Among children with different ISBS, the organism functioning conditions were less differently manifested. But “flexible” children had the lowest CP (58 %) and AS (4 %) levels of pathologic functioning block and the highest PR (20 %) level of normal functioning block in comparison to “labile” schoolchildren (CP 60 %, AS5 %, PR17 %) and “rigid” ones (CP 65 %, AS9 %, PR6 %).

Thus, it has been determined that the junior schoolchildren whose temperament is characterized by low behavioral manifestation (“quiet”) and sufficient behavioral stereotype flexibility (“flexible”) show higher nonspecific resistance and adaptive responses by WBC differential data. This provides for normal organism functioning in comparison to the children with higher activity and lower flexibility of behavior.

Conclusions

Considering all of this it should be mentioned that intense (In) subjects, whose temperament is characterized by pronounced behavioral activity, stronger regulatory mechanisms at rest were observed. In quiet (Qu) subjects, with a low index of expression of behavioral responses, a higher HRI was found as compared to intense (In) subjects, with a pronounced component of activity of behavioral responses.

The specific features of autonomic regulation in subjects with different temperamental features may be a factor determining the efficiency of adaptive responses and, as a result, different health levels and reserves.

The study showed that the junior schoolchildren of Krasnoyarsk regardless of normal physical development have low adaptive capability in average meaning they are substantially prone to diseases.

Any functional system has regulatory mechanisms including among other things the psychophysiological capability. Therefore, adaptive reserves can depend not only on the functional capabilities of the blood formation system and other systems but also by temperamental feature manifestation of a child particularly the manifestation of behavioural activity features.

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Антропологические исследования роли темперамента в психосоматических корреляциях у взрослых и детей

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В настоящее время актуальной проблемой исследования является определение роли темперамента, обусловленного индивидуальными особенностями нервной системы, в адаптации организма к окружающей среде. Существующее понятие «диапазон адаптации» исходит из оценки способности функциональных систем изменять свои характеристики, чтобы обеспечить гомеостаз при реализации адаптационных меха-

низмов, в том числе путем смены режимов поведения. Исходя из этого цель нашего исследования — комплексная оценка показателей адаптационных реакций, состояний и резерва здоровья у молодых людей и младших школьников с разными типами темперамента.

В данной работе представлены результаты исследования variability сердечного ритма, интегративного показателя здоровья у молодых здоровых лиц и неспецифической резистентности у младших школьников с разной выраженностью черт темпераментальных черт. Установлено, что лица с разной выраженностью черт темперамента, характеризующих активность поведения, имеют особенности вегетативной регуляции функций и адаптационного потенциала, что является фактором, обеспечивающим проявления и эффективность адаптивных реакций и, как следствие, различный уровень здоровья.

Таким образом, полученные результаты демонстрируют взаимосвязь темпераментальных черт личности с уровнем и резервом здоровья, выявляют механизмы, лежащие в основе психосоматических отношений у детей и взрослых.

Ключевые слова: темперамент, психосоматические отношения, неспецифическая резистентность, адаптационные реакции и состояния, variability сердечного ритма, уровень здоровья, молодые здоровые люди, младшие школьники.

Научная специальность: 19.00.02 — психофизиология.
