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ORIGINAL ARTICLE

Speed of Thought and Speed of Feet: Examining Perceptual-Cognitive Expertise and Physical Performance in an English Football Academy

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Abstract

The world's greatest professional football players are able to execute effective tactical decisions as well as fulfil various physical demands. However, the degree to which both are associated with greater potential in a football academy is unknown. Therefore, the aim of this study was to investigate decision-making skill and physical performance as contributing factors to coach potential rankings in an English football academy. Ninety-eight outfield academy players (Foundation Development Phase [FDP] under-9 to under-11 $n=40$; Youth Development Phase [YDP] under-12 to under-16 $n=58$) participated in the study. They engaged in 45 film-based simulations at two occlusion phases (e.g., the visual display is cut-off at a precise time during an action), firstly "during" and secondly "post" execution, to examine decision-making skill. Participants also completed four fitness tests to examine physical performance. A classification of "higher-potentials" (top third) and "lower-potentials" (bottom third) were applied through coach rankings. Independent *t*-tests compared the decision-making and physical performance tests. Higher-potentials made significantly more accurate decisions within the "post" phase within the FDP ($P<0.05$) and the "during" phase within the YDP ($P<0.05$). Additionally, higher-potentials were significantly faster for the 0–30 m sprint in both the FDP and YDP ($P<0.05$), with higher-potentials within the YDP also significantly faster in the 0–10 m sprint ($P<0.05$) and jumped significantly higher in the countermovement jump ($P<0.05$). These findings indicated that greater football potential may be associated with superior perceptual-cognitive expertise and quicker sprint ability in both academy age phases, with a greater discriminatory function within the older cohort.

Keywords Decision-making · Sprint ability · Fitness testing · Academy football · Talent identification · Talent development

Introduction

Football academies in England are specialist-training programmes established and funded by professional football clubs with the primary objective of developing players towards senior professional status [14, 25]. As a result of the complex and dynamic nature of the talent development process in youth football, over 90% of players who join an academy fail to make it as a professional [36]. Therefore, it is in each individual academy's interest to provide their youth football players' the maximum opportunity to develop and achieve their potential. As a result, it is important to measure and analyze factors that may contribute to greater development, to further support developmental systems and processes applied within youth football. The world's greatest professional football players are characterised by expert decision-making ability, whilst possessing outstanding physical competencies, both of which have a critical impact on performance [40]. Consequently, the cognitive function of perceptual-cognitive expertise (PCE) [3, 44, 45, 52, 53, 55] and the physiological feature of physical performance [5, 6, 35, 42, 46, 51, 58], should be explored at academy level to examine their respective contribution towards coach perceptions of potential.

Through applying film-based simulation tests, researchers possess the capability to analyze a participant's ability

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to select correct situational probabilities and strategic decision-making skill [44, 49, 54]. For example, according to McPherson and Kernodle [33], experts develop memory structures called "action plan profiles" and "current event profiles" that facilitate superior strategic decisions during competitive situations. The ability to process and recognise specific situations is a result of the multifaceted and selective long-term memory structures, which is crucial for anticipation and decision-making in football [53]. Players must process information from the ball, teammates, and opponents before deciding on an appropriate response based upon the current objectives (e.g., tactics and opposition) and actions (e.g., technical skill and physical capacity). These decisions are repeatedly made under pressure, with opponents trying to limit time and space accessible to execute the desired action [53]. Indeed, Roca et al. [45], Ward and Williams [52], and Williams et al. [55] found advanced PCE in youth football players from professional youth academies between the ages of 9 and 17 years in comparison to "sub-elite" and "non-elite" groups. Thus, PCE can be considered an important characteristic to develop in young football players.

However, whilst studies examining PCE from a football perspective have generally tested a single occlusion phase (e.g., the visual display of an opponent's action is cut-off at a precise time during an action) to discriminate performance outcomes, Belling et al. [3] applied three occlusion points to test decision-making ability. During their Online Assessment of Strategic Skill in Soccer (OASSIS), Belling et al. [3] used "pre", "during", and "post" execution clips to observe PCE through decreasing difficulty as a result of occluding before, during, or after the player on the ball has executed their necessary action, respectively. Their results revealed that domain-specific skill, namely decision-making ability, is more predictive of skill-group membership compared to domain-general measures (i.e., the Berlin Numeracy Test and the Mental Rotations Test). Belling et al. [3] also highlighted how they experienced difficulty in securing highly-skilled participants, thus highlighting the need to test the determinants of PCE ability and tangible potential independent of academy football players.

Football is a physically competitive sport that is characterised by varying intermittent sprints and explosive actions [29]. Barnes et al. [1] illustrated that the evolution of sprinting attributes had increased in the English Premier League from 2006-07 to 2012-13, such as, sprint distance (+35%), number of sprints (+80%), and high-intensity running distance (+30%). Therefore, the talent development process within football academies must consider physical performance measures to identify and develop this athletic ability. Physical performance measures provide an objective evaluation of a young football players' athletic development and performance [13, 20, 22, 27, 43]. Despite the conflicting data within physical performance studies [7, 8, 22, 23, 32] the general consensus supports the use of fitness testing in youth football. For instance, Williams et al. [56] discovered sprint changes increased beyond the "worthwhile" effect of 1% for 0–10 m and 0–30 m sprints, as well as 1.8% for countermovement jump (CMJ) performance during the early teenage years.

Further research from Gil et al. [17, 18] and Mirkov et al. [37] revealed how explosive muscle power, sprint performance, agility, and coordination are characterised by chronological age in "elite" youth football players aged 11–14 years. Deprez et al. [12] and Le Gall et al. [27] also proposed that several fitness characteristics, including measures assessed by the CMJ and 0–40 m sprint, may determine the likelihood of players proceeding to higher standards of football in international youth football players at under-14 and under-16 age groups. Likewise, Gonaus and Muller's [19] ten-year longitudinal study revealed a combination of physiological variables are useful for discriminating "drafted" national youth team players against their "non-drafted" peers, with football-specific speed and upper limb power appearing to be the greatest predictors. In addition, Emmonds et al. [15] revealed 0–10 m and 0–20 m sprint at under-16 and under-18′s had a significant influence on obtaining a professional contract at aged 18 years. It is important to highlight that these particular studies are often retrospective in design, ignore the current observations regarding age group development, and are regularly examined within a single discipline (e.g., psychological or physiological).

Although PCE research has been investigated within youth football previously, the originality of this current study is the incorporation of two decision-making phases, including "during" and "post" execution. The inclusion of two decision-making phases is a result of the proposed increase in difficulty of the "during" phase clips compared to the "post" phase clips, which may provide a useful method to discriminate age and/or potential. Additionally, the incorporation of physical performance measures supports the novelty of a multidimensional approach required for talent development literature [11]. Thus, the purpose of this study was to examine the discriminant function of decision-making ability (film-based simulation tests) and physical performance measures (fitness tests) based on whether they could differentiate "higher-potentials" and "lower-potentials" (coach potential rankings) from an age phase-specific perspective (Foundation Development Phase [FDP] and Youth Development Phase [YDP]).

Methods

Sample and Design

Ninety-eight male participants were examined within their age phase; FDP (under-9 to under-11; $n=40$) and YDP (under-12 to under-16; $n=58$). All participants were recruited from the same Tier 4 English professional football club and their Category 3 academy. Only outfield players were included due to the contrasting development pathway for goalkeepers and their position-specific requirements [18]. Decision-making measures were conducted in a classroom as part of a typical training session, while fitness tests were collected as part of the clubs' ongoing physical development programme. Parental consent and player assent were collected prior to the study commencing. The study was approved by the Ethics Committee of Sport and Health Sciences at the University of Exeter.

Measures

Film-based simulation tests

Film-based simulation tests were applied to examine the players' decision-making skill, which have been proved to be valid and reliable measures for PCE research in youth football [3]. Action sequences were selected from live football match footage of academy players aged 18–19 years engaging in a competitive game, filmed from an elevated angle above and behind the goal. Following general build-up play of 5–10 s in duration, the clips unexpectedly occlude immediately prior to a critical decision moment. At this point, an occlusion display appears that shows the pitch lines (i.e., boundaries, eighteen yard box, and half way line) and the location of the ball on a white screen. This screen is frozen for 7 s whereby the participant has to select their answer on the response sheet before the next clip automatically begins.

Forty-five clips were created for two different phases ("during" and "post" execution), thus 90 clips are viewed by the players in total. "During" clips are considered more difficult as the occlusion happens as the action is executed, as opposed to the "post" clips that are occluded after the execution with a duration 0.5 s longer. Consequently, clips are viewed in this order, with a response sheet completed separately and collected before the next batch of clips begin, to prevent players changing their answer when they see the longer clips. The 45 film-based simulations are distributed into three decision-making skills, including "select action", "select direction", and "select pass recipient", thus creating 15 clips for each (see Fig. 1).

"Select action" requires the participant to choose one of three techniques they think the player on the ball is going to complete. "Select direction" requires the participant to choose one of four directions they think the player is about to play the ball. Finally, "select pass recipient" requires the participant to choose one of four teammates they think the person on the ball is going to pass to. Techniques are nominated from the answer sheet (pass, dribble, or shoot) for the "select action" clips, while options appear on the occluded white screen (A, B, C, and D) for the "select direction" and "select pass recipient" clips. The participants viewed all 90 film-based simulations (45 "during" and 45 "post" clips) through a high-definition video projector (Sony VPL-DX221). Players were seated separately for approximately 45 min and were unable to engage with each other; similar to generic examination conditions.

Physical performance tests

Physical performance tests were conducted with the participants to measure specific physiological parameters including acceleration, sprint, agility, and jump abilities. These tests were executed by the first author and have been proved valid and reliable measures for talent development research in youth football (e.g., [39, 41, 57]). Players were already familiarised with these testing procedures since they were already part of the academy fitness testing protocol.

The 0–30 m sprint test started 1 m behind the first set of timing gates (Brower TC Timing System, Draper, Utah, USA). Participants sprinted until passing the final set of timing gates. Timings for 0–10 m and 0–30 m were taken to observe acceleration and sprint speed respectively. The L-agility test required participants to start 1 m behind the first set of timing gates (Brower TC Timing System, Draper,

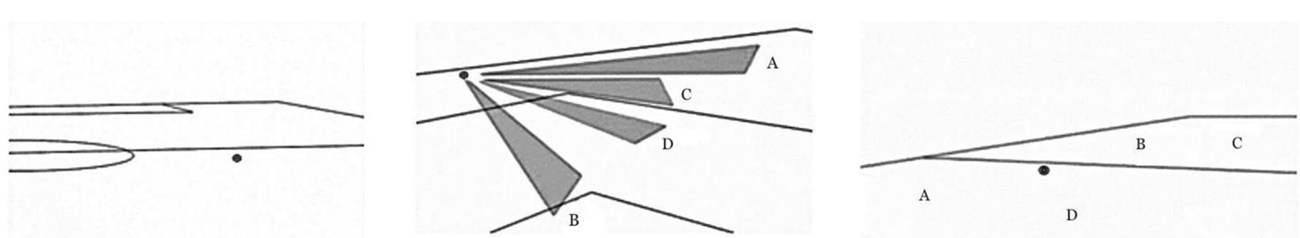

Fig. 1 Occlusion displays for PCE testing. Adapted from Belling et al. [3]

Utah, USA), then run forwards 5 m around the tall centre cone, run 5 m to the left hand cones and place one foot between the two marker cones, and then turn and follow the same path back to the start. In the second trial, players performed the same test, but this instance running 5 m to the cones on the right hand side. During the CMJ test (Just Jump system, Probotics Inc. 8602 Esslinger CT, Huntsville, Alabama, USA) players were instructed on the importance of using a countermovement and the need to take-off and land with straight legs, with the jump height (cm) recorded for analysis. Three trials were completed for each test with the best result taken for investigation. Players' conducted these physical performance tests in a sports hall, whist players' conducted a familiarity session prior to the data collection to counteract any earning effects.

Coach potential rankings

Two coaches from each age group ($n=16$), who were deemed suitable assessors (UEFA Pro, "A", or "B" Licensed alongside either the FA Advanced Youth Award or the FA Youth Award), were asked to rank their players from top to bottom in relation to their perception of the player's potential to develop to senior professional status. This created a linear classification of high potential players down to their low potential peers, with each age group then split into thirds using tertiles. This created a group of "higher-potentials", who represent the top third, and a group of "lower-potentials", who represent the bottom third. This enabled a distinct comparison between the higher-potentials and lower-potentials within each age group, with the middle third discarded from the study ($n=34$). For the purpose of this age phase-specific research, the higher- (height 144.6 ± 8.2 cm, weight 37.7 ± 5.6 kg, percentage of adult height attained 82.3% ± 3.8%) and lower-potentials (height 141.9 ± 7.9 cm, weight 35.8 ± 5.2 kg, percentage of adult height attained 81.2% ± 3.1%) from the under-9 to under-11 were grouped together within the FDP ($n=26$), and the higher- (height 166.3 ± 10.4 cm, weight 55.9 ± 11.7 kg, percentage of adult height attained 95.7 ± 3.9%) and lower-potentials (height 163.4 ± 12.1 cm, weight 52.7 ± 11.4 kg, percentage of adult height attained 93.2% ± 5.2%) from the under-12 to under-16 were grouped together within the YDP ($n=38$). The results from the PCE and physical performance tests were subsequently compared between higher- and lower-potentials throughout the FDP and YDP to observe any differences. It is important to highlight that coach perception regarding talent development has been used in previous empirical research [28], thus offering valid and reliable measure of player potential. In addition, coach observation and opinion is central to the subjective nature of youth sport, with modern objective information readily available to professional coaches to support their judgement [47, 48].

Data analysis

All data are expressed as z-score (mean ± standard deviation). As a result of the differing results between age groups due to their chronological age (e.g., older players anticipated to generally record greater PCE and physical abilities) data was standardised using z-scores within their respective age group, to allow an unbiased grouping of players in both the FDP and YDP. Independent samples t-tests were used to compare the higher- and lower-potentials PCE "during" and "post" tests and physical performance tests. The statistical power for the t-test for FDP and YDP was calculated for detecting a large effect size (Cohen's $d=0.8$) with significance considered at $P<0.05$. Effect sizes were interpreted as small 0.2, medium 0.5, and large 0.8 [10]. A binary logistic regression was also used to model higher- and lower-potential status within the FDP and YDP, comprising of univariate and multivariate analyses of PCE and physical performance tests. The pseudo R-squared values, odds ratios (ORs), and 95% confidence intervals (CIs) are reported for each model. Correlation analyses were used to examine the relationships between variables before further multivariate analysis was conducted. Multivariate logistic regression models of PCE and physical performance tests were assessed for multicollinearity [38]. Variables with a variance inflation factor (VIF) of less than 4.0 were included in the model [21]. All analyses were conducted using IBM SPSS Version 23.

Results

Film-based simulation tests

The statistical power was 0.63 for the FDP and 0.78 for the YDP. Within the FDP, there was a significant difference between higher- and lower-potentials for the PCE "post" test ($d=0.84$), with higher-potentials demonstrating greater mean results compared to the lower-potentials [$t(24)=2.15$, $P=0.042$]. Within the YDP, a significant difference was observed between higher- and lower-potentials in the PCE "during" test ($d=0.73$), with higher-potentials demonstrating greater mean results compared to the lower-potentials [$t(36.00)=2.27$, $P=0.030$]. Age phase z-scores and independent t-test results are displayed in Table 1. Actual mean values from each age group are shown in Table 2.

Univariate regression of PCE tests (see Table 3) showed a significant association of PCE "post" with higher-potentials within the FDP, but only accounted for a small amount of variance within the sample (Cox & Snell $R^2=0.158$). PCE "during" had a significant association with higher-potentials within the YDP, but the model only accounts for small variance (Cox & Snell $R^2=0.104$).

Physical performance tests

Within the FDP, there was a significant difference between higher- and lower-potentials for the 0–30 m sprint ($d = 1.24$), with higher-potentials demonstrating faster mean results compared to lower-potentials [$t(24) = -3.16$, $P = 0.004$]. The binary logistic regression of univariate factors within FDP showed significant associations between the 0–30 m sprint and higher-potentials (Cox & Snell $R^2 = 0.282$), with the 0–30 m variable significant within the univariate model ($P < 0.05$). Within the YDP, there was a significant difference between the higher- and lower-potentials in the 0–10 m sprint [$d = 1.21$; $t(36) = -3.70$, $P = 0.001$], 0–30 m sprint [$d = 1.86$; $t(36) = -5.79$, $P < 0.001$], and CMJ [$d = 0.97$; $t(36) = 2.00$, $P = 0.005$], with higher-potentials having superior mean results compared to the lower-potentials. The 0–10 m, 0–30 m, and CMJ had significant associations with higher-potentials from logistic regressions (Cox & Snell $R^2 = 0.269$, 0.457, and 0.192, respectively), with each variable significant within their respective model ($P < 0.05$).

Table 1 Descriptive statistics of *z*-scores and *t*-tests for PCE and physical performance tests

PCE and physical factors	Age phase	Higher-potentials	Lower-potentials	*P*
Film-based simulation tests				
PCE "during"	FDP	− 0.05 ± 1.03	− 0.20 ± 0.91	0.679
	YDP	0.43 ± 0.93	− 0.29 ± 1.09	**0.030**
PCE "post"	FDP	0.15 ± 0.84	− 0.58 ± 0.89	**0.042**
	YDP	0.19 ± 0.82	− 0.46 ± 1.14	0.052
Physical performance tests				
0–10 m sprint	FDP	− 0.20 ± 1.13	0.41 ± 0.89	0.134
	YDP	− 0.53 ± 0.80	0.56 ± 1.01	**< 0.001**
0–30 m sprint	FDP	− 0.41 ± 0.88	0.68 ± 0.87	**0.004**
	YDP	− 0.64 ± 0.81	0.74 ± 0.64	**< 0.001**
CMJ	FDP	0.11 ± 0.95	− 0.20 ± 1.04	0.439
	YDP	0.54 ± 1.05	− 0.37 ± 0.80	**0.005**
L-agility test	FDP	− 0.37 ± 1.09	0.20 ± 0.92	0.163
	YDP	− 0.16 ± 0.98	0.33 ± 1.01	0.136

Table 2 Age group actual mean values across PCE and physical performance tests

PCE and physical factors	FDP			YDP				
	U9	U10	U11	U12	U13	U14	U15	U16
Film-based simulation tests								
PCE "during"								
Higher-potentials	24.2	28.33	29.2	29	28.5	31.8	28.5	34
Lower-potentials	26.6	24.33	28.2	24.25	25.5	28.4	31	29.5
PCE "post"								
Higher-potentials	26.4	31	33	32.75	35.25	33	32	35.5
Lower-potentials	24.2	23.33	32	29.5	30.5	33	33.5	33.5
Physical performance tests								
0–10 m sprint								
Higher-potentials	2.15	2.11	2.03	2.05	1.95	1.95	1.87	1.84
Lower-potentials	2.18	2.10	2.21	2.11	2.04	2.03	1.98	1.88
0–30 m sprint								
Higher-potentials	5.50	5.23	5.25	5.11	4.94	4.65	4.59	4.28
Lower-potentials	5.60	5.44	5.61	5.39	5.14	5.04	4.87	4.45
CMJ								
Higher-potentials	30.98	36.8	33.9	34.2	36.18	45.42	43.65	47
Lower-potentials	30.5	36.07	32.26	30.83	33.4	37.02	38.28	46.3
L-agility test								
Higher-potentials	6.30	5.86	6.18	5.95	6.29	5.76	5.77	6.05
Lower-potentials	6.33	6.30	6.31	6.48	6.2	6.05	5.79	5.92

Table 3 Univariate logistic regressions of PCE tests

Age phase	Predictor	Chi-square goodness of fit	β	Odds ratio	Cox & Snell R^2
FDP	PCE "during"	$\chi^2(1)=0.189$, $P=0.664$	0.183	1.200 (0.525; 2.838)	0.007
	PCE "post"	$\chi^2(1)=4.485$, $P=0.034$	1.016*	2.763 (1.073; 9.165)	0.158
YDP	PCE "during"	$\chi^2(1)=3.935$, $P=0.047$	0.695*	2.00 (1.008; 4.543)	0.104
	PCE "post"	$\chi^2(1)=3.362$, $P=0.067$	0.631	1.879 (0.959, 4.134)	0.089

*$P<0.05$

The univariate models for the physical performance tests are presented in Table 4.

Multivariate analysis

Correlation analysis showed low to moderate association between the PCE and physical performance tests, with the exception of the 0–10 m and 0–30 m sprints within the FDP (Pearson correlation coefficient = 0.78, $P<0.001$) and the YDP (Pearson correlation coefficient = 0.75, $P<0.001$). Similarly, correlation analysis showed an association between PCE "during" and "post" within the FDP (Pearson correlation coefficient = 0.63, $P=0.001$) and the YDP (Pearson correlation coefficient = 0.71, $P<0.001$). The multivariate model for both the FDP and YDP contained all variables with the exception of the 0–10 m sprint due to its high VIF. Within the FDP, results of the multivariate logistic regression showed a significant association between the physical performance tests and higher-potentials [$\chi^2(5)=11.594$, $P=0.041$], with 0–30 m sprint a significant predictor in the model. Within the YDP, results of the multivariate logistic regression showed a significant association between the physical performance tests and higher-potentials [$\chi^2(5)=28.012$, $P<0.001$], with 0–30 m sprint a significant predictor in the model. Results of the multivariate logistic regression are presented in Table 5.

Discussion

This multidimensional study aimed to identify characteristics associated with age phase-specific potential. The key findings within the FDP showed higher-potentials had a significantly greater PCE "post" score, whilst also possessing a significantly quicker 0–30 m sprint speed, compared to lower-potentials. Within the YDP, a greater discriminatory function was prevalent, as higher-potentials had a significantly greater PCE "during" score, whilst also demonstrating a quicker 0–10 m sprint speed, 0–30 m sprint speed, and higher CMJ, compared to lower-potentials. Within both age phases, the 0–30 m sprint was the largest predictor of higher-potential status, with the OR more than double that of other factor within univariate and multivariate regression analyses.

Similarly to previous research comparing PCE skills in "elite" and "non-elite" youth football players, this present study supports the hypothesis that higher-potentials have significantly enhanced PCE skills compared to lower-potentials in at least one of the decision-making phases. This demonstrates that a differentiation in PCE skill may

Table 4 Univariate logistic regressions of physical performance tests

Age Phase	Predictor	Chi-square goodness of fit	Coefficient	Odds Ratio (95% CI)	Cox & Snell R^2
FDP	0–10 m sprint	$\chi^2(1)=2.458$, $P=0.117$	– 0.645	0.525 (0.206; 1.169)	0.09
	0–30 m sprint	$\chi^2(1)=8.604$, $P=0.003$	**– 1.399***	0.247 (0.062; 0.660)	0.282
	CMJ	$\chi^2(1)=0.666$, $P=0.415$	0.334	1.397 (0.628; 3.373)	0.025
	L-agility test	$\chi^2(1)=2.118$, $P=0.146$	– 0.591	0.554 (0.224; 1.220)	0.078
YDP	0–10 m sprint	$\chi^2(1)=11.262$, $P<0.001$	**– 1.274****	0.280 (0.100; 0.616)	0.269
	0–30 m sprint	$\chi^2(1)=21.966$, $P<0.001$	**– 2.553****	0.078 (0.011; 0.294)	0.457
	CMJ	$\chi^2(1)=7.683$, $P=0.006$	**1.033***	2.809 (1.324; 7.272)	0.192
	L-agility test	$\chi^2(1)=2.871$, $P=0.090$	– 0.603	0.547 (0.241; 1.095)	0.077

*$P<0.05$, **$P<0.01$

Table 5 Multivariate logistic regressions of physical performance and PCE tests

Age Phase	Predictor	Coefficient	SE	Wald's χ^2	Odds Ratio (95% CI)
FDP	0–30 m Sprint	− 1.532*	0.530	$\chi^2(1) = 3.856$, $P = 0.025$	0.216 (0.032; 0.798)
	CMJ Height	− 0.567	0.780	$\chi^2(1) = 0.734$, $P = 0.392$	0.567 (0.128; 1.959)
	L-Agility	0.145	0.706	$\chi^2(1) = 0.042$, $P = 0.837$	1.157 (0.299; 5.696)
	PCE 'during'	− 0.368	0.769	$\chi^2(1) = 0.229$, $P = 0.632$	0.692 (0.124; 2.906)
	PCE 'post'	1.161	0.810	$\chi^2(1) = 2.057$, $P = 0.152$	3.194 (0.693; 18.635)
	Constant	0.326	0.530	$\chi^2(1) = 0.374$, $P = 0.539$	1.385 (0.500; 4.347)
YDP	0–30 m Sprint	− 4.130**	1.570	$\chi^2(1) = 6.917$, $P = 0.009$	0.016 (0.001; 0.181)
	CMJ Height	− 1.020	0.874	$\chi^2(1) = 0.95$, $P = 0.243$	0.361 (0.050; 1.802)
	L-Agility	− 0.008	0.677	$\chi^2(1) = 0.008$, $P = 0.991$	0.992 (0.233; 4.014)
	PCE 'during'	0.829	0.759	$\chi^2(1) = 1.923$, $P = 0.275$	2.290 (0.538; 12.365)
	PCE 'post'	0.822	0.782	$\chi^2(1) = 1.104$, $P = 0.293$	2.275 (0.505; 12.629)
	Constant	0.210	0.593	$\chi^2(1) = 0.125$, $P = 0.603$	1.234 (0.392; 4.571)
Model fit	Log likelihood			Cox & Snell R^2	Nagelkerke R^2
FDP	− 12.225			0.360	0.480
YDP	− 10.892			0.541	0.722

$^*P < 0.05$, $^{**}P < 0.01$

not exclusively exist for "elite" and "non-elite" youth football players [31, 52, 55], but also between higher- and lower-potentials within a football academy context. Additionally, it is important to highlight this discrimination is in both the FDP and YDP, which indicates superior PCE may be possessed by higher-potential players throughout the development process (from aged 8 to 16 years). However, a longitudinal cohort design is recommended to demonstrate its stability.

When examining the differences between the FDP and YDP, there appears to be a reverse effect the older the players get. For instance, although the "during" phase could not distinguish higher- and lower-potentials in the FDP, they did establish a significant difference with the "post" phase clips. It can be suggested this is a result of the increasing ease of the "post" phase clips compared to the "during" phase clips. In contrast, the significant discrimination between higher- and lower-potential players within the YDP for the "during" phase is possibly a result of older players engaging longer within the talent development system. This may have allowed them to build up and develop superior anticipation and decision-making skills compared to their younger counterparts. For instance, Roca et al. [45] and Williams et al. [55] examined PCE and practice history profiles in elite youth footballers, revealing their "high-performing" groups had accumulated significantly more hours in football-specific play activities (e.g., playground, park, street) compared to the "low-performing" groups. Thus, practical implications support the consideration of applied PCE training programmes within football academies to facilitate the development of decision-making skills [34, 45, 52, 55].

Although film-based simulation tests offer a significant advantage surrounding their methodological rigour and control [31], it remains unclear how well these tests may accurately represent on-field performance [30]. The decoupling of perception and action provides a clear distinction between task designs in which participants are required to make an actual movement and those in which participants respond by selecting an answer [50]. Thus, it is also important to consider contemporary PCE research, which appears to be completing in-situ designs to support a greater practical association between PCE and performance outcomes [50]. Overall, however, the PCE results from this current study emphasise the importance of developing decision-making skill, through identifying task-related cues, body positioning, and possibilities for the player in possession of the football [54].

The physical performance outcomes of this current study highlight the increasing importance of fitness testing characteristics throughout the development process, whereby more features discriminated higher- and lower-potentials within the YDP compared to the FDP. When considering the importance of physical characteristics during senior professional match-play, the ability to make forward runs in possession to support teammates on the ball is a key moment during competitive fixtures. For example, Faude et al. [16] revealed straight sprinting is the most frequently used action in goal situations in professional football. Consequently, it may be suggested that sprint ability is a useful measure for examining changes in competence. From a youth development context, the results from the current study regarding 0–30 m sprint correspond with previous findings from Gil et al. [17, 18] and Le Gall et al. [27], who illustrated the importance of speed within academy football. Likewise, Deprez et al. [12], Emmonds et al. [15], and Gonaus and Muller [19] also found no differences in acceleration speed within their under-9 to under-11 age groups of players who eventually progressed to professional status and those who did not. However, they too revealed significant differences in the 0–10 m sprint test at under-12 to 18′s age groups, thus providing further indication of the increasing physical requirements to support greater development towards senior professional status. In addition, this collective research from Austria, Belgium, England, and Spain provides universal evidence regarding the importance of sprint ability in youth football players.

The CMJ findings of this current study demonstrate no association with higher development in an English football academy for players aged 8–11 years. These results are converse to those of Gil et al. [18], who found that pre-selected under-10 outfield players from a professional football academy performed better in the CMJ test compared to non-selected players. However, their study presents this physical difference between selected and non-selected players, whereas the current research discriminates academy players independently. Consequently, both Gil et al. [18] and this current study combined offer the suggestion that CMJ ability differentiates academy and non-academy FDP players. Moreover, the current results of the YDP players concur with a number of observational and longitudinal studies, which have highlighted a positive association between superior CMJ ability and performance outcomes within football (e.g., [12, 20, 27]). Additionally, further evidence has shown similar power related tests are associated with greater performance outcomes within the YDP [12, 37]. Therefore, superior power supports the proposal of increased coach-perceived potential within the YDP through its increased function and relevance.

Although significant findings were revealed for sprint ability and CMJ, this current study revealed no relationship between higher-potential in an English football academy for players within the FDP and YDP for L-agility speed. Interestingly, while the present findings from both the sprint abilities and CMJ are reinforced through existing research (e.g., [18, 35], results for the L-agility speed appear to differ from previous studies. For example, Mirkov et al. [37] and Gil et al. [17] reported agility is amongst the essential characteristics for successful development. Thus, it appears evidence for agility and potential development outcomes remains inconclusive. When focussed on a physical performance perspective, it is important to indicate that acceleration, speed, and power alone cannot solely predict the outcome of overall development [19]. Although physical factors are identified as key characteristics in higher-potentials within academy football, they could be further analysed alongside other variables to correspond with the holistic nature of talent identification and development.

Limitations and Future Directions

A limitation of researching football academy populations are issues with access and the consequences for methodological drawbacks. In this particular study, our accessibility to a relatively large sample of professional football academy players was paramount. In addition, statistical analyses procedures were applied within practical limitations and in a manner to reduce potential bias introduced to both data and models. Thus, this research does not only provides a novel illustration of PCE and physical performance attributes within the talent development process, it also offers a useful benchmarking tool for clubs, coaches, and practitioners. With regards to external validity, as a result of the cultural and social dynamics embedded within the English football talent pathways, the cognitive and physical characteristics of these Category 3 players may be different to youth football players in other countries or categories. Thus, consideration regarding category status and location is required before direct comparisons are made.

It is also important to consider whether the results of this current study are due to relative age [9] or maturation effects [2]. For instance, it has been previously evidenced that chronologically older players may gain performance and selection advantages over their younger, age-matched peers in youth football [24]. Further, those with advanced maturation status have also been shown to possess greater cognitive and physiological capabilities compared to their less-mature but same-aged equivalents [26]. In this particular sample, higher-potentials were taller, heavier, and had advanced maturation status compared to the lower-potentials in both the FDP and YDP. Thus, it is crucial that coaches and practitioners realise that coach potential rankings may in fact be a maturational effect. Thus, further research is required to explore the implications of coach potential rankings on relative age and maturation status, which may further support the importance of grouping athletes based on biological age rather than chronological age [4].

Future research should consider collecting these variables from a longitudinal perspective, to offer suggestions regarding what PCE abilities and physical performance indicators differentiate individuals who achieve professional status and those who do not. Additionally, the coaching process surrounding how these PCE and physical performance measures are developed from an age-specific context also requires further investigation. Nevertheless, this research provides a useful insight into the PCE and physical qualities that facilitate developmental outcomes within an academy environment, while also observing age phase-specific considerations.

Conclusion

To the best of the researcher's knowledge, this is the first study to examine the combined effects of film-based simulations and fitness tests on coach potential rankings within a professional football academy. Thus, this highlights PCE and physical performance differences between both higher-potentials and age phases within an English academy football environment. Whilst adding to the sparse literature, this research also provides football academy practitioners with the rationale to incorporate PCE and physical developmental activities within their training programmes, to facilitate greater multidimensional development.

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Data Availability Due to commercial concerns, the research data supporting this publication are not publicly available.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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