

Standardization of a Visual Depth Test Tailored for Under-19 Tennis Athletes

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ORIGINAL STUDY

Standardization of a Visual Depth Test Tailored for Under-19 Tennis Athletes

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Abstract

This research provides coaches with a standardized, scientifically validated test to assess visual depth in youth tennis players under 19. The test aims to facilitate continuous evaluation of players' performance during both training and official competitions. The research addresses the lack of standardized tests that accurately assess visual depth in youth tennis players under 19, particularly under conditions simulating actual competition. The absence of such essential assessment tools for this age group constitutes a significant research gap. Therefore, the researchers undertook the task of designing and standardizing the test. The objectives of the research included designing and standardizing a test to measure the level of visual depth in youth tennis players under 19 years old, in addition to developing standards and levels to evaluate and measure visual depth in this age category. The researchers used the descriptive method in the form of a survey, as it suits the nature of the problem. The research sample consisted of 67 youth tennis players under 19 years old from the central and southern provinces. Two players were excluded due to non-compliance, bringing the total research sample to 65 players. Five players were allocated for the pilot study, while the Development sample included 60 players. After designing the test and applying it to the Development sample, the researchers concluded that the test is capable of detecting the level of visual depth in youth tennis players under 19 years old. Standards and levels specific to this test were established with the goal of advancing the game of tennis among youth players under 19.

Keywords: Test development, Test standardization, Visual depth

1. Introduction

In light of the significant advancements in modern sports, there is a growing need to develop objective and accurate tools to assess both the skill-related and psychological aspects of athletes, especially in sports that rely heavily on visual-motor skills such as tennis. Visual depth is considered one of the fundamental components of visual perception, directly influencing timing accuracy and eye-body coordination, making it a critical factor in determining performance levels. Despite its importance, there is a noticeable gap in the availability of standardized tests designed to measure visual depth among youth tennis players under 19 years of age, as most existing tools rely on general metrics that are not tailored to this specific age group or to the unique demands of tennis. Therefore, this research aims to design and standardize a visual depth

test that aligns with the development and athletic characteristics of youth tennis players, contributing to an accurate evaluation of their visual capabilities and assisting in the development of optimal training programs through a scientific methodology involving statistical analysis and ensuring reliability and validity. The significance of the study lies in providing coaches with a standardized and scientifically grounded test to measure visual depth in youth tennis players under 19 years of age for the purpose of continuous performance evaluation during training and official competitions, given that tennis requires many abilities, particularly visual ones, and visual depth is one of the crucial visual abilities in the sport. It plays a key role in receiving the ball from the opponent and returning the serve without interruption, with matches potentially lasting for hours. Fadhil and Fouad (2018) stated the role of the senses, especially

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vision, in learning and the speed of perception. This highlights the importance of focusing on visual abilities specifically, in addition to other critical skills, and thus evaluating and understanding their level requires a specially designed and standardized test that reflects the demands of tennis performance. [Star \(2016\)](#) mentioned that “tennis is one of the sports that needs to define the level of its practitioners to establish a scientific basis for testing and training, and the importance of measurement and testing in tennis appears through diagnosis, classification, motivation, selection, and prediction.” Based on the researchers’ experience in testing, measurement, and the sport of tennis, they found it necessary to construct a visual depth test for tennis players in environments similar to competitive conditions, and due to the scarcity of such important tools for assessing players, this presents a research problem that requires a solution. Accordingly, the researchers constructed the necessary test and developed its standards and levels with the aim of advancing the level of tennis among youth players under 19 years of age. The study aimed to build a test to measure visual depth in youth tennis players under 19 and to establish standards and levels to evaluate this ability among the same group. The study was limited to youth tennis players under 19 years of age in the central and southern provinces.

1.1. Study methodology and field procedures

Population and Sample of the Study: The research population was deliberately selected and consisted of youth tennis players under 19 years of age from the central and southern provinces, totaling 67 players as shown in [Table 1](#). The research sample, which included the Development sample and the exploratory sample, was selected randomly. Two players were excluded due to non-compliance, resulting in a total sample of 65 players, with 5 players forming the exploratory sample and 60 players comprising the main Development sample. The researchers used the descriptive method with a comprehensive survey approach to address the research problem and achieve its objectives. Data were collected by consulting Arabic and foreign sources.

[Table 1](#) shows the details of the research sample, indicating the central and southern provinces with a total of 67 players distributed among the mentioned provinces as shown in [Table 1](#), representing 100%. The exploratory sample consisted of 5 players from Baghdad province, representing 7.46%, while the Development sample included 60 players, representing 89.55%.

Table 1. Details of the sample from the central and southern provinces.

Serial No.	Province	Numbers	exploratory	Development
1	Baghdad	20	5	15
2	Karbala	10	–	10
3	Babylon	8	–	8
4	Al-Muthana	2	–	2
5	Diyala	10	–	10
6	Al-Najaf	5	–	4
7	Maysan	6	–	5
8	Al-Basra	6	–	6
Total	8	67	5	60
Percentage	–	100%	7,46%	89,55%

1.2. Means, devices, and tools used for data collection

1.2.1. Means of data collection

Interview, questionnaire, registration forms, Arabic and foreign references and sources, the designed test, and standardized scores.

1.2.2. Devices and tools used for data collection

Tennis court, tennis balls, tennis rackets, measuring tape, HP computer, stopwatch, colored adhesive tapes, whistle.

1.2.3. Steps for designing and standardizing the test

Test Design: The researchers designed a proposed test to measure visual depth according to the technical and legal performance requirements of tennis. After presenting the test to experts and specialists in the fields of tennis, testing, measurement, and motor learning for evaluation and feedback on the following points:

1. The test truly measures the visual depth of youth tennis players under 19 years old.
2. The test is easy to perform.
3. The test is economical in terms of tools and time required.
4. The test is suitable for the research sample and their capabilities.

After collecting opinions and conducting the exploratory trial, the final version of the test was concluded.

1.2.4. Description of the final test

Test Name: Visual Depth Test in Tennis

Purpose of the Test: To measure the visual depth for forehand and backhand strokes.

Tools Used: Official tennis court, 15 tennis balls, 5 tennis rackets, Colored adhesive tape (5 cm wide) used to draw a rectangle in the middle of the court divided into 5 smaller rectangles; each area is assigned a specific letter as shown in [Fig. 1](#).

Performance Method: The player stands behind the baseline at the center of the line in a ready position. The coach stands opposite the player's hitting arm and directs the balls towards the service line. The player prepares to hit the balls directed by the coach to the service line. The player must hit the balls — alternating between forehand and backhand strokes. Before hitting each ball, the player must specify the number of the area they intend to direct the ball to. This continues until 10 balls are played. The coach prepares and throws the ball to the player's side at point T. The half-court facing the player is divided by colored adhesive tape (5 cm wide) into 4 numbered zones as follows: Zone 1, Zone 2, Zone 3, and Zone 4. Each zone measures 2.25 meters, as shown in Fig. 1.

1.3. Scoring method

1. If the ball lands inside the designated area, the player is awarded 1 point.
2. If the ball lands outside the designated area, the player scores 0 points.
3. The highest score a player can achieve is 10 points.

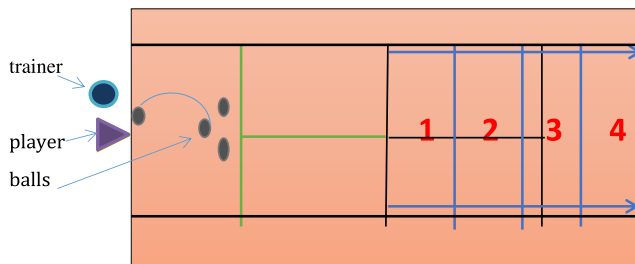


Fig. 1. Illustrates the performance method of the visual depth test for forehand and backhand strokes in tennis.

Notes:

- ✓ The symbol ● represents the tennis balls.
- ✓ The symbol ▷ represents the tennis player.
- ✓ The symbol ○ represents the coach who directs the balls onto the court.
- ✓ The squares on the right side of the court represent the designated target areas for ball placement.

1.4. Exploratory experiment

The researchers conducted the exploratory experiment on Wednesday, 27/3/2024, with a sample of 5 youth tennis players under 19 years old. The experiment was repeated less than one week later, on Sunday, 31/3/2024, using the same sample and under the same conditions. The purpose of the pilot study was to:

1. Determine the suitability of the test for the research sample.
2. Identify the adequate time needed to perform the test.
3. Detect any difficulties that the researchers and the assisting team might face.
4. Identify the necessary tools to conduct the test.
5. Establish the scientific foundations of the test.

1.5. Scientific foundations of the test

1.5.1. Test validity

Farhat (2001) defined test validity as “the accuracy in measuring what the test was designed to measure or the extent to which the test measures what it is intended to measure” (p. 111). In addition to establishing content validity by presenting the test to experts and specialists, validity was confirmed by calculating the differences between the test results of 67 youth tennis players under 19 years old and through the expert agreement rate. The results showed a 100% agreement among experts with some minor modifications.

1.5.2. Test reliability

Reliability was determined using the test-retest method. The first test was administered on Wednesday, 27/3/2024, and was repeated on Sunday, 31/3/2024, under the same conditions. The researchers calculated the correlation coefficient between the test and retest results, which indicated a high degree of reliability, as shown in Table 2.

1.5.3. Test objectivity

To verify the objectivity of the test, the researchers relied on the scorers' grades during the retest and calculated the correlation coefficient between the scorers' grades. The results showed that the test has a high level of objectivity, as indicated in Table 2. Therefore, the test is considered objective and its results cannot be manipulated. The test is also objective because it is reliable, as Khreibat (1989) mentioned: “The higher the reliability coefficient, the higher the objectivity coefficient, and vice versa.” (p. 8)

Table 2 shows the reliability and objectivity coefficients, error level, and statistical significance of the visual depth test. The reliability coefficient reached

Table 2. Shows the reliability and objectivity coefficients, the error level, and the statistical significance.

Tests	Reliability coefficient	Sig	Statistical significance	Objectivity coefficient	Sig	Statistical significance
Visual depth	886%	0,00	Significant	0,921	0,00	Significant

*Significant if sig $\leq$ 0.05.

Table 3. Shows the mean, standard deviation, and skewness coefficient for the visual depth test.

Variables	Arithmetic mean	Median	Standard deviation	Skewness coefficient
Visual Depth Test	6,24	6	0,985	0,730

Table 4. Presents the standard scores corresponding to the raw scores of the visual depth test.

Standard scores	Raw scores	Standard scores	Raw scores	Standard scores	Raw scores	Standard scores	Raw scores	Standard scores	Raw scores
80	9,18	65	7,71	50	6,24	35	4,77	20	3,3
79	9,082	64	7,612	49	6,142	34	4,672		
78	8,984	63	7,514	48	6,044	33	4,574		
77	8,886	62	7,416	47	5,946	32	4,476		
76	8,788	61	7,318	46	5,848	31	4,378		
75	8,69	60	7,22	45	5,75	30	4,28		
74	8,592	59	7,122	44	5,652	29	4,182		
73	8,494	58	7,024	43	5,554	28	4,084		
72	8,396	57	6,926	42	5,456	27	3,986		
71	8,298	56	6,828	41	5,358	26	3,888		
70	8,2	55	6,73	40	5,26	25	3,79		
69	8,102	54	6,632	39	5,162	24	3,692		
68	8,004	53	6,534	38	5,064	23	3,594		
67	7,906	52	6,436	37	4,966	22	3,496		
66	7,808	51	6,338	36	4,868	21	3,398		

0.886, with an error level of 0.00, indicating that the statistical significance is significant. The objectivity coefficient was 0.921 with an error level of 0.00, also indicating significant statistical significance.

1.5.4. Application of the test on the development sample

The test was applied on the Development sample consisting of 60 youth tennis players under 19 years old from the central and southern provinces. The testing period was from Monday, 27/5/2024 to Sunday, 2/6/2024. After two months from the first application on the same sample, the standards and levels specific to the test were established.

1.6. Verification of test validity

Difficulty and Ease Level: “A good test is one that successfully differentiates between individuals by achieving what is known as a normal curve”. To determine the sample distribution quality according to the test, the skewness coefficient was used, which recorded a value of 0.724. This confirms the normal curve for the test because “skewness in a normal curve ranges between ± 1 ” (Bahi, 1999, p. 64).

Discriminatory Ability: After collecting and processing the raw scores of the test, the scores were arranged in descending order from highest to lowest. Then, 50% of the highest scores (30 players) and 50% of the lowest scores were selected to demonstrate the test's ability to discriminate among the research sample players. The discrimination was calculated using the independent samples t-test. Statistical analysis

confirmed that the test has a strong discriminatory ability since the sig value for the calculated t was less than the significance level of 0.05.

Statistical Tools: The SPSS statistical package was used to extract the following statistical measures: arithmetic mean - Standard deviation - Simple correlation coefficient - Coefficient of variation - Independent samples t-test.

2. Results

Presentation of the standardized scores and levels for the visual depth test.

Table 3 shows that the mean score of the visual depth test reached 6.24, the median was 6, with a standard deviation of 0.985, and the skewness coefficient was 0.730. It is clear from Table 3 that the data for the visual depth test among the research sample were normally distributed.

Table 4 shows the standard scores corresponding to the raw scores of the visual depth test. The standard scores ranged from 80 to 20, while the raw scores ranged from 9.18 to 3.3, as illustrated above.

Table 5. Presents the raw scores, their ranges, and their corresponding percentages for the normative levels in the researched variables.

Very good	Good	Medium	Pass	Low	Very low
71–80	61–70	51–60	41–50	31–40	21–30
2,145%	13,585%	34,135%	34,135%	13,585%	2,145%

Raw Score Ranges and Their Percentages for the Visual Depth Test

8,298–9,18		7,318–8,2		6,338–7,22		5,358–6,24		4,378–5,26		3,398–4,28	
Numbers	%	Numbers	%	Numbers	%	Numbers	%	Numbers	%	Numbers	%
3	5%	18	30%	26	43,3%	8	13,3%	4	6,6%	1	1,6%

Table 5 shows the raw scores, their ranges, and their corresponding percentages for the normative levels of the visual depth test. The performance levels are categorized as follows: Very Good, Good, Average, Acceptable, Poor, and Very Poor. Each level corresponds to a specific standard score range—for example, the Very Good level ranges from 71 to 80, with a corresponding percentage of 2.145%. The Good level ranges from 61 to 70, with a corresponding percentage of 13.585%, and so on for the remaining levels and their corresponding percentages. As for the raw score ranges and their percentages, they follow the same performance levels but vary in exact values and distribution, as shown above.

3. Discussion

After the two researchers reached the results by applying the proposed test and to achieve the research objective of finding the standardized scores for the depth perception test, the raw data were obtained, as “it requires converting raw scores to standardized scores” (Ibrahim & Majid, 2000, p. 361), which is a means to determine the relative status of raw scores and thus these scores can be transformed and their results evaluated. Therefore, the two researchers calculated the standardized scores according to Tables 3 and 4. After statistically processing the test results and deriving them from the main experiment sample scores, the researchers were able to extract the means and standard deviations. Then, they used the method of (sequencing) to establish the standardized tables, relying on the specific relationship to find the standardized score:

Modified standardized score (TScale) = mean $\pm$ constant amount by sequencing.

The mean in this formula represents the score (50) in the standardized score tables because the modified standardized score is:

A standardized score with a mean of (50) and a standard deviation of (10) (Naji & Bastawisi, 1984: 274). The constant amount represents the number added or subtracted from the mean for each test. This method is considered one of the best methods used to find standardized scores as it provides a wider range of scores. The following explains the steps of this method (Wiley, 2010, p. 32):

Step One: Calculate the mean and standard deviation of the researched variables.

Step Two: Divide the standard deviation by (10) to obtain the constant number.

Step Three: Prepare tables for the modified standardized scores ranging from (80–20), placing the mean score opposite the number (50) in the table.

Step Four: Add the values obtained from step two, the constant amount, to the mean and to each subsequent value up to (80), and subtract the same value (constant) from the mean and sequentially down to (20), as observed in Table 4. After converting all raw scores of the indicators to standardized scores, and to complete the work phases, it is necessary to use standardized levels that agree with the nature of this study. Therefore, the researcher used the method of drawing standardized levels according to normal distributions using the natural curve (Gaussian curve) to determine the standardized levels, which “is one of the most common distributions in the field of physical education because many of the traits and characteristics measured in this field approximate the normal curve” (3).

In the normal distribution, approximately (99.72%) of cases fall within three standard deviations from the mean (4), based on units of standard deviation from the mean of those distributions in the percentage of cases falling between the standardized marks of the normal curve.

In the normal distribution, data are distributed according to the following percentages:

(68.27%) of the data fall between (mean $\pm$ 1 standard deviation)

(95.44%) of the data fall between (mean $\pm$ 2 standard deviations)

(99.73%) of the data fall between (mean $\pm$ 3 standard deviations)

Table 5 shows, by comparing the percentages achieved by the sample members in the tested exam, that the test scores were concentrated at the average and good levels as shown above, with percentages of (13.585%–34.135%) respectively.

Regarding the very weak level with a percentage of (2.145%), the weak level with (13.585%), the acceptable level with (34.135%), the average level with (34.135%), the good level with (13.585%), and the very good level with (2.145%), the above percentages approximate the ideal percentages of the area under the normal curve. The researchers consider the percentages that appeared logical because players during training units undergo various exercises that enhance their ability to perceive depth and their

ability to direct the ball to the area they specify, thus this will positively reflect on the player's scoring points.

Wasam Riyadh (2018) stated, Forms of play help develop visual and motor abilities and provide optimal responses suitable for real playing situations.

Abdel Halim Hafiz (2016) mentioned, This game is characterized by some special features, namely the small size of the ball, its fast movement, rotation, and different strokes, which means it requires a high level of visual abilities that must be developed and elevated.

4. Conclusions and recommendations

4.1. The study arrived at the following conclusions

1. The test designed by the two researchers is capable of detecting the level of visual depth perception among young tennis players under 19 years of age.
2. The research sample was distributed across six ascending levels: (very weak, weak, acceptable, average, good, very good).
3. The highest percentages in the depth perception test for young tennis players under 19 years were concentrated at the average level.

4.2. The study's recommendations can be summarized as follows

1. To adopt the current test as a tool to detect the level of depth perception for young tennis players under 19 years of age.
2. To emphasize the importance of developing visual abilities in general and depth perception in particular among young tennis players under 19 years of age.

Conflict of Interest

None.

Ethical statement

We declare that all tables included in this study are our own authorship and writing, after approval by

the scientific committee ratified by the College Council to approve the topic in November 2023.

Author's contributions

All contributions of this study were done by the researchers (Ibtisam Husham and Warda Ali) who get the main idea and work on writing and concluding also with number of experts, Ms. Sana Khalil in Statistics, Tariq Ali Yousef in revision.

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Data availability

The data that support the findings of this study are available on request from the corresponding author.

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تقنين اختبار العمق البصري المُصمم خصيصاً للاعبين التنس تحت سن 19 عاماً

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المستخلص

يقدم هذا البحث أداة مقننة ومثبتة علمياً لتقييم إدراك العمق البصري لدى لاعبي التنس الشباب دون سن 19، وذلك بهدف تمكين المدربين من إجراء تقييمات دقيقة ومستمرة للقدرات الإدراكية البصرية للاعبين أثناء التدريب والمنافسات الرسمية. وتعالج الدراسة النقص الواضح في الأدوات المعيارية المتخصصة بقياس إدراك العمق لدى لاعبي التنس في الفئات العمرية الصغيرة، وهو ما يشكل فجوة بحثية تحد من دقة التقييم وتطوير المواهب. وانطلاقاً من ذلك، قام الباحثان بتصميم وتقنين اختبار يتناسب مع هذه الفئة العمرية. وقد تمثلت أهداف البحث في تصميم وتقنين اختبار موثوق بقياس إدراك العمق البصري لدى لاعبي التنس دون 19 عاماً، ووضع معايير ومستويات معيارية يمكن اعتمادها للتقييم. واستخدم الباحثان المنهج الوصفي بأسلوب المسح لملاءمته طبيعة المشكلة البحثية. تكونت عينة البحث من 67 لاعب من محافظات الوسط والجنوب في العراق، وتم استبعاد لاعبين 2 لعدم الالتزام، ليصبح العدد النهائي 65 لاعباً. خُصص 5 لاعبين منهم للدراسة الاستطلاعية، في حين شكلت العينة الأساسية للبناء 60 لاعباً. وبعد تصميم الاختبار وتطبيقه على عينة البناء، أظهرت النتائج أن الاختبار قادر على الكشف عن الفروق في مستوى إدراك العمق البصري لدى لاعبي التنس دون 19 سنة. وبناءً على ذلك تم التوصل إلى معايير ومستويات أداء خاصة بهذا الاختبار مما يجعله أداة عملية لتطوير عمليات الانتقاء والمتابعة في لعبة التنس لهذه الفئة العمرية.

الكلمات المفتاحية: بناء الاختبارات، تقنين الاختبارات، إدراك العمق البصري، التنس للشباب