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THE SIGNIFICANCE OF WORKING MEMORY AND MOTOR COORDINATION IN THE FIELD OF PHYSICAL EDUCATION AND SPORTS SCIENCES AND TECHNIQUES

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Abstract:

The allure of conducting scientific research focused on developing the cognitive processes of athletes stems from the unique characteristic of these studies to investigate the dynamic nature of humans as they engage in physical and sporting activities. This study aims to highlight the significance of working memory and motor coordination in the field of physical education and sports sciences. Employing a descriptive approach aligned with the study's nature, we establish the validity of the proposed hypothesis, which posits that working memory and motor coordination play a crucial role in athletic performance, particularly within the realm of STAPS (Sciences and Techniques of Applied Physical Activities and Sports).

Keywords: Working memory; motor coordination; physical education and sports sciences.

Introduction

The field of physical activity and sports science is a relatively new and multifaceted discipline that draws upon various scientific domains, including psychology, physiology, education, biomechanics, and neurochemistry. Each of these contributing disciplines has undergone its historical development to establish its core subject matter. In the early stages of its development, epistemology identified the circulatory system as the fundamental element of physical activity and sports science. This early emphasis stemmed from the prevailing scientific understanding at the time, as scientific disciplines often influence each other. For instance, the concept of the water pump, a technological advancement, was applied to sports, leading to the belief that the circulatory system was the most crucial aspect of sports science; that is, the primary goal of the exercise was to improve circulation. Subsequently, the steam engine, an invention that revolutionized energy production, had a profound impact on sports science, leading to physiology being recognized as the central discipline. As time progressed and psychology entered the realm of sports, its influence became increasingly evident, particularly in its role in influencing competitive outcomes and preparation strategies. This led to the emergence of sports psychology as a prominent discipline within sports science. Psychology underwent a significant paradigm shift, transitioning from the behaviorist school to the cognitive school. This shift involved delving into the "black box" that behaviorists had largely ignored, specifically examining intelligence and its various components. Intelligence was recognized as a crucial factor in human development, and this realization resonated technically with the field of sports science, particularly about motor and learning methods.

Subsequently, this concept was applied to the tactical aspect of sports, giving rise to the concept of information processing systems, a cornerstone of cognitive psychology.

This modern discipline, encompassing various scientific fields, has shed light on the "black box" that the behaviorist school had left unexplored. It has provided a detailed account of mental processes, describing them as a series of sequential operations, each influenced by the preceding one and influencing the subsequent one. As a result, mental processes have become the focus and substance of the tactical aspect of physical activity and sports science. Additionally, this discipline has addressed the technical aspect, which in turn includes the fundamental techniques of various disciplines and the psychomotor aspect of sports technique, often referred to as the "iceberg" model. This invisible aspect of the iceberg encompasses mental, psychological, and physical processes that interact with one another. Therefore, mental processes are considered the primary and active component in executing techniques and selecting appropriate tactical solutions in technical-tactical situations. So that we are searching to know :

What is the Significance of Working Memory and Motor Coordination in the Field of Physical Education and Sports Sciences and Techniques ?

Literature Review

attention, is the first mental operation, and its function is to gather information about the situation. Next comes inhibition, the second mental operation, which involves suppressing and controlling irrelevant information. This is followed by working memory, the third mental operation, which processes this information by drawing upon knowledge and experiences stored in long-term memory to generate solutions and select the best and most appropriate one.

If working memory selects dribbling as a strategy, the player then moves on to select the most suitable dribbling technique for the specific situation. This involves planning or programming the execution stages of the dribbling technique, essentially finding the most appropriate motor scheme for the chosen dribbling tactic. This selection is primarily based on the athlete's motor skills and coordination abilities. In this study, we focused on the most important aspect of motor skills: kinesthetic coordination.

Therefore, for dribbling to be effective, and continuous, and allow the player to seamlessly transition to the next action (shooting, passing, or continuing the dribble), the athlete must select a motor scheme that aligns with their physical, coordination, and technical abilities, as well as the opponent's level and the overall situation.

Despite football's immense popularity in Algeria, there is a significant weakness in training high-level players. This weakness stems not only from neglecting the cognitive aspects but more importantly from a lack of awareness and understanding of its importance in high-level competition. Algerian players excel at basic techniques and their execution, likely due to traditional socio-cultural emphasis on the aesthetics of dribbling during matches. The focus remains solely on the outward display, neglecting the cognitive aspect of dribbling execution. From our perspective, if a player dribbles past one or two opponents, they are considered skilled, regardless of whether it disrupts the game flow, leads to a lost ball, or results in a poor pass.

Consequently, players in their formative stages lack interest in the cognitive aspects and the specific characteristics of this sport, where dribbling serves the game's progression. Dribbling is not a pre-programmed technique but rather a real-time production that adapts to the current situation and

seamlessly transitions into subsequent actions. All of this depends on the cognitive development of both the coach and the player during the formative stages. However, Algerian players learn through repetitive practice of static techniques, similar to the behaviorist school of thought, without utilizing the concept of a "black box" that programs these techniques, movements, and controls, and adjusts their variations based on the situation, position, and the player's capabilities.

During the learning of a dribbling technique, without considering the opponent's characteristics, abilities, and overall situation, the player receives various pieces of information, including the player's position, stance, distance to teammates, and goal. This information is processed by working memory, which then generates appropriate solutions for the given situation. If dribbling is determined to be the optimal solution, the player proceeds to the next stage of selecting the type of dribble and then the subsequent stage of execution.

It is important to note that each technique has its own set of constants and variables (amplitude, time, and force). Working memory, with its two subcomponents, programs these techniques by adjusting or determining the appropriate degree of variables for the current situation and the subsequent actions in the match. Working memory also selects the initial motor system that aligns with the predetermined variables.

The brain is composed of trillions of microscopic neurons that form the basic structure, as illustrated in Figure 1. These neurons exhibit both chemical and electrical activity. Neurotransmitters, chemical substances, are first introduced into the neuron via the dendrites at the top of the cell. These neurotransmitters provide signals to the cell, either excitatory or inhibitory. The cell body receives these chemical signals from the dendrites and determines whether there is sufficient excitatory signal to allow the neuron to release its chemical payload. If so, an action potential occurs, generating an electrical signal that travels along the axon (this electrical signal has been detected using certain brain recording techniques employed by researchers). Once the electrical signal reaches the end of the axon, the synaptic terminals release neurotransmitters into the synapse, where they are collected by nearby neurons. The process then begins again [1].

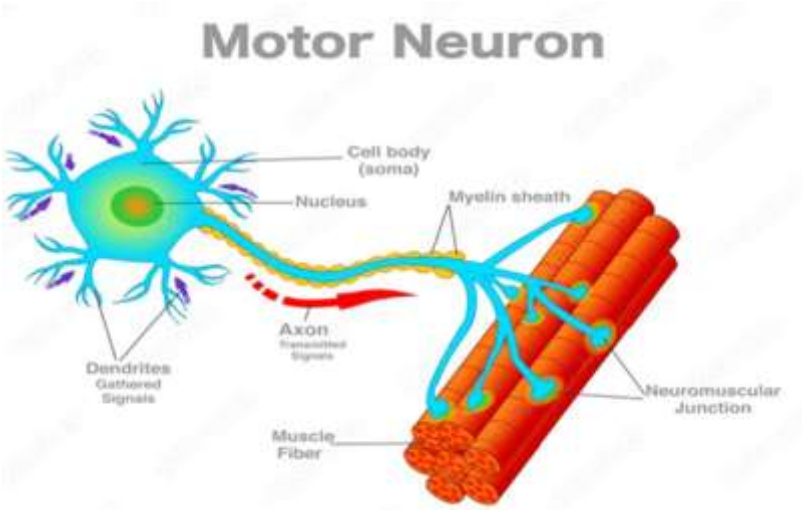

Figure 1. illustrates the basic structure of the neuron.

H. Ebbinghaus (1850-1909) is considered one of the pioneers in the study of applied psychology. He was also the first to study a higher mental process, memory, and believed that memory is nothing more than simple conscious recollection. Ebbinghaus directed his research towards the

storage and retrieval of information and concluded from his research that the association between information is very important for it to be stored in memory. These results led to the associationist school, whose fundamental idea is that psychological life is founded on the association of information[2].

According to Baddeley, working memory is limited in its capacity, like short-term memory, but working memory is not only capable of storage but also of processing incoming information. It consists of three components: (*Phonological Loop, Visuospatial Sketchpad, and Central Executive)*

Sensory inputs, feedback loops, and descending motor commands control the motor neurons in the spinal cord, which innervate skeletal muscles and form the final common pathway of the motor system. Stretch reflexes arising from muscle spindle inputs are a fundamental type of automatic movement. However, even at this level, multiple connections of spinal interneurons are necessary for coordinated reflex contractions of flexor and extensor muscles on both sides of the body. Central pattern generators within the central nervous system can generate complex behaviors without feedback from the periphery. Thus, respiratory movements, which are rhythmic, regular, and automatic, arise from the use of a motor program that relates to the rhythmic activity of neurons within the brainstem. Meanwhile, the rate and depth of breathing are modified by sensory inputs as well as by voluntary and involuntary commands from higher centers, including the cortex. Walking and running are mediated by programmed neural interactions in the spinal cord and higher centers. They ensure that the limbs move appropriately, with the correct phase relationships. In addition, purely voluntary movements involve recruiting lateral components of motor control, namely anticipation and planning. The destination must be determined, the path designed, the appropriate synergistic muscles contracted, and movements initiated in parts of the body, except for the arm, to compensate for shifts in balance and the effects of gravity[3].

Individual Differences in Working Memory

Working memory capacity is one of the most important determinants of individual variation in cognitive skills. This variation in working memory capacity is evident in the ability to sustain performance when performing skills while processing information. Differences in working memory are manifested in the performance of different tasks, and performance on these skills is a good indicator of working memory capacity. Numerous studies have reported individual differences in performance on tasks that involve working memory skills and their specific components. These studies show that an individual can exhibit high performance in certain aspects of working memory while exhibiting low performance in others. For example, an individual may show high scores on visuospatial working memory skills while showing low scores on verbal working memory skills [4].

Working Memory Models

The single-process theory of memory, according to one set of principles, is considered by Witig to be one of the most widely accepted single-process theories in explaining memory. These principles are broadly the association theory and the affect theory. The two-process theory adds two types of memory to its explanation of the phenomenon: short-term memory (STM) and long-term memory (LTM). STM is a relatively transient memory that lasts about 30-60 seconds and has limited capacity. LTM, on the other hand, is considered relatively permanent, of unlimited length and capacity, and deeper in its processing of information [5]As illustrated in Figure(2)[6] .

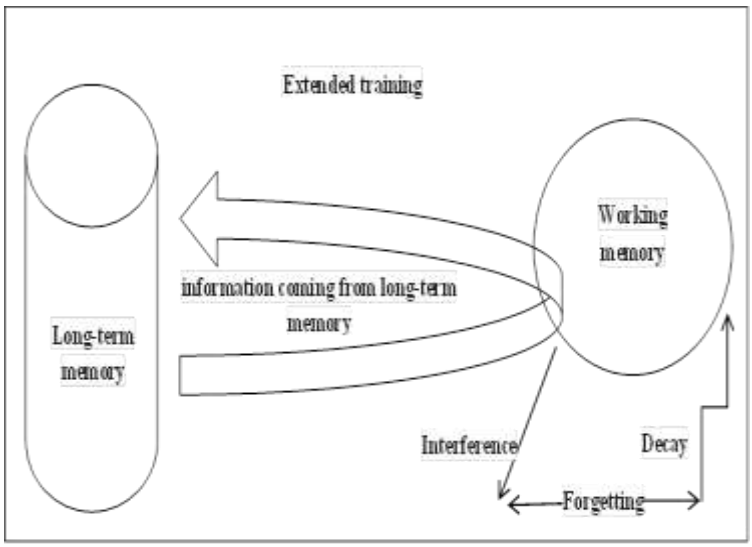

Figure 2. the retention of information in working memory through repetition**.**

Conclusion

Based on the information presented, we can conclude that working memory and motor coordination play a crucial role in the field of physical education and sports science and technology. This can be summarized as follows:

- ✓ Enhancement of the cognitive aspect, specifically the level of higher mental processes.
- ✓ Processing of information related to the sports field in various disciplines.
- ✓ Reaching the most appropriate solution to problems quickly and systematically.
- ✓ Conservation of effort through motor coordination by avoiding the involvement of non-essential muscles in performing the motor skill in the field. The work is limited only to the muscles related to the actual performance of the skill (direct relationship between the sharpness of motor coordination and the economy of effort).
- ✓ Formation of experience at the level of the stimulated neurons (nerve impulses) involved in recalling the skills stored in the learners' motor records.
- ✓ Speed of future response to stimuli that require the performance of a motor skill or motor behavior.
- ✓ In addition to the coordination of motor behavior, there is also beauty and fluidity during performance

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[6] Figure 2. The retention of information in working memory through repetition. See Jurden (1995) and Baddeley (1986) for detailed discussions of this concept.