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Visual Scanning and Technique Improve Performance in a Standardized Soccer Passing Task

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Abstract

Background/Objectives: Passing is the most frequent and impactful action in soccer. It requires players to control the ball and pass accurately with either foot, make quick decisions, and scan the field while under pressure. Using a recently developed series of passing tests that vary in complexity and scanning demands, we examined how a player's choice of technique when controlling and passing the ball, along with their ability to scan effectively, influenced passing performance. Methods: Forty-five elite U12 and U13 players from a Brazilian academy completed three passing tests involving directional turns across 120°, 180°, and 360°. Each pass was video-coded based on foot orientation (back or front foot), foot dominance (dominant or nondominant), and pass direction (toward the dominant or nondominant side). The study tested whether (i) the most common technique used varied with pass direction due to a preference for the dominant foot, (ii) performance varied across foot techniques, and (iii) scanning prior to ball reception enhanced outcomes. Results: Players preferred techniques that used their dominant foot, such as controlling and passing with their back foot (back–back) when turning to the dominant side (58% in 120° and 57% in 180° tests) and controlling with their back foot and passing with the front (back–front) for the nondominant side (66% and 55%; χ^2 = 292.96 and 312.87, $p < 0.001$). However, using the dominant foot sometimes led to slower, less efficient actions. In the 120° test, back–front was the fastest technique (+1.11 passes/min vs. back–back), while front–back was the slowest (−4.20 passes/min, $p < 0.001$). In the 360° test, scanning improved turn accuracy (from 51% to 73%) and performance, resulting in 4.20 more passes/min, fewer control errors (11% vs. 31%), and fewer target misses (3% vs. 10%; all $p < 0.001$). Conclusions: These findings highlight the value of effective scanning and foot technique under varied conditions, and offers coaches a practical tool for player analysis, feedback, and development.

Keywords: performance; skill; passing; football

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1. Introduction

Soccer is a dynamic sport in which two teams of 11 players, along with the ball, are in constant motion. Through a combination of dribbling, passing, and shooting, each team attempts to maneuver the ball around and between opponents to score goals. While elite players are often celebrated for their dribbling and shooting skills, passing is the most frequently executed skilled action during games [1–3]. Notably, teams that pass more frequently and more effectively than their opponents are more likely to win [3–6]. An

effective pass typically involves receiving and controlling the ball, followed by delivering an accurate pass—often under pressure from defenders trying to limit options or regain possession. Players generally have a preferred (dominant) foot for controlling and passing [7,8], but the optimal foot choice is highly context-dependent. For instance, the trajectory of the incoming ball and the positioning of nearby defenders may determine which foot is best suited for control. Likewise, the player's body orientation relative to both the ball and the target can influence which foot is best for passing. Being able to pass accurately with either foot is therefore a highly valuable skill [9]. To perform consistently under varying conditions and pressures, players must be proficient in both controlling and passing with either foot.

Another key element of effective passing is decision-making, particularly identifying the best passing option. Teammates may be positioned in front, behind, or to either side, requiring players to quickly scan their surroundings—often while under pressure—to make informed decisions. The timing of scanning relative to ball reception can significantly impact performance. Players who scan before receiving the ball tend to possess it for less time [10,11], make more switches of play and forward passes [12], and complete a higher percentage of passes [13], all of which contribute to maintaining possession and creating attacking opportunities. Given the importance of passing, numerous assessments have been developed to measure passing ability [14–18]. However, most do not require players to visually scan their environment, even when offering multiple target options. For example, the Loughborough Soccer Passing Test (LSPT) [16] requires players to pass to four rebound boards but uses auditory cues to signal the next target. More recently, Hunter and colleagues [19] introduced three passing tests that incorporate visual scanning using rebound boards and an integrated light system. These tests require players to visually identify the next target between each pass, simulating more realistic match demands. The tests successfully differentiated between first- and reserve-team players and predicted performance in small-sided 3v1 Rondo games (Hunter and colleagues [19]). In these tests, players had to control and pass the ball across various angles (e.g., 60°, 120°, or 180° to the left or right) while adapting to different scanning demands. Although these tests revealed performance differences among players, the mechanisms underpinning high performance remain unclear. Specifically, which techniques enable more effective control and passing?

Some techniques are likely to be more efficient than others, and to explore this, we first define foot orientation in relation to the incoming ball. For example, consider a left-sided midfielder with their back to the sideline receiving a forward pass from a central defender. In this case, the left foot is the back foot (farthest from the ball's path), and the right foot is the front foot (closest to the ball). If the player controls the ball with their front (right) foot and passes with their back (left) foot, this is a front–back technique. However, the back–front sequence—controlling with the back foot and passing with the front foot—is likely the most efficient in many situations. In our example, the player allows the ball to travel across the body, controls it with the back (left) foot toward the target, and immediately passes with the front (right) foot. With an effective first touch, no additional steps are needed: the back foot is used to control the back and is then placed beside it, and the front foot executes the immediate pass [20–22]. In contrast, other techniques often involve an extra step. For instance, in the front–front technique, the player controls the ball with the front foot, places it down, steps with the back foot, and only then passes with the front foot. This extra movement likely reduces efficiency compared to the back–front sequence. While using the dominant foot may be generally better (and preferred) than with the nondominant foot [23–25], the time costs associated with an extra step to pass the ball (when controlling first with their dominant foot) may play a greater role in determining passing performance—though this remains to be tested.

The aim of this study was to investigate how the technique a player uses to control and pass the ball influences performance. We video-recorded skilled players from a Brazilian youth academy as they completed the passing tests developed by Hunter and colleagues [19]. Each touch (control and pass) was coded based on foot orientation (e.g., front–back, back–front) and foot dominance (dominant or nondominant). For instance, if a right-footed player controlled the ball with the left foot and passed with the right, this was classified as a nondominant–dominant sequence. We predicted that (i) the most common technique used would vary with pass direction, due to a preference for the dominant foot; (ii) performance would differ across techniques, with the back–front sequence the fastest; and (iii) scanning before receiving the ball would lead to better performance.

2. Methods

2.1. Participants

Participants were members of the under-12 (n = 23) and under-13 (n = 22) squads from an elite Brazilian youth academy, whose senior team at the time of data collection competed in Brazil's Série A competition. All players were of a high standard and competed in local state competitions and some national club tournaments. The average age of participants was 12.8 years (SD = 0.58; range = 11.64–13.55). Written consent was obtained from guardians in accordance with the ethical standards of the University of Queensland (Australia) and the University of São Paulo, Ribeirão Preto campus (Brazil). Individual players could refuse to take part if they chose.

2.2. Study Design

Players' passing ability was assessed over seven one-hour sessions, with each player participating in one session. During testing, players completed three passing tests of varying complexity, designed by Hunter and colleagues [19]. Each player completed one trial of the 120-degree test and two trials each of the 180-degree and 360-degree tests. The order of the 180-degree and 360-degree tests alternated between sessions. Within each session, players alternated between these two tests until both were completed twice, with the 120-degree test always performed last (note: two players did not complete the 120-degree test). Each player's foot dominance was also recorded.

2.3. Passing Tests

We used the three passing tests described in Hunter and colleagues [19] that employed specially constructed rebound boards measuring 1.1 m in width and 0.5 m in height. Each board featured a central hole with a 5 cm diameter (Figure 1). Directly behind these openings, a RoxPro vibration/light sensor (A-Champs Inc., Barcelona, Spain) was installed. The sensors illuminated to indicate the next target in a predetermined sequence. At the start of a trial, players struck the ball toward the board displaying the initial light. Once contact was made, that light switched off, and another light instantly activated on a different board to signal the subsequent target. This cycle continued until the trial ended. Participants were required to control the ball with at least one touch before making each pass, though they were free to choose the foot and technique employed. If a pass failed to reach the target or an error occurred (see details below), the player was given a replacement ball to resume the attempt. The RoxPro system logged the interval between consecutive successful board strikes. These timings were later expressed as passes per minute, providing a performance index for each participant [19].

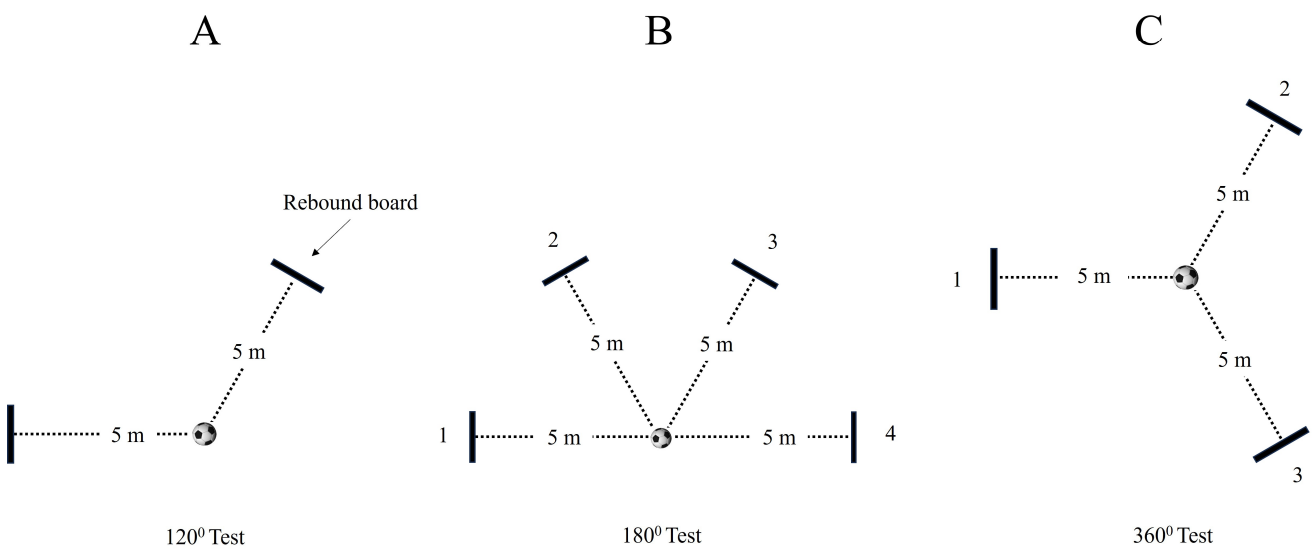


Figure 1. The design of the 120-degree (**A**), 180-degree (**B**), and 360-degree passing tests (**C**) used in this study.

In the 120-degree test, two rebound boards were arranged 120° apart, both angled toward a shared focal point located 5 m away. Players started each trial from this focal point, with the initial target randomized between individuals. Each participant completed ten passes to either side, excluding the very first pass, resulting in a total of 20 attempts. Because only two boards were involved and the next target was always predictable, this drill was the least demanding in terms of decision-making—it required no visual search. Nonetheless, success still depended on precise passing and clean ball control.

For the 180-degree test, four boards were positioned along a 180° arc, each spaced 60° apart and facing the same central point 5 m away. Depending on the programmed light sequence, players had to rotate their bodies through angles of 60°, 120°, or 180° before striking the next pass. Each directional turn was repeated three times, amounting to 18 passes. Beyond the technical skills required in the 120-degree task, this test challenged players to scan for the next target. The most effective approach was to scan immediately after hitting the current board, before receiving the return ball, enabling a first touch that set up an accurate, rapid pass. Waiting to scan until after ball reception was possible, but it demanded more versatile control to cope with multiple directional options.

The 360-degree test involved three boards distributed evenly at 120° intervals around a complete circle, all directed toward the same focal point and set 5 m away. Players carried out ten passes to each side (20 in total). This test combined the technical requirements of the 120-degree setup with the need to anticipate the next target in advance of receiving the ball. If scanning was delayed until after the first touch, performance could vary: a well-directed touch might assist in making the next pass quickly, while a poorly oriented one could force additional adjustments of body or ball position.

All trials were video-recorded, and each pass was classified as successful, erroneous, or invalid. Invalid attempts occurred when players attempted a one-touch pass; these were excluded from analysis. Errors included missed boards or miscontrolled balls requiring a replacement ball. Because such mistakes reflected individual performance, a consistent penalty was applied. Specifically, the median pass time across across all tests—4.60 s—was assigned whenever a replacement ball was needed. This ensured a standardized time cost approximating the typical duration for missing, receiving a new ball, and resuming play.

2.4. Video Analysis

All trials were recorded at 30 frames per second (GoPro), and a single experienced researcher (35 years in playing, coaching, or soccer research) analyzed the footage using Kinovea software (version 0.8.15) [26]. For each pass, the following data were coded: (i) the foot used to control and pass the ball (categorized as dominant/nondominant and front/back), (ii) the number of touches taken between passes, and (iii) the outcome of each pass (hit, error, or invalid). In addition, (iv) the direction of the next pass in relation to foot dominance was recorded. For example, in the 180-degree test, if a player received the ball from board 2 and the next target was board 4 (Figure 1B), a pass to the right was coded as a dominant-side pass for right-footed players and a nondominant-side pass for left-footed players (Figure 2). In the 360-degree test, whether players turned in the correct direction toward the next target (yes or no) was also recorded. For instance, if the ball returned from board 1 and the next target was board 2 (Figure 1C), turning to the left was incorrect. First-time passes were deemed invalid.

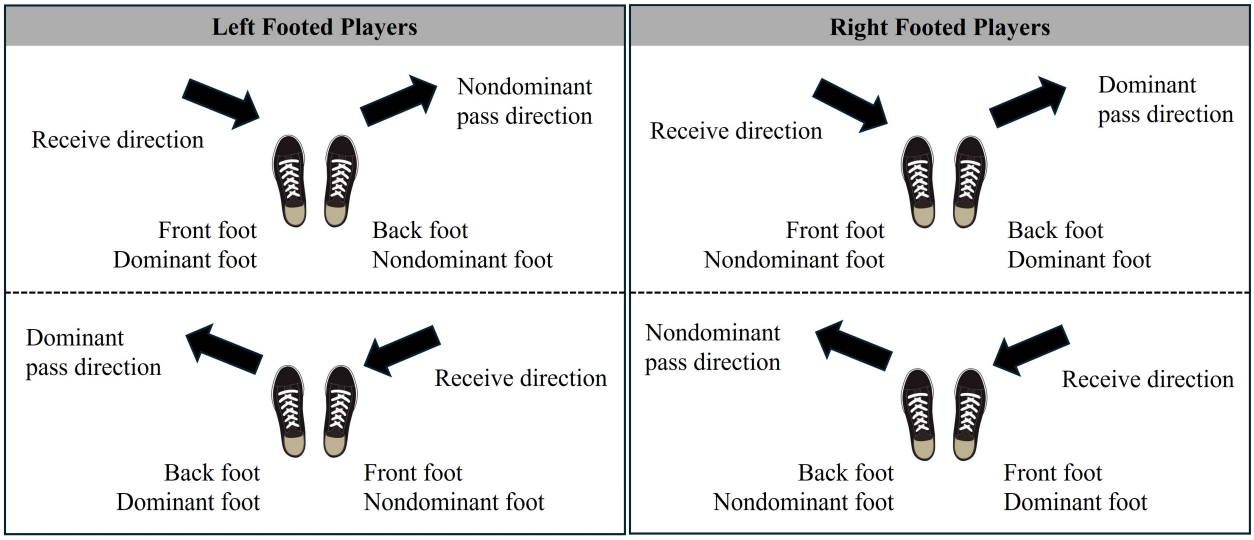


Figure 2. Graphical explanation of technique coding.

We also recorded whether a player completed a successful visual scan before receiving the ball during the 360-degree test. A successful scan had two criteria. First, the player scanned in a way that clearly indicated they had correctly identified the next target before receiving the ball. With only two possible targets on the 360-degree test, an appropriately timed scan of either board was considered successful, as the player would either see the next target board with the light on or the non-target board with light off. Either scenario would inform players of the next target board. Second, the scan occurred early enough to allow an effective first touch toward the target. The most obvious sign was when players looked up to identify the target and then returned their gaze to the ball in time to take a first touch in the correct direction. Late or ambiguous scanning during or after ball reception was not considered successful.

A random sample of 5 trials (totaling 85 valid passes) was re-analyzed for scanning behavior. Intra-rater reliability was excellent (Cohen's Kappa = 0.876, $p < 0.001$).

2.5. Statistical Analysis

On the 120-degree and 180-degree tests, we first used chi-square tests [27] to assess whether technique choice was associated with pass direction (prediction i). Then, to examine performance differences between techniques (prediction ii), we ran linear mixed-effects models [28] for each test, estimating the effect of foot orientation (e.g., back–front)

on passes per minute (simple model). Only valid (target-hitting) passes were included, and player ID was entered as a random effect to account for repeated measures. To assess whether performance varied depending on the foot used, we ran a second set of linear mixed-effects models that included pass direction and an interaction term between technique and foot orientation (full model).

On the 360-degree test, players who did not scan still had a 50% chance of turning in the correct direction by chance, meaning scanning might not always yield a performance benefit in terms of passes per minute. Therefore, we assumed scanning affected performance through a two-step process: (i) scanning increased the likelihood of turning in the correct direction, and (ii) turning in the correct direction improved performance. To test this, we used a generalized linear mixed-effects model (binomial) [28] to determine whether scanning (yes/no) increased the odds of turning correctly (yes/no), including player ID as a random effect. Next, we used a linear mixed-effects model to estimate how pass direction and turning correctly (yes/no) influenced passes per minute, including an interaction term and player ID as a random factor.

We further examined whether turning correctly influenced touch count by applying another generalized linear mixed-effects model (binomial), with outcome coded as one touch vs. more than one touch. Finally, we used a generalized linear mixed-effects model to determine whether turning in the correct direction (yes/no) and pass direction influenced whether the next pass was successful (hit/miss), including interaction terms and player ID.

All analyses were conducted using R (version 4.1.0), with the stats [27], lmerTest [28], and emmeans [29] packages. Prior to analysis, the distribution of the data for each test was checked with a Shapiro–Wilk Normality test. The 120-degree test ($p = 0.68$) and 360-degree test ($p = 0.33$) data were normally distributed, and the 180-degree test data showed mild positive skewness ($p < 0.001$). No data transformations were deemed necessary as linear mixed-effects models are robust to non-normal assumptions [30].

3. Results

3.1. 120-Degree Passing Test

The frequency that each foot technique was used when undertaking the 120-degree test was associated with the direction of passing relative to a player's dominant foot (χ^2 (3, N = 734) = 292.96, $p < 0.001$). When passing to their dominant side (i.e., right-footed players passing to a rebound board on their right side), players most frequently used the back–back (dominant–dominant) (58%) or back–front (dominant–nondominant) technique (33%). However, when passing to the nondominant side, players most frequently used the back–front (nondominant–dominant) (66%) or front–front (dominant–dominant) technique (23%).

Technique had a significant effect on passing performance (Figure 3). In the initial model, which included only technique as a predictor, the back–back technique served as the reference category, with a mean estimated performance of 31.65 passes/min ($SE = 0.44$). The back–front technique led to a significant increase in passing rate compared to back–back, with an estimated gain of +1.11 passes/min ($SE = 0.30$, $t(689.26) = 3.68$, $p < 0.001$), making it the most effective technique overall. In contrast, the front–back technique resulted in the lowest performance, showing a significant decrease of −4.20 passes/min ($SE = 0.54$, $t(682.58) = -7.72$, $p < 0.001$). The front–front technique also significantly underperformed relative to back–back, with a reduction of −2.22 passes/min ($SE = 0.43$, $t(679.74) = -5.23$, $p < 0.001$).

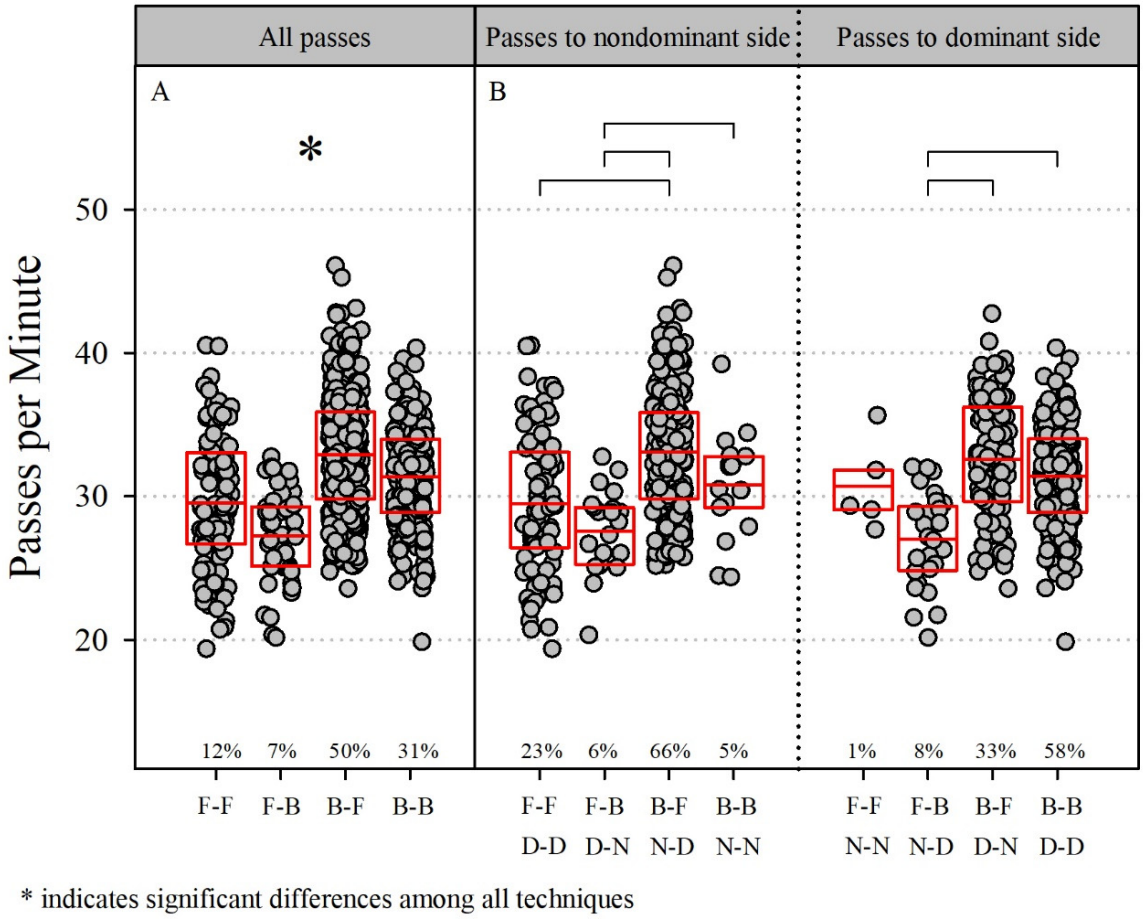


Figure 3. Relationship between technique and performance (passes/min) on the 120-degree test. Panel (**A**) = simple model, panel (**B**) = full model. Each data point represents a single event of controlling and passing the ball. Red boxplots indicate mean, 25th quartile, and 75th quartile. Black brackets indicate significant differences between pairs of techniques. The frequencies with which each technique was used are presented as percentages. F = front; B = back; D = dominant; N = nondominant.

To explore whether the effect of technique depended on the direction of the pass, a second model included turn direction (dominant vs. nondominant side) and its interaction with technique (Table 1; Figure 3). In this model, the main effect of turn direction was not statistically significant (Estimate = −0.46, *SE* = 0.85, *t*(675.25) = −0.54, *p* = 0.590), indicating that performance did not differ significantly when players turned toward their dominant or nondominant side overall. Importantly, the performance advantage of the back–front technique observed in the simpler model was no longer significant (Estimate = 0.42, *SE* = 0.41, *t*(689.29) = 1.02, *p* = 0.307), suggesting that its benefits may be direction-specific rather than consistent across all trials. None of the interactions between technique and turn direction reached statistical significance (e.g., nondominant × back–front: Estimate = 1.34, *SE* = 0.94, *t*(676.54) = 1.43, *p* = 0.153), although the trend suggests that back–front may offer advantages when turning to the nondominant side. Notably, the front–back technique remained significantly worse than back–back (Estimate = −4.52, *SE* = 0.69, *t*(675.28) = −6.55, $p < 0.001$), confirming it as the least effective method regardless of direction. The front–front technique, while showing a negative trend, did not reach statistical significance in the full model (Estimate = −1.87, *SE* = 1.52, *t*(674.21) = −1.23, *p* = 0.218).

Table 1. Linear mixed-effects model of passes/min on the 120-degree test, predicted by turn direction and technique (full model). Intercept refers to turns toward the dominant side using the back–back technique.

	Estimate	*SE*	df	*t* Value	*p*
(Intercept)	31.721	0.445	62.763	71.269	<0.001
Nondominant direction	−0.459	0.850	675.250	−0.539	0.590
Back–Front	0.423	0.414	689.293	1.023	0.307
Front–Back	−4.519	0.690	675.276	−6.545	<0.001
Front–Front	−1.873	1.519	674.211	−1.233	0.218
Nondominant direction: Back–Front	1.340	0.936	676.540	1.432	0.153
Nondominant direction: Front–Back	1.083	1.306	677.061	0.829	0.408
Nondominant direction: Front–Front	0.007	1.777	676.502	0.004	0.997

3.2. 180-Degree Passing Test

The frequency with which each technique was used on the 180-degree tests was also associated with pass direction (χ^2 (3, N = 1435) = 312.87, $p < 0.001$). When turning to the dominant side, players most often used the back–back (dominant–dominant) technique (57%) or back–front (dominant–nondominant) technique (22%). However, when turning to the nondominant side, players most often used the back–front (nondominant–dominant) technique (55%) or front–front (dominant–dominant) technique (34%).

Technique also had a significant impact on performance in the 180-degree passing test (Figure 4). In the initial model using technique as the sole predictor, the back–back technique served as the reference category, with an estimated mean performance of 30.25 passes/min (*SE* = 0.35). The back–front technique showed no significant difference from back–back, with a small and non-significant decrease of −0.17 passes/min (*SE* = 0.30, $t(1343.14) = -0.57$, $p = 0.567$). In contrast, the front–back technique was associated with a significant performance reduction of −2.86 passes/min (*SE* = 0.47, $t(1343.21) = -6.06$, $p < 0.001$), and the front–front technique yielded a similarly large and significant decrease of −2.82 passes/min (*SE* = 0.35, $t(1335.28) = -8.16$, $p < 0.001$). These results indicate that techniques involving front-foot control, particularly those that begin with the front foot, consistently result in poorer performance under the demands of the 180-degree task.

In the full model, which included turn direction (dominant vs. nondominant side) and its interactions with technique, further patterns emerged (Table 2; Figure 4). The main effect of turning toward the nondominant side was statistically significant, with a performance increase of +1.51 passes/min compared to turning toward the dominant side (*SE* = 0.70, $t(1340.64) = 2.15$, $p = 0.032$). Interestingly, in this model, the back–front technique showed a significant decline relative to back–back (Estimate = −1.44, *SE* = 0.44, $t(1338.94) = -3.30$, $p = 0.001$), which contrasts with its neutral effect in the simple model. Both front–back and front–front techniques remained significantly worse than back–back (−2.48 and −4.47 passes/min, respectively; both $p < 0.001$), reinforcing their inefficiency in this task. A significant interaction effect was found for the nondominant × front–back condition (Estimate = −2.33, *SE* = 1.18, $t(1343.96) = -1.98$, $p = 0.048$), suggesting that front–back performance deteriorated further when players turned toward their nondominant side.

3.3. Scanning and the 360-Degree Passing Test

In the 360-degree test, we first examined the prevalence and effectiveness of visual scanning. Players scanned successfully before receiving the ball in 29% of trials (*SD* = 0.22; range = 0–100). Only 16% of players (7 out of 43) scanned successfully in at least 50% of trials. When players did scan, they were significantly more likely to turn in the correct direction, with turn accuracy improving from 51% (no scan) to 73% (with scan). Scanning

before receiving the ball was a strong predictor of correct turning direction ($\beta = 0.86$, $z = 6.77$, $p < 0.001$) (Figure 5).

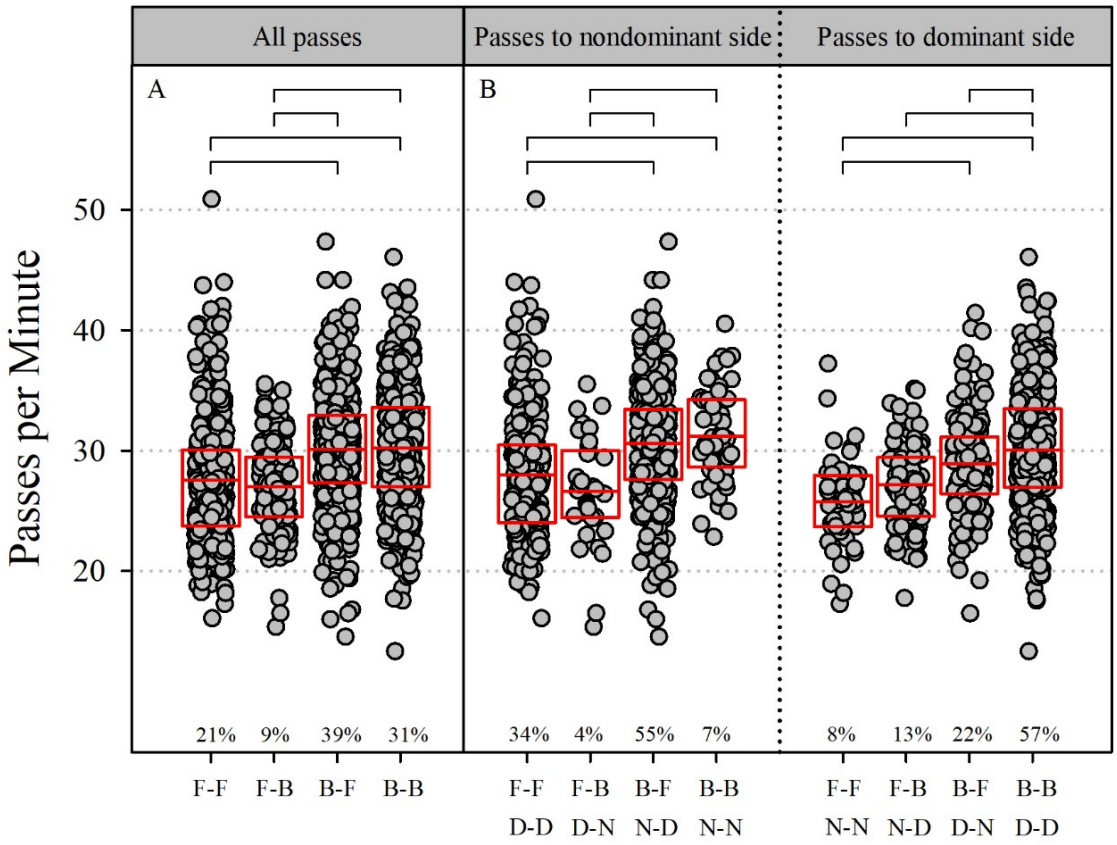


Figure 4. Relationship between technique and performance (passes/min) on the 180-degree test. Panel (**A**) = simple model, panel (**B**) = full model. Each data point represents a single event of controlling and passing the ball. Red boxplots indicate mean, 25th quartile, and 75th quartile. Black brackets indicate significant differences between pairs of techniques. The frequencies with which each technique was used are presented as percentages. F = front; B = back; D = dominant; N = nondominant.

Table 2. Linear mixed-effects model of passes/min on the 180-degree test, predicted by turn direction and technique (full model). Intercept refers to turns toward the dominant side using the back–back technique.

	Estimate	***SE***	**df**	***t* Value**	***p***
(Intercept)	30.101	0.362	83.600	83.070	<0.001
Nondominant direction	1.508	0.701	1340.642	2.151	0.032
Back–Front	−1.435	0.435	1338.937	−3.295	0.001
Front–Back	−2.481	0.534	1344.355	−4.646	<0.001
Front–Front	−4.473	0.664	1339.859	−6.737	<0.001
Nondominant direction: Back–Front	0.456	0.825	1339.964	0.552	0.581
Nondominant direction: Front–Back	−2.332	1.180	1343.964	−1.976	0.048
Nondominant direction: Front–Front	0.685	0.994	1348.432	0.689	0.491

Performance outcomes were closely linked to whether players turned in the correct direction (Figure 5). Players who turned correctly completed 4.20 more passes per minute than those who turned incorrectly ($SE = 0.31$, $t = 13.62$, $p < 0.001$) (Table 3; Figure 5). This difference was even greater when turning toward the nondominant side, with a performance drop of 5.3 passes/min when turning incorrectly compared to correctly.

Successful scanning and turning also improved ball control: when players turned correctly, they needed more than one touch to pass just 11% of the time, compared to 31% when they turned incorrectly ($\beta = -1.73$, $t = -7.43$, $p < 0.001$). Similarly, turning correctly reduced passing errors, with players missing the target only 3% of the time versus 10% when they turned incorrectly ($\beta = 1.18$, $t = 3.54$, $p < 0.001$).

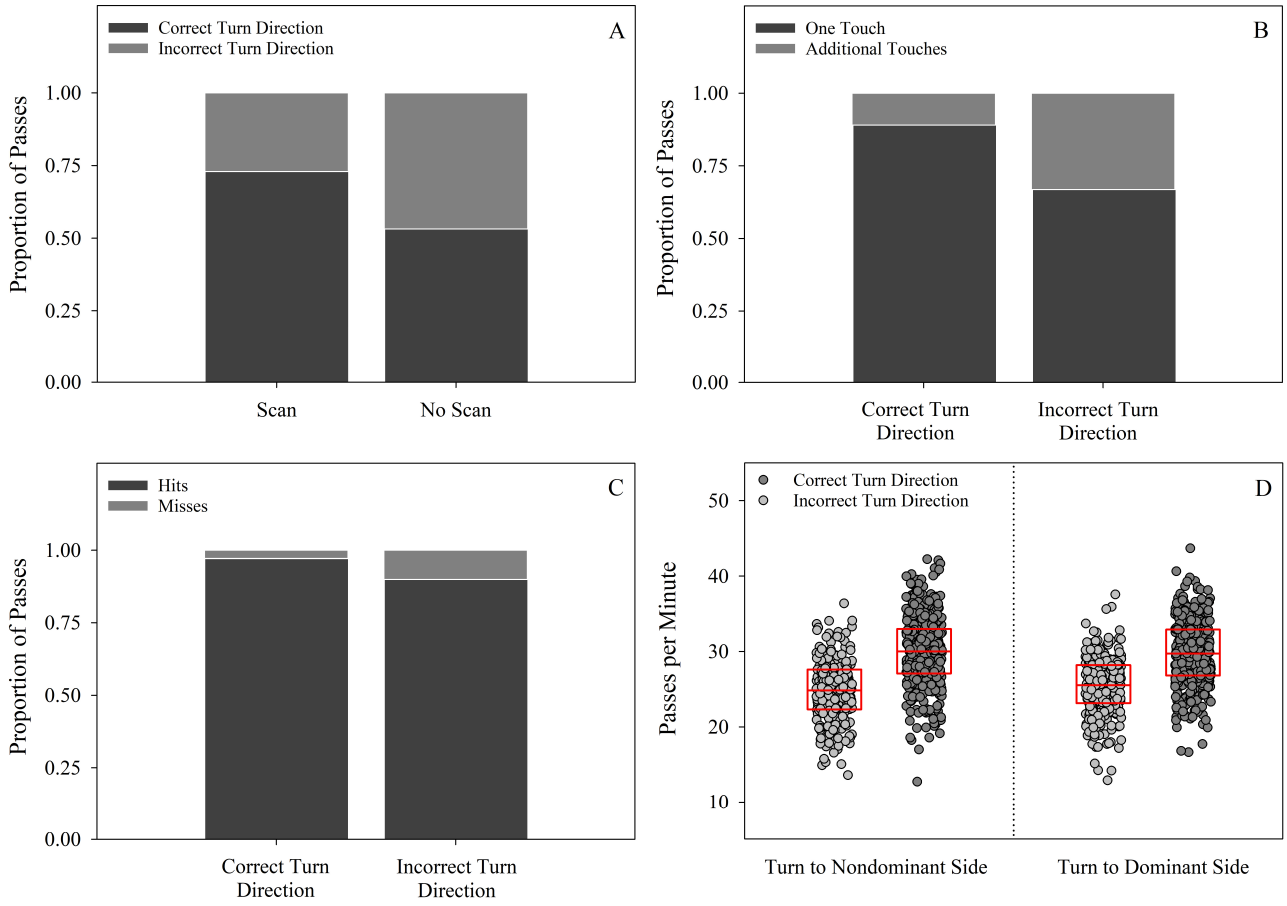


Figure 5. Impact of scanning on passing performance. Scanning increases the likelihood of turning in the correct direction (panel (**A**)); turning in the correct direction reduces the likelihood of additional touches (panel (**B**)); turning in the correct direction increases the likelihood of hitting the target board (panel (**C**)); turning in the correct direction allows more passes per minute (panel (**D**)). Red boxplots indicate mean, 25th quartile, and 75th quartile (panel (**D**)).

Table 3. Linear mixed-effects model of passes/min on the 360-degree test, predicted by pass direction (dominant or nondominant) and whether players turned the correct direction (yes or no). Intercept refers to passes toward the dominant side but turning in the incorrect direction.

	Estimate	*SE*	df	*t* Value	*p*
(Intercept)	25.496	0.335	110.944	76.128	<0.001
Nondominant direction	−0.760	0.332	1408.867	−2.290	0.022
Turned correct direction (yes)	4.204	0.309	1417.440	13.622	<0.001
Nondominant direction: Turned correct direction (yes)	1.122	0.438	1418.792	2.562	0.011

4. Discussion

This study investigated how technique and visual scanning influenced passing performance in elite youth soccer players. As predicted, we found the technique players used was

associated with the direction of the pass, reflecting a clear preference for their dominant foot. This bias was especially pronounced when passing to the nondominant side and often led players to select control–pass combinations that were not the most efficient. In addition, performance differed across techniques, with specific techniques consistently leading to faster, more accurate passes. We also found that players who scanned before receiving the ball in the 360-degree test performed better. Players who scanned turned in the correct direction more often, took fewer touches, and hit the target more often. Taken together, these findings highlight the importance of developing not only technical skills but also perceptual and decision-making abilities in youth players.

Specific passing techniques consistently outperformed others in both the 120- and 180-degree tests, and their effectiveness often depended on the direction of the pass relative to the player's dominant foot. In the 120-degree test, the most effective technique was back–front, followed by back–back, front–front, and front–back. Despite its superior performance, back–front (dominant–nondominant) was only used 33% of the time when passing to the dominant side, while back–back (dominant–dominant) was used 58%, suggesting a strong preference for staying on the dominant foot. This preference became even more evident when passing to the nondominant side. In those cases, players used back–front (nondominant to dominant) 66% of the time, which is double the rate used when passing to the dominant side. Less efficient techniques like front–front (dominant–dominant) were still used 23% of the time, and the potentially more efficient back–back (nondominant–nondominant) was rarely chosen. These patterns reflect a consistent bias toward the dominant foot, even when it limits performance. In the 180-degree test, the highest-performing techniques were again back–back and back–front. When passing to the dominant side, players used one of these two techniques 77% of the time, with back–back (dominant–dominant) alone accounting for 57%. However, when passing to the nondominant side, back–back (nondominant–nondominant) was used just 7% of the time. Players often relied on the slower front–front (dominant–dominant) technique when passing to the nondominant side, used in 34% of passes, which further shows a tendency to prioritize foot preference over technical efficiency. Interestingly, reliance on the dominant foot only improved passing performance in the 180-degree test, not the 120-degree test. Players using back–front or front–front techniques in the 180-degree test performed better when passing when using their dominant foot. This is likely due to the greater cognitive and technical demands of the 180-degree task, which required additional scanning requirements and the ability to pass in multiple directions with less predictable ball control. This increased complexity likely led to detectable performance differences between the dominant and nondominant foot, with the dominant being more proficient [23–25].

As the perceptual and cognitive demands of the tests increased—such as in the 180- and 360-degree tests—players were more likely to revert to familiar but suboptimal strategies, such as consistently using their dominant foot. This behavioral pattern reflects a well-documented phenomenon in motor learning: when under pressure or faced with uncertainty, players often default to overlearned or automatic motor responses, even if these are not the most effective for the task at hand [31–33]. In our study, the tendency to select dominant-foot techniques despite poorer performance suggests that increased task complexity may have overwhelmed some players' ability to process information and adapt their motor responses. This supports broader theories in skill acquisition, which argue that expert performance relies not only on motor proficiency, but also on the ability to manage cognitive load and flexibly apply the most efficient solution in response to contextual demands [31–33]. These insights emphasize the importance of training approaches that simulate cognitive pressure, helping players develop the capacity to maintain adaptable and efficient decision-making under realistic game constraints.

Scanning is important for better passing performance in games because it allows players to observe their surroundings before receiving the ball. This early awareness helps them select a target location and plan their next move in advance, enabling quicker and more accurate passing decisions [10,11,13]. Our results demonstrate that scanning provides clear performance benefits in a controlled passing test. On the 360-degree test, players successfully scanned before receiving the ball less than 30% of the time, suggesting the task was particularly challenging for this age group. Players who did scan were more likely to turn in the correct direction, reduce the number of touches needed, and increase the likelihood of hitting the target—ultimately resulting in a higher passes-per-minute rate. Although our data clearly show that players who scan before receiving the ball perform better in the 360-degree test, it remains to be tested whether these benefits directly translate to game situations. Improving the ability to scan while the ball is moving toward the player is likely to further support effective passing in match scenarios. Importantly, our tests could be adapted into training environments to encourage and develop scanning behaviour. By implementing structured tasks that require players to scan and by tracking their performance over time, coaches can foster this critical skill. While an initial decline in performance is expected due to the added cognitive load of managing a second task, this challenge is likely to promote long-term improvements. As scanning becomes more automatic, players could experience enhanced passing efficiency and decision-making under pressure.

Scanning is not merely a passive act of "looking," but an active process of detecting affordances—that is, opportunities for action that emerge based on the player's capabilities and the game context [34]. This idea is linked to the concept of perception–action coupling, which is a core principle in motor control and ecological dynamics [34–36]. In soccer, affordances may include passing gaps, spaces to turn, or the positioning of teammates and defenders. These are not static features but are perceived in relation to the player's own movement possibilities. For example, a narrow gap for passing may afford a quick through ball for a technically skilled player, but not for one with less performance under pressure. In our study, as task complexity increased—from the 120-degree to the 360-degree test—the demand on players to perceive and act upon such affordances also increased. The performance drop-off in the 360-degree test suggests that many players struggled to maintain effective perception-action coupling under higher spatial and temporal uncertainty. In contrast, players who successfully scanned before receiving the ball were more likely to identify useful affordances early, make correct turning decisions, and complete quicker, more accurate passes. This further emphasizes the importance of training environments that integrate perceptual demands with motor execution to support the development of more adaptive, game-relevant skills.

While our tests were conducted without defenders, they provide a controlled and repeatable way to assess individual technical habits, allowing for detailed analysis of a player's strengths and deficiencies. These insights can be used to design personalized training interventions. For example, if a player shows a consistent bias toward dominant-foot passing in the 180-degree test, coaches can introduce drills that promote the use of back–back or back–front techniques with the nondominant foot. Similarly, a player's scanning frequency in the 360-degree test can be tracked before and after targeted scanning exercises to assess improvement. This diagnostic approach allows for tailored training plans that address not just technical execution, but also perceptual and decision-making skills—core aspects of modern coaching philosophy. Over time, these tests can also be used to monitor progress, helping players and coaches identify which interventions are most effective and adjust training accordingly. While the direct translation of test performance to

match outcomes still requires further validation, the structured nature of these assessments offers a valuable tool for individualized player development.

Although this study sample was composed of only U12–U13 boys, our findings are likely applicable to the wider soccer community, regardless of sex or playing ability. Different groups of players (e.g., elite adults or novice players) may perform better or worse overall than our group of players on these tests (passes/min), but the trends we identified here are likely consistent across all groups. For example, the techniques available to control and pass the ball (e.g., back–front or front–front) are consistent across all players. Similarly consistent is the additional step (and time cost) involved if a player chooses to use the front–front technique instead of the back–front technique. Therefore, the performance differences we found among techniques are likely applicable to all soccer players. One may argue that elite adult players would not display the same bias toward their dominant foot found here. However, as this bias is present in the world's best players in matches [7–9], it would likely appear if these players were to do these tests. The benefits of scanning on the 360-degree test are also likely to be consistent across all players. For example, if a player does not scan, the likelihood of them turning in the correct direction is still 50%, regardless of their playing ability—and the associated performance costs for turning incorrectly are also likely to be consistent across different player abilities. However, the prevalence of scanning on our tests is likely to increase as playing ability and experience increase, yet this remains to be tested.

Our results were limited by small sample sizes in some instances. For example, on the 120-degree test, the simple linear mixed-effects model found the back–front sequence to be faster than all other techniques. However, when the pass direction was included in the model, there was no performance difference between the back–front and back–back techniques. This discrepancy may be explained by small sample sizes, particularly for passes toward the nondominant side. While one could confidently argue that the back–front technique was faster than the back–back technique when passing to the nondominant side, the back–back technique was used only 5% of the time. Identifying statistically significant differences in this scenario is inherently difficult. Future research could instruct players to use certain techniques to obtain more balanced datasets and better identify performance differences among techniques. However, this comes with a cost of not identifying biases towards certain techniques or foot usage (dominant vs. nondominant).

5. Conclusions

This study highlights how passing technique and visual scanning interact to shape performance in elite youth soccer players. While the controlled tests used here do not replicate all aspects of match play, they uncover technical and perceptual patterns that are likely to influence on-field decision-making and execution, particularly under pressure. The consistent preference for the dominant foot, even at the expense of efficiency, points to a key developmental area that coaches can address through targeted training. Likewise, the strong link between scanning and improved passing performance reinforces the need to integrate perceptual training alongside technical drills. Crucially, the testing framework used in this study provides a practical, repeatable method for identifying individual player tendencies and tracking progress over time. By using these assessments diagnostically, coaches can create tailored programs that challenge players to improve weak areas, such as scanning frequency or nondominant foot use, while monitoring growth in a structured way. Future research should continue to explore how these controlled measures translate into match performance, but the present findings offer a strong foundation for more individualized and effective player development.

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Informed Consent Statement: All players and parental and legal guardians gave verbal and written consent to be involved in the study. All data were analyzed anonymously.

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References

1. Konefał, M.; Chmura, P.; Zacharko, M.; Chmura, J.; Rokita, A.; Andrzejewski, M. Match outcome vs match status and frequency of selected technical activities of soccer players during UEFA Euro 2016. *Int. J. Perform. Anal. Sport* **2018**, *18*, 568–581. [CrossRef]
2. Shafizadeh, M.; Taylor, M.; Peñas, C.L. Performance Consistency of International Soccer Teams in Euro 2012, a Time Series Analysis. *J. Hum. Kinet.* **2013**, *38*, 213–226. [CrossRef] [PubMed]
3. Bekris, E.; Gioldasis, A.; Gissis, I.; Komsis, S.; Alipasali, F. Winners and losers in top level soccer. How Do They Differ? *J. Phys. Educ. Sport* **2014**, *14*, 398–405.
4. Janković, A.; Leontijević, B.; Pašić, M.; Jelušić, V. Influence of certain tactical attacking patterns on the result achieved by the teams participants of the 2010 FIFA World Cup in South Africa. *Phys. Cult.* **2011**, *65*, 34–45. [CrossRef]
5. Redwood-Brown, A. Passing patterns before and after goal scoring in FA Premier League Soccer. *Int. J. Perform. Anal. Sport* **2008**, *8*, 172–182. [CrossRef]
6. Pappalardo, L.; Cintia, P. Quantifying the relation between performance and success in soccer. *Adv. Complex Syst.* **2018**, *21*, 1750014. [CrossRef]
7. Carey, D.P.; Smith, G.; Smith, D.T.; Shepherd, J.W.; Skriver, J.; Ord, L.; Rutland, A. Footedness in world soccer: An analysis of France'98. *J. Sports Sci.* **2001**, *19*, 855–864. [CrossRef]
8. Carey, D.P.; Smith, D.T.; Martin, D.; Smith, G.; Skriver, J.; Rutland, A.; Shepherd, J.W. The bi-pedal ape: Plasticity and asymmetry in footedness. *Cortex* **2009**, *45*, 650–661. [CrossRef]
9. Bryson, A.; Frick, B.; Simmons, R. The returns to scarce talent: Footedness and player remuneration in European soccer. *J. Sports Econ.* **2013**, *14*, 606–628. [CrossRef]
10. Jordet, G.; Bloomfield, J.; Heijmerikx, J. The hidden foundation of field vision in English Premier League (EPL) soccer players. In Proceedings of the MIT Sloan Sports Analytics Conference, Boston, MA, USA, 1–2 March 2013.
11. McGuckian, T.B.; Cole, M.H.; Chalkley, D.; Jordet, G.; Pepping, G.-J. Visual Exploration When Surrounded by Affordances: Frequency of Head Movements Is Predictive of Response Speed. *Ecol. Psychol.* **2018**, *31*, 30–48. [CrossRef]
12. McGuckian, T.B.; Cole, M.H.; Jordet, G.; Chalkley, D.; Pepping, G.-J. Don't Turn Blind! The Relationship Between Exploration Before Ball Possession and On-Ball Performance in Association Football. *Front. Psychol.* **2018**, *9*, 2520. [CrossRef]
13. Jordet, G.; Aksum, K.M.; Pedersen, D.N.; Walvekar, A.; Trivedi, A.; McCall, A.; Ivarsson, A.; Priestley, D. Scanning, Contextual Factors, and Association With Performance in English Premier League Footballers: An Investigation Across a Season. *Front. Psychol.* **2020**, *11*, 553813. [CrossRef] [PubMed]
14. Malina, R.M.; Cumming, S.P.; Kontos, A.P.; Eisenmann, J.C.; Ribeiro, B.; Aroso, J. Maturity-associated variation in sport-specific skills of youth soccer players aged 13–15 years. *J. Sports Sci.* **2005**, *23*, 515–522. [CrossRef] [PubMed]
15. Russell, M.; Benton, D.; Kingsley, M. Reliability and construct validity of soccer skills tests that measure passing, shooting, and dribbling. *J. Sports Sci.* **2010**, *28*, 1399–1408. [CrossRef] [PubMed]

16. Ali, A.; Williams, C.; Hulse, M.; Strudwick, A.; Reddin, J.; Howarth, L.; Eldred, J.; Hirst, M.; McGregor, S. Reliability and validity of two tests of soccer skill. *J. Sports Sci.* **2007**, *25*, 1461–1470. [CrossRef]
17. Bekris, E.; Kounalakis, S.; Ispirlidis, I.; Katis, A. Evaluation of ball passing and space detection skill in soccer: Implementation of two new soccer tests. *Res. Sports Med.* **2020**, *28*, 518–528. [CrossRef]
18. Wilson, R.S.; Sandes de Souza, A.P.; Santiago, P.; Ignacio, D.L.; Smith, N.M.A. Individual performance in passing tests predicts age-independent success in small-sided soccer possession games. *Transl. Sports Med.* **2020**, *3*, 353–363. [CrossRef]
19. Hunter, A.H.; Smith, N.M.A.; Bitugu, B.B.; Luguterah, A.W.; Wilson, R.S. Scanning When Passing: A Reliable and Valid Standardized Soccer Test. *Biomechanics* **2025**, *5*, 61. [CrossRef]
20. Franks, I.M.; Hanvey, T. Cues for goalkeepers: High-tech methods used to measure penalty shot response. *Soccer J.* **1997**, *42*, 30–33.
21. Diaz, G.J.; Fajen, B.R.; Phillips, F. Anticipation from biological motion: The goalkeeper problem. *J. Exp. Psychol. Hum. Percept. Perform.* **2012**, *38*, 848. [CrossRef]
22. Levanon, J.; Dapena, J. Comparison of the kinematics of the full-instep and pass kicks in soccer. *Med. Sci. Sports Exerc.* **1998**, *30*, 917–927. [CrossRef]
23. Hunter, A.H.; Smith, N.M.A.; Camata, T.V.; Crowther, M.S.; Mather, A.; Souza, N.M.; Ramos-Silva, L.F.; Pazetto, N.F.; Moura, F.A.; Wilson, R.S. Age-and size-corrected kicking speed and accuracy in elite junior soccer players. *Sci. Med. Footb.* **2022**, *6*, 29–39. [CrossRef] [PubMed]
24. Rodríguez-Lorenzo, L.; Olmo, F.-D.; Sánchez-Molina, J.A.; Martín-Acero, R. Kicking Ability and Kicking Deficit in Young Elite Soccer Players. *Kinesiol. Int. J. Fundam. Appl. Kinesiol.* **2018**, *50*, 194–203. [CrossRef]
25. Barbieri, F.A.; Gobbi, L.T.B.; Santiago, P.R.P.; Cunha, S.A. Dominant–non-dominant asymmetry of kicking a stationary and rolling ball in a futsal context. *J. Sports Sci.* **2015**, *33*, 1411–1419. [CrossRef] [PubMed]
26. Fernández-González, P.; Koutsou, A.; Cuesta-Gómez, A.; Carratalá-Tejada, M.; Miangolarra-Page, J.C.; Molina-Rueda, F. Reliability of Kinovea® Software and Agreement with a Three-Dimensional Motion System for Gait Analysis in Healthy Subjects. *Sensors* **2020**, *20*, 3154. [CrossRef]
27. R Core Team. *R: A Language and Environment for Statistical Computing*; R Foundation for Statistical Computing: Vienna, Austria, 2021.
28. Kuznetsova, A.; Brockhoff, P.B.; Christensen, R.H. lmerTest package: Tests in linear mixed effects models. *J. Stat. Softw.* **2017**, *82*, 1–26. [CrossRef]
29. Lenth, R.V. emmeans: Estimated Marginal Means, aka Least-Squares Means. 2023. Available online: https://CRAN.R-project.org/package=emmeans (accessed on 15 May 2025).
30. Schielzeth, H.; Dingemanse, N.J.; Nakagawa, S.; Westneat, D.F.; Allegue, H.; Teplitsky, C.; Réale, D.; Dochtermann, N.A.; Garamszegi, L.Z.; Araya-Ajoy, Y.G. Robustness of linear mixed-effects models to violations of distributional assumptions. *Methods Ecol. Evol.* **2020**, *11*, 1141–1152. [CrossRef]
31. Moreira, P.E.D.; Dieguez, G.T.d.O.; Bredt, S.d.G.T.; Praça, G.M. The Acute and Chronic Effects of Dual-Task on the Motor and Cognitive Performances in Athletes: A Systematic Review. *Int. J. Environ. Res. Public Health* **2021**, *18*, 1732. [CrossRef]
32. Schaefer, S.; Scornaienchi, D. Table Tennis Experts Outperform Novices in a Demanding Cognitive-Motor Dual-Task Situation. *J. Mot. Behav.* **2020**, *52*, 204–213. [CrossRef]
33. Wood, G.; Vine, S.J.; Wilson, M.R. Working memory capacity, controlled attention and aiming performance under pressure. *Psychol. Res.* **2016**, *80*, 510–517. [CrossRef]
34. Avilés, C.; Navia, J.A.; Ruiz-Pérez, L.-M.; Zapatero-Ayuso, J.A. How Enaction and Ecological Approaches Can Contribute to Sports and Skill Learning. *Front. Psychol.* **2020**, *11*, 523691. [CrossRef]
35. Bergmann, F.; Gray, R.; Wachsmuth, S.; Höner, O. Perceptual-Motor and Perceptual-Cognitive Skill Acquisition in Soccer: A Systematic Review on the Influence of Practice Design and Coaching Behavior. *Front. Psychol.* **2021**, *12*, 772201. [CrossRef]
36. Fajen, B.R.; Riley, M.A.; Turvey, M.T. Information, affordances, and the control of action in sport. *Int. J. Sport Psychol.* **2008**, *40*, 79–107.

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