

Analyzing the influence of playing time and partial score on the tactical behavior in the duel 2 vs 2 in the offensive process in handball, using the polar coordinates technique

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Título: Analizando la influencia del tiempo de juego y puntuación parcial en el comportamiento táctico en el duelo 2 vs 2 en el proceso ofensivo en balonmano, utilizando la técnica de coordenadas polares.

Resumen: Diferentes estudios hacen referencia a como el tiempo de juego, la puntuación parcial y la interacción de ambos influyen en los comportamientos de jugadores y equipos. Con este estudio se intentó demostrar la compleja realidad del comportamiento táctico en el ataque en la Copa de Europa Masculina, mediante la detección de patrones de comportamiento y vincularlos al tiempo de juego y a la puntuación parcial. Se utilizó metodología observacional, y para el análisis de los datos se utilizó la técnica de coordenadas polares. El instrumento de observación fue construido *ad hoc* y validado. La optimización de la herramienta incluye el control de calidad del dato, mediante el análisis de la fiabilidad del observador intra e inter a través del índice Kappa de Cohen (rango entre .85 y 1), y la aplicación del análisis de generalizabilidad (los índices G son adecuados para todos los modelos estimados) que confirman la fiabilidad del instrumento. La muestra contenía todas las situaciones de 2vs2 que se produjeron durante el proceso de ataque organizadas en igualdad numérica 6vs6, en dieciséis partidos (n = 390).

Como principales resultados se pueden referir que el tiempo de juego influyó en la toma de decisiones en relación con los medios tácticos empleados, a excepción de los últimos diez minutos, donde no se encontraron patrones de comportamiento cuando el marcador es un empate.

Palabras-clave: Metodología Observacional; Coordenadas polares; Comportamiento táctico; Análisis del rendimiento; Balonmano.

Abstract: Different studies have referred that the playing time and partial score, as well as the interaction between these two influences the behaviors of players and teams. With this study we intended to realize the complex reality of tactical behavior in the attack in Men's European Cup, by detecting behavior patterns and linking them to playing time and partial score.

We used the observational methodology and for data analysis we used the polar coordinates. An instrument of observation has been constructed *ad hoc* and validated. The tool optimization included the quality data control, using the analysis of intra and inter observer reliability by Cohen's Kappa index (range between .85 and 1), beyond the application of generalizability analysis (G indexes are suitable for all models estimated) confirming the instrument reliability. The sample contained all of 2vs2 situations that occurred during the organized offensive process in numerical equality 6vs6, in sixteen games (n = 390).

As main results we can refer that the playing time influenced the decision-making in relation to the tactical means used, excepting the last ten minutes, where no patterns were found. The results also show that there are fewer behavior patterns when the score is a draw.

Key words: Observational methodology; Polar coordinates; Tactical behavior; Performance Analysis; Handball.

Introduction

Handball is a team game and invasion game with simultaneous participation, with its own characteristics, forming a complex system in which the strategic tactical behavior is determinant (Garganta, 2009; Tavares, 1999; Ribeiro, 2002; Prudente, 2006; Leite, Barreira, 2014; Sequeira, 2012; Sousa, 2014). Complex system in sport, namely in team games, “*consist of structurally and functionally heterogeneous components which interact (generally informationally or / and mechanically) with varying intensities and spanning different spatio-temporal scales. They are also adaptive and goal directed changing and fitting their behavior to emerging constraints*” (Balagué, Torrents, Hristowski, Davids, Araújo, 2013:pp.5). An approach based on complexity sciences has been used in different studies of sport in general, team games and handball in the last years (Balagué, Torrents, 2011; Balagué, Torrents, Hristowski, Davids, Araújo, 2013; Camerino, Chaverri, Anguera, Jonson, 2012; Davids, Araújo, Shuttleworth, 2005; Hughes, Bartlett, 2002; McGarry, Anderson, Wallace, Hughes, Franks, 2002; Lozano,

Camerino, 2012; Martin-Acero, Lago, 2005; Vilar, Araújo, Davids, Button, 2012).

Handball has had a constant evolution in terms of processes and dynamics of the game, which has been the subject of various studies, namely those related to decision-making and the technical/tactical strategic behavior in the performance and success of the sport. However, very few studies have covered these topics, despite the growing number of authors who have already focused on them. (Prudente, 2006; Ribeiro 2002; Santos, 2004; Santos, 2012; Sequeira, 2012; Silva, Garganta, Janeira, 2008; Sousa, 2014).

What drives us to study this sport, is the complexity of the game, the constant difficulty in assessing the performance of the teams and athletes and the constant search for answers that may contribute towards the improvement in the performance.

This study used the observational methodology, a methodology that emphasizes the perceptible behaviors that occur in the natural context of its participants and used an *ad hoc* observation instrument, which distinguishes it from the other methodologies (Anguera y Hernández-Mendo, 2014) and which has been used in research studies in the actions of the game, in team games and particularly in Handball (Anguera y Hernández-Mendo, 2013, 2014; Lozano, Camerino, 2012; Sequeira, 2012; Sousa, 2014; Sousa, Prudente,

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Sequeira y Hernández-Mendo, 2014). The reason for using the technique of polar coordinates analysis is based on the fact that it enables a vectorial representation of the complex grid of inter-relationships established between the different categories of an observation system, including a perspective that is both prospective and retrospective, with the advantage of working as a technique that allows the reduction of data (Gorospe y Anguera, 2000). Lago y Martín-Acero (2005) defend that this analysis technique is a powerful and adequate way of analysing the complexity of team games, while other authors emphasize the possibility/advantage of using the sequential analysis and the polar coordinates in the study of Handball (Morillo-Baro, Reigal e Hernández-Mendo, 2015; Prudente, Garganta e Anguera, 2010; Ramirez, Lemos, Bonilla, Silva y López (2013); Sousa et al., 2014).

The aim of this study is to contribute towards a better understanding of the offensive process in Handball and focuses on the relationship between the players that occurs in the duel 2 vs 2 in the offensive process. Group tactic is considered an important link between individual tactic (1vs1) and team tactic, which is crucial to creating favorable finalization situations of attack (Antón-García, 2000; Rimmert, 2003; Prudente, 2006; Roman-Seco, 2005; Sevin & Bilge, 2005). In addition to being considered a basic form of cooperation (Antón-García, 2000), group tactic 2 vs 2 is referred to by Rimmert (2003) as important to the success of the training, enabling a deeper insight of the tactical decisions of the players involved in the group's tactical. Moreover, is it important to refer that different authors have mentioned the existence of different duels in the game (1 vs 1, 2 vs 2 and 3 vs 3) which as they have also referred, is crucial to creating finalization situations in offensive actions in an organized attack (Antón-García, 2000; Lago y Martín-Acero, 2005; Prudente, 2006; Roman Seco, 2005; Sequeira, 2012; Sevin e Bilge, 2005; Sousa, 2014). From these duels, the one 2 vs 2 has been identified as one of the factors associated to the success of the teams, which led us to deepen the knowledge concerning the technical/tactical behavior of the players during those duels in the attack.

Sousa (2014) previously studied the situations of 2 vs 2, regarding tactics used, based on the knowledge that score and playing time influence the behavior of the players and the teams (Silva et al, 2008; Teles e Volossovitch, 2015; Volossovitch, Dumangane, Rosati, 2012). We now thought it important to check the relationship between these behaviors and the evolution of the partial score and the playing time.

The objective of this study was to analyze, characterize and detect patterns of offensive behaviors in 2 vs 2, establishing the relationship between tactical actions and related efficiency and the evolution of the score and the playing time, in the case of numerical equality, in organized attack, during the final games of Men's European Cup 2012.

Method

The study used observational methodology, which according to Anguera (2009) is, nowadays, the one more widely adopted in the study of team games due to its accuracy, systematization, flexibility and capacity to be used in more complex situations. The observational design used was idiographic, multidimensional, follow-up, located in the first quadrant and the data used is type 1 (Anguera, Blanco, Hernández-Mendo y Losada, 2011). The observation session established a period of data recording time between the moment prior to the beginning of the use of the tactics in the situation of game 2 vs 2, up to the loss of the ball, with or without a shot (either due to technical fault or violation to the rule) or after 5 consecutive passes taken after the use of that tactical mean. The observation was non-participative, carried out from the viewing of videos of the matches recorded directly from the television broadcast, with a maximum limit of 10% of unobservability (Anguera, 1990).

This study was conducted on a sample of matches of the European Cup 2012, because it met the necessary quality criteria found in a high level international competition, due to the participation of the world's most elite teams and coaches. It also provided offensive sequences carried out in numerical equality and 6 vs 6 using the game method of organized attack. We had concluded from a previous study that over 60% of the attacks occur in these conditions. The sample was formed by all the situations of 2 vs 2 (n = 390), registered during the observation of the offensive sequences mentioned above.

Participants

Sixteen matches were observed, both in the preliminary phase (8) and final phase (8) involving only the first nine teams in the final ranking of the Men's European Cup 2012, where all of the attacks registered were in numerical equality 6 vs 6 (total 1028), which used the game method of organized attack and where 390 situations of 2 vs 2 occurred.

The criterion used in the exclusion of 2 vs 2 game situations to be observed and registered was based on the unobservability criteria of Anguera (1990), and therefore, the offensive sequences in situation of 2 vs 2 that did not comply with the criteria were excluded. Sequences of game where the method of organized attack was not used were equally excluded, in addition to those where there was no numerical equality of 6 vs 6.

Observation tool

The instrument used was a system combining both field format and category systems developed *ad hoc*, based on previous studies on the analysis of the game of Handball (Prudente, 2006; Ribeiro, 2002; Silva 2008; Volossovitch, 2008), focusing, specifically, on the observation of the duels 2 vs 2. The system was expertly validated by consensus at construct-level and its reliability and generalizability tested in a previous study (Sousa, Prudente, Sequeira and Hernández-Mendo,

2014) presenting adequate reliability, validity and precision (Cohen's Kappa for intra and inter-reliability over .70, relative G Coefficient and absolute G Coefficient For the C / O model of .989, and .000 for the O / C model).

The instrument included, as main criteria, Organized Defense, Type of Defense, Playing Time, Score, Specific Positions, Tactical Means and Result of the Action, from which category systems were developed and each indicator defined, covering exhaustively, the actions and behaviors that could occur in these situations of the game (Table 1).

Table 1. Criteria, Category and Codes of Observation Instrument.

Criteria	Category	Codes
Organized Defense (OD)	6:0/	6_0
	5:1/	5_1
	4:2/	4_2
	3:2:1/	3_2_1
	3:3/	3_3
	1:5/	1_5
	5+1	5+1
	4+2/	4+2
	HxH/	HxH
	Open	Abert
Close	Nabrt	
Playing Time (TJ)	0'-10' mins of playing time	A1
	10'01'' - 20'	A2
	20'01'' - 30'	A3
	30'01'' - 40'	B1
	40'01'' - 50'	B2
	50'01' - 60'	B3
Score	E	E
	V1	V1
	V2	V2
	V3	V3
	V4	V4
	D1	D1
	D2	D2
	D3	D3
	D4	D4
Beginning of the action 2vs2	With the ball and Pivot on the left side	CBPvE
	With the ball and Pivot in the centre	CBPvC
	With the ball and Pivot on the right side	CBPvD
	Without the ball and Pivot on the left side	SBPvE
	Without the ball and Pivot in the centre	SBPvC
	Without the ball and Pivot on the right side	SBPvD
	With stop and Pivot on the left side	CSPvE
With stop and Pivot in the centre	CSPvC	
With stop and Pivot on the right side	CSPvD	
Specific Positions	Left Back/Pivot	LEPv
	Right Back/Pivot	LDPv
	Central/Pivot	CPv
	Central/Left Back	CLE
	Central/Right Back	CLD
Tactical Mean	Lock with Shot	Bl
	Lock with Continuity	BIC
	Cross with Shot	CruzF
	Cross with Continuity	CruzC
	Fix	Fix
	Fix/Uncheck	FixDs
	Inversion	Inv
Result of the	Goal	G

Criteria	Category	Codes
Action	7M Shot	7M
	Shot against Block	RBl
	Shot stopped by the Goalkeeper	RDGR
	Shot Out	RFr
	Shot against the Post	RPST
	Technical Fault	FT
	Offensive Fault	FA
	Continuity of Play	CJ

Recording

The games were recorded from television broadcast and stored in an external disk Toshiba STORE ALU 2S, to be later coded and observed.

Analysis instrument

Two versions of the Hoisan software program were used on two different occasions: on the first one, version v.1.6 (Hernández-Mendo, López-López, Castellano, Morales-Sánchez & Pastrana, 2012) to observe and register, using the instrument tool (Sousa, 2014), the data of the sequences and, on the second one, version v.1.6.3.3.2 to analyze the data of the sequence of events regarding the 2 vs 2 situations occurring during the match, using the analysis technique of polar coordinates.

The generalizability analysis was carried out using the SAGT v1.0 software program (Hernández-Mendo, Blanco-Villaseñor, Pastrana, Morales-Sánchez y Ramos-Pérez, 2016).

Procedure

The recorded games were transferred from the external disk to a MacBook Air computer. Afterwards, all of the matches of the sample were viewed (16), so as to select the offensive sequences carried out in numerical equality 6 vs 6 and in organized attack, excluding all the others. Then, a second viewing of all the match sequences previously selected took place, eliminating all the sequences that did not occur in game situations of 2 vs 2. We, therefore, obtained a total of 390 game sequences in numerical equality 6 vs 6, using the game method of organized attack, in which 2 vs 2 situations occurred.

Each 2 vs 2 sequence was observed once at normal speed and afterwards both in slow-motion and normal speeds as often as necessary to enable a correct register of all the actions and behaviors occurring during the offensive sequence.

The two observers, who registered the sequences, had previously done research in Handball and written a thesis on the sport using observational methodology, in addition to a long experience as coaches of this sport. In the initial phase, the observers held a meeting to view Handball matches, to discuss, to find consensus and train the observation, in order to register the different behaviors identified using the developed observation instrument.

Data Quality Control

The observational methodology demands data quality control, so as to detect and eliminate the source of errors or deviations in the quality of the data observed (Blanco y Anguera, 2003), so as to guarantee the reliability and not to undermine the research (Anguera, 2009; Anguera y Blanco, 2003; Anguera, Blanco, Losada y Hernández-Mendo, 2000; Blanco y Anguera, 2003).

To assess the reliability of the data collected using our observation instrument, we resorted to Kappa's statistics (Cohen, 1960) to assess the intra and inter-observer agreement. The instrument was developed *ad hoc* with the objective of observing and studying the duels 2 vs 2 in handball. The results had been analyzed in a previous study, (Sousa, Prudente, Sequeira y Hernández-Mendo, 2014) and considered excellent (range between .85 and 1).

In addition to Kappa, the generalizability theory (Blanco, Castellano, Hernández-Mendo, Sánchez-López y Usabiaga, 2014; Blanco, Castellano y Hernández-Mendo, 2000; Castellano, Hernández-Mendo, Gómez de Segura, Fontexta y Bueno, 2000; Salas y Hernández-Mendo, 2016), was used to exclude the sources of errors variation for the different observers, the observation instrument or the categories used. This analysis revealed and reinforced the excellent results, with 97.82% of variation associated to facet categories (C),

while the indexes G (relative and absolute) revealed a high level of reliability and precision (model C/O over .9) and a good level of adjustment to the categories in model O/C.

Results

Polar coordinates analysis

Using the technique of polar coordinates, in the search for patterns between tactical actions and the playing time, the results shows significant associations between the categories related to the playing time and the categories related to the tactical means in organized attack in the matches of the Men's European Cup 2012 (Table 2). As shown in Fig.1, considering the given behavior as the "first 10 minutes of playing time" (A1) and the different target behaviors, the categories related with the "tactical action" and "result of the action", we found that the given behavior activates and is activated by the tactical action "cross", both with continuity and with shot, and the result of the action "continuity of play". Similarly it inhibits and is inhibited by the tactical action "inversion" and the result "goal". This behavior inhibits the tactical action "lock with continuity" and the results "technical fault" and "shot against block", and is activated by them. The map of inter-relationships shows, in quadrant 4 that the given behavior activates and is inhibited by the tactical action "fix".

Table 2. Given Behavior: A1 and Target Behaviors: tactical action and result of the action.

Category	Quadrant	P.Prospective	P.Retrospective	Ratio	Radio	Angle
Tactical Mean_CruzF	I	2.97	.38	.13	3 (*)	7.2
Tactical Mean_CruzC	I	.16	3.29	1	3.29 (*)	87.26
Tactical Mean_Fixar	IV	.12	-3.53	-1	3.53 (*)	271.94
Tactical Mean_BloqC	II	-2.09	4.32	.9	4.79 (*)	115.8
Tactical Mean_Inv	III	-.86	-1.86	-.91	2.05 (*)	245.37
Result of the action_Golo	III	-.62	-3.64	-0.99	3.69 (*)	260.27
Result of the action_RBl	II	-.12	2.31	1	2.31 (*)	92.89
Result of the action_FT	II	-2.02	2.08	.72	2.89 (*)	134.17
Result of the action_CJ	I	1.99	3.47	.87	4 (*)	60.09

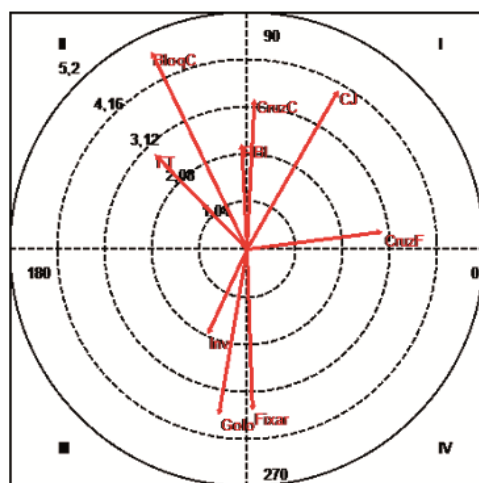


Figure 1. Given Behavior: A1; Target Behaviors: tactical action and result of the action.

Legend: BloqC - Lock with Continuity; CruzC - Cross with continuity; CruzF - Cross with shot; Fixar - Fix; Inv - Inversion; Bloq - Lock; FixDs - Fix/Uncheck; CJ - Continuity of Play; RBl - Shot against Block; Golo - Goal; FT - Technical Fault.

As can be seen in Table 3, significant associations were detected. Fig.2 shows a map of inter-relationships that occur between the given behavior "playing time" "A2" (between minutes 10'01" and 20") and the target behaviors referred to "tactical action" and "result of the action". From this map, we can see that the given behavior activates and is strongly activated by the tactical action "cross with continuity". It also activates and is activated, with lower intensity, by the results "shot stopped by the goalkeeper" and "continuity of play" and on the other hand, inhibits and is inhibited by "cross with continuity". We also detected that this behavior activates and is inhibited by the tactical actions "lock with continuity" and "inversion", the latter, with less intensity, al-

so activates the results “shot out”, “technical fault” and “offensive fault”, and is inhibited by them. Similarly, it is possible to observe in quadrant 2 that the given behavior “A2”

inhibits the result of the action “goal”, and is inhibited by it.

Table 3. Given Behavior: A2 and Target Behaviors: tactical action and result of the action.

Category	Quadrant	P.Prospective	P.Retrospective	Ratio	Radio	Angle
Tactical Mean_CruzF	I	2.48	6.19	.93	6.67 (*)	68.16
Tactical Mean_CruzC	III	-3.22	-.28	-.09	3.23 (*)	185.03
Tactical Mean_BloqC	IV	4.16	-3.44	-.64	5.4 (*)	320.41
Tactical Mean_Inv	IV	1.73	-1.86	-.73	2.54 (*)	312.92
Result of the action_Golo	II	-4.27	.28	.06	4.28 (*)	176.31
Result of the action_RDGR	I	2.87	2.6	.67	3.88 (*)	42.17
Result of the action_RFr	IV	2.42	-1.19	-.44	2.69 (*)	333.76
Result of the action_FT	IV	.19	-2.91	-1	2.92 (*)	273.71
Result of the action_FA	IV	1.33	-2.77	-.9	3.08 (*)	295.65
Result of the action_CJ	I	2	.83	.38	2.16 (*)	22.62

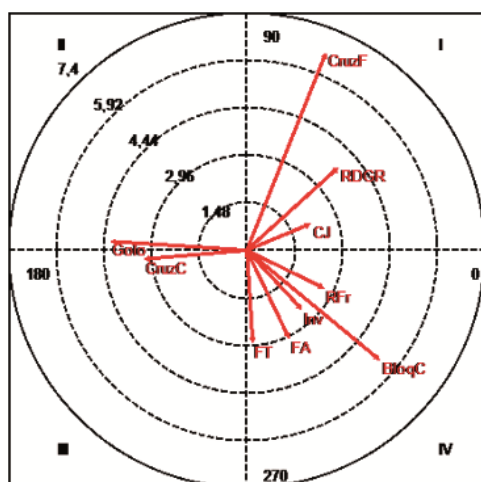


Figure 2. Given Behavior: A2; Target Behaviors: tactical action and result of the action.

Legend: BloqC - Lock with Continuity; CruzC - Cross with Continuity; CruzF - Cross with shot; CJ - Continuity of Play; FA - Offensive Fault; FT - Technical Fault; Golo - Goal; Inv - Inversion; RDGR - Shot stopped by the goalkeeper; RFr - Shot out.

When we considered the given behavior “A3” (between minutes 20’01” and 30’), we identified some significant associations (table 4), such as the one between this behavior and the tactical actions “lock” and “inversion”. These actions were activated, and activated the given behavior, in the case of “inversion” with higher intensity, as well as results of the action “technical fault” and “offensive fault”, which were equally activated and activated the given behavior. In quadrant 3, we can see that the given behavior inhibits and is inhibited by the target behavior “cross with shot” and by the result “shot against block”. Quadrant 4 shows that the given behavior activates the result “goal” and is inhibited by that result. It also shows that it inhibits the result “shot stopped by goalkeeper”, by being activated by it, as shown in quadrant 2 (Fig 3).

Table 4. Given Behavior: A3 and Target Behaviors: tactical action and result of the action.

Category	Quadrant	P.Prospective	P.Retrospective	Ratio	Radio	Angle
Tactical Mean_Bloq	I	1.52	2.04	.8	2.54 (*)	53.38
Tactical Mean_CruzF	III	-1.3	-2.57	-.89	2.88 (*)	243.21
Tactical Mean_Inv	I	.37	3.16	.99	3.18 (*)	83.25
Result of the action_Golo	IV	3.62	-4.16	-.75	5.51 (*)	311.05
Result of the action_RDGR	II	-2.75	3.68	.8	4.59 (*)	126.75
Result of the action_RBl	III	-2.39	-1.99	-.64	3.11 (*)	219.84
Result of the action_FT	I	2.71	1.76	.54	3.23 (*)	32.99
Result of the action_FA	I	.26	3.57	1	3.58 (*)	85.79

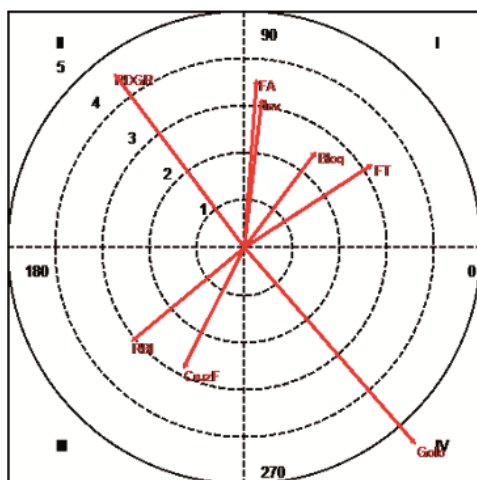


Figure 3. Given Behavior: A3; Target Behaviors: tactical action and result of the action.

Legend: Bloq - Lock; CruzF - Cross with shot; FA - offensive Fault; FT - Technical Fault; Golo - Goal; Inv - Inversion; RB1 - Shot against block; RDGR - Shot stopped by the Goalkeeper.

Considering the given behavior as the period of game between minutes 30'01" and 40' (B1) we can infer from table 5 and from the map (Fig 4) that there is a significant probability that the given behavior may activate and be activated by the tactical action "fix/uncheck", "shot against the post" and "goal", while it inhibits and is inhibited by "cross with shot" and by "shot stopped by the goalkeeper". Moreover, this map of behaviors shows that the given behavior activates "cross with continuity" with strong intensity, as well as the result of the action "shot against block".

Table 5. Given Behavior: B1 and Target Behaviors: tactical action and result of the action.

Category	Quadrant	P.Prospective	P.Retrospective	Ratio	Radio	Angle
Tactical Mean_CruzF	III	-2.53	-1.09	-.39	2.76 (*)	203.22
Tactical Mean_CruzC	IV	3.76	-1.36	-.34	4 (*)	340.06
Tactical Mean_FixDs	I	.17	2.14	1	2.15 (*)	85.56
Result of the action_Golo	I	.06	2.62	1	2.62 (*)	88.6
Result of the action_RDGR	III	-.73	-2.34	-.95	2.45 (*)	252.68
Result of the action_RPst	I	1.82	1.76	.7	2.53 (*)	44.06
Result of the action_RB1	IV	2.06	-1.33	-.54	2.45 (*)	327.26

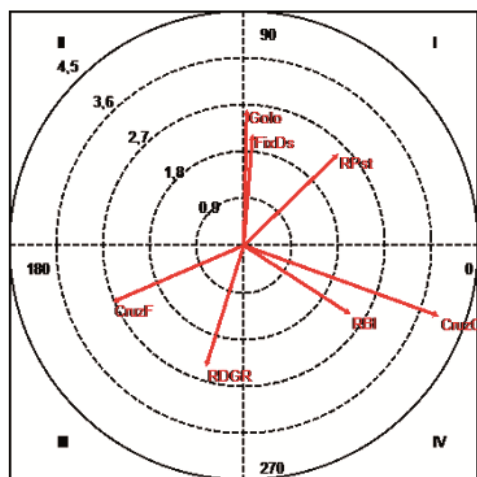


Figure 4. Given Behavior: B1; Target Behaviors: tactical action and result of the action.

Legend: CruzC - Cross with Continuity; CruzF - Cross with shot; FixDs - Fix/Uncheck; Golo - Goal; RB1 - Shot against Block; RPst - Shot against the post; RDGR - Shot stopped by the Goalkeeper.

The results show (table 6) a significant association confirmed in Fig 5 where we observe a significant probability that the given behavior "B2" (in the period of time between minutes 40'01" and 50") may activate and be activated, with high level of intensity, by the tactical action "fix" and the action result "goal", as well as inhibit and be inhibited by the target behaviors "cross with shot" and "lock with continuity", and the action results "continuity of play" and "shot stopped by goalkeeper". This map of behaviors also shows the presence of a significant inter-relationship in which the tactical action "inversion" is inhibited and activates the result of the action "7 meters" and "shot against block".

Table 6. Given Behavior: B2 and Target Behaviors: tactical action and result of the action.

Category	Quadrant	P.Prospective	P.Retrospective	Ratio	Radio	Angle
Tactical Mean_CruzF	III	-2.17	-2.57	-.76	3.36 (*)	229.82
Tactical Mean_Fixar	I	2.81	3.46	.78	4.46 (*)	50.9
Tactical Mean_BloqC	III	-1.96	-1.33	-.56	2.37 (*)	214.2
Tactical Mean_Inv	II	-2.62	2.52	.69	3.64 (*)	136.06
Result of the action_Golo	I	1.83	3.24	.87	3.72 (*)	60.54
Result of the action_7M	IV	1.91	-1.24	-.54	2.28 (*)	327.16
Result of the action_RDGR	III	-1.24	-1.54	-.78	1.98 (*)	231.04
Result of the action_RPst	II	-2.22	.45	.2	2.27 (*)	168.56
Result of the action_RBl	IV	2.27	-.64	-.27	2.36 (*)	344.35
Result of the action_FT	II	-.25	1.96	.99	1.97 (*)	97.14
Result of the action_FA	III	-1.55	-1.57	-.71	2.21 (*)	225.24
Result of the action_CJ	III	-1.63	-2.64	-.85	3.11 (*)	238.36

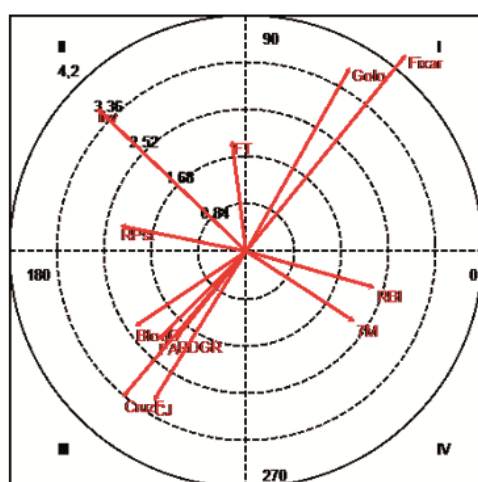


Figure 5. Given Behavior: B2; Target Behaviors: tactical action and result of the action.

Legend: Bloq - Lock; BloqC - Lock with continuity; CruzC - Cross with continuity; CruzF - Cross with shot; CJ - Continuity of play; Fixar - Fix; FA - offensive fault; FT - Technical fault; Golo - Goal; Inv - Inversion; RBl - Shot against block; RPst - Shot against the post; RDGR - Shot stopped by the Goalkeeper Defense ; RFr - Shot out.

Considering the partial score as the given behavior and the tactical actions and their results (table 7), we found that the given behavior “score” “D1” (the team is losing by one at the moment of the tactical action) significantly activated and was activated by the tactical actions “cross with continuity” and “inversion”. It also activated the “continuity of play” by inhibiting the action “lock” and the result “goal” (Fig 6).

Table 7. Given Behavior: D1 and Target Behaviors: tactical action and result of the action.

Category	Quadrant	P.Prospective	P.Retrospective	Ratio	Radio	Angle
Tactical Mean_Bloq	III	-1.24	-1.87	-.83	2.24 (*)	236.39
Tactical Mean_CruzC	I	2.29	.37	.16	2.32 (*)	9.14
Tactical Mean_Fixar	II	-1.29	1.82	.81	2.23 (*)	125.46
Tactical Mean_BloqC	II	-.98	2	.9	2.23 (*)	116.18
Tactical Mean_Inv	I	3.62	.18	.05	3.62 (*)	2.88
Result of the action_Golo	III	-2.71	-1.28	-.43	3 (*)	205.27
Result of the action_7M	IV	2.41	-.02	-.01	2.41 (*)	359.54
Result of the action_CJ	I	2.02	.21	.1	2.03 (*)	5.84

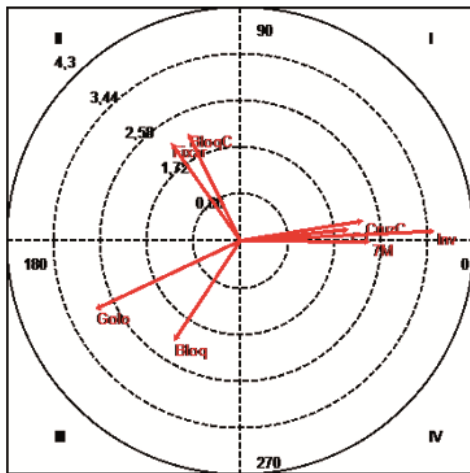


Figure 6. Given Behavior: Score D1; Target Behaviors: tactical action and result of the action.

Legend: Bloq - Lock; BloqC - Lock with continuity; CruzC - Cross with continuity; CJ - Continuity of Play; Fixar - Fix; Golo - Goal; Inv - Inversion; 7M - 7 meters.

Table 8 shows a significant probability that the given behavior “D2” (the team is losing by two at the moment of action) may inhibit the target behaviors “cross with continuity” and “fix/uncheck”, activating the tactical actions “fix” and “lock” and also the result of the action “shot stopped by the goalkeeper”, as we can see in Fig 7

Table 8. Given Behavior: D2 and Target Behaviors: tactical action and result of the action.

Category	Quadrant	P.Prospective	P.Retrospective	Ratio	Radio	Angle
Tactical Mean_Bloq	IV	1.97	-.26	-.13	1.98 (*)	352.33
Tactical Mean_CruzC	III	-2.15	-1.46	-.56	2.6 (*)	214.15
Tactical Mean_Fixar	I	1.13	1.92	.86	2.23 (*)	59.46
Tactical Mean_FixDs	III	-.71	-2.52	-.96	2.62 (*)	254.29
Result of the action_RDGR	I	2.93	1.12	.36	3.14 (*)	20.84
Result of the action_RFr	II	-2.6	.01	0	2.6 (*)	179.71

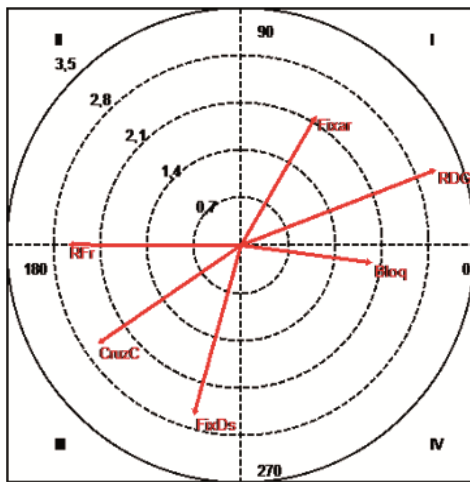


Figure 7. Given Behavior: Score D2; Target Behaviors: tactical action and result of the action.

Legend: Bloq - Lock; CruzC - Cross with continuity; Fixar - Fix; FixDs - FixUncheck; RDGR - Shot stopped by the Goalkeeper; RFr - Shot out.

In Table 9 the results show significant associations and in Fig. 8 we can observe how the given behavior “D3” interrelates (the team is losing by three at moment of action) with the tactical actions and respective result. We found that “D3” activated the tactical action “cross with shot” and the result of the action “offensive fault”, and inhibited “fix/uncheck” and “technical fault”.

Table 9. Given Behavior: D3 and Target Behaviors: tactical action and result of the action.

Category	Quadrant	P.Prospective	P.Retrospective	Ratio	Radio	Angle
Tactical Mean_CruzF	I	3.43	.99	.28	3.57 (*)	16.19
Tactical Mean_FixDs	II	-2.17	.42	.19	2.21 (*)	169.15
Result of the action_FT	III	-1.42	-1.69	-.77	2.21 (*)	230.05
Result of the action_FA	IV	3.19	-.13	-.04	3.19 (*)	357.61

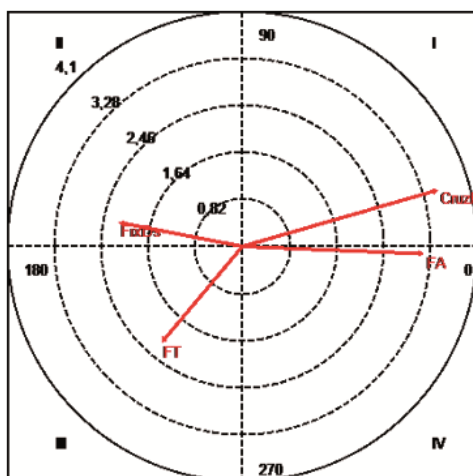


Figure 8. Given Behavior: Score D3; Target Behaviors tactical action and result of the action.

Legend: CruzF - Cross with shot; FixDs - Fix/Uncheck; FA - Offensive fault; FT - Technical fault.

As can be inferred from Fig.9 a vectorial map that results from table 10, the given behavior “D4” (the team is losing by four goals at moment of action) activates “goal” and “cross with continuity”, inhibiting the tactical actions “inversion”, “fix” and “fix/uncheck”, as well as the results “shot stopped by the goalkeeper” and “shot against block”

Table 10. Given Behavior: D4 and Target Behaviors: tactical action and result of the action.

Category	Quadrant	P.Prospective	P.Retrospective	Ratio	Radio	Angle
Tactical Mean_CruzC	IV	2.49	- .78	- .3	2.61 (*)	342.64
Tactical Mean_Fixar	III	- .46	-2.33	- .98	2.38 (*)	258.95
Tactical Mean_FixDs	II	- .46	2.68	.99	2.71 (*)	99.67
Tactical Mean_Inv	III	-2.61	-1.37	- .46	2.95 (*)	207.7
Result of the action_Golo	I	3.81	1.02	.26	3.95 (*)	14.91
Result of the action_RDGR	III	-2.52	-1.21	- .43	2.8 (*)	205.6
Result of the action_RBI	III	-2.01	-1.7	- .65	2.63 (*)	220.24

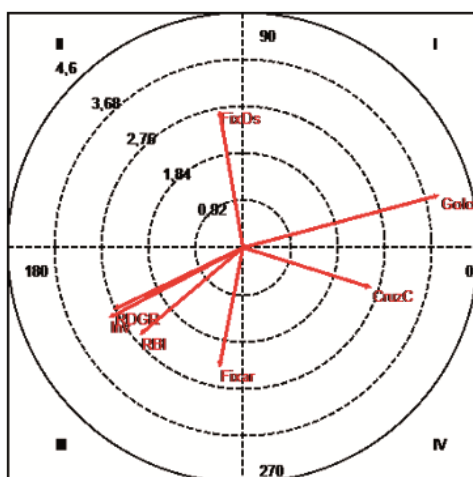


Figure 9. Given Behavior: Score D4; Target Behaviors: tactical action and result of the action.

Legend: CruzC - Cross with continuity; Fixar - Fix; FixDs - Fix/Uncheck; Golo - Goal; Inv - Inversion; RBI - Shot against block; RDGR - Shot stopped by the Goalkeeper.

When there was a draw in the score of the game (score “E”) the results show a significant association (table 11), and we found that the given behavior activated the tactical action “cross with continuity” and that same behavior inhibited the action “fix” and the result “offensive fault”, as can be seen in the figure (Fig.10).

Table 11. Given Behavior: E and Target Behaviors: tactical action and result of the action.

Category	Quadrant	P.Prospective	P.Retrospective	Ratio	Radio	Angle
Tactical Mean_CruzC	I	1.29	1.96	.84	2.34 (*)	56.73
Tactical Mean_Fixar	III	- .28	-2.75	-1	2.76 (*)	264.28
Result of the action_FA	III	- .07	-2.18	-1	2.19 (*)	268.29

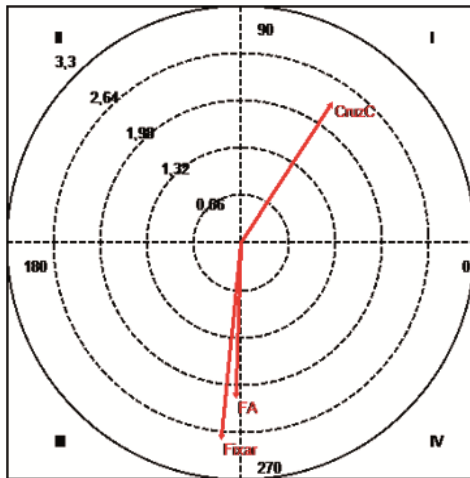


Figure 10. Given Behavior: Score E; Target Behaviors: tactical action and result of the action.

Legend: CruzC - Cross with continuity; Fixar - Fix; FA - Offensive fault.

Fig. 11 shows a map of inter-relationships, that result from table 12, where the given behavior “score” “V1” (the team is winning by one at moment of action) activates the target behavior tactical action “fix” and “fix/uncheck”, inhibiting the action “cross with shot”, the score “V1” activates the result “7 meters” and inhibits the results “offensive fault” and “shot stopped by the goalkeeper”.

Table 12. Given Behavior: V1 and Target Behaviors: tactical action and result of the action.

Category	Quadrant	P.Prospective	P.Retrospective	Ratio	Radio	Angle
Tactical Mean_CruzF	III	-1.21	-2.19	-.87	2.5 (*)	241.01
Tactical Mean_Fixar	I	.97	1.91	.89	2.15 (*)	63.03
Tactical Mean_FixDs	IV	3.18	-.72	-.22	3.26 (*)	347.31
Result of the action_7M	IV	.03	-3.05	-1	3.05 (*)	270.58
Result of the action_RDGR	II	-1.34	1.61	.77	2.09 (*)	129.91
Result of the action_RPst	I	2.2	.85	.36	2.36 (*)	21.22
Result of the action_FA	II	-1.8	1.16	.54	2.14 (*)	147.23

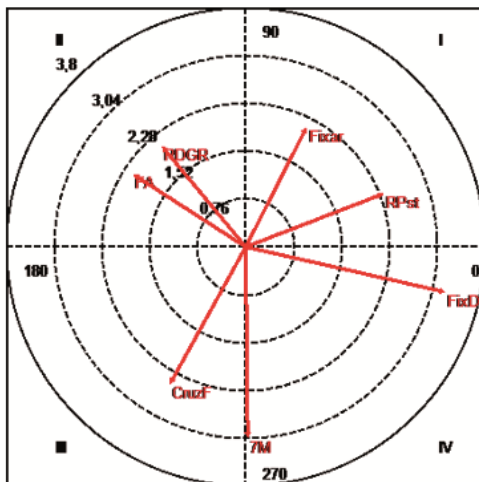


Figure 11. Given Behavior: Score V1; Target Behaviors: tactical action and result of the action.

Legend: CruzF - Cross with shot; Fixar - Fix; FixDs - Fix/Uncheck; FA - Offensive fault; RPst - Shot against the Post; RDGR - Shot stopped by the Goalkeeper; 7M - 7 meters.

Considering the given behavior “V2” and the target behaviors, only one association (table 13) of inhibition was detected, when the result “goal” occurred (Fig 12).

Table 13. Given Behavior: V2 and Target Behaviors: tactical action and result of the action.

Category	Quadrant	P.Prospective	P.Retrospective	Ratio	Radio	Angle
Result of the action_Golo	II	-2.2	.95	.4	2.4 (*)	156.67

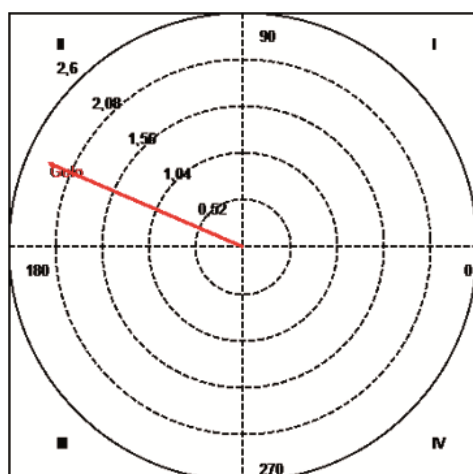


Figure 12. Given Behavior: Score V2; Target Behaviors: tactical action and result of the action.
Legend: Golo - Goal.

We can observe from Fig. 13, built with results from table 14, that the given behavior “V3” shows a high intensity relationship with the tactical action “inversion”, activating it, as well as the results “goal” and “shot out”. It is also possible to observe that the given behavior inhibits the tactical action “lock” and the result of the action “7 meters”.

Table 14. Given Behavior: V3 and Target Behaviors: tactical action and result of the action.

Category	Quadrant	P.Prospective	P.Retrospective	Ratio	Radio	Angle
Tactical Mean_Bloq	II	-1.96	.14	.07	1.97 (*)	175.81
Tactical Mean_Inv	I	3.99	1.33	.32	4.2 (*)	18.46
Result of the action_Golo	IV	1.83	-.98	-.47	2.08 (*)	331.94
Result of the action_7M	II	-2.44	1.57	.54	2.9 (*)	147.3
Result of the action_RF	I	2.03	1.07	.47	2.29 (*)	27.78

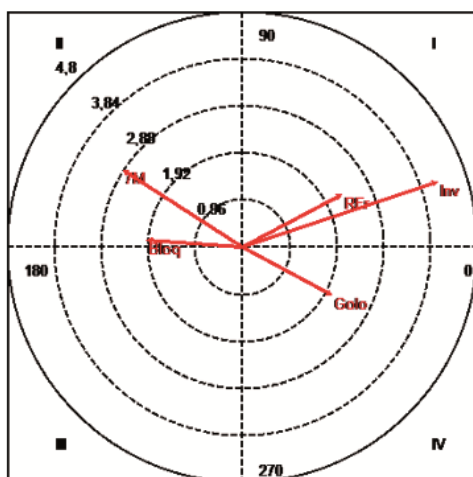


Figure 13. Given Behavior: Score V3; Target Behaviors: tactical action and result of the action.
Legend: Bloq - Lock; Golo - Goal; Inv - Inversion; RF - Shot out; 7M - 7 meters.

After the analysis of the polar coordinates, the results (table 15) show significant associations. We can see that the given behavior “V4” activates the tactical action “lock”, as well as the result of the actions “goal” and “shot out”, inhibiting “cross with shot” and “shot stopped by the goalkeeper” (Fig 14).

Table 15. Given Behavior: V4 and Target Behaviors: tactical action and result of the action.

Category	Quadrant	P.Prospective	P.Retrospective	Ratio	Radio	Angle
Tactical Mean_Bloq	I	1.83	1.7	.68	2.5 (*)	42.93
Tactical Mean_CruzF	III	-1.87	-1.27	-.56	2.26 (*)	214.25
Result of the action_Golo	I	2.6	1	.36	2.78 (*)	21.05
Result of the action_RDGR	III	-1.7	-1.15	-.56	2.05 (*)	214.19
Result of the action_RF	IV	.36	-2.12	-.99	2.15 (*)	279.62

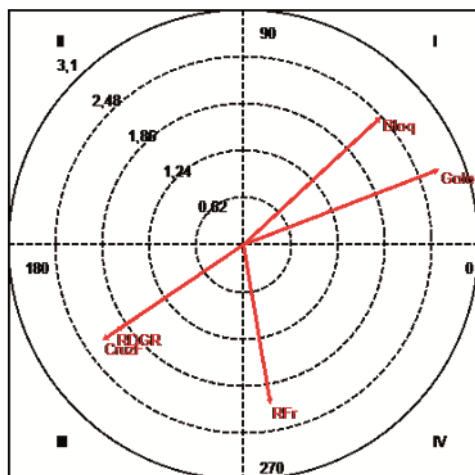


Figure 14. Given Behavior: Score V4; Target Behaviors: tactical action and result of the action.

Legend: Bloq - Lock; CruzF - Cross with shot; Golo - Goal; RDGR - Shot stopped by the Goalkeeper; RFr - Shot out.

Discussion and Conclusions

According to Sequeira (2012) it is important to get deeper knowledge of the tactical aspects and a more conscious and guided use of the tactical actions so as to increment its level of efficiency.

The organized attack is still considered the most important phase of the game in the finalization of the offensive process (Prudente, 2006; Sousa, 2014; Sequeira, 2012). However, the finalization attempts during this phase of the game have been decreasing as a consequence of a higher rhythm in the matches and shorter time of attack, as well as a better opposition in the organized defense (Sequeira, 2012). This author also registered that nevertheless, the finalization attempts occur mostly in a context of numerical equality and result balance.

The aim of this study was to analyze, characterize and detect patterns of offensive behavior in situations 2 vs 2 occurring during the organized attack and in numerical equality 6 vs 6, relating the tactical actions with the playing time and the partial score.

The study used the procedure of polar coordinates, resorting to the observation software Hoisan, version 1.6.3.3.2 (Hernández-Mendo, López-López, Castellano, Morales-Sánchez, y Pastrana, 2012) which enabled the vectorial representation and maps of behavior.

The study of the game of handball, using the technique of polar coordinates has been previously carried out by several authors (González, Botejara, Puñales, Trejo y Ruy, 2013; Ramirez, Lemos, Bonilla, Silva y López, 2013; Prudente, Garganta & Anguera, 2010), which enabled a deeper understanding of this sport.

According to the results obtained, we could verify that in the duration of the match, the tactical actions used and its efficiency changed, which confirms what was stated by Teles e Volossovitch (2015). The first ten minutes of the match

(A1) are associated with relations of tactical activation “cross with continuity”, “cross with shot” and “fix”, as well as activating the result of the action “continuity of play”. On the other hand, the playing time “A1” inhibits “the goal” as a result of the tactical action used. The playing time “A2”, consequently, activates the actions “cross with shot”, “lock with continuity” and “inversion”, also activating the results of the action “shot stopped by the goalkeeper”, “continuity of the play”, “shot out”, “technical fault” and “offensive fault”, and inhibits the action “cross with continuity” and the result “goal”. From “A1” to “A2”, an increase in the result of actions associated with the playing time is noticed, and is, therefore, in line with the tactical actions activated. A similar number (8 and 9) of association relationships between the variables of the system related to “tactical actions” and “result of actions” were detected in both “A1” and “A2”, as shown in the behavior maps drawn. However, in “A2” the number of associated tactical actions is lower than in “A1” and the number of “result of actions” associated with “A2” and the “tactical actions” is higher. Continuing the analysis of the evolution of identified associations between the variables in question and its relationships, during the periods of playing time, one can observe that in “A3” the number of “tactical actions” that seem to be associated decrease (3), and the number of “result of actions” that seem associated increases (5). Curiously, it is at this moment of the match, the last 10 minutes of the first half, that the tactical means “inversion” and “lock”, and the results “goal”, “offensive fault” and “technical fault” occur associated as if being activated, while “cross with shot” and the results of action “shot stopped by the goalkeeper” and “shot against block” are inhibited. Given this evolution during the playing time, we can conclude that both in “A1” and in “A2”, the teams try to engage in an organized game using tactical actions, planned according to the studied opponent. Then the reality of the game sets in and consequently the interactive dynamics of that particular match are imposed, leading to better choices, adapted to a higher associated efficiency, as a result of the tactical means adopted, occurring both as activated and activating (“inversion” and “lock”) and thus enabling situations of shot without opposition but which can also develop into actions of greater risk of loss of ball without finalizing with shot, as can be shown by the activation of “offensive fault” and “technical fault”.

In the second half of the match, both in “B1” and in “B2”, the number of associated “tactical actions” related with the “playing time” and with the “result of the actions” observed, is lower than in “A1” and “A2”, and similar to “A3”, occurring also associated as if activating the result “goal” together with the tactical actions “fix” and “fix/unchecked”, although “fix”, in “B2” appears as associated to the activation of “shot against block” and “7 meters”. These results are expected because in the case of the action “fix/unchecked”, it maximizes the 6 meter shot resulting in a possible goal, while “fix” maximizes a shot from back, with a possible attempt of a pass to 6 meters and consequently, a

fault committed on the receiver of the pass which is sanctioned with a 7 meter free shot.

Curiously, no significant results were found in "B3" (value of vectors > 1.96). Coaches often refer to the fact that balanced matches are resolved in the last 10 minutes of the match (i.e. "B3") a fact already proven by Teles e Volossovitch (2015). The absence of associations between the noted system variables, may mean that, at this moment of the match, even in situations of organized attack and in numerical equality, the teams play a more "spontaneous" game and also more interconnected with the opponent's game, seeking above all, the advantage of the mistakes made by the opponent, taking more individual actions and opting for fewer 2 vs 2 tactical actions.

According to the results obtained, we can conclude that there is a relationship between the use of tactical actions and its efficiency and the evolution of the score, in all the partial scores studied, and a map of the inter-relationships between the system behaviors can be drawn.

One aspect worth nothing is that, having the score as given behavior, the unfavorable result (D1, D2, D3 and D4) is associated with a larger number of relationships, in terms of use of tactical actions (13 relationships of association), than when the result is favorable (V1, V2, V3 and V4), in which there is a lower number of relationships of association between the evolution of the score with the use of tactical actions (7 relationships of association).

However, these results change when we have the result of the tactical actions as target behaviors, given that when the score is unfavorable, we detected 9 relationships of association, while in situations where the score is favorable to the team that uses them, we identified 11 relationships of association.

Score "D1" is associated with the relationships that activate the tactical means "cross with continuity" and "inversion" as well as the activation of the result of the action "7 meters". On the other hand, this partial score "D1" inhibits the actions "lock", "lock with continuity" and "fix", also inhibiting the "goal" as a result of the adopted tactical action.

Score "D2", in turn, activates the actions "cross with shot" and the result of the action "offensive fault" and inhibits "fix/uncheck" and the "technical fault". Thus, and according to the results obtained, we could observe that the score "D1", "D2" and "D3" were associated with situations of inefficiency, either due to the activation of "shot stopped by the goalkeeper", of "offensive fault" or due to the fact that there was an association of inhibition of "goal". However, the results obtained from the given behavior "D4", show a reverse trend, as this behavior is associated with situations of efficiency, such as the activation of the result of the action "goal" and inhibition of the "technical fault".

When the given behavior was "E" – a draw – the map of inter-relationships showed that this behavior was associated with the activation of the conditioned behavior "cross with continuity" and the inhibition of the result of the action "of-

fensive fault". These situations may be associated to the fact that in situations of a balanced score, the teams resort to less risky situations, opting for safer situations so as to decrease the risk of losing the ball due to technical faults or shots that are not so favorable.

The maps of inter-relationships of behaviors, having as given behaviors the favorable score ("V1", "V2", "V3" e "V4"), are mostly associated with situations of efficiency, such as the activation of "goal" and "7 meters", and with the inhibition of situations considered as inefficiency "shot stopped by the goalkeeper". These results confirm previous studies (Prudente, 2006; Silva et al, 2008, Santos, 2012, Sequeira, 2012) that have identified the 2 vs 2 situations as favorable for the attack.

The score "V1" is associated with relationships of activation of the tactical actions "fix" and "fix/uncheck" as well as the activation of the result of the action "7 meters" and "shot against the post". However, this score inhibits the action "cross with shot", also inhibiting the "offensive fault" and "shot stopped by the goalkeeper", as a result of the tactical action used. These results are consistent since "fix/uncheck" promotes a relationship between the 1st-line of attack (back, central back) and the pivot, which leads to a finalization situation by the latter, often causing opportunities for illegal defense and promoting situations of 7 meters or, in the case of finalization, situations of favorable shot and of difficult resolution for the goalkeeper. This situation is defended by some authors (Ehret, Johansson, Zovko e Constantini, 1995), who have identified the inclusion of situations that resort to backs and the pivot, as the most used strategy that teams adopt to take advantage of the quality of this situation, indicating these relationships as situations of valuable tactical nature to overcome defense in Handball and also for a relationship between the use of the pivot with the winning teams (Montoya, Moras & Anguera, 2013 e Silva et al, 2008).

Given behavior "V2" was the behavior revealing the fewest vectors in the map of inter-relationships, i.e. fewer situations of association between behaviors. In this case, this behavior is only associated with the inhibition of the result of the action "goal", a situation which is the opposite of the remaining favorable given behaviors.

Given behaviors "V3" and "V4" reveal similar maps of inter-relationships. In this case, with the activation of the result of the action "goal" and "shot out", as well as the activation of the action "lock", to which behavior "V3" also includes the activation of the action "inversion". These behaviors inhibit the "shot stopped by the goalkeeper" and "cross with shot", in the case of "V4", and inhibition of "7 meters", in the case of the given behavior "V3". In the case of these two given behaviors, there is a similarity which points towards the result of the action with shot ("shot out" and "goal").

When the largest score difference was registered (D4 and V4), a relationship of mutual activation between the "score" and "goal" occurred. With a difference, however: when the

team was winning (V4) there was a relationship of mutual activation between the score and the variables “lock” and “goal” whereas when the team was losing (D4) there was no relationship of mutual activation with the tactical means but only with “goal”. These results may correspond, on the one hand, to a less attentive defensive attitude towards the opponent who is winning (V4), which facilitates the finalization of whoever is losing (D4), and on the other hand, to the incapacity of the team, who is at a disadvantage on the scoreboard, to engage in group tactical actions (2 vs 2) or opt for a more individualized game.

These results may encourage a reflection in terms of planning for the coaches. It helps them to better understand how the score and playing time influences the use of tactical means and the efficiency of the actions, taking into account the tendencies in the evolution of the match. Consequently, it enables them to choose the actions that better adapt to the

situations of today’s Handball, closely directed towards group tasks, such as situations of 2 vs 2.

This study was carried out prior to the last change in the rules of the game, which allowed teams to play without a goalkeeper, thus influencing the number of attacks played in numerical equality 6 vs 6.

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