

Excellence in sport performance. The Russian psychophysiological approach

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Abstract. The article reveals in detail more than 50 years of scientific and practical experience of Russian sports psychologists in the training of elite athletes - members of national sports teams. The works of well-known scientists who were employees of the Saint-Petersburg Scientific-Research Institute for Physical Culture describe the sequence of development of the psychophysiological approach. A description of the psychophysiological methods developed at the Institute, their capabilities and results of practical use in the scientific and methodological support of sports training of elite athletes is given. Authors provide a scientific justification for the fact that the use of a psychophysiological approach, based on I. Pavlov's ideas, to determine current psychophysiological conditions and innate individual characteristics, including talents and giftedness, is an indispensable tool for a sports psychologist in the practice of training and developing the potential of athletes to achieve excellence in sport performance.

1 Introduction

The main course of Saint-Petersburg Scientific-Research Institute for Physical Culture (SPbNIIFK) is to combine the interdependence of sport, science and education that includes sport and science development and improves education. Sport development includes elite sports, youth sports, mass sport, and physical culture (exercises). The science development includes scientific elaborations and innovative technologies' implementation; hardware methods for the performance of objective assessment; collaboration between related areas; partnership with sports federations, teams, coaches and athletes, and real data analytics and generalization. To improve education, sports, and physical culture, professional education, professional standards, advanced training, and retraining are used.

Sports talent detection and development is currently actual and studied from various perspectives: genetic [1], relative age effect [2-4], brain activity [5-6], personal characteristics [7], social factors [8-9].

The results of this long-term research confirm that the psychophysiological approach is the most relevant to solve this problem. It is based on the doctrine about the nervous system properties (NSP) of a person [10], which subsequently had been elaborated in differential

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psychophysiology scientific developments [11-12]. The typological complex (TC) of NSP conception by E.P. Ilyin provides to determine inborn penchants for specific activities, sports, professions, individual activity style. When determining the NRS, instrumental techniques such as nervous system strength, mobility of excitation and inhibition processes, external and internal equilibrium are indispensable [12-14]. An athlete who engages in sports activity in accordance with his inborn penchants can achieve excellence in sport performance with the lowest energy costs and sustain motivation at a constantly high level. The practical application of this study in the national team training process of elite athletes allows us to assert the existence of model TC in various kinds of sports, disciplines and playing positions [15, 16]. For coaches, this is the knowledge instrument to apply an individual approach for optimization of the athletes' talent development while preparation throughout the sport periodization [15].

2 History of sport psychology developments

The history of St. Petersburg Scientific Research Institute of Physical Culture begins in the 30s of the last century. However, this paper considers a shorter period started in the 70s devoted to sports psychology and psychophysiology. In the 1970s - 1980s, Prof. Valentin Bulkin worked on development of psychological and pedagogical control methods for the Olympic Games preparation. He studied the environmental influences and interpersonal qualities, choosing the directions of sport psychodiagnostic, established a relationship between the mental processes and the psychophysiological state of an athlete and personal and individual characteristics as determining factors of the mental state.

In the 1980s - 1990s, Yuri Hanin (PhD) and Yuri Kiselev (PhD) were working on the improvement of the complex operational psychological control methods. They developed the unified method for assessing the athletes' physical and psychological readiness, the method for assessing the precompetitive mental state of the athlete and Individual Zones of Optimal Functioning (IZOF) Model: Emotion-performance relationship in sport.

In the 1990 - 2000s, Prof. Pavel Buntzen created the automated systems with independent interpretation of data and the automated expert system for diagnosing the state of health and psychophysical potential of the athlete and non-athlete. As part of the development of the methodological approaches to improve athletes' competitive reliability, he worked as the organizer of joint scientific research with the Örebro University (Sweden), together with Prof. Lars-Eric Unestahl, aimed to develop a mental training system for athletes.

Started in 2000 - 2010s, Prof. Konstantin Korotkov introduced research bases the bioelectrography scientific approach, the method of Gas Discharge Visualization (GDV) into the sports psychology practice. The GDV method was implemented into the sports preparation system for objective diagnostic of athletes' psychophysiological processes and states. Prof. K. Korotkov holds 17 patents on biophysics inventions, he is an author of over 10 books and is a key speaker at congresses and seminars in 43 countries until today.

In 2000 - 2016, Prof. Evgeny Ilyin, Honored Scientist of Russian Federation, developed ideas of Nobel Prize laureate Ivan Pavlov. Prof. E. Ilyin is a founder of the Russian scientific school of general and differential psychophysiology in sports and professions. He developed "locomotors techniques", express methods for assessing human nervous system properties (strength of the nervous system, mobility of excitation and inhibitory processes, internal and external balance). He is an author of "Typological Complex of NSP Concept", where the connection between NSP and innate giftedness, talents, aptitude and excellence in performance is described. He developed the term "talent detection" - the athlete innate

individual psychological and psychophysiological characteristics, capabilities and predisposition to certain kind of activity.

The Laboratory of sport psychology and psychophysiology was formed as a part of the Department of innovative technologies in sports in 2016. The Laboratory members considered the model psychological and psychophysiological characteristics development to identify sport gifted children during the selection and sport specialization – talent detection; mental training modernization for different sports and practical use to increase the athletes' preparation and competitive adaptive abilities. The Laboratory members perform psychological readiness assessment and psychological training included into the sport system preparation of Olympic, Paralympic and Deaflympic teams.

3 Application of psychophysiological approach

Scientists of SPbNIIFK use the psychophysiological approach in sports performance for excellence that means the application of physiological methods and typological approach to the definition of innate human features and characteristics based on the theory proposed by I. Pavlov (Nobel prize laureate), which was developed in Russia within the scientific school of differential psychophysiology (B. Teplov, V. Nebylitsyn, V. Merlin, K. Gurevich, E. Ilyin, E. Golubeva, M. Kabardov).

4 “Locomotor techniques” for assessing the human nervous system properties

To assess the properties of the human nervous system and determine the typological complex of the NSP, the “Locomotor techniques” are used. These express methods are implemented using the hardware and software complex “PROGNOSIS”, which makes it possible to quickly (10-15 minutes) identify the complete TC of the NSP composition of a person (older than 6 years) and to forecast his/her innate psychological characteristics (giftedness, talents, abilities) [11,13,17]. Typological complex of NSP comprises mobility of inhibition and excitation processes, nervous system strength, external and internal balance. Individual psychophysiological innate features, for which the composition of the typological complexes of NSP causing high or low degree of their expression is known, include characteristics of intellectual activity, characteristics of individual performance style, resistance to adverse conditions, volitional features and characteristics of psychomotor system. Characteristics of intellectual activity include promptitude of formation of the visual image, intentional and unintentional memory, concentration of attention, ability to switch attention, speed of thought process, the type of mindset (artistic, intellectual), critical thinking and creativity. Characteristics of individual performance style include duration of preparation for activity, pace of activity start-up and pace of learning, planning or spontaneity of action, adaptability to dynamic situations, propensity to competition and leadership (process or result orientation). Resistance to adverse conditions and volitional features comprises emotional and mental stability, courage in stressful situations, resoluteness, ability to work until a sign of fatigue, adaptability to adverse environmental factors, patience, working when fatigued and perseverance (resistance to monotonous state). Characteristics of the psychomotor system include kinesthetic memory, sense of balance, coordination, complex response rate, speed of simple motor response, sprint inclinations, stayer inclinations and recovery process rate.

5 Gas discharge visualization

The determination of the energy supply level and structure by the gas discharge visualization method is also a part of psychophysiological approach. Gas discharge visualization method is the computer registration and analysis of the object luminescence stimulated by an electromagnetic field with amplification in a gas discharge, based on the Kirlian effect. This method allows evaluating an athlete's reaction to a training process, to monitor recovery processes and prevent overtraining and the emotional exhaustion [15, 18, 19].



Fig. 1 Monitoring of the psychophysiological current state in Paralympic national para-hockey team during the training [15]

6 Galvanic skin reaction

The next method is conscious self-regulation skill registration by biofeedback (BOS) based on the galvanic skin reaction (GSR) BOS training is an affordable and effective way for the active influence of one's emotional state and helps to achieve the maximum performance level. It helps to develop a steady habit to maintain a calm and attentive state, without undue stress and anxiety, formatted and consolidation of the mental self-regulation skills, psycho emotional and muscle tension reduction. BOS method helps to evaluate skill level of the athlete's self-regulation of the psychological state, ability to regulate psychophysiological state, ability to concentrate and stay focused on the individual strategy for a given time period and the effectiveness of the individual self-regulation strategy. In practice, such methods of correction of the psychophysiological state of athletes are used as auto-training sessions (ATS), rest sessions under hypnosis, light and sound stimulation (LSS), instilling desired attitudes and training in combination with ATS and LSS with online GSR control.

7 Psychological sports periodization

Psychological diagnostic and control of the athlete's psychophysiological state should be used in accordance with the sports periodization. For example, the athlete's innate psychological characteristics definition is carried out during the transition and preparatory period to get the correct result. Psychophysiological state monitoring by GDV should be conducted during transition, preparatory and competitive period. Conscious self-regulation skill evaluation by GSR should be conducted during transition and preparatory period.

Nevertheless, the psychophysiological approach is only the part of methods in many year training system and is an addition to the main coach tool - psychology-pedagogical methods, which are aimed to reveal the potential of a person. Psychology-pedagogical methods are necessary as a means to implement the recommendations received with the help of psychophysiological methods. This combination has an external origin in relation to the athlete and is aimed at changing the regulators of internal and external human activity. This is the set of tools and methods used by a coach and psychologist. These tools and methods should be based on the fundamental scientific principles of sports pedagogy and psychology, organically fit into the training process and solve the problems of psychological support of sports activities.

Sports training is a system which includes the psychological, general physical, special physical, technical, tactical, theoretical, and integral directions. Psychological preparation structure incorporated into the sports training annual cycle includes transition, preparatory, precompetitive and competitive period. General preparation includes transition and preparatory period; special preparation includes precompetitive and competitive period [20].

There exists a concept of psychological readiness formation. If we imagine this concept as a pyramid, then the individual psychophysiological innate features are in its foundation, pedagogical concepts (consciousness, activism, accessibility, connection of education with practice, scientific and education reliability) occupy the layer above. Next layer is training of physical and psychological qualities and the last one is psychological readiness (ability to control feelings, thoughts, actions, optimal emotional state, interference immunity, self-confidence, and the desire to implement preparedness).

Consistent psychological support of athletes at sports events is carried out in different periods according to the psychological sports periodization. Transition and preparatory period include primary diagnostics of innate psychological and psychophysiological athlete characteristics. As a result, the information and recommendations for the coach are obtained; information and recommendations for the athlete and development of individual programs of psychological preparation and correction of adverse conditions are elaborated. Transition, preparatory, and competitive period include daily monitoring of the psychophysiological athlete state. As a result, the information and recommendations for the coach and the athlete are obtained; individual classes are hold according to the developed programs using express methods of mental states correction [20].

The structure of scientific and methodological support of the elite athletes teams have to be carried out according to the training periodization. The stage-by-stage complex surveys should be carried out during transition and preparatory period. These are level determination of various aspects of the athlete's physical and motor potential at separate stages. The surveys during preparatory period systematically control the training process to increase its effectiveness and prevent overloads, overstrain, violations of adaptive processes; assessment of the level and structure of physical, technical, psychological readiness, health status. The surveys during competitive period include competitive activity evaluation, the features analysis of competitive activity by sports, technical and tactical results of competitive activity [20].

8 Conclusion

In modern conditions, health-saving methods for assessing and identifying gifted athletes, improving the quality of sports selection, which ensure successful self-realization of all participants in joint sports activities, and control monitoring of psychophysiological states

are of particular importance. The distinctive features of the proposed psychophysiological methods include scientific validity, objectivity, efficiency of research procedures, processing and issuance of results as the basis for the formation of practical recommendations for specialists who manage the training of athletes. These features will enhance the potential and effectiveness of the proposed psychophysiological approach to solving the problems of giftedness and sports selection in sports and further development of excellence of sport performance. The indicated psychophysiological approach to the problems of modern sports should be continued and deepened, since it is aimed at one of the key psychological and pedagogical tasks - ensuring the successful self-realization and preparation for important competitions of all participants in joint activities, both athletes and coaching staff.

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