The effect of colorful and varied visual skill exercises on the development of sensory perception and complex skill performance among futsal players

El efecto de los coloridos y variados ejercicios de habilidad visual en el desarrollo de la percepción sensorial y el rendimiento de habilidades complejas entre los jugadores de fútbol sala

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Abstract

Objective: This study aimed to evaluate the effect of colorful and varied visual skill exercises with proposed playing areas on the development of some sensory perceptions and complex skill performance among futsal players, and to compare their effectiveness with the conventional training method.
Methodology: Sixty futsal players from the Iraqi Futsal League participated, equally divided into an experimental group (30) and a control group (30). The experimental group underwent the visual training program, while the control group followed their usual training routine. Specialized tests were used to measure foot distance perception, leap distance sense, and stopping, rolling, handling, and scoring skills, both before and after the intervention.
Results: Results showed statistically significant improvements across all studied variables within the experimental group (calculated “t” values ranged from 3.86 to 6.70). Post-test comparisons between the two groups also revealed a statistically significant superiority of the experimental group in all variables (calculated “t” values ranged from 2.685 to 5.154), with experimental effect sizes ranging from 0.89 (large) to 1.72 (very large).
Discussion: The discussion suggests that improvements in sensory perceptions enhance skill performance.
Conclusions: We conclude that colorful and varied visual skill exercises are highly effective in developing key sensory perceptions and complex skill performance in futsal players.

Keywords

Visual exercises; sensory perceptions; complex skill performance; futsal.

Resumen

Objetivo: Este estudio tuvo como objetivo evaluar el efecto de ejercicios de habilidad visual coloridos y variados con áreas de juego propuestas en el desarrollo de algunas percepciones sensoriales y el rendimiento de habilidades complejas entre jugadores de fútbol sala, y comparar su efectividad con el método de entrenamiento convencional.
Metodología: Participaron sesenta jugadores de fútbol sala de la Liga Iraquí de Fútbol Sala, divididos a partes iguales en un grupo experimental (30) y un grupo control (30). El grupo experimental se sometió al programa de entrenamiento visual, mientras que el grupo control siguió su rutina de entrenamiento habitual. Se utilizaron pruebas especializadas para medir la percepción de la distancia de los pies, el sentido de la distancia de salto y las habilidades de parada, rodadura, manejo y puntuación, tanto antes como después de la intervención.
Resultados: Los resultados mostraron mejoras estadísticamente significativas en todas las variables estudiadas dentro del grupo experimental (los valores de "t" calculados oscilaron entre 3,86 y 6,70). Las comparaciones posteriores a la prueba entre los dos grupos también revelaron una superioridad estadísticamente significativa del grupo experimental en todas las variables (los valores "t" calculados oscilaron entre 2,685 y 5,154), con tamaños de efecto experimental que oscilaron entre 0,89 (grande) y 1,72 (muy grande).
Discusión: La discusión sugiere que las mejoras en las percepciones sensoriales mejoran el rendimiento de las habilidades.
Conclusiones: Concluimos que los ejercicios de habilidad visual coloridos y variados son altamente efectivos en el desarrollo de percepciones sensoriales clave y el rendimiento de habilidades complejas en jugadores de fútbol sala.

Palabras clave

Ejercicios visuales; percepciones sensoriales; desempeño de habilidades complejas; futsal.

Introduction

Futsal is a dynamic sport that demands high levels of motor, cognitive, and sensory performance due to its fast-paced nature, confined space, and frequent changing situations that necessitate quick and accurate decision-making (Barros et al., 2012). In this environment, athletic superiority is not limited to physical and technical abilities but extends to perceptual-visual efficiency and a player's ability to effectively process sensory information and respond with appropriate motor decisions (Vickers, 2007). Sensory perceptions, such as judging distances and spatial positions, are pivotal for precise ball control, accurate passing, effective shooting, and successful maneuvering in tight spaces (Williams et al., 1999).

Numerous studies indicate that complex skill performance in team sports heavily relies on the ability to receive, analyze, and rapidly interpret visual information (Abernethy, 1996). The human eye acts as a vital sensor, providing the brain with the necessary data for motor planning and execution. However, many traditional training programs in football and futsal primarily focus on fundamental physical and technical aspects, often neglecting a systematic and specific development of perceptual-cognitive and visual abilities. This deficiency might limit players' potential to reach peak performance, especially in situations demanding complex and rapid responses (Marteniuk, 1976).

In recent years, there has been increasing interest in training based on visual and cognitive challenges as a strategy to enhance athletic performance (Faubert & Sidebottom, 2012). Similar studies in various sports have shown that interventions targeting the visual system can contribute to improvements in aspects such as reaction time, visual attention, game reading, and even actual motor performance (Romeas et al., 2016). For instance, a study by Romeas et al. (2016) indicated that visual training can improve performance in sports requiring rapid visual processing. In the context of football, Janelle & Hatfield (2008) suggested that meticulously designed training tasks involving diverse visual stimuli can enhance players' ability to make better decisions on the field.

What distinguishes this study and makes it a qualitative addition to the field is its focus on integrating multiple factors in visual skill exercises: the use of colorful and varied visual stimuli, applied within proposed and changeable playing areas. This diversity in stimuli and training conditions is believed to better simulate the complexity of real-game situations in futsal and supports the principles of Differential Learning (Schöllhorn et al., 2009). This may lead to more effective adaptive responses from the central nervous system, reflecting a comprehensive improvement in sensory perceptions and complex skill performance.

The current study aimed to identify the following:

- The effect of colorful and varied visual skill exercises with proposed playing areas on the development of some sensory perceptions and complex skill performance levels in futsal players. The superiority of colorful and varied visual skill exercises with proposed playing areas over the traditional training method in developing some sensory perceptions and complex skill performance levels in futsal players.

Method

Study Design

The researchers employed an experimental approach, utilizing a design with two equivalent groups and pre- and post-measurements (Hammood et al., 2024; Khalaf et al., 2025).

Participants

Research community and sample

The study consisted of players from Iraqi futsal league clubs for the 2023-2024 season. The focus was on the players participating in the qualifying league for the Iraqi Premier League, whose total number reached (80) players.

Sample selection process

The research sample was selected randomly and stratified to ensure a balanced representation of the various clubs participating in the qualifying league. This was done as follows:

Initial classification: Players are categorized according to the clubs to which they belong.

Random selection: From each club, a certain number of players were randomly selected, in proportion to the size of the club, bringing the total number of participants in the study to (60) players.

Split groups: Divide the selected players into two equal groups:

Control group: includes (30) players.

Experimental group: includes (30) players.

This division was done randomly by lot to ensure that the two groups were as equal as possible before the start of the experiment.

Exclusion criteria

To ensure the integrity and correctness of the data, players who meet any of the following criteria have been disqualified:

Players who are injured or suffer from any health issues that may affect their performance in tests.

Players who are absent from the training modules designated for study or who do not commit to attending regularly.

Equivalence between the two groups

To ensure scientific accuracy and reliability in the results of the study, which aims to evaluate "The effect of colorful and varied visual skill exercises on the development of sensory perception and complex skill performance among futsal players," care was taken to achieve equivalence between the experimental and control groups. This ensures that any differences observed in the final results are directly attributable to the effect of the independent variable (the proposed exercises) and not to pre-existing differences between the two groups.

Objectives of Equivalence

Ensure a unified starting point: To confirm that the research sample begins from a comparable level in relevant variables before applying the independent variable.

Minimize the impact of extraneous variables: To reduce the influence of any external factors that might affect and distort the study's results.

Increase the accuracy and reliability of results: To enhance confidence that the observed differences are a true outcome of the experimental intervention.

Variables in which Equivalence was Achieved

Equivalence between the two groups was achieved in the following variables, which are crucial for the characteristics and performance of futsal players:

Age: The average ages of participants in both groups were very similar, and there were no statistically significant differences between them.

Gender: All study participants (a total of 60 players, 30 per group) were male, ensuring homogeneity of the two groups in this variable.

Previous Experience: All participants had previous futsal experience exceeding two years, confirming their equivalent level of experience.

Initial Level of Sensory Perceptions: It was confirmed that there were no statistically significant differences in the pre-test results for sensory perceptions.

Initial Level of Complex Skill Performance: It was confirmed that there were no statistically significant differences in the pre-test results for complex skill performance.

Equivalence Procedures

To achieve this equivalence, the following procedures were followed:

Random Selection and Assignment: Players were selected from the research population (futsal players from Iraqi League clubs participating in the qualifying league), totaling 60 players. Thereafter, they were randomly assigned to the experimental and control groups, with each group comprising 30 players. This random assignment ensures that any potential extraneous variables are equally distributed between the two groups, minimizing their impact on the results.

Screening and Exclusion: Injured players or those absent from training sessions were excluded before the start of the experiment to ensure group homogeneity and suitability for full participation in the study.

Pre-measurements and Statistical Tests: Pre-measurements were conducted for all the variables mentioned above (age, experience, sensory perceptions, complex skill performance). Subsequently, an Independent Samples t-test was used to confirm that there were no statistically significant differences between the means of the two groups in these variables.

Defining the study variables and how to measure them

In this study, researchers aim to measure some complex skills in futsal, as well as some sensory perception tests. These skills and tests were selected based on a thorough review of the relevant scientific literature, as well as the researchers' insight and deep understanding of the dimensions of the research problem. To determine the most appropriate tests for the research sample, the proposed tests to measure these variables were presented to seven experts specialized in the field.

Validation of the tests mentioned

We would like to clarify that the tests mentioned have been adapted or developed to suit the specificity of futsal. Although some concepts may be inspired by soccer tests, the application and standards should be specific to futsal due to the different space, ball, and rules.

The tests mentioned are

Forward Leap Distance Sense Test: This test aims to measure the player's ability to estimate distance visually and kinetically when performing a front jump, which is an important aspect of predicting distances within the narrow futsal court.

Foot Sense Test: This test measures the accuracy of the deep tactile sensation of the foot, which is vital for precise ball control and passing in small areas.

Stopping, Rolling, and Handling Test: This test measures the ability to receive, suppress, control, roll, and then pass the ball accurately, which is an essential skill in offensive and defensive futsal situations.

Stopping, Rolling, and Scoring Test: This test focuses on combining ball reception and control skills with the ability to shoot towards the goal, and reflects the ability to finish attacks effectively.

Validation of skill tests

Verification of skill tests designed specifically for futsal has been emphasized, namely:

Quenching, rolling, and handling tests in futsal.

Testing the skills of suppression, rolling, and shooting in futsal.

These tests were validated by presenting them to seven experts in the field: university professors specializing in sports training and futsal).

Expert opinions have ensured that the most accurate and appropriate tests to measure the target variables in the study are selected and effectively adapted to the specific futsal environment(Hussein Fayyad et al., 2025).

The importance of expert opinions

Expert opinions are central to the validation process, ensuring that tests actually measure what they are designed to measure. Expert feedback also helps identify and modify any weaknesses in tests to improve

their accuracy and relevance, especially when adapting tests from a general sport (such as football) to a specialized sport (such as futsal).

Table 1. Percentage of agreement of experts in tests appropriate for the skills under study

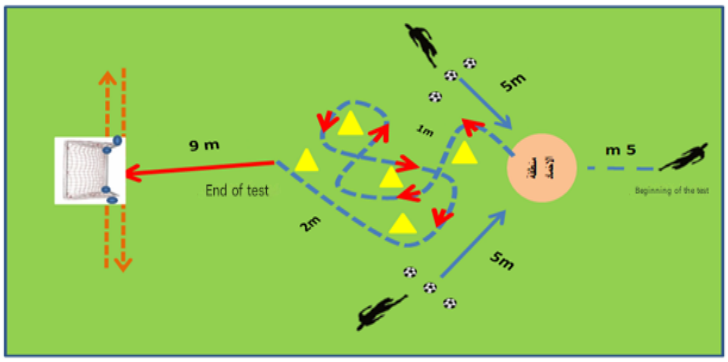
	Candidate Test	Total, number	Number of agreements	Agreement percentage
1	Forward Leap Distance Sense Test	7	6	%85.714
2	Foot Sense Test	7	7	%100
3	Stopping, Rolling, and Handling Test	7	7	%100
4	Stopping, Rolling, and Scoring Test	7	6	%85.714

Tests used

Futsal skill tests:(Karim & Khalil, 2022)

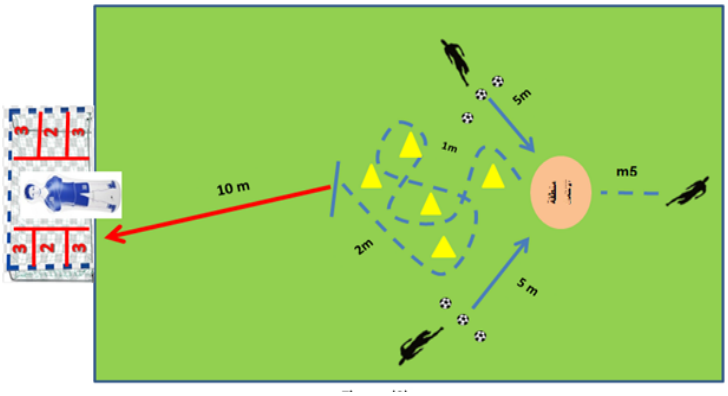
1. Futsal dribbling, rolling, and handling test.

Figure 1. Shows quenching, rolling, and handling football tests for the bowls.



2. Futsal dribbling, rolling, and scoring skills test.

Figure 2. Shows the test of quenching, rolling, and scoring skills in futsal.



Procedure

In research design, participants are divided into two main groups: the Control Group and the Experimental Group. The fundamental differences between these two groups lie in the nature of the intervention they receive, while they are equal in all other variables before the trial begins.

Experimental Group

This group receives the independent variable or experimental intervention whose effect the research aims to measure. The experimental group is the one that will undergo:

Apply visual skill exercises in different colors and numbers, and with suggested play areas.

These exercises will be specifically designed to develop sensory perceptions and complex skill performance of futsal players.

These exercises will be carried out regularly and according to a specific schedule during the study period.

The goal of this group is to observe changes or improvements in their sensory perceptions and complex skill performance as a direct result of these exercises.

Control Group

This group does not receive the independent variable (experimental intervention). Instead, they:

Continue her usual training routine or receive no additional training related to the independent variable.

Her training routine must be identical to what she was before the study, or she must receive alternative training that does not contain the specific "visual skill exercise" component that the experimental group receives.

Do not apply visual skill exercises in different colors and numbers, and with suggested play areas during the study period.

The goal of this collection is to provide a basis for comparison by observing this group.

Applied procedures

The applied research experiment was carried out over eight weeks, with three training units per week. The experiment used visual skill exercises, which are the independent variable in the research, which included exercises varying in number and color, and were carried out in suggested play areas. The researchers designed 12 skill exercises, focusing on futsal skills by controlling the number of players and the colors of their clothes. Three exercises were applied in each training unit during the central part for a duration of 20 to 25 minutes, including exercise time and breaks in between. The details and procedures of the exercises were carried out under the supervision and follow-up of the researchers.

Visual skill exercises were carried out as follows:

First, the researchers suggested four different play areas:

(10 × 20) meters, representing a quarter of the area of the stadium.

(20 × 20) meters, representing half of the area of the stadium.

(20 × 30) meters, representing three-quarters of the area of the stadium.

(20 × 40) meters, representing the entire area of the stadium.

Second: The members of the experimental group were divided into two groups, with 5 players for each group, and each group wore a different color from the color of the other group, for example (red and yellow).

The first proposed area: (10 × 20) meters

First week:

Unit One: 5 players in red uniforms versus 5 players in yellow uniforms.

Unit 2: 6 players in red uniforms versus 4 players in yellow uniforms.

Unit 3: 7 players in red uniforms compared to 3 players in yellow uniforms.

Second week:

Unit 4: 5 players in red uniforms versus 5 players in yellow uniforms.

Unit 5: 4 players in red uniforms versus 6 players in yellow uniforms.

Unit 6: 3 players in red uniforms versus 7 players in yellow uniforms.

Thus, the remaining units of the leading search experiment are carried out based on this division of the number of players and the colors of their clothes at the rate of two weeks for each proposed space: (20 × 20) meters, (20 × 30) meters, and (20 × 40) meters, and at a rate of three units per week.

Data analysis

The results of the statistical analysis represent the objective basis for understanding the effect of colorful and varied visual skill exercises on the sensory perception and complex skill performance of futsal players. After collecting and validating, the data was statistically analyzed using IBM SPSS Statistics v25. The analysis included the use of arithmetic mean, standard deviation, and (T) tests for correlated and uncorrelated samples to compare the results between the pre-and post-tests of each group. The T-test was also used to compare the results of the post-test of the two study groups. In addition, the experimental effect size was calculated (Ali et al., 2024; Mohammed Hammood et al., 2025; Omar et al., 2025).

Results

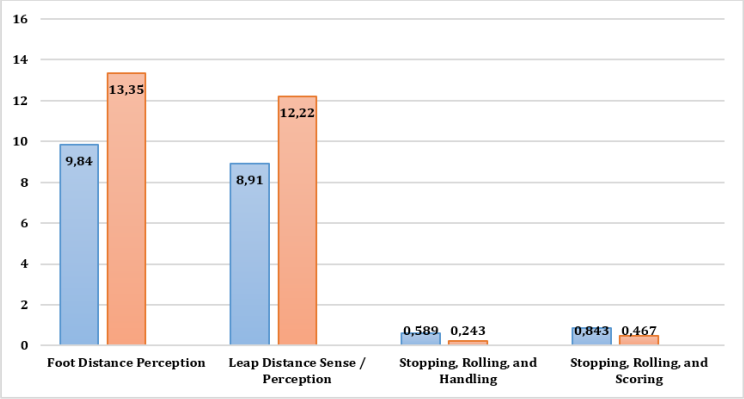
Degrees of Freedom (df): Since the experimental group size is 30 players, the degrees of freedom for the paired t-test are n−1=30−1=29.

Critical "t" Value (Two-tailed, α=0.05, df=29): Approximately 2.045. If the calculated "t" value is greater than this absolute value, the differences are considered statistically significant.

Table 2. Shows the results of the pre- and post-tests of the study variables.

Variables	Unit of measure	Pretest		Post-test		Difference in arithmetic means	Standard deviation difference	Calculated T value
		Arithmetic mean	Standard deviation	Arithmetic mean	Standard deviation			
Distance perception by foot	cm	59,12	26,3	9.84	1,81	2.75	1.45	6.70
Sense perception of lateral distance	cm	11.19	3.15	8,91	1.89	2.28	1.26	5.72
Drop, roll, and tackle	Degree, second	0.192	0.013	0.528	0.27	0.336	0.257	3.86
Drop, roll, and tackle	Degree, second	0.363	0.062	0.843	0.43	0.48	0.368	4.137

Figure 1. It shows the comparison between the results of the pre-and post-tests.



Analysis of the Updated Table 2 According to the Research Title

Studied Variables

1. "Foot Distance Perception" Variable (Unit: cm)

- Measurements:

    - Pre-test Mean: 12.59 cm
    - Post-test Mean: 9.84 cm
    - Difference in Means: 2.75 cm (Decrease, indicating improved accuracy).
- Standard Deviation:
    - Pre-test: 3.26
    - Post-test: 1.81
    - Difference in SDs: 1.45 (Decrease, indicating increased consistency in performance).
- Calculated "t" Value: 6.70

Analysis: This variable shows a statistically significant improvement in the accuracy of foot distance perception. The calculated "t" value (6.70) is significantly larger than the critical value (2.045), confirming that the reduction in perceptual error after training is not due to chance. The decrease in standard deviation further supports that players' performance became more consistent in this perception.

2. "Lateral Distance Sense Perception" Variable (Unit: cm)

- Measurements:
    - Pre-test Mean: 11.19 cm
    - Post-test Mean: 8.91 cm
    - Difference in Means: 2.28 cm (Decrease, indicating improved accuracy).
- Standard Deviation:
    - Pre-test: 3.15
    - Post-test: 1.89
    - Difference in SDs: 1.26 (Decrease, indicating increased consistency in performance).
- Calculated "t" Value: 5.72

Analysis: Similarly, this variable demonstrates a statistically significant improvement in the accuracy of lateral distance perception. The calculated "t" value (5.72) is well above the critical value (2.045). The reduction in both the mean and standard deviation confirms that visual exercises contributed to making this perception more accurate and consistent.

3. "Stopping, Rolling, and Handling" Variable (Unit: degree/second)

- Measurements:
    - Pre-test Mean: 0.192 degrees/second
    - Post-test Mean: 0.528 degrees/second
    - Difference in Means: 0.336 (Increase, indicating improved performance).
- Standard Deviation:
    - Pre-test: 0.013
    - Post-test: 0.27
    - Difference in SDs: 0.257 (Significant increase, indicating higher variability in performance).
- Calculated "t" Value: 3.86

Analysis: This variable showed a statistically significant improvement in mean performance, increasing from 0.192 to 0.528 degrees/second. The calculated "t" value (3.86) confirms this significance. However, a notable increase in the standard deviation suggests that the individual responses of players to the training were varied; some may have achieved significant leaps in performance while others improved less, leading to a wider spread of skill levels.

4. "Rolling, Handling, and Scoring" Variable (Unit: degree/second) - New Variable

- Measurements:
  - Pre-test Mean: 0.363 degrees/second
  - Post-test Mean: 0.843 degrees/second
  - Difference in Means: 0.48 (Increase, indicating improved performance).
- Standard Deviation:
  - Pre-test: 0.062
  - Post-test: 0.43
  - Difference in SDs: 0.368 (Large increase, indicating higher variability in performance).
- Calculated "t" Value: 4.137

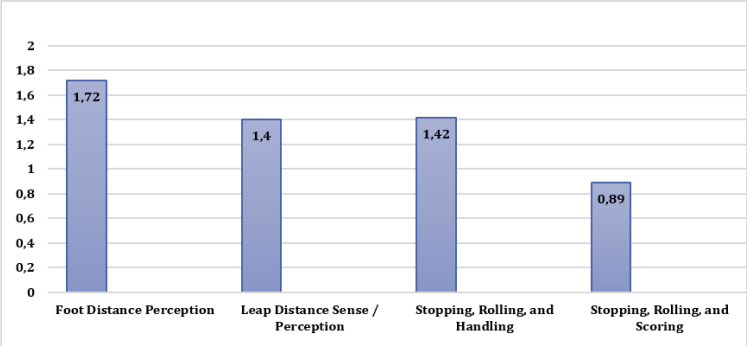
Analysis: This variable demonstrates a substantial and statistically significant improvement in mean performance from 0.363 to 0.843 degrees/second. The calculated "t" value (4.137) is above the critical value, confirming that the exercises had a positive impact on this complex skill. Similar to the previous skill variable, there is a significant increase in the standard deviation, indicating that individual player responses to this type of training were diverse, and some might have achieved much higher performance levels than others.

Table 3. Results of the two research groups for the post-tests and the size of the experimental effect.

Variables	Unit of measure	Control group		Experimental group		Calculated value of (t)	Standard Error	Experimental Effect Size
		Arithmetic mean	Standard deviation	Arithmetic mean	Standard deviation			
Distance perception with feet	cm	13.35	2.26	9.84	1,81	5.154	2.04	1.72
Sense of jump distance	cm	12.22	2.76	8,91	1.89	4.200	2.36	1.40
Stopping, rolling, and handling	Degree, second	0.243	0.09	0,528	0.27	4.253	0.20	1.42
Stopping, rolling, and scoring	Degree, second	0,467	0.41	0.843	0.43	2.685	0.41	0.89

Degrees of Freedom (df): For comparing two independent groups, the degrees of freedom are df (nexperimental+ncontrol)−2=(30 + 30)−2=58. Critical "t" Value (Two-tailed, α=0.05, df=58): Approximately ±2.000. If the calculated "t" value is greater than this absolute value, the difference is considered statistically significant.

Figure 2. Shows the size of the experimental effect of the research variables.



Effect Size: Effect size is a crucial indicator that goes beyond merely showing statistical significance; it quantifies the practical significance or real-world importance of the observed differences. It provides an estimate of the strength of the relationship between the independent variable (visual skill exercises) and the dependent variables (sensory perceptions and complex skill performance), thus indicating the effectiveness of the intervention in an applied setting.

Common interpretations for Cohen's d effect size are:

- Small: d=0.20
- Medium: d=0.50
- Large: d=0.80 and above

Variable Analysis

1. "Foot Distance Perception" Variable (Unit: cm)

- Means and Standard Deviations (Post-test):
  - Control Group: Mean 13.35 cm, Standard Deviation 2.26 cm.
  - Experimental Group: Mean 9.84 cm, Standard Deviation 1.81 cm.
- Calculated "t" Value: 5.154
- Experimental Effect Size: 1.72

Analysis: This variable shows that the average foot distance perception for the experimental group (9.84 cm) is significantly lower than that of the control group (13.35 cm) in the post-test. Since a lower value indicates higher accuracy in perception (less error), this difference points to a significant and statistically significant improvement in foot distance perception accuracy in the experimental group compared to the control group. The calculated "t" value (5.154) is substantially larger than the critical "t" value (2.000). Furthermore, the experimental effect size (1.72) is classified as very large, confirming the practical and clinical importance of the visual exercises' impact on this perception.

2. "Leap Distance Sense" Variable (Unit: cm)

- Means and Standard Deviations (Post-test):
  - Control Group: Mean 12.22 cm, Standard Deviation 2.76 cm.
  - Experimental Group: Mean 8.91 cm, Standard Deviation 1.89 cm.
- Calculated "t" Value: 4.200
- Experimental Effect Size: 1.40

Analysis: We observe that the average leap distance sense for the experimental group (8.91 cm) is markedly lower than that of the control group (12.22 cm) in the post-test. This indicates a significant and statistically significant improvement in the accuracy of leap distance sense in the experimental group. The calculated "t" value (4.200) is higher than the critical "t" value (2.000). The experimental effect size (1.40) is also classified as very large, emphasizing that the visual exercises had a strong practical impact on this sensory perception.

3. "Stopping, Rolling, and Handling" Variable (Unit: degree/second)

- Means and Standard Deviations (Post-test):
  - Control Group: Mean 0.243 degrees/second, Standard Deviation 0.09 degrees/second.
  - Experimental Group: Mean 0.528 degrees/second, Standard Deviation 0.27 degrees/second.
- Calculated "t" Value: 4.253
- Experimental Effect Size: 1.42

Analysis: This variable shows that the average performance in stopping, rolling, and handling for the experimental group (0.528 degrees/second) is considerably higher than that of the control group (0.243 degrees/second). Assuming a higher value indicates better skill performance, this difference points to a significant and statistically significant improvement in complex skill performance in the experimental group as a result of the training. The calculated "t" value (4.253) is much larger than the critical "t" value (2.000). The experimental effect size (1.42) is classified as very large, confirming the practical importance of the exercises' impact on this skill.

4. "Stopping, Rolling, and Scoring" Variable (Unit: degree/second)

- Means and Standard Deviations (Post-test):
    - Control Group: Mean 0.467 degrees/second, Standard Deviation 0.41 degrees/second.
    - Experimental Group: Mean 0.843 degrees/second, Standard Deviation 0.43 degrees/second.
- Calculated "t" Value: 2.685
- Experimental Effect Size: 0.89

Analysis: We observe that the average performance in stopping, rolling, and scoring for the experimental group (0.843 degrees/second) is higher than that of the control group (0.467 degrees/second). This indicates a statistically significant improvement in this complex skill in the experimental group. The calculated "t" value (2.685) is greater than the critical "t" value (2.000). The experimental effect size (0.89) is classified as large, affirming a significant practical impact of the visual exercises on this skill.

Discussion

This study aimed to evaluate the impact of a training program based on colorful and varied visual skill exercises with proposed playing areas on the development of certain sensory perceptions and complex skill performance in futsal players. The statistical results derived from the pre-test and post-test analyses (Table 1) and the post-test comparisons between the experimental and control groups (Table 2) revealed strong and clear indications confirming the effectiveness of the proposed training program.

The results concerning the variables "Foot Distance Perception" and "Leap Distance Sense" showed a significant and statistically significant improvement within the experimental group from the pre-test to the post-test (Table 1). More importantly, the post-test comparisons between the two groups (Table 2) demonstrated a clear superiority of the experimental group in the accuracy of these perceptions compared to the control group. The high calculated "t" values (5.154 and 4.200, respectively), which exceeded the critical table value of 2.000 at a significance level of 0.05, indicate strong statistical significance for these differences.

This improvement is further reinforced by the very large experimental effect size values (1.72 for Foot Inertia Perception and 1.40 for Leap Distance Sense). These values indicate that the intervention had a substantial practical impact, confirming that players exposed to the colorful and varied visual exercises became more accurate in estimating distances, which is crucial in the fast-paced and confined environment of futsal (Reilly et al., 2009). This can be explained by the idea that colorful exercises and varied visual tasks increase the challenge to the players' visual and cognitive systems, enhancing their ability to process visual information more quickly and accurately, thereby improving motor and perceptual prediction (Abernethy, 1996). Furthermore, varied training environments (proposed playing areas) stimulate the adaptation of sensory systems, leading to enhanced proprioception and peripheral vision, both essential components for optimal futsal player performance (Williams et al., 1999).

Similarly, the results for the variables "Stopping, Rolling, and Handling" and "Stopping, Rolling, and Scoring" showed a statistically significant improvement in average performance within the experimental group from pre-test to post-test (Table 1). Crucially, the post-test comparisons between the two groups (Table 2) revealed the experimental group's superiority in performing these complex skills compared to the control group, with calculated "t" values (4.253 and 2.685) being statistically significant.

The large experimental effect size values (1.42 for Stopping, Rolling, and Handling and 0.89 for Stopping, Rolling, and Scoring) underscore the practical significance of these improvements. This suggests that the enhancement of sensory perceptions through visual exercises positively impacted the ability to execute complex technical skills that demand high accuracy in ball control and rapid decision-making under pressure (Davids et al., 2008). A player with better visual-sensory perception can read situations faster, estimate distances, and judge passing and shooting angles more accurately, directly affecting the quality and precision of skill execution (Vickers, 2007).

It is worth noting an interesting observation from the analyses in Table (1), which was the increase in standard deviations for the complex skill performance variables (Stopping, Rolling, and Handling, and Rolling, Handling, and Scoring) after training within the experimental group. Despite the overall improvement in the mean, this might indicate a variability in individual player responses to the training program. Some players may have achieved very significant gains, while others' gains were more moderate, leading to a wider dispersion in performance levels. This variability could be due to individual differences in initial abilities, experience, or even the extent of commitment and adaptability to new visual stimuli (Schmidt & Lee, 2011).

These findings are consistent with scientific literature emphasizing the close relationship between perceptual-visual abilities and motor performance in team sports, especially those requiring rapid information processing in confined spaces like futsal (MacMahon & Reilly, 2007). The use of different colors and numbers and proposed playing areas in exercises reflects the principles of Differential Learning, which focuses on exposing learners to a wide variety of conditions and stimuli to enhance adaptability and flexibility in performance (Schöllhorn et al., 2009).

The study highlights the potential for developing the perceptual-sensory and motor skills of futsal players through carefully designed and targeted training programs. This has significant practical implications for coaches, who can integrate these types of exercises into their training sessions to enhance players' overall performance beyond just traditional physical or technical aspects.

This study clearly confirms that the application of colorful and varied visual skill exercises with proposed playing areas leads to statistically and practically significant development in sensory perceptions and complex skill performance among futsal players. These results constitute a valuable addition to the knowledge in the field of sports training and provide a practical framework for developing more effective training programs in futsal.

Conclusions

Based on the findings obtained through the application and analysis of pre-test and post-test results for both the experimental and control groups, the following key conclusions can be drawn:

- The colorful and varied visual skill exercises, applied in proposed playing areas, demonstrated high effectiveness and significant statistical value in developing the accuracy of sensory perceptions in futsal players, specifically foot distance perception and lateral distance sense. This was reflected in the reduction of perceptual errors and increased consistency of performance in the experimental group compared to the control group, with a very large practical effect size.
- The proposed exercises contributed significantly, both statistically and practically, to improving the complex skill performance of futsal players, specifically in stopping, rolling, and handling, and stopping, rolling, and scoring skills. This was evident through the clear superiority of the experimental group in the post-tests.
- The results underscore the pivotal role of training specifically aimed at developing visual-sensory perceptual abilities in elevating the level of skill performance in futsal players. Improved perceptions directly translate into better quality, accuracy, and speed of decision-making and skill execution.
- Despite the overall improvement in average complex skill performance, an observed variability in individual player responses to the training led to increased dispersion in performance for some skills.

Based on the preceding conclusions, the following recommendations are put forth for specialists and researchers in the fields of futsal and sports training:

- It is recommended to integrate and include colorful and varied visual skill exercises with diverse playing areas as an essential and core component within the daily training units for futsal teams across different age categories.

- Coaches should give greater attention to the visual-sensory perceptual aspect in their training programs, not just limiting themselves to traditional physical and technical aspects, given its direct and tangible impact on improving overall player performance
- It is advised to leverage the principles of Differential Learning when designing exercises by continuously varying visual stimuli and training conditions to stimulate adaptation and enhance perceptual-motor flexibility in players.
- Further future studies are recommended to focus on analyzing the reasons for variability in player responses to targeted training programs, with the aim of developing more personalized and tailored training programs to suit individual player differences.
- It is advisable to conduct longitudinal studies to assess the long-term effect of these exercises on the sustained development of sensory perceptions and complex skill performance in futsal players.

The possibility of applying this methodology (visual skill exercises) can be explored in other team sports that require high visual accuracy and spatial perception in confined spaces.

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