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Original Article

Psycho-motility of a person in the context of its psychophysiological support and genetic determination

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Abstract.
Article is devoted to solving the actual problem of sports medicine and physical education under the concept of the psycho-physiological support and genetic determination of the person's psycho-motility organization. The aim of the research was to provide a theoretical analysis of the psycho-physiological support and genetic determination of the person's psychomotor peculiarities and to determine the students' adaptability to physical loads. An individualized assessment of motility and psycho-motility abilities was implemented among 151 persons aged 17-19 (75 young men and 76 young women) according to the author's program of a comprehensive examination of their psychophysical state using the NS PsychoTest system and employing valid methods of psycho-motility examination and functional capacity of the cardio-respiratory system. The leading factors that ensure human adaptation to physical loads were identified; they reflect the genetically determined basic properties of the individual's nervous system. The study established the significance order of these factors, namely: "motor", "sensorimotor", "anthropometric", "excitation" (they cover 72,03% of the total dispersion). A criterial scoring analysis indicates that 11,2% of students have a high degree adaptability to physical loads, sufficient – 35,7%; insignificant – 40% of students; maladapted – 13,1%. It was found out that the mechanisms of psycho-physiological support and genetic control of the individual characteristics of the motility and psycho-motility personal abilities should be investigated under genetic psychophysiology concept.
Key Words: psycho-motility, psychophysiological support, person's adaptability.

Introduction.

Modern science in various knowledge fields (psychology, physiology, medicine, physical education and sports) considers psycho-motilityas the unity of the individual motor activity with their ideas, thoughts and feelings. The outstanding neurophysiologist I. M. Sechenovhas priority not only in the terminological definition of "psycho-motility", but also in understanding that the human mental activity is closely related to the person's psycho-motor organization. Person's psycho-motor abilities are manifested in various forms of their practical mental activity: verbal (participation of muscleswhich provide phonation and language articulation), emotional, psychophysiological and behavioral (facial expressions, poses, expressive movements), as well as in locomotions (walking, running, jumping, and other types of motor activity). Today there is no need to reveal the leading role of psycho-motility in providing such mental activity forms as learning, professional skills in sports, art, medicine, science and other socially significant spheres of human life.

Functional opportunities of the cortical level of managing psycho-motility are limitless but they are usef only partially, nevertheless the construction of different movements types and all the levels of arbitrary psycho-motility activity are subordinated exactly to the cortical level. The optimal interaction of the hierarchical levels of motor acts regulation is provided by both rigid genetically determined regulation schemes which were built as a result of phylogeny and acquired in the ontogenesis (due to own sensory and motor experience) and flexible, labile schemes of psycho-neuro-immune-endocrine regulation.

It should be noted that even simple pupillary responses to the light stimulus (eye reflex) require the formation and realization of the adequate task of the psycho-motility program with functioning of the inverse communication mechanisms. Herewith, timely correction of motor activity is carried out, therefore the neurophysiological support of these psycho-motor acts is an adequate and promising object for psychophysiological and genetic research. Using the oculodynamic characteristics of visual afferentation we have established a pattern of individual specific reactivity (ISR) to a light stimulus that has a scientific and applied value, since it provides an opportunity to assess the children and adults' psycho-physiological state by using the pupillography method [4, 5].

The motility field, which includes the language and the writing, is easily tested and by the parameters of its individualized assessment we can study the peculiarities of temperament, the sensory perception of certain information signals, the peculiarities of the examined person's psycho-physiological state, as well as the person's

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intellectual characteristics. Only through movement, a person receives the necessary sensory information: visual perception at the expense of oculodynamic parameters of visual afferentation, auditory perception, haptic perception due to hand and fingers movements. It is the study of movements, as a means of active interaction between a person and their surrounding that led the famous scientist N. A. Bernstein (in the 40th of the twentieth century) to create a new and productive knowledge field – physiology of activity. The person's psycho-motor abilities have a significant genetic origin, but inheritance mechanisms of genes that determine the person's natural motor abilities remain unclear in many aspects.

Further studies of the person's psycho-motility organization in the concept of psychophysiological and genetic individuality are promising both in theoretical, methodological and scientific sense, and are applied to solve the actual problems of sportive medicine and physical education.

*Aim of research:*theoretical analysis of psychophysiological support and genetic determination of person's psycho-motor abilities and determination of the student's adaptability to physical loads.

Material & methods.

An analysis of modern theoretical and methodological approaches to the study of personality psycho-motorcapacity from the standpoint of their psycho-physiological support and genetic determination has done in the context of elaborating the individuality problem in the field of natural sciences and sports physiology. Individualized assessment of students' motility and psycho-motor features was conducted according to the author's program of psychophysical state complex examination. The research was carried out among students of the Odessa National Academy of Food Technologies and the South Ukrainian National Pedagogical University named after K. D. Ushynsky; 151 persons aged 17-19 (young men n = 75, young womenn = 76) were examined. The assessment of individual characteristics of students' physical and psychophysiological state was carried out using conventional anthropometric and motility features testing methods as well as the valid methods for psychomotor state studying. Psychophysiological researches were done in accordance with the recommendations for psychophysiological diagnostics by hardware-software complex "NS Psychotest" [12]. Functional data of the cardiovascular and respiratory systems were evaluated by the parameters of heart rate at rest, breath hold at inhale (BHin) and exhale (BHex), which allowed to calculate the functional potential of the cardio-respiratory system (CRS). CRS potential was determined by the equation: CRS = (BHin + BHex) / heart rate, where: CRS – cardio-respiratory potential (nominal unit); BHin – breath holdat inhale (s); Dex – breath holdat exhale (s); heart rate at rest (beats/min).

The algorithm of determining the students' adaptability to physical loads had the following sequence: 1. Diagnostic – testing the person's physical and psychophysiological state. 2. The choice of valid criteria acceptable for determining the student's adaptability to physical loads after anthropometric data, motor features, the psycho-motility state and CRS functional capabilities. 3. The quantitative and qualitative scale elaboration based on the average values of the selected criteria for converting the results into points. 4. Calculation of the points amount for each student after obtaining the results of comprehensive survey. 5. Integrative assessment of the person's adaptability to physical activity at the appropriate degree (high, sufficient, insignificant, non-adaptable). 6. Analytical – the interpretation of the obtained results as to the studied contingent distribution by the degree of adaptability to physical loads.

A factorial analysis aimed at identifying those leading factors that provide the person's adaptability to physical loads was carried out. For the statistical processing, we used the IBM SPSS 20 and EXEL software.

Results.

The person's locomotor reactions have such a peculiar thing as the possibility of implementing the same movement types by the inclusion of various levels of regulation: conscious (arbitrary) and automated, which allows to differentiate the psycho-physiological levels of its provision. Therefore, the researcher has a unique opportunity to assess the genotype-environment ratios in the variability of such traits asperson'spsycho-motorpeculiarities. The motor acts parameters as an object of genetic research have an advantage in cognition of a person's individuality; so their estimating is productive for the study of psycho-physiological support and genetic determination of person's psycho-motility [1, 5].

The individual characteristics of the studied motor reactions have a high correlation level with psychometric intelligence estimates: the IQ coefficient correlates with the individual variability of the latent periods of motor reactions and generally, rapidity of all motor acts correlates with the human intelligence level. Moreover, these movement parameters reveal that the correlation level with IQ is the same with the classical psychological tests of Raven and Wechsler, who study the person's intellectual abilities.

The well-known psycho-geneticist A. Anastasi emphasizes the high specificity and genetic causation of motility tests, which determine the speed and regulatory characteristics associated with the accuracy of the person's movements. The genetic conditionality of the motor reaction processing (switching actions) is proved, it has a direct connection with the nervous processes mobility and reflects the individual variability of psycho-motor features. Movement tests aimed at diagnosing fine motility coordination have high retesting reliability with high inheritance coefficients (0,8-0,94). The training process may alter the absolute estimates of the movement tests success, but it does not negate the significance of the genetic contribution into phenotypic

variability of person'spsycho-motorcapacity. It should be emphasized that genotype-environment interactions are the natural physiological mechanism of the human genome functioning; they implement the individual development in general and determine any personality capacity, including psycho-motor ones.

Sports activity is an individual realization of complex skills, its success depends on many factors (morphological, physical, psycho-physiological and psychological), but its importance differs for some kinds of sport, i.e. it comes about the variability of the personality's motor abilities in accordance with various motor activity types. That is to say about a necessity to identify the individual natural inclinations to specific types of sports activities. According to the results of twin athletes' studies, it turned out that among monozygotic twins 66% couples had athlete parents (father and mother), but among dizygotic – only 26% of couples; a study of 60 couples in which only one of the twins was an athlete showed that among them only 6% were monozygotic and 85% – dizygotic twins [14]. These psychogenetic studies confirm a familial genetic predisposition to sports activities. An analysis of outstanding athletes' pedigrees revealed a rather clear family resemblance: 55% of the national-level athletes had at least one of the parents involved in sports, and 22% of them participated in top-level competitions (even grandparents). As far as swimmers are concerned, this percentage distribution was even higher: 62% of their parents were in the national teams. The motor activity of the twins was fixed both by the fine motility state (pulling thread into a needle, manipulative actions with fingers, handwriting), and by results of coarse motility (ball throwing, neck-humeral reflex).

All person's involuntary movements have a high genetic determination; extrapyramidal nerve pathways carry out their regulation. Particularly, a neck-humeral reflex (the initial stage of stress reactivity) and protective reflexes (defensive, aggressive) have extrapyramidal innervation. Voluntary motor acts, which can be improved by sports activity process, are provided, above all, by the cortical level of controlling psycho-motility and person's emotional and volitional tone plays a leading role in their implementation.

The above-mentioned data allow us to conclude that the genetic determination of the psycho-motor personality capacities, which are conditioned by the peculiarity of metabolic and psychophysiological support, has been provennow.

We should consider such a metabolic index, which shows the natural abilities of the cardiovascular and muscular systems as the maximum volume of oxygen that a person can use (VO_{2max}), so far as this parameter is widely used in the physiological support of movements studies [14]. VO_{2max} indicates the effectiveness of the enzyme systems that provide the body with oxygen, including human motor activity. As to VO_{2max}- indicator, the following is known: its average population value is 40±4 ml/min/kg and it does not significantly change during the human life and as a result of training (its possible increase is only by 20-30%). At the same time, its value can reach a level of 70-80 ml/min/kg for international class athletes and it is quite clear that this parameter reflects a specific individual personality trait, i.e. may be the result of the training process to a lesserextent. Genetic studies have shown a high coefficient of VO_{2max} inheritance: it is in the range of 0,7–0,9 and there is a significant similarity in the parents-children pairs. Physical activity may facilitate to its growing but the increasing degree of this indicator is limited by the individual genotype. So the VO_{2max} can be used as a prognostic sign, which works as a kind of genetic marker for the person selection in certain sports with higher requirements for the cardiovascular and muscular systems functioning.

Another mechanism of muscle activity energy provision, namely, anaerobic processes, is also genetically determined. The inheritance coefficient of biochemical parameters characterizing the intensity of anaerobic processes in the body ranges from 0,70 to 0,99. That is to say, that the effectuation of aerobic and anaerobic processes in the human body is genetically determined, which causes the inheritance of those psycho-motorcapacity, the implementation of which depends on their effectiveness [2, 9, 13].

At intensive search for genes that may be associated with the success of sports activities, the authors distinguish genes of paramount and secondary importance; the latter include those that predominantly determine the characteristics of the cardiovascular system functioning [13]. The genetic markers of primary importance that may be associated with sports activities are the following: ACE I (I-allele of the angiotensin-converting enzyme gene - endurance marker), ACE D (D allele of the ACE gene – speed and strength marker), ACTN3 R (allele of the α-actin-3 gene – speed and strength marker), ACTN3 X (X-allele of the ACTN3 gene – endurance marker), ADRA2A (allele of the α-2-adrenoreceptor gene – endurance marker), AMPD1 C (C34 allele of the AMP-deaminase gene – endurance marker), PGC1A Gly (Gly-allele of the α 1 α-coactivator γ-receptor gene, which is activated by peroxisome profilers – endurance marker), mtDNA H (mitochondrial DNA haplogroup – endurance marker), mtDNA K (mitochondrial DNA haplogroup – marker of aerobic working capacity restriction), mtDNA J2 of mitochondrial DNA – marker of aerobic working capacity restriction [13].

The results of comprehensive research with young students allowed us to offer valid criteria for an individualized assessment of the physical and psycho-physiological state, which are suitable for determining the person's psycho-motorcapacities. The peculiarities of students' physical state were determined by anthropometric parameters and the results of motor abilities testing. The individual characteristics of students' psychophysiological state were investigated according to the objective parameters of psycho-motor activity and the functional capabilities of the cardio-respiratory system. The following criteria were chosen to determine the individual characteristics of the physical and psycho-physiological state: Body mass index, Force index, Pigne's Index, Running speed, Coordination, Strength endurance, Speed strength, Flexibility, The latent period duration

of the visual-motility reaction, Level of sensori-motor excitation, Level of sensori-motor accuracy, Leading hand rapidity, The brain's functional asymmetry coefficient, The thinking activity (rapidity of action), The cardio-respiratory system functional potential.

In accordance with the specified criteria the results obtained by each studentconcerninganthropometric indicators,motorcapacities, psycho-motilityparametersand functional reserve of the cardio-respiratory systemand were converted into points: 1 point– very bad; 2 points – unsatisfactory; 3 points – satisfactory; 4 points –good; 5 points – excellent.Total scoredetermined for each person,allowed to estimate adaptive capabilitiesin plan of effectuation physical loads of different orientations.Comparison of the received individual parametersofphysical and psycho-physiological statewith a normative range of valuesby samplingallowed to determine for each studentthe total scoreaccording to the valid criteria,which provided an opportunityto assesson a developed points scaleperson'sadaptability to physical loads.

Average values of the selected criteriaare presented in table 1. Itdemonstratesthe assessment of physical and psychophysiological state of students(young men and young women)and the values were used as a normativerangeto determinea measure of adaptability to physical loadsforeach person.

Table 1

Criteria of assessing physical and psychophysiological state of students

№	Indicators and units of measurement	Young men(n = 75)		Young women(n=76)	
		$\bar{x}$	m_x	$\bar{x}$	m_x
1.	Body length, cm	177,4	0,82	160,51	0,69
2.	Body weight, kg	71,70	1,6	61,33	0,94
3.	Body mass index, nominal units	22,81	0,57	21,61	0,33
4.	Circumference of the chest at rest, cm	91,31	0,99	86,4	0,98
5.	Pigne's index	17,42	2,46	17,85	1,52
6.	Wrist's dynamometer right hand, kg	47,60	0,93	27,95	0,45
7.	Wrist's dynamometer left hand, kg	45,10	0,84	26,66	0,39
8.	Strength's index, nominal units	130,17	2,32	91,01	1,92
9.	Running 100 m, s	14,21	0,11	17,63	0,07
10.	Shuttle run 4 × 9 m, s	9,87	0,04	11,42	0,07
11.	Jump inlength from place, cm	217,70	1,68	160,51	0,69
12.	Push ups, number of times	27,20	1,61	16,44	0,71
13.	Lifting the trunk from lying to the sitting position for 1 min, number of times	39,41	0,98	34,39	0,88
14.	Bending trunk forward from sitting position, cm	7,90	0,77	12,68	0,76
15.	Latent period of simple visual-motilityreaction, ms	287,08	5,05	298,35	4,42
16.	Latent period of complex visual-motilityreaction, ms	444,14	5,78	463,71	4,37
17.	Sensor excitation by reaction to a moving object, ms	7,93	1,27	8,65	1,37
18.	Sensori-motoraccuracy by reaction to a moving object, ms	28,98	1,01	31,42	0,56
19.	Number of touches of leading hand, times	7,39	0,06	6,74	0,05
20.	Coefficient of functional asymmetry of the brain, nominal units	6,34	0,24	7,11	0,25
21.	Rapidity of action, s	361,59	11,35	357,12	7,8
22.	Heart rate at rest, beats per minute	73,07	0,50	76,79	0,62
23.	Breath hold at inhale, s	65,04	2,11	46,99	1,40
24.	Breath hold at exhale, s	40,91	1,40	36,71	1,01
25.	Potential of cardiorespiratory system, nominal units	1,59	0,06	1,09	0,03

Selected criteria, characterizinggenetically determined person's motorand psycho-motorcapacities, as the results of our own research prove, can be used to determinethe degree of student's adaptability to physical loads.On the basis of criterion scoreassessment'sit was revealedthat the percentage distribution of the studied contingent of students by the degreeof adaptabilityto physical loadswas the following:high degree was found in 17(11,2%) students;sufficient degree –in 54persons (35,7%);insignificant adaptation rate – in 60persons (40%);maladaptationwasassigned to 20 students (13,1%).

Factor analysis was employedtodeterminethe leading componentsofperson'spsychophysical, which provide adaptability to physical loads.It was carried out by the method of the main componentswith varimax rotation and was performed by 23 components,among whichfactor's weightr ≥ 0,5was considered significant.

As the factorial analysis of parametersobtained from the studentsshowed,a definite matrix includedfour significant factors,which cover 72,03% of the total dispersion.According to the obtained data,the first significant factoramounted to 35,28%;its components include the following parameters:running at 100 m (0.83), shuttle running 4 to 9 m (-0,732),heart rateat rest(-0,684),rapidity of the wrist (0,633),push-ups (0,617), lifting the trunk from lying to the sitting position for 1 min(0,764), coefficient of functional asymmetry of the brain(-0,563), length jumpfrom place(0,505).The second most significant factor had 21,41%of the total dispersionand its

components include the following parameters:latent period of complex visual-motility reaction(-0,772),latent period of simple visual-motility reaction (-0,729),sensor-motilityaccuracy(-0,727),breath hold on an inhale(0,701),breath hold on an exhale(0,653),rapidity of action(-0,533).It was found out that the third factor containedanthropometric parametersthat arebody weight(-0,723),body length(0,569),wrist's dynamometer right hand(0,681) and wrist's dynamometer left hand (0,676).Contribution of the third factor into total dispersion is 9,03%.The fourth factor which had the smallest contribution (6,31%)into total dispersionincluded such factors as normative range ofsensori-motorexcitation(0,820)and flexibility(0,76).Therefore, the results of the conducted factor analysis showed:the greatest significance was found in parameters of motor and psycho-motorcapacities,as well asheart rate at rest (factor I – "motional");a significant contributionfactor II (sensori-motor)which includedlatent periods of visual sensori-motor reactionsand breath hold on an inhale; substantial participation of factor III ("anthropometric")which integrated a complex of anthropometric data;the least significant factor is IV ("excitability"), whichincluded sensori-motor excitation and flexibility.

The factor analysis confirmsthe legitimacy of employing the selected criteria,whichassessindividual characteristics of studentsby blocks of anthropometry,motorand psycho-motorcapacitiesas well as the functioning of the cardiovascular and respiratory systems.

Discussion

Psychophysical possibilities of a person as an individual,who performs movements,are individualized characteristics,and motor capacitiesreflect the unity of the neurophysiological and psychological mechanismswhich providethe psycho-motilityof a person which wasconfirmed by our research and the works of other scientists[6, 8, 9].The presented results showed, that realization of psychophysiological paradigmprovides an opportunityby means of using modern hardware and software complexes toobjectively assess the individual peculiarities of person'spsycho-motility[5, 6, 8].The conducted studies provethe need to take into account individual characteristicsof psychophysical state of studentsfor improving the organization of physical education process.The use of medical and pedagogical controlin physical education and sportspromotes timely application of health-improving technologies by specialists that are aimed at increasing the adaptive capacity of the person[4, 6, 16].

It should be noted thatthere isstillno exact informationabout a share contributionof this or thatgenein the adaptation of a person to physical loads,regarding,in particular,the success of sports resultsin a concretekind of sport.It is advisabletoput the information about genetic markersbeyond the biological systems and main metabolic processes of the organism,which are dependent on these markers.In the context of psychophysiological supportand the genetic determination of person's psycho-motor capacitiesit is worthmentioning the prospects of the studyofgenetic markers for the following groups of effects on:1)cell proliferation and differentiation(specialization) of cells and tissues; 2) features of energy exchange and the course of metabolic processes;3) resistance of the organism to hypoxia;4) determination of the basic properties of the nervous system;5) functioning of the musculoskeletal system;6) maintenance function of cardiovascular and respiratory systems;7) individual peculiarities of higher nervous function and psychophysiological state of a person.

The revealed leading factors, which provide adaptation of the person to physical loads("motor", "sensori-motor", "excitability"),reflect the basic properties of the human nervous system(excitability, strength, lability, mobility),which are genetically determined[1, 13].As it is well-known, the temperament of a persondetermines how quickly the individual performssome actionsand his personalitycharacteristics are genetically determinedand ontogenetically stable,temperamental characteristics of the personalways have a manifestation in cross situations,are reflected in all spheres of mental activityand determine success in various kind of sports.

Perspective and productive for solving topical issues of improving the organization of physical education classesand selection to various sportsare further scientific studies in the directionofdefiningthe mechanisms of genetic determinationand psychophysiological support of psycho-motilityin the context of considering adaptive capabilities of a person.

Conclusions

1. Research of a person'spsychomotor organization in the context of psychophysiological support and genetic determinationis perspective in both theoretical, methodological and in scientific, applied planin the context of solving current problems of sports medicine and physical education.

2. An individualized assessment of the physical and psycho-physiological state of students is implementedaccording to the selected criteria.Comparison of the obtained individual parameterswith a normative range of valid indicatorsof motor and psycho-motorcapacities,as well as the functional capacity of the cardio-respiratory systemon the basis of the developed criteriapoint scaleprovided an opportunity to assess the degree of person's adaptability to physical loads.

3. The study revealed the leading factors,that provide adaptability of the person to physical activityand reflect the genetically determined basic properties of the nervous system of the individual(excitability, strength, lability, mobility)and established the order of significance of these factors,namely, "motor", "sensori-motor","anthropometric", "excitability" (they cover 72,03% of the total dispersion).

4. Mechanisms of psychophysiological support and genetic control of individual motor characteristicsand the psycho-motor capacities of the person are too complex,they require careful and thorough further researchand this scientific direction should be developed in the context of genetic psychophysiology.

Conflicts of interest – If the authors have any conflicts of interest to declare.

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