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Article

Perceptual and Motor Skills
2021, Vol. 128(4) 1684–1711
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DOI: 10.1177/00315125211016350
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How Informational Constraints for Decision-Making on Passing, Dribbling and Shooting Change With the Manipulation of Small-Sided Games Changes in Futsal

David Pizarro[1], Alba Práxedes[1], Bruno Travassos[2,3], Bruno Gonçalves[3,4,5], and Alberto Moreno[6]

Abstract

In this study, we explored how manipulating floaters' positions in small-sided futsal games (SSGs) promote changes in the informational constraints that support decision-making (DM) for passing, dribbling and shooting tactics. We made changes in four experimental 3 vs 3 small-sided game conditions with 30 male futsal players (U19 age category): (a) Floaters Off (FO), (b) Final Line Floaters (FLF), (c) Lateral

[1]Faculty of Life Sciences and Nature, University of Nebrija, Madrid, Spain
[2]Research Center in Sport Sciences, Health and Human Development (CIDESD), Department of Sport Sciences, University of Beira Interior, Covilhã, Portugal
[3]Portugal Football School, Portuguese Football Federation, Oeiras, Portugal
[4]Departamento de Desporto e Saúde, Escola de Saúde e Desenvolvimento Humano, Universidade de Évora, Évora, Portugal
[5]Comprehensive Health Research Centre (CHRC), Universidade de Évora, Évora, Portugal
[6]Faculty of Sport Sciences, University of Extremadura, Cáceres, Spain

Corresponding Author:
David Pizarro, Faculty of Life Sciences and Nature, University of Nebrija, Del Hostal s/n, La Berzosa, 28248 Madrid, Spain.
Email: dpizarro@nebrija.es

Floaters own field sideline (LFofsl) and (d) Lateral Floaters full field sideline (LFffsl). We assessed players' activity with WIMU PRO^{TM} software during the SSGs, using the Game Performance Evaluation Tool (GPET) to analyze a total of 1,635 decisions. DM for dribbling was generally based on the interpersonal distance between the ball carrier and direct opponent, considering the defensive team length and the offensive team area. Shooting decisions were constrained, by certain attacking-defending teams' spatial-temporal relations with regard to playing space and team balance as affected by manipulating floaters' positions. The coaches' decisions to change the floaters' positions during SSGs may change informational variables sustaining the dribbling decision, but no changes in SSG variables affected passing DM.

Keywords
ecological dynamics, team sports, futsal, informational constraints, decision-making

Introduction

Based on the ecological dynamics' framework in predominantly open motor skills team sports like futsal, players must be skilled in adaptive and autonomous decision-making (Withagen et al., 2017). In other words, each player must be attuned to informational game constraints to decide what to do and how to do it in accordance with the behaviors of teammates and opponents (Chow et al., 2007; Corrêa et al., 2014). Within this framework, decision-making (DM) ability is defined as each player's ability to choose functional actions with or without the ball from among a range of possible actions (or so-called affordances; Gibson,1979/1986; Rietveld & Kiverstein, 2014) that emerge from the available spatial-temporal relations for achieving a specific goal (Hastie, 2001). Consequently, coaches have to help players develop on-field autonomy by facilitating their active exploration of a landscape of available individual and collective affordances that provide opportunities for potential performance solutions (Araújo et al., 2006; Chow et al., 2016; Withagen et al., 2017; Woods et al., 2020). Based on previous considerations, improving players' decision-making requires that training tasks be designed to expose players to game contexts that sample the actual perceptual-motor demands of competition (Travassos, Gonçalves et al., 2014).

Over the past few decades, researchers have investigated the available spatial-temporal information (e.g., interpersonal distance, relative velocity and relative angle) that supports players' and teams' tactical behaviors over the game (Araújo et al., 2006; Passos et al., 2014; Vilar, Araújo, Davids, & Button, 2012; Travassos et al., 2011; Travassos, Araújo, Duarte et al., 2012). For example, futsal players must make many decisions as they perceive the available field information relative to the positions of the ball and the opposing players while co-adapting their position in relation to teammates (Bennett et al., 2019; Travassos, Araújo, Davids, Vilar et al., 2012). That is, while a pass decision seems to emerge from variations of the angles between the ball carrier and the nearest defender and teammate that defines the time for a ball interception (Corrêa, Vilar et al., 2012; Travassos, Araújo, Davids, Vilar et al., 2012; Vilar, Araújo, Davids et al., 2014), the dribble seems to emerge from variations of interpersonal distance and its rates of change (velocity and variability) between a ball carrier and their direct opponent (Travassos, Araújo, Davids, Esteves et al., 2012; Vilar, Araújo, Travassos et al., 2014); and from shots at the goal when the ball carrier ensures critical values of angular interpersonal relations and distances with the direct defender and the goalkeeper position when near the goal (Corrêa et al., 2020; Vilar, Araújo, Davids, & Button, 2012; Vilar, Araújo, Davids, & Travassos, 2012; Vilar et al., 2013).

Complex tactical DM in futsal is a fundamental concern when designing representative training tasks that allow coaches to improve individual athlete and collective team performances. Small-sided games (SSGs; commonly used modified games that take place in tight spaces, involving small numbers of players and with modified rules) have been proposed as an effective method for improving skills and enhancing acquisition of expertise in team sports (Davids et al., 2013; Práxedes et al., 2019). Through the manipulation of task constraints, SSGs promote perceptual-action relationships that are similar to those in full game or game phases; SSGs maintain the unstable, dynamic and unpredictable nature of game play, while more directly coupling certain players actions to the available information (Coutinho et al., 2019; Davids et al., 2013; Travassos, Gonçalves et al., 2014). In this sense, coaches must manipulate the relevant task constraints (e.g., presence of floaters and their positioning in SSGs [acting either on the sidelines or in the playing field]) to highlight some informational constraints that promote tactical awareness and functional behaviors according to specific game contexts (Gonçalves et al., 2016; Travassos, Gonçalves et al., 2014).

Previous studies attempted to provide a broader comprehension of the impact of altering SSG characteristics (task constraints), such as the number of players per team (Gonçalves et al., 2016; 2017; Práxedes et al., 2018), the pitch size (Coutinho et al., 2018), number of targets (Travassos et al., 2018) and the presence of floaters (Castellano et al., 2016; Clemente et al., 2016; Padilha et al., 2017; Pizarro et al., 2021) on players' physical individual and collective tactical actions. For example, regarding the manipulation of floaters, Ric et al. (2015) suggested that the use of on-field floaters increased players' decision-making efficiency due to their distribution over the breadth of the field. Moreover, on-field floaters might have afforded more opportunities for passing the ball, allowing the team to maintain ball possession (Castellano et al., 2016; Vilar, Araújo, Travassos et al., 2014). On the other hand, Padilha et al. (2017) revealed that the use of floaters on the sidelines encouraged players to keep ball possession during offensive organization by making more effective use of playing space (width and length) in the opponent's half, as well as promoting the team's defensive stability by decreasing the spaces between teammates during defensive organization.

Beyond just identifying general variations in players' tactical behaviors by manipulating SSG conditions, such as floater positions, there is a need to better understand how such manipulations may change the informational constraints supporting player DM. Little is known about the impact that manipulating SSGs may have on the informational constraints that support specific individual decision-making for the tactical behaviors associated with passing, a dribbling or shooting in team sports. Accordingly, we explored how manipulating floaters' positions in futsal SSGs promotes changes in the informational constraints supporting successful DM for passing, dribbling and shooting tactics. We expected to identify both the invariant informational constraints on DM (i.e., spatial-temporal constraints that do not change for the emergence of each pass, dribble or shoot according to the manipulation of the SSGs) and the variant constraints (i.e., spatial-temporal constraints that changes for the emergence of each pass, dribble or shoot according to the SSG manipulations).

Method

Participants

The participants for this study were 30 male futsal players from the under-19 (U19) category of four Spanish clubs (M age = 17.71, SD = 0.71 years). All participants had similar levels of expertise and participated in the same competition (the first regional league). All teams had the same amount of training (i.e., players performed two training sessions of 60 minutes per week with an official match played during the weekend). The research project was fully approved by the Ethics Research Committee of a Spanish University. Participants were treated according to the American Psychological Association's ethical guidelines such that we procured informed participant consent form all participants 18 years old or older, and we procured informed consent from parents/guardians of all participants under the age of 18 (who also gave their personal assent). All participants were also assured of confidentiality and anonymity in the dissemination of any research data.

Design and Procedures

This study was designed as an independent measure approach under four experimental conditions (four SSGs) in which we manipulated floater positioning. The SSGs (Goalkeeper [GK] + 3 vs 3 + Goalkeeper [GK]) were designed to reflect the presence and absence of "floaters" (one per team) as follows: (a) "Floaters Off" (FO); (b) "Final Line Floaters" (FLF), (c) "Lateral Floaters (own field sideline)" (LFofsl) and (d) "Lateral Floaters (full field sideline)" (LFffsl) (see Figure 1). These SSGs were selected because they are especially relevant to futsal coaches and scientists. To our best knowledge, no studies have analyzed the effects of positioning floaters in SSGs (inside or outside the pitch). The positioning of the floaters inside the pitch promotes greater variability and greater difficulty in checking what is happening in the game. On the other hand, the different positioning of the floaters outside allows us to have more defined conditions (SSGs). In addition, each position of the floater is associated with different game systems in attack (for example, FLF is associated with the offensive game system 3-1 and LFofsl with the offensive game system 4-0). In all situations, we conducted tests on a field of 30 meters long by 15 meters wide. These measures respected the player-space ratio used by futsal players according to the maximum length and width dimensions ($40\,m \times 20\,m$) of the real game (for each player of a team, 10 meters large and 5 meters regular, without goalkeepers).

Players were gathered in five groups of six individuals (G1 to G5; goalkeepers and floaters were not considered as participants in this study). All participants played once in each situation in random order and on a different day. For each group, each testing day lasted ≈90′/day, including a 12-minute warm-up and five 12-minute SSGs (consisting of 3-minutes playing and 1-minute rest + 3-minutes playing and 1-minute rest + 3-minutes playing and 1-minute rest) + periods of change GPS devices between groups of players. During the rest intervals between bouts, players could drink water. To complete all the data

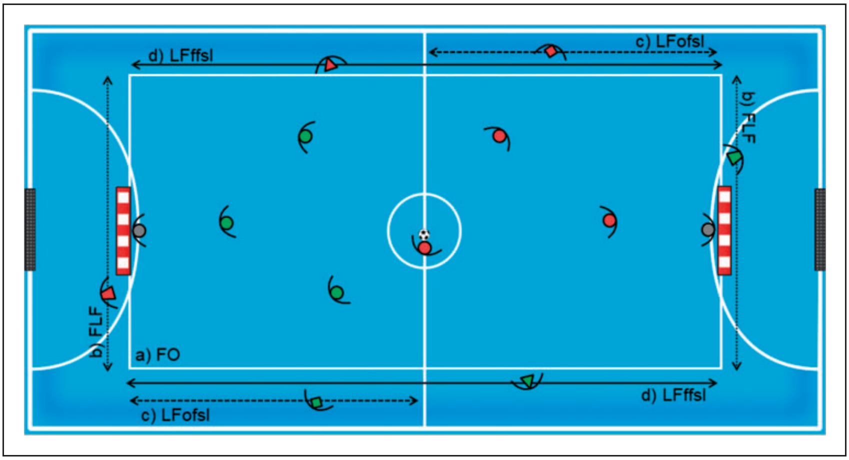

Figure 1. Experimental Conditions. FO = Floaters Off; FLF = Final Line Floaters; LFofsl = Lateral Floaters own field side line; LFffsl = Lateral Floaters full field side line.

Table 1. Testing Sessions Plan.

	Day 1			Day 2			Day 3			Day 4		
Time[a]	WU	SSG		WU	SSG		WU	SSG		WU	SSG	
12′	G1	–	–	G1	–	–	G1	–	–	G1	–	–
12′	G2	G1	FO	G2	G1	LFffsl	G2	G1	LFofsl	G2	G1	FLF
12′	G3	G2	LFffsl	G3	G2	FO	G3	G2	FLF	G3	G2	LFofsl
12′	G4	G3	LFofsl	G4	G3	FLF	G4	G3	FO	G4	G3	LFffsl
12′	G5	G4	FLF	G5	G4	LFofsl	G5	G4	LFffsl	G5	G4	FO
12′	–	G5	FO	–	G5	FLF	–	G5	LFffsl	–	G5	LFofsl

WU = warm-up; SSG = small-sided game; G1 = first group of 6 players (= for G2, G3, G4 and G5).
[a]The remaining time (since 90) is allocated to GPS changes.

collection, the design was conducted in four testing sessions on consecutive days, as shown in Table 1.

Game situations were explained, and participants were asked to play at their best level to succeed in SSGs (score in the opposite goal). Coaches and experimenters did not provide any verbal feedback during the SSG. As for rules, floaters were only allowed to perform offensive actions, with a maximum of two touches; their actions were limited to space between two marks, parallel to each line (side or final), and they could not score a goal. Also, goalkeepers could not get out of the finish line. A throw-in was granted after the ball crossed the lines delimited by the floaters' area. During the test, players were asked not to go inside the floaters' area. No measures of goalkeepers were assessed. Extra balls were placed around the field to allow a quick game restart if the ball went out of bounds.

Data Collection

The dependent measure we used yielded a categorical variable that reflected the participants' decision-making or DM. This measure, the Game Performance Evaluation Tool (GPET), has been shown to be reliable for game-performance assessments ($\alpha = .97$) (García-López et al., 2013), based on indirect and external systematic observation. This methodology has been used in previous studies to measure players' DM in competitive game situations (Pizarro et al., 2019; 2020) and to measure the influence of the environment on DM (Travassos et al., 2013).

We defined DM as the process whereby athletes select one type of attack from a series of alternatives to execute it at a specific moment and in a real game situation (Bar-Eli et al., 2011). Through the GPET, we coded DM as 1, if successful (e.g., for passing action, passing to an unmarked teammate) or 0 if unsuccessful (e.g., for dribbling action when there was an unmarked teammate in a better position). To evaluate DM, we recorded all the actions (passing, dribbling and shooting) that each player executed. After that, the actions for which DM was correct (coded as 1) were selected to develop statistical analyses.

All the game actions were recorded in SSGs using a video camera, recording angle conversion lens (×0.75): VCL-HGA07B and a Hama Gamma tripod Series. The camera was placed in the corner of the playing field, at a height of 4 meters, guaranteeing an optimal view of all the game actions. Videos were transferred to a computer (Acer Aspire E15), after which data were recorded onto a Microsoft Office Excel 2010 sheet and exported to SPSS Inc., Released 2009 (PASW Statistics for Windows, Version 18.0, Chicago: SPSS Inc.).

The independent or informational constraints considered for analyses are defined in Table 2.

These variables were selected for their relevance in understanding DM processes in team sports in general and in futsal in particular. Previous studies recommended their use [e.g., Coito et al. (2020)]. Specifically, the variables of interpersonal distances have been previously studied to learn how DM occurs in game contexts. Our study aimed to understand if, through the manipulation of the positioning of the floaters, there would be changes in other variables at a collective level. We aimed to know what different spatial-temporal occupations might occur in different dimensions and to check how the affordances of the players changed. Those position-related variables that related to distance, width, length and surface area for a players' activity were assessed using inertial measurement units (IMUs) with ultra-wideband (UWB) tracking system technology from WIMU PRO™ (Realtrack Systems, Almeria, Spain) (see Figure 2). The sampling frequency of WIMUs for the positioning system was 18 Hz. Like previous studies, the devices were turned on about 10 to 15 minutes before the warm-up and placed on players with a specific custom neoprene

Table 2. Description of Each Informational Constraint Considered for Analysis.

Categories	Informational variables	Definition
Interpersonal distances	Distance between teammates	Distance between the attacker who carries out the action and his closest teammate.
	Attacker-defender distance	Distance between the attacker who carries out the action and his closest opponent.
Width and length playing space	Width offensive team	Distance between offensive players on the x axis
	Width defensive team	Distance between defensive players on the x axis
	Length offensive team	Distance between offensive players on the y axis
	Length defensive team	Distance between defensive players on the y axis
Playing space	Area offensive team	Area formed by all the players of attacker team.
	Area defensive team	Area formed by all the players of defensive team.
Team balance	Centroids distance	Distance between teams' centroids

Note. Based on Coito et al. (2020).

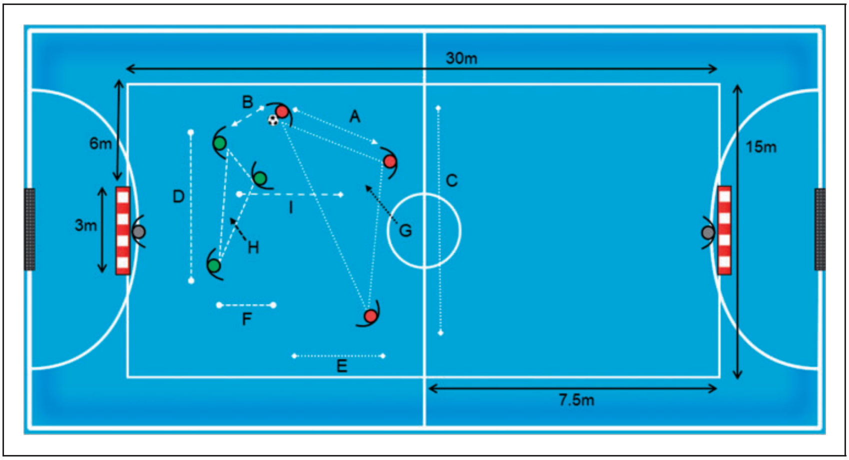

Figure 2. Definitions of the Informational Constraints Analyzed. A = distance between teammates; B = attacker-defender distance; C = width offensive team; D = width defensive team; E = length offensive team; F = length defensive team; G = area offensive team; H = area defensive team; I = centroids distance.

vest located on the middle line between the scapulae at the C7 level (Ribeiro et al., 2020). The system has six UWB antennas, placed outside the court and operates using triangulation between the antennas and the units to derive each unit's X and Y coordinates. With the exclusion of rest and changes time, data from SSGs were analyzed using SPRO Software (Realtrack Systems SL, Almeria, Spain). WIMU inertial devices have been shown to be a valid and reliable system (Bastida-Castillo et al., 2019).

Statistical Analysis

In comparing the variations on game conditions supporting passing, dribbling and shooting actions across SSGs, we used a Shapiro-Wilk test to assess the data's normal distribution. We used a non-parametric repeated measure ANOVA (Friedman) to compare variables for actions according to the game scenarios (SSGs). We assessed pairwise comparisons based on the Durbin-Conover test. Also, the descriptive results were presented as medians and minimum and maximum values for each variable. Statistical significance was set at $p < .05$, and calculations were completed using the Jamovi Project (Computer Software Version 1.2, 2020).

Further, we performed a discriminant analysis to understand which variables better discriminated the passing, dribbling and shooting action for each SSG. The players' actions were used as grouping variables to perceive the discriminatory power (weight) of each of the informational constraints in the characterization of each SSG. This approach led to four discriminant analyses (one for each SSG). For each small-sided game, the statistical specifications of the model included (a) a descriptive analysis (*M* and *SD*) for each of the actions (i.e., passing, dribbling and shooting); (b) eigenvalues to show the canonical correlations whose value (between 0 and 1) indicated to what extent the discriminant variables made it possible to differentiate the three groups; (c) Wilks' Lambda, which expressed the total variability proportion not due to differences among the groups; (d) group centroids to show the location of the actions in each of the two discriminant functions, making it possible to see if they are located, on average, in the positive or negative scores of the function; and (e) the structure coefficients (SCs) to determine the correlation of the variables with the discriminant functions (1 and 2) such that the larger the magnitude of the coefficients, the greater the contribution of that variable to the discriminant function, showing the ones that contribute most to discriminating from the value $\geq|0.30|$ (Tabachnick & Fidell, 2007). Statistical analyses were performed using SPSS Inc., Released 2009 (PASW Statistics for Windows, Version 18.0, Chicago: SPSS Inc.).

Results

In total, players made 1,625 tactical decisions within 20 analyzed SSGs. Players made 852 passing actions (296 in FO, 196 in FLF, 170 in LFofsl and 190 in LFffsl), 643 dribbling actions (194 in FO, 159 in FLF, 128 in LFofsl and 162 in LFffsl), and 130 shooting actions (37 in FO, 25 in FLF, 30 in LFofsl and 38 in LFffsl). Among passing actions, differences were found in offensive team length ($\chi^2 = 10.96$, $p = .012$) and defensive team length ($\chi^2 = 11.42$, $p = .010$). LFofsl revealed higher significant values of length offensive team than FO and FLF revealed higher significant values of length defensive team than FO and LFofsl and LFffsl. Dribbling actions showed significant differences in offensive team length ($\chi^2 = 20.02$, $p < .001$) where FLF revealed lower length offensive team than LFofsl and LFffsl (see Table 3).

Table 4 presents the descriptive analysis and results of discriminant function analysis for the FO SSG. Figure 3 shows the territorial map of the discriminant functions for the decision's made. The discriminant analysis produced two discriminant functions, with function 1 representing 75.3% of the total variance of the cases and function 2 representing 24.7%. The canonical correlations of functions 1 and 2 were, respectively, 0.41 and 0.25, with both functions statistically significant (Wilks' Lambda = 0.78, $p = <0.001$; and Wilks' Lambda = 0.94, $p = <0.001$, for functions 1 and 2, respectively). The informational variables that contributed most to distinguish DM into function 1, were teammate distance (SC = .94), opponent distance (SC = .45) and offensive team width (SC = −.38), with a greater weight for shooting (Group centroid = 1.594) (see Figure 3). Success in DM for shooting tended to occur with higher values for

Table 3. Descriptive and Inferential Analysis for Considered Variables for Action According to the Different Game Formats (SSG).

			FO			FLF			LFofsl			LFffsl					Pairwise Comparisons (Durbin-Conover)
Action	Categories	Variable	median	min	max	median	min	max	median	min	max	median	min	max	χ^2	p-value	
Passing	Interpersonal distances	Teammate distance (m)	6.80	0.56	12.4	6.73	1.30	16.4	6.79	1.68	16.3	6.99	1.02	12.5	3.21	.361	–
		Opponent distance (m)	2.26	0.57	8.89	2.25	0.21	9.80	2.58	0.44	7.26	2.33	0.43	13.5	5.35	.148	–
	Width and length playing space	Width offensive team (m)	7.89	0.40	14.2	8.30	0.38	13.4	7.54	0.44	13.5	7.64	1.07	13.2	7.46	.059	–
		Width defensive team (m)	4.60	0.65	11.2	4.63	0.41	10.8	4.41	1.08	11.2	4.82	0.06	8.49	0.29	.961	–
		Length offensive team (m)	5.72	0.00	21.1	5.55	0.14	15.9	6.82	0.06	23.1	6.23	0.00	22.2	10.96	**.012**	b | c
		Length defensive team (m)	4.76	0.00	19.0	5.59	0.20	14.3	4.55	0.05	12.9	4.77	0.02	18.4	11.42	**.010**	a | c | d
	Playing space	Teammate area (offensive team) (m^2)	19.4	0.17	63.8	17.2	0.15	72.9	20.2	0.06	75.4	21.0	0.00	73.1	6.04	.110	–
		Teammate area (defensive team) (m^2)	9.02	0.02	66.0	10.2	0.03	45.7	9.51	0.04	59.0	9.37	0.27	37.5	3.03	.388	–
	Team balance	Distance between centroids (m)	2.52	0.19	7.80	2.71	0.25	9.38	2.65	0.13	7.83	2.71	0.10	12.5	3.00	.392	–
Dribbling	Interpersonal distances	Teammate distance (m)	6.50	0.92	15.8	6.34	1.82	19.4	7.02	0.81	16.0	7.00	1.19	15.6	5.73	.126	–
		Opponent distance (m)	1.98	0.49	10.4	2.10	0.60	8.00	1.94	0.50	11.9	2.02	0.29	10.5	0.24	.970	–
	Width and length playing space	Width offensive team (m)	7.37	0.77	14.3	7.71	1.69	13.6	7.94	0.40	13.4	7.24	1.03	12.7	6.92	.074	–
		Width defensive team (m)	4.97	0.22	10.7	4.95	0.66	12.2	5.15	0.77	12.8	5.18	0.70	9.45	6.35	.096	–
		Length offensive team (m)	6.07	0.00	22.1	5.32	0.57	17.7	7.05	0.63	15.8	6.60	0.00	18.6	20.02	**<.001**	c | d
		Length defensive team (m)	5.83	0.10	17.6	5.83	0.27	16.8	5.88	0.20	18.9	6.08	0.02	23.3	0.62	.891	–
	Playing space	Teammate area (offensive team) (m^2)	18.3	0.01	44.8	16.9	0.09	60.9	20.0	0.58	75.8	19.2	0.35	73.5	6.37	.095	–
		Teammate area (defensive team) (m^2)	11.4	0.13	61.8	11.3	0.65	49.2	12.0	0.18	70.7	13.0	0.16	73.8	5.75	.124	–
	Team balance	Distance between centroids (m)	2.02	0.13	11.2	2.27	0.05	10.6	2.33	0.43	7.73	2.15	0.10	7.50	3.49	.322	–
Shooting	Interpersonal distances	Teammate distance (m)	6.39	2.00	15.4	6.87	1.83	17.1	7.55	1.88	17.3	6.99	0.78	19.3	1.40	.705	–
		Opponent distance (m)	1.96	0.50	8.00	2.32	0.36	9.87	2.41	0.66	8.56	2.33	0.58	8.31	2.65	.449	–
	Width and length playing space	Width offensive team (m)	6.32	0.11	10.4	5.99	1.39	10.5	6.54	1.87	11.3	6.14	2.86	11.8	1.52	.678	–
		Width defensive team (m)	4.60	0.02	10.4	3.80	1.62	7.98	4.33	1.02	9.61	4.08	0.11	6.00	1.19	.755	–
		Length offensive team (m)	12.1	3.50	22.3	11.4	1.18	21.1	10.7	2.43	21.4	10.8	0.45	20.6	1.17	.759	–
		Length defensive team (m)	6.54	1.36	20.1	7.02	0.02	14.8	7.32	2.03	20.3	5.96	1.68	14.8	0.91	.822	–
	Playing space	Teammate area (offensive team) (m^2)	27.6	4.24	57.8	26.5	2.71	89.7	26.9	5.03	82.2	22.8	0.56	78.6	0.44	.931	–
		Teammate area (defensive team) (m^2)	9.94	1.32	54.9	8.04	0.01	50.5	15.2	0.10	60.2	8.79	0.02	34.7	3.86	.277	–
	Team balance	Distance between centroids (m)	2.28	0.57	5.32	2.33	0.17	6.99	1.77	0.29	11.0	2.40	0.10	6.74	2.43	.489	–

Note. FO = Floaters Off; FLF = Final Line Floaters; LFofsl = Lateral Floaters (own field side line); LFffsl = Lateral Floaters (full field side line).
Pairwise Comparisons: a = FO vs FLF; b = FO vs LFofsl; c = FLF vs LFofsl; d = FLF vs LFffsl.

teammate distance, mean values of opponent distance and lower offensive team width when compared to dribbling and passing actions. On the other hand, the informational variables that contributed most to distinguish successful DM into function 2 were defensive team width (SC = .64), offensive team length (SC = .50) and defensive team length (SC = −.46), with a greater weight for dribbling (Group centroid = 0.314) (see Figure 3). Success in DM for dribbling tended to occur with mean values of offensive team length and defensive team length and lower offensive teammate area when compared with passing and shooting. Values were really similar between them.

Table 5 presents the descriptive analysis and results of discriminant analysis for the FLF SSG. Figure 4 shows the territorial map of the discriminant functions for the decision's made. The discriminant analysis computed two discriminant functions, with function 1 representing 75.4% of the total variance of the cases and function 2 representing 24.6%. The canonical correlations of functions 1 and 2 were, respectively, 0.41 and 0.25, with both functions statistically significant (Wilks' Lambda = 0.78, $p = <0.001$; and Wilks' Lambda = 0.94, $p = <0.001$, for functions 1 and 2, respectively). The informational variables

Table 4. Descriptive Analysis and Results of Discriminant Analysis for the FO SSG.

	Actions			Structure coefficients	
Variables	Passing	Dribbling	Shooting	Function 1	Function 2
Teammate distance	6.80 ± 2.1	6.56 ± 2.5	7.32 ± 3.5	**.94***	.19
Opponent distance	2.67 ± 1.7	2.59 ± 1.8	2.65 ± 1.9	**.45***	−.25
Width offensive team	7.85 ± 2.5	7.39 ± 2.5	6.04 ± 2.2	**−.38***	**−.35***
Width defensive team	4.71 ± 1.7	4.99 ± 1.8	4.36 ± 2.1	.21	**.64***
Length offensive team	6.08 ± 3.3	6.43 ± 3.7	12.01 ± 4.6	.11	**.50***
Length defensive team	5.15 ± 3.0	6.32 ± 3.6	6.86 ± 4.0	−.02	**−.46***
Teammate area (offensive team)	20.30 ± 11.4	18.74 ± 11.4	28.66 ± 13.5	−.16	**.30**
Teammate area (defensive team)	10.79 ± 8.2	13.34 ± 10.2	13.66 ± 11.5	.15	−.19
Distance between centroids	2.76 ± 1.4	2.40 ± 1.6	2.55 ± 1.1	.00	−.08
Eigenvalues					
Eigenvalue	n.a.	n.a.	n.a.	.21	.07
% of Variance	n.a.	n.a.	n.a.	75.3	24.7
Cumulative %	n.a.	n.a.	n.a.	75.3	100.0
Canonical correlations	n.a.	n.a.	n.a.	.41	.25
Wilks' Lambda	n.a.	n.a.	n.a.	.78	.94
Chi-Square	n.a.	n.a.	n.a.	123.62	32.00
Significance	n.a.	n.a.	n.a.	<.001	<.001

*SC discriminant value ≥|0.30|.

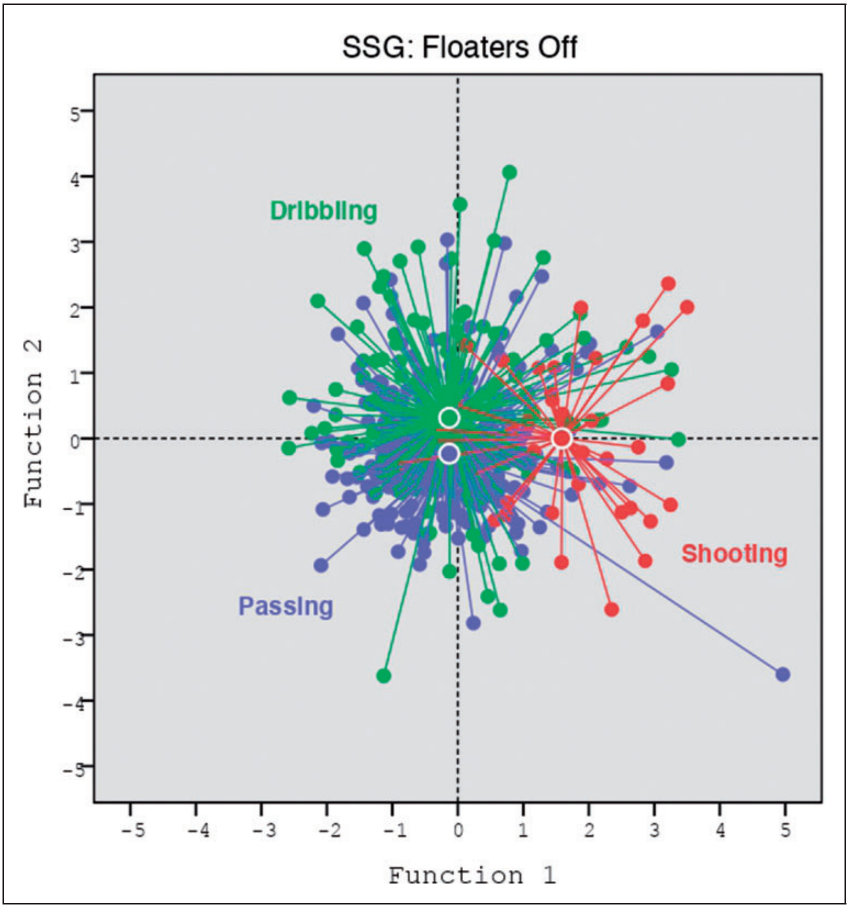

Figure 3. Territorial Map of the Discriminant Functions for the Action's Clusters.

that contributed most to the classification of the actions into function 1, in order of importance were teammate distance (SC = .91), opponent distance (SC = −.51) and offensive team width (SC = −.47), with a greater weight for shooting (Group centroid = 1.438) (see Figure 4). Success in DM for shooting tended to occur with higher values for teammate distance, higher values of opponent distance and lower values for offensive team width when compared to dribbling and passing actions. On the other hand, the informational variables that contributed most to the classification of the DM into function 2, in order of importance were defensive team width (SC = .69), opponent team distance (SC = .43), offensive team (SC = −.39) length, defensive team length (SC = .34) and offensive teammate area (SC = .33), with a greater weight for *dribbling* (Group centroid = −0.298) (see Figure 4). Success in DM for dribbling tended to occur with lower defensive team width, higher opponent distance, higher offensive team length, lower defensive team length and higher offensive teammate area when compared with passing and shooting.

Table 6 presents the descriptive analysis and results of discriminant analysis for the LFofsl SSG. Figure 5 shows the territorial map of the discriminant functions for the decisions made. The discriminant analysis computed two discriminant functions, with function 1 representing 64.2% of the total variance of the cases and function 2 representing 35.8%. The canonical correlations of functions 1 and 2 were, respectively, 0.33 and 0.25, with both functions statistically significant (Wilks' Lambda = 0.83, $p = <0.001$; and Wilks' Lambda = 0.94, $p = <0.001$, for functions 1 and 2, respectively). The informational variables that contributed most to the classification of the actions into function 1, in order of importance were teammate distance (SC = .83), opponent distance (SC = −.64), offensive teammate area (SC = .35), defensive teammate area (SC = −.34) and offensive team width (SC = .32), with a greater weight for shooting (Group centroid = 1.059) (see Figure 5). Success in DM for shooting tended to occur with higher values for

Table 5. Descriptive Analysis and Results of Discriminant Analysis for the FLF SSG.

	Actions			Structure coefficients	
Variables	Passing	Dribbling	Shooting	Function 1	Function 2
Teammate distance	7.12 ± 2.4	6.62 ± 2.6	7.60 ± 3.6	**.91***	.13
Opponent distance	2.75 ± 1.7	2.65 ± 1.7	2.94 ± 2.3	**−.51***	**.43***
Width offensive team	8.23 ± 2.4	7.68 ± 2.6	5.96 ± 2.0	**.47***	.18
Width defensive team	4.69 ± 1.7	5.02 ± 2.0	4.36 ± 1.7	−.06	**.69***
Length offensive team	6.15 ± 3.2	5.82 ± 3.0	11.04 ± 6.2	−.07	**−.39***
Length defensive team	5.88 ± 3.0	6.32 ± 3.4	7.10 ± 4.1	.18	**.34***
Teammate area (offensive team)	20.03 ± 13.2	18.59 ± 11.9	29.18 ± 18.5	−.17	**−.33***
Teammate area (defensive team)	11.53 ± 7.4	13.29 ± 9.0	11.49 ± 9.9	.19	−.26
Distance between centroids	3.07 ± 1.6	2.49 ± 1.5	2.63 ± 1.5	.09	.10
Eigenvalues					
Eigenvalue	n.a.	n.a.	n.a.	.21	.07
% of Variance	n.a.	n.a.	n.a.	75.4	24.6
Cumulative %	n.a.	n.a.	n.a.	75.4	100.0
Canonical correlations	n.a.	n.a.	n.a.	.41	.25
Wilks' Lambda	n.a.	n.a.	n.a.	.78	.94
Chi-Square	n.a.	n.a.	n.a.	96.45	24.82
Significance	n.a.	n.a.	n.a.	<.001	<.001

*SC discriminant value ≥|0.30|.

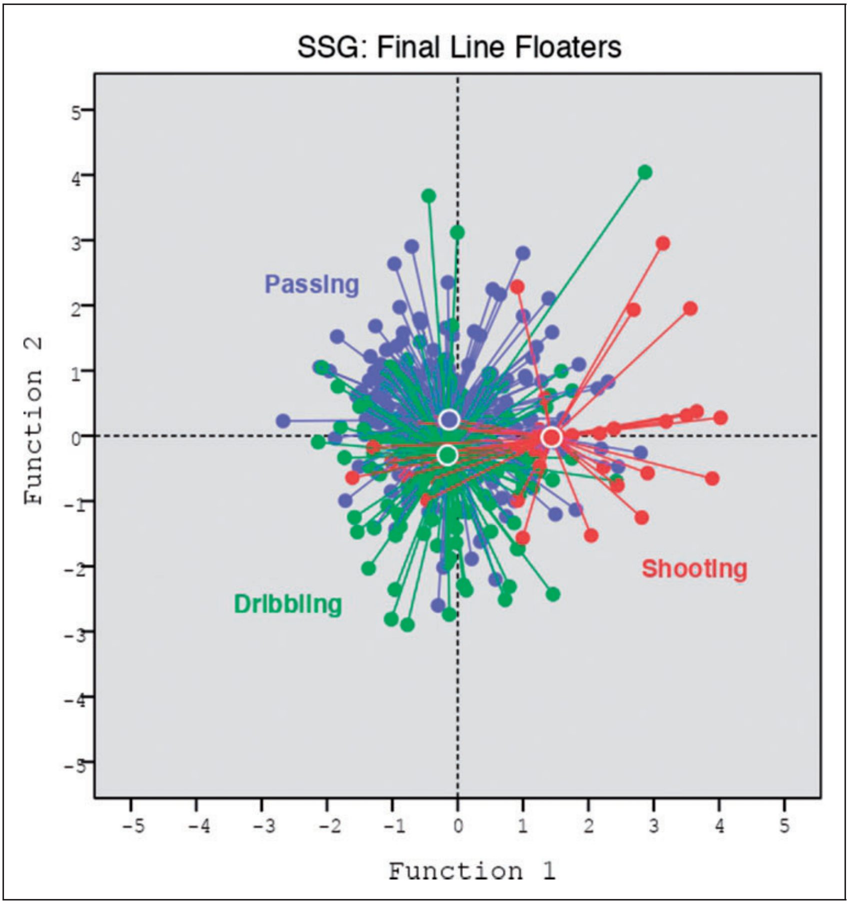

Figure 4. Territorial Map of the Discriminant Functions for the Action's Clusters.

teammate distance, lower values of opponent distance and lower offensive team width when compared to dribbling and passing actions. In addition, offensive teammate area (show the highest values for shootings compared to dribbling and passing actions. On the other hand, the informational variables that contributed most to distinguishing successful DM into function 2, in order of importance were opponent distance (SC = .61), defensive team length (SC = .56), offensive teammate area (SC = .40) and defensive teammate area (SC = .35), with a greater weight for dribbling (Group centroid = 0.325) (see Figure 5). Successful DM for dribbling tended to occur with mean values of defensive team length, offensive teammate area (offensive team) and defensive teammate area, and higher values of opponent distance compared to decisions in passing and shooting.

Table 6. Descriptive Analysis and Results of Discriminant Analysis for the LFofsl SSG.

	Actions			Structure coefficients	
Variables	Passing	Dribbling	Shooting	Function 1	Function 2
Teammate distance	7.09 ± 2.0	7.23 ± 3.1	7.69 ± 3.1	**.83***	−.19
Opponent distance	2.92 ± 1.5	2.93 ± 2.4	2.83 ± 1.7	**.64***	**.61***
Width offensive team	7.63 ± 2.4	7.93 ± 2.6	6.56 ± 2.1	**.32***	.08
Width defensive team	4.67 ± 1.7	5.23 ± 2.1	4.62 ± 2.1	.19	.03
Length offensive team	7.03 ± 3.6	7.23 ± 3.3	10.83 ± 5.2	−.04	.03
Length defensive team	4.99 ± 2.8	6.40 ± 3.4	7.48 ± 4.0	−.02	**.56***
Teammate area (offensive team)	21.77 ± 13.1	23.27 ± 16.4	27.60 ± 16.1	**.35***	**.40***
Teammate area (defensive team)	11.11 ± 8.5	13.82 ± 10.7	15.36 ± 11.7	**−.34***	**.35***
Distance between centroids	2.89 ± 1.5	2.65 ± 1.5	2.48 ± 2.2	−.21	−.22
Eigenvalues					
Eigenvalue	n.a.	n.a.	n.a.	.12	.07
% of Variance	n.a.	n.a.	n.a.	64.2	35.8
Cumulative %	n.a.	n.a.	n.a.	64.2	100.0
Canonical correlations	n.a.	n.a.	n.a.	.33	.25
Wilks' Lambda	n.a.	n.a.	n.a.	.83	.94
Chi-Square	n.a.	n.a.	n.a.	58.11	21.14
Significance	n.a.	n.a.	n.a.	<.001	<.001

*SC discriminant value ≥|0.30|.

Table 7 presents the descriptive analysis and results of discriminant analysis for the LFffsl SSG. Figure 6 shows the territorial map of the discriminant functions for the decisions made. The discriminant analysis computed two discriminant functions, with function 1 representing 58.3% of the total variance of the cases and function 2 representing 41.7%. The canonical correlations of functions 1 and 2 were, respectively, 0.36 and 0.31, with both functions statistically significant ($p < 0.001$), (Wilks' Lambda = 0.78, $p = < 0.001$; and Wilks' Lambda = 0.90, $p = < 0.001$, for functions 1 and 2, respectively). The informational variables that contributed most to the classification of the actions into function 1, in order of importance were teammate distance (SC = .69), opponent distance (SC = .64), offensive team width (SC = .49) and defensive team width (SC = −.38). with a greater weight for dribbling (Group centroid = 0.459) (see Figure 6). Successful DM for dribbling tended to occur with lower values for teammate distance and opponent distance, mean values for offensive team width and higher values for defensive team width compared to passing and shooting.

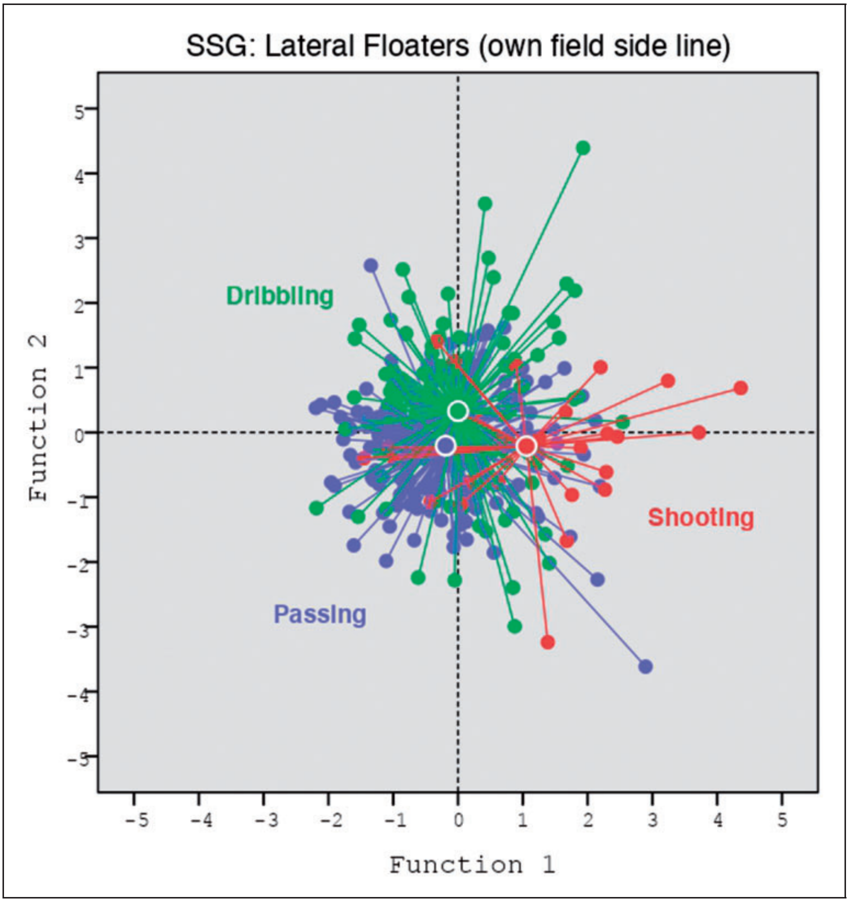

Figure 5. Territorial Map of the Discriminant Functions for the Action's Clusters.

On the other hand, the informational variables that contributed most to the classification of the DM into function 2, in order of importance were offensive teammate area (SC = .87), opponent distance (SC = −.44), defensive teammate area (SC = .40), distance between centroids (SC = .40) and offensive team width (SC = .34), with a greater weight for shooting (Group centroid = 0.976) (see Figure 6). Successful DM for shooting tended to occur with higher values for opponent distance and offensive teammate area), lower values for offensive team width and mean values for defensive teammate area and distance between centroids compared to passing and dribbling.

Table 7. Descriptive Analysis and Results of Discriminant Analysis for the LFffsl SSG.

	Actions			Structure coefficients	
Variables	Passing	Dribbling	Shooting	Function 1	Function 2
Teammate distance	7.20 ± 2.2	6.99 ± 2.7	7.42 ± 4.1	**.69***	−.01
Opponent distance	2.78 ± 1.8	2.66 ± 1.9	2.95 ± 1.6	**.64***	**−.44***
Width offensive team	7.68 ± 2.4	7.18 ± 2.7	6.48 ± 2.4	**.49***	**.34***
Width defensive team	4.67 ± 1.6	5.42 ± 1.8	3.94 ± 1.3	**−.38***	−.20
Length offensive team	6.64 ± 3.6	7.27 ± 3.7	10.46 ± 5.2	−.12	.08
Length defensive team	5.11 ± 3.0	6.61 ± 3.9	6.59 ± 3.3	−.10	.09
Teammate area (offensive team)	22.56 ± 13.1	21.75 ± 14.9	29.02 ± 20.3	.05	**.87***
Teammate area (defensive team)	10.71 ± 6.6	15.79 ± 11.8	11.21 ± 8.5	−.17	**−.40***
Distance between centroids	2.94 ± 1.7	2.42 ± 1.3	2.52 ± 1.6	−.14	**.40***
Eigenvalues					
Eigenvalue	n.a.	n.a.	n.a.	.15	.11
% of Variance	n.a.	n.a.	n.a.	58.3	41.7
Cumulative %	n.a.	n.a.	n.a.	58.3	100.0
Canonical correlations	n.a.	n.a.	n.a.	0.36	0.31
Wilks' Lambda	n.a.	n.a.	n.a.	0.78	0.90
Chi-Square	n.a.	n.a.	n.a.	93.42	39.42
Significance	n.a.	n.a.	n.a.	<.001	<.001

*SC discriminant value ≥ |0.30|.

Discussion

This study explored how manipulating the floaters' positions in futsal SSGs promoted changes in the informational constraints that support successful tactical DM for passing, dribbling and shooting. Generally, results did not reveal significant differences between informational constraints for successful passing, dribbling and shooting in the different SSGs (FO, FLF, LFofsl and LFffsl). Such variations have been previously reported but without reference to each particular action. Therefore, we highlighted, through a discriminant function analysis, the invariant and variant spatial-temporal relations that sustained successful decisions for passing, dribbling and shooting tactical actions for each small-sided game condition.

Regarding DM for *shooting*, results highlighted the following specific invariant informational constraints: teammate distance, opponent distance and offensive team width (see Figure 7). That is, the affordances to shoot at goal under different SSGs, seem to be supported by the surrounding informational constraints of immediate teammate and opponent (local relations) but also by the

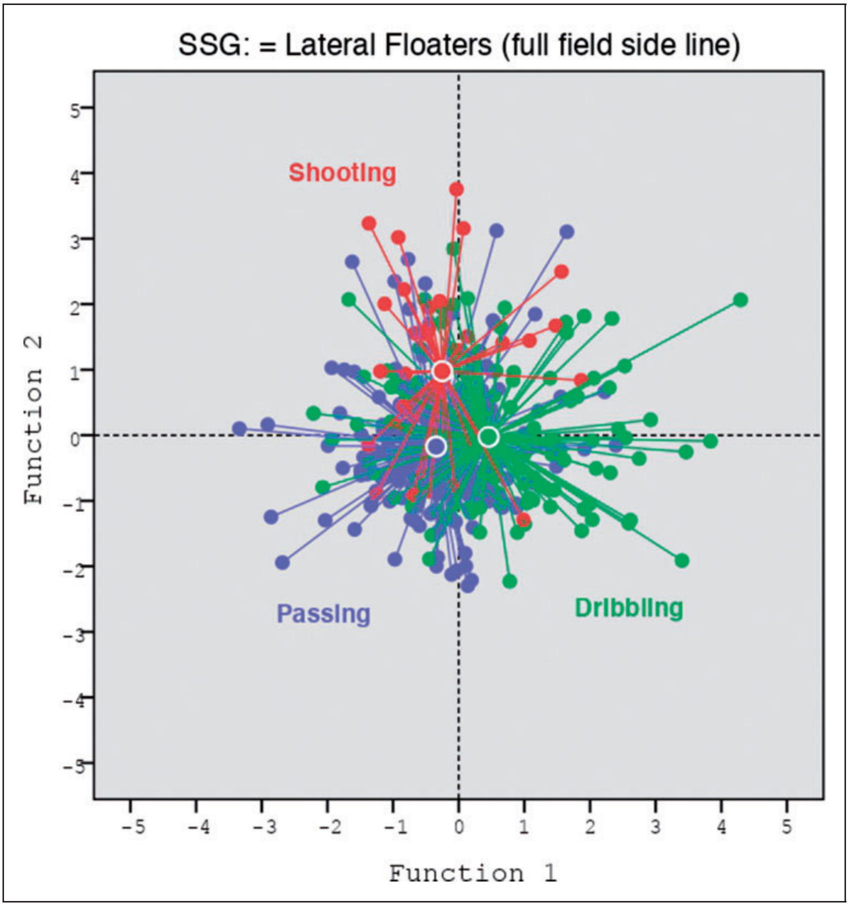

Figure 6. Territorial Map of the Discriminant Functions for the Action's Clusters.

general width of the offensive team on the field (team spatial-temporal relations) (Vilar et al., 2013). In line with our results, previous research revealed that despite the variability of contexts that occur over the game, players reach to create contexts to successfully perform (Duarte, Araújo, Freire et al., 2012; Gonçalves et al., 2017; Santos et al., 2018). Thus, the shooting lines were not only created by the behavior of the players with the ball to their direct opponents, but also considered the movement of the teammate to open space and the movement of other teammates to maintain the balance in occupying the field. Previous research has argued that this is a multi-level process for creating opportunities for action (Bourbousson et al., 2014).

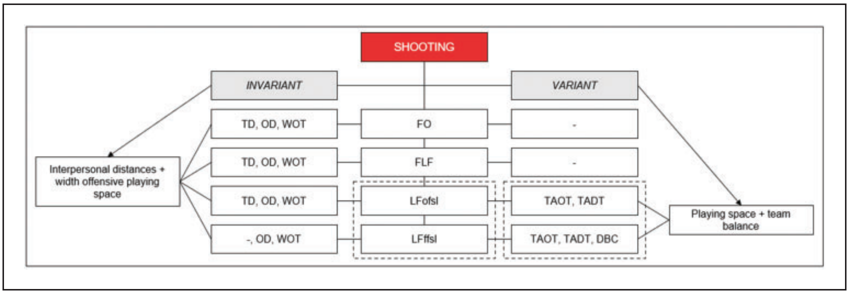

Figure 7. Invariant and Variant Informational Constraints That Discriminate Success DM in Shooting Action According to SSG. TD = teammate distance; OD = opponent distance; WOT =width offensive team; TAOT = team area offensive team; TADT = team distance defensive team; DBC = distance between centroids.

In this particular study, the optimal spatial-temporal relations that sustain the invariant informational constraints for shooting were stable for teammate distance, attacker-defender distance and offensive team width. In this sense, it seems that the information that supported the correct DM to shoot at the goal was stable, regardless of the manipulation of the floaters position for these three SSGs. Coaches should attend to further practice in tactical shooting actions.

On the other hand, our results showed that floaters' positioning changed the value of some informational constraints for shooting. Such variables were designated as variant informational constraints: offensive and defensive team area for LFofsl and LFffsl; and distance between centroids for LFffsl (see Figure 7). Interestingly, the team spatial-temporal relations defined by the team area and the distance between centroids of offensive and defensive teams seemed to not support the emergence of successful DM for shooting in all SSGs, but only according to specific SSGs. The changes in SSG conditions, mainly defined by the floaters' position (LFofsl and LFffsl), promoted changes in teams' dynamics, with implications for shooting environments. The changes between conditions in the emergence of shooting actions required a player's constant focus of attention to adjust their shooting actions according to the specifics of each SSG condition (Travassos, Gonçalves et al., 2014). Concerning playing space variables, offensive and defensive team areas helped to understand the addition of sideline floaters on the increased area of play within SSGs, with implications for the emergence of shooting lines (Frencken et al., 2011; Gonçalves et al., 2016). Considering that the presence of floaters promoted unbalanced numerical relationships between teams, such results are in line with previous research showing that manipulating the numerical relation between teams or even the number of target goals changed the space occupied between teams (Duarte, Araújo, Freire et al., 2012; Frencken et al., 2011). To summarize, based on our results, shooting DM was generally based on the interpersonal distance between the ball carrier and the direct opponent, considering the offensive team's width. Also, shooting was constrained, by certain attacking-defending teams' spatial-temporal relations as they related to playing space and team balance after manipulating the floaters' positions. We found that the coaches' decision to change the floaters' positions in SSGs may change the informational variables that sustain the shooting decision.

Regarding DM for *dribbling*, our results highlighted the following specific invariant informational constraints: opponent distance, defensive team width, defensive team length and offensive team area (see Figure 8). In line with previous results for shooting, the affordances for dribbling under different SSGs, seem to be supported by the surrounding informational constraints of opponent distance (local relations) but also by the width and length of the defensive team, and offensive team area (team relations) (Vilar, Araújo, Travassos et al., 2014).

Regarding the interpersonal variable of opponent distance, our results reinforce previous findings that when the attacker approaches the defender with variations in relative velocity between them, their relationship enters a state of critical coordination with an advantage to one of the players, and thus a dribble tends to occur (Passos et al., 2008). In this particular study, our results are in line with Corrêa et al. (2016), who exposed that right dribbling actions tended to occur with defined ball-carrier distances. Corrêa et al. (2016) inferred that the interpersonal coordination between attacker with the ball and his closest defender reached a critical range of spatial relationship values that may have functioned as potential control parameters through variability, constraining the dribbling.

In addition to previous studies that evaluated the dribble in 1 vs 1 SSG conditions, our study also revealed that the 1 vs 1 in 3 vs 3 SSGs is not only supported by ball carrier-opponent local relationships but also by team

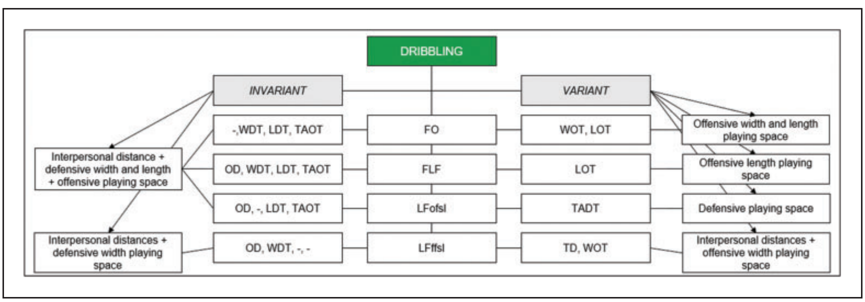

Figure 8. Invariant and Variant Informational Constraints That Discriminate Successful DM in Dribbling Action According to SSG. TD = teammate distance; OD = opponent distance; WOT =width offensive team; WDT = = width defensive team; LOT = length offensive team; LDT = length defensive team; TAOT = team area offensive team; TADT = team distance defensive team.

relationships (defensive and offensive width and length, and offensive team area), supporting nested informational constraints from collective team behaviour to individual actions (Duarte, Araújo, Correia et al., 2012). Thus, the ball carrier was guided by the particular information from the opponent, but also by the open space inside the defensive team's area, as defined by its width and length in relation to the space created by the offense's own team. Our results showed that the optimal spatial-temporal relations between teams that sustain the invariant informational constraints for dribbling were stable for the defensive team's width, the defensive team's length and lastly the offensive team area. Particularly, the defensive team's width and length seemed to be quite stable to the occurrence of dribbling actions and consequently required players' attention for the identification of not only space to destabilize the individual relations with the opponent but also the team relations with opponent team (Woods et al., 2020).

On the other hand, our results showed that changing the floaters' position changed the value of some informational constraints for dribbling. Such variables were designated as variant informational constraints: offensive team width and length (FO), offensive team length (FLF), defensive team area (LFofsl) and teammate distance (LFffsl) (see Figure 8). Thus, changes in SSG conditions, particularly as defined by the position of floaters, promoted changes in teams' dynamics, with implications for the emergence of dribbling. These changes between conditions in the emergence of dribbling actions required that players understand the changes promoted by manipulating the floater position on teams' dynamics, and consequently adjusting their dribbling actions according to the specifics of each SSG condition (Gonçalves et al., 2016; Travassos, Gonçalves et al., 2014).

When played without floaters (FO), offensive team width and length seemed to have also sustained the dribbling actions. Thus, when the 3 vs 3 was played with numerical balance, at the team level, the defensive team's width and length, and the offensive team's area need to be balanced with the offensive team's width and length. In this balanced player SSG, the attacking team must constantly develop explorative performances as they seek to create space and break symmetry with the defending players to create opportunities for progress or scoring goals (Corrêa et al., 2012). In opposition, defenders try to maintain spatial-temporal relations with the attackers, particularly near the ball, but also at a team level (Travassos, Vilar et al., 2014). When the floater was introduced, numerical unbalanced situations tended to occur with consequences to the context of play that supported dribbling actions. Regarding FLF, the positioning of floaters in the final line seemed to highlight information regarding offensive team length; the LFofsl, tended to highlight information regarding defensive team area; and the LFffsl highlighted teammate distance. As observed for shooting, the presence of floaters promoted a numerical imbalance between teams promoting adjustments especially at a team level. However, in the case of dribbling, the LFffsl also promoted changes in teammate distance and consequently on the local relations that supported dribbling actions. Summarizing, based on our results, the DM for dribbling was generally based on interpersonal distance between a ball carrier and their direct opponent, considering the defensive team's length and the offensive team's area. Also, shooting was constrained, by certain attacking-defending teams' spatial-temporal relations as related to playing space and team balance variations with manipulating floaters' positions. Thus, coaches' decision to change the position of floaters in SSGs may change the informational variables that sustain the decision for dribbling.

Regarding passing actions, none of the functions (set of variables) in any of the four SSGs revealed a capacity to discriminate successful DM. This could be due to the great variability presented in the contexts of play that support different passing actions in comparison with the dribbling and shooting actions in futsal. Therefore, we could assume that passing actions tend to occur in more variable contexts, also requiring adjustments in the timing and coordination to ensure successful actions. Further research should consider the type of pass in which this DM occurs to more precisely identify the contexts that sustain each type of passing action in futsal (Travassos, Araújo, Davids, Vilar et al., 2012).

Limitations and Future Directions

As this research was based on only male futsal players under the age of 19, generalization to more diverse samples is limited. Further research should utilize players of varying age, ability and gender. On the other hand, this intervention was carried out in natural context, where some contextual variables are difficult to control. In this sense, players' DM could be affected by the contextual variables as outcome or current score (potentially affecting playing behaviors). Additionally, we studied only floater position manipulations, and future studies might apply this paradigm to other manipulations, such as the number of players or available space for play. Moreover, due to the nature of the adaptations on the DM process, these results cannot be transferred to other practice. Thus, we recommend the development of this research in other sports.

Conclusions

This study significantly improved our understanding of the effects on tactical DM for various futsal actions (dribbling, passing and shooting) of changing floaters' positions in SSGs. These data provided useful insights for understanding the invariant and variant informational constraints that guide players through the affordances for futsal play and, consequently, this study aids the design of training tasks that will expose players to similar perceptual-motor demands as actual competition. Particularly, data from this study advance previous research by revealing that the information that sustains shooting and dribbling is related to interpersonal relations between players and to the width and length of a team's playing space. Each of our four SSG conditions not only critically maintained the information sustaining each action decision, but also revealed other variant information characterizing the context of play in accordance with the variables manipulated. Coaches should understand how their manipulation of floaters' positions line up with their training aims for game actions. If coaches use: (a) FO SSG, for dribbling, the changed informational constraints will be the offensive team's width and length; (b) FLF SSG, for dribbling, the changed informational constraint is the offensive team length; (c) LFofsl SSG, for shooting, the changed informational constraints will be the offensive and defensive team's area; and for dribbling, will be the defensive team's area; (d) LFffsl SSG, for shooting, the changed informational constraints will be the offensive and defensive team's area and the distance between centroids; and, for dribbling, will be teammate distance and offensive team's width.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study has been carried out thanks to the contribution of the Junta de Extremadura through the European Regional Development Fund. A way to make Europe (GR18129). Bruno Travassos was partially supported by Fundação para a Ciência e Tecnologia (UID04045/2020) to develop this study.

ORCID iDs

David Pizarro https://orcid.org/0000-0002-0859-0709
Alberto Moreno https://orcid.org/0000-0003-0112-9394

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Author Biographies

David Pizarro is an Assistant Professor at the Faculty of Life and Nature Sciences, University of Nebrija, Madrid (Spain). Also, he is a coach at the Atlético de Madrid youth academy. His research interests are teaching methodologies as nonlinear pedagogy in youth football and futsal, analysis of the tactical behavior and decision-making processes in formative stages of futsal.

Alba Práxedes is an Assistant Professor at the Faculty of Life and Nature Sciences, University of Nebrija, Madrid (Spain). Also, she is a coach at the Atlético de Madrid youth academy. Her research interests are teaching methodologies in youth football, sport expertise in football, analysis of the tactical behavior in formative stages of football, and school-based interventions in order to analyze the effects on the cognitive expertise and execution skills as well as other issues such as motivation and leisure-time physical activity.

Bruno Travassos is an Assistant Professor at University of Beira Interior, and researcher of CreativeLab from CIDESD, Research Center in Sport Sciences, Health and Human Development. He integrates the Portugal Football School from Portuguese FA and works as Sport Scientist in Portuguese National Futsal teams.

Bruno Gonçalves is an Associate Professor at the University of Évora (Évora, Portugal) and research at the Comprehensive Health Research Centre (CHRC). He graduated with a PhD in collective movement behaviour in association football, where he developed expertise in capturing and filtering data using high-tech instruments and advanced processing computations. This expertise has led him to build a solid national and international reputation in collective movement behaviour and performance analysis in team sports.

Alberto Moreno is an Associate Professor at the Faculty of Sport Sciences at the University of Extremadura, Spain. His research focuses in physical education and sport contexts. Specifically, in cognitive processes, such as the decision making in volleyball and football.