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Original Article

Number of players manipulation effect on space and concentration principles of the game representativeness during football small-sided and conditioned games

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Abstract:
When planning training programs, coaches must secure that modified game conditions through which they intend to enhance the acquisition of tactical skills and decision-making represent real contexts of regular matches and promote similar performance behaviours. In this sense, this study aimed to analyse the effect of number of players manipulation on intra-teams' coordination during offensive and defensive specific principles (space and concentration, respectively) application in Football small-sided and conditioned games. The intra-team coordination was measured through two dispersion variables - teams' width and length - during offensive and defensive sequences of small-sided and conditioned games with number of players' manipulation (3v3, 4v4 and 5v5). The playing phase (offensive or defensive) had a significant effect on width (F (1, 54) = 31.17, $p < 0.01$, η^2 = 0:37) and length (F (1, 54) = 5.09, $p = 0.03$, $\eta^2 = 0.09$). During offensive phase, teams' width and length were significantly higher than during the defensive phase. The number of players also had a significant effect on teams' width (F (2, 54) = 22.25, $p < 0.01$, $\eta^2 = 0.45$) and length (F (2, 54) = 24.18, $p < 0.01$, $\eta^2 = 0.47$). Were found differences between all game conditions for width. The length was significantly lower on 3v3 compared to 4v4 (p <0.01), and 5v5 (p<0.01). Given the constraints, teams had a tendency to maintain specific principles of the game (space and concentration) during attacking and defending. In addition, the increase of players on same space of play induce higher dispersion values both on attack as on defence.
Key Words: soccer; training; tactical skills; collective behaviour; team coordination; action fidelity.

Introduction

Training programs of team sports, like association football, frequently use small-sided and conditioned games (SSCGs) for improving players' performance on tactical, technical and physical competences, concurrently. In relation to the full-game version, SSCGs increase players' involvement with specific skills and similar situations by manipulating rules and number of players on reduced pitch areas (Casamichana & Castellano, 2010; S. Hill-Haas, Dawson, Impellizzeri, & Coutts, 2011).

In the last decade or so, several studies have addressed the physiological, physical and technical components of SSCGs (e.g., (Abrantes, Nunes, Macãs, Leite, & Sampaio, 2012; Dellal et al., 2012; Harrison, Gill, Kinugasa, & Kilding, 2013; S. V. Hill-Haas, Dawson, Coutts, & Rowsell, 2009; Kelly & Drust, 2009; Koklu, Asci, Kocak, Alemdaroglu, & Dundar, 2011; Rampinini et al., 2007). Nevertheless, despite SSCGs have been widely used by team sports coaches for shaping individual and collective tactical behaviours, there are lacking evidence-based guidelines to support their coaching practices.

SSCGs offer several possibilities for manipulation of key informational task constraints (e.g. number of players, pitch dimension, etc.) to shape the emergence of co-adaptive team behaviours through exploration of performance solutions. In this sense, recent studies have investigated the dynamics of interpersonal interactions in team sports supported by key informational constrains (e.g.,Correia et al., 2012; B. Travassos, Davids, Araújo, & Esteves, 2013; Vilar, Araújo, Davids, & Button, 2012).

From a constraints-led approach (Keith Davids, Button, & Bennett, 2007; Newell, 1986), behaviours emerge from the dynamical interaction between each individual, the environment and task constraints (Brymer & Davids, 2013; Chow et al., 2006; K. Davids, Araujo, Correia, & Vilar, 2013; Vilar et al., 2012). Changing the environmental conditions (e.g., playing on wet or dry surfaces, under heat or cold temperatures, etc.), a task's specific constraints (e.g., number of players, pitch dimensions, rules, etc.) or the individual characteristics (e.g., technique or fitness skills) may lead to the emergence of distinct interactive behavioural patterns. By manipulating key informational constrains, practitioners stimulate a continuous co-adaption of players towards

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specific intended goals, by constantly (re) orientating themselves through perception of the contextual information emerging from their interaction with the competitive environment (K. Davids et al., 2013).

One of the main concerns of practitioners when planning their teaching and training programs is to secure that the modified game conditions through which they intend to enhance the acquisition of tactical skills and decision-making represent real contexts of regular matches and promote similar performance behaviours. In this sense, SSCGs-based training programs should promote representative relationships of players with key sources of information from the performance environment (Bruno Travassos, Duarte, Vilar, Davids, & Araújo, 2012) and the emergence of similar performance behaviours (i.e., action fidelity) (Duarte Araújo, Davids, & Passos, 2007; Stoffregen, Bardy, Smart, & Pagulayan, 2003).

The concept of representativeness (Brunswik, 1955) refers the actions and decisions of actors (in our case, players) in a task should be supported by information that represent the natural environment in which they usually perform and the decision is made (i.e., the game) (D. Araújo, Davids, & Hristovski, 2006; Bruno Travassos et al., 2012).

Some researchers have been studying team ranges in formal football games and in SSCGs to provide information and understanding of tactical aspects (Duarte et al., 2013; Folgado, Lemmink, Frencken, & Sampaio, 2014). However, the representativeness on some kind of SSCGs in relation to formal game is still unknown.

Few recent studies had discussed the effects of the individual playing area (IPA) on tactical behaviours through manipulation of number of players and pitch dimension (Folgado et al., 2014; Frencken, van der Plaats, Visscher, & Lemmink, 2013). Folgado et al. (2014) analysed lpwratio variable (length and width ratio) and centroid distance between teams according to number of players manipulation (GK+3v3+GK and GK+4v4+GK) in three different age groups (U-9, U-11 and U-13). The number of players' manipulation had no conclusive effect or specific trend on lpwratio and any significant difference between teams' centroid distance. In another study, Frencken et al. (2013) verified the effect of IPA variation (through pitch dimension manipulation) on lateral and longitudinal distance between teams' centroids. A decrease in pitch length or width reduced teams' centroid distances in the same direction and increased centroid distances in the opposite direction. Nevertheless, remain unknown manipulation effects of these constraints on SSCGs representativeness. Thus, to consider that a SSCG is representative of the formal game we understand that specific principles of attack and defence in Football (space and concentration, respectively) should remain unaffected.

In order to satisfy some specific principles of association football, the attacking team must expand effectively on field to find and explore free spaces (space principle). Contrariwise, the team that is defending has to close down space to prevent the opponent to progress on the field with the ball (concentration principle) (Costa, Garganta, Greco, & Mesquita, 2009). Some studies presented these official football games characteristics. For example, Moura, Barreto Martins, Anido, Leite De Barros, and Cunha (2012) analysed official football games from Brazilian Championship and perceived that when lose the ball teams decrease surface area while when recovery the ball teams increase surface area.

Regarding these principles, team ranges (width and length) can be exploited as indicators for a better collective behaviour comprehension (Duarte, Araújo, Correia, & Davids, 2012). In SSCGs, it is not well understood how the aforementioned attacking and defending principles are influenced by number of players manipulation while maintaining pitch dimension constant and how such constraints impact on the SSCGs representativeness in relation to formal game.

Following these insights, the aim of this study was to investigate the effect of number of players' manipulation on application of offensive and defensive specific principles (space and concentration, respectively) during SSCGs practice. Second, we sought to compare about SSCGs representativeness and action fidelity with number of players manipulation in same pitch dimension. We expected that offensive team width and length be higher in all SSCGs formats, demonstrating constant application of specific principles of the game.

Material & methods

Participants

Ten players (M = 13.6, SD = 0.52 years) competing at a regional-level in the local under-15 years Association Football competition, with playing and training experience (M = 4.10, SD = 1.77 years) participated in this study. Their legal tutors provided a signed and informed consent form authorizing their participation on this experiment. All procedures were in accordance with the Declaration of Helsinki and had approval of the Ethics Committee of Faculty of Sport of University of Porto (03/2013 CEFADE).

Data collection

Players were divided equally in two teams of equivalent skills by their coach. They performed in three different SSCGs formats, varying in number of players, in the following order: 3v3, 4v4 and 5v5. Pitch dimension was 36 x 28 m (length x width) for all SSCGs formats, therefore, varying the individual playing area as follows: ≈168m² on 3v3, ≈126m² on 4v4 and ≈100.8m² on 5v5. Two mini-goals (120 x 80cm, width x height) were positioned on both goal line and each one was located seven meters distance from one pitch corner. No goalkeepers were used. The work/rest ratio was 1:1 (5-min of play and 5-min of recovery). The coach set the

SSCGs time duration and rest periods based on the usual duration of other types of SSCGs that he used to implement in his training sessions. During the recovery periods the players rehydrated and performed low intensity activities at will (e.g., performing short passes in pairs). All trials were conducted according to the official rules of association football, except for the offside rule, that was not applied. Also, any intervention by the coach like instructions or orientations about organizational aspects were performed during practice.

All SSCGs were video recorded and an unobtrusive-global positioning measure tracking device (Qstarz BT-Q1000eX) was carried by the players. Each participant's 2D positional coordinates were recorded at a sampling frequency rate of 10Hz. Pitch coordinates were calibrated using four GPS devices placed in each corner of the pitch for two minutes. Absolute positions were used to set the Cartesian coordinate systems, with the origin placed at its centre of the pitch. Longitudinal and latitudinal (spherical) coordinates were converted to Euclidean (planar) coordinates using the Haversine formula (Sinnott, 1984).

Variables

There were selected the five longest team ball possessions for each SSCG format (yielding ten sequences per SSCG). All sequence durations were calculated in seconds and showed no significant differences between 3 v 3 (17.20 ± 6.57), 4 v 4 (13.00 ± 5.69) and 5 v 5 (13.70 ± 5.80, p = 0.54) SSCGs formats. For each sequence, the teams' width and length were calculated (Figure 1). Width and length have units of meters (m) and were computed for each second of play as the difference between maximum and minimum values of y- and x-coordinates, respectively (i.e., the distance between the players furthest to the right and to the left for width, and the distance between the players furthest forward and backward for length). Then, for each sequence, were calculated the mean width and length for both teams for statistical purposes. The values obtained were distributed according to having or not ball possession (attacking and defending teams) during each sequence.

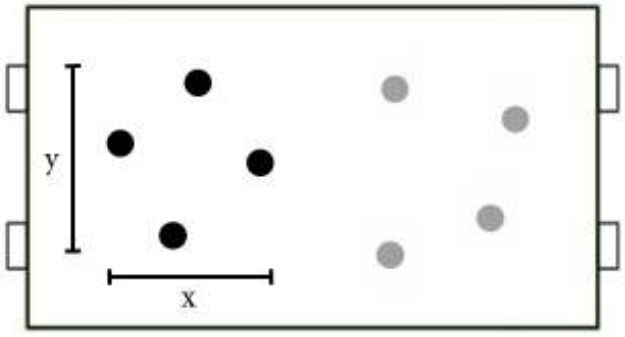

Fig.1. Graphical representation of team width (y) and length (x) collective variables in a 4 v 4 SSCG format.

Statistical procedures

Separate two-way ANOVAs, using width and length as between factors, were conducted to analyse the effects of playing phase (attacking and defending) and number of players (3v3, 4v4 and 5v5) as within factors, during the selected playing sequences. Statistically significant outcomes were followed up using a Bonferroni *post-hoc* adjustment. The significance level was established at 5% ($p < 0.05$).

All variable computations and statistical procedures were conducted in MATLAB® R2011b software (The MathWorks Inc, Natick, MA, USA) and SPSS® 20.0 software
(IBM SPSS Inc., Chicago, USA).

Results

Width

Figure 2A illustrates means ± standard deviations of teams' width during attacking and defending for each treatment (3v3, 4v4 and 5v5). It indicates a tendency, for both attacking and defending teams, to increase width as the number of players increases, while the attacking team maintains higher values than defending team. Two-way ANOVAs showed significant main effects of playing phase, F (1, 54) = 31.17, $p < 0.01$, $\eta^2 = 0.37$, and number of players, F (2, 54) = 22.25, $p < 0.01$, $\eta^2 = 0.45$. No interaction effects were found, F (2, 54) = 0.70, p = 0.50, $\eta^2 = 0.03$ (Table 1). Bonferroni multiple comparisons indicated differences between all number of players conditions. The 3v3 (M = 10.73, SE = 0.56) presented narrower values than 4v4 (M = 13.79, SE = 0.56, p = 0.01) and 5v5 (M = 15.99, SE = 0.56, $p < 0.01$), while the 4v4 presented significant lower values than 5v5 (p = 0.02).

Length

Figure 2B also shows a tendency for teams' length to increase with number of players and higher values during attacking than defending. Significant main effects of playing phase, F (1, 54) = 5.09, p = 0.03, $\eta^2 = 0.09$, and number of players, F (2, 54) = 24.18, $p < 0.01$, $\eta^2 = 0.47$, were found (see Table 1). There were no

interaction effects between playing phase and number of players, F (2, 54) = 0.19, p = 0.82, η^2 = 0.01. *Post hoc* analysis to number of players revealed lower values to 3v3 (M = 8.08, SE = 0.64) than 4v4 (M = 12.38, SE = 0.64, $p < 0.01$) and 5v5 (M = 14.26, SE = 0.64, $p < 0.01$), but not between 4v4 and 5v5 (p = 0.13).

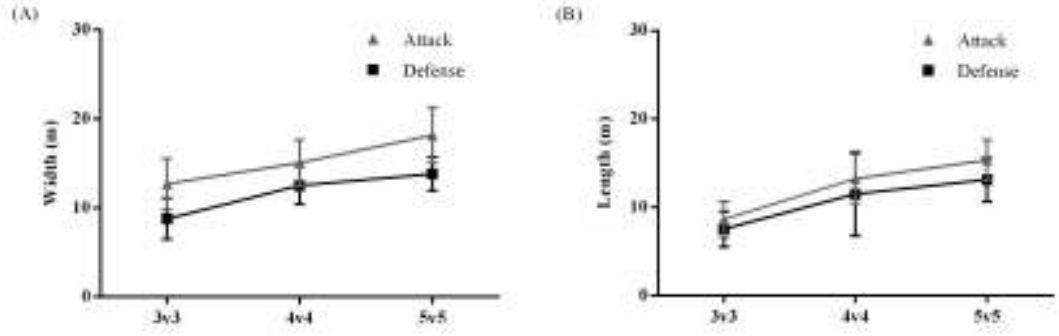

Fig. 2. Mean ± standard deviations of team width (A) and team length (B) according to playing phase (attack or defence) and number of players (3v3, 4v4 and 5v5).

Table 1. Main effects of playing phase (attack or defence), number of players (3v3, 4v4 and 5v5) and playing phase × number of players on team width and length.

	Playing phase			Number of players			BP × NP		
Variables	*F*	df1	df2	*F*	df1	df2	*F*	df1	df2
Width	31.17	1	54**	22.25	2	54**	0.70	2	54
Length	5.09	1	54*	24.18	2	54**	0.19	2	54

Note. *F* = result of the ANOVA test; df1 = degrees of freedom between groups; df2 = degrees of freedom within groups. *$p < 0.05$; **$p < 0.01$.

Discussion

The purpose of this study was to investigate the effect of number of players' manipulation on offensive and defensive specific principles application (space and concentration, respectively) during SSCGs practice. Once official football games showed higher width and length during offensive phase than during defensive phase (Moura et al., 2012), in compliance to space and concentration specific principles, we expected that this behaviour maintain unaffected during all SSCG formats.

Confirming our hypothesis to this study, teams presented higher values to width and length when in attacking situation comparatively when in defending. This mean that players were capable to co-adapt and auto-organize in front of different task constraints, since had no intervention about the manner that they should play. These results were in accordance with previous researches (Duarte, Araújo, Freire, et al., 2012; Moura et al., 2012). During a 3v3 SSCG task, Duarte, Araújo, Freire, et al. (2012) showed that surface area was significantly higher for attacking teams when an assistance pass was made and differences to the defensive team surface area increased when the ball crossed the defensive line. In official matches, Moura et al. (2012) showed that teams tended to increase and decrease their surface area after recover and lose the ball, respectively. ENREF_14

In addition, results showed that teams' width and length tended to be higher in the SSCGs conditions involving more players. This implicates that increasing number of players while maintaining pitch dimensions constant constrains the teams to expand their spatial ranges to explore space (Costa et al., 2009). Curiously, in Frencken et al. (2013) work, lower IPA obtained by manipulating pitch dimension while maintaining number of players constant, resulted on lower absolute teams' surface areas. Hence, varying IPA by manipulating number of players or by manipulating pitch dimensions possesses different implications on emergent teams' behavioural patterns. Therefore, this evidence is an important aspect for coaches to consider when planning SSCG tasks, since manipulation of IPA through different constraints manipulation (i.e., pitch dimension or number of players) promote different contextual information as well as new *affordances*. These changes on players interaction with the environmental information creates constant co-adaptive behaviours on team coordination process (Silva, Garganta, Araújo, Davids, & Aguiar, 2013).

Furthermore, there were not found significant differences in length between 4v4 and 5v5 treatments. This could mean that the increment of one player from 3v3 to 4v4 allowed teams to harness more space on both width and length on the field, but the increment of players from the 4v4 to 5v5 treatments stimulated teams to expand significantly only on the side-to-side direction of the field. In other words, this behaviour may also express co-adaptation in intra-team coordination process to explore wings as consequence of the constraint related to the mini-goals positioned near to the pitch corners. This assumption is reinforced by the fact that our

results showed absolute width values larger than length on all SSCGs. This could be another characteristic of emerged behaviours patterns influenced by constraint of the two mini-goals positions. In an official match of Premier League (Elite England division), Duarte et al. (2013) found higher width values in relation to length values during most time of the game on both teams. Thereby, the sample that participated in our study presented similar behaviours comparatively to the formal match mentioned before, assuming as a fundamental characteristic of SSCGs representativeness (K. Davids et al., 2013) and action fidelity (Stoffregen et al., 2003).

Therefore, our results showed that players in this experiment were able to co-adapt to task constraints depicted by different structures of play - 3v3, 4v4 and 5v5 – and still securing these specific principles of play (space and concentration). Thus, SSCGs seems to constitute useful training tasks to develop collective tactical behaviours with formal game representativeness (K. Davids et al., 2013) and action fidelity (Stoffregen et al., 2003).

Conclusions

The findings of this study shed light on how the manipulation of IPA (through modifications of number of players while maintaining pitch dimensions constant) influences the application of "space" and "concentration" specific principles in SSCGs. These results show that collective principles of the game (space and concentration) were preserved across SSCGs with number of players' manipulation. Moreover, the playing phase (attacking and defending) also implied different tactical behaviours, with teams displaying larger dispersion values during attacking phases. Increases in teams' dispersion values, here depicted by team width and length, occurred when more players were involved in the SSCGs.

From a pedagogical perspective, these results suggest that SSCGs constitute representative game situations in which the specific principles of attacking and defending are not distorted since different informational constraints on behaviour (3v3, 4v4 and 5v5) promoted players' co-adaptation to satisfy such basic rules.

More studies addressing emergent tactical behaviours during SSCGs are needed in order to understand the effects of other constraints, like pitch dimensions, unbalanced numerical relations, etc., on players co-adaptation, SSCGs representativeness and action fidelity, in respect to full-game situations.

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