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Variability and creativity in small-sided conditioned games among elite soccer players☆

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ABSTRACT

Objective: Small-sided conditioned games (SSCG) in soccer are games with a small number of players, often played on smaller than regular pitches and with adapted rules. It has been argued that SSCG foster soccer players' physical, technical and tactical performances and creativity. This study tested the latter conjecture by analysing video-footage of individual actions of elite soccer players in 5 v 5, 6 v 6, 7 v 7 SSCG played during regular training sessions and 11-aside training matches. Based on the ecological dynamics approach, we hypothesized that smaller formats would result in players making more individual actions. We additionally anticipated that the smaller formats players would induce a larger repertoire of actions, that is, an increased variability of actions, and that such increase in variability would be associated with more creative actions. Along the same lines, we reasoned that midfielders would make more creative actions than defenders and attackers.
Method: We categorized 3555 soccer actions on the ball and without the ball of 24 elite soccer players.
Results: Players produced more actions in smaller SSCG formats compared to the larger SSCG format and the 11-aside match. They also produced more different actions in SSCG than the 11-aside match. Furthermore, ten creative actions (i.e., actions that were adequate and only made by one or two players) were discerned. The creative actions emerged most often in the smaller SSCG, and were absent in the 11-aside matches. Finally, strikers, defenders and midfielders did not show reliable differences in terms of number, variability and creativity of action.
Conclusion: SSCG in soccer do indeed stimulate variability and creativity of individual actions. It is important to confirm whether these immediate effects of SSCG generalize across longer time scales.

1. Introduction

> *I trained three – four hours a week at Ajax when I was little, but played three – four hours a day on the street. So where do you think I learnt football?*" - Johan Cruyff

Small-sided conditioned games (SSCG) in soccer are games with a small number of players on each side, played on smaller than regular pitches and with adapted rules. SSCG are often seen as institutionalized street soccer, because they are typically less structured and more playful than the official game. Soccer coaches use SSCG to purposely improve players' physical, technical and tactical performances *in* game situations that recreate the inherently dynamical performance demands of match play (Davids, Araújo, Correia, & Vilar, 2013; Hill-Haas, Dawson, Impellizzeri, & Couts, 2011; Reilly & White, 2005). It stands to reason that SSCG not only develops players' technical and tactical skills, but may also foster creative play (Santos, Memmert, Sampaio, & Leite, 2016; see also; Memmert, 2007; Memmert & Roth, 2007). To test this conjecture, the present study analysed the individual actions during SSCG and 11-aside matches, which had been played as part of regular training sessions by players of an elite European soccer club.

In mainstream cognitive science, creativity is defined as the manifestation of a novel, original, yet appropriate and feasible idea, thought or insight to solve a problem (e.g., Guilford, 1956). Accordingly, it is only after the idea is formed, that it gets materialized in action. The action itself is not seen as part of the creation of the idea (see Withagen & van der Kamp, 2018). As such, creativity typically refers to internal mental or cognitive processes that reside inside the head (Kounios & Beeman, 2014; Nijstadt, De Dreu, Rietzschel, & Baas, 2010). However, rather than considering creativity as an uniquely individual characteristic, proponents from an ecological dynamics approach have argued that original and appropriate actions are as much reinforced by the individual as the task and environment (Hristovski, Davids, Araújo, &

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Passos, 2011; Orth, van der Kamp, Memmert, & Savelsbergh, 2017; Withagen & van der Kamp, 2018; see also; Simonton, 2003). Accordingly, creative action emergence is a situated and distributed process (Glaveanu, 2012, 2014). The primacy of the *interaction* between the individual, task and environment implies that creativity emerges in the unfolding of the action, during an individual's attempt to satisfy the constraints of the situation (Glaveanu, 2014; Orth et al., 2017; Torrents, Ric, Hristovski Torres-Ronda, Vicente & Sampaio, 2016; Withagen & van der Kamp, 2018). Notice that this approach links creative actions primarily to the individual level rather than to the societal level, also because investigations on the individual or inter-individual levels are more feasible (Boden, 1994; Orth et al., 2017). In principle, however, the emergence of novel actions during an individual's exploration of the constraints of the situation (also referred to as P-creativity, see Boden, 1994) may turn out to be a creative action on the societal level or for the whole history of humankind as well (i.e., H-creativity, Boden, 1994), especially if the individual is an expert in his or her domain of skill.

From the ecological dynamics approach, novel and appropriate actions may arise under constraint variations that invite the individual to explore different ways to adapt to the constraints. For example, Hristovski et al. (2011) had boxing athletes strike a boxing bag hung at varying positions from left to right in the front of the participants. Athletes first used routine straight or hook actions, but a few among them started to use an unconventional back-fist action when the bag was positioned more laterally. Hristovski et al. described the discovery of this new action as an 'action insight' (p. 195), and argued that it had emerged within the participants' search for ways to adapt to the changing constraints. More recently, also Orth, McDonic, Ashbrook, and van der Kamp (2019) utilized a kickboxing task, in which novice athletes were to strike the bag at its left side with a criterion impact force. Task constraints were manipulated by having the participants wear a large padded glove on their left hand. This resulted in the left hand becoming less functional, and required the athlete to search for unconventional solutions (i.e., using the right hand to hit the left side of the bag). Orth et al. (2019) observed that athletes who succeeded in achieving the required impact force, not only showed a larger variety of actions or techniques (i.e., they searched less repetitively) than the unsuccessful athletes, but were also more likely to exhibit unconventional or creative actions (e.g., spinning back-fist). Hence, practice conditions that stimulate exploration and enhance variability of functional movement patterns or actions (i.e., increase degeneracy within the action repertoire, Seifert, Komar, Araújo, & Davids, 2016) are more likely associated with the discovery of creative actions (Santos et al., 2018). That is, generating a greater number of different actions would benefit the emergence of actions that can be considered creative (Simonton, 2003; see also; Richard, Lebau, Becker, Inglis, & Tenenbaum, 2018). For SSCG this implies that creative soccer actions are presumably facilitated by those games that enhance the variability of players' actions.

Research in SSCG demonstrates that the number of players, size of the pitch and rules of the game influence the number of individual actions that soccer players produce. This effect presumably relates to differences in the available space and time to play with different SSCG formats (Aguiar, Botelho, Lago, Maças, & Sampaio, 2012; Kelly & Drust, 2009; Owen, Twist, & Ford, 2004; Platt, Maxwell, Horn, Williams, & Reilly, 2001; Torrents et al., 2016; Vilar, Duarte, Silva, Chow, & Davids, 2014). However, whether SSCG can also be designed to affect the variability of actions, that is, the number of different actions, has largely remained equivocal. For example, Owen et al. (2004) investigated the frequency of occurrence of different on the ball soccer actions (i.e., pass, receive, turn, dribble, header, tackle, block and interception, receive, and pass) as function of a game's format (i.e., different number of players and pitch size). They showed that decreasing the number of players (i.e., from 5 v 5 to 1 v 1) resulted in an increase of the total number of actions performed by the individual players (see also Torrents et al., 2016). Owen et al., however, did not report on the variability of actions, that is, whether players also showed a larger action repertoire in SSCG formats with fewer players. Yet, research focussing on collective team actions (i.e., soccer tactics) suggests that smaller games may enhance variability of actions. That is, Aguiar, Gonçalves, Botelho, Lemmink, and Sampaio (2015); see also Silva et al., 2014; Torrents et al., 2016) showed that collective play in smaller games is less predictive than in larger games (i.e., from 5 v 5 to 2 v 2). The authors argued that in smaller games there is a less commitment to the collective, resulting in higher variability in inter-player distance and player position. Accordingly, smaller games may also allow, or force, players to vary or explore (individual) actions more.

The current study examined how SSCG format affects the number, variability and creativity of individual actions among elite soccer players. To this end, pre-recorded video-footage of games with different number of players (i.e., 5 v 5, 6 v 6, 7 v 7 SSCG and 11-aside training match), pitch size and rules were analysed. Importantly, the games were part of regular training sessions, instead of being designed for experimental purposes. The video-footage thus provided naturalistic observations of games that had been played to concurrently promote the players' tactical and physical performances and *not* for the purpose of measuring variability or creativity of individual actions. As such the chance of response bias was eliminated. Within an ecological dynamics approach, it is argued that an individual's adaptation to changing environmental and task constraints results in the spontaneous emergence of softly-assembled patterns of coordination (Davids, Glazier, Araújo & Barttlett, 2003: Orth et al, 2017). To assess the variability in these patterns of coordination, researchers would, using high-dimensional kinematic recordings, aim for a low-dimensional description of the coordination patterns and determine how their stability unfolds over time under constraint manipulation. However, since we were limited to the use video-footage that only allowed behavioural analyses, we categorized the individual soccer players' actions or techniques (for overview, see Appendix I) as a proxy for describing the patterns of coordination that emerge in the different SSCG formats. These action categories were, among others, derived from earlier work that did also address creativity in soccer actions based upon the ecological dynamics approach (Santos et al., 2018; Torrents et al., 2016; for a similar approach, see; Hristovski et al., 2011; Orth et al., 2019). Considering that the ecological dynamics approach captures creative actions as original and functionally efficient (Hristovski et al., 2011; see also; Simonton, 2003), we defined actions as creative if they were performed by one or two players only (i.e., original, rare) and successful (i.e., functional, adequate). As such, creative action emergence was defined over the local constraints (i.e., Boden, 1994).

Based on previous observations in SSCG (Owen et al., 2004), we hypothesized that smaller games would lead to the players making more actions (i.e., within a fixed 10-min time interval). Following predictions from ecological dynamics (Orth et al., 2019; see also, 2017; Simonton, 2003), we additionally anticipated that in the smaller games players would also show a larger repertoire of actions, that is, an increased variability of actions, and that this purported increase in variability of actions would go together with a larger number of creative actions. Finally, we explored the effects of player's playing position. Although, previous work has not explicitly addressed the relationship between playing position and creativity, there appears to be a (sometimes tacit) assumption among practitioners and researchers that attackers are more likely to produce creative actions than players who play in a defending position. For example, Memmert, Baker, and Bertsch (2010) planned to compare highly creative and less creative athletes and for this purpose recruited participants among offensive and defensive players, respectively. By contrast, rather than considering creativity as an inherent characteristic of attacking players, we reasoned that midfielders in comparison to defenders and attackers would make more actions, show a larger action repertoire, and hence produce more creative actions.

2. Method

2.1. Participants

Video-footage of elite soccer players were analysed. A priori power analysis ($\alpha = 0.05$, 1-$\beta = 0.80$, $f = 0.30$) indicated that a minimum of 24 players were necessary. The pre-recorded video-footage was selected from 5 v 5, 6 v 6 and 7 v 7 SSCG and 11-aside training matches, which had been played as a part of training or match preparation over a period of three subsequent seasons (i.e., 2012-2013, 2013-2014, and 2014-2015). This selection allowed us to include 24 players, that is, 10 defenders, 6 midfielders, and 8 attackers. The players (all men) ranged in age from 17 to 32 with a mean age of 21.3 years (SD = 3.46). They were all professional players affiliated with the same elite European soccer club and playing for their national team (i.e., 10 played for a national youth team, U19-U21). The following inclusion criteria were used: (1) the player was not a goalkeeper; (2) the player had no injury during time of the video-recording; (3) the player must at least have played once in each of three SSCG and the 11-aside training match across the three seasons; (4) the player must play the first 10 min of each of three SSCG and the 11-aside training match; (5) the quality of video-footage must permit reliable identification of individual actions.[1] For each player that fulfilled these criteria, we choose the first of each of three SSCG and 11-aside match that they had played, starting in the 2012-2013 season. Table 1 shows for each of three SSCG and the 11-aside match how many players were selected from a season. It also provides information about the total number of SSCG played during training and the total number of different players involved. The study was carried out in accordance with the guidelines of the local university's ethics committee. At the start of each season, the players had provided written informed consent for the video-recordings and other data-collection during training sessions and matches to be used for scientific research. They were therefore not asked to consent for this particular study.

2.2. Material and apparatus

The practice games and matches were video-recorded with Local Position Measurement (LPM) technology (©Inmotio).[2] This technology consists of 10 base stations (i.e., antenna's) installed around the field, with each player wearing a bib with a transponder. The base station tracks the displacement of the transponders and is used, among others, to provide the coach with players' training and match data (e.g., distance covered, average running speed, accelerations, and so on). The sample frequency depends on the number of active transponders on the field with a maximum of 1000 Hz. For example, with 22 players, the resulting sampling frequency is 1000 Hz divided by 22 is 45 Hz. The LPM system was synchronized with HD motioCams, which video recorded from different perspectives and allowed automatic tracking and zooming of individual players (i.e., transponders). This video-footage was used to identify and categorize the actions of individual players.

2.3. Procedure and design

The 5 v 5, 6 v 6 and 7 v 7 and 11-aside matches were the most frequent played and recorded SSCG formats during training. According to the coaching staff, which did not change across the three seasons, because SSCG are played with fewer players, each individual player gets more touches of the ball, allowing concurrent improvements in players' tactical and physical performances. Since the analysed SSCG were part of regular training sessions, and not designed for research purposes, no experimental control was exercised over factors that potentially could have affected the players' soccer actions. All the SSCG included two sides with goalkeepers, but the goalkeepers' actions were not included in the analyses. The SSCG were played on a pitch with markings, which divided the field in squares and rectangles of different sizes (Fig. 1). It is customary at the club to play the 5 v 5 and 6 v 6 SSCG within the two central squares, resulting in an area measuring 36 m long and 18 m wide, while for the 7 v 7 SSCG an additional square is added, resulting in an area measuring 54 m long and 18 m wide. The measures stem from club tradition, rather than being scientifically underpinned. The 11-aside matches were played on a regular 11-aside field of 105 m long and 64 m wide. All SSCG and matches were played on a natural grass pitch. The SSCG were played with official rules, except there were no throw-ins. When the ball went out of play, the goalkeeper from the team that would have been assigned the throw-in under the official rules, would play the ball from his goal. The 11-aside training matches were played with official match rules and referee. Finally, the frequency and content of coach instructions and feedback before and during the SSCG and 11-aside matches were not standardized.

Table 1
Distribution of SSCG and 11-aside matches, the total number of players involved and selected across the three seasons.

Format	Season		
	2012–2013	2013–2014	2014–2015
5 v 5			
Total number of games/matches	10	8	4
Total number of players[1] involved	40	26	5
Number of participants selected	10	4	10
6 v 6			
Total number of games/matches	10	6	5
Total number of players[1] involved	41	25	22
Number of participants selected	6	8	10
7 v 7			
Total number of games/matches	14	17	10
Total number of players[1] involved	34	28	24
Number of participants selected	11	4	9
11v 11			
Total number of games/matches	10	12	8
Total number of players[1] involved	35	42	28
Number of participants selected	1	5	18

NB. [1]The total number of players involved does not include the goalkeepers.

Each of the 24 participants was individually analysed. For each of the three SSCG and the 11-aside match, the first game that they had played across the three seasons was analysed (Table 1). Different SSCG and matches were analysed for the different players, and team compositions were never exactly the same. For all SSCG, all the actions made in the first 10 min were analysed. For the 11-aside matches, the first 10 min of effective playing time (i.e., only when the ball was in the game) were analysed.

2.4. Data analysis

Based on previous work (Werner, 1989; Kroger & Roth, 1999; Owen et al., 2004; Santos et al., 2018; Torrents et al., 2016) a score sheet was developed listing the definitions of possible soccer actions (i.e., technical skills). These included actions on the ball and actions without the ball. Other actions were defined during actual analysis, resulting in a list with a total of 37 different actions (see Appendix I). Each action was identified and categorized, and also evaluated in terms of its success (i.e., adequate, non-adequate). For each individual player, we counted the total number of actions and the number of different action categories per game and match, and in doing so, also evaluated whether the action was adequate or non-adequate. An action was considered

[1] The 2012-2013 season was the first year the recordings were made during training sessions. This went together with some technical inadequacies which were largely overcome in later seasons.

[2] See https://www.inmotio.eu.

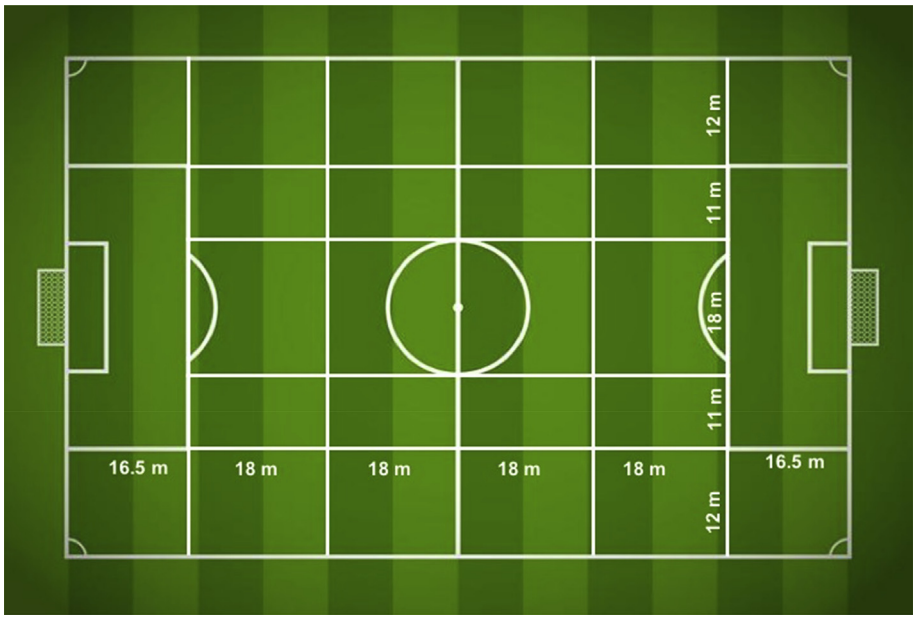

Fig. 1. The training pitch and markings. Note: The 5 v 5 and 6 v 6 SSCG were played within the two central squares, resulting in an area measuring 36 m long and 18 m wide, while the 7 v 7 SSCG an additional square was added, resulting in an area measuring 54 m long and 18 m wide. The 11a-side matches were played across the entire pitch.

adequate when its objective (as described in Appendix I) was accomplished, while for non-adequate actions this objective was not accomplished. The first author (S.C.), who is an experienced soccer performance analyst, including at the participating club, gathered and selected the recordings, and identified and categorized all actions and judged them on adequacy. To determine interobserver reliability, a second performance analyst independently inspected a random sample of 8 SSCG and 2 11-aside matches. The resulting interobserver reliability for the number (ICC = 0.79) and type of action (Cohen's $\kappa = 0.83$) was high, and moderate for the adequacy of actions (Cohen's $\kappa = 0.68$) (Koo & Li, 2016; McHugh, 2012).

Next, following earlier work (Gillebaart, Förster, Rotteveel, & Jehle, 2013; Kleinmintzl, Goldstein, Mayseless, Abecasis, & Shamay-Tsoory, 2014; see also; Simonton, 2003), we used a 5% criterion for an action to be classified as original. In other words, those actions that were performed by approximately 5% of the players or less (i.e., two or one players) were considered original. When the action was also performed successfully (i.e., adequate), it was considered a creative action.

2.5. Statistical analysis

We planned to submit the dependent variables to separate 3(group: defenders midfielders, attackers) by 4(format: 5 v 5, 6 v 6, 7v 7, 11-aside) ANOVA with repeated measures on the last factors In case the sphericity assumption was violated, Greenhouse-Geisser corrections for the p-value were used. Post hoc tests were planned using t-tests with Bonferroni correction. For effect size, n_p^2 were reported. Effects sizes smaller than 0.06 were considered small, between 0.06 and 0.14 as moderate, and larger than 0.14 as large.

3. Results

3.1. Number of actions

In total, the players produced 3555 actions, 82% of which were adequate. Fig. 2 shows how the actions were distributed across formats and position. The analysis of variance on the number of actions revealed significant main effects of format, $F(3, 63) = 38.1$, $p < 0.001$, $\eta_p^2 = 0.65$, and position, $F(2, 21) = 4.32$, $p < 0.05$, $\eta_p^2 = 0.29$. The two factors did not significantly interact, $F(6, 63) = 0.80$, $p = 0.56$, $\eta_p^2 = 0.07$. Post hoc indicated that the smaller the format the more actions players made; that is, all comparisons differed significantly

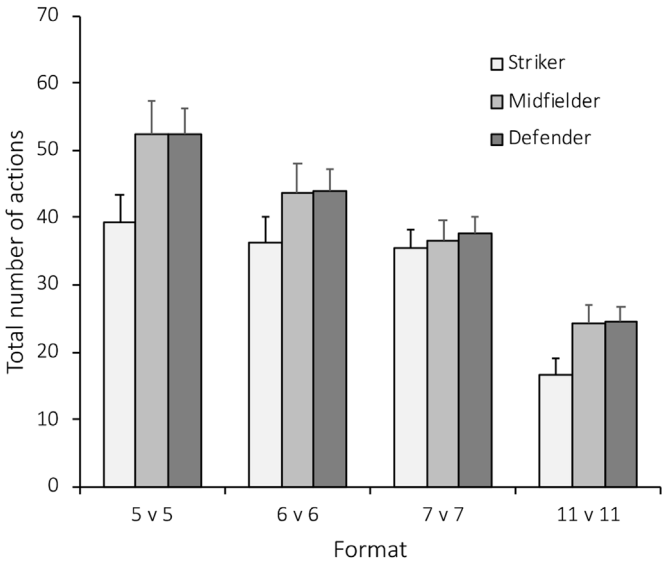

Fig. 2. Average number of actions (and SE) as a function of format and position.

except those between the 5 v 5 and 6 v 6 and the 6 v 6 and 7 v 7 games. The post hoc analysis did not confirm significant differences in the total number of actions between strikers, midfielders and/or defenders.

3.2. Number of different action categories (variability)

Fig. 3 shows the number of different action categories across format and position. The analysis of variance showed a significant main effect of format, $F(3, 63) = 12.1$, $p < 0.001$, $\eta_p^2 = 0.37$, but not for position, $F(1, 21) = 3.13$, $p = 0.07$, $\eta_p^2 = 0.23$. The interaction was not significant either, $F(3, 63) = 0.94$, $p = 0.47$, $\eta_p^2 = 0.08$. Post hoc indicated that players produced actions from more action categories in the three SSCG-formats than in the 11-aside match.

3.3. Number of rare actions (originality and creativity)

The action categories that were exclusively produced by two or one players (i.e., approx. 5% of the players) were defined as rare or original. This was true for 14 actions from 6 categories made by 8 players

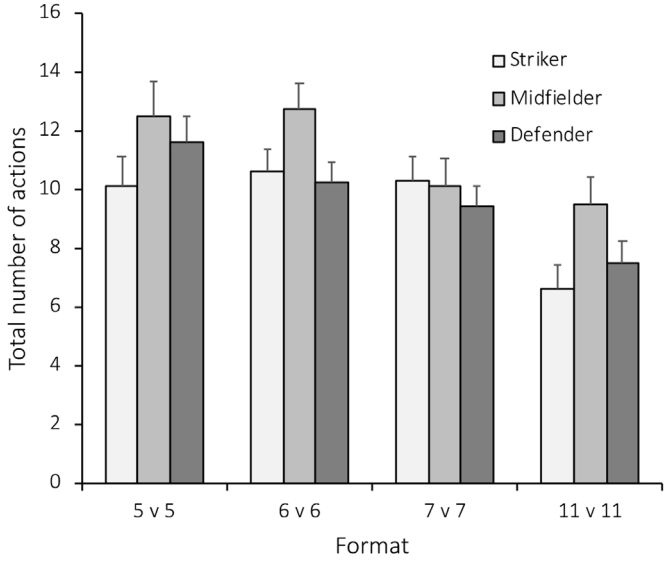

Fig. 3. Average number (and SE) of action categories as a function of format and position.

Table 2
Original actions.

Action Category	Number of players	Number of occurrences
Pass with chest	1	1
Zidane turn	2	4
Maradona turn	2	2
Sole turn	1	2
Kick with outside foot	1	3
Overlap[a]	1	2

[a] An anonymous reviewer argued that overlap is not an unconventional action. However, the occurrence of overlap strongly depends on team tactics. Within the constraints of the 4-3-3 system played by the participating club, fullback players make no overlaps with winger players. Accordingly, although overlap would not count as an creative action for soccer in general (i.e., worldwide, H-creativity), within the local constraints of the group of players in this study (i.e., P-creativity), it definitely is.

(Table 2). Of these actions, 10 were adequate and could thus be defined as creative. Fig. 4 shows how these original and creative actions were distributed across format and position. Logically, the number of original and creative actions is very low, preventing us from performing statistical analyses. Nonetheless, we like two emphasize two observations. First, the number of original and creative actions seem to reduce with the size of the format, with none appearing during the 11-aside training match (Fig. 4a). Second, if anything, the midfielders appear to make original and creative actions less often than defenders and strikers (Fig. 4b).

4. Discussion

In recent years, researchers have shown an increasing interest in creativity in soccer, not the least because coaches, pundits and researchers alike consider creativity a very desirable quality for a soccer player (Memmert, 2006, 2014; Memmert et al., 2010). For, the unpredictable actions that a creative soccer player produces can be the turning point in a match (Memmert, 2014). Accordingly, researchers have looked how creative players can be nurtured. In this respect, a general consensus exists that informal, playful, unstructured sport settings with only a minimum of instructions promote creativity compared to organized sport settings (Bowers, Green, Hemme, & Chalip, 2014; Memmert & Roth, 2007; Santos et al., 2016). However, the empirical evidence is not unequivocal. For example, Memmert et al. (2010) used retrospective interviews among elite sports players, including soccer, and found that players who were rated as most creative had a longer history (i.e., hours spent) of both sport-specific unstructured play activities *and* sport-specific structured training than players who were considered least creative. In a similar study, Bowers et al. (2014) concluded that the more creative players had struck a better balance between the time spent in the unstructured and structured activities.

From an ecological dynamics approach, the distinction between in unstructured play and structured sport-specific setting is too coarse. Regardless of practice setting being part of organized sports or not, creative actions are thought to emerge under constraints that stimulate a player to explore different movement patterns or actions (Hristovski et al., 2011; Orth et al., 2017). There are two key issues here. First, practice conditions that increase the variability of actions, that is, enhance the action repertoire, are more likely to induce creative actions. Second, practice conditions must be representative, since creative actions emerge *in* an attempt to adapt to the constraints of the situation. Our aim in this study was, therefore, to test if the manipulation of task constraints that ostensibly boosts variability of actions is also associated with more creative actions. To this end, we compared variability and creativity of the individual actions of elite soccer players in small-sided conditioned games (SSCG) and 11-aside training matches. We hypothesized that smaller SSCG formats would lead to increased variability of action and to more creative actions, because previous work had shown that reducing the number of players and the size of the field increases the number of actions produced by individual players (e.g., Owen et al., 2004; Torrents et al., 2016).

Our findings largely support the hypothesis: the dynamics of the smaller SSCG formats led players to produce more actions on the ball and/or without the ball than the larger SSCG format and the 11-aside

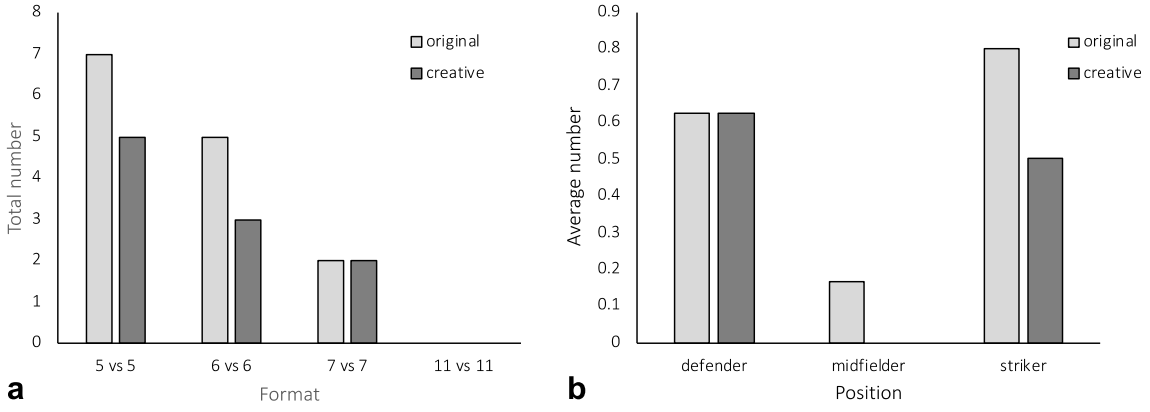

Fig. 4. (a) The total number of original and creative actions as function of format, and (b) the average number of original and creative actions as a function of position.

match. Possibly, during smaller SSCG, which are played with less players and on a smaller pitch, the available time and space limit passing options, resulting in individual players to make more actions on the ball. Moreover, smaller SSCG typically result in less commitment to team tactics, allowing more freedom for individual actions (Aguiar et al., 2015; Torrents et al., 2016). In addition, the smaller SSCG formats challenged players to adapt in more different ways than in the 11-aside match, that is, a larger number of different actions was explored. And finally, creative actions (i.e., the ten successful actions that were produced by one or two players (i.e., approx. 5%)) only occurred in the SSCG, and mostly in the smallest 5 v 5 game. Accordingly, the current findings provide support for the hypothesis from the ecological dynamics approach that, since creative actions arise from variability of action, practice conditions that enhance variability of action are more likely to induce creative actions (Hristovski et al., 2011; Orth et al., 2019, 2017; Santos et al., 2016).

We also explored whether a player's position (and/or role) in the team affects the emergence of creative actions. We suspected that midfielders would produce more actions than defenders and attackers because they would produce more actions. Others have implied that, following preconceptions of expert coaches, attackers would be more creative than defenders (Memmert et al., 2010). Yet, neither of these hypotheses were supported. If anything, and the current data does not allow great confidence,[3] midfielders made almost no creative actions, while the number of creative actions among defenders and attackers did not appear to differ. Relatedly, there were also no differences found with respect to the number of (different) actions for three playing positions. Accordingly, we could not show that variability of actions did vary as a function of player's position. Clearly, we need a larger amount of observations to appraise whether differences in creative action emergence as a function of player position are consistent with projections of the ecological dynamics approach (cf. Orth et al., 2017).

4.1. Strengths and limitations

This is one of the few studies in the sport of soccer to provide support for the contention from the ecological dynamics approach (e.g., Hristovski et al., 2011; Orth et al., 2019; see also, 2017; Simonton, 2003) that practice conditions that enhance variability of individual actions are also more likely to induce creative actions. In an earlier study, Santos et al. (2018) demonstrated something along the same lines by showing that a differential learning approach, which purportedly imposes a large variability of action (Schöllhorn, Mayer-Kress, Newell, & Michelbrink, 2009), resulted in more creative actions. Crucially, however, our findings comprise observations of authentic training forms in elite soccer, rather than re-created test situations with increased risk of response bias, among others. The findings, thus, truly (re-)present what happens on the field. Yet, naturalistic observations also typically come at the expense of experimental control. The current study is no exception. Consequently, we now know that smaller SSCG formats are associated with more creative actions, but the current observations do not allow for delineating the exact local constraints underpinning creative action emergence (e.g., in terms of the available time and space to produce an action, the degree to which the player is enslaved by the collective, the coach's instructions and so on). This would also locate how creative action emergence is distributed across the individual, task and environment (Glaveanu, 2012, 2014).

Also, the ecological dynamics approach entails a formalized description of the soccer actions, rather than the colloquial descriptions used in the current study. Such formalization of actions or patterns of coordination into so-called low dimensional order parameters would allow for identifying the specific (changes in) constraints within SSCG that affect the emergence and (de-)stabilisation of coordination patterns (cf. Zanone & Kelso, 1992). In this respect, although we did not involve experts to subjectively rate or evaluate the creativity of actions as is typically done (e.g., Memmert et al., 2010; Santos et al., 2018), the present quantitative approach can only be considered an initial first step.

Finally, our observations provide direct evidence that SSCG instantly expand the action repertoire and creative action, but they fall short in showing that regularly playing SSCG during practice can result in more creative actions in competitive matches. To further substantiate that SSCG can indeed foster creative actions across longer time-scales, longitudinal studies are needed comparing the production of creative actions of players that experienced varying amounts of SSCG in practice over a season (cf. Memmert, 2007:; Santos et al., 2018).

To conclude, we confirmed the often voiced but never tested belief that training forms using small-sided conditioned games (SSCG) stimulate the occurrence of creative actions in elite soccer players. That is, the dynamics in smaller SSCG led players to produce more actions from a larger number of action categories, resulting in more creative actions. Accordingly, next to improving physical, tactical and technical performances, we would recommend the use of SSCG in order to enhance players' action repertoire and creativity -if, that is, the observed immediate effects of SSCG indeed generalize across longer time scales.

CRediT authorship contribution statement

Simone Caso: Conceptualization, Methodology, Investigation, Formal analysis, Resources, Data curation, Writing - original draft, Visualization. **John van der Kamp:** Conceptualization, Formal analysis, Methodology, Writing - review & editing, Visualization.

Declaration of competing interest

None.

Appendix I. Action categories

Action on the ball	Definition
Pass inside foot	Player in possession sends the ball to teammate with inside of the foot.
Pass outside foot	Player in possession sends the ball to teammate with outside of the foot.
Pass volley	Player in possession sends the ball to teammate volleying it (using any part of the body).
Pass chipping	Player in possession sends the ball to teammate by chipping the ball.
Pass through gap (short distance)	Player in possession sends the ball to teammate through a gap between two opponent players (short distance).
Pass through gap (long distance)	Player in possession sends the ball to teammate through a gap between two opponent players (long distance).
Pass into space (short distance)	Player in possession sends the ball to teammate into free space (short distance).
Pass into space (long distance)	Player in possession sends the ball to teammate into free space (long distance).
Pass with chest	Player in possession sends the ball to teammate using the chest.
Pass with foot heel	Player in possession sends the ball to teammate with the heel of the foot.
Reception	Player (attempts) to gain control of the ball in order to possess terrain.
Header shooting	Player heads the ball to score on goal.

[3] The number of participants in each group was relatively small and unequal.

Header passing	Player heads the ball to pass to teammate.
Tackle	Action intended to dispossess an opponent who possesses the ball
Interception	Player contacts the ball enabling him to retain possession, preventing an opponent's pass from reaching its intended destination.
Ronaldo turn	A player makes a Cristiano Ronaldo chop turn to confuse an opponent player.
Cruijff turn	A player makes a Cruijff turn to confuse an opponent player.
Ronaldinho turn	A player makes a Ronaldinho turn to confuse an opponent player. It consists of a touch on the ball first with the outside and then inside of the foot.
Zidane turn	A player makes a Zidane turn to confuse an opponent player. Stop the ball with the sole of the foot, and goes around an opponent player using the other sole of the foot.
Maradona turn	A player makes a Maradona turn to confuse an opponent player.
Outside turn	A player makes a turn to confuse an opponent player, passing sideward using the outside of the foot.
Sole turn	A player makes a turn to confuse an opponent player, passing side ward using the sole of the foot.
Drive	Movement of ball carrier towards the goal or changing direction in order to play in other areas of the pitch line.
Kick with inside foot	Player kicks the ball with the inside foot to score a goal.
Kick with outside foot	Player kicks the ball with the outside foot to score a goal.
Kick volley	Player kicks the ball, volleying it with any other part of the body except foot and head to score a goal.

Action without the ball	Definition
Performing one-two	A move in which a player passes the ball to teammate and expects to receive it back immediately.
Press	Action to regain the ball or attempt to make the opponent lose the ball pressuring him.
Overlap	A player sends the ball to teammate and then runs beyond that player to receive the ball or to drag/confuse an opponent player (e.g., a full back passes the ball to a winger, runs behind the winger and receives the ball).
Support	Player moves towards the ball carrier offering a passing option aimed at keeping ball possession.
Unmark	Player moves between the last defender and towards the goal line amplifying the effective playing space and offering a long pass option.
Block	Ball strikes a player, preventing an opponent's pass from reaching its intended destination
Delay	Action to slow down the opponent's attempt to move forward with the ball.
Movement into space (around opponent players)	Player moves into space going around opponent players in order to create 'free channels' to make the pass the ball to him.
Move to create gap (two players)	Player moves into space in order to create a gap between two opponent players to allow teammate to pass through ball through gap.
Turn without the ball	A player makes a change of direction without ball to confuse opponent player

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