International Journal of Physiology, Health and Physical Education

ISSN Print: 2664-7265
ISSN Online: 2664-7273
Impact Factor: RJIF 8.16
IJPHPE 2026; 8(1): 01-06
www.physiologyjournals.com
Received: 02-11-2025
Accepted: 05-12-2025

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The effect of exercises using a ball launcher on developing cognitive speed and the accuracy of shooting skills in 14-year-old football players

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DOI: https://www.doi.org/10.33545/26647265.2026.v8.i1a.148

Abstract
The Effect of Training Using a Ball-Launching Machine on the Development of Perceptual Speed and Shooting Accuracy in Football Players Aged 14 Years.

This study examines the effect of training using a ball-launching machine on the development of perceptual speed and the accuracy of shooting performance among football players aged (14) years. This stems from the importance of these variables in improving the skill performance of young players, particularly as perceptual speed is considered one of the vital indicators of response speed and decision-making in various game situations.

The significance of the research lies in the need to adopt modern training aids such as the ball-launching machine, which provides game-like situations similar to real training environments and relies on accurate visual processing and rapid motor response. The use of this device also increases the player's perceptual load, enhancing concentration and contributing to the development of skill abilities, especially in situations that require quick decision-making and shooting accuracy.

The researcher adopted the experimental method to identify the effect of these exercises. The research population consisted of players aged (14) years. The initial sample included (30) players, of whom (10) were excluded due to commitment issues or injury, resulting in a final sample of (20) players. The sample was divided into two groups: an experimental group that underwent a training program using the ball-launching machine for a period of (8) weeks, and a control group that received the traditional training program adopted by the academy.

The results of the study showed a clear and statistically significant improvement among members of the experimental group in the variables of perceptual speed and shooting accuracy compared to the pre-test measurements, indicating the effectiveness of exercises using the device in developing perceptual and skill-related responses associated with shooting performance.

These findings confirm that the ball-launching machine contributes to enhancing visual processing speed, reducing response time, and increasing the accuracy of skill execution among youth players, thereby raising their performance level in real game situations and improving opportunities for achieving sporting success.

The researcher recommends integrating the ball-launching machine into youth training programs and adopting it as an effective auxiliary tool for coaches to develop perceptual and skill variables, achieving integration between perceptual and motor aspects and contributing to the improvement of technical performance in football.

Keywords: Ball-launching machine, Perceptual speed, Shooting accuracy, Youth football players, Training aids

Introduction

In light of the rapid development in sports training methods, the development of perceptual abilities in football players has become one of the essential elements relied upon by coaches and researchers, especially among youth players aged (14) years. This age stage is considered a sensitive period that requires special attention to developing perceptual and skill-related aspects due to their direct impact on building the player's technical and physical foundation for the future [9].

In this context, modern training devices, including the ball-launching machine, have gained increasing importance as training aids that simulate real game situations. These devices contribute to enhancing visual processing, increasing response speed, and raising the perceptual load on the player, which in turn improves the accuracy of skill execution.

Based on this importance, the present study, entitled "The Effect of Exercises Using a Ball-Launching Machine on Perceptual Speed in Football Players Aged 14 Years," aims to identify the effectiveness of using this device in developing perceptual speed and the accuracy of shooting performance among youth football players [6].

Research Problem

Football is one of the team sports characterized by high speed of performance and a variety of constantly changing situations, which require the player to simultaneously combine physical, technical, and perceptual abilities. This is particularly evident when performing decisive skills such as shooting, which represents the primary objective and the final outcome of all actions during a match. A player's success in this skill largely depends on the speed of perceiving various stimuli on the field, as well as the ability to select the appropriate motor response and execute it with high accuracy in a short time [3].

However, it is observed that most training programs directed at grassroots players in football schools and academies rely on traditional methods that focus on repetitive direct skill performance, especially in shooting, without giving sufficient attention to developing the perceptual abilities accompanying these skills. This training pattern leads to a deficiency in the player's speed of perceiving changing game situations, and consequently to weaker response speed and lower accuracy of performance during actual matches.

In light of the technological development witnessed in the field of sports training, modern devices such as the ball-launching machine have emerged, providing diverse and stimulating playing situations and helping to increase the number of repetitions under conditions similar to those of a match. (7)In addition, these devices play a role in stimulating the neuromuscular system of the player, which contributes to developing perceptual speed and improving performance accuracy. Nevertheless, field observations of teaching and training programs for grassroots players in football schools and academies indicate limited use of such modern training aids, which may deprive players of advanced educational and training opportunities that could enhance their technical and perceptual levels [10, 1].

Accordingly, the research problem emerges from the need to study the effect of exercises designed using a ball-launching machine on the development of perceptual speed among football players aged (14) years, in order to answer the following question:

What is the effect of exercises using a ball-launching machine on the development of perceptual speed in football players aged (14) years?

Research Objectives

1. To identify the level of perceptual speed in football players aged (14) years.
2. To design exercises using a ball-launching machine to develop perceptual speed in football among the research sample.
3. To determine the effect of the exercises used on developing perceptual speed in football among the members of the research sample.

Research Hypotheses

There are statistically significant differences between the results of the pre-test and post-test in perceptual speed, in favor of the post-test, among football players aged (14) years.

Research Fields

1. **Human Scope:** A sample of players from the Amo Baba Football School aged (14) years.
2. **Spatial Scope:** Al-Shaab International Stadium.
3. **Temporal Scope:** The study period extends from 21/2/2025 to 29/4/2025.

Research Methodology

The research method used in this study is the experimental method, specifically the one-group experimental design (experimental group) with pre-test and post-test measurements, as follows:

1. The researcher relied on a single experimental group of football players aged (14) years.
2. A pre-test was conducted for the research variables (perceptual speed).
3. A training program using a ball-launching machine was then applied to the members of the group.
4. A post-test was conducted for the same variables.
5. A comparison was made between the results of the pre-test and post-test to determine the effect of the exercises.

Research Population and Sample

The research population consists of all football players aged (14) years affiliated with the Ministry of Youth and Sports (Amo Baba Academy). The researcher selected a sample from the Amo Baba Football School. The total initial research sample included (30) players; (5) players were excluded due to lack of commitment, and another (5) players were excluded due to injuries. Accordingly, the final research sample consisted of (20) players.

These players were subjected to both pre-tests and post-tests to determine the effect of exercises using a ball-launching machine on perceptual speed.

Devices and Tools Used in the Research:

The researcher relied on a set of devices and tools to conduct the experiment, apply the exercises, and collect data. These included the following:

1. Devices

a) A ball-launching machine (Ball Shooting Machine), used to apply the specific exercises and to develop perceptual speed and shooting accuracy.
b) A stadiometer for measuring players' heights in centimeters.
c) An electronic scale for measuring players' weights in kilograms.
d) A digital stopwatch for measuring the times related to the tests.
e) A laptop computer and statistical software for data processing and analysis.

Equipment

A. Regulation footballs compliant with international specifications.
B. A legal football goal (colored and mounted on a wooden board).
C. Cones/markers for defining performance areas and organizing drills.
D. Forms for recording results and field observations.
E. Pens, papers, and supporting office supplies.

3. Perceptual Speed Test

A. Test Name

Visual Reaction to Movement Test (Reaction Time Test) - Franciscus Donders

B. Purpose of the Test

To measure the players' perceptual reaction speed when facing visual stimuli related to football, such as an incoming ball or the coach's movement, and to determine the speed of decision-making and execution.

C. Equipment Used

1. Ball launching machine.
2. Digital stopwatch or electronic timing device.
3. Cones to mark the player's starting and ending points.
4. Result recording forms.

D. Test Procedure

1. The player stands at the starting point facing the goal or a designated area.
2. The ball launcher releases a colored ball.
3. The player must respond quickly by performing a specified action (such as moving toward the ball or shooting at the goal).
4. The test is repeated several times (3 trials for each player) to reduce error and increase measurement accuracy.
5. The device is placed outside the penalty area at a distance of 16-26 meters from the goal.

E. Scoring

1. Record the time elapsed from the moment the ball is launched or the visual signal appears until the player begins the correct movement.
2. Calculate the average time for each player as a measure of perceptual speed.

Pretests

Before implementing the training program using the ball-launching machine, the researcher conducted pretests on all players in the sample on Tuesday (25/2/2025) to determine the baseline level of each player in the dependent research variables, namely perceptual speed.

Main Experiment

After completing the pilot study and conducting the pretests on all players in the sample, the researcher proceeded to implement the main experiment on the experimental group consisting of 20 players.

A. Objectives of the Main Experiment

1. To study the effect of exercises using the ball-launching machine on the players' perceptual speed.
2. To compare the post-test results with the pre-test results in order to determine the effect of the training program.

Procedures of the Main Experiment

1. The training program was divided into organized sessions, with each session including a specific number of exercises using the ball-launching machine.
2. The experiment lasted for a specified period (three sessions per week, with each session lasting 45 minutes).
3. The exercises were applied in the same manner to all players, while ensuring uniform environmental conditions and testing equipment.
4. After the completion of the training period, post-tests were conducted on all players using the same procedures as the pretests.

Posttests

After the completion of the training period using the ball-launching machine as part of the main experiment, the researcher conducted posttests on all players in the experimental group to measure the effect of the training program on the dependent variables, namely perceptual speed [2].

Table 1: Shows the values of the means and standard deviations for the cognitive speed variable

Variables	Unit of Measurement	Test	Mean	Sample Size	Standard Deviation	Standard Error
Cognitive Speed Test	Second	Pre-test	7.3365	20	.70620	.15791
		Post-test	5.7460	20	.45303	.10130

It can be seen from Table (4), which presents the values of the means, standard deviations, and standard errors for the pre-test and post-test, as well as the level of development for the cognitive speed variable:

The mean value for the cognitive speed variable in the pre-test was 7.3365, with a standard deviation of 0.70620 and a standard error of 0.15791, whereas the mean value in the post-test was 5.7460, with a standard deviation of 0.45303 and a standard error of 0.10130. (4)

The translation into English is:

Table 5: Shows the means, standard deviations of the differences, standard error, and the calculated (T) value for the cognitive speed variable for the research sample.

Variables	Mean Difference	Standard Deviation of the Differences	Standard Error of the Differences	T-valu	Error Rae	Significanc
Cognitive Speed Test	1.59050	.54426	.12170	13.069	.000	Statistically significant

The results of Table (5) show the presence of statistically significant differences between the pre-test and post-test results for the experimental group, in favor of the post-test for the cognitive speed variable. The mean difference for the cognitive speed test was 1.59050, with a standard deviation of 0.54426 and a standard error of 0.12170. The calculated T-value was 13.069, and the significance value was Sig = 0.000, which is less than the adopted significance level (0.05). This indicates clear and significant differences between the pre-test and post-test in favor of the post-test.

This improvement in performance can be attributed to the effectiveness of the device used (ball launcher), which is considered a modern training tool that allows the coach to monitor the player's performance during execution without being occupied with manually returning the ball or organizing the training setup. The device also helped

increase the number of attempts within a short period, consistent with the principle of intensive practice, contributing to enhancing learning and consolidating skill performance among the players [25].

The researcher also notes that employing this training aid clearly contributed to improving both the speed and accuracy of shooting in its various forms (ground shots, half-volley, and direct volleys), making performance more focused and closer to automatic execution, with a noticeable reduction in the rate of errors committed [5, 18, 15].

The results of the cognitive speed test showed a clear improvement between the pre-test and post-test, as the mean response time decreased from 7.3365 seconds to 5.7460 seconds, a reduction that is statistically significant at the 0.05 level. This decrease reflects an enhancement in the players' ability to perceive and respond to visual stimuli associated with game situations more quickly. This improvement can be attributed to the nature of the exercises using the ball launcher, which provided a stimulating training environment and contributed to enhancing neuromuscular efficiency while reducing motor latency when responding to unexpected stimuli [22].

The development in cognitive speed is closely related to the principles of motor learning. Repeated exposure to visual stimuli such as balls projected at varying speeds and angles enhances neural processing speed and improves decision-making ability. This improvement aligns with the literature in sports training, which emphasizes that rapid response to stimuli is a key factor in enhancing skill performance in football, particularly among younger age groups, who are in a sensitive stage for developing cognitive and motor abilities [14].

The results indicate that the improvement in cognitive speed (from 7.33 seconds to 5.74 seconds) represents a significant development in one of the most important components of football performance [13]. Young players heavily rely on the speed of perceiving visual stimuli (ball movement, coach signals, opponent positioning) before making the appropriate decision. Successful shooting at the goal depends not only on physical and technical abilities but begins with a precise cognitive stage that precedes execution. This aligns with Enoka (2016) [25], who noted that "the speed of sensorimotor perception forms the primary foundation for any successful skill performance."

The aim of using such devices is to achieve the highest possible speed and accuracy in performance. Therefore, it is essential to balance both speed and accuracy to reach their optimal levels [19]. This can be done by gradually increasing speed while focusing on maintaining the achieved accuracy, enabling players to perform at maximum speed and precision [11].

The researcher believes that the significant reduction in cognitive response time can be explained by neural adaptations resulting from repeated training. A player who is consistently exposed to sudden visual stimuli, such as balls projected by the device, becomes more capable of shortening neural processing time in the central nervous system, activating neuromuscular pathways more quickly, and reducing motor latency before initiating movement. This explanation aligns with Roca *et al.*, who stated that repeated training under conditions similar to competition enhances the efficiency of neural pathways, thereby improving motor responses.

Introducing sudden stimuli or unexpected scenarios in training effectively stimulates players to respond quickly and accurately. These situations help players anticipate the required action, act rapidly, maintain continuous attention, mental alertness, and make precise decisions [24]. This aligns with the findings of Shaimaa Ali Khamis and Raed Abdul Amir Abbas, who explained that decision-making accuracy depends on two main factors: first, the precise identification of the stimulus, which provides the necessary diagnostic information for an appropriate response, and second, the stored information in memory, representing the individual's previous experiences. The more accurate and diverse the stored information, the greater the player's ability to select the most suitable and precise motor response [21]. Thus, these training stimuli prepare the player in terms of positioning and timing, positively impacting performance quality, response speed, and decision accuracy in dynamic game situations.

This is consistent with Shamedt (2000), who emphasized that there must be harmony between the stimulus and the response in performing sports skills during critical game situations, which require rapid responses and precise execution by anticipating immediate and fast events during play [16].

Cognitive speed relies heavily on visual perception, including the ability to visualize shapes, perceive relationships between them, and quickly and accurately distinguish their direction. Visual perception works in parallel with visual memory, enabling the cognitive analysis of stimuli, distance perception, and spatial relationships between stimuli, which depends entirely on visual function and memory.

Training conditions should be designed to simulate or exceed the difficulty of actual match conditions to achieve the highest training effect. To accomplish this, the coach must expose the player to diverse training scenarios that require speed and accuracy in observing and interpreting stimuli. Early perception of these stimuli allows the player to determine the most appropriate motor action at the right moment, enhancing skill performance. With repeated training scenarios, players accumulate experience, becoming more sensitive to stimuli and faster in perceiving dynamic situations during competition. The use of tools and training aids plays a significant role in developing spatial and temporal awareness, which are essential indicators of cognitive-motor skill development. Continuous training also enhances ball sense, a specific type of precise observation and high control, enabling the player to handle the ball with expertise and efficiency while accurately perceiving its characteristics and behavior during play [12, 17].

These results align with Chmura *et al.* (2018) [30], who highlighted the importance of cognitive response speed in improving tactical and skill performance in football, noting that players with faster cognitive responses demonstrate higher accuracy in passing and shooting under pressure. Similarly, Andrew, M., McRobert *et al.* (2021) [22] confirmed that developing decision-making speed is directly related to improving technical performance in offensive skills.

Bilal Khalaf (2011) indicated that the use of training devices effectively enhances trainees' skills and diversifies their knowledge sources. These devices also increase players' cognitive awareness, attention, and mental visualization

capacity while improving their ability to make appropriate reactions in changing game situations [20].

It can be concluded that cognitive speed reflects the rapid transfer of sensory information from the environment to the brain, while stored information and prior experiences form the link between perception and action, which is the essence of motor intelligence. In this context, intelligence is the speed of perceiving stimuli and connecting them to stored experiences to make the appropriate decision. Thus, intelligence and cognitive speed are interdependent processes; the presence of intelligence is essential for cognitive speed, whereas its absence leads to weakness or lack of speed.

Ya'rub Khayoun (2006) [21] stated that repeating responses to the same stimulus accelerates decision-making, reduces reaction time, and increases response speed. He added that having accurate information and varied stored motor programs enables individuals to select the most precise and suitable response for a situation, reflecting the close relationship between repeated learning, cognitive experience, and motor performance speed.

Arslan, C. *et al.* (2021) [24] noted that ball-launching devices allow players to repeatedly practice specific scenarios, helping them develop technical skills and tactical awareness under conditions similar to match demands. This repeated exposure positively impacts the development of cognitive abilities, such as anticipation and decision-making [24].

Mohammed Al-Obaidi (2009) [17] indicated that "using devices and tools in a way that matches learners' levels encourages them to exert maximum effort, increases their motivation to apply what they learn, and presents educational situations in various forms that require them to remain alert and responsive."

Arslan, C. *et al.* (2021) [24] noted that "modern ball-launching systems can be programmed at different speeds, angles, and frequencies, allowing for individualized and progressive training programs aimed at developing cognitive speed and anticipation in a controlled training environment." Using the ball launcher provides a training environment characterized by repetition, precision, and gradual difficulty something difficult to achieve through traditional methods [23]. The ability to control the ball's speed and launch angle makes training scenarios very close to competitive reality. Andrzejewski *et al.* (2016) [23] emphasized that players exposed to match-like situations during training achieve higher levels of neural and skill adaptation compared to routine training.

Conclusions

In light of the results obtained by the researcher, the following conclusions were reached:

1. Exercises using the ball-launching machine proved effective in developing perceptual speed among football players, reflecting an improvement in the speed of processing visual stimuli related to game situations and in decision-making at the initiation of motor execution.
2. The use of the device achieved the principle of training specificity by controlling the speed, angle, and direction of the ball, thereby providing progressive and varied situations that enhance motor learning and stabilize skill patterns.
3. The device provided a controlled training environment that enabled the coach to monitor performance, deliver immediate feedback, and reduce unwanted variability in training conditions, which was reflected in greater performance consistency.
4. The adoption of organized repetition of attempts within a short time contributed to improving learning quality, while maintaining player focus and reducing common execution errors.

Recommendations

In light of the research conclusions, the researcher recommends the following:

1. Adopting the ball-launching machine within youth training units for shooting skills, with the design of clear protocols for ball speed, delivery angles, and progressive difficulty.
2. Integrating perceptual speed exercises (responses to visual/motor stimuli) into training programs and directly linking them to applied attacking skills such as shooting and finishing attacks.
3. Applying the principle of organized repetition while varying situations (different speeds, multiple angles and distances, and target-specific zones) to ensure skill stabilization and expand motor alternatives.
4. Using the device as a tool for objective evaluation in pretests and posttests, ensuring controlled measurement conditions and enhancing the validity of results.
5. Training coaches to analyze real-time performance and provide constructive feedback during the use of the device, while documenting technical observations for each player to support individualized follow-up.

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