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SEARCH FOR WAYS TO ASSESS THE PROPERTIES OF THE NERVOUS SYSTEM FOR USE IN SPORTS SELECTION

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ABSTRACT

This article explores scientific approaches and modern methods for assessing the functional properties of the nervous system in the process of sports selection and talent identification. Particular attention is paid to the role of neurophysiological and psychophysiological characteristics, including the strength, mobility, balance, and adaptability of nervous processes, in determining an individual's potential for successful athletic performance. The study examines various assessment techniques, such as simple and choice reaction time tests, tapping tests, sensorimotor coordination assessments, attention and cognitive flexibility measurements, and electroencephalographic examinations. The importance of evaluating individual differences in nervous system functioning is emphasized, particularly in relation to the specific demands of different sports disciplines. Furthermore, the article discusses the potential integration of traditional psychophysiological testing with modern digital technologies to improve the objectivity, reliability, and practical applicability of sports selection procedures. It is concluded that a comprehensive, scientifically grounded assessment of nervous system properties may contribute to more informed talent identification, individualized training programs, and long-term athlete development. However, such assessments should be used alongside physical, technical, psychological, and developmental indicators rather than as independent criteria for sports selection.

Keywords: sports selection, temperament, nervous system, typologic properties, questionnaires, reflex-motor tests

INTRODUCTION

Traditionally, the identification of sports talent is based on physical and physiological characteristics, as well as performance in a particular sports discipline [1,2]. However, in order to achieve high results in sports, as well as to select promising athletes, it is important to take into account not only the structure of the body, but also individual psychological qualities manifested in the features of human behavioral reactions, in

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particular, temperament [3,4]. Since the selection of promising athletes is carried out in the places of their residence from the local population, the problem of individual differences in temperament has repeatedly raised the question of the number of individuals of one type or another both in the human population as a whole and in their individual groups (for example, in athletes) [5-7]. In this regard, an important role is played by the determination of a complex of several typological properties of the nervous system, which, according to E.M. Teplov [8], although they do not predetermine any strictly defined forms of behavior, form a certain basis that facilitates the formation of some forms of behavior with the difficulty of others.

The ambiguity of the results of their selection obtained so far indicates that the issue regarding the optimality of the methods and criteria used has not been resolved.

In this regard, the purpose of this work was to identify the optimal method for assessing the temperament and properties of the nervous system for use in the selection of promising athletes.

MATERIAL AND METHODS OF RESEARCH

The study was carried out on 145 volunteers who did not go in for sports and were students of secondary and higher educational institutions, as well as 33 football players - highly qualified athletes with the sports categories of Candidate Master of Sports and Master of Sports, students of children's and youth sports schools of the Andijan region. All the subjects were males aged 14-20 years. They conducted a study of temperament by grouping the typological properties of the central nervous system, determined using the unconditional-reflex method of B.P. Ilyin [7].

In addition, in 76 out of 145 volunteers who did not go in for sports, temperament was also determined according to the test questionnaire of O. Strelau [9], and in 58 of them - also according to the questionnaire of G. Eysenck [9].

The study was carried out in a comparative aspect to identify possible differences between the unconditional-reflex method (according to B.P. Ilyin) and the questionnaire (according to O. Strelau) to determine the typological properties of the central nervous system, as well as between all the methods used to determine temperament. For the same purpose, when using the questionnaire G. Eysenck's calculation of the distribution of temperament types was carried out both according to the classical method and according to the method of G.V. Sukhodolsky [10].

The choice of these questionnaires was based on differences in approaches to the study of forms of behavior, since temperament is determined according to the questionnaire of O. Strelau through the separate allocation of each property of the nervous system, and according to the questionnaire of G. Eysenck through the assessment of the complex manifestation of a number of properties of the nervous system.

Statistical processing of the results obtained was carried out in the form of calculation of relative values (frequency in percentage), when comparing which the formula was used to identify the reliability of differences between the indicators [11]:

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$$t = \frac{P_1 - P_2}{\sqrt{\frac{N_1P_1 + N_2P_2}{N_1 + N_2}\left(100 - \frac{N_1P_1 + N_2P_2}{N_1 + N_2}\right)\frac{N_1 + N_2}{N_1 * N_2}}},$$

where P1 is the frequency of the indicator in the first group under study; P2 is the frequency of the indicator in the second group under study; N1 is the number of respondents in the first group; N2 is the number of respondents in the second group. The statistical significance of the measurements obtained was determined according to the Student's criterion with the calculation of the probability of error.

RESEARCH RESULTS

In the studied population (Fig. 1), the ratio of temperaments calculated according to the questionnaire of O. Strelau was as follows: sanguine people were most often detected, followed by melancholics and cholerics (26% and 19%, respectively), as well as in equal numbers (11% each) of phlegmatics and persons who did not fall into any of the groups. When using physiological tests according to B.P. Ilyin, similar results were revealed with slight differences, in particular, in the ratio of groups, sanguine and melancholic (38% and 31%, respectively) had slightly larger proportions, phlegmatics occupied a tenth, and persons who did not fall into any of the groups somewhat less (8%).

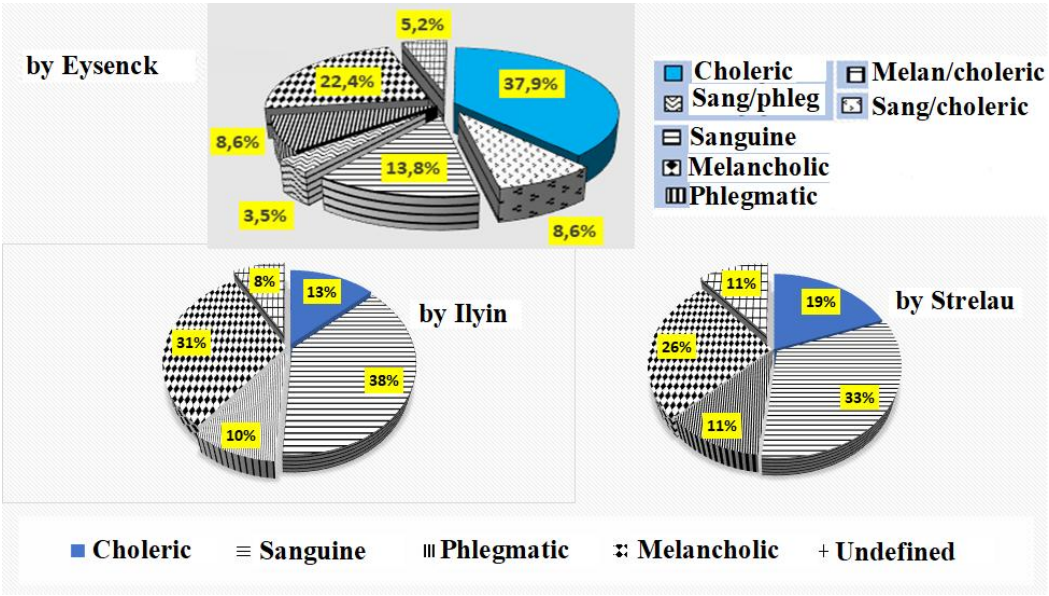


Figure 1. The spectrum of temperaments in the population, determined by the methods of Eysenck, Strelau and Ilyin

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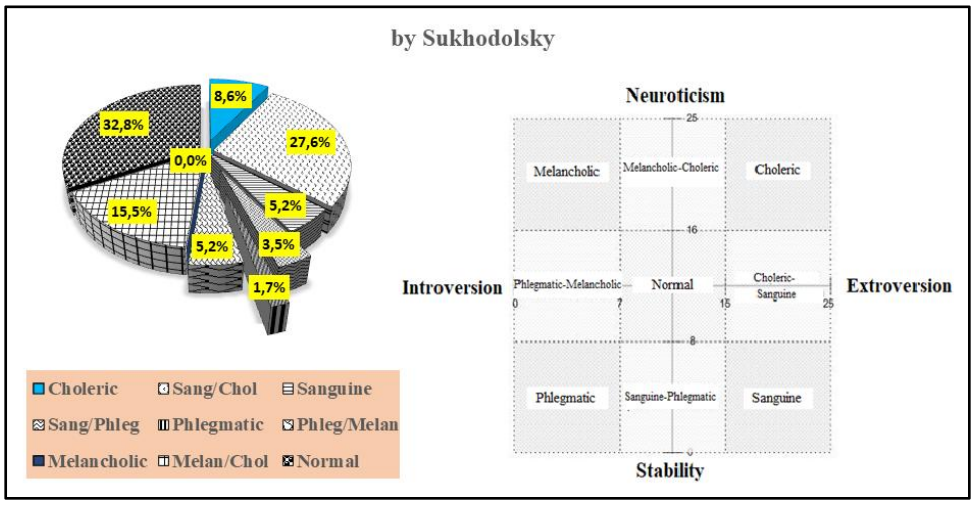


Figure 2. The spectrum of temperaments in the population, determined by the Eysenck method and calculated in the Sukhodolsky modification

More significant differences were revealed when testing according to the questionnaire G. Eysenck, where the largest number were choleric (38%), followed by melancholics (22.4%) and sanguine (13.8%), and phlegmatic were the least (8.6%). In the case of a value of any indicator (extraversion or neuroticism) equal to 12, i.e. its falling directly on the axis of one of the scales (the x-axis abscissa or ordinate), it was also necessary to distinguish intermediate groups (17.3% in total), of which the share of the sanguine/choleric group was 8.62%, the melancholic/choleric group was 5.17%, and the share of the sanguine/phlegmatic group was minimal (3.45%).

Recalculation of the distribution of temperament types according to the method of G.V. Sukhodolsky (Fig. 2) of the results obtained according to the questionnaire G. Eysenck showed a more than 5-fold excess of the number of persons in the intermediate groups relative to the number of representatives of the four classical temperaments. In particular, the proportion of choleric and sanguine decreased to 8.62% and 5.17%, respectively, while the proportion of phlegmatics was only 1.72% against the background of the complete disappearance of melancholic. On the other hand, the proportion of persons who, according to G.V. Sukhodolsky's definition, were assigned to the "norm" group, reached 32.76%, and intermediate groups, such as sanguine/choleric and melancholic/choleric, increased significantly and a new group appeared - melancholic/phlegmatic with a share of 5.17%.

Based on the differences in the results, we considered that for the purposes of selecting promising athletes, it would be better to identify the relationship between sports abilities and the capabilities of the central nervous system on the basis of grouping the subjects directly depending on various combinations of specific typological properties of the central nervous system, identified using the unconditional-reflex method of B.P. Ilyin.

Therefore, three main typological properties of the CNS were further distinguished: the strength of excitation processes, the mobility of nervous processes, and the equilibrium of excitation and inhibition processes, various combinations of variants of which served as the basis for grouping the subjects.

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It is known that each of these properties is divided into 2 or 3 variants according to the degree of intensity, the boundaries between which have already been determined [6,7]. These variants reflect the high or low intensity of the property, as well as the intermediate part located between them. For example, according to the degree of severity of excitation processes in the central nervous system, groups with a strong, weak and medium type are distinguished, and the latter can also be divided into medium-strong and medium-weak. Regarding the mobility of nervous processes, two variants are distinguished: mobile and inert, while according to the equilibrium of the processes of excitation and inhibition, 3 variants are defined: balanced, unbalanced with a predominance of excitation processes, and unbalanced with a predominance of inhibition processes.

In addition, in our age of intensive development of Artificial Intelligence, the more information data there is, the better the conditions for their machine processing and the more accurate the result becomes, which can invaluable increase the effectiveness for predicting future sports performance. At the same time, a simple description of various combinations of variants of typological properties of the central nervous system inherent in a particular person in the form of a verbal text already acquires a certain cumbersomeness and greatly complicates software (computer) processing. And here the preliminary digitization of the terms used to improve the possibility of machine processing of a large amount of data becomes especially relevant.

For this purpose, we propose the coding of variants of the typological properties of the CNS in the form of the following numerical designation, written sequentially through a dash, where the first position reflects the strength of the excitation processes, the second – the mobility of the excitation processes, the third – the equilibrium or predominance of the excitation and inhibition processes.

In the first position, the strength of the excitation processes is reflected as: 1 - strong type, 2a - moderate-strong, 3 - medium-weak and 3 - weak. In the second position, there is a division as: 1 - mobile and 2 - inert; in the third - as: 1 - unbalanced in excitation, 2 - balanced, 3 - unbalanced in inhibition. The quantitative and percentage distribution of various combinations of typological properties of the central nervous system among healthy individuals who are not involved in sports is presented in Fig. 3.

According to the well-known rules for determining temperament according to our coding: 1-1-1 denotes choleric, 1-1-2 - sanguine, 1-2-2 - phlegmatic and 3-2-3 - melancholic. As can be seen from Figure 3, among the studied contingent, the most common are representatives of the group with the code indicator 1-1-2 (19.3%), which belong to sanguine, 2a-1-2 and 3-2-3, each with 9-11%, among which were choleric and melancholic. Further, with indicators of 5-7%, there were groups with code indicators 2b-1-2, 2a-1-1 and 3-1-3. The largest part of the subjects were groups with indicators of 2-4% (1-2-2, 2b-1-1, 3-1-2, 2b-2-3, 3-1-1, 2a-2-2 and 3-2-2), which included phlegmatics. 3-2-1, 2a-1-3), and with the absence of people - only two (2b-2-1 and 1-2-3).

To identify the relationship between sports abilities and the capabilities of the central nervous system, we conducted studies of various combinations of specific typological properties of the central nervous system in athletes involved in football, as the most numerous representatives of one sport.

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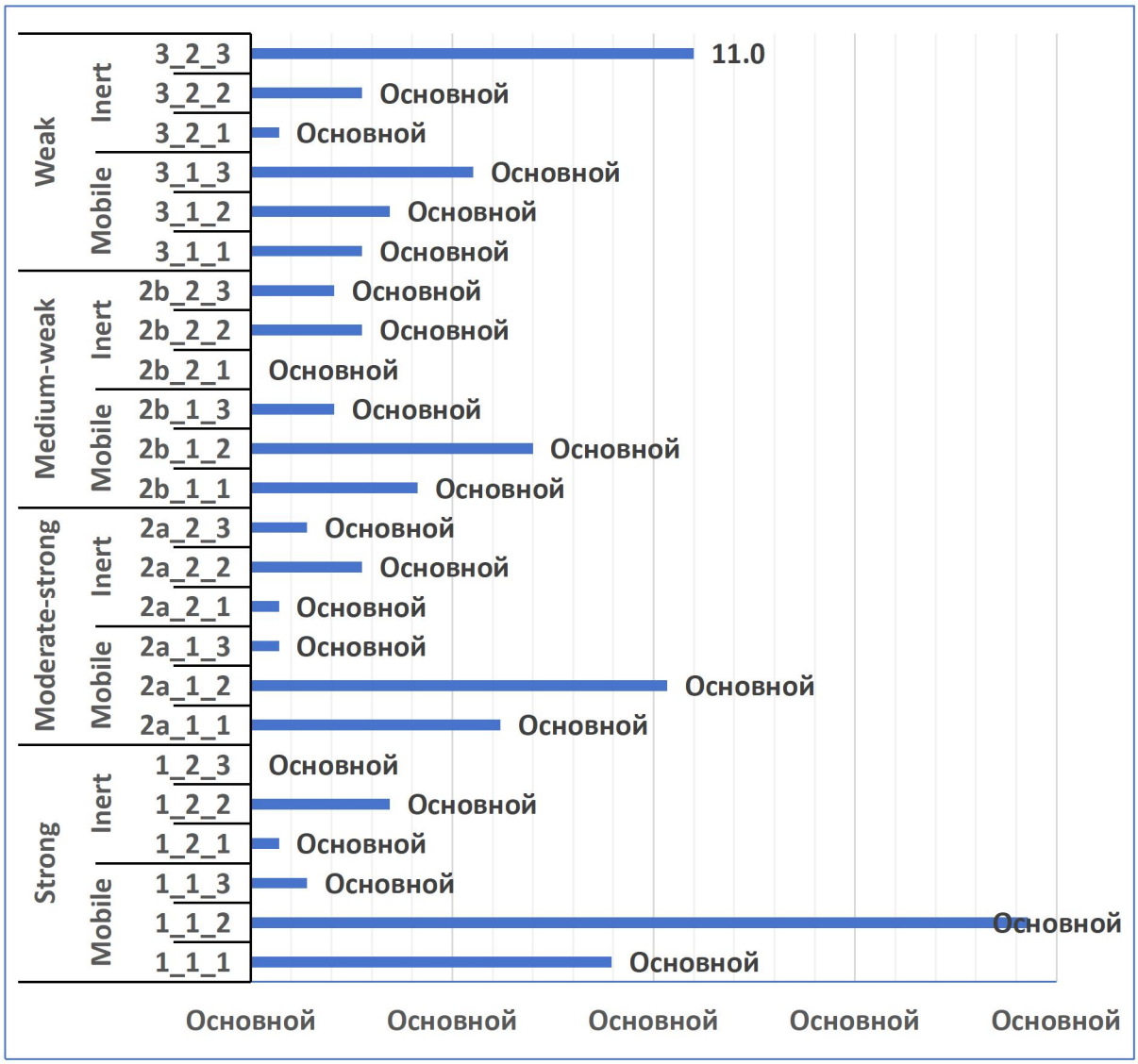


Figure 3. Variants of combinations of typological properties of the central nervous system and their detection among persons who are not involved in sports

Note: the data are expressed as a percentage; the first column contains variants of the strength of excitation processes, the second column contains variants of mobility of nervous processes, and the third column contains the coding of variants of typological properties (described in the text)

The quantitative distribution of various combinations of typological properties of the central nervous system among football players is presented in Fig. 4. It shows that among the football players the most common are representatives of the groups with the code index 1-1-2 (24.2%) and 1-1-1 (21.2%), which belong to sanguine and choleric people, respectively. The next in number were the athletes of the groups: 1-2-2, 2a-1-2 and 2b-1-2, having 9.0% each, all of whom had a balance of nervous processes. At the same time, among the athletes, there were no persons with inhibition imbalance, as well as representatives of the weak type of the central nervous system with inert nervous processes.

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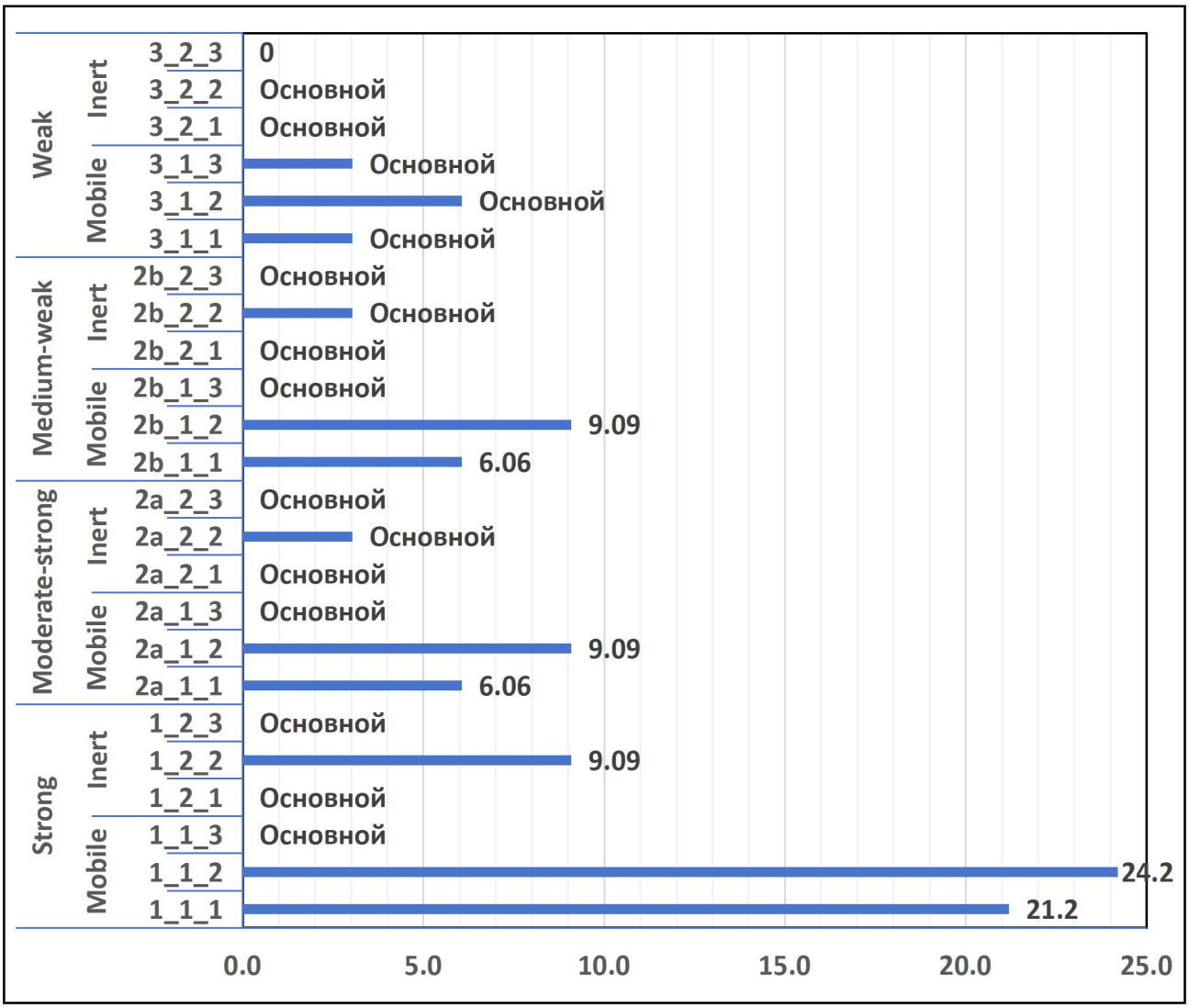


Figure 4. Variants of combinations of typological properties of the central nervous system and their detectability among football players

Note: Same as for Figure 3.

As can be seen from Figure 4, half (12) of the theoretically possible combinations of typological properties of the central nervous system were not identified among football players, 10 of which were identified among people who are not involved in sports. Moreover, in the groups 1-1-1, 3-1-2 and 1-2-2, the share of athletes was 2-3 times higher than among those among people who are not involved in sports. However, the calculation of the reliability of statistical differences between the groups showed that only two groups revealed statistical significance at $P < 0.05$. Namely, the 1-1-1 variant of combinations of typological properties of the central nervous system turned out to be a positive marker for the search for promising athletes in relation to football, and the negative one was 3-2-3.

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DISCUSSION OF THE RESULTS

When comparing the results obtained in determining temperament using different methods, the sharpest differences in parameters were revealed only in relation to the questionnaire G. Eysenck, according to which the proportion of cholerics was 2-3 times higher, while the proportion of sanguine was 3.5-4 times, and the proportion of melancholics was 1.2-1.5 times lower than those according to other methods. For example, according to the questionnaire G. Eysenck, the total proportion of sanguine and choleric, taking into account the intermediate group of sanguine/choleric, becomes 56.9%, while when tested according to the method of O. Strelau, the same indicator is 52%, and according to B.P. Ilyin - 51%.

To the question why such differences occur and what significance it has in relation to the choice of the methodology that is optimally suitable for the selection of promising athletes, the following explanations can be given.

As for the intermediate and uncertain groups, of which Eysenck tested according to G. Eysenck turned out to be the largest number, it can be said that its basis lies in the very procedure for determining temperament, since H. Eysenck derives four types of temperament on the basis of two polar factors: "E" extroversion – "I" introversion, "C" stability – "T" anxiety, located in the "circle" scheme (Fig. 2). In this circle, the combination "ES" is identified with sanguine, and "ET" with choleric. At the same time, the comparison of these indicators, according to B.P. Ilyin [6,7], with the severity of excitation and inhibition showed that the "ES" type is choleric, and the "ET" type is sanguine. Moreover, this was facilitated by the lack of solid arguments in favor of arranging the types of temperaments in a "circle", and not according to the linear scheme, which was adhered to by many authors, from Hippocrates to I.P. Pavlov and his students [12]. Moreover, no theoretical or experimental grounds were found to believe that the number of the main types of the nervous system should be exactly four, and not more, if only because intermediate forms were not taken into account. And here, even theoretically, when the intermediate forms are arranged in a "circle", there will be one more than in a linear scheme, only because the circle is a closed figure.

At the same time, taking into account the fact that temperament types in their pure form are quite rare in life, G.V. Sukhodolsky [10] additionally distinguished four "intermediate" and "normal" types of temperament (Fig. 2). In his opinion, Eysenck's map of temperaments should be considered as a matrix, the rows of which show the direction (introversion - average - extroversion), while the columns correspond to the levels of emotional stability (neuroticism - average - stability). At the same time, the "Average" boundaries were set as 7-15 for extraversion, and 8-16 for neuroticism.

As we can see, the majority of the subjects are located between the boundaries of the "Average or Norm" closer to the middle of the coordinate system (according to the normal distribution). In other words, G.V. Sukhodolsky tried to single out a new type of temperament, which, in general, actually turned out to be an intermediate group for all classical temperaments at once. However, it cannot be new in any way, since for this it was necessary to place some new property of the central nervous system, or a combination of them, or at least some new factor as the basis. Although G. Eysenck does not distinguish intermediate groups, we had to do so, since one of the indicators (extraversion or neuroticism) fell directly on one of the scales of the coordinate system. And here, of course,

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the problem of subjectivity arises, which consists in the choice of boundaries in determining the type of temperament, establishing which G.V. Sukhodolsky was forced to single out a separate group called "norm".

In addition, this in no way explains the different data of temperament testing conducted by different methods in the same people. Apparently, this can be to a certain extent the result of fluctuations in the quantitative parameters of testing under the influence of some factors on the central nervous system (for example, fatigue or stress). Thus, Murik S.E. [13], who studied the influence of a person's functional state on the manifestation of temperament when testing the same people in the morning and evening on the same day by various methods (according to B.P. Ilyin, G. Eysenck and O. Strelau), found a change in the answers to some questions on the G. Eysenck test in most of the subjects.

Since the answer to such questions may depend on the current state of the individual's motivational and emotional sphere, changes caused by a stressful situation or fatigue cannot but affect the individual's self-esteem and his attitude to objective reality [14]. This gives reason to assume a certain degree of subjectivity (or fluctuations in the studied indicators in the quantitative aspect) when testing temperament using questionnaires according to both the tests of G. Eysenck and O. Moreover, when studying various populations using questionnaires, in addition to the language barrier, it is possible that problems related to the local mentality will arise, which can be attributed to subjective factors [15].

On the other hand, in our studies, the proportion of intermediate and uncertain groups was revealed to be almost twice as large when determining temperament according to the method of G. Eysenck, and 12 times more in the study according to G.V. Sukhodolsky than in the use of other tests. Apparently, this is due to a more significant influence of quantitative fluctuations in the indicators of neuroticism and extra-introversion on the manifestations of temperament (i.e., on the transition of quantity into quality) relative to the O. tests. Strelau and B.P. Ilyin, where temperament was calculated on the basis of determining such typological properties of the central nervous system as the strength of excitation and inhibition processes, their equilibrium and the speed of occurrence.

At the same time, the identification of four classical temperaments was carried out according to the classification of I.P. Pavlov [16,17], where they correlate with the following combinations of typological properties of the nervous system: sanguine (strong, balanced, mobile), choleric (strong, unbalanced, mobile), phlegmatic (strong, balanced, inert) and melancholic (weak). However, other combinations (for example, strong, unbalanced, inert, or persons with average strength of the central nervous system) inevitably fall into an indefinite group.

All this emphasizes the importance of accurately determining the quantitative limits, namely, the strength of the nervous system, since changes in this parameter (for example, depending on the functional state) can lead to a change in the type of temperament [18]. In this case, it is desirable to conduct repeated studies until the results are stable, as well as to distinguish the studied groups not by the type of temperament, but directly by the severity of each property of the central nervous system. At the same time, it would be more expedient to use physiological tests instead of questionnaires to identify the latter.

Since each person manifests 3 typological properties of the central nervous system at the same time, in order to characterize him, it is necessary to indicate which of the variants

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of these properties are inherent in him. For example, the following properties are inherent in a particular subject: a strong type of the central nervous system, mobile, unbalanced with a predominance of excitation processes, which in combination characterize him as choleric.

Thus, it is possible to distinguish all 4 types of temperament, but various combinations of variants of typological properties of the central nervous system can form another 20 groups that are not characterized as certain types of temperament. Probably, it is from them that intermediate types of temperament, as well as indeterminate types, are formed. But, no matter how intermediate types of temperament are formed, their number theoretically cannot exceed 6. Therefore, even if one indefinite group is added to them, their number is still almost 3 times less than the 20 combinations of variants of typological properties of the central nervous system.

According to our data, the proportion of persons with pronounced signs of 4 types of temperament is only 42.71%. While the remaining 20 combinations most likely belong to intermediate groups, but to which it remains unknown as yet unknown. This is a problem that for practical purposes may not need to be solved due to the controversial nature of the issue of determining some types of temperament. For example, I.P. Pavlov classified all representatives of the weak type of the central nervous system as melancholic, regardless of the assessment of the severity of other typological properties of the central nervous system, since he considered them to be the disabled type [16]. Other scientists did not agree with this definition, since in this case representatives of the weak type would not exist at the present time due to their elimination due to evolutionary processes [19]. In addition, it was noted that the weakness of nervous processes can be well compensated by the manifestation of other properties of the central nervous system, as well as the high sensitivity of nerve cells, which makes it possible to identify impending danger in advance and avoid it in a timely manner.

Taking into account the revealed contradictions in determining the features of temperament, we came to the conclusion that it is optimal to group the subjects depending on various combinations of specific typological properties of the central nervous system directly, and not through the determination of temperament.

In this regard, we proposed the coding of variants of typological properties of the CNS in the form of a digital designation, which will facilitate and accelerate the digital processing of a large amount of information, and we hope to increase the efficiency for predicting future sports performance. Having divided athletes and non-athletes into 24 groups of theoretically possible combinations of typological properties of the CNS, we have established significant differences between them.

To the question of whether they can serve as markers for the search for promising athletes in relation to football, the answer may be to calculate the reliability of statistical differences between the groups. In this study, only two groups with statistically significant differences were identified, one of which can serve as a positive marker (1-1-1 - choleric temperament), and the other - a negative marker (3-2-3 - melancholic temperament). It should be noted that if the contingent of subjects increases, there is a possibility of achieving statistical significance for other groups of variants of combinations of typological properties of the central nervous system, but this will be especially difficult in relation to the selection of elite athletes. Therefore, we began our research with one of the

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most popular sports - football, selecting several teams - winners of prestigious competitions. In relation to other sports, it will be much more difficult to do the same. In any case, the results obtained can be widely used to search for and select promising athletes in relation to football.

CONCLUSIONS

1. Determination of the type of temperament has a higher accuracy if the methods used are based on the assessment of the typological properties of the central nervous system, as well as on physiological tests, instead of questionnaires.

2. For the purpose of selecting promising athletes, it is better to identify the relationship between sports abilities and the capabilities of the central nervous system on the basis of grouping subjects directly depending on various combinations of specific typological properties of the central nervous system.

3. Coding of variants of combinations of typological properties of the central nervous system in the form of a numerical designation is proposed, which makes it possible to divide the subjects into 24 theoretically possible groups.

4. Two variants of combinations of typological properties of the central nervous system have been identified, which can serve as a positive (1-1-1 - choleric temperament) and negative (3-2-3 - melancholic temperament) marker for use in the selection of promising athletes in relation to football.

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