

# Influence of Sports Games on Coordination Abilities of Adolescents as a Component of Physical Development: Neuropsychological Features

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**Abstract:** *The article reveals perspectives on sports games aimed at physical development and development of coordination skills of adolescents. Physical exercise has a positive effect on such psychological properties of students as memory, thinking, attention, speed and accuracy of reactions, logic, perception of motoric of one's own body and the sense of external space. The basic statement of neuropsychology that the basic intelligence of a person being physical intelligence is revealed. Development of coordination skills is an important qualitative aspect of motor activity, reflecting the level of physical fitness. Purposeful formation of coordination abilities enables to solve a number of problems of physical, aesthetic and intellectual improvement of adolescent students. The use of sports games in the process of physical education promotes a favourable development of motor coordination, and thus helps increase the level of motor readiness of adolescents during sports activities, as well as provides the highest efficiency in the process of physical development.*

**Keywords:** *Neuropsychology, psychomotor development of adolescents, sports game activities.*

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## Introduction

In modern conditions, there is a growing interest in such human qualities as the ability to quickly navigate in space, respond quickly to signals of external environment, finely differentiate one's muscular sensations and regulate the degree of muscle tension. The concept such as "coordination" also includes a sense of rhythm, the ability to control muscle relaxation, and the ability to act quickly in non-standard environments. Obviously, development of coordination skills contributes to the growth of the indicators of motor functions, such as endurance, speed, flexibility and strength. For example, there are studies of coordination abilities in young football players (Ljach & Witkowski, 2010), which show that the use of special coordination training aimed at developing specific coordination skills (CS) has led to greater improvement, with CS and technical skills of athletes from experimental groups were significantly higher (by 2.5–38.3 and 3.6–12.2%, respectively) than athletes from control groups who developed CS by a traditional method, using dexterity exercises.

It is also argued that the importance of stability of motor coordination levels in childhood and its role in determining organized sports participation may have consequences for talent identification, as well as potential health benefits in childhood and lifelong period (Halaidiuk et al., 2018; Komogorova et al., 2021; Maksymchuk et al., 2020a; Maksymchuk et al., 2020b; Palamarchuk, 2020; Sitovskyi, 2019; Vandorpe et al., 2012).

Games have long been an integral part of human life and are used to foster and develop various qualities of the younger generation, including physical. By its very nature, the game unobtrusively encourages its participants to use their knowledge, skills and abilities in concerted action with teammates, develops attention, operational thinking, a sense of teambuilding, responsibility, mutual aid and many other socially important and useful qualities.

Boychuk (2015) believes that the purposeful development of coordination skills of students in the process of physical education and sports training helps increase the process of training movements. The most important coordination skills for outdoor games are the ability to differentiate movement parameters, react, navigate in space and coordinate movements. The use of the combined method in the process of physical education of schoolchildren will promote the correct learning of movements, increase the level of movement skills and children's interest in training.

## **Neuropsychological features and psychomotor development of adolescents who play sports**

Echemendia and Bauer (2015) in their paper reviewed a brief history of sports neuropsychology, providing a basic overview of the code of ethics, and discussed key ethical concepts such as charity, independence and autonomy. The role of ethnic/racial cultural considerations in sports neuropsychology, as well as ethical issues related to the use and development of tests, the different roles that sports neuropsychologists play in sports medicine, and several illustrations of the challenges faced by sports neuropsychologists in terms of confidentiality, competence, defining the role and boundaries of roles are discussed. Although this article does not provide simple answers to complex questions, it highlights the areas that require thoughtful discourse for clinicians who engage in the dynamic and evolving nature of ethical sports practice in neuropsychology.

Organization, programming and control of any motor action occur at different levels of the central nervous system according to the principle of dynamic subordination. Higher (leading) levels of construction of motor activity always regulate semantic movements and program processing of movements. The lower (“background”) levels, which are under control of the higher ones, serve the executive, or motor sides of movements (rolling stock). Sensory corrections of both leading and background levels provide the motor action of the stability of the supporting parts of the body, in the synergetic coherence of all links involve the kinematic chain, muscle force efficiency, spatial accuracy, stability, etc.

There is an opinion that engagement in any kind of sports is aimed primarily at physical development. This is true, but not the whole story. But memory, thinking, attention, speed and accuracy of reactions, logic, perception of one’s own body motoric and a sense of external space – all this helps to consolidate sports training. Neuropsychology believes that the basic intelligence of human is physical intelligence. It begins to form in a child at its early motor development, its biorhythms, respiratory processes, the moment of birth and in the first year of life. The plasticity of the child’s brain is quite high up to 9 years old, then it begins to decline. However, this plasticity of each person persists throughout life. Therefore, the brain of an adult can also be trained and developed, including through physical exercise. During development of physical intelligence, the potential of mental and emotional intelligence increases. Therefore, when choosing a sports activity, it is necessary, first of all, to listen to recommendations of neuropsychology.

During physical exercise, the work of the centre of gravity of the athlete's body is improved, which guarantees balance of the body in space. That is, at this time the hemispheric interaction in the brain improves, and this is a factor in improving the speed of thinking processes.

There are also studies that look at the relationship between physical education (physical education), physical activity at school (school physical activity), school sports and successfulness. Research shows that such activities can have a positive effect on learning and memory. There is also a positive link between physical activity and cognitive health observed in schoolchildren. In addition, an important by-product of enhanced school activity will be increased fitness (Trudeau & Shephard, 2008).

*Complex muscle development.* As one moves, the muscles of the rectus and oblique muscles tense. This has a very positive effect on the stability of the energy potential of brain structures and regulation of excitation/inhibition processes in them. It also serves to develop dexterity, physical plasticity and flexibility.

*Self-control and consistency.* During physical exercise, special attention is paid to torso rotations, body extension and smooth movements, which makes all actions more thoughtful. That is, there is a development of the kinetic factor and the functions of programming, regulation and control. The anterior and frontal lobes of the brain are responsible for these functions. Thoughtful movements affect dexterity, form a consistent approach to performing various tasks (arithmetic, writing, reading and memorizing information), alignment of handwriting and sense of rhythm.

*Manual dexterity.* For effective grip with the hand, one needs a sense of size, relief and grip angle. This will further serve to develop the tone of fine motor skills, which also affects the function of speech.

*Neurodynamic brain function* – it is the structure responsible for stable circulation of energy in all areas of the human brain. Aerobic load during intense training contributes to further coordinated work of the processes of excitation and inhibition of brain cells. This type of load stimulates and develops a relatively constant level of concentration, distribution and switching of attention, as well as stable memorization of information.

*Functions of the cerebral hemispheres.* Visual perception of the general trajectory of the route and its analysis in detail serves development of the functions of the left and right hemispheres.

*Emotional and volitional sphere and self-esteem.* Since any type of exercise/training is aimed at achieving results, it is very important to go beyond one's achievements. The ability to set goals and achieve them is the property of a stable adult character. Therefore, regular training gradually

teaches adolescents discipline, control over their feelings in case of failure, help see progress and understand the cause-effect relations between the training process itself and improvement of the result. Training strong-willed qualities over one's previous results reinforces self-esteem and proper pride.

Modern physical education is traditionally considered only as a means of optimizing the physical status of an individual, which, as a rule, is reduced only to formation of motor ability, normalisation of the younger generation through intellectual and socio-psychological development, which limits the possibility of holistic personality formation (Pasichnyk et al., 2015).

### **Development of coordination skills in the process of physical exercises**

Numerous studies show that different types of human coordination manifestations in physical education, sports, labour and military activities, everyday life are quite specific. Therefore, instead of the basic existing term "dexterity", which turned out to be very ambiguous and vague, the term "coordination abilities" was introduced into theory and practice, and the system of such abilities and the need for a differentiated approach to their development began to be discussed. In the system of motion control, one of the main concepts on the basis of which others are built, there is a concept of coordination of movements, i.e., the organization of controllability of the musculoskeletal system. According to Giuriato et al. (2021), regular participation in strength training and coordination activities is positively correlated with health benefits in sports (team and individual). The content of maturity is a recognized parameter in assessing the results of physical training. The results show that control over body size and body shape, coordination exercises and early development (determined by a positive inclination parameter) benefit children in performing tasks related to physical fitness and motor activity.

In defining the concept of coordination abilities, the fundamental point is: what the criteria for assessing these abilities are. The results of many years of research allow us to make the following generalizations. Therefore, to avoid possible misunderstandings, it is first necessary to clarify that the criteria are the main features on the basis of which coordination abilities are assessed. In other words, it is an assessment of the level of coordination capabilities and their individual components. The main criteria for assessing coordination skills are: accuracy, speed, rationality and ingenuity, which have qualitative and quantitative characteristics.

Participation in organized sports gives young people the opportunity to increase their physical activity and develop physical and social skills. However, when the demands and expectations of organized sports exceed the maturity and readiness of the participant, the positive aspects of participation may vanish. The nature of parental or adult involvement can also affect the extent to which participation in organized sports is a positive experience for pre-adolescents. This is an update of the previous policy on athletics for preschool children and includes guidelines for sports for preschool children (Committee on Sports Medicine and Fitness and Committee on School Health, 2001).

Based on the above, the correctness of performing motor actions has two sides: qualitative, which intends to bring the movement to the intended goal, and quantitative – the accuracy of movements. In all cases, it is a question of target accuracy, directly related to the successful solution of the motor assignment. This accuracy can be of “final character” in relation to the final moment of the movement. Here it is synonymous with accuracy. A positive transfer of target accuracy was revealed, which is manifested in various ballistic movements that have an accuracy objective.

In another group of cases, the target accuracy “takes a procedural nature”, manifesting itself in the direction of dosing muscle efforts, i.e., in the directions of movements. A distinction should be made between the accuracy of reproduction, differentiation, evaluation and measurement of spatial, temporal and force parameters of movements; accuracy of reaction to a moving object; target accuracy. Although there is information in the literature that between these indicators of accuracy in some cases there are positive relationships, but there is much more reason to believe that these indicators are relatively independent manifestations of accuracy, which in different ways characterize the coordination abilities of an individual.

In the process of control and regulation, complex in terms of coordination of motor actions, adolescents can coordinate their motor activities on one criterion. For example, other criteria apart, the indicator of assessment of coordination abilities in general developmental coordination exercises without sports gears (various combinations of movements and positions of arms, legs, torso) there is almost always correctness (adequacy, accuracy) of performing these movements. The leading feature of the assessment of coordination abilities belonging to the group of ballistic movements with a focus on accuracy, will be the accuracy of the hit, etc. However, these qualitative and quantitative criteria of coordination abilities isolated from each other are extremely rare. The so-called complex criteria are incomparably more common. In this case, students coordinate their

motor activities simultaneously on two or more criteria: speed and efficiency (skiing on average terrain); accuracy, timeliness and speed (when performing transfers and other technical sports and game techniques); accuracy, speed and agility (in sports and martial arts), etc. Such complex criteria for assessing coordination abilities are indicators of the effectiveness of the implementation of holistic purposeful motor actions or a set of these actions, where there is a demand for human coordination abilities.

### **Analysis of the impact of sports games on the development of physical qualities in adolescents**

In the methodological literature, unfortunately, the possibilities of the sports-game method of development of physical qualities in adolescents are still insufficiently revealed. However, the practice of teachers considered by us shows that with the correct use of this method senior students are always enthusiastic, internally fit. Such their attitude is explained by the fact that in the game everyone is worried about their success and the success of their team. It is because of this attractiveness that this position can change for the better indifference, and sometimes a negative attitude towards development of strength qualities in senior students. The effective and competitive side of the game method captivates students, forces them to show their physical and mental strength in the competition for the championship, to achieve victory.

Sports games are combined with gymnastics, athletics, active games, ski training, swimming. The method of conducting such games in physical education lessons is subject to general requirements, but also has its own specifics, which is associated with the need to maintain a certain intensity of the lesson. This dictates the efficiency, clear thoughtfulness of methodological techniques, the need to ensure that all students participating in the games, received approximately equal load. The teacher must create conditions for active participation in the game of all students.

Sports games are usually held in a frontal or group method. In the first case, everyone plays the same game (sometimes divided into two - three teams). In the second case, the games are used to solve educational problems and at the same time there are two or three, not one game in the classroom. Boys and girls often play separately. When conducting games, it is impossible to achieve a sufficiently selective effect on the muscles and internal organs of adolescents. In this regard, it is necessary to skilfully use games in combination with other means of physical education, especially gymnastics.

Sports games can be held in any part of the lesson. In the preparatory part their main task is the organization of attention, body warming up, improvement in various constructions. In the main part of the lesson with the help of games a variety of pedagogical tasks related to improvement of motor skills can be solved. The task of the final part of the lesson is to bring the body to a relatively calm state, organized ending of the lesson. Therefore, games that do not require tension and excitement are held here. The method of playing games requires more careful monitoring of the load for adolescents with relatively poor physical development. If sports games are well learned and held at the lessons, they quickly become usual for children in everyday life, and this is very important in the general work in physical education of students. In the school pedagogical process, it is important not only to conduct a game itself, but also to organize the whole lesson of physical education, preliminary selection of the game, its purpose and combination with the program material. A game can be part of the lesson, as well as its main content. The physical education lesson, which includes a sports game, is subject to the usual requirements. For more effective implementation of the planned content of such a lesson, it is important to carefully consider conditions for conducting it:

- creation of hygienic conditions;
- accounting for the placement and movement of players during the game.

Organization of the lesson includes an appropriate appointment and use of assistants to monitor actions of players, and work with adolescents who are exempt from classes. These games accumulate many types of movements, the contractile capabilities of muscles in them, as a rule, are not fully used, but the main task of games with elements of general developmental exercises is not to achieve maximum results, but to strengthen the musculoskeletal system, general physical development. As a rule, such games are rich in plots and motor actions, which helps to successfully solve the problem of not only physical but also moral education. During the game, children learn to follow the rules, think fast, show will and endurance, help each other.

When describing games with elements of general developmental exercises, the game material with simple gymnastic exercises is taught first, which simultaneously promote development of attention, intelligence and orientation on the playground. Then games with skills of transfer and throwing of a ball, overcoming of obstacles possible for teenagers are described. Thus, mobile games are combined with gymnastics, athletics, sports games, ski training, swimming.

The body of senior high school students is characterized by greater stability. The musculoskeletal system is quite flexible, plastic. Muscles continue to grow and strengthen, that is why the strength data of adolescents are still not great; the body is not yet ready for heavy exercise. However, at this age the activity of the heart and blood vessels stabilizes, lung capacity increases. Therefore, the games include short runs and jumps, a variety of energetic running and movements of the arms, legs, torso, which contributes to the normal development of adolescents. The developing organism feels an increasing need for oxygen. The respiratory system of students is more developed than in primary school age, but breathing is not yet deep enough. Sports games with active movements help strengthen the respiratory system.

The author of the approach to the development of physical qualities and improving the health of adolescents notes that extracurricular work on acquisition of theoretical knowledge, aimed at creating a lasting motivation for self-study on physical education and conscientious attitude to one's health. The use of the proposed innovative technology contributed to the improvement of health, physical development, level of physical fitness, physical activity of students in grades 10-11 (Khrystova, 2018).

Adolescents begin to think more critically and abstractly, they develop the ability to think abstractly. This enables them to master more complex games with numerous rules. Strengthening control over emotions contributes to development of endurance in action, discipline, tact in relation to teammates. Students' actions in sports games become more coordinated, accurate, game tactics are improved, the ability to dodge players quickly and deftly increases, the choice of tricks from a conventional opponent is enriched, as well as ways to fight them in martial arts or with the support of teammates. The conditions for performing actions become more complex, the complexity of the tasks set before the players increases. The rules of the game are becoming more complicated, and resolving game conflicts requires participants to have well-developed willpower and endurance.

Adolescents are interested in games in which joint efforts are aimed at achieving a common goal. They are becoming more attracted to games in which each team has a specific task: to work together to gain an advantage over another team, to win the game.

Thus, the methodology of sports games includes unlimited opportunities for integrated use of various techniques aimed at shaping the child's personality, skilful pedagogical guidance. Of particular importance is general training, pedagogical observation and foresight.

## Conclusions

Therefore, the analysis of the problem shows that all the criteria for assessing coordination skills are complex and ambiguous. They are specifically manifested in real motor activities and in various combinations with each other. All this should be taken into account both in the selection and development of appropriate methods for assessing coordination skills, and in the analysis of specific indicators.

By coordination abilities we mean the capabilities of individuals that determine their readiness for optimal control and regulation of motor action. All criteria for assessing coordination skills are complex and ambiguous. They are specifically manifested in real motor activities and in various combinations with each other.

In the ontogenetic development of motor coordination: the child's ability to develop new motor programs reaches its maximum at the age of 11 - 12 years old. During adolescence, there is an improvement in coordination skills. The general level of development of coordination abilities reached at this age creates wide preconditions for improvement of motor activity.

It is recommended to include exercises for development of coordination skills not only in isolation, but also in combination with exercises aimed at developing other qualities (speed, strength, endurance, agility) in the lessons of physical culture and sports training, which will give the greatest training effect.

The game method is a means of training that ensures effectiveness of the educational process, access to a wealth of knowledge, expands possibilities of information transfer and control of students' knowledge in the learning process.

The method of conducting sports games consists of the following components: selection and planning of games, creating interest in the game, conducting the game and its management, ending the game and summarizing. The technique of conducting sports games is aimed at fostering emotional, conscious mastery of various motor skills.

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