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ORIGINAL RESEARCH

Effects of playing football matches with two balls on spatial exploration: Average and one-by-one analyses

Asier Gonzalez-Artetxe[1]✉, Asier Los Arcos[2,3], and Jokin Aginaga[4]

[1]Department of Musical, Visual Arts and Physical Education Didactics, Faculty of Education and Sport, University of the Basque Country, UPV/EHU, Vitoria-Gasteiz, Araba, Spain; [2]Department of Physical Education and Sport, Faculty of Education and Sport, University of the Basque Country, UPV/EHU, Vitoria-Gasteiz, Araba, Spain; [3]Society, Sports and Physical Exercise Research Group (GIKAFIT), University of the Basque Country, UPV/EHU, Vitoria-Gasteiz, Araba, Spain; and [4]Institute of Smart Cities (ISC), Public University of Navarre, Iruñea – Pamplona, Navarre, Spain

Abstract

Background: Football task design lies in manipulating the relevant features of the game considering the consequences these modifications can have on players' performance. Adding an extra ball may boost academy footballers' possibilities of interaction and challenge them to readjust their motor conduct according to the uncertainty of a novel game scenario. **Objective:** This study compared young footballers' spatial exploration index (SEI) overall and one by one during simulated matches played with one or two balls. **Methods:** Forty-four association football players from U14 and U16 teams of the same club played two 60-minute matches with all the official game rules and regulatory conditions. The unique difference was that one match was played with a single ball and the other with two balls simultaneously. Positional data were gathered during matches using a Global Positioning System (GPS) to assess each footballer's SEI central tendency and approximate entropy (ApEn) measures. **Results:** The average SEI of both U14 (p = .01; η^2 = .066, medium) and U16 (p < .001; η^2 = .187, large) players was lower, and its ApEn higher (U14: p < .001, η^2 = .014, small; U16: p < .001, η^2 = .035, small), during the two-ball match in comparison to the standard one-ball match. The graphical representation shows how their relative positioning changed between matches, breaking team formation in two during the two-ball condition. From an individual perspective, the second ball affected defenders mainly. Most of them reduced their intervention area, acted more unpredictably within this, and got closer to their target compared with the standard one-ball match. **Conclusions:** Adding an extra ball led young footballers to explore less space more unpredictably, especially defenders. So, a one-by-one analysis may assist coaches in evaluating each player's tactical response to football training.

Keywords: team sports, soccer, tactical behaviour, positional data, task constraints

Introduction

Association football is a collective duel in which success depends primarily on the capacity to handle the uncertainty produced by the lack of information about teammates' and, above all, adversaries' intentions (Parlebas, 2013). So, tactical competence becomes critical. Training allows players to acquire the skills to anticipate opponents' intentions and deceptively organize their own teams' intentions. For that purpose, coaches manipulate the structural and distinctive features of football (i.e., the playing space, the ball, the playing time, and participants' relations) considering the consequences these modifications can have on players' performance (Parlebas, 2013). However, they should not expect equal responses from all the players because decision-making is, after all, individual (Davids et al., 2013; Parlebas, 2013). That is, each footballer copes with each situation in a different way according to their characteristics and playing competence. Indeed, a newly released study carried out with U14 and U16 developmental players showed how the same training intervention based on free and conditioned eight-a-side games might impact each player differently: while team average outcomes did not change considerably, a one-by-one analysis revealed that most of the U16 players explored the space in a more regular way (Gonzalez-Artetxe et al., 2023). Assessing the consequences of modifying footballers' relationships between them and with the space, the time, or the equipment from an individual point of view may assist coaches in evaluating individual responses during training tasks.

Several authors have emphasized the need to design and implement alternative training scenarios that expose players to more complex situations than in traditional training, which satisfies the need to adapt to the uncertainty of the game constantly (Renshaw & Chow, 2019; Ribeiro et al., 2021; Schöllhorn et al., 2012). Whereas consequences of altering spatial features such as pitch sizes (Clemente et al., 2023) or positioning of the goals (Castellano et al.,

✉ **Corresponding author:** Asier Gonzalez-Artetxe, e-mail asier.gonzalez@ehu.eus, ORCID® record https://orcid.org/0000-0001-5007-4524

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2016) during small-sided games have been extensively studied, little is known about modifications related to the ball (Coutinho et al., 2022; Santos et al., 2020). The ball is the object that influences footballers' response absolutely because it is the cornerstone of the game, and success depends on introducing it to the opponent's goal. Santos et al. (2020) employed different types of balls like handballs and rugby balls, while Coutinho et al. (2022) used standard ones but limited their use to a maximum of one or two touches; with similar results: academy footballers' spatial exploration index (SEI) decreased when they played with the rugby ball or were limited to a one-touch in comparison with free-touch small-sided games played with football balls. Likewise, both motor praxeology (Parlebas, 2013) and differential learning (Santos et al., 2018; Schöllhorn et al., 2012) propose altering players' relationship with the ball, for example, playing with more than a ball, to elicit task complexity.

Thus, this study aims to explore the consequences of playing with one or two balls during simulated football matches. The term 'simulated' is used here to refer to full-side games (ten vs ten plus goalkeepers) with all the official regulatory conditions called. Game formats that reproduce competitive settings may help transfer training outcomes to competition (Riboli et al., 2022). The effects of manipulating the number of balls in play had been evaluated by specific and individual-nature behavioral variables like SEI and its approximate entropy (ApEn). Gonçalves et al. (2017) developed the SEI as a pitch-positioning-derived variable able to reveal players' pitch exploration according to the different game scenarios, with higher values corresponding to those who cover more space during the game. This metric summarizes players' movement variability and represents their space of intervention (Low et al., 2020). ApEn quantifies the (logarithmic) likelihood that runs of patterns with m points that are close remain close within a tolerance factor r on subsequent incremental comparisons (Pincus, 1991). In an applied sense within the football context, lower values of ApEn reflect more regularity, while higher ones manifest more unpredictability (Pincus & Huang, 1992). Not limiting to average outcomes for all the players and respecting the individual nature of the SEI, individual responses have been assessed through a one-by-one analysis that considers each player separately (Gonzalez-Artetxe et al., 2023). Therefore, this study compared young footballers' SEI during simulated matches played with one or two balls overall and one by one. The complexity of playing with an extra ball is expected to lead them to explore more.

Methods

Participants

Forty-four footballers from U14 and U16 teams purposively recruited from the same club, a partner of a Spanish First Division club, took part in the study. The post hoc achieved power (1–β) was .94, computed with the G*Power standalone power analysis program (Version 3.1.9.7 for Windows; Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany) for an effect size of 0.5, and α of .05 (Faul et al., 2007). Participants (U14s: n = 22, age 13.1 ± 0.58 years, height 1.59 ± 0.08 m, body mass 47.5 ± 9.17 kg, 5.83 ± 0.65 years competing in football; U16s: n = 22, age 14.8 ± 0.75 years, height 1.70 ± 0.07 m, body mass 57.1 ± 7.07 kg, 6.81 ± 0.51 years competing in football) were developmental players (McKay et al., 2022) because they recognized football as their specific sport, trained three times per week for an hour and a half (i.e., more than 150 weekly minutes), and competed on weekends in local league official matches. Parents/guardians, coaches, players, and the club management were fully informed about the purpose and procedures of the intervention before giving informed written consent for children's participation. The study followed the ethical principles for medical research involving human subjects of the World Medical Association (Declaration of Helsinki, 2013) and was approved in advance by the Ethics Committee for Research involving Human Beings (GIEB in Basque) of the University of the Basque Country (Code M10_2021_328).

Study design

The study was conducted during the middle of the competitive period (February 2023). Both U14 and U16 teams played two 60-minute simulated matches, interspersed through one week and at least two days before and after the competition in the club's artificial turf pitch where they train and compete. Coaches of each team formed two balanced groups, A and B, according to players' football competence and their position (Gonzalez-Artetxe et al., 2022). These groups faced each other during two ten vs. ten plus goalkeepers matches played in a 100 m long × 60 m wide pitch (273 m^2 per player), with official 11-a-side goals and league balls (size no. 5), and respecting all the official game rules, including the offside rule set on the halfway line and all the regulatory interruptions (e.g., throw-ins, corners, and goal kicks). The unique difference was that one match was played with a single ball and the other, for the first time to the players, with two balls simultaneously. In the case of the two-ball match, offside was relative to each ball, and the regulatory interruptions were restarted as established by the rules while the other ball kept in play.

In order not to exceed the 90-minute training schedule, players completed their standard pre-match warm-up for 15 minutes and then played over two 30-minute halves with a 10-minute break. Both groups of U14 and U16 teams employed their usual 1–4–4–2 formation with all the footballers in their playing position: one goalkeeper, two central defenders and two fullbacks, two central midfielders and two wingers, and two strikers. Goalkeepers participated but were excluded from the data analysis because of the singularity of their position. No feedback from the coaches was given during gameplay to avoid influencing participants' conduct (Gonzalez-Artetxe et al., 2022; Santos et al., 2020).

Data collection

Positional data were gathered during matches by a time-motion tracking system (WIMU PRO, RealTrack Systems, Almeria, Spain) using a Global Positioning System

(GPS) with a 10 Hz sampling frequency. This equipment, composed of lightweight inertial devices worn in a special vest by all the players (the same during the two matches), has been validated for tactical analysis during continuous tests (Bastida-Castillo et al., 2019), with a mean absolute error of less than 50 cm (x-coordinate 41.2 ± 17.3 cm, y-coordinate 47.6 ± 8.97 cm). Data were recorded in a field apart from metallic materials, and the environmental conditions remained similar during matchdays: cold temperatures (3.5–8.3 ºC), humidity gradients above 65% to 90% without precipitation, almost no air circulation from nothing to 4 km/h, and clear cloudless weather. The positional data were downloaded and exported after the session using S PRO software (Version 990; RealTrack Systems, Almeria, Spain). According to a survey to assess the quality of the positional data measurement (Rico-González et al., 2020), data collection was satisfactory (i.e., 80% score).

Data processing

Each GPS device gathered positional data with a 10 Hz frequency, that is, every 0.1 s, but there was no synchronization between different players' data. Thus, before making any calculations, data synchronization was necessary. The synchronization was carried out in two steps. First, the data for each player were interpolated for each instant in which one of the devices had a measurement. This way, data for every player at every time instant in which there was a measurement was obtained. Second, the vector of instants of one of the GPS devices was taken as a reference, and the positional data of all players at these reference time instants were selected. The process was performed using linear and cubic interpolations, and the comparison between them showed no significant differences since the variation in the position of a player in 0.1 s is very small.

The SEI of player k at instant i was calculated with his positional data as shown in Equation 1, using x and y axes for the length and the width of the field, respectively. $P_{xk(i)}$ and $P_{yk(i)}$ represent, respectively, the k^{th} player's position coordinates for the x and y axis at instant i, whereas $P_{xk(m)}$ and $P_{yk(m)}$ are the mean position coordinates of player k for x and y axes.

$$SEI_{k(i)} = \sqrt{(P_{xk(i)} - P_{xk(m)})^2 + (P_{yk(i)} - P_{yk(m)})^2} \quad (1)$$

The intervention area of each player could be represented by an ellipse centered at its mean coordinates $P_{xk(m)}$ and $P_{yk(m)}$. The semi-major and semi-minor axes of the ellipse were calculated by means of the principal component analysis (PCA) via singular value decomposition (Brunton & Kutz, 2019). PCA analysis allowed to decompose high-dimensional data into its most statistically descriptive factors and for each player's coordinates, it provided the two principal orthogonal directions with maximal correlation with his positioning measurements. The length of the semi-major and semi-minor axes obtained with the PCA are the standard deviation (SD) of the data in each principal direction.

Together with central tendency measures (M ± SD), approximate entropy (ApEn) measures of the SEI of each player were computed for each 1,000 data points (N). ApEn quantifies the (logarithmic) likelihood that runs of patterns with m points that are close remain close within a tolerance factor r on subsequent incremental comparisons (Pincus, 1991). Then ApEn is referred to as ApEn(m, r, N), where N is the number of analyzed data, m is the length of data that will be compared, and r is tolerance of similarity criterion.

In accordance with the seminal work of Pincus (1991), the ApEn of a time data set was calculated as follows. Let SEI_k be a vector with the time series data of player k at every time instant of a match: $SEI_k(1)$, $SEI_k(2)$, …, $SEI_k(N)$. Fixing the value of m, sequence vectors $x(i)$ are formed according to Equation 2:

$$x(i) = [SEI_k(i), SEI_k(i+1), \dots, SEI_k(i+m-1)] \quad (2)$$

Then, for each $i \in [1, N-m+1]$, $C_i^m(r)$ coefficient is defined as Equation 3:

$$C_i^m(m) = \frac{number\ of\ j\ such\ that\ d[x(i), x(j)] \le r}{N-m+1} \quad (3)$$

where (Equation 4):

$$d[x(i), x(j)] = \max_{k=1,\dots,m} (|SEI_k(i+k-1) - SEI_k(j+k-1)|) \quad (4)$$

Once coefficient $C_i^m(r)$ was stated, ApEn was calculated as shown in Equation 5:

$$ApEn(m, r, N) = \Phi^m(r) - \Phi^{m+1}(r) \quad (5)$$

where (Equation 6):

$$\Phi^m(r) = \frac{\sum_{i=1}^{N-m+1} \log C_i^m(r)}{N-m+1} \quad (6)$$

The length of the compared runs was chosen to be m = 2 and the tolerance factor r = 0.2 * SD of each data set. All computations were run with MATLAB (version R2020a for Windows; MathWorks, Natick, MA, USA).

Statistical analysis

Outcomes are presented as means ± SD for all the players altogether (average) and for each one of them (one by one). Since data did not follow a normal distribution according to the Kolmogorov-Smirnov test, SEI central tendency and ApEn measures between matches were compared using the Mann-Whitney U test. Eta squared (η^2) was calculated to assess the magnitude of playing with one or two balls and was interpreted as trivial, <.01; small, .01–.06; medium, .06–.14; and large, >.14 (Cohen, 1988). Statistical significance was set at p < .05, and analyses were performed using the IBM SPSS Statistics for Windows (Version 22.0; IBM, Armonk, NY, USA).

Results

Average comparisons between both matches revealed a lower SEI for players of both U14 (p = .01; η^2 = .066, medium) and U16 (p < .001; η^2 = .187, large)

categories when playing with two balls (U14 17.8 ± 3.38 m, U16 16.0 ± 3.07 m) compared with a single one (U14 19.5 ± 1.44 m, U16 18.2 ± 1.19 m). SEI_{ApEn} was higher in both categories (U14: $p < .001$, $\eta^2 = .014$, small; U16: $p < .001$; $\eta^2 = .035$, small) when playing with two balls (U14 0.0625 ± 0.0217 arbitrary units, U16 0.0712 ± 0.0246 arbitrary units) in comparison to the one-ball (U14 0.0570 ± 0.0207 arbitrary units, U16 0.0670 ± 0.0210 arbitrary units).

The U14 footballers' one-by-one analysis (Table 1) revealed that the SEI of most of them, four-fifths, was significantly lower when playing with two balls than with one. All central defenders' pitch exploration was moderately lower ($\eta^2 = .075–.105$, medium) when they played with two balls simultaneously. The players who explored more playing with two balls than with one were one central midfielder, one winger, and two strikers ($p < .001$; $\eta^2 = .000–.011$, trivial to small). About entropy individual analysis (Table 2), the SEI_{ApEn} of half of the defenders, two central defenders and two fullbacks was significantly and moderately ($\eta^2 = .066–.136$, medium) higher with two balls than with one.

Assessing U16 players individually (Table 3) indicated that almost all SEI, 17 of 20, was significantly lower when they played with two balls instead of one, considerably for three central defenders and one fullback ($\eta^2 = .072–.157$, medium to large). One central defender, one central midfielder, and one winger's SEI were significantly but not considerably higher when playing with two balls than with one ($p < .001$; $\eta^2 = .003–.025$, trivial to small). Regarding entropy (Table 4), seven of eight defenders' SEI_{ApEn} was significantly and considerably ($\eta^2 = .088–.303$, medium to large) higher when they played with two balls than with one.

Figure 1 shows footballers' pitch exploration for each group and each match at a glance. The graphical representation displays how the mean position and the space covered by the players of both the U14 and U16 categories differed when they played with one or two balls. Defenders, who explored less with two balls than with one (Tables 1 and 3), played closer to their own goal during this match than during the one-ball match.

Discussion

This study compared young footballers' pitch exploration overall and one by one during simulated matches played with one or two balls, with notable average findings: the SEI of players of both categories was lower when they played with two balls instead of one, and their entropy measures were higher during this match. The one-by-one analysis revealed that playing with two balls impacted defenders primarily, who covered considerably less space, acted more unpredictably, and played closer to their own goal during the two-ball match than the one-ball one.

Contrary to expectations, players explored less space playing with two balls than one ball during full-side games. Similarly, changing the ball type from a standard football ball to handballs or rugby balls (Santos et al., 2020) or conditioning its use to a maximum of one touch (Coutinho et al., 2022) decreased U14 and U17 footballers' SEI, respectively, during small-sided games. That is, altering their relationship with the ball from the standard quantity, type,

Table 1 U14 players' spatial exploration index (m) mean ± standard deviation, sense of the response (higher/lower), and effect sizes (η^2) for pairwise comparisons playing with one or two balls

Player	One ball	Two balls	Response	Effect size
Defenders				
Central defender #A1	17.8 ± 7.55	13.8 ± 7.75	↓	.075, medium
Central defender #A2	18.8 ± 7.83	14.0 ± 7.65	↓	.095, medium
Central defender #B1	17.6 ± 10.4	12.4 ± 8.28	↓	.093, medium
Central defender #B2	16.6 ± 9.73	11.1 ± 6.81	↓	.105, medium
Right fullback #A	21.0 ± 10.6	19.4 ± 10.8	↓	.006, trivial
Right fullback #B	19.9 ± 9.70	17.9 ± 10.1	↓	.016, small
Left fullback #A	19.3 ± 11.1	13.9 ± 7.31	↓	.057, small
Left fullback #B	18.1 ± 9.57	16.1 ± 10.6	↓	.022, small
Midfielders				
Central midfielder #A1	20.3 ± 9.76	23.1 ± 12.0	↑	.011, small
Central midfielder #A2	20.1 ± 9.86	19.0 ± 10.1	↓	.000, trivial
Central midfielder #B1	19.6 ± 9.10	18.3 ± 9.32	↓	.005, trivial
Central midfielder #B2	21.9 ± 11.4	19.1 ± 11.9	↓	.024, small
Right winger #A	22.1 ± 10.8	23.0 ± 12.9	↑	.003, trivial
Right winger #B	19.7 ± 10.5	18.5 ± 9.47	↓	.003, trivial
Left winger #A	20.6 ± 11.1	20.4 ± 12.0	↓	.000, trivial
Left winger #B	20.9 ± 11.9	20.7 ± 10.8	↓	.000, trivial
Strikers				
Striker #A1	18.7 ± 7.96	19.0 ± 10.6	↑	.000, trivial
Striker #A2	18.6 ± 10.8	16.4 ± 10.7	↓	.014, small
Striker #B1	18.8 ± 9.20	21.6 ± 11.5	↑	.001, trivial
Striker #B2	18.3 ± 8.08	17.8 ± 8.87	↓	.003, trivial

Note. ↑ = significantly ($p < .05$) higher than playing with one ball; ↓ = significantly ($p < .05$) lower than playing with one ball. All effect sizes are presented as positive values to show the magnitude of differences in pairwise comparisons.

Table 2 U14 players' spatial exploration index approximate entropy (arbitrary units) mean ± standard deviation, sense of the response (higher/lower), and effect sizes (η^2) for pairwise comparisons playing with one or two balls

Player	One ball	Two balls	Response	Effect size
Defenders				
Central defender #A1	0.059 ± 0.019	0.065 ± 0.018		.032, small
Central defender #A2	0.061 ± 0.020	0.067 ± 0.021		.028, small
Central defender #B1	0.057 ± 0.022	0.069 ± 0.022	↑	.066, medium
Central defender #B2	0.055 ± 0.021	0.075 ± 0.026	↑	.136, medium
Right fullback #A	0.050 ± 0.016	0.055 ± 0.020	↑	.068, medium
Right fullback #B	0.058 ± 0.017	0.067 ± 0.025		.019, small
Left fullback #A	0.051 ± 0.019	0.066 ± 0.022	↑	.125, medium
Left fullback #B	0.061 ± 0.021	0.071 ± 0.026		.038, small
Midfielders				
Central midfielder #A1	0.054 ± 0.019	0.052 ± 0.015		.002, trivial
Central midfielder #A2	0.055 ± 0.018	0.063 ± 0.015		.052, small
Central midfielder #B1	0.066 ± 0.022	0.072 ± 0.020		.023, small
Central midfielder #B2	0.060 ± 0.024	0.058 ± 0.017		.001, trivial
Right winger #A	0.060 ± 0.018	0.052 ± 0.017	↓	.055, small
Right winger #B	0.054 ± 0.021	0.064 ± 0.020		.051, small
Left winger #A	0.058 ± 0.020	0.061 ± 0.024		.002, trivial
Left winger #B	0.050 ± 0.023	0.053 ± 0.014		.046, small
Strikers				
Striker #A1	0.065 ± 0.019	0.057± 0.021		.046, small
Striker #A2	0.053 ± 0.020	0.065 ± 0.027		.036, small
Striker #B1	0.057 ± 0.020	0.058 ± 0.023		.006, trivial
Striker #B2	0.062 ± 0.025	0.063 ± 0.019		.000, trivial

Note. ↑ = significantly ($p < .05$) higher than playing with one ball; ↓ = significantly ($p < .05$) lower than playing with one ball. All effect sizes are presented as positive values to show the magnitude of differences in pairwise comparisons.

Table 3 U16 players' spatial exploration index (m) mean ± standard deviation, sense of the response (higher/lower), and effect sizes (η^2) for pairwise comparisons playing with one or two balls

Player	One ball	Two balls	Response	Effect size
Defenders				
Central defender #A1	16.6 ± 7.94	12.4 ± 6.38	↓	.078, medium
Central defender #A2	17.7 ± 9.71	17.8 ± 12.1	↑	.003, trivial
Central defender #B1	17.8 ± 10.6	11.3 ± 6.00	↓	.120, medium
Central defender #B2	17.9 ± 9.80	10.9 ± 6.16	↓	.157, large
Right fullback #A	17.8 ± 8.88	13.9 ± 7.80	↓	.049, small
Right fullback #B	17.2 ± 9.58	13.8 ± 7.85	↓	.072, medium
Left fullback #A	17.3 ± 9.20	14.5 ± 7.91	↓	.023, small
Left fullback #B	17.4 ± 9.28	12.6 ± 6.89	↓	.033, small
Midfielders				
Central midfielder #A1	19.5 ± 9.54	21.4 ± 10.9	↑	.007, trivial
Central midfielder #A2	20.0 ± 9.96	16.8 ± 10.5	↓	.033, small
Central midfielder #B1	21.0 ± 11.2	19.6 ± 11.2	↓	.005, trivial
Central midfielder #B2	18.2 ± 9.63	16.0 ± 9.90	↓	.016, small
Right winger #A	18.2 ± 10.3	17.9 ± 10.2	↓	.000, trivial
Right winger #B	16.3 ± 9.40	16.2 ± 9.05	↓	.000, trivial
Left winger #A	18.1 ± 10.4	21.5 ± 11.3	↑	.025, small
Left winger #B	18.3 ± 9.56	17.3 ± 10.6	↓	.006, trivial
Strikers				
Striker #A1	18.2 ± 9.01	15.2 ± 8.31	↓	.032, small
Striker #A2	17.8 ± 8.20	14.6 ± 7.68	↓	.041, small
Striker #B1	20.2 ± 10.3	19.0 ± 10.2	↓	.004, trivial
Striker #B2	18.3 ± 8.42	16.7 ± 8.84	↓	.010, small

Note. ↑ = significantly ($p < .05$) higher than playing with one ball; ↓ = significantly ($p < .05$) lower than playing with one ball. All effect sizes are presented as positive values to show the magnitude of differences in pairwise comparisons.

Table 4 U16 players' spatial exploration index approximate entropy (arbitrary units) mean ± standard deviation, sense of the response (higher/lower), and effect sizes (η^2) for pairwise comparisons playing with one or two balls

Player	One ball	Two balls	Response	Effect size
Defenders				
Central defender #A1	0.062 ± 0.021	0.084 ± 0.021	↑	.261, large
Central defender #A2	0.055 ± 0.020	0.061 ± 0.025		.011, small
Central defender #B1	0.059 ± 0.021	0.091 ± 0.029	↑	.303, large
Central defender #B2	0.062 ± 0.022	0.087 ± 0.027	↑	.204, large
Right fullback #A	0.063 ± 0.019	0.086 ± 0.026	↑	.258, large
Right fullback #B	0.058 ± 0.023	0.078 ± 0.023	↑	.152, large
Left fullback #A	0.064 ± 0.021	0.079 ± 0.023	↑	.088, medium
Left fullback #B	0.069 ± 0.024	0.087 ± 0.022	↑	.135, medium
Midfielders				
Central midfielder #A1	0.062 ± 0.021	0.057 ± 0.017		.014, small
Central midfielder #A2	0.058 ± 0.019	0.057 ± 0.018		.000, trivial
Central midfielder #B1	0.060 ± 0.018	0.057 ± 0.016		.009, trivial
Central midfielder #B2	0.059 ± 0.021	0.061 ± 0.021		.000, trivial
Right winger #A	0.063 ± 0.022	0.062 ± 0.019		.000, trivial
Right winger #B	0.059 ± 0.022	0.066 ± 0.019		.036, small
Left winger #A	0.060 ± 0.022	0.063 ± 0.022		.001, trivial
Left winger #B	0.061 ± 0.017	0.069 ± 0.025		.025, small
Strikers				
Striker #A1	0.065 ± 0.021	0.070 ± 0.021		.006, trivial
Striker #A2	0.067 ± 0.019	0.072 ± 0.020		.015, small
Striker #B1	0.064 ± 0.024	0.071 ± 0.022		.025, small
Striker #B2	0.066 ± 0.021	0.067 ± 0.025		.000, trivial

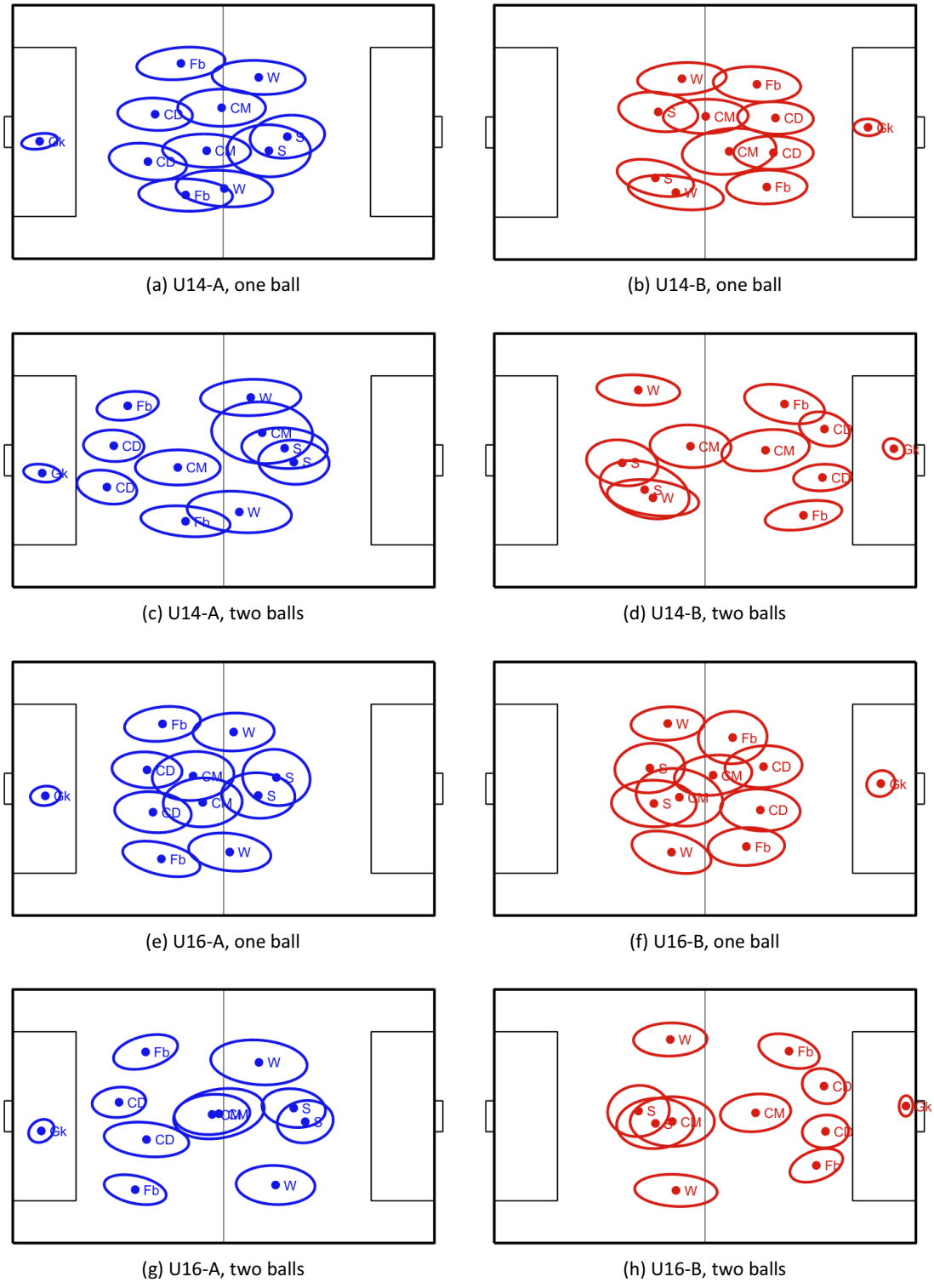
Note. ↑ = significantly ($p < .05$) higher than playing with one ball. All effect sizes are presented as positive values to show the magnitude of differences in pairwise comparisons.

or usage to a non-customary amount, form, or utilization decreased their pitch exploration during different-sided games. Young footballers might explore less, keeping their position during the game, to adapt better to the uncertainty generated by these manipulations. The one-by-one analysis confirmed the effect of the number of balls on the pitch: a significant reduction in the SEI occurred for almost all the footballers of both categories, 16 and 17 of 20 for U14 and U16, respectively. However, the magnitude of the consequences of playing with one or two balls varied among players. All the U14 and three of four U16 central defenders' SEI was moderately to largely lower during the two-ball match in comparison to the standard one-ball match. These results should prevent coaches from expecting and generalizing the same training effects for the whole team (Gonzalez-Artetxe et al., 2023; Renshaw & Chow, 2019; Schöllhorn et al., 2012). An individual point of view could provide more exhaustive and applicable information about the consequences of modifying the structural and distinctive features of the game during training.

The absolute space explored by the players was complemented with the entropy measures to quantify the regularity or (un)predictability of their SEI. U14 and U16 average entropy outcomes were significantly higher when playing with two balls instead of one. This suggests that young footballers' pitch exploration became more unpredictable when adding another ball; that is, they covered less space during the match with two balls and behaved more irregularly in this reduced intervention area. So, coaches who want to raise task uncertainty and perturb and stress their players' spatial exploration can add an extra ball to offer them more possibilities of (inter)action. In line with the differential learning approach (Santos et al., 2018; Schöllhorn et al., 2012), altering the structural features of football radically, playing with two balls, appears to be an appropriate training strategy to increase task complexity and challenge players to find adaptive and functional game solutions. However, the one-by-one analysis exposed that only the SEI_{ApEn} of the defenders, mainly U16, increased significantly and considerably when they played with two balls instead of one. Except for a U14 winger whose SEI_{ApEn} decreased significantly but not considerably when playing with two balls, the entropy measures of the rest of the midfielders and strikers of both categories remained similar during both matches. Hence, as previously seen with intervention effects (Gonzalez-Artetxe et al., 2023), the average outcomes of the team might not reflect the task consequences truthfully. A one-by-one analysis that evaluates each player separately looks to be a complementary tool suitable for comprehending how the same training task may affect each player differently.

Additionally, graphically representing footballers' intervention area (position, size, and shape of the ellipses) could qualitatively assess their spatial exploration and distribution on the pitch (Fernández-Peña et al., 2022; Gonçalves et al., 2017; Low et al., 2020). For instance, Fernández-Peña et al. (2022) carried out four different-length seven-a-side games and hypothesized that the more players involved, the more uniformly they would be distributed on the ground. They also encouraged future researchers to evaluate players' pitch

Figure 1 Graphical representation of U14 and U16 players' spatial exploration index on the pitch for each group (left – Team A, right – Team B) during 60-minute simulated football matches (above – one ball, below – two balls)



(a) U14-A, one ball

(b) U14-B, one ball

(c) U14-A, two balls

(d) U14-B, two balls

(e) U16-A, one ball

(f) U16-B, one ball

(g) U16-A, two balls

(h) U16-B, two balls

Note. Gk = goalkeeper; CD = central defenders, Fb = fullbacks; CM = central midfielders, W = wingers; S = strikers.

exploration during larger game formats and under different task conditions. In general, differences in the relative positioning of both U14 and U16 teams on the pitch were apparent between matches: Playing with two balls altered both teams' habitual and preset 1–4–4–2 formation, that is, breaks the uniformity of the playing system. From an individual perspective, graphical representation aligned with and enriched the one-by-one analysis. Compared with the rest of the players, defenders look to be those who modified their relative positioning on the pitch the most. As well as exploring less and more unpredictably, they exhibited a relative mean positioning closer to their

own goal during the two-ball match than the one-ball one. In practice, academy coaches might benefit from adding another ball to elicit near-to-goal (inter)actions in a real-context game situation.

Conclusions

Adding an extra ball led young footballers to explore less space more unpredictably, especially defenders. So, a one-by-one analysis might assist coaches in evaluating each player's tactical response to football training.

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Conflict of interest

The authors report no conflict of interest.

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