IKR Publishers

IKR Journal of Education and Literature (IKRJEL)
Journal homepage: https://ikrpublishers.com/ikrjel/
Volume-1, Issue-3 (November-December) 2025
OPEN ACCESS
ISSN: 3107-7684 (Online)

The Role of Creative Cognitive Abilities in Enhancing the Accuracy of Skill Performance in Tennis

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DOI:*10.5281/zenodo.18352691*

ARTICLE INFO

Article history:
Received : 15-12-2025
Accepted : 25-12-2025
Available online : 23-01-2026

Citation: Hamza, D. S., Mudherhasan, A., Abdalhussein, A. A. K., Hasan, H. F., & Kzar, M. N. (2025). The Role of Creative Cognitive Abilities in Enhancing the Accuracy of Skill Performance in Tennis. *IKR Journal of Education and Literature (IKRJEL)*, 1(3), 95-107.

ABSTRACT **Original Research Article**

This study aimed to investigate the role of creative cognitive abilities in enhancing skill performance accuracy in tennis by examining the relationship between these abilities and the accuracy of selected basic tennis skills. The descriptive correlational method was adopted due to its suitability for the nature and objectives of the study. The research sample consisted of students from the Department of Physical Education and Sports Sciences. Data were collected using a creative cognitive abilities scale developed based on the principles of lateral thinking, in addition to standardized skill accuracy tests for tennis, including the serve, forehand groundstroke, and backhand groundstroke. Statistical analysis was conducted using the arithmetic mean, standard deviation, and Pearson's correlation coefficient. The results indicated that the participants possessed a good level of creative cognitive abilities and revealed a positive, statistically significant relationship between these abilities and skill performance accuracy, with the strongest correlation observed in the forehand skill. The study concluded that enhancing creative cognitive abilities contributes effectively to improving skill performance accuracy in tennis.

Keywords: Creative cognitive abilities, Lateral thinking, Skill performance accuracy, Tennis.

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Chapter One

Introduction to the research

1.1 Introduction to the Research and its Importance

Thinking is one of the most prominent higher mental processes, playing a pivotal role in guiding human behavior, particularly in situations requiring analysis, problem solving, and decision-making. This process is characterized by its ability to generate ideas, reorganize experiences, and produce innovative solutions that transcend traditional frameworks, making it a fundamental element in the development of individual performance across various fields, including sports. An individual's thinking style is influenced by a range of educational, social, and cognitive factors that contribute to shaping their mental abilities and directing them toward specific patterns of mental processing.

Creative cognitive abilities are among the most important outputs of advanced thinking, as they are linked to mental flexibility, rapid response, and the ability to adapt to changing situations, as well as producing atypical responses characterized by accuracy and efficiency. These abilities are particularly important in activities that require rapid interaction with environmental variables, where relying solely on physical skills is insufficient to achieve optimal performance; rather, a clear integration between mental processes and motor performance is required.

In tennis, the importance of this integration is clearly evident, given the game's fast pace, the multitude of competitive situations, and the constant evolution of playing styles. Accurate skill execution demands a high degree of ability to analyze the situation, anticipate the opponent's behavior, and make the right decision at the right time and place. This makes creative cognitive abilities a crucial element in enhancing the precision of skill performance. Furthermore, the efficient execution of fundamental tennis skills is closely linked to a player's capacity for rapid mental processing, flexible thinking, and precise responses to various stimuli during play.

Based on these findings, the importance of the current research lies in highlighting the role of creative cognitive abilities in enhancing the accuracy of skill performance in tennis, by studying the relationship between advanced cognitive aspects and skill performance level. This research comes in response to the need to employ modern cognitive frameworks in developing athletic performance, contributing to building a more comprehensive scientific foundation for training and motor education, and enhancing performance efficiency in tennis from a contemporary scientific perspective.

Research Gap

Despite the growing body of research that has examined the role of cognitive factors in sports performance, most previous studies have focused primarily on general mental skills such as attention, perception, and decision-making, while the specific role of creative cognitive abilities, particularly those related to lateral thinking, remains underexplored in the context of tennis performance.

Furthermore, existing research has largely investigated cognitive influences on performance in a general sense, without empirically examining how creative cognitive processes contribute to the accuracy of specific tennis skills, such as the serve, forehand groundstroke, and backhand groundstroke. In addition, few studies have integrated creativity-based cognitive frameworks with objective skill accuracy measurements in tennis.

Therefore, a clear research gap exists in understanding how creative cognitive abilities can be quantitatively linked to skill performance accuracy in tennis players. Addressing this gap is essential for developing more comprehensive training approaches that integrate cognitive creativity with technical skill execution. The current study seeks to fill this gap by investigating the relationship between creative cognitive abilities and the accuracy of selected basic tennis skills.

1.2 Research problem

Tennis is a sport that demands a high level of precision in skill execution due to its fast-paced and ever-changing game situations, requiring a delicate integration of physical, technical, and cognitive aspects. In practice, it is observed that a number of tennis players experience clear difficulties in executing some basic skills accurately and consistently, as well as fluctuations in performance during play, particularly in skills that require high-level coordination between different parts of the body.

The nature of these difficulties lies in the fact that performing tennis skills, particularly forehand and backhand groundstrokes, depends on the organized and synchronized integration of movements of the lower and upper limbs and torso, along with higher-order cognitive processes including speed of perception, situation analysis, and rapid decision-making. Furthermore, the ball's varied trajectories and bounce speed increase the complexity of the movement, demanding a high level of cognitive ability from the player to adapt to the changing dynamics during performance.

Despite the traditional focus of training on physical and technical aspects, the inadequate utilization of creative cognitive abilities can contribute to reduced accuracy in skill performance and negatively impact the efficiency of motor skills execution. This highlights the problem addressed by the current research: the need to study the role of creative cognitive abilities in enhancing the accuracy of skill performance in tennis, as a factor influencing the improvement and maintenance of performance quality within the context of athletic competition.

1.3 Research Objectives

The present study aims to investigate the role of creative cognitive abilities in enhancing the accuracy of skill performance in tennis. Specifically, the study seeks to:

1. To determine the level of creative cognitive abilities among tennis players.
2. To assess the level of accuracy of selected basic tennis skills (serve, forehand groundstroke, and backhand groundstroke).
3. To examine the relationship between creative cognitive abilities and skill performance accuracy in tennis.
4. To identify the tennis skill most influenced by creative cognitive abilities.

1.4 Research Questions

Based on the research objectives, the study attempts to answer the following questions:

1. What is the level of creative cognitive abilities among tennis players?
2. What is the level of accuracy of basic tennis skills among tennis players?
3. Is there a significant relationship between creative cognitive abilities and skill performance accuracy in tennis?
4. Which tennis skill shows the strongest association with creative cognitive abilities?

1.5 Research areas

Current research areas are defined according to the following frameworks:

1. human field Tennis players in Baghdad clubs
2. Spatial field the indoor sports hall at the College of Physical Education and Sports Sciences - University of Baghdad.
3. Time domain the period extending from 1/5/2025 until 20/7/2025.

Chapter Two

Theoretical framework and similar studies

2.1 Theoretical Framework

2.1.1 Creative Cognitive Abilities

2.1.1.1 Concept of Creative Cognitive Abilities (Analytical Perspective)

Creative cognitive abilities have been widely discussed in cognitive psychology as higher-order mental processes that enable individuals to generate novel ideas, reorganize experiences, and adapt flexibly to complex situations. These abilities are rooted in mental flexibility, intellectual fluency, and the capacity to perceive indirect relationships, emphasizing the generation of multiple alternatives rather than reliance on a single solution (Abu Jado & Nofal, 2007). From a functional perspective, creative cognition also plays a crucial role in guiding behavior and enhancing rapid decision-making in dynamic environments (Al-Sharqawi, 2003).

Although these perspectives differ in their theoretical emphasis, they converge on the idea that creative cognitive abilities serve as a mechanism for organizing thought processes and optimizing performance under changing conditions. In sports contexts, this convergence becomes particularly significant, as athletes must continuously process environmental cues and adjust their motor responses accordingly. Previous research has shown that precise skill performance cannot be achieved through physical abilities alone, but requires the integration of cognitive and motor processes to ensure effective execution (Hamza, 2018).

Despite this theoretical recognition, most existing studies have examined creative cognition in educational or general performance settings, with limited empirical investigation into how these abilities influence sport-specific skill accuracy, especially in tennis. This gap highlights the need for research that operationalizes creative cognitive abilities within sport performance and examines their direct relationship with accuracy in basic tennis skills, which is the focus of the current study.

2.1.1.2 Approaches to Developing Creative Cognitive Abilities

Lateral thinking is a cognitive approach that contributes to developing creative cognitive abilities. It involves transcending traditional thinking patterns and seeking unconventional alternatives to address problems. De Bono indicated that this thinking style relies on reorganizing ideas and breaking prevailing mental frameworks, thus allowing for the generation of new and innovative solutions. (De Bono, 2001).

Lateral thinking is not viewed as an independent cognitive pattern, but rather as a tool that supports creativity, contributing to enhanced mental flexibility and intellectual fluency, which are essential components of creative cognitive abilities. This concept has been formally included in the Oxford English Dictionary as a method for solving problems using unconventional approaches, reflecting its importance in various applied fields, including mathematics. (De Bono, 2005).

In tennis, this cognitive approach contributes to improving players' responses to changing competitive situations by diversifying their motor solutions and enhancing their ability to adapt to the speed and variety of game styles, which positively impacts the accuracy of their skill performance.

2.1.1.3 Components of Creative Cognitive Abilities

Creative cognitive abilities consist of a set of integrated mental components, most notably selecting appropriate hypotheses, asking the right questions, generating creative ideas, and then subjecting these ideas to logical analysis to arrive at viable solutions. Abu Jado and Nofal emphasize that these components represent the cognitive foundation of creative thinking, given the mental flexibility and ability to reorganize information that they require.(Abu Jado & Nofal, 2007).

Al-Sharqawi also points out that the integration of creativity and logic is a prerequisite for effective thinking, as it ensures the transition from merely generating ideas to employing them practically in a way that serves sound performance. (Al-Sharqawi, 2003).

2.1.1.4 Creative Cognitive Abilities and Skill Performance (Analytical & Comparative Perspective)

Creative cognitive abilities play a crucial role in shaping motor skill performance by enabling athletes to analyze situations, anticipate movement trajectories, and select the most appropriate response under time pressure. Previous research has indicated that cognitive creativity contributes to reducing performance errors and enhancing consistency, particularly in open-skill sports where players face continuously changing environmental conditions (Hamza, 2018; Abu Labn, 2016).

However, studies differ in their interpretation of how cognitive abilities influence motor performance. Some researchers argue that creative cognition primarily supports decision-making speed and adaptability, while others emphasize its role in movement precision and control. This variation suggests that the influence of creative cognitive abilities may differ depending on the type of skill being

performed. Open skills, such as groundstrokes in tennis, require continuous adjustment to external stimuli, whereas closed skills, such as the serve, allow greater control over performance conditions.

Despite these theoretical insights, empirical studies examining the direct relationship between creative cognitive abilities and the accuracy of specific tennis skills remain limited. Most previous research has focused on general performance outcomes rather than comparing different skill types within the same sport. Therefore, it remains unclear which skills are most affected by creative cognitive processes. The current study addresses this gap by comparing the influence of creative cognitive abilities on the accuracy of the serve, forehand groundstroke, and backhand groundstroke, thereby providing a more detailed understanding of how creativity contributes to skill execution in tennis.

2.1.1.5 Creative Cognitive Abilities Skills

Creative cognitive skills are fundamental pillars for developing advanced thinking, enabling individuals to handle complex situations flexibly and generate innovative responses that enhance performance. These skills comprise a set of integrated mental processes that play a pivotal role in improving the accuracy of skillful performance, particularly in activities requiring rapid decision-making and multiple alternatives, such as tennis.

First: The skill of generating new perceptions

Perception refers to the awareness and deep understanding of the nature of a situation. It is a conscious mental process aimed at interpreting and organizing stimuli to allow for appropriate decision-making or problem solving. This skill is embodied in an individual's ability to form a unique internal perspective by reinterpreting and understanding the situation from multiple angles, thus guiding thinking toward more accurate and effective responses. This perceptual ability contributes to consciously directing motor performance, positively impacting the precision of skill execution.

Second: The skill of generating new concepts

Concepts are cognitive tools used to organize experience and interpret phenomena. They represent methods or patterns for understanding how things are done. Forming new concepts requires mental effort to extract meaning from various experiences, particularly abstract concepts, which form the basis of advanced cognitive analysis. The ability to derive clear concepts enables individuals to find multiple alternatives and to refine and strengthen these concepts, thereby contributing to improved performance and effectiveness.

Third: The skill of generating new ideas

This skill lies in an individual's ability to apply their acquired concepts and transform them into practical ideas when facing problems. Those who possess this skill are characterized by their reluctance to readily reject new ideas, their openness to unconventional solutions, and their willingness to transcend the rigid constraints of logical thinking when necessary. This style of thinking tends toward optimism and constructiveness, focusing on generating new ideas rather than merely evaluating existing ones, thus fostering creativity and improving performance.

Fourth: The skill of generating new alternatives

The ability to generate alternatives is a crucial creative cognitive skill, requiring a broad search for multiple options within a single situation, rather than limiting oneself to obvious or conventional alternatives. This type of thinking emphasizes reorganizing available information in various ways, enabling the production of diverse and unconventional solutions. The goal is not simply to select the "best" alternative, but to expand the range of possible options, thereby fostering mental flexibility and enhancing the ability to adapt to changing situations.

Fifth: The skill of generating new and original creations

Generating original creations is linked to the ability to produce something new rather than merely analyzing the old. De Bono points out that creativity is based on creating new ideas or patterns of thinking, and that this type of creative production often requires more time and effort compared to familiar creations. (De Bono, 2005). This skill enables the individual to go beyond traditional solutions and produce innovative responses that contribute to performance development, especially in areas that require high precision and continuous innovation, such as skill performance in tennis.

2.1.2 Concept of Accuracy (Analytical Perspective)

Accuracy in sports performance is not merely a mechanical outcome of movement execution, but rather the result of a complex interaction between perceptual, cognitive, and motor processes. While traditional definitions describe accuracy as the ability to direct voluntary movements toward a specific target (Hussein, 1985), contemporary motor learning literature emphasizes that accuracy is highly dependent on the athlete’s ability to process information, anticipate outcomes, and regulate movement timing under varying conditions (Schmidt, 1991).

From a cognitive perspective, accuracy is influenced by how effectively an athlete perceives environmental cues, selects appropriate motor responses, and adjusts movement parameters in real time. This means that accuracy cannot be separated from cognitive processes such as attention, perception, and decision-making, particularly in fast-paced sports like tennis where the performer has limited time to respond. Researchers have highlighted that precision emerges when there is effective coordination between neural control, muscular activation, and cognitive regulation of movement (Alwan, 2000; Hasan, 2011).

In tennis, accuracy is especially critical because players must continuously adapt their strokes to variations in ball speed, spin, and placement. This dynamic environment places high demands on creative cognitive abilities, which enable players to generate alternative movement solutions and adjust their actions flexibly during performance. Therefore, accuracy in tennis should be understood as a cognitively mediated skill, rather than a purely technical attribute, which supports the rationale of examining its relationship with creative cognitive abilities in the current study.

First: Spatial (spatial) accuracy

This refers to directing the movement to a specific spatial or position. This type of accuracy depends primarily on the end of the movement or the final point of the performance, as controlling the accompanying movement in the final stage plays an important role in accurately hitting the target.

Second: Temporal accuracy (timeliness)

This type of technique focuses on controlling the timing of movements, particularly in fast-paced actions where timing is crucial to successful execution. Timing accuracy is linked to the player's ability to coordinate movement speed with the demands of the situation, ensuring the skill is executed at the opportune moment.

Third: Accuracy timing

It is a type of precision related to movements whose success requires a precise alignment between the timing of the action and the accuracy of its execution. The timing of the movement is a fundamental factor in achieving correct performance, which makes it closely related to temporal accuracy. (Alwan, 2000).

Modern literature on motor learning indicates that accuracy and speed are complementary aspects of movement behavior. Many athletic skills require a delicate balance between speed and accuracy, particularly in games characterized by rapid changes in situation and fast pace. This integration underscores the importance of cognitive and motor control in guiding performance, which contributes to improving the quality of skill execution. (Schmidt, 1991).

In light of this, it can be said that accuracy is the product of a complex interaction between physical, skill-based, and cognitive aspects, which highlights its importance in the context of the current research, especially when linked to the role of creative cognitive abilities in enhancing the accuracy of skill performance in tennis.

2.1.3 Basic Skills in Tennis

The fundamental skills in tennis represent the foundation of technical and tactical performance, as a player's competitive level is largely determined by their ability to execute these skills with accuracy and adaptability. While traditional training literature emphasizes mastering the mechanical aspects of tennis skills (Al-Kadhimi, 2000), more recent approaches highlight that effective performance also depends on the integration of cognitive and perceptual processes that guide movement selection and execution.

Tennis is characterized by a wide variety of basic strokes that differ according to competitive situations, ball trajectory, speed, and opponent positioning. This diversity requires players not only to possess technical proficiency but also to make rapid cognitive decisions regarding the most appropriate stroke selection. As noted by Al-Najjari (2004), accuracy in skill execution is a key indicator of a player's skill level, especially in situations that demand quick adaptation to constantly changing game conditions.

From a cognitive perspective, tennis skills can be classified into closed skills, such as the serve, which are performed under relatively stable conditions, and open skills, such as forehand and backhand groundstrokes, which require continuous perception, anticipation, and adjustment. Open skills place greater demands on creative cognitive abilities, as players must generate multiple alternatives and adapt their movements in real time to unpredictable stimuli.

The basic tennis skills include a range of key strokes, most notably the serve, forehand groundstroke, backhand groundstroke, volley, smash, half-volley, drop shot, overhead stroke, and lob. Mastery of these skills, particularly groundstrokes and serves, depends on the effective integration of physical, technical, and cognitive abilities. The player's ability to select the appropriate stroke at the right moment reflects efficient cognitive processing during performance, which directly aligns with the objective of the current study in examining the role of creative cognitive abilities in enhancing skill performance accuracy in tennis.

2.1.3.1 Sending

The serve is one of the most fundamental skills in tennis, as it is the single shot that initiates a rally and often gives the player a clear offensive advantage. The serve is crucial in controlling the pace of the match and imposing a style of play, providing direct opportunities to score points, as well as having a psychological impact by putting the player in an attacking position and forcing the opponent into a defensive posture on the court. (Farag, 2007).

The serve is considered one of the main offensive tools in tennis, and its effectiveness increases when it combines speed and precision. A successful serve requires a high degree of attention and concentration, along with a thorough understanding of its technical phases, enabling the player to grasp the mechanics and execute it correctly. The serve also depends on generating sufficient power, accurately directing the ball, and maintaining complete body balance throughout the action, allowing for the production and efficient use of maximum energy.

The serve has undergone a remarkable evolution in both style and variety. It is no longer merely a means of initiating play, but has become an offensive powerhouse, often aimed at winning the point directly and thus controlling the game and

the match. Mastering the serve, along with other fundamental strokes, is a crucial element in raising a tennis player's technical level, making it one of the most important skills in the overall development of the game.

Although the serve may seem relatively easy for beginners, it is a complex skill that requires consistent practice to reach a high level of proficiency, as it relies on neuromuscular coordination, speed of movement, and precision of direction. A successful serve is achieved through the integration of speed, accuracy, and ball spin, as well as the necessity of mastering the second serve to avoid giving the opponent an opportunity for a direct attack.

The serve in tennis varies depending on the technique, the ball's spin, and its speed. The main types of serves can be classified as follows: (Farag, 2007):

1. Straight (simple) transmission
2. Low arc transmission (cutting)
3. High arc transmission (twist)
4. reverse transmission
5. Sending under the arm

The diversity of these types is an indicator of the importance of cognitive and skill-based abilities in choosing the appropriate serve type according to the competitive situation, which enhances the role of creative cognitive abilities in improving the accuracy of tennis players' skill performance.

2.1.3.2 Front Ground Strike

The forehand groundstroke is one of the most common shots in tennis. It is executed after the ball bounces off the ground on the player's preferred side and is widely used at all levels of play. This shot is a cornerstone of skillful performance, characterized by its high power generation and control over the ball's trajectory, as well as being one of the most effective attacking shots. (Al-Kadhimi & Al-Tai, 2014).

The front ground stroke is relatively easy to learn compared to other strokes, making it one of the first skills emphasized in early education. Mastering it is a prerequisite before moving on to other skills. Despite its simplicity, executing it accurately requires precise timing and high coordination between the feet, torso, and striking arm to ensure balance and the necessary power during execution.

At advanced levels, the forehand groundstroke is the most prominent offensive weapon for tennis players, used to pressure the opponent and win points, given its superior power and accuracy compared to the backhand groundstroke in many competitive situations. Proper use of this skill is a clear indicator of a player's technical proficiency and ability to control the tempo of the game. (Al-Atwi & Al-Zuhairi, 2009).

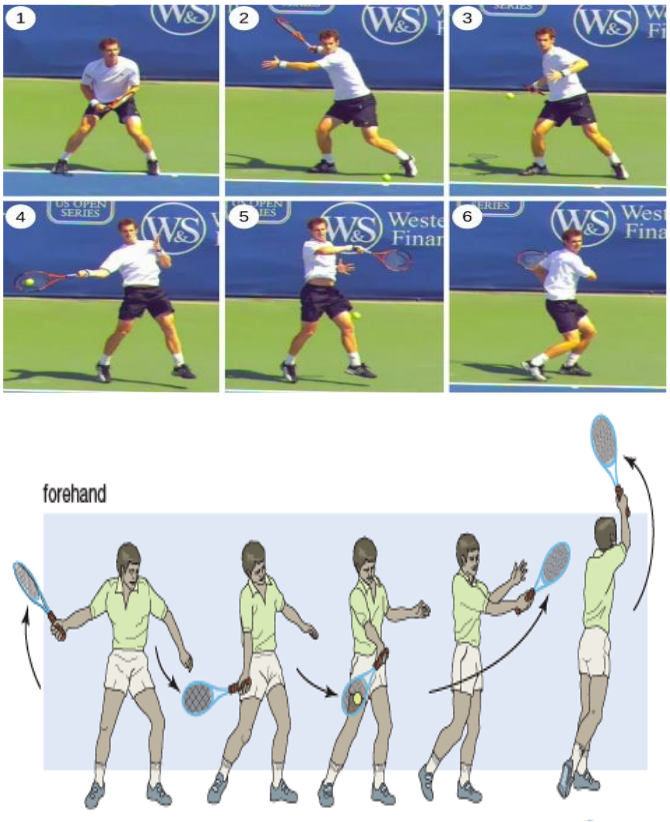

Figure (1): Stages of performing the forehand groundstroke in tennis

2.1.3.3 Backhand Groundstroke

A backhand groundstroke, also known as a forehand groundstroke, is a powerful stroke that strikes the ball with the back of the racket, the side opposite the striking arm. It is a fundamental skill in tennis due to its frequent use during play. This skill is just as important as a forehand groundstroke, as it allows the player to effectively handle shots aimed at their weaker side.(Al-Kadhimi& Al-Tai, 2014).

The backhand groundstroke is considered one of the most technically challenging shots, especially for beginners and juniors, as it requires more practice to master compared to the forehand groundstroke. This is due to the need for precise neuromuscular coordination, good control of body and racket positioning during execution, and accurate timing when striking the ball.

The backhand groundstroke is used as both a defensive and offensive tool. It allows the player to return the ball to the court in defensive situations, and it can also be used offensively to confuse the opponent and change the direction of play. Mastering this skill is an important element in achieving balance in technical performance and enhancing the ability to respond to various competitive situations in tennis. (Al-Atwi & Al-Zuhairi, 2009).

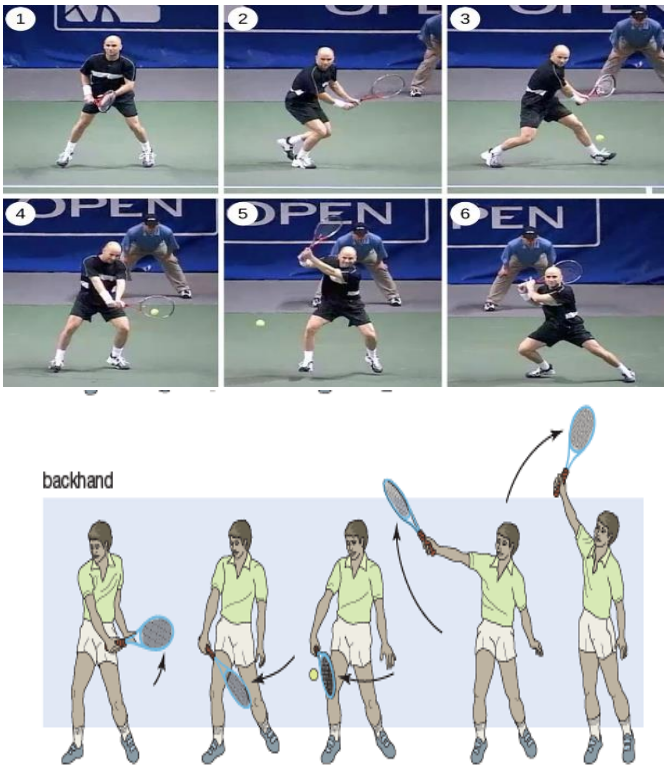

Figure (2): Stages of performing the backhand stroke in tennis

Chapter Three

Research methodology and field procedures

3.1 Research Methodology

The researcher used the descriptive approach with a correlational methodology, as it was well-suited to the nature of the research problem and its objectives. These objectives sought to identify the role of creative cognitive abilities in enhancing the accuracy of skill performance in tennis, by studying the relationship between variables without attempting to control them. This approach is one of the most common in sports research, as it allows for a precise scientific description and analysis of the phenomenon.

3.2 Research Community and Sample

The research community consisted of tennis players who practice the game within regular training programs and possess a skill level that allows for the application of the measurement tools and tests approved in the research.

As for the research sample, it was deliberately selected from the research population, in accordance with the study's objectives and scientific requirements, with the sample reaching (30) players tennis players.

The sample was divided as follows:

- (6) Players they were assigned to conduct the pilot study, and in proportion20%from the total sample size, in order to ensure the clarity of the instruments and their suitability for application.
- (24) Players they were assigned to conduct the main experiment, and in proportion80%from the sample size, for the purpose of collecting and statistically analyzing data.

The selection of the sample members took into account similarities in physical and skill characteristics and training age, in order to achieve a suitable degree of homogeneity and ensure the accuracy of the research findings.

The sample size of 30 tennis players was considered appropriate for the descriptive correlational design adopted in this study. Similar sample sizes have been widely used in sports psychology and motor performance research when the target population is homogeneous and the measurement tools are applied under controlled conditions. Moreover, the selected sample size allows for reliable correlation analysis using Pearson's coefficient, provided that assumptions of normality and linearity are met. The homogeneity of the sample in terms of training age, skill level, and practice environment further supports the adequacy of the sample size for achieving valid and interpretable results.

3.3 Devices, tools, and methods of data collection

The researcher used a range of appropriate scientific devices, tools, and methods to collect the required data, in accordance with the nature and objectives of the research, and these included the following:

1. **Creative Cognitive Abilities Scale**
   It was used to measure the level of creative cognitive abilities in tennis players, and includes dimensions such as mental flexibility, idea generation, and perception of alternatives.
2. **Tests of skill performance accuracy in tennis**
   Standardized skill tests were used to measure the accuracy of performance in some basic tennis skills, particularly the serve and groundstrokes.
3. **Registration and data entry form**
   It was designed for the purpose of recording test results and converting them into data suitable for statistical analysis.
4. **Personal interviews**
   Interviews were conducted with a number of tennis players and coaches, with the aim of supplementing some information related to skill performance and interpreting the results.

3.4 Main search procedures

3.4.1 A tool for measuring creative cognitive abilities

To measure creative cognitive abilities, the researcher relied on a standardized instrument designed based on the principles of non-traditional thinking, and aligned with the performance requirements of tennis. This measurement tool was similar in structure and objectives to lateral thinking scales used in educational literature, particularly those based on Edward de

Bono's theoretical framework for lateral thinking, which is considered a key cognitive foundation for creativity.

The scale consists of a series of items formulated as mental puzzles and challenges, designed to measure an individual's ability to analyze situations from multiple perspectives, generate unconventional alternatives, and transcend familiar thought patterns, thus reflecting the examinee's level of mental flexibility. The final version of the scale comprises. (20) paragraph,

To ensure the instrument's validity and suitability for the research sample, the researcher presented the scale to a select group of specialists in measurement, evaluation, and sports psychology. This was done to assess the clarity, accuracy, and effectiveness of the items in measuring the intended dimension. After analyzing the experts' feedback, the scale was approved in its final form, having achieved complete agreement. (100%) This indicates its high degree of suitability for field application.

The Creative Cognitive Abilities Scale was selected because it is grounded in lateral thinking theory, which is considered one of the most widely accepted cognitive frameworks for measuring creative thinking in applied contexts. The scale was designed to assess mental flexibility, idea generation, and the ability to perceive alternative solutions, all of which are directly relevant to performance demands in tennis. Adapting this scale to a sport-specific context enhances its ecological validity and ensures that the measured cognitive abilities reflect actual performance-related thinking processes.

3.4.1.1 Scale Correction Mechanism

A simple and straightforward correction method was adopted in processing the results of the Creative Cognitive Abilities Scale, where one mark was allocated for each correct answer, while zero marks were given for each incorrect answer, according to the approved correction key.

The examinee's total score is calculated by summing the scores obtained in all items of the scale, and thus the scale scores range between:

- (0) Minimum grade
- (20) Higher limit degree
- And a hypothetical average of (10) grades

3.4.2 Tests of skill performance accuracy in tennis

To measure the accuracy of skill performance in tennis, the researcher adopted a set of scientifically validated skill tests, selected after reviewing specialized literature in the field of training and motor learning. The selection of these tests ensured they were standardized, suitable for the Iraqi context, and appropriate for the skill level of the research sample and the nature of the targeted skills.

The tests of skill performance accuracy were limited to the following basic skills.:

1. **Transmission accuracy**
   Using the Hoyt test to measure the accuracy of the serve in tennis.
2. **Forward ground strike accuracy**
   Using the White test to measure the accuracy of forehand groundstroke performance.
3. **Accuracy of the backhand groundstroke**
   Using the Hoyt test to measure the accuracy of backhand groundstroke performance.

These tests were chosen because of their scientific credibility, their ability to provide accurate indicators of skill performance accuracy, and their widespread use in relevant mathematical research.(Al-Kadhimi & Al-Tai, 2014).

3.4.2.1 Serving Skill Test

Test objective:

This test aims to measure the accuracy of a tennis serve by assessing a player's ability to direct the ball to specific areas within the service box in a series of controlled attempts. This test is a crucial indicator for evaluating skill performance, given the essential role of the serve in controlling the flow of the game and achieving offensive advantages.

The figure shows (1) Method of conducting the test and distributing the accuracy zones within the tennis court.

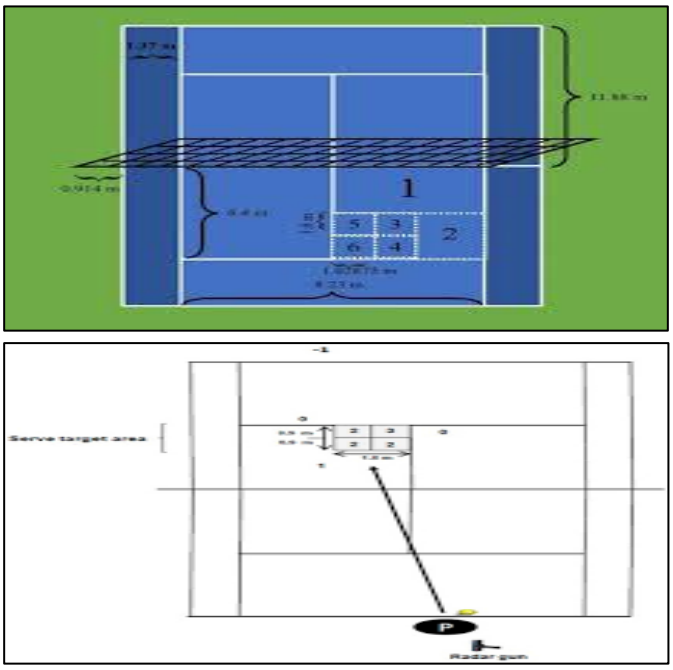

Figure (3): Measuring the accuracy of the serve in tennis

Procedures for performing the Hoyt test to measure transmission accuracy

The accuracy of the serve is tested after the court has been prepared according to the test requirements. A rope with a diameter of (1.4) inches is fixed at both ends to the top posts of the net, so that the distance between the rope and the net is (4) feet Meanwhile, the distance between the rope and the ground surface increases to (7) feet This is to adjust the ball's trajectory during the serve.

After the warm-up and preparation period, the test subject stands behind the baseline designated for singles serving and is given five practice serves to familiarize themselves with

the test requirements. Following this, the player performs ten actual serves, during which the ball must land within the designated service area.

The transmission area was divided into several calendar zones, each assigned different scores according to the ball's landing location; six zones were adopted, each carrying numerical values. (1–2–3–4–5–6)These represent different levels of accuracy, as follows:

- Area number (1) To a rectangle with dimensions of (15 x 13.5) feet.
- Area number (2) To a rectangle with dimensions of (6 x 10.6) feet.
- The regions represent (3–4–5–6) Equal rectangles, each measuring (5.1 x 3) feet.

The same numbers indicate the points allocated to each zone, provided that the ball passes between the net and the rope during the serve.

A shot is not counted if the ball touches the rope or net, and the shot must be retaken. A ball that goes over the rope counts as a shot but is awarded zero points, even if it lands within a valid service area. The score for a shot is calculated based on the area within the service area where the ball lands.

The player's final score is calculated from the total points obtained in the ten attempts, and the highest possible score for the test is (60) points.

Testing the forehand and backhand strokes in tennis

Test name:

Measuring the accuracy of forehand and backhand strokes in tennis.

This test is conducted on a standard tennis court, after preparing the necessary equipment, which includes tennis rackets, (30) tennis balls, a data recording form, and a rope secured according to the approved test method. The figure illustrates this. (2) Laboratory standing areas, the mechanism for executing the two ground strikes, as well as the approved evaluative areas for calculating accuracy scores.

This test aims to assess the player's ability to accurately direct the ball when performing the two ground shots, reflecting the level of skill control and motor coordination during performance.

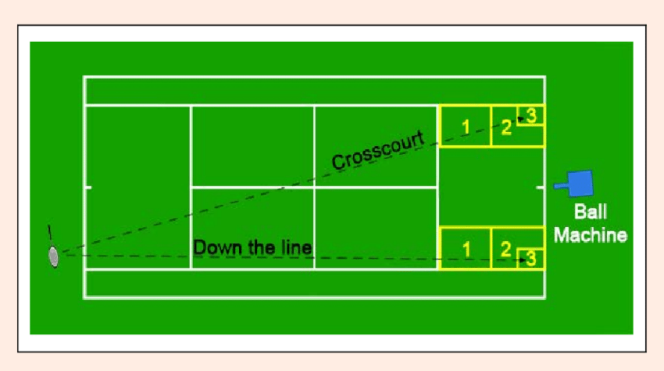

Figure (4): Test to measure the accuracy of the forehand and backhand strokes in tennis

The figure illustrates (2) The technical settings for the test to measure the accuracy of the forehand and backhand ground strokes in tennis, where a horizontal rope is fixed to two poles in the uprights of the net and parallel to it, at a height of (7) feet above the ground, and at a horizontal distance of (4) feet from the net, in order to determine the permissible path for the ball to pass through during the execution of the strokes.

Three parallel lines are also drawn between the transmission line and the baseline, with a distance of [amount] separating them.(4.5) feet these lines are used to divide the playing area into calendar zones that are used to calculate accuracy scores.

The player stands at the center mark located in the middle of the baseline and is initially given five practice attempts to familiarize themselves with the test procedure and requirements, after receiving the necessary instructions and guidance from the instructor or test administrator. The test requires that the ball be thrown directly behind the service line, either using a ball-throwing machine if available, or by the instructor.

Next, the player begins attempting to return the ball using either a front hand groundstroke or a backhand groundstroke, with each player allocated ten attempts for the front hand groundstroke and ten attempts for the backhand groundstroke. The player's score is calculated based on the total points achieved in the ten attempts for each skill.

For an attempt to be considered valid, the ball must pass through the net from below and under the rope, and progressively increasing evaluation scores are awarded, ranging between(1–5) degrees the score depends on the area where the ball lands. If the ball passes over the rope, the attempt is counted, but only half the score allocated to the landing area is awarded. The maximum possible score for the test is 50 points.

3.4.3 Exploratory Experiment

The researcher ensured the implementation of a pilot study before commencing the main application, in order to guarantee the accuracy of the procedures and the reliability of the measurement tools used in the research. This pilot study was conducted on a sample consisting of (10) players from the research community, dated 9/6/2025This is to determine the validity of the tools, ensure the clarity of the test instructions, and identify potential difficulties that the researcher or team may encounter during the implementation of field tests.

The pilot study also aimed to determine the time required to answer the items on the Creative Cognitive Abilities Scale (Lateral Thinking), and the results showed that the average time taken to answer was approximately(25) minutes this timeframe is suitable and does not place a burden on the participants. The results of the pilot study contributed to enhancing the readiness of the research procedures and ensuring the smooth implementation in the main study.

3.4.4 Scientific Foundations of the Measurement Instrument

First: The validity of the scale

Validity is a fundamental characteristic that measurement instruments must possess, as it indicates the extent to which the instrument can measure the trait or phenomenon for which it was designed. To verify the validity of the Creative Cognitive Abilities Scale, the researcher employed content validation by presenting the scale items to a group of experts and specialists in the fields of sports psychology, measurement, and evaluation.

Experts were asked to provide their scientific opinions on the clarity, appropriateness, and effectiveness of the paragraphs in measuring the intended dimension. After collecting and analyzing the responses, the results showed a high degree of agreement among the experts. (100%) The validity of the scale items indicates that it has a high degree of content validity and can be relied upon in field application.

Second: Scale reliability

The reliability of a scale refers to the consistency of its results when administered again under similar conditions, and it is an important indicator of measurement accuracy and stability. To verify the reliability of the Creative Cognitive Abilities Scale, the researcher used the test-retest method.(Test Retest). The use of content validity and test–retest reliability procedures ensured that the measurement instrument possessed both conceptual accuracy and temporal stability, which are essential requirements for cognitive assessment tools used in sports performance research.

Retest

The scale was first applied to the number of individuals in the pilot study sample.(10) players the scale was then re-administered to the same sample two weeks later, under the same conditions. After data entry and statistical processing, the researcher calculated the Pearson correlation coefficient between the scores of the first and second administrations.
The results showed a high correlation coefficient, indicating that the scale has a very good degree of reliability, and confirming its suitability for use in measuring creative cognitive abilities within the research sample.

3.5 Main Research Experience

After completing all preliminary procedures and ensuring the readiness of the measurement tools, the researcher conducted the main research experiment, in which the Creative Cognitive Abilities Scale was applied, in addition to tests of skill performance accuracy in tennis, on [date].15/6/2025This is a date that falls within the timeframe specified for the search procedures.

The application procedures were implemented with the assistance of a support team, adhering to the scientific guidelines for each test and standardizing performance conditions for all members of the sample in terms of the application location, test sequence, and performance time. This contributes to reducing the influence of external factors and enhances the accuracy and objectivity of the data obtained.

3.6 Statistical Methods

Data were analyzed using descriptive and inferential statistical methods appropriate to the study design and research objectives. Means and standard deviations were used to describe the level of creative cognitive abilities and skill performance accuracy. Pearson's correlation coefficient was employed to examine the relationship between creative cognitive abilities and accuracy of tennis skills, as both variables were continuous and measured on interval scales. The selection of Pearson's correlation was further justified by the assumption of linear relationships between variables and the relative normality of score distributions. Statistical significance was set at $p \leq 0.05$, and all analyses were conducted using a standard statistical software package.

Chapter Four

Presenting, analyzing, and discussing the results

The results obtained from the research instruments were presented, then analyzed and interpreted scientifically and rigorously. In this chapter, the researcher employed descriptive and inferential statistical methods appropriate to the nature of the research, in order to provide a clear picture of the creative cognitive abilities and the level of accuracy of skill performance in tennis among the sample group.

Table 1: It shows the arithmetic means and standard deviations of the research variables.

variable	arithmetic mean	standard deviation	hypothetical mean
Lateral thinking	13.120	1.874	10
Sending	32,080	6.945	—
front ground strike	30.940	6.882	—
backhand groundstroke	28,670	5.963	—

Table (1) shows the descriptive values represented by the arithmetic means and standard deviations of the research variables, which included creative cognitive abilities (lateral thinking), in addition to the accuracy of skill performance in basic tennis skills (serve, forehand groundstroke, and backhand groundstroke).

The results for the lateral thinking variable indicate that the arithmetic mean reached (13,120) This is higher than the hypothetical adult average. (10) This indicates that the sample members possess a good level of creative cognitive abilities. The standard deviation also reached. (1.874) This indicates a relative decrease in the dispersion of scores, reflecting the

convergence of the sample members' levels in this variable, and enhancing the homogeneity of the studied sample.

Regarding the variables of skill performance accuracy in tennis, the results showed the superiority of the serve skill, which recorded the highest mean score. (32,080) With a standard deviation of (6.945), this indicates that the players possess a relatively high level of accuracy in serving performance, which is attributed to the fact that serving is a relatively closed skill that allows the player to control the performance conditions.

Meanwhile, the arithmetic mean for the front ground stroke skill reached (30,940) With a standard deviation of (6.882), which reflects a good level of performance with moderate variation among the sample members, and this is explained by the common use of this skill in play, and the players' reliance on it in offensive situations.

As for the backhand ground stroke skill, it came in last place in terms of the arithmetic mean, reaching (28,670) With a standard deviation of 5.963, this indicates a relative decrease in accuracy compared to the previous two skills. This is expected given the high level of neuromuscular coordination required for this skill and its greater difficulty compared to the forehand strike, especially in changing game situations.

In general, the results in the table show a suitable level of creative cognitive abilities and accuracy of skill performance among the sample members. These descriptive indicators also pave the way for studying the nature of the correlation between the research variables.

The descriptive results indicate that the participants possessed a relatively high level of creative cognitive abilities, which may be attributed to their continuous exposure to diverse training situations that require problem-solving and rapid decision-making. This finding is consistent with previous research suggesting that regular engagement in open-skill sports enhances cognitive flexibility and creative thinking (Hamza, 2018). The relatively lower variability in lateral thinking scores further indicates a homogeneous cognitive level among the sample, which strengthens the reliability of the correlational findings.

Regarding skill performance accuracy, the higher mean score observed in the serve can be explained by the closed nature of this skill, which allows greater control over performance conditions. Similar findings have been reported in previous motor learning studies, where closed skills typically show higher consistency and accuracy compared to open skills (Schmidt, 1991). This suggests that environmental predictability plays a key role in stabilizing performance accuracy.

Table 2: It shows the relationship between lateral thinking and tennis skills.

variable	Correlation coefficient with lateral thinking	Level of significance
Sending	0.538	moral
front ground strike	0.601	moral
backhand groundstroke	0.567	moral

Table (2) shows the results of the simple correlation coefficient(Pearson) between lateral thinking as one dimension of creative cognitive abilities, and the accuracy of skill performance in basic tennis skills (serve, forehand groundstroke, and backhand groundstroke).

The table results indicate positive and significant correlations between lateral thinking and all the skills studied, demonstrating that a higher level of lateral thinking among players is associated with improved accuracy in tennis skills, which aligns with the nature of athletic performance that demands a high degree of cognitive processing and rapid decision-making.

The correlation coefficient between lateral thinking and transmission accuracy reached (0.538) This is a statistically significant positive correlation, indicating that players with better unconventional thinking are more capable of directing their serves accurately, even though this skill is considered relatively closed.

The results also showed that the highest correlation coefficient was between lateral thinking and frontal groundstroke accuracy, where the correlation coefficient reached (0.601) This is a positive and significant correlation, reflecting the great importance of the cognitive role in performing this skill, especially its requirement for quick assessment of the ball's trajectory, selection of the appropriate angle, and decision-making in a short time during play.

As for the backhand groundstroke, the correlation coefficient with lateral thinking was reached (0.567) This is also a statistically significant positive correlation, although it is lower than that of the front stroke. This is explained by the fact that the back stroke is a skill characterized by a higher degree of technical complexity and requires significant neuromuscular coordination, which may relatively reduce the impact of the cognitive aspect alone on the accuracy of its performance.

In general, the table's results confirm a clear positive relationship between lateral thinking and the accuracy of skill performance in basic tennis skills, which supports the research hypothesis and indicates that developing creative cognitive abilities can effectively contribute to improving the skill performance of tennis players.

To determine the significance of correlation coefficients, the researcher relied on comparing the calculated values with the tabulated value. (0.36) At a significance level of (0.05) and degrees of freedom of (28), the results showed that all calculated correlation coefficients were greater than the

critical value, indicating significant correlations between lateral thinking and the accuracy of skill performance in basic tennis skills.

The researcher believes that the nature of tennis skills demands high levels of concentration and precision when executing shots, especially in situations requiring precise targeting of the shot and the ball's landing point. Furthermore, creative cognitive abilities, particularly lateral thinking, rely on analyzing situations from multiple perspectives, rather than simply relying on conventional, sequential solutions. This positively impacts the accuracy of the skill performance.

The research results indicate a positive correlation between lateral thinking and skill performance accuracy, favoring the forehand groundstroke first, followed by the backhand groundstroke, and then the serve. This is because the forehand stroke is one of the most frequently used skills during play, and it requires speed in perceiving the situation and making the appropriate decision, along with accuracy in directing the ball, making it more affected by creative cognitive abilities compared to the serve, which is a relatively closed skill.

These results can also be explained in light of De Bono's theory, which emphasizes that lateral thinking relies on experience and practice in generating creative solutions, rather than rote learning or traditional logical reasoning. Since the participants possessed a good level of education and athletic experience, resulting from continuous training and participation in diverse playing situations, this contributed to enhancing their ability to employ lateral thinking in skill performance.

Therefore, a higher level of lateral thinking among players contributes to improving the accuracy of skill performance in tennis, as this game requires the full engagement of the senses, along with high levels of attention and concentration, especially in individual skills of a precise technical nature.

The significant positive correlations between creative cognitive abilities and the accuracy of tennis skills support the theoretical assumption that cognitive creativity plays a crucial role in guiding motor performance under time constraints. The strongest relationship observed between lateral thinking and forehand groundstroke accuracy highlights the cognitive demands of this open skill, which requires continuous perception, anticipation, and decision-making. This finding aligns with the view that open skills are more sensitive to cognitive processes than closed skills (Al-Najjari, 2004).

The comparatively lower correlation with the serve may be explained by the reduced variability of environmental stimuli during performance, as the player controls the initial conditions of execution. Similar trends have been reported in studies examining the relationship between cognitive skills and performance accuracy in closed motor tasks (Abu Labn, 2016). These results indicate that creative cognitive abilities exert a differential influence on tennis skills depending on their cognitive and environmental demands.

Chapter Five

Conclusions and Recommendations

5.1 Conclusions

In light of the research findings, their analysis, and discussion, the following set of scientific conclusions can be drawn:

1. The research sample showed that they possessed a good level of creative cognitive abilities, which reflects their ability to deal with changing skill situations in tennis with flexibility and effectiveness.
2. The results showed a statistically significant positive correlation between creative cognitive abilities and the accuracy of skill performance in tennis, confirming the active role of cognitive aspects in improving the quality of motor performance.
3. It became clear that the impact of creative cognitive abilities was more pronounced in relatively open skills, particularly the forehand groundstroke, compared to closed skills, such as the serve, reflecting the importance of varied thinking and decision-making during performance.
4. The results indicate that improving the accuracy of skill performance in tennis depends not only on physical and technical training, but also requires the integrated development of mental abilities, especially those related to creativity and unconventional thinking.

5.2 Study Limitations

Although the findings of the current study provide valuable insights into the role of creative cognitive abilities in enhancing skill performance accuracy in tennis, several limitations should be acknowledged. First, the study sample was limited to a specific group of university-level tennis players, which may restrict the generalizability of the findings to other age groups or competitive levels. Second, the use of a correlational design does not allow for causal inference, and future experimental studies are recommended to examine the direct effects of creativity-based cognitive training on skill performance accuracy. Third, the study focused on selected basic tennis skills, and future research may extend the investigation to include tactical performance, decision-making speed, and match-based performance indicators. Recognizing these limitations provides a clearer context for interpreting the results and supports the need for further research in this area.

5.3 Recommendations

Based on the research findings, the researcher recommends the following:

1. The need to integrate the development of creative cognitive abilities into tennis education and training

programs, due to its positive impact on enhancing the accuracy of skill performance.
2. Adopting modern training methods that encourage diverse thinking, problem-solving, and decision-making, instead of relying solely on traditional methods based on repetition.
3. Conducting future studies that address creative cognitive abilities and their relationship to other variables, such as motor speed, neuromuscular coordination, or tactical performance in individual and team sports.

Expanding the scope of the research to include samples of varying levels and mathematical experience, in order to verify the reliability of the research results and their generalizability.

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