

Development of a Motor–Neural Testing System Using Motion-Tracking Technology to Measure Skill Response Speed in Volleyball for Youth Players

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Abstract: The researcher used an experimental method using a design of two equivalent groups with pre- and post-tests, as it is appropriate for the nature of the problem and aligns with the objectives of the study. The research population consisted of youth volleyball players aged (12–16 years) registered in the sports academies of Al-Anbar Sports Club, totaling (16) players. The most important conclusions were that the motor–neural exercises used in the training program significantly improved the skill response speed of the experimental group, which was reflected in their performance on the post-tests, particularly in the moving-ball response test. The motion-path tracking exercises enhanced motor accuracy and visual–motor coordination among the experimental group, leading to better execution of fundamental volleyball skills.

Keywords: Test System, Motion-Tracking Technology, Skill Response, Volleyball.

Introduction

Research Significance

A test is a presentation where responses are collected from the subject. Measured both qualitatively and quantitatively. Measurement is a collection of data of a performance or a task completed by a sports person by using scientific techniques.

It has become necessary to rely on modern assessment methods that seek to determine reaction time, as it represents one of the fundamental determinants of athletic performance, especially in sports that rely on rapid ball exchange, such as volleyball. Players must develop the ability to make decisions and respond quickly to various stimulus, including the direction of the ball and the movement of the opponent.

With latest developments in motion-tracking technologies, it became possible to collect accurate data on players' movement patterns. Hence, the importance of this research lies in the need to develop a true testing system that measures reaction time using the latest technologies, allowing researchers and coaches to analyze motor skills better.

Research Problem

The researcher observed through his experience in Volleyball the absence of a standardized, true testing system that relies on motion-tracking technology to measure skill response speed among young players. This absence limits coaches' ability to accurately assess players' performance levels and identify strengths and weaknesses.

Most youth players suffer from deficiencies in several perceptual abilities related to the game—such as perception of distance, time, force, and direction—which negatively affect their motor response speed when performing skills. Therefore, the researcher sought to develop a motor–neural testing system using motion-tracking technology to measure skill response speed among youth volleyball players.

Research Objectives

1. To design a testing system based on motion tracking for measuring skill response speed among youth volleyball players.
2. To identify the level of skill response speed among youth volleyball players.
3. To determine the relationship between the indicators of the tracking system and the technical performance level of youth volleyball players.

Research Hypotheses

There are statistically significant differences attributed to the impact of the proposed system on measuring skill response speed among youth volleyball players, in favor of the experimental group (Mohammed Hammood et al, 2025) (Mohammed et al, 2025) (Omar et al, 2025).

Methodology

Research Method

The researcher employed the experimental method using a design of *two equivalent groups with pre- and post-tests*, as it is appropriate for the nature of the problem and aligns with the objectives of the study.

Research Population and Sample

The research population consisted of youth volleyball players aged (12–16 years) registered in the sports academies of Al-Anbar Sports Club, totaling (16) players.

Table 1. Description of the Research Sample

Variable	Unit of Measurement	Mean	Standard Deviation
Age	years	13.55	1.2
Height	cm	159.2	6.74
Weight	kg	59.88	5.31
Training Years	years	3.44	1.6

Tools and Devices Used in the Study

1. Two-dimensional motion-tracking system (IMU – Optical).
2. High-resolution camera installed in the volleyball court.
3. Video-analysis software for determining response time and movement speed.
4. Technical performance evaluation form (attached as an appendix).

Research Tests

1. Moving Ball Response Test:
 2. Measures motor and skill response speed when facing a suddenly moving ball, and the player's ability to make decisions and execute an appropriate skill.
3. Visual and Auditory Response Test:
 4. Measures motor response speed to visual or auditory stimuli and the player's ability to differentiate stimulus type and select the proper response.
5. Movement Path Tracking Test:
 6. Measures the player's ability to follow a defined path with speed and accuracy using hand or body movements, while recording errors, deviations, and performance time.

Pre-Tests

Pre-tests were administered on 6/2/2025 at Al-Anbar Sports Club volleyball court at 10:00 a.m, where the proposed skill tests were conducted.

Training Exercises Used in the Study

The researcher prepared a set of exercises directly related to the tests (Moving Ball – Visual & Auditory – Movement Path Tracking).

First: Exercises Related to the Moving Ball Response Test

1. Multidirectional Ball Reaction.
2. Unexpected ball from behind the screen.

Second: Exercises for Visual and Auditory Response

1. Light Reaction Drill.
2. Sound Cue Drill.

Third: Exercises Related to Movement Path Tracking

1. Ladder Track.
2. Movement-path tracking using the ball.

Main Experiment

The main experiment was conducted from 9/2/2025 to 9/3/2025 on the volleyball court of Al-Anbar Sports Club. The exercises designed by the researcher were administered to the experimental group as shown in the table below:

Table 1. The main experiment

Day	Type of Exercise	Number of Sets	Duration
First	Moving Ball + Paths	4 sets	25 minutes
Second	Visual + Auditory	6 sets	30 minutes
Third	Motor Paths + Skill Integration	4 sets	25 minutes

Post-Tests

Post-tests for both groups were administered on 31/10/2025 at Al-Anbar Sports Club volleyball court.

Statistical Methods

The Statistical Package for Social Sciences (SPSS) was used (Abdullateef Abduljabbar et al, 2025) (Fayyad et al, 2025) (Khalaf et al, 2025).

Result and Discussion

Table 2. Control Group

Tests	Pre-test (Median / IQR)	Post-test (Median / IQR)	Wilcoxon Value	Sig. Level	Significance
Moving Ball Response	2.33 / 0.32	2.12 / 0.22	1.13	0.22	Not significant
Visual–Auditory Response	0.462 / 0.050	0.399 / 0.27	1.31	0.29	Not significant
Movement Path Tracking	58 / 4.8	62 / 3.4	1.36	0.21	Not significant

Table 3. Experimental Group

Tests	Pre-test (Median / IQR)	Post-test (Median / IQR)	Wilcoxon Value	Sig. Level	Significance
Moving Ball Response	2.87 / 0.36	2.03 / 0.14	2.42	0.01	Significant
Visual–Auditory Response	0.487 / 0.031	0.363 / 0.04	2.86	0.03	Significant
Movement Path Tracking	60 / 4.7	66 / 3.5	3.15	0.02	Significant

Table 4. Comparison Between the Two Groups

Tests	Experimental Group (Median / IQR)	Control Group (Median / IQR)	Mann–Whitney Value	Sig. Level	Significance
Moving Ball Response	2.03 / 0.14	2.12 / 0.22	9.1	0.18	Significant
Visual–Auditory Response	0.363 / 0.04	0.399 / 0.27	8.77	0.13	Significant
Movement Path Tracking	66 / 3.5	62 / 3.4	12.1	0.06	Significant

Conclusions

1. The motor–neural training used in the program demonstrated a clear ability to improve reaction time among the experimental group, which was reflected in their after-test performance—especially in the moving-ball response test.
2. Training based on visual and sound stimuli contributed to improving the players' sensory–neural processing efficiency, resulting in a reduction in their reaction time compared to the control group.
3. Movement-path tracking exercises helped develop motor precision and visual–motor coordination among the experimental group, which led to enhanced efficiency in performing fundamental volleyball skills.
4. Integrating perceptual–motor training with reaction time training provided players with better opportunities to build many motor programs within a single skill situation, making it easier for them to cope with fast changes during volleyball.

Recommendations

1. Highlight the importance of training players to develop fast responses to visual and sound stimuli, as these represent important components influencing the quality of making decisions during the game.
2. Emphasize implementing integrated exercises that combine sensory reception of stimuli with good motor responses, preferably performed in open environments that simulate playing conditions.
3. Urge the design of new training exercises that simulate real-game scenarios in volleyball, making players develop flexible motor programs capable of adapting to changing situations.

Adopt motor–neural tests (path tracking, ball response, visual and sound response) as assessment tools to measure the development of the play, reinforce strengths, and weakness areas.

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