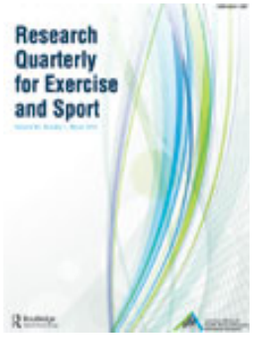

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Different Marks in the Pitch Constraint Youth Players' Performances During Football Small-sided Games

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ABSTRACT

Purpose: This study aimed to compare players' performances when manipulating the external markings of the pitch during football small-sided games. **Methods**: Ten under-15 players performed a 5-a-side (plus goalkeepers) under three conditions: (i) Lines, the game was played in a pitch in which the external boundaries were painted with full lines; (ii) Dashed, the game was played in a pitch in which the external boundaries were painted with dashed lines; (iii) Corners, the game was played in a pitch were the external boundaries were delimited by one marker at each pitch corner. Players' positional data was used to compute tactical and time-motion variables. Also, technical analysis was comprised using video footage. **Results**: Results showed similar tactical, physical and technical performances between the Lines and Dashed conditions. In contrast, the Lines condition showed small higher effects than Corners scenario in the time spent synchronized in longitudinal and lateral displacements, game pace, total distance covered, distance covered while jogging, number successful dribbles and shots on target. The Lines scenario has also revealed a lower effective playing space, distance covered at walking and running and a lower number of passes (small effects) compared to Corners. **Conclusions**: These results highlight that these changes in informational perception constraints modify players movement behavior. Accordingly, pitches with more visible boundaries were likely to decrease team dispersion, which may optimize team synchrony and technical performances, while decreasing the distance covered at higher speeds. Coaches may use this information to modify the types of pitch external boundaries markings, exposing the players to different environmental information.

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Positioning; collective behaviour; team sports; informational constraints

In football, small-sided games (SSG) have been considered as an optimal training solution to concurrently develop the players' tactical, technical and physical performances (Dellal et al., 2011; Folgado, Gonçalves, & Sampaio, 2017; Memmert et al., 2015; Santos et al., 2018). These situations are usually played in pitches with smaller areas, involving a lower number of players and often played with adapted rules in regard to the official 11-a-side match (Dellal et al., 2011). A considerable number of studies have been developed to understand the manipulation of the number of players (e.g. 1vs1 to 3vs3, 4vs4 to 5vs5 or even 5vs5 to 5vs3) (Aguiar, Gonçalves, Botelho, Lemmink, & Sampaio, 2015; Vilar et al., 2014b) and also the manipulation of the pitch size (e.g. small to large) (Hodgson, Akenhead, & Thomas, 2014; Kelly & Drust, 2009; Olthof, Frencken, & Lemmink, 2017).

Overall, previous reports have shown that manipulations in task constraints have led to the emergence of different interpersonal relations between the players and opponents, as well as different physical and technical performances (Olthof et al., 2017; Vilar et al., 2014b). Accordingly, the management of the space by the different number of players seems to constraint the perceptions of players' spatial-temporal relations (Travassos, Gonçalves, Marcelino, Monteiro, & Sampaio, 2014). These evidence highlight that players adaptations to changes on game environments are regulated by the environmental information that they perceive in order to perform (Gonçalves et al., 2016; Memmert et al., 2015; Travassos, Duarte, Vilar, Davids, & Araujo, 2012). In these game-based situations, players from each team share the same environment and have to continuously adjust their actions to the perceived variables with the intention of achieving a common goal (Gonçalves, Marcelino, Torres-Ronda, Torrents, & Sampaio, 2016; Passos, Araujo, & Davids, 2016). For this purpose, teammates must individually

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and collectively seek for relevant environmental information that might lead to the emergence of adaptive movement behaviors (Gonçalves et al., 2016; Grehaigne, Bouthier, & David, 1997; Passos et al., 2016).

Previous research has revealed that changes in physical properties of the environment can lead to changes in the perception of information with clear implications in the emergence of movement behaviors (Warren, 2006). In fact, there have been some attempts to study the effects of informational constraints that derived from spatial references, such as pitch internal boundaries restrictions during game-based situations (Coutinho et al., 2017; Gonçalves et al., 2016). For example, Gonçalves et al. (2016) revealed that restricting players displacements to a specific pitch area decreased players interpersonal coordination and physical demands over game-based situations. Coutinho et al. (2017) also revealed decreased physical performance and speed of contraction and dispersion when spatial references were added to the SSG.

Accordingly, the manipulation of the physical properties of the environment through the addition of pitch restrictive markings emphasizes distinct information that players use to adjust their movement behavior to perform (Gonçalves et al., 2016; Travassos et al., 2014; Vilar, Araujo, Travassos, & Davids, 2014a). Thus, coaches should account with the influence of such reference lines when designing training tasks for specific tactical, physical and/or technical improvements. However, research regarding how the manipulation of physical properties of game environment constraint players' actions is still scarce. For instance, it is not clear how changes in the type of pitch boundaries used (e.g. the use of cones, lines and/or dashed lines is a usual practice of coaches during the training sessions) constraints adaptive behavior of players and teams. It is possible that having a pitch with well-defined limits might allow players to improve the perception of the free space to play compared to a pitch that contains only partial markers, by highlighting the information related to the field boundaries. Concomitantly, the aim of this study is to analyze how changes in the type of marking of the pitch external boundaries affect players' tactical, physical and technical performances during football SSG. It is expected that the modifications in the marking of the pitch external boundaries promote changes to the spatial-temporal coordination tendencies between players. By marking only the field corners as the pitch external boundaries it might be hypothesized that teams will increase their dispersion, also leading to different physical and technical behaviors.

Methods

Participants

Ten youth football players (age = 13.7 ± 0.5 y; height = 163.1 ± 6.1 cm; body mass = 56.2 ± 4.2 kg; with 6.1 ± 0.9 years of experience) participated in this study. The players' maturity status was assessed by using a predictive equation that considers the chronological age, standing height, sitting height and body mass (Mirwald, Baxter-Jones, Bailey, & Beunen, 2002). In this sense, all players were considered as normal in their maturity stages, and the mean age of peak height velocity was −0.04 ± 0.41 years (Mirwald et al., 2002). The players performed 3 training sessions (90 to 115 minutes) per week with an official eleven-a-side match played during the weekend in a regular football field (104 × 64 m). Two goalkeepers were part of the study but were excluded from the analysis, given their specific positioning. An informed and written consent was provided to the coaches, players, and their parents, as well as by the club, before the beginning of the study. All participants were notified that they could withdraw from the study at any time. The study protocol followed the guidelines and was approved by the Local Institutional Research Ethics Committee and conformed to the recommendations of the Declaration of Helsinki.

Design

The study designed consisted on a repeated measure approach under three experimental conditions, in which were manipulated the marking of the pitch external boundaries (see Figure 1): (i) a control situation by playing an SSG in a pitch with external complete lines boundaries (Lines scenario) (ii) a pitch with external dashed lines boundaries (Dashed); and (iii) a pitch with an external painted marker in the corners (Corners). For this purpose, the games were always played using 5-a-side (plus goalkeepers) formats. The 5-a-side plus goalkeeper was chosen due on the basis that it has at least one player per sector (1 defender, 3 midfielders and 1 forward), and therefore, it has a higher similarity in players positional role with the 11-a-side match.

Procedures

The design was conducted in seven testing sessions for three weeks. In the first week, one familiarization session was completed, in which the players experienced every SSG scenarios used during testing sessions. Then, in each following week, three testing sessions in non-

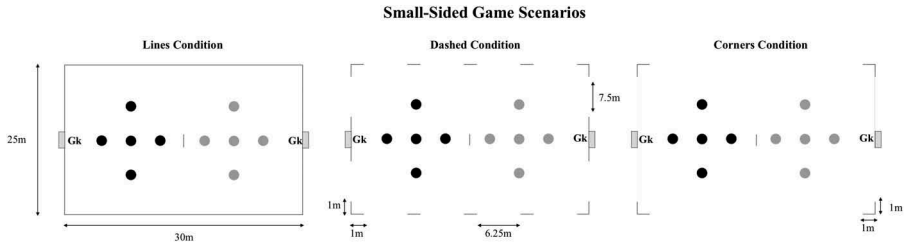

Figure 1. Representation of SSG pitch external boundaries conditions: pitch with lines (left figure—Lines), pitch with dashed lines (middle figure—Dashed) and with just corners (right figure—Corners). *Note*. m = meters.

consecutive days were performed to assess players' performance in one of the three SSG scenarios. Each testing day consisted of one condition randomly selected. Before the testing sessions, it was applied a standardized 15-min warm-up, that consisted of running and a ball possession game (5-a-side). All sessions were carried out at the same time of day, avoiding possible effects of circadian rhythms on the results. Furthermore, the conditions were tested under similar weather conditions (mean temperature 10ºC ± 3ºC).

The ten best players were selected by the head coach according to his perception of their physical, technical and tactical skills (Sampaio, Lago, Gonçalves, Macas, & Leite, 2014), and then divided into two balanced teams. The 5-a-side SSG (plus goalkeepers) was performed on a natural grass 30 × 25 m (length × width) pitch using formal 7-a-side goals. The SSG of each condition lasted for a total of 24-min, based on 3 bouts of 6-min of match play with 3-min of passive recovery period between bouts. Several balls were placed around the field to allow its replacement as fast as possible, with the aim of decrease time lost during the games. No coach feedback or encouragement was allowed during the conditions. In addition, the SSG scenarios were performed with the official game rules, apart from the offside rule that was not applied. SSG situations can be very different between bouts due to the complex and dynamic properties of the game. To ensure an adequate similarity between the situations, the bout-to-bout variability was accessed using ICC from the total distance covered and results were moderate to excellent (ICC = .85 CI = 0.68 to 0.93).

Tactical and physical variables

The players' positional data and the distance covered during SSG were collected using 5 Hz global positioning system (GPS) units (SPI-PRO, GPSports, Canberra, ACT, Australia). The players' latitude and longitude coordinates obtained from game units were exported and processed using appropriate routines in Matlab® (MathWorks, Inc., Massachusetts, USA) (see Folgado, Duarte, Fernandes, and Sampaio (2014a) to data management guidelines).

The positional data were used to assess the team effective playing space (EPS), measured as the area occupied by all outfield players from each team (Gonçalves et al., 2016). Also, the distance between dyads from the same team (n = 10 dyads per team), i.e., representing a pair of teammates that share the intention of achieving the common goal (Gonçalves et al., 2016) was computed. The distance between dyads was expressed by the absolute values (m), the magnitude of the variability, expressed by the coefficient of variation (CV) (Gonçalves et al., 2016) and the structure of variability, expressed by the approximate entropy (ApEn) (Gonçalves et al., 2016). The ApEn technique has been used to assess the regularity of a time series (Duarte et al., 2012; Gonçalves et al., 2016), and its outcome varies from 0 to 2, in which values closer to 0 means more repeatable patterns. For example, values closer to 0 in the distance between dyads, means that the players are likely to be in a repeatable distance between them during the game. The imputed values used to compute were 2 to vector length (m) and 0.2*std to the tolerance (r) (Yentes et al., 2013). Finally, the time that teammate's dyads spent synchronized in both longitudinal and lateral directions was measured to assess the intra-team coordination tendencies. For this purpose, these two last variables were processed using the Hilbert transform (Palut & Zanone, 2005) and applied for all possible dyads for the five outfield teammates per team. The near-in-phase synchronization of each dyad was quantified form the percentage of time spent between −30º to 30º bin (near-in-phase mode of coordination) (Folgado et al., 2014a).

The total distance covered, the distance covered at different movement speed categories, and the game pace (km/h) for each player were calculated (Gonçalves et al., 2016). The following speed categories were considered for analysis: walking (0.0–3.5 km/h); jogging (3.6–14.3 km/h) and running (>14.4 km/h) (Gonçalves et al., 2016). In this study, the distance

covered while sprinting was not considered as the small pitch size (62.5 m^2 of relative pitch area) may not allow the players to cover the distance at high speeds (Hodgson et al., 2014; Olthof et al., 2017).

Technical data

The SGG were recorded using a digital video camera, Sony NV-GS230, that was fixed at a 2-m height and aligned in the midfield part of the pitch. Then, the video files were downloaded to a computer and a notational analysis was performed using the LongoMatch software (Longomatch, version 1.3.7., Fluendo) (Santos et al., 2018). The following individual performance variables were collected: successful passes, successful dribbles, shots on target and goals (Liu, Gómez, Gonçalves, & Sampaio, 2015). All the technical variables were expressed as a percentage (%) from the total values. The videos were analyzed by an experienced performance analyst, and the data reliability was inspected by retesting 17.5% of the sample. The intra-class correlation was deemed as high (>0.91) (O'Donoghue, 2010).

Statistical analysis

The descriptive statistics were reported as mean and standard deviations for all variables. Comparison between conditions (Lines vs. Dashed, Lines vs. Corners) were determined using raw data for the technical variables, while for the positional and physical variables the effects were estimated in percent units through log-transformation (to reduce the non-uniformity of error) and uncertainty in the estimate was expressed as 90% confidence limits confidence intervals (Cumming, 2012; Hopkins, Marshall, Batterham, & Hanin, 2009). The threshold for a change to be considered practically important (the smallest worthwhile difference) was 0.2 × between game standard deviation (SD). Uncertainty in the true effects of the conditions was evaluated based on non-clinical magnitude-based inferences. The following magnitudes of clear effects were considered: 25 to 75%, possibly; 75% to 95% likely; 95% to 99%, very likely; >99% most likely (Hopkins et al., 2009). Effect sizes statistics (Cohen's *d*) were assessed using the following ranges: <0.2, trivial; 0.2 to 0.59, small; 0.60 to 1.19, moderate; 1.20 to 1.99, large; and >2.0, very large (Hopkins et al., 2009).

Results

Table 1 and Figure 2 presents the outcome comparisons among considered tactical, physical and technical

Table 1. Descriptive tactical, physical and technical analysis (mean ± *SD*). Difference in means and uncertainty in the true differences comparisons among the considered SSG scenarios.

	SSG Scenarios			Difference in means Uncertainty in the true differences	
Variables	Lines (mean ± *SD*)	Dashed (mean ± SD)	Corners (mean ± SD)	Lines vs Dashed	Lines vs Corners
Tactical Variables					
Distance btw Dyads (m)	8.87 ± 1.79	8.89 ± 1.86	9.20 ± 1.81	0.11 ± 2.12, Most Likely Trivial	3.85 ± 2.17, Possibly ↑
Distance btw Dyads (CV)	0.41 ± 0.07	0.41 ± 0.07	0.41 ± 0.07	1.04 ± 2.37, Very Likely Trivial	0.74 ± 2.79, Likely Trivial
Distance btw Dyads (ApEn)	0.26 ± 0.05	0.25 ± 0.24	0.25 ± 0.04	−2.44 ± 2.84, Possibly ↓	−0.39 ± 2.72, Possibly ↓
Effective Playing Space (m^2)	68.93 ± 13.52	69.62 ± 15.67	75.16 ± 16.26	0.31 ± 5.79, Unclear	8.28 ± 6.40 Likely ↑
Longitudinal Sync. (%)	46.36 ± 12.43	43.33 ± 10.68	39.33 ± 10.07	−5.87 ± 4.02, Possibly ↓	−14.99 ± 4.49, Most Likely ↓
Lateral Sync. (%)	33.08 ± 9.85	31.78 ± 9.66	29.27 ± 10.23	−3.99 ± 5.75, Likely Trivial	−13.35 ± 6.66, Likely ↓
Physical Variables					
Game Pace (km/h)	4.89 ± 0.79	4.47 ± 0.63	4.68 ± 0.66	−0.10 ± 0.12, Possibly ↓	−0.21 ± 0.15, Likely ↓
Total Distance Covered (m)	488.92 ± 78.51	479.33 ± 62.52	463.84 ± 67.66	−1.41 ± 2.56, Likely Trivial	−4.81 ± 3.12, Likely ↓
Walking (0.0–3.5 $km.h^{-1}$)	85.65 ± 20.11	90.75 ± 19.27	93.52 ± 18.66	6.48 ± 4.00, Likely ↑	9.93 ± 4.99, Very Likely ↑
Jogging (3.6–14.3 $km.h^{-1}$)	386.37 ± 89.81	371.22 ± 72.62	349.62 ± 75.03	−2.69 ± 4.08, Likely Trivial	−8.78 ± 4.83, Likely ↓
Running (> 14.4 $km.h^{-1}$)	16.90 ± 13.77	17.35 ± 13.64	20.70 ± 16.81	6.84 ± 27.05, Unlikely	52.57 ± 42.37, Likely ↑
Technical Variables					
Successful Passes (%)	71.45 ± 27.44	71.02 ± 26.02	74.17 ± 25.85	−1.82 ± 7.27, Unlikely ↓	5.31 ± 10.43, Possibly ↑
Successful Dribbles (%)	62.99 ± 42.40	59.17 ± 39.58	47.13 ± 39.61	−2.54 ± 16.18, Unclear	−45.83 ± 25.14, Very Likely ↓
Shots on Target (%)	43.55 ± 39.30	36.55 ± 34.18	29.15 ± 34.62	−6.90 ± 12.87, Possibly ↓	−11.50 ± 16.38, Possibly ↓
Goals (%)	21.06 ± 29.22	22.54 ± 31.69	25.82 ± 28.72	−2.26 ± 9.37, Unclear	−1.17 ± 14.34, Unclear

Note. Comparison between conditions (Lines vs. Dashed, Lines vs. Corners) were determined using raw data for the technical variables, while for the positional and physical variables the effects were estimated in percent units through log-transformation (to reduce the non-uniformity of error). CL = confidence limits; *n* = number; m/s = meter per second; m = meters; CV = coefficient of variation; ApEn = approximate entropy; ↑ = Higher; ↓ = Lower; SD = Standard Deviation

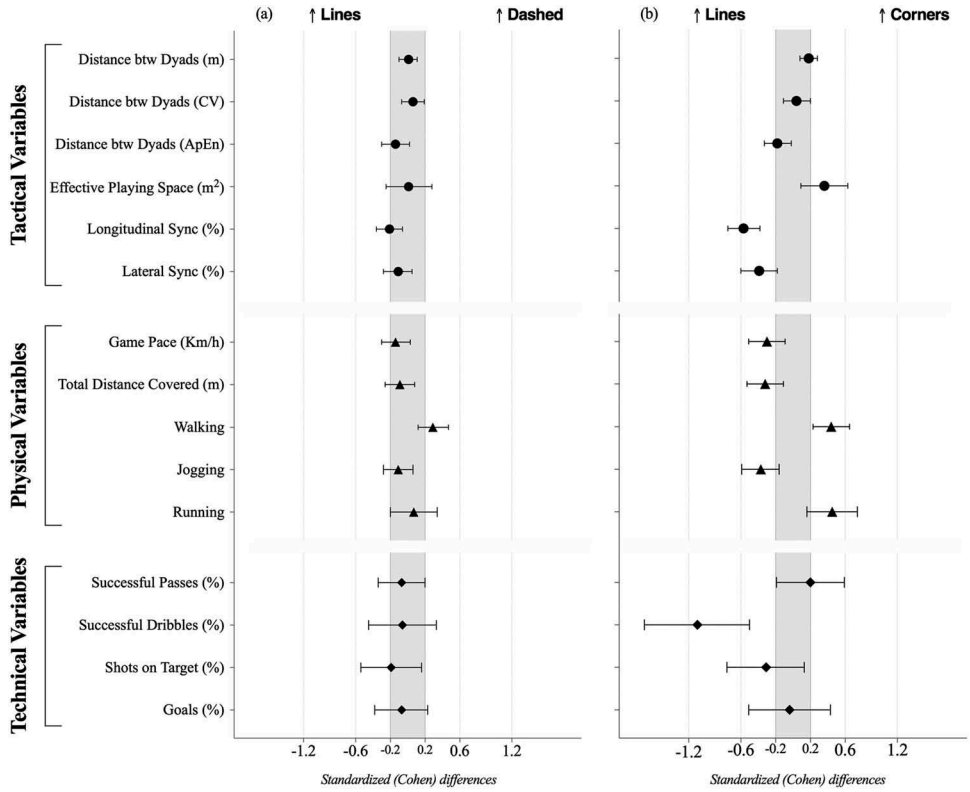

Figure 2. Standardized (Cohen) differences in tactical, physical and technical variables according to the SSG Scenario (Lines vs Dashed: a) left panel, b) Lines vs Corners). Errors bars indicate uncertainty in the true mean chances with 90% confidence intervals. *Note*. m = meters; CV = coefficient of variation; ApEn = approximate entropy; Sync = synchronization.

variables between the considered SSG. Regarding tactical behavior, there was a likely ~8% increase in the effective playing space (small effects) in the Corners compared to the Lines condition. It was also observed that both Dashed and Corners scenarios revealed, respectively, a possibly ~6% and a most likely ~15% decrease in the time spent synchronized for the longitudinal direction (small effects) compared to the Lines scenario, respectively. In addition, Corners also showed a likely ~13% decrease in the lateral direction (both with small effects) than the Lines scenario. All the other results revealed unclear effects between SSG scenarios.

From the physical perspective, the Dashed condition presented likely ~6% increase in the distance covered during walking (small effects) than the Lines condition. The Corners promoted a very likely ~10% increase in the distance covered while walking and likely ~53% increase during running in comparison with Liners condition (small effects). For the other side, the Corners demanded likely lower game pace, total distance covered and distance covered during jogging (small effects).

The technical analysis revealed no practical differences between the Lines and Dashed conditions. However, a very likely lower number of successful dribbles (moderate effects) and a possible lower number of shots on target (small effects) was found for the Corners scenario compared to the Lines condition, while in turn it the Corners also presented a possibly higher number of passes (small effects) compared to the Lines scenario.

Discussion

This study aimed to identify how the manipulation of pitch external boundaries during football SSG, constraints youth players' tactical, physical and technical performances. The results revealed that no substantial differences were found between the Lines and Dashed scenarios. On the other side, there were considerable differences between the Lines and Corners scenarios. Accordingly, compared to Corners pitch boundaries, the Lines revealed higher times spent synchronized in both longitudinal and lateral directions, higher game pace, total distance covered and distance covered in jogging, as well as the higher number of offensive technical indicators. However, the Lines has also shown lower effective playing space, distance covered while walking and running and lower number of passes. These results suggest that changes on physical properties of the environment, promoted by the change

on pitch external boundaries used, led to changes in perception of space for play with clear implications in the emergence of movement behaviors. Accordingly, the use of Lines in comparison with only corners markers emphasize the space of play and allow players to improve their spatial-temporal relations on the field (Gonçalves et al., 2016; Travassos et al., 2014; Vilar et al., 2014a).

The results from the present study did not reveal differences between the game scenarios in the teammates' distance, regarding their absolute values, variability, and regularity.

It suggests that players, even with the manipulation of pitch boundaries, regulate their interpersonal relations using other information, such as teammates positioning, rather than the pitch boundaries. Nevertheless, these similar positioning (i.e., teammates' distance, regarding their absolute values, variability, and regularity) promoted different functional behaviors and different game dynamics (i.e., with changes in technical, positional and physical variables), especially when comparing the Lines with the Corners scenario. These evidences highlight that players need to be attuned with intra-team spatial-temporal information to ensure their structural stability, while at the same time they also retrieve information from the physical pitch game conditions (Travassos et al., 2014; Vilar et al., 2014a), such as pitch boundaries marking, to face the competitive dynamics of the game, leading to adaptive behaviors across conditions.

In the present study, higher effective playing space was found during the Corners scenario. While the ability to use the available pitch space seems to be related with higher game knowledge (Folgado, Lemmink, Frencken, & Sampaio, 2014b; Gonçalves et al., 2016) and better exploration of game principles (Ouellette, 2004), it also seems to be constrained by the available environment information (Gonçalves et al., 2016). In previous research, lower player space exploration has been found when the players positioning was limited to specific pitch zones compared to free spacing scenarios (Gonçalves et al., 2016). Therefore, the pitch restrictions might have constrained the players to explore and scan the space (Gonçalves et al., 2016). In a similar way, it is possible that the absence of the pitch external boundaries during the Corners condition might have emphasized the search for space, and consequently, the exploration of all available space to values near or over the marking limits, promoting a greater team dispersion. Furthermore, this increase in team dispersion is likely to affect the players' activity demands. In fact, it was found a higher distance covered while running during this condition. Thus, as more free space is available, players are more likely to exploit them, displacing at higher intensities in order to gain an advantage over their opponents (Olthof et al., 2017).

The players' movement synchronization has been used to assess players tactical performance. In fact, players from the same team are likely to coordinate their behaviour in order to achieve the same goal (Folgado et al., 2014a; Gonçalves et al., 2016; Grehaigne et al., 1997) and, therefore, it is possible that higher movement synchronization may indicate higher tactical performances (Coutinho et al., 2017; Folgado et al., 2014a; Folgado, Duarte, Marques, & Sampaio, 2015; Folgado et al., 2017). In the present study, higher values of movement synchronization were found in the Lines condition compared to the other scenarios. These findings may be related to the reduced visual information from the pitch boundaries during the Corners condition. That is, while the players' movement behavior seems to be adjusted based on the positioning of their teammates, this movement synchrony may also be dependent on the existing boundaries which specify the limits in which the team must act (Grehaigne et al., 1997). Therefore, the absence of pitch lines may constrain players' perception of distance (Fajen, Riley, & Turvey, 2009), with consequences on their positioning. In fact, previous reports showed that players may use pitch lines to adjust the distance between players (Coutinho et al., 2017). Additionally, the higher movement synchronization found during the Lines condition might also result from the lower team dispersion and from less distance between dyads. This is in line with previous reports, which have shown that the time that players spent synchronized is linked with their spatial proximity (Folgado et al., 2015, 2014b).

The Lines condition showed higher game pace, total distance covered, distance covered at jogging and less distance covered in walking and running compared with the Corners scenario. These results seem to be linked with the tactical data, mainly with the time that players spent synchronized during the Lines scenario. In fact, previous reports showed decreased physical demands with increased in collective synchrony (Folgado et al., 2017). Therefore, this higher synchronization may reflect better tactical performances, which is likely to decrease the need of cover distance at high speeds for positional adjustments (Folgado et al., 2017; McGarry, Anderson, Wallace, Hughes, & Franks, 2002). Nevertheless, the players still have to move to maintain the team interpersonal coordination, thus, the increases in the total distance covered and distance covered at jogging may result from this need (Gonçalves et al., 2016).

The technical analysis revealed a higher number of successful dribbles and shots during the Lines but lower number of passes than the Corners condition. As previously mentioned, the existing pitch external boundaries during the Lines condition may provide additional information to players in regard to distances (e.g., to the target, to the nearest defender), which is likely to help them in their decisions (Fajen et al., 2009). For example, the defenders seem to adjust their positioning according to the information on the distance of the attackers to the target with the aim of decrease shooting opportunities (Vilar et al., 2014a). In this sense, it is possible that the presence of the lines may provide more information on the available space and afford the players to use the dribble more often during the Lines condition. In addition, the higher number of shots on target found in this condition may be related to this increase in successful dribbles. That is, by dribbling an opponent, the attacker might have additional time and space to scan the environment and search for goal scoring opportunities. In fact, previous works shown that attackers successful performances during 1vs1 were related with unpredictability in the interpersonal coordination with the defender (Duarte et al., 2012) and misalignment with the defender (Laakso, Travassos, Liukkonen, & Davids, 2017; McGarry et al., 2002; Vilar et al., 2014a). Also, is it possible that the lower team dispersion found during the Lines condition resulted in fewer opportunities to pass (Vilar et al., 2014b), and the dribble and shot may have emerged as a functional movement behavior to overcome the decreased space conditions to pass. In fact, the higher number of passes found during the Corners condition seems to support these results.

Overall, the present study has shown similar players performance during SSG with different pitch external boundaries markers, either full lines or dashed lines. In fact, no effects were found in most of the tactical, physical and technical variables, which seems to suggest that coaches can use both conditions without modifying the players' performance. In contrast, the Corners scenario has only partial external boundaries, and this seems to modify the emergence of the functional adaptive behaviors, leading to distinct tactical, physical and technical behaviors than in the Lines scenario. In the end, coaches should account with mark type of external pitch boundaries, as it seems to lead to different players behaviors, mainly when comparing a pitch with full external marking with a pitch that contains only partial boundaries.

Whilst this study adds novel and important findings regarding the different type of pitch markings on the players' movement behavior, some limitations should be acknowledged. Firstly, the lower sample size used in this study may limit the generalization of results. Furthermore, it is also possible that different results may emerge with older players and with players of different expertise, since they interact differently with the environmental information (Mann, Williams, Ward, & Janelle, 2007), and therefore further studies should be developed using a larger sample size and with different levels of expertise.

Conclusions

The effects of manipulating the pitch external boundaries have impacted the players' performances during football SSG. The Lines condition showed higher values of team synchronization in both lateral and longitudinal direction, and thus it can be used as an optimal task to emphasize team coordination. The Lines and Dashed scenarios revealed similar results, suggesting that coaches can use both situations with minimal changes in the players' performance. However, different results were found when the pitch external boundaries are less evident as in the Corners condition. Accordingly, higher team dispersion was found in the Corners, which seems to impair the team collective synchrony and lead to an increase in the distance covered at higher intensities. Nevertheless, coaches may vary in the conditions used during practice sessions to promote variability and adaptive behaviors. These findings suggest that the changes in the tasks informational constraints modified the players' opportunities for action, leading to the emergence of different movement behaviors.

What does this article add?

The present research article provides important information regarding how players seem to adapt their movement behavior according to the available information from the environment, such as spatial references. More specifically, this study reveals that the players' adopt different physical, technical and tactical behaviors as a result of the type of markings in pitch external boundaries during SSG. Considering that coaches manipulate SSG constraints in order to develop functional movement behaviors, the results from this study highlight that the pitch boundaries should be also considered. As so, the results from this study may have a clear impact in the way how coaches design training tasks, as well as in upcoming experimental studies using SSG that should report how the pitch is marked.

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