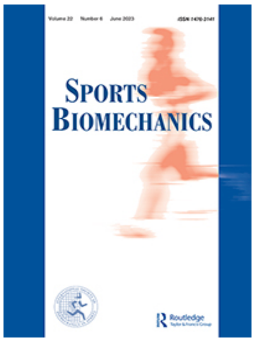

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Interpersonal coordination of opposing player dyads during attacks performed in official football matches

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ABSTRACT

The purpose of this study was to characterise the interpersonal coordination between opponent players during offensive sequences in official matches and to verify if offensive sequences ended in shots to goal present different coordination patterns when compared than those that ended in defensive tackles. A total of 580 offensive sequences occurred during matches resulting in shots to goal ($n = 172$) or defensive tackles ($n = 408$) were analysed. The bidimensional coordinates and technical actions of male professional football players ($n = 1160$) were obtained using a video-based tracking system. Dyads were defined using a network analysis and composed of the nearest opponent. Interpersonal coordination of the dyads was analysed using the vector coding and the frequency for each coordination pattern was computed. In-phase was predominant for all displacement directions and offensive sequences outcomes, and antiphase was the least frequent. For lateral displacements, offensive sequences ending in shot to goal presented lower frequency for in-phase and higher frequency for offensive player phase than ended in defensive tackle. This information about the relationship of opponent players dyads during decisive moments of the matches provides fundamentals for future research and assists coaches to understand the different behaviours in successful and unsuccessful attacks.

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KEYWORDS
Dynamical systems; interpersonal interaction; kinematics; tactics; vector coding

Introduction

The game of football is a complex system with many elements interacting and several levels of organisation, called subsystems, starting from a macro to micro level. Teams are subsystems composed of groups of players with the same tactical functions, and these groups are subsystems constituted by the players (McGarry et al., 2002). From a dynamical systems perspective, football can be analysed at the macro level regarding the matches or the teams and at the micro level that is the players (Grehaigne et al., 1997; McGarry et al., 2002). According to Glazier (2010), information about a group can be

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obtained through analyses of individual behaviours, clarifying how players influence and are influenced by this dynamic system that they are part of.

From a macro perspective, the relationship between opponent teams during football matches was evaluated through the coordination analysis techniques applied to time series data (Bartlett et al., 2012; Moura et al., 2016; Siegle & Lames, 2013). In this way, by the relative phase analysis using the Hilbert transform, Siegle and Lames (2013) assessed coordination of the longitudinal displacements of teams' centroids during a football match. Similarly, Bartlett et al. (2012) used a correlation analysis to evaluate the coordination dynamics of tactical collective behaviour during the matches. Finally, Moura et al. (2016) analysed the coordination of teams' spread behaviour using the vector coding technique during successful and unsuccessful offensive sequences. To the best of our knowledge, the study conducted by Moura et al. (2016) was the only one to use the vector coding technique in the analysis of football, although this technique has already been widely applied to human movement coordination analysis in clinical and sport contexts (Beitter et al., 2020; Chang et al., 2008; Ferber et al., 2005; Heiderscheit et al., 2002; Maddox et al., 2020; Needham et al., 2015; Pelegrinelli et al., 2020; Pereira et al., 2018; Sparrow et al., 1987; Wilson et al., 2008). The vector coding technique makes it possible to analyse the coordination between two time series through the relative motion that represents the relationship of their oscillations as a function of the time. This technique can quantify the relationship of two oscillators that, for instance, can be represented by players' positions. From each pair of subsequent data points of each oscillator a relative motion is drawn. The coordination pattern is identified using the coupling angle that represents the angle between consecutive coordinates of this relative motion pattern. The advantage of this technique compared to other methods (e.g., relative phase methods derived from phase angle and correlation analysis) in assessing other coordination patterns that represent which oscillator is leading the time series (Beitter et al., 2020; Needham et al., 2015; van Emmerik et al., 2004), not just the in-phase and anti-phase relationship. The coupling angle used to identify the coordination pattern in the vector coding provides direct information about the movement patterns (magnitude oscillations), while other techniques that require derivation of the high-order variables may be more sensitive to subtle changes (frequency oscillations), making it difficult to interpret movement patterns (van Emmerik et al., 2004).

Thus, the vector coding technique can be a useful tool to assess coordination patterns between football players during matches, mainly because the studies that were performed to analyse the relationship between opponents focused on collective tactical behaviour (Bartlett et al., 2012; Moura et al., 2016; Siegle & Lames, 2013). In this way, the relationship of dyads constituted by opponent players during decisive moments was not explored during official football matches, despite having already been the subject of research in other team sports, such as rugby (Correia et al., 2014), and futsal (Travassos et al., 2011; Vilar et al., 2014). It was demonstrated that the coupling patterns of 1 vs. 1 rugby player dyads influence the performance outcomes, providing information about the spatial exploration behaviours of opposing players and showing how players create or perceive possibilities to achieve their performance goals (Correia et al., 2014). In addition, Vilar et al. (2014) suggested that relationships between the individual and the environment can be evidenced by interpersonal coordination, in which the defensive players coordinate their movements to prevent possibilities of offensive players' actions. Additionally, Travassos et al. (2011) highlighted different phase relations of player dyads from offensive and defensive teams, with attacking players presenting greater variability in-phase relations than defensive players because the attacking players try to destabilise the in-phase relation and defensive players try to preserve it. Therefore, due to the relevance of dyadic coordination analysis suggested for other team sports, interpersonal relationships affect performance outcomes, and attacking players seek to break the in-phase relation (Correia et al., 2014; Travassos et al., 2011; Vilar et al., 2014). Although these findings are from different modalities, some of these behaviours may be similar in football, as demonstrated in coordination analysis conducted with collective tactical variables in football that showed higher frequency of in-phase relation, as well as greater variability of coordination dynamics of the teams, and an increase in frequency of attacking team phase in successful offensive attempts compared to unsuccessful (Bartlett et al., 2012; Moura et al., 2016; Siegle & Lames, 2013). One can argue whether the relation between opponents may reflect on success during defensive and offensive actions. Therefore, the coordination analysis of opposing player dyads during offensive attempts in official football matches could assist in the characterisation of real situations that players experience when interacting with their opponents and to understand how these interactions are associated with offensive or defensive success in situations that directly affect performance. Likewise, the vector coding technique can provide additional information about the coordination between the players, allowing a better understanding of the spatial exploration of the players during these decisive moments in football.

Thus, the purpose of this study was to characterise the interpersonal coordination between opponent players during offensive sequences in official football matches. Specifically, we investigated whether offensive sequences that ended in shots to goal presented different coordination patterns between the opponents when compared to those that ended in defensive tackles. Our initial hypotheses were that (1) the in-phase coordination pattern would be more frequent than the other coordination patterns and (2) the offensive sequences that ended in shots to goal would present a higher frequency of offensive player phase coordination pattern, that is, the offensive player leads the time series as an individual strategy of anticipating movements in relation to the opponent to overtake him.

Methods

Participants and data collection

Eight official football matches of the Serie A of the Brazilian national league ($n = 4$) and Serie A2 of the Sao Paulo Regional League ($n = 4$) were analysed, and 230 male professional football players were involved in the matches. Images of the matches were registered by four to six digital cameras (30 Hz; resolution of 640×480 pixels), and the cameras were placed at the highest points of the stadiums and remained fixed throughout the match. Each camera covered approximately a quarter of the pitch, with an overlapping region between them. After the matches, the video sequences were transferred to the computer and manually synchronised by the same evaluator through the identification of a common event in the overlapped region, for example, a kick in the ball. Subsequently, the system automatically keeps the video sequences synchronised.

A total of 580 offensive sequences that occurred during the matches ended in shots to goal ($n = 172$) or defensive tackles ($n = 408$) were analysed. The matches occurred with at least 72 h after the previous match, temperature from 23.2ºC to 35.2ºC, relative humidity from 34% to 86% (according to the National Institute of Meteorology—INMET – Brazil), in official stadiums (natural grass, ~ 105 × 68 m) and in accordance with Federation Internationale de Football Association (FIFA) rules. The study was conducted in accordance with the Declaration of Helsinki and was approved by the local Ethics Committee (Protocol #299797418.2.0000.5404).

The trajectories of the players during the matches were obtained by the automatic tracking system of DVideo software (Barros et al., 2007; Figueroa et al., 2006a, 2006b; Lara et al., 2018; Pereira et al., 2018). The automatic tracking rate of DVideo software was 94% with the remaining processed frames solved manually by an experienced operator. The average error for determination of the player position and the distance covered was 0.3 m and 1.4%, respectively (Barros et al., 2007; Figueroa et al., 2006a, 2006b). The bidimensional coordinates, in metres, of 36 specific points on the pitch measured by a measuring tape before the matches were used to define the reference coordinate system associated with the pitch. The image plane coordinates were determined via the interface of DVideo software by the identification of the corresponding projections of these points in the image. Thus, players' bidimensional coordinates relative to the pitch coordinate system were obtained by the homography parameters of the image-object transformation calculated based on the direct linear transformation method (Abdel-Aziz & Karara, 2015). A third-order Butterworth low-pass with a cut-off frequency of 0.4 Hz was used to filter the players' trajectories based on a previously proposed protocol (Barros et al., 2007).

The players' technical actions were registered using the DVideo software, which makes it possible to identify the actions performed and events that occur during the matches (actions: dribble, pass, control, shot to goal, tackle; events: corner kick, foul, goal, goal kick, offside, throw-in), the outcome (successful or unsuccessful), and the player who performed the action. The reliability of intra- and interrater agreement of this notational analysis system was 97.77% and 93.90%, respectively (Caetano et al., 2020).

Data analysis

Dyads and offensive sequences

The notational data were used to create a time series that defines the team that had possession of the ball at each instant of time according to previously proposed methods (Moura et al., 2012, 2013). Additionally, these data were used to identify the offensive sequences, which start at the moment that the team gets ball possession and finish after a shot to goal or defensive tackle. A minimum of five actions performed by the same team was used to consider an offensive sequence, and the technical actions of shots to goal or defensive tackles arising from events such as corner kicks and fouls were excluded from the analyses.

Network analysis was applied to determine the player dyads using the players' bidimensional coordinates according to a previous study (Caetano et al., 2020). All players have their own network containing their proximity degree to all opposing players, then the dyads were determined by a player and his opponent with highest degree of proximity. The players involved in this analysis were just the player who performed the action and the opposing player who constituted the dyad at the moment of conclusion of the offensive sequence. For example, throughout the offensive sequence, both the player who performed the shot to goal or defensive tackle and his nearest opponent at that instant were analysed.

Interpersonal coordination

Players bidimensional coordinates were used to analyse the coordination between the players that compose a dyad. The players' displacements are diverse coordinates information ordered in time; that is, this information constitutes a time series that presents oscillations representing the position changes (Figure 1(a)). Then, the coordination analysis in the dyads was performed through the relationship between two oscillatory signals in longitudinal (Figure 1(b)) and lateral displacements (Figure 1(c)) separately.

The coordination in the dyads was analysed using the vector coding technique that allows the assessment of the spatial relationship between two players through their coordinates relative to the pitch coordinate system. Therefore, first, a relative motion plot (Figure 2) of the players' bidimensional coordinates was created and analysed individually for lateral (y coordinate) and longitudinal (x coordinate) displacements relative to the pitch coordinate system. In the relative motion plot, the x-axis represents the defensive player coordinate, and the y-axis represents the offensive player coordinate. The coupling angle (θvc) between the players' coordinates was defined Equation (1) by the vector coding technique proposed by Sparrow et al. (1987), represented by the angle from a vector connecting two consecutive coordinates relative to the right horizontal (Figure 2).

$$\theta_{vc_{(i)}} = tan^{-1}\left(\frac{C_{2_{(i+1)}} - C_{2_{(i)}}}{C_{1_{(i+1)}} - C_{1_{(i)}}}\right), i = 1,\ 2,\ \ldots,\ n-1 \qquad (1)$$

where i indicates the instant of time, C_1 represents defensive player coordinate, C_2 offensive player coordinate, and n the total frames that the players were analysed.

The coupling angle projected on the centre of the unit circle makes it possible to identify the coordination pattern at each instant that represents an instantaneous spatial relationship defined from the coordination patterns that can be identified (antiphase, in-phase, defensive player phase, and offensive player phase), as suggested by Chang et al. (2008). The four patterns are found at the vertical, horizontal and 45° diagonals (Figure 2). An antiphase coordination pattern occurs when coupling angles are 135° and 315°, indicating that both players are moving in opposite directions simultaneously (Figure 3(a)). In other words, 45° and 225° are in-phase couplings, which means that the players are moving simultaneously in the same direction (Figure 3(b)). In the case where the coupling angles are 0° or 180°, it represents the defensive player phase (defensive player leading the time series), that is, the defensive player moves, and his opponent does not move or move with some time lag (Figure 3(c)). However, coupling angles of 90° or 270° represent the offensive player phase (offensive player leading the time series), in other words, the offensive player moves, and his opponent does not move or moves with some time lag (Figure 3(d)). The coupling angles were classified into one of the four coordination patterns

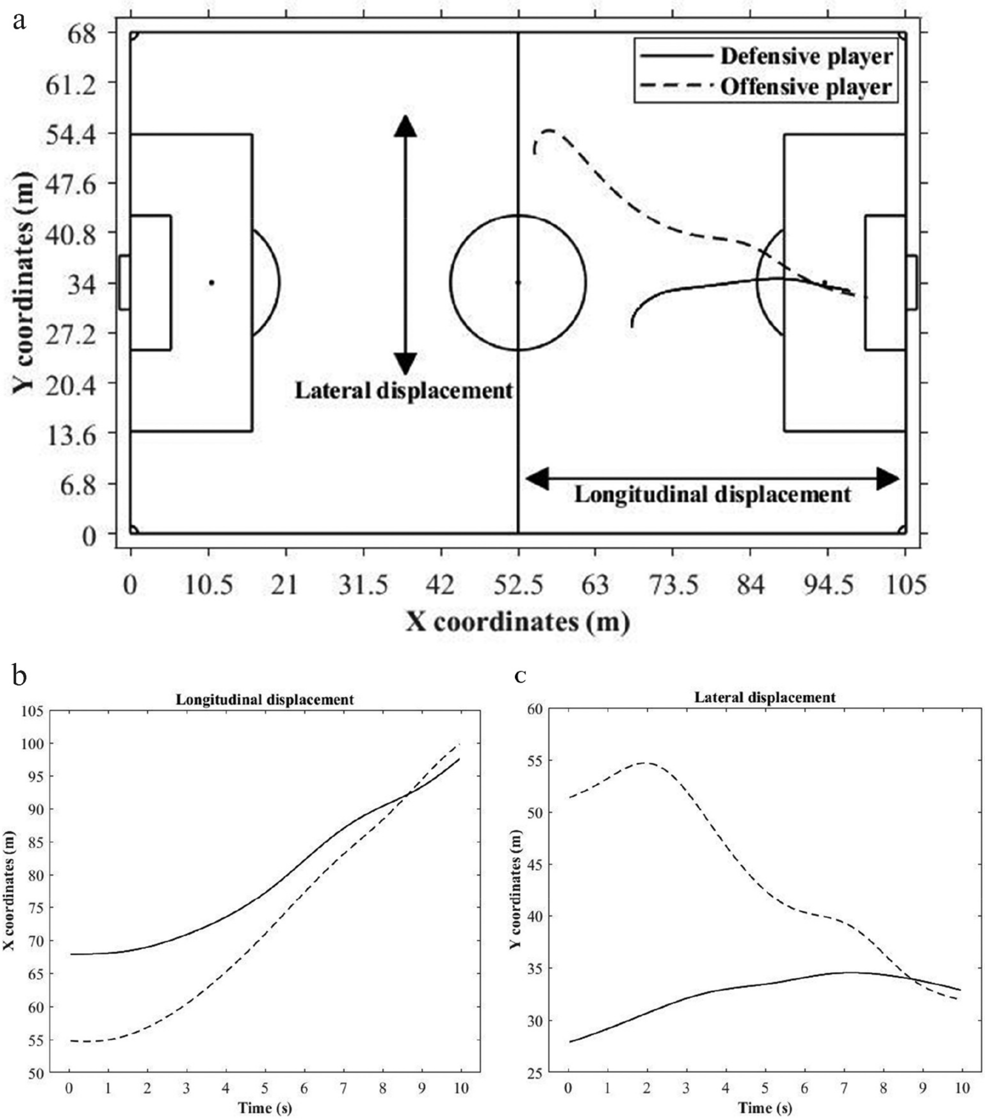

Figure 1. Representation of two displacement time series (a) and the longitudinal (b) and lateral (c) Displacements separately.

(Table 1). The unit circle was divided into 45° bins, as rarely the coupling angles are precisely vertically, horizontally, or diagonally from 45°, according to previously proposed by Chang et al. (2008). In addition, for each offensive sequence, we analysed a unique dyad, created histograms, and calculated the relative frequencies of each coordination pattern.

Due to the directional nature of coupling angle data, representative measures of central tendency (e.g., mean angle) and variability (e.g., angular dispersion) of the vector coding time series of the offensive sequences are possible using the circular statistics procedures (Zar, 2010). However, it was verified that the descriptive measures are

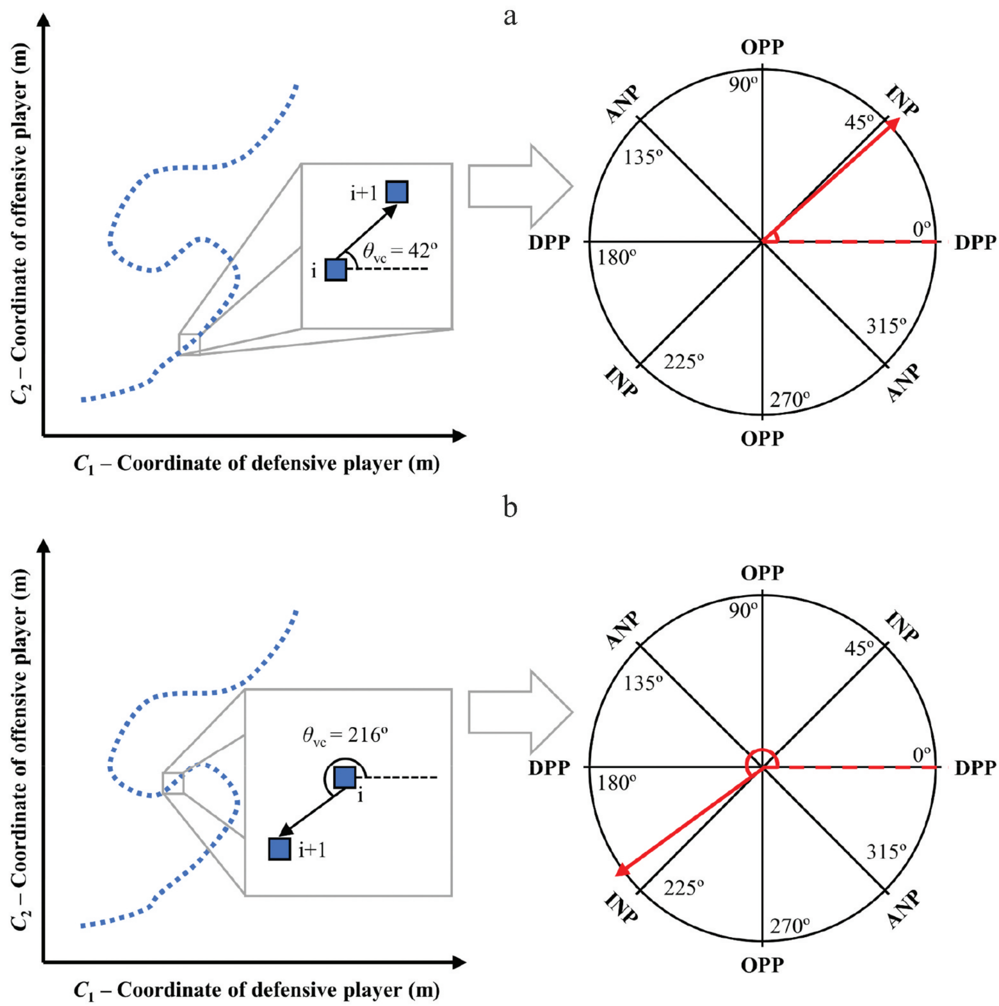

Figure 2. A relative motion plot of the defensive and offensive players' displacement time series with an expanded view of a coupling angle and the projection of this angle on the unit circle resulting in the in-phase pattern in the bins 22.5° to 67.5° (a) and 202.5° to 247.5° (b).

undefined; that is, it is impossible to define a representative mean direction, so these descriptive measures were not presented.

Statistical analysis

Lilliefors and Levene's tests were conducted to confirm the normality of the distribution and homogeneity of the variance of the data of coordination patterns frequency, respectively. The frequencies of coordination patterns were compared using two-way analysis of variance (offensive sequence: ended in defensive tackle and ended in shot to goal; coordination pattern: antiphase, in-phase, defensive player phase, and offensive player phase). When differences were found in the *F*-test, the Tukey honestly significant difference test was performed as a post hoc test. Then, effect sizes were calculated as partial eta-squared (η_P^2) and classifications were adopted (0.01 = small, 0.06 = medium,

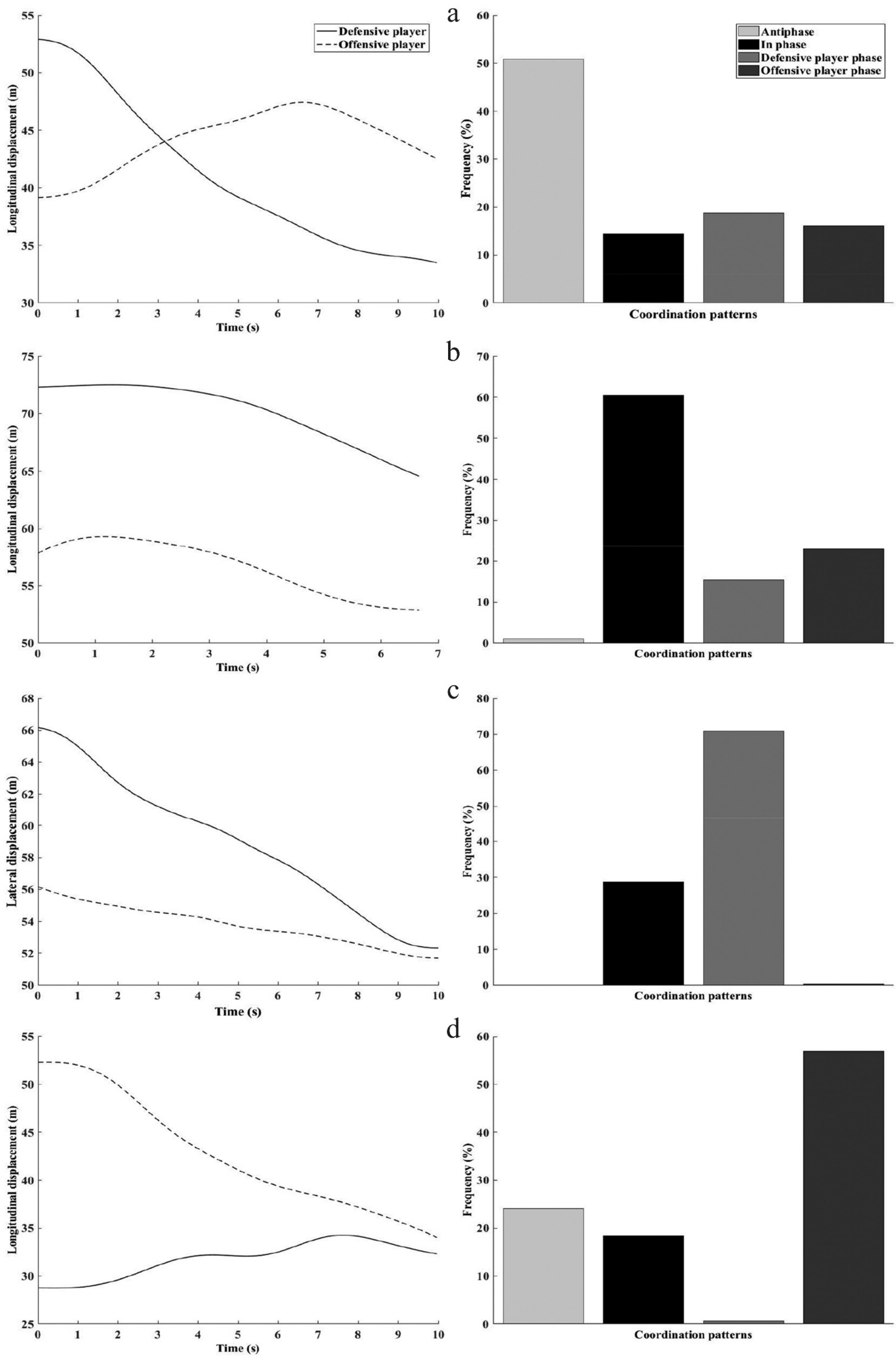

Figure 3. Examples of the displacements time series (left panels) and the histograms (right panels) with predominance of the antiphase (a), In-phase (b), Defensive player phase (c), and offensive player phase (d) Coordination pattern.

Table 1. Classification of coordination patterns according to the coupling angles.

Coordination pattern	Coupling angles
Antiphase	$112.5° \le \theta_{vc} < 157.5°$, $292.5° \le \theta_{vc} < 337.5°$
In-phase	$22.5° \le \theta_{vc} < 67.5°$, $202.5° \le \theta_{vc} < 247.5°$
Defensive player phase	$0 \le \theta_{vc} < 22.5°$, $157.5° \le \theta_{vc} < 202.5°$, $337.5° \le \theta_{vc} \le 360°$
Offensive player phase	$67.5° \le \theta_{vc} < 112.5°$, $247.5° \le \theta_{vc} < 292.5°$

0.14 = large) according to previously proposed methods (Cohen, 1988). A significance level of $P < 0.05$ was used for all statistical analyses.

Results

Figure 4 shows an example of the results of vector coding analysis applied to an offensive sequence. The mean and standard deviation of the percentage of time spent in each coordination pattern for the longitudinal displacement during offensive sequences ended in defensive tackles and shots to goal are presented in Table 2. Statistical differences were found in the main effect for coordination patterns ($F(3,2319) = 536.93$; $P < 0.01$; $\eta_p^2 = 0.41$; Large) in the longitudinal displacement. The main findings showed that antiphase was less frequent than other coordination patterns, and in-phase presented a higher frequency than defensive player phase and offensive player phase (Figure 5(a)). No

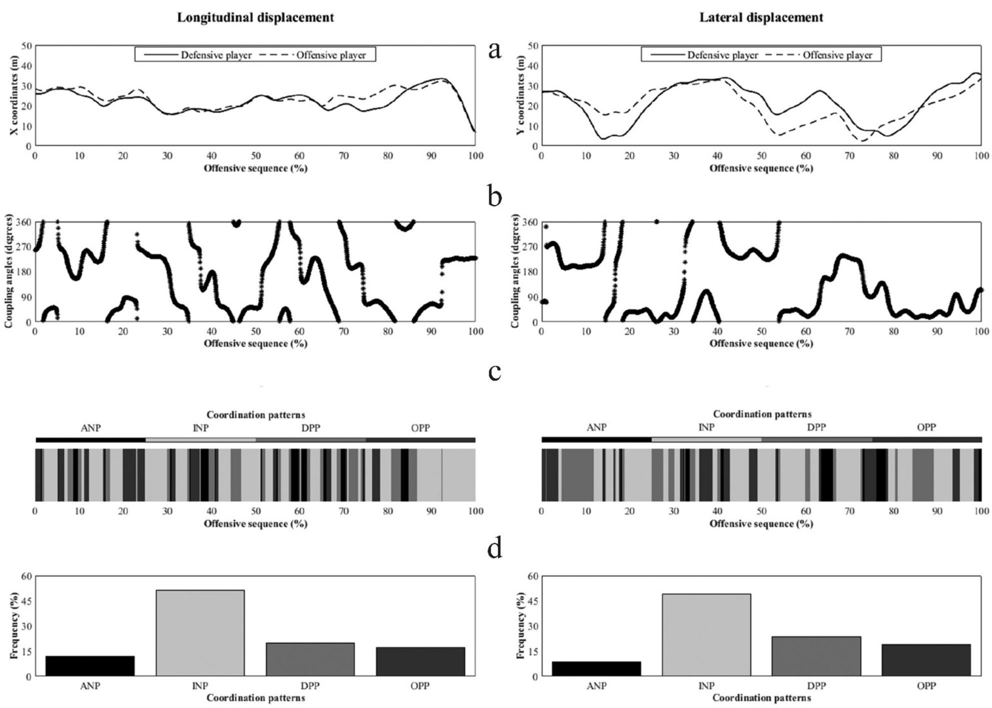

Figure 4. Representation of the vector coding analysis results for longitudinal (left panels) and lateral (right panels) displacements obtained from players' dyads displacements (a), The corresponding coupling angles (b), Coordination pattern (c), and histograms (d).

Table 2. Mean (standard deviation) of frequency (%) in each coordination pattern for longitudinal and lateral displacements considering main effect, offensive sequences ended in defensive tackle and shot to goal.

	Antiphase	In-phase	Defensive player phase	Offensive player phase
Longitudinal displacement				
Main effect	10.3 (13.4)	54.1 (25.9)	17.5 (17.8)	18.1 (17.0)
Ended in defensive tackle	11.0 (14.2)	53.4 (25.8)	18.3 (17.7)	17.4 (16.0)
Ended in shot to goal	8.8 (11.2)	55.8 (26.4)	15.7 (17.8)	19.7 (19.0)
Lateral displacement				
Main effect	12.5 (13.3)	43.2 (24.9)	22.1 (18.7)	22.2 (19.0)
Ended in defensive tackle	11.8 (13.2)	45.5 (25.7)	22.4 (19.2)	20.3 (19.0)
Ended in shot to goal	14.1 (13.4)	37.8 (21.9)	21.5 (17.3)	26.6 (18.4)

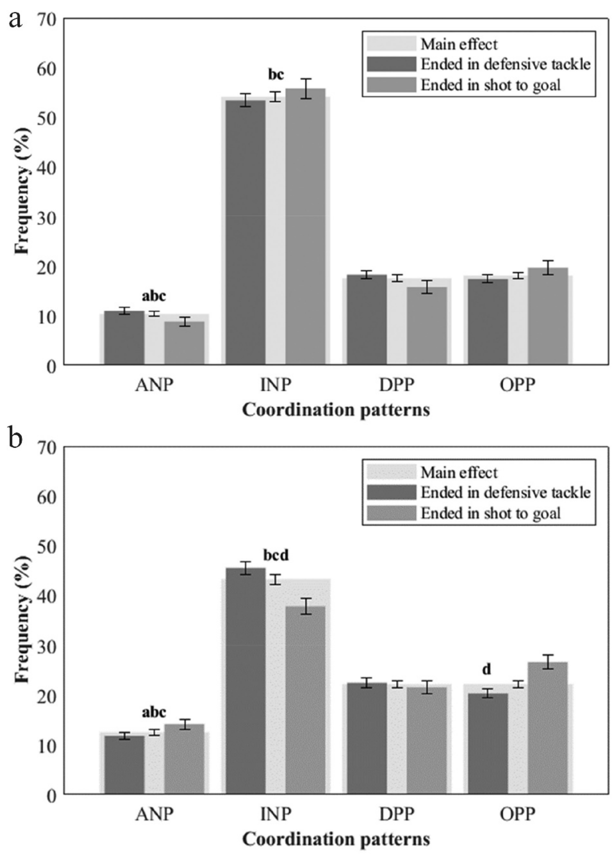

Figure 5. Mean (bars) and confidence intervals (error bars) of frequency of each coordination pattern in longitudinal (a) and lateral displacement (b) for main effect, offensive sequence ended in defensive tackle and shot to goal. (a) significant difference between antiphase (ANP) and in-phase (INP); (b) significantly different from defensive player phase (DPP); (c) significantly different from offensive player phase (OPP); (d) significantly different from ended in shot to goal.

statistically significant differences were found for the interaction between coordination pattern and offensive sequences.

The mean and standard deviation of the frequency of the coordination patterns during the offensive sequences for the lateral displacement are presented in Table 2. The results showed significant differences for the interaction between offensive sequence and coordination pattern ($F(3,2319) = 11.46$; $P < 0.01$; $\eta_p^2 = 0.02$; Small). Offensive sequences ending in defensive tackles presented higher frequency values for the in-phase coordination pattern than ended in shots to goal (Figure 5(b)). Furthermore, the offensive player phase was more frequent in offensive sequences ended in shots to goal compared to the ones ended in defensive tackles (Figure 5(b)). The main effect was found for coordination pattern ($F(3,2319) = 188.31$; $P < 0.01$; $\eta_p^2 = 0.20$; Large), presenting higher frequency for in-phase compared to all other coordination patterns, and antiphase pattern less frequent than defensive player phase and offensive player phase (Figure 5(b)).

Discussion and implication

This study aimed to characterise the coordination between opponent players during offensive sequences using the vector coding technique, investigating the success during defensive and offensive actions. We analysed the relative frequencies of the coordination patterns in offensive sequences ended in shots to goal and defensive tackles. The main findings showed that the in-phase coordination pattern was more frequent than the others, both in the longitudinal and lateral displacements. These results are completely in line with our first initial hypothesis, which suggested a higher frequency of the in-phase compared to other coordination patterns. Our second hypothesis was that, in the offensive sequences ending in shot to goal, a higher frequency of the offensive player phase would be found. This outcome was partially observed in the lateral displacements, with the in-phase coordination pattern showing less frequency and the offensive player phase being more frequent in offensive sequences ending in shots to goals than those ending in defensive tackle.

The results of relative frequencies in each coordination pattern demonstrated that the predominant pattern was in-phase for longitudinal and lateral displacements considering the offensive sequences regardless of the outcome. This finding has already been found in another study that analysed team centroid coordination in the longitudinal direction (Siegle & Lames, 2013). Likewise, Moura et al. (2016) found a predominance of the in-phase relationship of the opponent teams spread time series during offensive sequences. Our study showed that even in decisive moments of the matches, such as offensive sequences, the in-phase pattern is predominant in coordination of the dyads, corroborating the findings for collective tactical behaviour (Moura et al., 2016; Siegle & Lames, 2013). Another finding that stands out is that the antiphase relationship was less frequent than the others in both displacements for offensive sequences ended in shot to goal or defensive tackle. This outcome suggests that during the offensive sequences the players tend to move simultaneously in the same direction as their opponent. During another significant part of the time, the players probably react to their opponent's displacement because the defensive and offensive player phases together are approximately 40% of the time. This finding was obtained by the vector coding technique that make it possible to identify which players is leading the time series, as well as this technique provides direct information about the movement patterns of the players and reveals, from a practical perspective, that players are performing moves and forcing his opponents to react.

When we analysed the frequencies of the coordination patterns according to the results of the offensive sequences (defensive tackles vs. shots to goal), there were differences only in the lateral displacement. A lower frequency of the in-phase coordination pattern was found for offensive sequences ended in shots to goal compared to ended in defensive tackles. This behaviour was reported in a similar way by Bartlett et al. (2012), who demonstrated less predictable coordination dynamics in successful offensive attempts than in unsuccessful attempts for tactical collective. Previously, Siegle and Lames (2013) suggested that perturbations of the in-phase pattern may result in attempts of shots to achieve the goal. Our results also highlighted a higher frequency of the offensive player phase in offensive sequences that ended in shots to goal when compared to the ones that ended in defensive tackles. A similar behaviour was reported by Moura et al. (2016), who found a greater frequency of the attacking team phase in successful than unsuccessful offensive sequences. Thus, this reduction of the in-phase pattern and the increase of the offensive player phase found in offensive sequences that ended in shots to goal suggests that the offensive players should try to break the in-phase relationship to increase their chance of success. On the other hand, from the defensive perspective, maintaining the in-phase relationship can be related to greater chances of defensive success. These suggested behaviours can be subsidised by the findings of the study conducted by Vilar et al. (2013), that analysed the influence of opposing players on the performance of shot to goal attempts during futsal matches and demonstrated a higher probability of interception of the ball when the shooter's nearest opponent is closer to the interception point (supposed ball trajectory). In addition, the authors suggested that shot to goal opportunities can be created by the offensive player through movements to remove their opponents from the ball trajectory towards to the goal.

In addition to analysing the coupling angle data through the histogram to identify the time spent in each coordination pattern, we applied circular statistical procedures to obtain an additional characterisation by the descriptive measures of the vector coding time series. However, the distribution of the coupling angle data did not make it possible to obtain representative descriptive measures and the distribution can be seen in Figure 6. This outcome probably explained by the high incidence of coupling angles in the bins referring to the in-phase coordination pattern, which are bins from completely opposite angles that represent players moving simultaneously in the same direction, that is, reducing or increasing the coordinates. Figure 6 makes it possible to visualise the predominance of coupling angles in the bins of 22.5° to 67.5° and 202.5° to 247.5°, and these data are directional, which represent opposite directions in the unit circle, but the same coordination pattern. Thus, compressing the coupling angle data to a smaller angle range, as previously adopted in human movement coordination analysis (Ferber et al., 2005; Foch & Milner, 2014; Pohl & Buckley, 2008; Pohl et al., 2007), for example, constraining it to two instead of four quadrants can be useful in this case. However, Silvernail et al. (2018) in their study that assessed human body segment coordination suggests several limitations with compressed data analysis and did not recommend it. Therefore, evaluating the effects of constraining the angle data in football player dyads' coordination analysis or similar phenomena, such as other team sports, is necessary. On the other hand, future analysis can also address the coordination patterns by

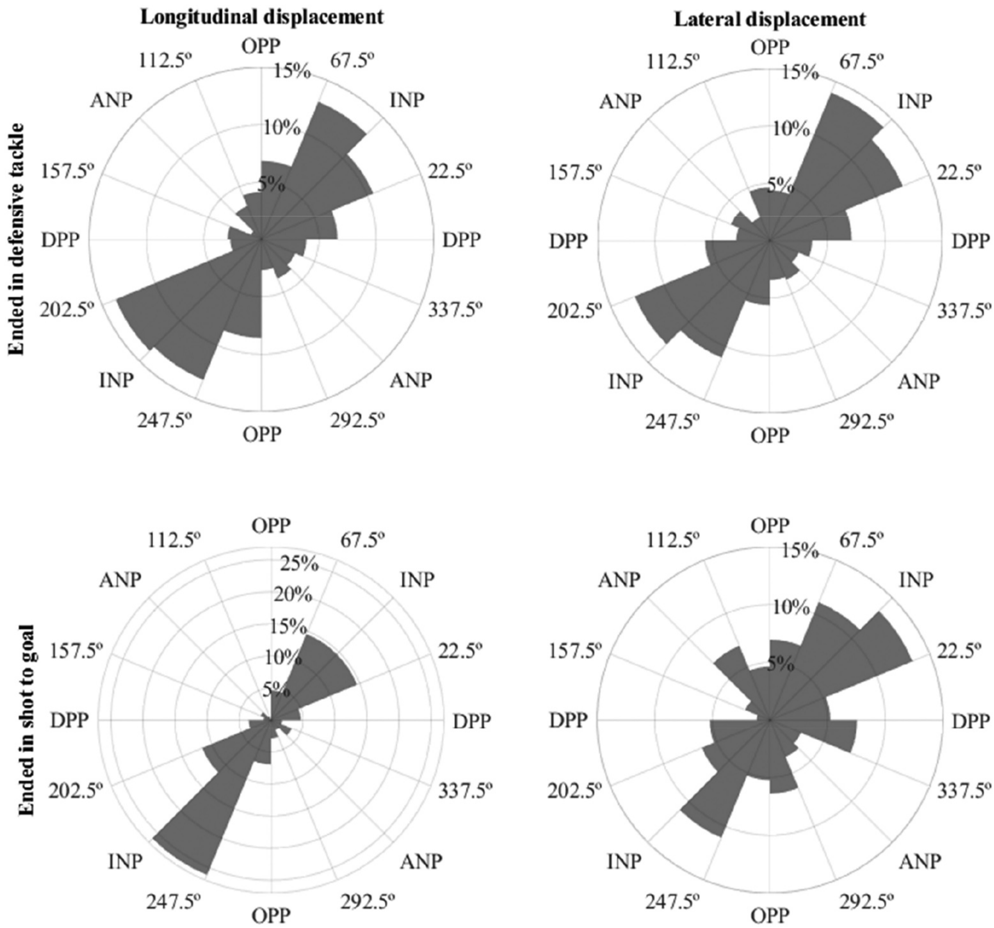

Figure 6. Circular histogram plot of offensive sequences ending in defensive tackle and shot to goal for longitudinal and lateral displacements. ANP: Antiphase; DPP: Defensive player phase; INP: In-phase; OPP: Offensive player phase.

decomposing the classifications into more than four patterns, for example, coupling angles in the bins of 22.5º to 67.5º and 202.5º to 247.5º, which can be visualised in the Figure 6, representing the in-phase pattern with the players increasing and decreasing their coordinates, respectively. This can originate from the smallest bins according to a previous proposal by Beitter et al. (2020) in human movement coordination analysis. This method allows the identification of new coordination patterns that can represent, for example, offensive players leading the time series in-phase (67.5º to 90º and 247.5º to 270º) or offensive players leading the time series in antiphase (90º to 112.5º and 270º to 292.5º), which are indicated by the bars in the circular histogram plot (Figure 6). Then, these new interpretations about the coordination patterns may show that successful offensive sequences are related to a specific relationship between the displacements of the players, that is, the offensive player leading time series and players moving in the same direction or offensive player leading time series with players moving in opposite direction.

In conclusion, the results of this study provide information about the interaction between opponent players during offensive sequences in official football matches. The relative frequencies of the coordination patterns demonstrated that the in-phase relation is predominant even in decisive moments of the matches. Furthermore, the interaction behaviour between elements in the football matches from a micro perspective analysis (i.e., interpersonal coordination of opponent player dyads) is similar to that already reported in the literature from a macro perspective (tactical collective measures). The vector coding analysis proved to be a useful tool, enabling us to identify which player was leading the time series and showed that a great part of the time the players were moving as a reaction to their opponent. From a practical perspective, the greater frequency of the offensive players leading the time series and less occurrence of the in-phase pattern in offensive sequences ended in shot to goal for lateral displacements demonstrated that the behaviour of anticipating movements in relation to the opponent can be associated with greater chances of success during attacks. On the other hand, from a defensive perspective, it may be interesting to keep the in-phase relation with the opponent to reduce his chances of success during attacks. However, other factors should be considered when interpreting the dynamics of these relationships, such as the pitch condition (natural or wet grass) and the width of the pitch, as they can affect the players' interaction with the ball and with other players. Furthermore, analysing players' coordination patterns considering the moments when they are with or without ball possession separately can provide new information about these relationships, elucidating the particularities of the distinct situations that the players experience during offensive sequences. The relationship of dyads during decisive moments of the official matches provides fundamentals for future research and assists coaches in understanding the different behaviours in successful and unsuccessful offensive sequences providing subsidies to identify and develop the individual traits of tactical behaviours of their players.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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