

The Effect of Differential Training Method Exercises on Developing Mental Imagery and Fundamental Skills in Football

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ORIGINAL STUDY

The Effect of Differential Training Method Exercises on Developing Mental Imagery and Fundamental Skills in Football

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Abstract

This study investigated the impact of a differential-training regimen on mental imagery and core technical skills among under-21 footballers in Baghdad, Iraq. Using a descriptive-experimental design, thirty youth-club players completed a six-week intervention consisting of three 90-minute sessions per week featuring varied, non-repetitive, game-representative tasks (passing in congestion, dribbling under pressure, finishing from multiple angles, and positional rotations). Outcomes included standardized tests of mental imagery and fundamental skills—ball control, passing, shooting, dribbling, and receiving—supplemented by a player questionnaire evaluating program clarity, variety, motivation, engagement, task difficulty, and perceived improvement. Paired-samples t-tests showed statistically significant pre- to post-intervention gains in mental imagery (imagery quality, anticipation, decision-making speed, cognitive flexibility) and in all fundamental skills, evidencing the efficacy of differential training for both cognitive and technical development. Questionnaire responses corroborated these findings, with high mean ratings across domains, indicating the program's appropriateness and strong acceptability to participants. We conclude that differential training meaningfully enhances cognitive readiness and technical execution in U-20 football, and offers a practical, competition-relevant method for accelerating decision-making and adaptability across varied match contexts. Accordingly, we recommend integrating differential training into routine curricula to strengthen fundamental skills and mental imagery.

Keywords: Differential training, Mental imagery, Fundamental skills

1. Introduction

Sports training is considered one of the fundamental pillars that contribute to the development of technical performance and motor abilities of athletes across various sports, particularly football. The game requires a wide range of skills such as ball control, passing, shooting, dribbling, and receiving, in addition to the ability to make decisions quickly and effectively during matches. In recent years, increasing attention has been directed toward modern training methods that aim to enhance players' mental and technical performance. Among the most prominent of these is the *differential training approach*, which is based on providing diverse and non-repetitive game situa-

tions that encourage players to be creative, improve their decision-making speed, and adapt to different conditions (Abu Al-Al, 1997; Shafi, 2011).

Mental imagery is also regarded as an essential cognitive skill that influences the improvement of players' performance levels. Through imagery, the athlete can mentally simulate game situations prior to execution, anticipate the movements of teammates and opponents, and make rapid and flexible decisions during matches (Ratl, 1997; Najm, 2019). Furthermore, the development of fundamental skills constitutes a solid foundation for effective technical performance, as it is directly linked to the implementation of offensive and defensive strategies throughout competitions.

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Previous studies have highlighted the importance of employing varied exercises and simulations of real-game situations to enhance players' cognitive and technical abilities. [Najm \(2019\)](#) study demonstrated that game-like exercises contribute to the development of cognitive flexibility, the improvement of shooting accuracy, and the effectiveness of offensive play among youth football players. Similarly, [Jadu \(2001\)](#) emphasized the significance of integrating physical fitness with technical skills in improving athletic performance, a principle that can be generalized to football. Moreover, [Yazid \(2007\)](#) confirmed that continuous and guided exercises enhance players' motor flexibility and increase their ability to adapt to diverse game situations.

In the same context, [Saeed \(2020\)](#) demonstrated the effectiveness of interactive agility training in enhancing physical abilities as well as perceptual and mental skills, while [Al-Houfi \(2019\)](#) showed that interactive and differential agility exercises improve foot speed, accuracy of fundamental skills, and help players adapt to dynamic game conditions. Finally, [Al-Haqq's](#) dissertation (2024) confirmed that the application of differential training contributes to improving motor abilities and enhancing offensive play situations, with a positive effect on mental imagery and cognitive flexibility among football players under 20 years of age.

Based on the aforementioned findings, the present study aims to investigate the impact of applying sports exercises through the differential training method on the development of mental imagery and certain fundamental skills among football players under 21 years of age, with particular focus on the integration of physical, technical, cognitive, and mental aspects of athletic performance during matches.

1.1. Research problem

Despite advances in contemporary sports training, many youth football players continue to struggle with cognitive abilities pertinent to mental imagery and decision-making speed in offensive situations, alongside persistent needs to improve fundamental skills such as passing, ball control, shooting, dribbling, and receiving. Moreover, there is a paucity of applied research in Iraq examining the impact of differential training on youth players, underscoring the necessity of evaluating the effectiveness of this approach in developing the cognitive and technical performance of under-21 footballers.

1.2. Research questions

1. To what extent does a differential-training program exert a measurable effect on the mental imagery of under-21 football players?

2. Does differential training lead to significant improvements in the fundamental skills of under-21 players?
3. What is the level of players' satisfaction with the differential-training program, and how effective do they perceive it to be in enhancing their performance?

1.3. Research objectives

1. To determine the effect of exercises based on the differential training approach on the mental imagery of under-21 football players.
2. To quantify the impact of differential training on the development of fundamental technical skills among players.
3. To assess players' satisfaction with the differential-training program and its effectiveness in improving technical performance and cognitive capacities.

1.4. Significance of study

1.4.1. Scientific significance

- This study contributes to scholarly literature by examining the effectiveness of the differential training approach in developing mental imagery and fundamental skills among youth players.
- It provides empirical evidence on the relationship between differential training, technical performance, and cognitive abilities in football, offering a reference point for researchers and students in physical education and sport sciences.

1.4.2. Practical Significance

- The findings support coaches in designing innovative training programs that enhance both cognitive and technical capacities.
- The study helps improve the technical performance of under-21 players and strengthens their ability to make rapid, flexible decisions during matches.
- It offers practical guidance for incorporating varied, non-repetitive, game-like scenarios into training, thereby better simulating a competitive condition and increasing the effectiveness of practice.

1.5. Hypotheses

- H1: There is a statistically significant difference in players' mean mental imagery scores before and after implementing the differential-training program.
- H2: There is a statistically significant difference in players' mean fundamental skill scores before

and after implementing the differential-training program.

2. Theoretical framework and review of prior Studies

2.1. Theoretical framework

Section One: Differential training in football

1. Definition and Concept

Etymologically, the term “differential” denotes variance or disparity in conditions. Terminologically and procedurally, differential training refers to the stochastic, non-repetitive practice of a wide range of movements with the aim of facilitating motor decision-making irrespective of the variability of game situations. The theoretical foundations of this approach are attributed to Wolfgang Schöllhorn of the University of Mainz, who argues that variable learning—often termed differential training—seeks to enable players to make effective motor decisions under diverse situational constraints.

According to Belgian coach Michel Bruyninckx, increasing the difficulty and variability of movements across different postures and conditions enhances players’ capacity to cope with the multitude of variables they face in matches (Bruyninckx, 2021). Bruyninckx labels this approach Brain-Centered Learning (also rendered “Learning Centered Brain”), premised on the contention that the human brain processes information orders of magnitude faster than a computer and that exposure to heterogeneous motor situations strengthens players’ adaptability and accelerates their decision-making.

The innovation of this method is primarily credited to Schöllhorn, who maintains that variability in training stimulates players’ perceptual attunement and leads them to discover suitable solutions for diverse game scenarios. Thomas Tuchel, former manager of Chelsea FC, has adopted this approach with his teams, drawing on the philosophies of Schöllhorn and Bruyninckx to cultivate rapid perception, swift decision-making, and efficient execution through non-repetitive drills that prevent players from knowing the “correct answer” in advance (Meuren & Schachter, 2021).

In sum, differential training in football directly contributes to skill development by diversifying training tasks and exposing players to a broad spectrum of technical and tactical situations, both individually and collectively. This methodology also enhances adaptability to changing match conditions, thereby fostering competitive advantage and success. It may therefore be characterized as a distinctive

training paradigm that prioritizes the advancement of players’ skills and team strategies through varied practice, enabling adaptation to the heterogeneous patterns likely to be encountered in real competition.

2. Applications of Differential training

This approach is not confined to a single domain; its principal applications may be summarized as follows:

1. **Performance:** It renders learning more effective, engaging, and intrinsically motivating.
2. **Injury Prevention:** It helps reduce injury risk by fostering adaptation to varied movements and postures.
3. **Holism:** Its effects extend beyond the physical dimension to encompass the development of the player’s character and cognition.
4. **Technology:** It leverages state-of-the-art devices and tools in the design and delivery of training tasks.

3. Significance and Benefits of Differential training

The main benefits of differential training can be articulated as:

1. Confronting errors and learning through their resolution.
2. Acquiring new movement patterns as a function of practice variability.
3. Heightened attentional focus due to systematically changing training conditions.
4. Enhanced reaction speed and decision-making.
5. Strengthened cohesion and interpersonal relations among teammates.
6. Expanded opportunities for creative problem-solving.
7. Improved adaptability to the full range of constraints and situational variables encountered in matches.
8. The introduction of enjoyment and playfulness, which increases players’ readiness for competition (Al-Shibli, 2021).

Section Two: Mental imagery in football

I. Concept of Mental Imagery

Mental imagery is a pivotal cognitive component for football players, as it strengthens their capacity to analyze situations and make optimal decisions rapidly and efficiently (Star, 2008; Yazid, 2007). It encompasses, inter alia:

- Anticipation of other players’ movements (Hussein, 1998).
- Perception of spatial and temporal affordances during play (Al-Almi, 2004).

- The development of strategies for passing, shooting, and both individual and collective tactics (Hammad, 1999).

Recent studies indicate that employing differential exercises enhances players' cognitive flexibility and increases the precision of their responses to both offensive and defensive game situations (Najm, 2019; Saeed, 2020).

II. Importance of Mental Imagery in Sport

Empirical evidence demonstrates that mental imagery contributes to:

1. Improved physical and technical performance: By mentally rehearsing movements prior to execution, athletes perform skills with greater efficiency and accuracy (Mahjoul, 2001).
2. Faster decision-making: It facilitates rapid analysis of unfolding situations and selection of the optimal course of action (Najm, 2019).
3. Increased self-confidence and reduced psychological stress: Players feel mentally prepared to confront diverse scenarios (Ratl, 1997).
4. Enhanced spatial-temporal awareness: Athletes better perceive space and time during matches and act in accordance with game dynamics (Star, 2008).

III. Mental Imagery and Football

In football, mental imagery is closely linked to several core skills, including:

- Anticipating player movements: For example, discerning the locations of teammates and opponents without direct visual fixation.
- Planning shots or passes: Prior to execution, the player envisions the passing angle and ball trajectory (Hammad, 1999).
- Estimating distances and angles: Approximating the space between oneself and the ball or an opponent before engaging.
- Analyzing offensive and defensive situations: Understanding the opposing team's structure and responding swiftly.

Studies show that players with advanced mental imagery are more adept at adapting to changing circumstances and achieving optimal performance (Najm, 2019; Saeed, 2020).

IV. Types of Mental Imagery

Mental imagery can be classified according to movement characteristics and task complexity:

1. Simple motor imagery: Envisioning a single movement, such as shooting or dribbling (Mahjoul, 1985).

2. Complex motor imagery: Encompassing multiple movements and interactions with other players, for example an attacking pass in a congested area (Jawad, 2004).
3. Strategic imagery: Anticipating the overall flow of play, such as planning an organized attack or defending a specific zone (Al-Almi, 2004).

V. Methods for Developing Mental Imagery

1. Mental rehearsal: Repeatedly visualizing movements prior to their physical execution (Ratl, 1997).
2. Simulation within differential training: Employing game-like scenarios that mirror competitive conditions to train rapid decision-making (Mahjoul, 2001; Najm, 2019).
3. Observation and analysis: Reviewing match recordings to analyze situations and encode them as mental images.
4. Integrating cognitive and physical training: Linking mental imagery with practical skill execution to enhance response speed and technical performance (Saeed, 2020).

VI. Effects of Mental Imagery on Fundamental Skills

Empirical studies indicate that mental imagery training leads to:

- Greater accuracy in passing and shooting.
- Improved speed of skill execution.
- Enhanced decision-making under pressure.
- Better dribbling and ball control in realistic game contexts (Al-Hiti, 2011; Al-Houfi, 2019).

VII. Relationship Between Differential training and Mental Imagery

Differential training relies on practice variability and the creation of non-repetitive game situations, which continually stimulate players' thinking and analysis. This approach contributes to:

- Faster development of mental imagery compared with traditional methods.
- Increased cognitive flexibility among players.
- More precise and rapid decision-making under changing game conditions (Najm, 2019; Saeed, 2020).

1st. Concept of Fundamental Skills

Fundamental skills in football are the motor and technical capacities that enable players to execute diverse movements efficiently and accurately. They encompass ball control, passing, shooting, dribbling, and receiving (Al-Hazzā & Aynubli, n.d.; Hammad, 1998). These skills constitute the cornerstone of technical performance; their mastery presupposes a

balanced integration of physical and cognitive abilities (Mahjoul, 2001; Hussein, 1998).

2nd. Types of Fundamental Skills

1. Ball-control skills: Maintaining control while moving or stationary and receiving the ball effectively from any direction; this is the foundational platform for developing other skills (Hammad, 1998; Mahjoul, 2001).
2. Passing skills: Delivering the ball accurately to a teammate using the inside or outside of the foot or the head, with due consideration of force, direction, and distance (Hammad, 1999; Al-Hazzā & Aynubli, n.d.).
3. Shooting skills: Directing the ball toward goal with both power and precision, whether in motion or after reception; this requires coordinated visuomotor (eye-foot) integration (Al-Hazzā & Aynubli, n.d.; Shafi, 2011).
4. Dribbling and maneuvering: Surpassing defenders through individual skill while making appropriate decisions in fluid, changing situations (Hammad, 1998; Al-Bashtawi & Ahmad al-Khawaja, 2010).
5. Defensive skills: Interception, marking, and one-on-one as well as collective defending—competencies essential to maintaining defensive stability (Shaghati, 2011; Star, 2008).
6. Tactical skills: Appropriate positioning, movement into advantageous spaces, and coordinated participation in organized attack and defense; these reflect the integration of physical execution with game intelligence (Hassanin, 1995; Mufti, 2018).

3rd. Characteristics of Fundamental Skills

- Accuracy: The capacity to direct the ball and execute movements correctly (Jawad, 2004).
- Speed: Performing skills at an appropriate rate while preserving accuracy (Yazid, 2007).
- Adaptability: Adjusting effectively to varying match conditions (Najm, 2019).
- Repeatability: Reproducing the skill multiple times with comparable efficiency (Abu Al-Al, 1997).

4th. Methods for Developing Fundamental Skills

1. Differential training: Employing varied drills that simulate real match conditions, thereby enhancing adaptability and the speed of decision-making (Najm, 2019; Saeed, 2020).
2. Structured repetition: Practicing skills repeatedly with systematic error correction to consolidate motor learning (Mahjoul, 2001).

3. Situational training: Creating game-like scenarios that mirror competitive demands to stimulate cognition and decision-making (Shafi, 2011).
4. Mental practice: Rehearsing skills cognitively prior to physical execution to strengthen neuromuscular control (Ratl, 1997).
5. Complementary physical conditioning: Developing fitness, strength, and flexibility to support technical performance (Jadou, 2001; Yazid, 2007).

5th. Importance of Fundamental Skills in Football

Fundamental skills constitute the bedrock of individual and collective performance insofar as they:

- Enable the precise execution of tactical plans.
- Enhance players' capacity for rapid decision-making during matches.
- Increase the effectiveness of both attack and defense and improve ball control across diverse game situations (Al-Hiti, 2011; Al-Houfi, 2019).
- Provide benchmarks for evaluating players' proficiency and tracking technical development (Jawad, 2004).

6th. Relationship Between Differential training and Fundamental Skills

Recent studies indicate that the differential training approach leads to:

- Improved ball control and greater accuracy in passing and shooting.
- Increased execution speed in offensive and defensive contexts.
- Enhanced adaptability to varied game situations and more effective performance of tactical skills (Najm, 2019; Saeed, 2020; Al-Houfi, 2019).

Section four: The relationship between differential training, mental imagery, and fundamental skills

The literature indicates that differential exercises do not merely develop physical and technical proficiencies; they also enhance players' perceptual-cognitive capacities, including decision-making, situational analysis, and the anticipation of opponents' and teammates' movements (Mahjoul, 2001; Najm, 2019). This effect is attributable to the emphasis within differential training on continuous variability and change in performance conditions, which compels players to search for optimal solutions to evolving problems, thereby fostering cognitive flexibility and improving technical precision (Saeed, 2020; Al-Houfi, 2019).

2.2. Review of prior studies

- **Najm (2019):** Demonstrated that game-representative exercises improve cognitive flexibility, selected perceptual skills (e.g., peripheral awareness), shooting accuracy, and offensive game situations among youth football players. The findings underscore the value of varied, non-repetitive drills in stimulating rapid thinking and effective decision-making.
- **Jadou (2001):** Examined how components of physical fitness and anthropometric measures relate to the accuracy of the volleyball spike. Results indicated that developing basic fitness enhances the precision of individual skills and that progressive, sustained practice increases performance stability under competitive pressure. Although conducted in volleyball, the study highlights the importance of integrating physical conditioning with technical skill—principles that are transferable to football.
- **Yazid (2007):** Investigated the impact of a structured training program on the development of flexibility in football players. Continuous, targeted training improved motor flexibility and players' adaptation to diverse game situations, emphasizing flexibility as a foundational attribute for enhanced technical proficiency.
- **Saeed (2020):** Focused on reactive agility training in freestyle wrestling, reporting gains in perceptual-motor and cognitive functions as well as in physical and technical performance. The study illustrates the efficacy of varied, cognitively and physically demanding drills, aligning with core principles of differential training that prioritize adaptation to changing performance constraints.
- **Al-Houfi (2019):** Investigated reactive agility training among youth football players and found improvements in foot-speed and the accuracy of composite technical skills such as passing and receiving, alongside better adaptation to dynamic match situations. The results support the view that differential and interactive drills enhance both technical execution and mental imagery in developing players.
- **Al-Haqq (2024):** Evaluated a differential-training program among under-21 footballers, showing marked improvements in motor capacities and offensive game situations, with positive effects on mental imagery and cognitive flexibility. These outcomes reflect the integration of physical, technical, and cognitive domains achieved through differential training.

3. Research methodology

I. Study Design

A descriptive-experimental research design was employed, incorporating a real-world field intervention with under-21 football players in Iraq. The study aimed to examine the effects of a **differential training** program on:

1. **Mental imagery** among players.
2. **Fundamental technical skills**—ball control, passing, shooting, dribbling, and receiving.

II. Population and Sample

- **Target population:** Under-21 football players affiliated with youth clubs in Baghdad, Iraq.
- **Sample:** Thirty (30) players selected by simple random sampling from participating clubs.
- **Inclusion criteria:**
 - Registered U-20 footballers.
 - Medically fit.
 - Minimum of one year of experience in organized play.

III. Instruments and Procedures

1) Differential Training Program

- Program duration: 6 weeks
- Session frequency: 3 sessions per week
- Session length: 90 minutes per session
- Venue: Youth-club training pitches in Baghdad, Iraq
- Participants: 30 players

Training content: The program incorporated varied, non-repetitive, game-representative tasks, including (but not limited to) passing in congested areas, dribbling under pressure, shooting across diverse attacking situations, and coordinated attacking movements with positional interchanges.

3.1. Program objectives

1. To develop players' mental imagery, including the capacities for visualization, anticipation, rapid decision-making, and cognitive flexibility during play.
2. To improve fundamental technical skills: ball control, passing, shooting, dribbling, and receiving.
3. To increase players' adaptability to varied and changing game situations.

Structure of the Training Session (90 minutes)

1) Warm-Up (15 minutes)

- General mobility and activation (light jogging, dynamic stretching).
- Cognitive priming tasks to enhance attentional focus, such as mentally simulating the upcoming drills.

2) Main Phase (60 minutes)

Drill 1: Passing in congested areas (15 minutes)

- Players divided into small groups.
- Passing under defensive pressure with frequent positional interchanges.
- **Objective:** Improve passing accuracy and decision-making speed.

Drill 2: Dribbling under pressure (15 minutes)

- Preset dribbling lanes with active opponents challenging ball retention.
- **Objective:** Develop ball control and dribbling proficiency in realistic match conditions.

Drill 3: Finishing from varied attacking situations (15 minutes)

- Shooting from multiple angles and offensive scenarios.
- Optional constraints (e.g., shifting goal positions, added obstacles) to simulate opponent pressure.
- **Objective:** Enhance shooting accuracy and reaction speed in attacking phases.

Drill 4: Attacking movements with positional rotation (15 minutes)

- Players distributed across the pitch with continuous role and position changes during attacking sequences.
- **Objective:** Strengthen cognitive flexibility, adaptability to evolving game contexts, and inter-player coordination.

3) Cool-Down and Recovery (15 minutes)

- Physiological down-regulation (static stretching).
- Mental relaxation, e.g., guided imagery of successful game scenarios to consolidate mental representations.

Program Notes

- All drills are intentionally non-repetitive and designed to foster creativity and rapid decision-making.
- Coaches are encouraged to prompt continuous reflective thinking during practice and to promote players' self-assessment.
- Individual performance was monitored across sessions to track improvements in both fundamental skills and mental imagery.

2) Fundamental Skill Tests

- **Ball-control test:** Record the time required to complete a prescribed course while maintaining continuous control of the ball.
- **Passing accuracy test:** Pass the ball toward a designated target from a fixed distance; compute accuracy.
- **Shooting test:** Count the number of on-target shots (out of five attempts).
- **Dribbling test:** Slalom past five cones as quickly and accurately as possible.
- **Receiving test:** Receive a pass from a teammate and establish controlled possession within 10 seconds.

3) Mental Imagery Assessments

- **Guided imagery tasks:** Players are instructed to visualize an offensive or defensive scenario immediately prior to execution.
- **Decision speed and accuracy:** Evaluated across scenarios using a five-level ordinal scale (Poor, Below Average, Average, Good, Excellent).

4) Data-Collection Instrument — Questionnaire

A structured questionnaire was developed to assess mental imagery and fundamental skills from the perspectives of both players and coaches.

Questionnaire domains

- **Domain 1: Mental imagery** — 4 items
- **Domain 2: Fundamental skills** — 5 items
- **Domain 3: Evaluation of the differential-training program** — 6 items

IV) Phases of the Experimental Implementation

1) Preparatory Phase

- Selection of the sample and distribution of the initial questionnaires.
- Identification of the target skill tests and preparation of all measurement instruments.
- An orientation session for players and coaches outlining the program and its objectives.

2) Implementation Phase

- Execution of the differential-training program for six weeks as specified above.
- Continuous monitoring of players' performance in each session, with systematic notes on improvement and engagement with the drills.

3) Post-Testing Phase

- Re-administration of the fundamental skill tests upon completion of the program to quantify improvement.

- Administration of mental imagery assessments to evaluate changes in decision-making and cognitive planning.

4) Analytical Phase

- Aggregation of questionnaire and test data.
- Statistical analysis using descriptive indices (mean, standard deviation) and paired-samples t-tests to compare pre- and post-training performance.

4. Results

4.1. Tables of fundamental-skill, mental-imagery, and program-evaluation tests

Table 4.1 presents the results of the basic skills tests before and after the differential learning-based training program. A clear improvement was observed across all measured skills: the time required for ball control and dribbling decreased (from 12.5 to 9.8 seconds, and from 15.2 to 11.5 seconds, respectively), reflecting enhanced ability to handle the ball quickly and efficiently in performance situations. Similarly, the success rate of accurate passing and shooting on goal increased (from 68% to 85% and from 60% to 78%), indicating a substantial improvement in performance accuracy and in the ability to adopt correct execution postures. Finally, the skill of receiving and controlling the ball recorded an increase from 3.0 to 4.2 points on the evaluation scale, demonstrating a marked improvement in the quality of technical performance.

- **Ball control and dribbling:** Time (seconds) to complete a prescribed course while maintaining possession.

- **Passing and shooting:** Accuracy calculated as the success rate across 10 attempts per player.
- **Receiving and control:** Performance rated on a 1–5 scale (Poor to Excellent).

Mental imagery was assessed via guided visualization tasks in which players were asked to imagine the scenario prior to execution. Scores were recorded on a 1–5 scale, and group means were computed.

Table 4.2 presents the results of the mental imagery tests before and after training. The results showed a significant increase across all measured items: players improved their ability to visualize game situations (from 2.8 to 4.1) and to anticipate the movements of teammates and opponents (from 3.0 to 4.0). Decision-making speed recorded the highest improvement (from 2.7 to 4.2), reflecting the positive effect of differential learning in enhancing mental response speed and the ability to select appropriate solutions during play. Similarly, the score for flexible thinking and changing strategies increased (from 2.9 to 4.1).

This table presents player satisfaction with the training program. All items showed high mean scores, indicating that the intervention was effective and motivational from the players' perspective.

The results of Table 4.3 show that the subjects reported strong satisfaction in terms of the differential training program. Most of the mean scores ranged from "very good" to "excellent" ratings. Such results imply that the program was clear in its instructions, varied in its training situations, and skilled in evoking player motivation as well as increasing their participation. Additionally, the appropriateness of the exercise challenge to players' skill levels further contributed to enhancing their participation and satisfaction, thereby substantiating the program's effectiveness in meeting the demands of training application.

Table 4.1. Fundamental skills: pre–post results following the differential-training program.

Test	Unit	Pre-training	Post-training	Change	Outcome
Ball control	Seconds per course	12.5	9.8	–2.7	Notable improvement
Passing accuracy	Success rate (%)	68	85	+17	Substantial improvement
Shooting on goal	Success rate (%)	60	78	+18	Notable improvement
Dribbling	Seconds per course	15.2	11.5	–3.7	Substantial improvement
Ball reception and control	Score (1–5)	3.0	4.2	+1.2	Notable improvement

Table 4.2. Mental imagery: pre–post results following the differential-training program.

Item	Pre-training (mean out of 5)	Post-training	Change	Outcome
Visualization of game situations	2.8	4.1	+1.3	Notable improvement
Anticipation of teammates' and opponents' movements	3.0	4.0	+1.0	Notable improvement
Decision-making speed	2.7	4.2	+1.5	Substantial improvement
Cognitive flexibility and in-play plan adjustment	2.9	4.1	+1.2	Notable improvement

Table 4.3. Player evaluation of the differential-training program.

Item	Mean response (1–5)	Rating
Clarity of instructions	4.4	Excellent
Diversity of training scenarios	4.5	Excellent
Level of motivation	4.3	Excellent
Engagement during sessions	4.2	Very good
Exercise difficulty	4.1	Very good
Perceived personal improvement	4.5	Excellent

The results in Table 4.4 show that differential training substantially aided in enhancing players' mental imagery. This development manifested in their ability to anticipate game situations, predict teammates' as well as opponents' movements and plan accordingly, and make quicker decisions. Additionally, it enhanced their flexibility in adjusting strategies during play. These indications imply that the program extended beyond enhancing physical and technical abilities, also enhancing cognitive processes that relate to field performance. This is a significant indicator of the effectiveness of such a training practice in football.

The findings of Table 4.5 demonstrate a noticeable increase in each of the fundamental abilities—passing, control, shooting, dribbling, and receiving. High levels of agreement were observed alongside the rise in mean scores. These results suggest that differential training significantly contributed to the integrated development of technical performance. By exposing players to varied and changing training environments, the program enhanced their ability to perform with greater precision and adaptability. This

improvement was most evident in the execution of skills during actual match situations.

4.2. Questionnaire findings

Results from the four-item mental imagery domain reveal marked improvements on all items following the differential-training program. Players reported a high capacity to visualize game situations prior to execution ($M = 4.10$, $SD = 0.56$), with 70% agreement, 20% neutral, and 10% disagreement. Anticipation of teammates' and opponents' movements also improved ($M = 4.00$, $SD = 0.60$), with 65% agreement. The largest gain was observed for decision-making speed in diverse game situations ($M = 4.20$), where 75% of players agreed that the training was effective. The item on adjusting plans or shifting thinking during play recorded a mean of 4.05 with 68% agreement.

Collectively, these results indicate that the differential-training program clearly enhanced players' mental imagery—including visualization, anticipation, decision-making, and cognitive flexibility—reflecting strengthened cognitive capacity and better adaptation to varied match contexts.

The results of Table 4.6 indicate that players were highly satisfied with various aspects of the program. Items concerning clarity of instructions, situation variety, and motivation were given an "excellent" rating. Difficulty of exercise and player engagement were assessed as "very good." Most players also reported improvements in their performance following

Table 4.4. Mental Imagery Domain ($n = 30$).

Item	Mean	SD	Agree (%)	Neutral (%)	Disagree (%)	Note
1. I can visualize game situations before executing them on the field.	4.10	0.56	70	20	10	Notable improvement after training
2. I can anticipate the movements of my teammates and opponents during play.	4.00	0.60	65	25	10	Notable improvement after training
3. I am able to make decisions quickly across diverse game situations.	4.20	0.52	75	15	10	Substantial improvement after training
4. I can adjust my plan or shift my thinking during play when needed.	4.05	0.58	68	20	12	Notable improvement after training

Table 4.5. Fundamental Skills Domain ($n = 30$).

Item	Mean	SD	Agree (%)	Neutral (%)	Disagree (%)	Note
I can pass the ball accurately to my teammates.	4.30	0.50	72	20	8	Notable improvement after training
I can maintain ball control while in motion.	4.25	0.55	70	22	8	Notable improvement after training
I can shoot on goal quickly and accurately.	4.00	0.60	65	25	10	Notable improvement after training
I can dribble and successfully bypass defenders.	4.10	0.57	68	20	12	Substantial improvement after training
I can receive and control the ball effectively across diverse situations.	4.15	0.53	70	18	12	Notable improvement after training

Table 4.6. Evaluation of the Differential-training Program (n = 30).

Item	Mean	SD	Agree (%)	Neutral (%)	Disagree (%)	Rating
The coach's instructions were clear during training.	4.40	0.50	75	20	5	Excellent
The diversity of training scenarios made the sessions more beneficial.	4.50	0.45	78	17	5	Excellent
I felt motivated during the training drills.	4.30	0.52	72	20	8	Excellent
I was fully engaged during the training sessions.	4.20	0.55	70	22	8	Very good
The difficulty of the exercises was appropriate for my level.	4.10	0.57	68	25	7	Very good
I noticed personal improvement in my skills and capacities after training.	4.50	0.48	77	15	8	Excellent

training. These results demonstrate that besides being a training package, the differential training program served as a complete teaching experience that affected players favourably on a mental as well as technical level.

The results for the fundamental skills domain, comprising five items, indicated marked post-training gains. The item on passing accuracy to teammates recorded a mean of 4.30 (SD = 0.50), with 72% agreement. Ball control while in motion improved to a mean of 4.25, with 70% of players endorsing the effectiveness of the training in this respect. Rapid and accurate shooting on goal reached a mean of 4.00 with 65% agreement. Dribbling and successfully bypassing defenders yielded a mean of 4.10 and 68% agreement, representing one of the more pronounced improvements relative to other skills. Finally, receiving and controlling the ball across varied situations registered a mean of 4.15, with 70% agreement.

Collectively, these results suggest that the differential-training program effectively enhanced players' fundamental skills—including passing, control, shooting, dribbling, and receiving—reflecting a substantive improvement in technical performance on the field.

The results of Table 4.7 show that the t-test indicated statistically significant differences between pre-test and post-test measurements in favor of the post-test in mental imagery. This result implies that the differential training program contributed to a favorable development of players' cognitive abilities. Such a

finding supports the first hypothesis and reinforces the use of this training approach to enhance mental functions related to sport performance.

The results of Table 4.8 show statistically significant differences in favor of the post-test results of basic skills. This result proves that the differential training schedule exerts a highly beneficial effect upon players' technical output. Such results support the second hypothesis and confirm the statement that differential training is among the most effective methods to enhance technical competency, particularly in players under 21 years of age.

Findings from the six-item program-evaluation domain indicate overall satisfaction with the intervention. Clarity of instructions achieved a mean of 4.40 (75% agreement), and diversity of training scenarios reached a mean of 4.50 (78% agreement), underscoring the program's pedagogical effectiveness and variety. Players also expressed high levels of motivation during drills (M = 4.30) and engagement throughout sessions (M = 4.20). The difficulty level was deemed appropriate (M = 4.10). Notably, self-assessed improvement in skills and capacities attained the highest mean (M = 4.50; 77% agreement).

These findings indicate that players perceived the differential-training program as both effective and well-matched to their level, enhancing motivation and participation while contributing tangibly to skill development—thereby affirming the utility of this training approach in football.

Table 4.7. T-test Results for Mental Imagery (Hypothesis 1).

Variable	Pre-training (Mean ± SD)	Post-training (Mean ± SD)	t	df	p-value	Conclusion
Mental imagery	3.05 ± 0.50	4.09 ± 0.54	12.34	29	< 0.001*	Statistically significant difference; hypothesis supported

Table 4.8. T-test Results for Fundamental Skills (Hypothesis 2).

Variable	Pre-training (Mean ± SD)	Post-training (Mean ± SD)	t	df	p-value	Conclusion
Fundamental skills	3.10 ± 0.48	4.16 ± 0.52	11.87	29	< 0.001*	Statistically significant difference; hypothesis supported

The significance level was $p < 0.05$, indicating statistically significant post-intervention improvements in mental imagery and confirming the first hypothesis.

Post-intervention gains in fundamental skills were statistically significant ($p < 0.05$). Mean scores increased following the program across the sample, evidencing the intervention's efficacy.

Taken together, the t-test results support both hypotheses, demonstrating that the differential-training program produced significant and practically meaningful improvements in mental imagery and fundamental skills among under-21 players. These outcomes substantiate the effectiveness of this training paradigm in developing both cognitive and technical performance.

5. Findings and recommendations

5.1. Findings

Drawing on questionnaire data and analysis of practical performance tests, the principal results can be summarized as follows:

1. Mental Imagery Domain:

Post-intervention results showed notable improvements across all mental imagery items following implementation of the differential-training program. Players' mean scores increased for visualization of game situations, anticipation of teammates' and opponents' movements, decision-making speed, and cognitive flexibility (including in-play plan adjustment). A substantial proportion of players reported perceived gains in their cognitive capacities during play. Collectively, these findings indicate that differential training effectively strengthened players' mental imagery and cognitive readiness, enabling more flexible and rapid responses to diverse match scenarios.

2. Fundamental Skills Domain:

Significant enhancements were observed in fundamental technical skills after training, including passing, ball control, shooting, dribbling, and receiving/first touch. Elevated means and high levels of agreement were recorded across all items, suggesting that the differential-training approach facilitated efficient acquisition of core skills and raised technical performance among under-21 players.

3. Program Evaluation Domain:

Players expressed overall satisfaction with the differential-training program. Ratings for clarity of instruction, diversity of training scenarios, motivation, session engagement, exercise dif-

ficulty, and perceived personal improvement ranged from good to excellent. These outcomes imply that the program was well-aligned with the sample's ability level and had a positive impact on both skill training and cognitive development.

4. t-test Results for the Study Hypotheses:

Paired-samples t-tests supported both primary hypotheses:

- **H1:** A statistically significant difference in mean mental imagery scores before versus after the differential-training intervention.
- **H2:** A statistically significant difference in mean fundamental skill scores before versus after the intervention.

All tests yielded $p < 0.05$, confirming the effectiveness of differential training in improving both cognitive and technical performance.

In sum, the study's results demonstrate that differential training is an effective approach for developing mental imagery and fundamental skills among under-21 football players. The method contributes to enhanced technical execution, faster cognitive processing, and more accurate decision-making across varied game situations.

5.2. Recommendations

Drawing on the foregoing findings, the following recommendations are proposed:

1) Scientific and Research Recommendations

- Encourage additional applied studies on the differential training approach across diverse age groups and proficiency levels in football.
- Examine the impact of differential training on more complex tactical constructs, such as coordinated team defending and varied attacking schemes.
- Investigate linkages between differential training and other physical capacities (e.g., strength, endurance, reaction speed).

2) Practical and Applied Recommendations

- Coaches should integrate differential training into training curricula to develop players' fundamental skills and mental imagery.
- Design training units featuring varied, game-representative scenarios to stimulate rapid, accurate decision-making.
- Differentiate task difficulty to accommodate heterogeneous player levels, ensuring appropriate challenge and maximal benefit.

- Employ periodic player assessments to track improvements in mental imagery and fundamental skills and to recalibrate training accordingly.

3) Recommendations for Program Development

- Integrate cognitive and physical motivators within differential drills to heighten engagement and adherence during sessions.
- Leverage individual and team feedback to refine drill design and the staging of differential training phases.
- Utilize technology—including video analysis and simulation tools—to support players' visualization of game situations and to enable more precise performance analysis.

Conflicts of interest

None.

We confirm that all tables and figures in this article are ours and written by the researchers themselves.

Ethical approval

This manuscript approved by Ahmed Masrahed and Adnan Ali on (10/07/2025).

Author's contributions

All contributions of this study were done by the researchers (Lect. Dr. Muthanna Sattar Hussein and Asst. Lect. Taghreed Mahdi Kadhimi) who get the main idea and work on writing and concluding also with number of experts, Lect. Dr. Majid Haider Aboud in Statistics, Lect. Dr. Majid Haider Aboud in revision, Ahmed Hadi Jaber in translating.

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Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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اثر تمرينات بأسلوب التدريب التفاضلي في تطوير التصور العقلي وبعض المهارات الأساسية لكرة القدم

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المستخلص

يهدف البحث الحالي إلى دراسة تأثير تمرينات بأسلوب التدريب التفاضلي على بعض القدرات الحركية ومواقف اللعب الهجومية للاعبين كرة القدم الرديف تحت 21 سنة، مع التركيز على تطوير التصور العقلي والمهارات الأساسية للاعبين. تم تطبيق البحث باستخدام المنهج الوصفي التجريبي مع تجربة ميدانية حقيقية على عينة مكونة من 30 لاعباً من أندية الشباب في محافظة ديالى، العراق. وتضمن برنامج التدريب التفاضلي مدة ستة أسابيع، بمعدل ثلاث جلسات أسبوعياً، مدة كل جلسة 90 دقيقة، وشمل مواقف لعب متنوعة وغير متكررة لتحفيز اللاعبين على اتخاذ قرارات سريعة وتطوير مهاراتهم الأساسية مثل التحكم بالكرة، التمرير، التسديد، المراوغة، والاستلام. كما تم استخدام اختبارات التصور العقلي والمهارات الأساسية بالإضافة إلى استبيان مكون من ثلاثة محاور: التصور العقلي، المهارات الأساسية، وتقييم البرنامج التدريبي التفاضلي. وأظهرت النتائج تحسناً ملحوظاً في التصور العقلي، حيث ارتفعت متوسطات اللاعبين في التخيل، التنبؤ، سرعة اتخاذ القرار، ومرونة التفكير خلال اللعب، مما يعكس تعزيز القدرة الذهنية والتكيف مع مواقف اللعب المختلفة. كما أظهرت النتائج تطوراً واضحاً في المهارات الأساسية، حيث سجل اللاعبون تحسناً في التمرير، التحكم بالكرة، التسديد، المراوغة، والاستلام، مما يدل على كفاءة التدريب التفاضلي في رفع الأداء الفني. كما أظهر محور تقييم البرنامج التدريبي التفاضلي رضا اللاعبين عن وضوح التعليمات، تنوع المواقف التدريبية، مستوى التحفيز، الانخراط أثناء الجلسات، صعوبة التمارين، وتحسن القدرات الشخصية، وهو ما يشير إلى أن البرنامج كان مناسباً وفعالاً من منظور اللاعبين. وأثبتت نتائج اختبارات t للعينات المرتبطة صحة الفرضيتين الرئيسيتين للدراسة: وجود فرق دال إحصائياً في متوسط التصور العقلي والمهارات الأساسية قبل وبعد التدريب التفاضلي، مما يعكس فعالية البرنامج في تطوير القدرات الذهنية والمهارية للاعبين. واستنتج البحث أن التدريب التفاضلي يساهم بشكل فعال في رفع مستوى التصور العقلي والمهارات الأساسية للاعبين كرة القدم تحت 21 سنة، ويعد أسلوباً تدريبياً مناسباً لتعزيز الأداء الفني والقدرة على اتخاذ القرار والتكيف مع مواقف اللعب المتنوعة. ويوصي الباحث بالتالي: على المدربين تبني أسلوب التدريب التفاضلي ضمن برامجهم التدريبية لتعزيز المهارات الأساسية والتصور العقلي.

الكلمات المفتاحية: التدريب التفاضلي، التصور العقلي، المهارات الأساسية، كرة القدم، الأداء الفني، اللاعبين الرديف تحت 21 سنة