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Section IV – Psychological and Sociological Aspects of Sport and Exercise

Criterion-Related Validity of the Skills.Lab Arena as a Soccer-Specific Assessment of Technical, Motor, and Cognitive Performance in Elite Youth Soccer Players

by

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This study aimed to examine the criterion-related validity and discriminatory capacity of a newly developed test battery administered in the Skills.Lab Arena, designed to assess technical, motor and cognitive performance in elite youth soccer players. Thirty-two male players (aged 14–15 years) completed four Skills.Lab Arena tasks (ground passing to a target, cognitive passing to a target, cognitive passing to a moving target, agility with a ball) and the Loughborough Soccer Passing Test (LSPT). Coaches independently rated each player's potential to reach the professional level, and a median split was applied to classify players into high- and low-potential groups. Criterion-related validity was evaluated using Pearson correlations between Skills.Lab outcomes and LSPT performance, while group differences were assessed with independent-samples t-tests. Receiver operating characteristic (ROC) analyses were conducted to determine the discriminatory ability of the Skills.Lab measures. Moderate-to-large correlations were found between Skills.Lab performance and LSPT time (r = 0.37–0.58). High-potential players outperformed low-potential players across most Skills.Lab tasks, with medium-to-large effect sizes (d = 0.84–1.23). ROC analyses provided additional support for the discriminatory capacity of most Skills.Lab measures, although the strength of discrimination varied across outcomes (AUC = 0.61–0.79). Overall, the findings provide preliminary evidence supporting the criterion-related validity of the Skills.Lab Arena test battery for assessing soccer-specific technical, motor, and cognitive performance in elite youth players.

***Keywords**: soccer; youth athletes; motor-cognitive skills; talent identification*

Introduction

Soccer is a sport characterized by complex perceptual, motor and cognitive demands arising from its open-skill nature, where performance depends on the ability to rapidly process information, anticipate emerging game situations and make effective decisions under time pressure (Araújo et al., 2019; Roca et al., 2012). Higher-level players typically show more efficient perceptual-cognitive processing, supporting effective motor execution and ultimately contributing to their competitive advantage (Huzarska-Rynasiewicz et al., 2026; Mann et al., 2007; Roca et al., 2018; Scharfen and Memmert, 2019; Vestberg et al., 2017). Assessing such integrated abilities is therefore crucial, as it provides insight into how effectively young players perceive, interpret and respond to dynamic match situations (Kelly et al., 2021), an aspect considered central in contemporary talent-identification frameworks (Murr et al., 2018; Triggs et al., 2025).

However, many commonly used soccer assessments do not fully reflect these demands. Traditional testing procedures focus largely on isolated physical, motor or technical skills

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(Clemente et al., 2022; Dambroz et al., 2022). Although informative, they fail to capture the cognitive complexity and decision-making requirements inherent to real match play. This limitation is particularly relevant in soccer, where concurrent motor and cognitive demands can impair tactical performance (Moreira et al., 2025). To evaluate tactical behavior and decision making in more representative contexts, game-based tools such as the game performance assessment instrument (Oslin et al., 1998), the game performance evaluation tool (Memmert and Harvey, 2008), and the system of tactical assessment in soccer (Costa et al., 2011) have been introduced. Yet their diagnostic precision remains limited because they rely heavily on subjective observations and lack consistent replication of the perceptual and cognitive demands characteristic of competitive environments (García López and Gutiérrez Diaz del Campo, 2018).

In recent years, this gap between diagnostic practice and the true demands of soccer has stimulated the development of more ecologically valid assessment methods. With increasing evidence for the role of cognitive functions in technical and tactical performance (Habekost et al., 2024; Vestberg et al., 2012, 2017), recent work has shifted toward assessments that embed perceptual-cognitive demands into soccer-specific motor tasks. This shift is reflected in a range of methodological innovations, including light-based visual processing manipulation using the Okkulo system to enhance visuomotor responsiveness (Rodrigues et al., 2025), immersive 360° video-based decision-making diagnostics that capture players' responses to realistic perceptual cues (Höner et al., 2023), as well as soccer-specific cognitive tasks integrating inhibitory control and cognitive flexibility with ball-related motor actions (Musculus et al., 2022). Recent evidence also shows that concurrent visual demands during soccer-specific dribbling modify performance and oculomotor behaviour (Heper et al., 2026), while visuomotor task complexity can influence training adaptations and transfer in ball-sport athletes (Zhang et al., 2026). Collectively, these approaches highlight a growing movement toward assessment and training paradigms that more accurately represent the complex cognitive-motor interactions characteristic of competitive play (Ward and Williams, 2003).

Building on this methodological progression, the ecological dynamics framework provides a broader theoretical rationale for developing testing environments that preserve the functional coupling between perception, cognition and action under conditions representative of the match context (Araújo et al., 2019; Roca et al., 2013). From this perspective, traditional laboratory tests lack the informational coupling that characterises real match behavior. Friebe et al. (2024b) developed a dual-task agility test specifically designed to quantify a player's ability to coordinate rapid changes of direction while processing time-critical visual and cognitive stimuli. Their findings showed that this integrated performance measure differentiated players across competitive levels and aligned meaningfully with match-derived indicators of expertise. The validity of this method was further supported by intervention research demonstrating the positive effects of 6-week motor-cognitive agility training on soccer performance (Friebe et al., 2024a).

Within this framework, the Skills.Lab Arena represents a significant advancement in soccer-specific performance assessment. The system provides an automated, three-dimensional environment enabling simultaneous evaluation of technical, motor and cognitive abilities under realistic, game-like conditions. It uses projected visual stimuli, motion tracking and real-time data acquisition to objectively assess reaction speed, technical precision and decision-making behavior. Building on these theoretical premises, Dolata et al. (2025) demonstrated that the Skills.Lab Arena offers a reliable and practically relevant platform for assessing soccer performance, showing that integrating motor and cognitive challenges within a controlled environment yields precise and reproducible data on players' abilities.

The aim of the present study was to advance the Skills.Lab Arena assessment system by examining the criterion-related validity of a newly developed integrated test assessing motor, technical and cognitive performance. Given that previous research has established the system's reliability and practical usefulness, the current study focused on determining whether this integrated test provides meaningful information beyond traditional technical assessments in identifying players with higher performance potential. Criterion-related validity was examined

by comparing test results with a traditional technical test and with external soccer-specific indicators, including the Loughborough Soccer Passing Test (Le Moal et al., 2014). In addition, test results were compared between two groups classified according to coaches' player ratings, representing expert evaluations of players' potential to compete at the professional level (Friebe et al., 2024b; Kelly et al., 2021). It was hypothesised that players rated as having higher potential would achieve better results, supporting the test's sensitivity to players' development and its criterion-related validity.

Methods

Participants

Thirty-two elite youth male soccer players aged 14–15 years (mean ± SD: 14.6 ± 0.5 years; body mass: 58.4 ± 7.2 kg; body height: 1.70 ± 0.07 m; weekly training load: ~10 h/week) participated in the study, providing sufficient statistical power for the analyses. An a priori power analysis was conducted using G*Power (version 3.1.9). Based on the effect size of $d = 1.28$ reported by Friebe et al. (2024a) for an independent-samples *t*-test between groups on a motor-cognitive agility measure, with an alpha level of 0.05 and statistical power of 0.95, the minimum required sample size was determined to be 30 participants. All players had at least three years of competitive experience and were regularly involved in structured training at a soccer club, practicing four times per week and competing in one championship match each weekend. Prior to the study, informed assent was obtained from all players, and written informed consent was provided by their legal guardians. This study was conducted following the principles of the Declaration of Helsinki and approved by the Bioethics Committee at the Poznan University of Medical Sciences, Poznań, Poland (Resolution No. 92/24; approval date: 08 February 2024).

Skills.Lab Arena

Motor and cognitive performance in soccer-specific tasks was assessed using the Skills.Lab Arena system (Anton Paar SportsTec GmbH, Austria). The setup consisted of four programmable ball machines (Machines 1–4) able to deliver balls at velocities of up to 130 km/h, and six high-speed cameras (resolution 2448 × 2048 pixels; 40 frames per second) that recorded ball flight and impact positions. Around the playing area, six projection surfaces with a total display area of approximately 60 m² presented visual targets and game scenarios. Ball impacts on the screens were detected by the system with an average spatial error of about 3.6 cm. System control and data acquisition were handled by dedicated servers running a 64-bit Linux Mint 21.2 operating system.

A detailed technical description of the Skills.Lab Arena, including calibration procedures, measurement accuracy, and system architecture, has been provided elsewhere (Dolata et al., 2025). In the present study, the system was used to administer four standardized tasks capturing different aspects of soccer-specific technical skills, motor abilities, and cognitive performance. Each task assessed performance based on the number (pts) of successful passes and/or shots (Tasks 1–3) and the time (s) required to execute each action.

Task 1—Ground Passing to a Target

In the first task, players executed ground passes to stationary targets displayed on the projection screens. Each player started in front of Machine 1, which delivered 10 consecutive balls at a speed of 40 km/h. After receiving the ball, the player controlled it and immediately played a ground pass towards a highlighted target zone appearing alternately on the left and right screens. This task primarily assessed first touch and passing accuracy, but also required rapid adjustment of the body position and decision making in response to the changing target locations and the pace of incoming balls (Figure 1, panel A).

Task 2—Cognitive Passing to a Target

The second task combined basic passing technique with a simple reorientation component. Players were positioned in the center of the Arena and received 20 passes delivered alternately from Machines 1 and 4 at a speed of 50 km/h. After controlling each ball, the player performed a 180° turn and then passed accurately to a static virtual teammate displayed on one of the screens. The position of the target varied between trials, so the player had to quickly identify the correct receiver, reorient the body, and adapt the direction and force of the pass. The task challenged technical execution, spatial orientation, and speed of

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information processing (Figure 1, panel B).

Task 3—Cognitive Passing to a Moving Target

The third task increased the cognitive and perceptual demands by introducing moving targets and virtual defenders. As in Task 2, players started from a central position and received 20 passes alternately from Machines 1 and 4, delivered at 55 km/h. After reception and a 180° turn, the player adjusted their position and played a pass to a moving virtual teammate displayed on the screen, while static defenders were shown as potential obstacles. Successful performance required anticipation of the target's movement, selection of an appropriate passing lane, and continuous adaptation of passing technique in a game-like decision-making context (Figure 1, panel C).

Task 4—Agility with a Ball

The fourth task focused on agility with the ball in a limited space. Players started near Machine 4, received a pass at a speed of 25 km/h, and then dribbled the ball as quickly as possible within a rectangular area measuring 3 × 5 m, following predefined movement constraints. The task required rapid changes of direction, close ball control, and quick adjustments of footwork and the body position in response to the ball trajectory and spatial limitations. Performance in this test reflected the player's ability to combine agility, speed, and technical control in a dynamically changing environment (Figure 1, panel D).

Loughborough Soccer Passing Test (LSPT)

Soccer-specific skills were assessed using the LSPT (Le Moal et al., 2014). The LSPT is a standardized soccer-specific test that evaluates passing accuracy, ball control, agility, and decision making under time pressure. During the test, players react to an unpredictable auditory signal indicating the color of the target and are required to pass the ball as quickly and accurately as possible to one of the four rebound boards, each marked with a different color. As soon as the ball returns to the player, the next color is called, forcing rapid reorientation, adjustment of the body position, and execution of another pass toward the newly indicated target. Each trial consists of 16 consecutive passes. The primary outcome measures are the total time needed to complete the trial and the additional penalty time assigned for technical or decision-related errors (such as inaccurate passes, hitting cones, or passing to the wrong target). The LSPT was performed three times following one familiarization trial, and the best performance was used for further analysis.

Procedure

The order of the tests was determined using block randomization across all participants. To minimize learning effects, a familiarization session was conducted one hour before the main testing session. On each testing day, players performed a standardized warm-up consisting of 10 min of jogging, joint mobility exercises, dynamic lower-limb stretching, and 5 min of ball-control exercises. The test sessions (Skills.Lab Arena, LSPT) were carried out on separate days, and all measurements for each player were conducted at the same time of the day to reduce potential influences of circadian variation on motor and cognitive performance.

Coaches' Rating

Players' potential was evaluated by eight experienced coaches (head coaches, assistant coaches, and strength and conditioning coaches), who independently rated the likelihood that each player would reach the professional level. In making these judgments, the coaches considered both motor abilities and game-related competencies. This form of expert evaluation has been reported as a valid and reliable indicator of long-term career progression in youth soccer (Friebe et al., 2024b). Coaches provided their ratings on a seven-point Likert scale ranging from 1 (very low potential) to 7 (very high potential). For each player, the mean coach rating was calculated and used for further analyses. Based on these ratings, players were divided into two subgroups using a median-split procedure, resulting in a high-potential group (HP, ratings >4.0) and a low-potential group (LP, ratings ≤4.0).

Statistical Analysis

After an initial plausibility check of the raw data, the Shapiro-Wilk test was used to assess normality and the Brown-Forsythe test was applied to examine homogeneity of variances. To evaluate the criterion-related validity of the Skills.Lab Arena tests, performance outcomes were correlated with the Loughborough Soccer Passing Test using the Pearson product-moment

correlation coefficient. In addition, independent-samples *t*-tests were conducted to determine whether the test battery discriminated between players classified into high- and low-potential groups based on the median value of the coaches' ratings. Furthermore, receiver operating characteristic (ROC) analyses were performed to examine the discriminatory ability of the Skills.Lab Arena outcomes to classify players into high- and low-potential groups. For each test, the area under the curve (AUC), optimal cut-off value (Youden, 1950), sensitivity, and specificity were calculated. The alpha level was set at $p < 0.05$. Correlation coefficients were interpreted as small ($|r| = 0.10–0.29$), moderate ($|r| = 0.30–0.49$), and large ($|r| \geq 0.50$), according to Cohen (1988). Effect sizes for group differences were expressed as Cohen's d and classified as small ($d < 0.40$), medium ($0.40 \leq d < 0.80$), and large ($d \geq 0.80$). All statistical analyses were performed using JASP software (version 0.16.1, jasp-stats.org).

Results

Descriptive statistics for all administered tests, expressed as mean values with standard deviations and 95% confidence intervals, are presented in Table 1.

A consistent pattern of associations emerged, showing that shorter LSPT time correlated with shorter execution time in the ground passing to a target test ($r = 0.576$, $p < 0.001$) and with higher accuracy ($r = −0.404$, $p = 0.022$). Similarly, shorter LSPT time was related to shorter execution time in the cognitive passing to a target test ($r = 0.420$, $p = 0.017$) and to higher accuracy ($r = −0.373$, $p = 0.036$). A comparable pattern was observed in the more demanding cognitive passing to a moving target test, where shorter LSPT time was associated with shorter execution time ($r = 0.538$, $p = 0.001$). Shorter LSPT performance time also correlated with faster execution in the agility with a ball test ($r = 0.477$, $p = 0.006$). No significant association was found between LSPT time and accuracy in the cognitive passing to a moving target task ($p = 0.139$). Scatterplots of the significant correlations between the LSPT and Skills.Lab Arena test outcomes are displayed in Figure 2 (panels A–F).

Players in the HP group outperformed those in the LP group across most Skills.Lab Arena tests (Table 2). The division into HP and LP groups was based on a median split of the Potential Rating score (median = 4.0). In the ground passing to a target test, the HP group achieved shorter execution times (2.31 ± 0.25 s vs. 2.57 ± 0.35 s, $p = 0.023$, $d = 0.85$) and higher accuracy (8.60 ± 1.50 vs. 6.80 ± 1.42, $p = 0.002$, $d = 1.23$). In the cognitive passing to a target test, HP players again performed faster (2.69 ± 0.06 s vs. 2.78 ± 0.13 s, $p = 0.025$, $d = 0.84$), whereas the difference in accuracy was not significant (4.16 ± 1.09 vs. 3.68 ± 0.94, $p = 0.192$). A similar pattern emerged in the cognitive passing to a moving target test, with faster execution in the HP group (2.99 ± 0.29 s vs. 3.25 ± 0.27 s, $p = 0.015$, $d = 0.91$) and higher accuracy (8.55 ± 3.21 vs. 5.81 ± 2.11, $p = 0.007$, $d = 1.02$). In the agility with a ball, HP players also completed the course faster than LP players (20.15 ± 0.95 s vs. 21.13 ± 0.90 s, $p = 0.005$, $d = 1.06$).

To further evaluate the discriminatory capacity of the Skills.Lab Arena tests, ROC analyses were conducted (Table 3). AUC values ranged from 0.61 to 0.79. Six of the seven outcomes demonstrated acceptable discriminatory capacity (AUC = 0.70–0.79), whereas accuracy in the cognitive passing to a target task showed weak discrimination (AUC = 0.61). The highest AUC values were observed for ground passing to a target accuracy and agility with a ball time (both AUC = 0.79), followed by cognitive passing to a moving target accuracy (AUC = 0.77) and execution time (AUC = 0.75).

Discussion

The primary aim of this study was to evaluate the criterion-related validity and discriminatory capacity of the newly developed Skills.Lab Arena test battery. The results demonstrated consistent associations between performance in the Skills.Lab Arena tasks and the Loughborough Soccer Passing Test, clear differences between players classified as of high and low potential, and outcome-dependent discriminatory capacity in ROC analyses. These findings support the relevance of the Skills.Lab Arena system as an integrated assessment of soccer-specific technical, motor and cognitive performance.

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Table 1. Descriptive statistics of the conducted performance tests.

Test	Measure	Mean ± *SD* (95% CI)
Ground passing to a target	time (s)	2.45 ± 0.33 (2.33–2.57)
	accuracy (pts)	7.64 ± 1.70 (7.03–8.26)
Cognitive passing to a target	time (s)	2.73 ± 0.11 (2.69–2.77)
	accuracy (pts)	3.91 ± 1.02 (3.54–4.28)
Cognitive passing to a moving target	time (s)	3.13 ± 0.30 (3.02–3.24)
	accuracy (pts)	7.09 ± 2.98 (6.02–8.17)
Agility with a ball	time (s)	20.67 ± 1.03 (20.30–21.04)
LSPT	time (s)	36.01 ± 1.85 (35.35–36.68)
Potential rating	score (pts)	4.72 ± 0.98 (4.37–5.07)

LSPT: Loughborough Soccer Passing Test; CI: confidence interval

Table 2. Group differences (HP vs. LP) in Skills.Lab Arena test performance.

Test	Measure	HP (n = 15) (mean ± *SD*)	LP (n = 17) (mean ± *SD*)	t	p	Cohen's d
Ground passing to a target	time (s)	2.31 ± 0.25	2.57 ± 0.35	−2.39	0.023	−0.85
	accuracy (pts)	8.60 ± 1.50	6.80 ± 1.42	3.48	0.002	1.23
Cognitive passing to a target	time (s)	2.69 ± 0.06	2.78 ± 0.13	−2.36	0.025	−0.84
	accuracy (pts)	4.16 ± 1.09	3.68 ± 0.94	1.33	0.192	0.47
Cognitive passing to a moving target	time (s)	2.99 ± 0.29	3.25 ± 0.27	−2.58	0.015	−0.91
	accuracy (pts)	8.55 ± 3.21	5.81 ± 2.11	2.88	0.007	1.02
Agility with a ball	time (s)	20.15 ± 0.95	21.13 ± 0.90	−3.00	0.005	−1.06

HP: high-potential group; LP: low-potential group.
Negative t and d values indicate faster performance in the HP group

Table 3. ROC analysis for classification between HP and LP players based on Skills.Lab Arena tests.

Test	Measure	AUC	Cut-off value	Sensitivity (%)	Specificity (%)
Ground passing to a target	time (s)	0.72	2.62	93.3	47.1
	accuracy (pts)	0.79	8.50	66.7	94.1
Cognitive passing to a target	time (s)	0.70	2.69	60.0	82.4
	accuracy (pts)	0.61	4.80	33.3	88.2
Cognitive passing to a moving target	time (s)	0.75	3.18	86.7	58.8
	accuracy (pts)	0.77	7.10	73.3	82.4
Agility with a ball	time (s)	0.79	20.61	66.7	82.4

AUC: area under the curve; higher AUC values indicate better discriminatory capacity

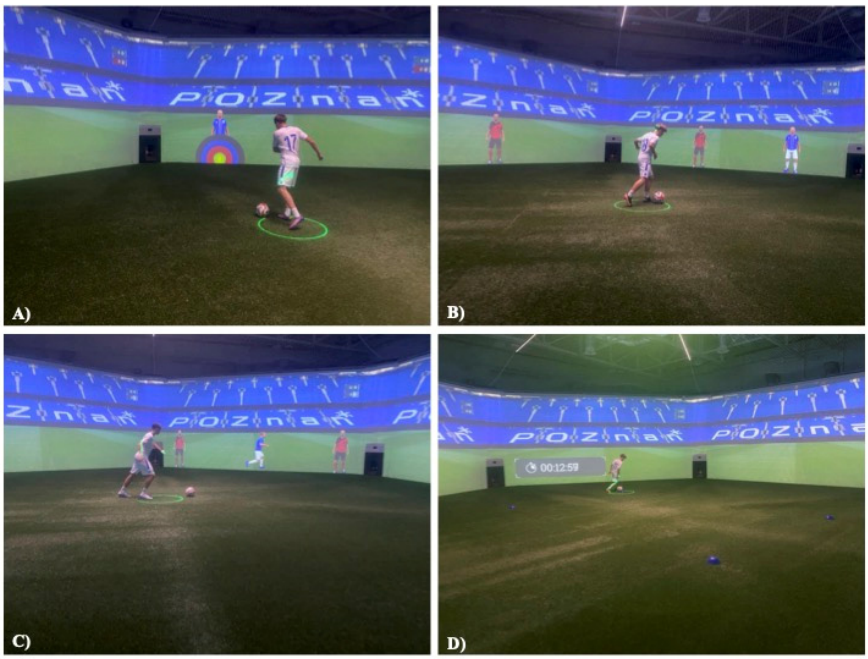


Figure 1. Examples of test setups in the Skills.Lab Arena: (A) ground passing to a target, (B) cognitive passing to a target, (C) cognitive passing to a moving target, and (D) agility with a ball.

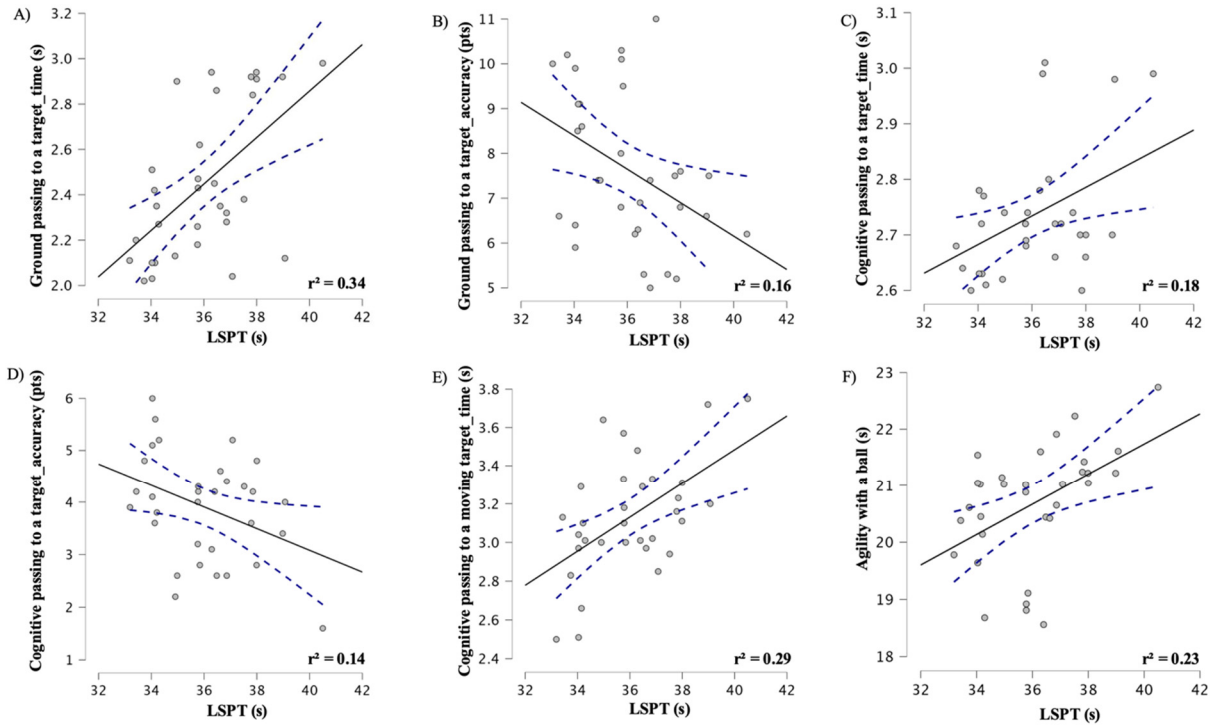


Figure 2. Scatterplots with linear regression lines illustrating the relationships between LSPT performance and Skills.Lab Arena test outcomes (A–F).

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A central aspect of the present findings is the relationship between Skills.Lab Arena performance and the LSPT, a widely used test of short-passing ability in youth soccer that combines time pressure with error-based scoring and integrates ball control, passing accuracy, perceptual processing and temporal constraints (Le Moal et al., 2014; Wang et al., 2024). The moderate-to-large correlations observed in this study (Figure 2) suggest that the Skills.Lab Arena tasks capture perceptual-motor demands similarly to those assessed by the LSPT. At the same time, the Skills.Lab Arena may extend beyond traditional technical assessments by integrating perceptual stimuli, dynamic targets, and real-time decision-making demands within a single testing environment. This integrated design may allow the system to capture aspects of perception-action coupling and visuomotor coordination that are more difficult to assess using conventional isolated technical tests. Consequently, the Skills.Lab Arena may provide complementary diagnostic information regarding players' ability to perform technical actions under cognitively demanding and more game-representative conditions. Overall, the observed relationships likely reflect shared demands related to rapid information processing, attention allocation, and the integration of multiple stimuli during movement execution.

In contrast, the lack of a significant association between LSPT time and accuracy in the cognitive passing to a moving target task suggests that this task may place additional demands on the spatiotemporal prediction and tracking of dynamic stimuli that go beyond the competencies primarily assessed in the LSPT. While LSPT performance reflects accurate passing under time pressure in a relatively constrained environment, successfully hitting a moving target requires continuous updating of ball-target relationships and more complex anticipatory control. This pattern indicates that the cognitive passing to a moving target accuracy measure may capture complementary aspects of game-relevant decision making and visuomotor coordination that are not fully represented in traditional passing assessments (Clemente et al., 2022).

Furthermore, the significant association between LSPT performance and agility with a ball aligns with research showing that agility-related abilities are important predictors of LSPT outcomes, underscoring the relevance of rapid changes of direction under time pressure for successful passing in perceptually and cognitively demanding situations (Benounis et al., 2013). At the same time, contemporary conceptualisations of agility emphasise that, although fast reactions to external stimuli are essential in unpredictable match situations, agility at the competitive level also relies on higher-order perceptual and decision-making processes such as anticipation and game reading (Sheppard and Young, 2006; Spiteri et al., 2018). This view is supported by studies demonstrating that executive functions, including inhibition, cognitive flexibility and attentional control, contribute meaningfully to on-field performance and the competitive level, explaining variance beyond anthropometric data and standard motor or technical tests (Huijgen et al., 2015; Vestberg et al., 2017).

Differences between high- and low-potential players provide an additional line of evidence for the criterion-related validity of the Skills.Lab Arena tests. In the present study, players classified as of high potential completed almost all tasks faster and, in most cases, with higher accuracy than their lower-potential peers, with effect sizes in the moderate-to-large range. From a validity perspective, the ability of an assessment to discriminate between groups differing in the current or expected performance level is a key requirement in talent-identification research (Murr et al., 2018). Similarly, Friebe et al. (2024b) demonstrated that a motor-cognitive dual-task agility test performed on the Skillcourt platform clearly differentiated elite youth players with higher coach-rated potential and greater playing time from those with lower ratings, using a median-split classification. This convergence indicates that motor-cognitive integrated testing formats, such as the Skills.Lab Arena and the Skillcourt dual-task test, are particularly sensitive to differences in players' quality and may therefore represent robust components within multidimensional talent-identification frameworks.

The ROC analyses further complemented these findings. Most outcomes demonstrated acceptable discriminatory capacity (AUC = 0.70–0.79), whereas cognitive passing to a target accuracy showed weak discrimination (AUC = 0.61). The highest AUC values were observed for

ground passing to a target accuracy and agility with a ball time (both AUC = 0.79). According to widely used guidelines, AUC values between 0.70 and 0.80 reflect adequate discrimination (Hosmer and Lemeshow, 2000). Overall, the ROC findings provide additional, although outcome-dependent, evidence of the test battery's ability to distinguish between players with higher and lower developmental potential.

From a theoretical standpoint, the present findings are consistent with the broader concept of perception-action coupling, which emphasises the continuous interaction among perceptual cues, cognitive processing and motor execution in open-skill sports (Araújo et al., 2006; Farrow and Abernethy, 2003; Roca et al., 2018). In this context, the Skills.Lab Arena system can be regarded as a practical implementation of this framework, as it requires players to interpret complex visual stimuli, select appropriate responses and perform precise actions under time pressure. Moreover, earlier research demonstrated that the Skills.Lab Arena provides reliable and practically useful indices of technical and cognitive performance in real time (Dolata et al., 2025), further strengthening the argument that it constitutes a valid and functionally meaningful platform for assessing soccer-specific abilities.

The practical implications of these findings are substantial. The Skills.Lab Arena tests may complement traditional technical assessments and subjective coach evaluations. Their added value lies in the ability to recreate perceptual-cognitive demands that are difficult to capture in standardised technical drills, thereby providing a more representative picture of game-relevant performance. This perspective aligns with broader recommendations in performance diagnostics, where authors argue that incorporating cognitive variables and realistic perceptual challenges into testing protocols results in a more comprehensive and valid evaluation of players' potential (Friebe et al., 2023; Musculus et al., 2022; Schumacher et al., 2024).

Several limitations must be acknowledged. The study involved a relatively small and homogeneous sample of elite male youth soccer players aged 14–15 years, which may limit the generalisability of the findings to other age groups, competitive levels, and female players. Accordingly, the present results should be interpreted as preliminary and population-specific. Moreover, although coach-rated potential has meaningful predictive value in talent research, it remains an indirect and partly subjective indicator of long-term success. In addition, given evidence that fatigue can influence multiple dimensions of soccer performance (Gnanasigamani et al., 2026), future validation protocols should carefully standardise and report the players' fatigue state at the time of testing. Future studies should therefore include broader and more diverse samples and apply longitudinal designs linking test outcomes with objective match-performance indicators and long-term players' development. Such approaches would provide stronger evidence for the practical predictive value of the Skills.Lab Arena assessments.

Conclusions

The findings of this study indicate that the Skills.Lab Arena test battery may represent a useful tool for assessing key technical, motor, and cognitive abilities relevant to soccer performance in elite youth players. By capturing multiple components of performance within a single, integrated testing format, the system may provide diagnostic information that complements traditional assessments. Overall, these findings provide preliminary support for the use of the Skills.Lab Arena as a complementary tool within multidimensional talent identification and players' development frameworks.

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