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ORIGINAL RESEARCH

Does training with visual occlusion improve technical skills in Under-14 football players?

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Abstract

Background: Visual occlusion reduces players' field of vision and directly affects their physical, technical and positional performance. Therefore, it is important to understand how visual perception is affected, and whether training with visual occlusion leads to an improvement in performance. **Objective:** This study aimed to examine whether training with visual occlusion could improve technical skills in young football players. **Methods:** Thirty male Under-14 amateur football players were randomly assigned to a visual occlusion group (OCC; n = 15) and a control group (CON; n = 15). In addition to the conventional training program, the OCC performed visual occlusion training sessions using spatial occlusion goggles that removed the sight of the participants' limbs and lower body. The CON performed only the conventional training program. The study consisted of a pre-test, two months of training intervention and a post-test. Contextualised technical skills were tested using the Loughborough Soccer Passing Test. **Results:** Both OCC (p = .21) and CON (p = .43) did not change Trial performance. However, the OCC experienced small-to-moderate improvements in Penalty time (p = .002; d = 0.51, 95% CI [0.10, 0.70]) and Global performance (p = .005, d = 0.44, 95% CI [0.05, 0.66]). The CON did not show changes in Penalty time (p = .61) and Global performance (p = .89) variables. A significant moment × group interaction was found in Penalty time (p = .016, η_p^2 = .19, 95% CI [.03, .48]) and Global performance (p = .011, η_p^2 = .21, 95% CI [.01, .45]). **Conclusions:** The OCC has shown a significant reduction in the amount of time required to complete the trial and the Penalty time. These results suggest that incorporating visual occlusion as a paradigm into a training program for football players may positively impact their technical skills.

Keywords: youth football, technical skills, visual occlusion, performance

Introduction

Football is a visually complex sport that involves different skills, for the most part dynamic, in which the visual function must operate in conditions of movement (Erickson, 2007). Footballers must often react to situations that change very quickly. Therefore, they should be prepared to make immediate decisions (Alesi et al., 2015). For this reason, training visual skills starting from youth categories can be very useful for progressively optimising players' choices and thus rationalising their actions in space (Wein, 2007). It must be considered that visual skills training also helps to calculate the trajectory of the ball better or to see the movements of teammates and opponents. This type of training improves peripheral vision, reaction times, and, most importantly, the ability to stay focused for the entire duration of a match (Dal Zotto, 2017). In this context, training with visual occlusion (blocking part of an athlete's vision while performing a skill) appears to help improve sport-specific skills (Mann et al., 2010). The ability to perform a skill without looking at the ball allows athletes to visually scan the environment, informing themselves about the most appropriate next action (Müller et al., 2017). To date, available research has applied visual occlusion to describe the identification of information sources and control processes for sports performance (Murgia et al., 2014).

Vision occlusion is typically classified as temporal or spatial occlusion (Nimmerichter et al., 2016). Traditionally, temporal occlusion removes or masks visual information over different time periods. In contrast, spatial occlusion removes only specific sources of information from the visuomotor workspace, such as a limb or tool (Vickers, 2007). It is essential to note the dominance of the temporal occlusion paradigm in the literature and the distinct lack of spatial occlusion research (Dunton, 2020). The research has mainly focused on the impact of video-based temporal occlusion on anticipation and decision-making skills (Mann & Savelsbergh, 2015). However, despite the suggestion that the video simulation approach is valid and reliable, it is important to note that it is more beneficial to perform these tasks in the applied setting as occurs in the paradigm of spatial occlusion (Müller & Abernethy, 2014).

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The spatial occlusion paradigm involves the use of spatial occlusion goggles (SOG) that block the athlete's vision of their extremities (i.e., arms and legs, while maintaining their vision straight ahead; (Dunton et al., 2020). A specific study on football (Dunton et al., 2019) assessed the impact of spatial occlusion on receiving and passing while concurrently calling a series of randomly generated numbers placed in front of participants. The authors found that the players may excessively look down during the initial wearing of the occlusion goggles or experience a decline in control abilities. However, this effect will dissipate as players become accustomed to the occlusion training and begin to guide their visual attention upward while performing the motor task. The benefit of spatial occlusion becomes evident once full visual conditions are returned, as evidenced in this study, where participants increased their passing performance while improving visual attention upward.

Although spatial occlusion research has provided a basis for understanding how athletes use visual information to identify the outcomes of particular sports tasks such as passing on overall performance in football (McGuckian et al., 2019), there is a paucity of research investigating the capabilities of spatial occlusion as a training tool.

Based on the current state of the art, this study aimed to examine whether spatial occlusion training improves technical skills in young football players. It was expected that the visual occlusion group (OCC) would experience an improvement in response accuracy and a reduction in response time and the number of errors once full visual conditions were returned. We hypothesised that through the use of SOG, there could be a significant improvement in the technical passing skills of the players of the OCC compared to the players of the control group (CON).

Methods

Participants

Thirty male Under-14 amateur football players who belonged to the same team competing at the regional level, coached by one of the study's authors, were randomly assigned to either the OCC or the CON. Both the OCC (n = 15, age 12.6 ± 0.4 years; height 170.5 ± 3.0 cm, weight 60.6 ± 3.8 kg) and the CON (n = 15; age 12.7 ± 0.4 years, height 170.7 ± 3.1 cm, weight 60.4 ± 3.6 kg) had an equal number of players from each position (6 defenders, 5 midfielders and 4 forwards). Each participant had a normal or corrected-to-normal vision and about 6 years of experience in the sport. The tool used to generate the randomization of the athletes was the TIPS Evaluation Framework, an acronym for the four criteria on which it is based: Technique, Intuition, Personality and Speed (Unnithan et al., 2012). Each of the four characteristics of the TIPS must be assigned a value from 1 to 10 (Jokuschies et al., 2017). Although the two groups were characterized by the same number of players from each position, the purpose of randomization was to ensure the constitution of groups was overall homogeneous based on the score derived from the TIPS. The average TIPS score for each group was shown in Table 1. The experimental procedure, risks and benefits were explained to the parents before participation. Informed consent was signed by the subjects' parents or legal guardians. The study adhered to the ethical code of the Declaration of Helsinki (1964), and procedures were in line with established ethical standards in sports sciences (Winter & Maughan, 2009). The study was approved by the institutional review board of Pegaso University of Naples (decision no. 2023-01).

Design

A study design was employed to test the difference in technical skills between the two groups over time. The pre-test was carried out in October, while the post-test was carried out after two months (in December). In addition to the conventional training program, the OCC performed visual occlusion training sessions using SOG that removed the sight of the participants' limbs and lower body. The SOG are produced by the American brand SKLZ and feature an adjustable elastic strap and soft flexible plastic rims for a comfortable fit.

The CON performed only the conventional training program following the indications provided by the Territorial Development Program coordinated by the Youth and School Sector, to which the club adhered (Madonna & Iovino, 2018). This program's primary objective is to propose a methodology that can create an environment where each player can express himself at best. It is described in the section on the conventional training program.

Conventional training program

All training sessions to which the two groups were subjected lasted on average 75 minutes, and the training frequency was three times a week over two months. All sessions were aimed at consolidating technical skills and decision-making. They included the following exercises: functional technique, position and possession games, small-sided games, body stability, agility, and coordination. A detailed description of the training sessions performed by the CON is reported in Table 2.

Visual occlusion training sessions

The visual occlusion training sessions were carried out only by the OCC. Each session lasted on average 75 minutes, performed twice a week with two days in between, for two months. Each session involved the following stages: 10 minutes of warm-up, 60 minutes of the central training phase divided into three parts (individual skills, technique and 1 vs. 1 drills, opposition games such as 3 vs. 3 or 5 vs. 5), and 5 minutes of cool down. The players of the OCC used SOG applied to the nose and cheekbones

Table 1 TIPS score evaluation for both groups

	OCC (n = 15)	CON (n = 15)
Technique	6.0 ± 0.7	6.0 ± 0.4
Intuition	6.2 ± 0.4	6.2 ± 0.4
Personality	6.5 ± 0.7	6.4 ± 0.5
Speed	6.6 ± 0.6	6.7 ± 0.6
Total score	6.3 ± 0.7	6.3 ± 0.6

Note. OCC = visual occlusion group; CON = control group.

during the session. They were placed perpendicular to the face and completely blocked the view around the feet at about 100–150 cm. The players were practically unable to look at their feet and the ball. While wearing the goggles, players were encouraged to perceive the surrounding space by paying attention to details.

The warm-up phase included 4 minutes of dynamic stretching, 15 reps per leg of foot lunge with rotation, 4 mini sprints with 30-second reps or dribbling with the ball to get used to using the SOG. The warm-up phase also included a 6-minute of a football structured game to improve motor awareness, control and coordination without stretching (Chaouachi et al., 2017). This game included 3 teams of 5 players each.

The main exercise phase allowed players to progress from simple to complex exercises and from low to high intensity. These included small-sided games to improve individual play techniques and develop the creativity of youth players. The consistent use of these drills over several weeks will likely promote changes in players' tactical or technical skills (Práxedes et al., 2018) or their fitness status (Clemente et al., 2021). Indeed, these drills may apply a multidimensional stimulus to players (e.g., technical/tactical, physiological/physical) while keeping them attentive to specific tactical aspects of the game (Ometto et al., 2018).

The cool-down phase consisted of stretching exercises where the main topics of the session were discussed. Sessions were multipurpose to develop different aspects of the game in the same session.

Loughborough Soccer Passing Test

To obtain an objective measure of short-passing ability, the first version of the Loughborough Soccer Passing Test (LSPT) was used (Ali et al., 2007). The LSPT was aimed at assessing the ability of the players to perform repeated, as accurate as possible passes in a "stressful"/time-limited situation. All players were already familiar with the testing procedures as part of their usual technical skill assessment program. The players' attention was focused on making the passes in the indicated area and on good space-time skills.

A rectangle of 12 (length) × 9.5 (width) meters includes two additional rectangles inside, one of 4 × 2.5 m and 2.5 × 1 m, so a 0.75 m wide corridor surrounds the smaller rectangle. The cones were placed at each corner of the central rectangles and in the centre of the smaller rectangle. On the outermost perimeter, in the central area of each side, there was a 2.5 m long and 30 cm high rectangle, with a 1 m extended coloured area in the middle. A target consisting of a 30 cm wide metal plate was placed inside a target area (60 × 30 cm). The test aimed to perform 16 passes, 8 over 3.5 m towards the long sides of the outer rectangle (red and white colours) and 8 over 4 m toward the short sides (blue and green colours) attempting to hit the metal. The test requires two operators, one controlling the time, the other indicating the target that the player must hit with the ball, calling a colour with a predetermined sequence. The colour was randomly defined so that the players were unaware of the succession of targets. The players were required to pass the ball throughout the corridor between the two internal rectangles. After bouncing off the coloured rectangles, the ball had to return to the central cone before being kicked against a new target called by the operator. The test began with the player entering the corridor and ended after completing the 16 passes in 43 seconds.

The same trained observer measured the test's performance using a stopwatch to avoid the inter-evaluator error. The following penalties/bonuses were applied to the time recorded:

- penalty 5 seconds if the player did not hit the rectangle or hit the wrong rectangle,
- penalty 3 seconds if the player touched the ball with his hands,
- penalty 3 seconds if the ball did not hit the target area (69 × 30 cm),
- penalty 2 seconds if the ball was not kicked in the corridor,
- penalty 2 seconds if the ball hit one of the cones,
- penalty 1 second for every second more than the maximum time of 43 seconds,
- bonus 1 second for each hit on a metal target.

The test was repeated in December and January. Players' performances were measured through three variables:

1. Trial, defined as the total time taken to complete 16 passes.
2. Penalty time, defined as the time resulting from the calculation of penalties and bonuses (penalties involved an increase in time, while bonuses involved a reduction in time).
3. Global performance, defined as the total time calculated from the sum of the Trial and Penalty time variables.

Statistical analysis

The normality of the data was verified using the Shapiro-Wilk test. An independent-sample *t*-test was performed to

Table 2 Conventional training program performed by both groups

Month	Technical objectives	Individual tactical objectives	Collective tactical objectives	Physical objectives
November	Ball conduction Ball possession Passes Dribbles Shots on goal	Defensive principles for 1 vs. 1 and 2 vs. 2 Marked/unmarked How to pressure and intercept the ball	3 vs. 1 to train ball possession and transitions Situational exercise of 2 vs. 1 with shot on goal 2 vs. 1 to conquer forward space	Aerobic and anaerobic endurance Rapidity Circuit to train coordination Static and dynamic balance
December	Transmission and control of the ball Feint and dribbling Shots on goal Headshot	Comprehension of offensive and defensive strategies concerning the ball and the opponent	Developments in offensive and defensive tactics Offensive transitions	Adaptation and transformation Rhythmization Rapidity Aerobic and anaerobic endurance

assume non-significant differences between values before the training program. A further independent-sample *t*-test was performed to assess between-group differences in post-intervention. A two-way repeated-measures analysis of variance was used to test for differences in training-induced changes in Trial, Penalty time and Global performance variables. The independent variables included one between-subjects factor (training intervention) with two levels (OCC and CON) and one within-subject factor (time) with two levels (pre-and post-intervention). To qualitatively interpret the magnitude of differences, effect sizes and associated 95% CI were classified as small (0.2–0.5), moderate (0.5–0.8) and large (> 0.8; Cohen, 1988). Statistical significance was inferred at $p < .05$.

Data were reported as Mean (*SD*) for all variables. Data analyses were performed using IBM SPSS Statistics (Version 27 for Windows; IBM, Armonk, NY, USA).

Results

All players completed both pre- and post-intervention assessments ($n = 30$). Both OCC and CON did not significantly change Trial performance. Moreover, the OCC experienced small-to-moderate improvements in Penalty time ($d = 0.51$, 95% CI [0.10, 0.70]) and Global performance ($d = 0.44$, 95% CI [0.05, 0.66]). However, the CON did not show changes in Penalty time and Global performance variables ($p > .05$). A significant moment × group interaction was observed in Penalty time ($\eta_p^2 = .19$, 95% CI [.03, .48]) and Global performance ($\eta_p^2 = .21$, 95% CI [.01, 0.45]). A description of changes found after the training period is shown in Table 3.

Discussion

The study aimed to verify whether training with visual occlusion significantly improved the technical skills of young footballers in addition to conventional football training. Results from the OCC in penalty time and global performance variables suggest that using SOG in an applied setting can positively impact performance. Removing the sight of the later stages of ball flight and lower limbs of the participants positively impacted performance once full visual conditions were returned as penalty time significantly decreased. On the other hand, observing the results obtained by the CON, no significant improvements were found in any of the three variables after the two months of training carried out. From the results obtained, it can be confirmed that football performance depends largely on the visual perceptual system that provides information for perception and action (Vaeyens et al., 2007). Furthermore, this study provided key information regarding how the players adjust their behaviour as a result of temporary occlusion (Santos et al., 2022).

Our findings are similar to those observed by Dunton et al. (2019), who also assessed the impact of visual occlusion on receiving and passing a football using visual stimulation training. In this study, thirty third-level sports management students who have had at least three years of playing experience in competitive football have significantly improved the accuracy of their passes thanks to the respective training intervention. The significant improvements in visual search behaviour and performance variables demonstrated by the perceptual training group in these studies are comparable to the significant improvement for participants in the current research. Our findings also reinforce the insights gained from Fransen et al. (2017), who suggested that training in restricted visual conditions would reduce reliance on visual information while performing complex motor skills (Fransen et al., 2017).

As studies of visual occlusion as a training tool will continue to progress, future research should seek to design football-specific activities in a more representative environment (Davids et al., 2013). It is necessary to ensure that the information that athletes receive from the training environment is similar to that of the performance environment to maximise the learning transfer, ensuring the perception-action coupling (Correia et al., 2019). Constraints must be inserted/manipulated in the design to encourage athletes to explore opportunities for action concerning the session's intention. The importance of an ecologically valid environment in the performer-environment relationship was previously addressed by Araujo et al. (2006). They explained the impact of interactions between individuals on decision-making in sport.

It is important to underline some limitations inherent to this study. First, a retention test could not be performed a few weeks after the second test. Through the retention test, we could verify if the significant improvements in the variables of this study had been maintained over time as a learning effect (Pizzera & Raab, 2012). Another significant limitation is the variability of biological maturation in the Under-14 football players (Figueiredo et al., 2009). Inter-individual variations in growth, development, functional capacity and specific youth football skills must be considered. Finally, it should be considered the OCC had additional training sessions than the CON.

Future research could focus on assessing gaze behaviour with eye-tracking technology to provide critical information relevant to potential changes in visual search behaviour

Table 3 Comparison of technical performance at the end of the two training programs

	OCC ($n = 15$)		CON ($n = 15$)		Moment × Group interaction	
Variable	*p*	Cohen's *d* [95% CI]	*p*	Cohen's *d* [95% CI]	*p*	η_p^2 [95% CI]
Trial (s)	.215	0.10 [–0.19, 0.40]	.436	0.04 [–0.11, 0.32]	.139	.07 [–.13, .29]
PT (s)	.002	0.51 [0.10, 0.70]	.610	0.01 [–0.17, 0.27]	.016	.19 [.03, .48]
GP (s)	.005	0.44 [0.05, 0.66]	.896	0.00 [–0.16, 0.15]	.011	.21 [.01, .45]

Note. OCC = visual occlusion group; CON = control group; CI = confidence interval; PT = penalty time; GP = global performance.

due to training with SOG. An inevitable future direction for research in spatial occlusion is to assess the impact across multiple sports. It is important to note that SOG can only be an effective training tool when athletes must perform sport-relevant tasks in the low-level visual field while directing their visual attention upwards. Different applications of visual occlusion in other sport contexts, such as anticipation or interceptive actions, need to be investigated.

Conclusions

Under-14 football players who performed the visual occlusion training program showed a significant reduction in the amount of time required to complete the trial and the Penalty time. These results suggest that incorporating the SOG as a tool into a training program for football players may positively improve passing skills.

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Conflict of interest

The authors report no conflict of interest.

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