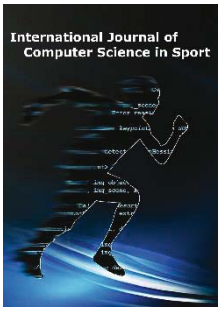
International Journal of Computer Science in Sport

Volume 19, Issue 2, 2020

Journal homepage: http://iacss.org/index.php?id=30

sciendo

DOI: 10.2478/ijcss-2020-0011



Diachronic analysis application for the detection of soccer performance standards: a case study

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Abstract

The purpose of this study is to analyse the interactions established by Gerard Piqué, one of the world's top defenders, within the general context of the team. The type of interactions (prospective and retrospective) that the player establishes with his team mates and opponents; the parts of the pitch where his actions are set in motion and later finished; his preferred skill or technical moves and finally his influence on set pieces are taken into account. His output throughout the 2012 UEFA Euro, where he played 100% of the game. The instrument of observation proposed by Maneiro & Amatria (2018) has been used. Polar coordinate analysis, a powerful tecnique capable of reducing the amount of data without compromising its analytical capacity, was used. The results showed significant interactions with players from the same and different lines thanks to technical actions of control, pass and carrying of ball. The analysis of the player's interactions within the general context of the team will provide other teams with tactical alternatives and allow themto organise special training programmes.

KEYWORDS: SOCCER; PERFORMANCE ANALYSIS; POLAR COORDINATE; OBSERVATIONAL METHODOLOGY; DEFENDER

Introduction

Research in football has traditionally focused on the subcategories that form the game limiting the sport to a series of simple photos with very little connection between them. The analysis of the interaction between the interpreting artists is highly demanded by scientists (Duarte, Araújo, Correia and Davids, 2012). It should be noted that it is not only about the superposition of elements interacting between one another, but the fact that a new object with different characteristics is born form that ineteraction (Nowak, 2006).

There are four main types of players or positions in football: goalkeepers, defenders, midfielders and strikers. Each position has different needs and paticularities. The characteristics, needs and movements of a striker (Castañer, Barreira, Camerino, Anguera, Canton, Hileno, 2016; Castañer, Barreira, Camerino, Anguera, Fernandes, & Hileno, 2017), differ from those related to a miedfielder (Duch, Waitzman y Amaral, 2010; Maneiro, Amatria & Anguera, 2019) as well as a defender (Wiemeyer, 2003). Every player must fulfil their function on the pitch so as to reinforce the team's structural heterogeneity (Balague, Torrents, Hristovski, Davids & Araújo, 2013).

An exhaustive analysis of defenders' attributes during a game was conducted by scientists. Bloomfield, Polman & O'Donoghue (2007), found that defenders typically make less physically intense efforts than miedfielders; Wiemeyer (2003) reveals that long-ball game, one-against-one struggles and speed are aspects of the game that professional defenders must dominate; according to Lucey, Bialkowski, Monfort, Carr & Matthews (2014), the reduction of an attacker's space is a good way to achieve greater success in defence, which is further claimed by Headrick, Davids, Renshaw, Araújo, Passos & Fernandes (2012).

Scientists have also introduced a series of tactical concepts that defenders must learn and put into practice in professional football. In line with that idea, Gréhaigne, Marchal & Duprat (2013) claim that the level and organisation of defenders is more important than the number of them on the pitch. On the other hand, Davids, Araújo & Shuttleworth (2005) sustain that a defender's level is determined by their ability to readjust their position according to the attacker's skill moves. Finally, Kannekens, Elferink-Gemser & Visscher (2010) assure that the performance and abilities of a defender vary depending on the formation and style adopted by the team. Therefore, decision-making is a vital element that should be introduced in the weekly training sessions.

All these studies provide valuable information which assist and guide coaches during their decision-making process. However, Gréhaigne, Bouthier & David (1997), Casal, Maneiro, Ardá, Marí & Losada (2017), and Duarte et al., (2012), insist that the biggest challenge in football is to analyse and understand how players coordinate their actions to achieve teamwork. The measurement and evaluation of how interactions between players are organised will add meaning to the quantitative data, which is generally presented in separation from the intervention on the ball (Svenson & Drust, 2005; Wallace & Norton, 2014; Di Salvo, Baron, Tschan, Montero, Bachl, & Pigozzi, 2007; Maneiro, Losada, casal & Ardá, 2017). A greater systematic understanding of defenders through an empirical analysis of the interactions they establish with their teammates as well as opponents, the strategic spaces of the pitch they prefer to use, their favourite skill moves and the way they take set pieces will provide football coaches and instructors with a larger amount of qualitative information. Consequently, this study will analyse the different interactions that Gerard Piqué, the highly successful Barcelona and Spain's defender, establishes with his teammates within the general context of the team especially his spatial, technical and tactical performance during his participation in the gameplay.

Method

Design

The observational method (Anguera, 1979; Portell, Anguera, Chacón-Moscoso, & Sanduvete-Chaves, 2015) is used to carry out this research project since considered one of the most appropriate for the analysis of spontaneous interactive behaviour between athletes.

The observational design (Blanco-Villaseñor, Losada, & Anguera, 2003; Sánchez-Algarra & Anguera, 2013) defined for this study is characterised by three features: a) it is punctual with intra-sessional monitoring; b) it is multidimensional in line with the observational instrument, and c) it is idiographic as it focuses on one player. Therefore, the observation complies with scientific criteria, from a global and non-participative observer perspective.

Participants

Gerard Piqué was analysed during his participation as a player of Spain's national football team in the 2012 UEFA Euro Cup resorting to observational sampling that was intentional.

Observational instrument

The observation instrument proposed by Maneiro and Amatria (2018) has been used (figure 1 & figure 2), proposing behavior J3 (Gerard Piqué) as focal behavior. The instrument is a combination of field format and category systems (Anguera, Magnusson & Jonsson, 2007).

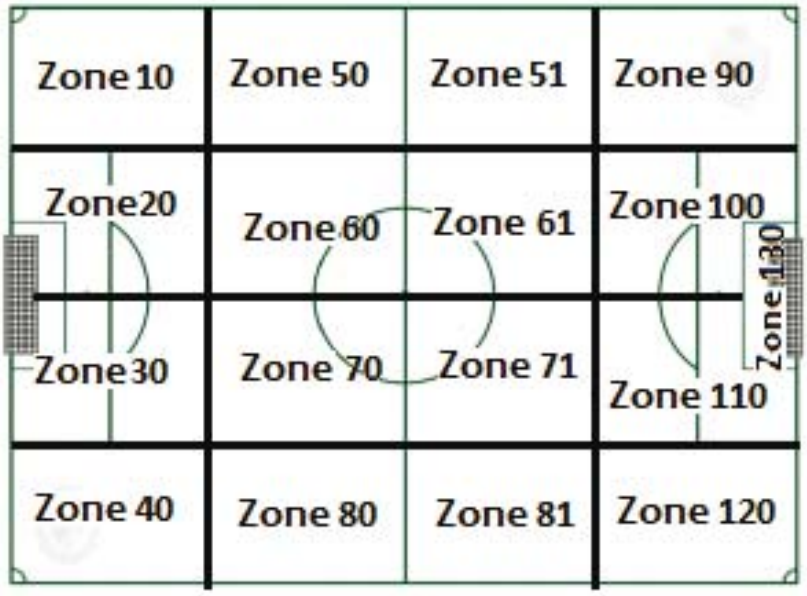

Figure 1. Spatial distribution of the field of play (Source: Maneiro and Amatria, 2018, p. 3)

No.	Dimension	Categories: codes and brief description
1	Ball possession	PO) possession of ball by team being observed; PC) possession of ball by rival team; Inob) unobservable
2	Player	J0) unidentified player; J1) player 1; J2) player 2; J3) player 3; J4) player 4; J5) player 5; J6) player 6; J7) player 7; J8) player 8; J9) player 9; J10) player 10; J11) player 11; J12) player 12; J13) player 13; J14) player 14; J15) player 15; J16) player 16; J17) player 17; J18) player 18; J19) player 19; J20) player 20; J21) player 21; J22) player 22; J23) player 23; JR) rival player.
3	Move initiation zone	ZI10, ZI20, ZI30, ZI40-safety sector-, ZI50, ZI60, ZI70, ZI80-creation sector in own half, ZI51, ZI61, ZI71, ZI81-creation sector in rival's half -ZI90, Z100, ZI110, ZI120, ZI130 –definition sector.
4	Move conclusion zone	ZF10, ZF20, ZF30, ZF40-safety sector-, ZF50, ZF60, ZF70, ZF80-creation sector in own half, ZF51, ZF61, ZF71, ZF81-creation sector in rival's half -ZF90, Z100, ZF110, ZF120, ZF130 –definition sector.
5	Contact with ball	C1) single contact with ball and regulatory throw-in/kick-in; C12) attempt to control the ball with 2 or more touches resulting in loss of ball; C2) control of ball (including catching of ball by goalkeeper) followed by a shot - regardless of whether the ball reaches a team member or is recovered by an opponent; C23) control of ball, followed by dribbling, and loss of ball; C24) control of ball, followed by dribbling, attempt to go around one or more opponents, and loss of ball; C3) control of ball, followed by dribbling and shot - regardless of whether the ball reaches a team member or is recovered by an opponent; C4) control of ball, passing of one or more opponents, and shot – regardless of whether the ball reaches a team member or is recovered by an opponent; C5) Header.
6	Interruptions	GTO) goal by team being observed; GATO) goal against team being observed, FKTO) free kick for team being observed; OTO) offside for team being observed; TITO) throw-in for team being observed; CKTO) corner kick or team being observed; GKTO) goal kick for team being observed; FKATO) free kick against team being observed; OATO) offside against team being observed; TIATO) throw-in against team being observed; CKATO) corner kick against team being observed; GKATO) goal kick against team being observed; NK) kick-off/neutral kick; KO) kick-off; EFH) end of first half; EM) end of match.
7	Interceptions	LB) loss of ball; RB) recovery of ball; OIC) occasional interception with continuation of play
8	Type of shot	SG) shot resulting in goal; SI) shot intercepted by opponent other than the goalkeeper; SBP) shot between the posts not resulting in a goal; SWP) shot wide of the posts; SSG) shot saved or cleared by the goalkeeper; HEG) header ending in a goal; HIG) header intercepted by opponent other than the goalkeeper; HBP) Header between the posts not resulting in a goal; HWP) Header wide of the posts; HBG) Header blocked or cleared by the goalkeeper.

Figure 2. Observational instrument. (Source: Maneiro and Amatria, 2018, p. 4)

Data recording and coding

The data recording process was carried out using the LINCE programme (v.1.2.) (Gabin, Camerino, Anguera & Castañer, 2012), obtaining an inter-observer concordance value of κ = 0.95. The collected data belongs to type IV and is, therefore, concurrent and base-time.

Three additional free programmes were also used: GSEQ (v.5.1) (Bakeman & Quera, 2011) for the lag sequential analysis, HOISAN (v.1.6.) (Hernández-Mendo, López-López, Castellano, Morales-Sánchez, & Pastrana, 2012) where the adjusted residuals obtained in the lag sequential analysis were analyzed for the obtention of polar coordinate parameters, and free program R to obtain the vectors in polar coordinate analysis (Rodríguez-Medina, Arias, Arias, Hernández-Mendo, & Anguera, 2019).

Data analysis

This diachronic study implies making a successive collection of qualitative data from the same participants along several sessions in the 2012 UEFA Euro Cup, with the objective of managing and analyzing data using quantitative techniques for categorical data (Bakeman & Quera, 2011; Magnusson, 2020; Quera, 2018; Sackett, 1980).

To apply this diachronic analysis, we should distinguish between *intersessional following* (Escolano-Pérez, & Blanco-Villaseñor, 2015; Portell, Anguera, Chacón-Moscoso, et al., 2015), when two or more sessions are studied during a period of time, and *intrasessional following* (Portell, Anguera, Chacón-Moscoso, et al., 2015), which allows to collect the data from the beginning to the end of each session. The requirement that must be met to perform each of the diachronic analysis, that are described in Anguera, Portell, Hernández-Mendo, Sánchez-Algarra, and Jonsson (in press), is that we have an intrasessional following record, which implies the continuous record of each observational session.

The *polar coordinate analysis* (Sackett, 1980) requires a previously performed *lag sequential analysis* (Bakeman, 1978; Bakeman & Quera, 2011). Lag sequential analysis allows us to study processes over sessions, yielding a dynamic vision about how the behavior patterns obtained allow researchers to know the sequence of events produced, elements of these patterns that could be modified, and the connections among them that can remain stable or evolve (Anguera, Portell, Hernández-Mendo, Sánchez-Algarra, and Jonsson, in press). An interesting aspect of the lag sequential analysis is that the study can be conducted prospectively (i.e., forwards) or retrospectively (i.e., backwards). This are two perspectives of diachronic analysis that can give answers to very different approaches, starting always from qualitative data.

The main elements of *lag sequential analysis* are given behavior, conditioned behavior, and lag. The *given behavior* can be established from a specific research problem, as a behavior that can initiate and promote some regularity along time, and the researchers want to examine the consistency of these regularities; the *conditioned behaviors* are those that can be significantly associated with the focal behavior from a statistical standpoint, forming part of the resulting behavior pattern; and *lag* is the place of order that occupies a certain conditioned behavior compared to the focal behavior. In each study that we discuss, we will propose as premises what the focal behaviors, the conditioned behaviors, and the lags will be.

Based on the given behavior, the matched frequencies are calculated, taking into account the conditioned behaviors and the lag, whether positive or negative. The matching frequency is a value consisting of the number of times that a certain behavior (conditioned behavior) appears after (if the lag is positive) or before (if the lag is negative) the given behavior. We can work with all the focal and conditioned behaviors that we deem necessary, in order to get z values, that we will need in polar coordinate analysis.

We illustrate this by proposing a simple example (only one dimension) corresponding to current data, from the dimensión *Contact with ball,* using the categories C1, C2, C3, C4, and C5.

Let us assume that the record of a session is: C1, C4, C3, C1, C5, C1, C4, C3, C1 C3, C1, C4, C5, C1, C4, C3, C1, C4, C3, C2, C1, C4, C3, C1, C5, C1, C4, C3, C4, C3. Now, if we consider *C1* as the given behavior, and all other categories as conditioned behaviors, we would find that the matching frequency of *C1* with *C4* in lag 1 is 7, because *C4* appears 7 times occupying the lag +1 regarding *C1*. In Table 1 we have the simple frequencies of each behavior, and all the matching behaviors corresponding to each given behavior compared to the conditioned behaviors, and for each lag (in the next section, we present an empirical demonstration).

From the simple and matched frequencies, and their totals, we found, respectively, the expected probabilities (which only refer to the effect of chance) and the conditional probabilities (which refer to the probability of occurrence of each conditioned behavior, in a certain lag, from a certain given behavior). There are also in Table 1. From here, the conditional probability values that are higher than the expected probability, in the respective lags, are statistically significant, and show us the behaviors that will be part of the behavior pattern because their probability of occurrence does not depend on chance, but on a demonstrated sequential association regarding the focal behavior.

Table 1. Simple and Matching Frequencies (on the Left Side) and the Expected and Conditioned Probabilities (on the Right Side). C1 is the given behavior.

	Simple and matched frequencies table						**Expected and conditional probabilities table**					
Lag	C1	C2	C3	C4	C5	TOTAL		C1	C2	C3	C4	C5
	10	1	8	8	3	30	Expected probabilites	0.33	0.03	0,26	0.26	0.1
+1	0	0	1	7	2	10	Conditional probabilites	0	0	0.1	**0.7**	**0.2**
+2	3	0	6	0	1	10		0.3	0	**0.6**	0	0.1
+3	5	1	0	4	0	10		**0.5**	**0.1**	0	**0.4**	0
+4	1	0	4	2	3	10		0.1	0	**0.4**	0.2	**0.3**
+5	5	0	2	2	1	9		**0.55**	0	0.22	0.22	0

To facilitate the explanation, an empirical demonstration carried out manually from the data in Table 2 is included. From this code matrix, the simple frequencies and the matching frequencies have been manually found (Table 1, left side), considering the lags +1 to +5. Also, because the totals are available, on the right side of Table 1, the *expected probabilities* (i.e., quotient between each simple and total frequency) and the *conditioned probabilities* (i.e., quotient between each matching frequency and the total) have been obtained. The expected probabilities indicate only the effect of chance, whereas the conditional probabilities correspond to the situation studied.

From the values obtained in Table 1, it is posible to calculate the Z values, which are needed in order to perform a polar coordinate analuysis:

$$Z = \frac{Pconditioned - Pexpected}{SD} \qquad (1)$$

$$\text{where} \quad SD = \sqrt{\frac{Pexpected*(1-Pexpected)}{Ntotal\ criterion}}$$

The polar coordinate analysis was developed by Sackett (1980) and despite the presence of empirical studies from earlier decades (Gorospe & Anguera, 2000) about polar coordinate analysis, its use in Sports Science is recent (Perea, Castellano, Alday, Hernández-Mendo, 2012; Maneiro, Amatria, Moral & López, 2018). Over the last years, there has been a growing interest in its application owing to its totally adequate characteristics and possibilities for the suggested type of study (Aragón, Lapresa, Arana, Anguera & Garzón, 2017; Castañer, et. al, 2017; Castañer et al., 2016).

The technique for the study of polar coordinates is based on the results obtained through the lag-sequential analysis (Bakeman, 1978). This analysis is conducted at both the prospective,

through the positive lag, as well as the retrospective level, through the negative lag that -once standardised (Z values)- are reduced using the Zsum parameter introduced by Cochran (1954). The calculation of the Zsum parameter, whose formula is $Z_{sum} = \frac{\sum Z}{\sqrt{n}}$ (where n stands for the number of lags), allows for the obtention of as many Zsum as lags for each specific category from the prospective and retrospective perspectives. Zsum is based on the principle that the sum of a number n of independent Z scores (as many calculated prospective as retrospective lags with the same quantity in each case and which should be at least 5) is normally distributed with μ=0 y σ=1. Consequently, the same quantity of Zsum and lags are obtained for every specific category in each of the two prospective and retrospective perspectives.

Each Zsum may carry a positive or negative sign, which wil therefore determine which of the four quandrants will contain the categories corresponding to the conditional behaviours in relation to the focal behaviour being displayed. The technique of the polar coordinates helps to identify the activation or inhibition relation of the focal behaviour (which would somewhat be parallel to the behaviour criterium of the lag-sequential analysis) and all or some of the categories of the observational instrument, which are the conditional or matching behaviours.

The length or radius parameters of the vector

($Lenght = \sqrt{(Z_{sum\,prospective})^2 + (Z_{sum\,retrospective})^2}$) and the angle ($\phi = Arc\,sen \frac{Z_{sum\ retrospective}}{Lenght}$) are calculated using the Zsum criterium and Zsum matching values for each of the conditional behaviours. For a significance level of .05 the length of the vector has to be >1.96. Once the length and the angle corresponding to each vector are obtained, the angle must be adjusted taking the quandrant where each vector will be located into account (see Table 2).

Table 2. Transformations to apply to the angle ϕ according to the quandrant where each vector is placed.

Sign of Z_{sum}		**Quadrant**	**Transformation of the angle ϕ**
Prospective Z_{sum}	**Retrospective Z_{sum}**		
Positive	Positive	I	No transformation
Negative	Positive	II	180- ϕ
Negative	Negative	III	180+ ϕ
Positive	Negative	IV	360- ϕ

The free computer programme HOISAN was used to calculate the parameters and graphical representation of the vectors prior to their interpretation (Hernández-Mendo et al., 2012). As a result, the vectors located in the first quadrant (Quadrant I) reveal that the focal and conditional behaviours are mutually activated, the vectors located in the second quadrant (Quadrant II) show that the focal behaviour inhibits the conditional behaviour but not inversely, the vectors located in the third quadrant (Quadrant III) indicate that both focal and conditional behaviours are mutually inhibited and, finally, the vectors located in the fourth quadrant (Quadrant IV) demonstrate that the conditional behaviour is activated by the focal behaviour but not inversely (Figure 3).

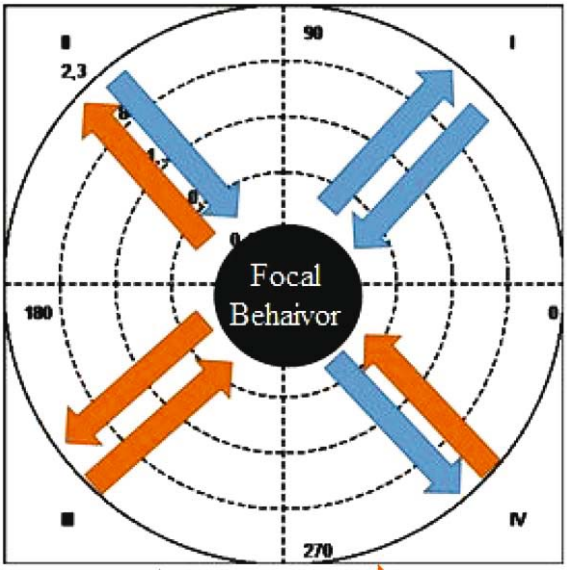

Figure 3. Graphical representation of the excitatory and inhibitory relations between the focal and conditional behaviours according to the quadrant where they are located = exitatory relation and = inhibitory relation between the behaviours and Behaviour. Focal = focal behaviour. (Source: Maneiro, Amatria & Anguera, 2019)

Results

As mentioned earlier, a preliminary lag-sequential analysis was required in order to carry out the polar coordinate analysis.

The results reflect six aspects in connection with Piqué's gameplay throughout the tournament being analysed:

a) Gerard Piqué's interaction with the other players of Spain's national football team.

b) Gerard Piqué's interaction with the zone or area where the actions are started.

c) Gerard Piqué's interaction with the zone or area where the actions are finished.

d) Gerard Piqué's interaction with the situations of play (regulated interruptions and interceptions).

e) Gerard Piqué's interaction with the skill move that he performs.

f) Gerard Piqué's interaction with the type of shot that he performs.

Finally, and with the objective of knowing the performance of Gerard Piqué before the same rival, a comparison has been made between the first match (group stage) and the last match played by the same player (final of the championship). Both matches have been played against the Italian national team.

The player Gerard Piqué (P3) was established as focal behaviour for the analysis.

a) Gerard Piqué's interaction with the other players of Spain's national football team:

For this analysis, the focal behaviour P3 was associated with other categories that make up the team (J0, J1, J2, J3, J4, J5, J6, J7, J8, J9, J10, J11, J12, J13, J15, J16, J17, J18, J19, J20, J21, J22 and J23) as well as the categories corresponding to an opponent (JR). This analysis aims to

check Gerard Piqué's readiness to engage with the different players during the game regardless of whether they are teammates or opponents.

The results (Table 3 & Figure 4), show the focal categories J20 with a ratio of 2.71 and an angle of 84.6º, J17 with a ratio of 6.04 and an angle of 42.57º, J15 with a ratio of 5.67 and an angle of 33.39º and J1 with a ratio of 6.09 and an angle of 18.4º, all of which are located in quadrant I where the focal behaviour activates the presence of the matching behaviour at both the prospective and retrospective levels.

In addition, the categories J9 with a ratio of 2.08 and an angle of 140.67º and JR with a ratio of 4.01 and an angle of 169.91º in quadrant II where the focal behaviour inhibits the presence of the matching behaviour at the prospective level and activates it at the retrospective level.

In relation to quadrant III, the obtained results present the categories J6, J10, J18, J21 and J22 with ratios of 5.18, 5.53, 4.14, 3.47 and 2.41, with angles of 220.52º; 209.02º; 209.08º; 251.38º and 233.51º respectively where the focal behaviour inhibits the presence of the matching behaviour at both the prospective and retrospective levels.

Finally, the results reveal the surprising presence of the category J14 with a ratio of 2.61 and an angle of 323.94º in quadrant IV where the focal behaviour activates the presence of the matching behaviour at the prospective but not the retrospective level.

Table 3. Results obtained from the polar coordinate analysis for the focal category P3 in relation to the teammates.

Category	Quadrant	Prospective Z_{sum}	Retrospective Z_{sum}	Radium	Angle
J0	II	-0.73	0.52	0.9	144.33
J1	I	5.78	1.92	6.09 (*)	18.4
J4	II	-0.63	0.53	0.82	140.07
J6	III	-3.94	-3.37	5.18 (*)	220.52
J7	III	-0.76	-0.36	0.84	205.2
J8	I	0.18	0.3	0.35	59.16
J9	II	-1.61	1.32	2.08 (*)	140.67
J10	III	-2.21	-1.23	2.53 (*)	209.02
J11	III	-0.72	-0.59	0.93	219.17
J13	IV	1.19	-1.54	1.95	307.74
J14	IV	2.11	-1.53	2.61 (*)	323.94
J15	I	4.74	3.12	5.67 (*)	33.39
J16	I	0.73	0.48	0.87	33.53
J17	I	4.45	4.08	6.04 (*)	42.57
J18	III	-3.62	-2.01	4.14 (*)	209.08
J20	I	0.25	2.7	2.71 (*)	84.6
J21	III	-1.11	-3.29	3.47 (*)	251.38
J22	III	-1.44	-1.94	2.41 (*)	233.51
JR	II	-3.94	0.7	4.01 (*)	169.91

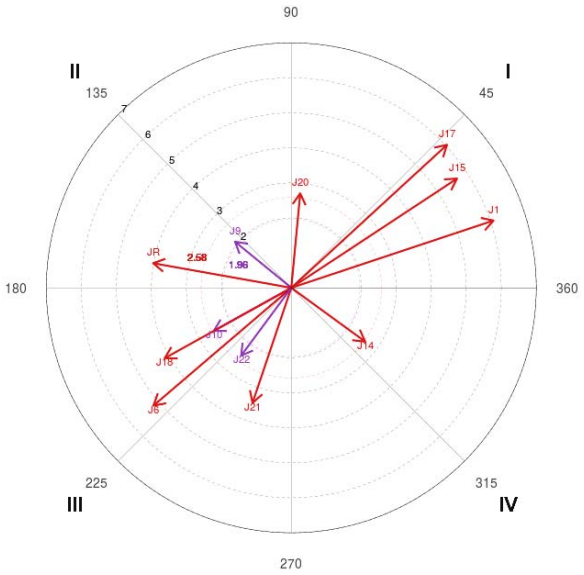

Figure 4. Representation of the behavioural map establishing the category P3 as the focal behaviour in relation to the teammates.

b) Gerard Piqué's interaction with the zone or area where the actions are started.

For this analysis, the focal behaviour P3 was associated with the different zones or areas where the actions are started on the field (ZI10, ZI 20, ZI 30, ZI 40, ZI 50, ZI 60, ZI 70, ZI 80, ZI 51, ZI 61, ZI 71, ZI 81, ZI 90, ZI 100, ZI 110, ZI 120 and ZI 130). This analysis intends to verify Gerard Piqué's readiness to engage in the play regarding space and the different starting zones where the actions performed during the game actually take place.

The results (Table 4 & Figure 5) show the focal categories ZI30 with a radius of 7.43 and an angle of 19.7º, ZI40 with a radius of 4.81 and an angle of 66.63º, ZI60 with a radius of 4.53 and an angle of 25.48º, ZI70 with a radius of 7.17 and an angle of 10.79º, ZI80 with a radius of 8.9 and an angle of 12.04º and ZI81 with a radius of 5.76 and an angle of 26.86º in quadrant I where the focal behaviour activates the presence of the matching behaviour at both the prospective and retrospective levels.

In quadrant II, where the criterium behaviour inhibits the presence of the matching behaviour at the prospective level and activates it at the retrospective level, the matching category ZI110 with a radius of 4.13 and an angle of 179.38º is noted.

As regards quadrant III, where the focal behaviour inhibits the presence of the matching behaviour at both the prospective and the retrospective levels, the matching category ZI51 with a radius of 5.61 and an angle of 190.75º; the category ZI61 with a radius of 5.37 and an angle of 205.31º; the category ZI90 with a radius of 6.21 and an angle of 193.23º; the category ZI100 with a radius of 7.23 and an angle of 196.14º; the category ZI120 with a radius of 4.71 and angle of 200.38ºand the category ZI130 with a radius of 2.79 and an angle of 184.42º.

Finally, the results reveal the surprising presence of the categories ZI20 with a radius of 2.94 and an angle of 324.59º and ZI50 with a radius of 2.23 and an angle of 309.72º in quadrant IV where the focal behaviour activates the presence of the matching behaviour at the prospective but not retrospective level.

Table 4. Results obtained from the polar coordinate analysis for the focal category P3 in relation to the starting zone.

Category	Quadrant	Prospective Z_{sum}	Retrospective Z_{sum}	Radium	Angle
ZI10	III	-0.03	-0.8	0.8	268.07
ZI20	IV	2.4	-1.7	2.94 (*)	324.59
ZI30	I	6.99	2.5	7.43 (*)	19.7
ZI40	I	1.91	4.42	4.81 (*)	66.63
ZI50	IV	1.43	-1.72	2.23 (*)	309.72
ZI60	I	4.09	1.95	4.53 (*)	25.48
ZI70	I	7.04	1.34	7.17 (*)	10.79
ZI80	I	8.7	1.86	8.9 (*)	12.04
ZI51	III	-5.51	-1.05	5.61 (*)	190.75
ZI61	III	-4.85	-2.29	5.37 (*)	205.31
ZI71	IV	0.16	-1.14	1.16	278
ZI81	I	5.14	2.6	5.76 (*)	26.86
ZI90	III	-5.96	-1.74	6.21 (*)	196.23
ZI100	III	-6.94	-2.01	7.23 (*)	196.14
ZI110	II	-4.13	0.04	4.13 (*)	179.38
ZI120	III	-4.42	-1.64	4.71 (*)	200.38
ZI130	III	-2.78	-0.21	2.79 (*)	184.42

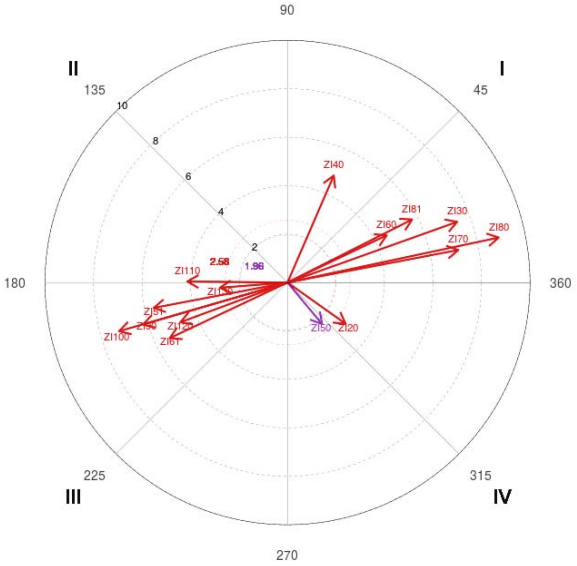

Figure 5. Representation of the behavioural map establishing the category P3 as the focal behaviour in relation to the starting zone.

c) Gerard Piqué's interaction with the zone or area where the actions are finished.

For this analysis, the focal behaviour P3 was associated with the different zones or areas where the actions are finished (ZF10, ZF20, ZF30, ZF40, ZF50, ZF60, ZF70, ZF80, ZF51, ZF61, ZF71, ZF81, ZF90, ZF100, ZF110, ZF120 and ZF130). This analysis intends to verify Gerard Piqué's readiness to engage in the play regarding the different finishing zones where the actions performed during the game take place.

The results (Table 5 & Figure 6) reveal the focal categories ZF30 with a radius of 7.6 and an angle of 59.12º, ZF40 with a radius of 7.16 and an angle of 78.4º, ZF70 with a radius of 11.48 and an angle of 59.93º, ZF80 with a radius of 8.5 and an angle of 23.34º and the matching category ZF81 with a radius of 3.97 and an angle of 15.8º in quadrant I where the focal behaviour activates the presence of the matching behaviour at both the prospective and retrospective levels.

In quadrant II, where the focal behaviour inhibits the presence of the matching behaviour at the prospective level and activates it at the retrospective level, the matching categories ZF110 with a radius of 4.94 and an angle of 177.87º and ZF130 with a radius of 4.05 and an angle of 168.85º are observed.

As regards quadrant III, where the focal behaviour inhibits the presence of the matching behaviour at both the prospective and retrospective levels, the matching category ZF51 with a radius of 5.85 and an angle of 227.05º; the category ZF61 with a radius of 6.06 and an angle of 249.96º; the category ZF90 with a radius of 4.25 and an angle of 202.79º; the category ZF100 with a radius of 6.44 and an angle of 202.19º and the category ZF120 with a radius of 5 and an angle of 216.09º are observed.

Finally, the results reveal the surprising presence of the categories ZF10 with a radius of 2.2 and an angle of 297.35º, ZF50 with a radius of 4.87 and an angle of 313.14º and ZF60 with a radius of 4.15 and an angle of 359.51 in quadrant IV, where the focal behaviouractivates the presence of the matching behaviour at the prospective but not retrospective level.

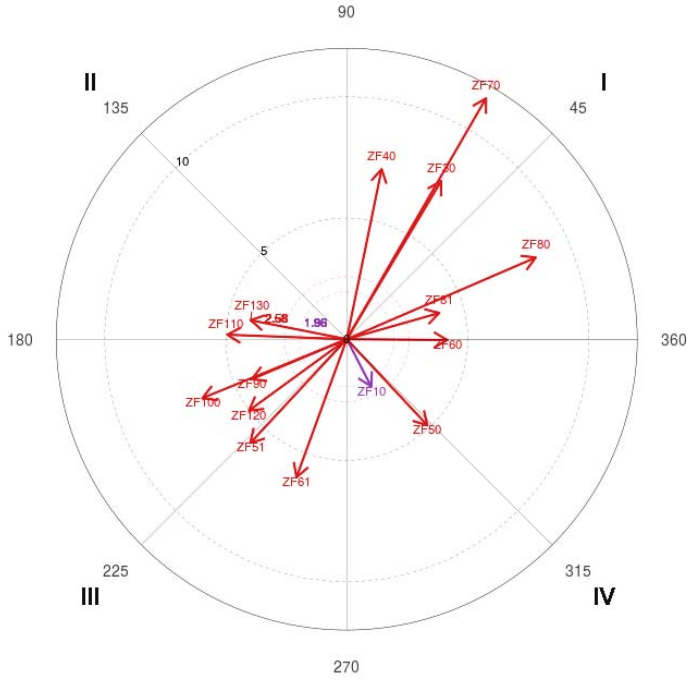

Figure 6. Representation of the behavioural map establishing the category P3 as the focal behaviour in relation to the finishing zone.

Table5. Results obtained from the polar coordinate analysis for the focal category P3 in relation to the finishing zone.

Category	Quadrant	Prospective Z_{sum}	Retrospective Z_{sum}	Radius	Angle
ZF10	IV	1.01	-1.95	2.2 (*)	297.35
ZF20	IV	0.86	-1.69	1.89	296.99
ZF30	I	3.9	6.52	7.6 (*)	59.12
ZF40	I	1.44	7.02	7.16 (*)	78.4
ZF50	IV	3.33	-3.55	4.87 (*)	313.14
ZF60	IV	4.15	-0.04	4.15 (*)	359.51
ZF70	I	5.75	9.93	11.48 (*)	59.93
ZF80	I	7.8	3.37	8.5 (*)	23.34
ZF51	III	-3.98	-4.28	5.85 (*)	227.05
ZF61	III	-2.08	-5.69	6.06 (*)	249.96
ZF71	IV	1.05	-1.17	1.57	311.77
ZF81	I	3.82	1.08	3.97 (*)	15.8
ZF90	III	-3.92	-1.65	4.25 (*)	202.79
ZF100	III	-5.97	-2.43	6.44 (*)	202.19
ZF110	II	-4.94	0.18	4.94 (*)	177.87
ZF120	III	-4.04	-2.95	5 (*)	216.09
ZF130	II	-3.97	0.78	4.05 (*)	168.85

d) Gerard Piqué's interaction with the situations of play (regulated interruptions and interceptions).

For this analysis, the focal behaviour P3 was associated with the matching categories related to the regulated interruptions and interceptions that happen during the game (GTO, GATO, FKTO, OTO, TITO, CKTO, GKTO, FKATO, OATO, TIATO, CKATO, GKATO, NK, KO, EFH, EM, LB, RB and OIC). This analysis intends to verify the frequency of the different situations taking place during the game in connection with this player when he gets involved in the action.

The results (Table 6 & Figure 7) show the focal LB category with a radius of 2.11 and an angle of 47.16º in quadrant I, where the focal behaviour activates the presence of the matching behaviour at both the prospective and retrospective levels.

As regards quadrant III, where the focal behaviour inhibits the presence of the matching behaviour at both the prospective and retrospective levels, the categories GTO with a radius of 2.34 and an angle of 225.15º, TITO with a radius of 3.29 and an angle of 235.03º, the category CKTO with a radius of 4.61 and an angle of 212.84º and the category OIC with a radius of 2.11 and an angle of 204.78º.

Finally, the results reveal the susrprising presence of the categories GKTO with a radius of 2.35 and an angle of 321.19º and TIATO with a ardio of 3.23 and an angle of 358.89º in quadrant IV where the focal behaviour activates the presence of the matching behaviour at the prospective but not retrospective level.

Table 6. Results from the polar coordinate analysis for the focal category P3 in relation to the regulated interruptions and interceptions during play.

Category	Quadrant	Prospective Z_{sum}	Retrospective Z_{sum}	Radius	Angle
GTO	III	-1.65	-1.66	2.34 (*)	225.15
FKTO	I	1.78	0.63	1.89	19.46
OTO	III	-0.29	-0.11	0.31	201.34
TITO	III	-1.88	-2.69	3.29 (*)	235.03
CKTO	III	-3.87	-2.5	4.61 (*)	212.84
GKTO	IV	1.83	-1.47	2.35 (*)	321.19
FKATO	IV	0.09	-0.35	0.36	284.38
OATO	II	-1.04	1.07	1.49	134.15
TIATO	IV	3.23	-0.06	3.23 (*)	358.89
CKATO	I	0.77	0.48	0.91	31.89
NK	II	-0.74	0.45	0.87	148.68
KO	II	-0.73	0.52	0.9	144.73
EFH	III	-0.77	-0.69	1.04	221.67
EM	II	-0.81	0.92	1.23	131.6
LB	I	1.71	1.85	2.52 (*)	47.16
RB	I	0.49	1.57	1.64	72.7
OIC	III	-1.92	-0.89	2.11 (*)	204.78

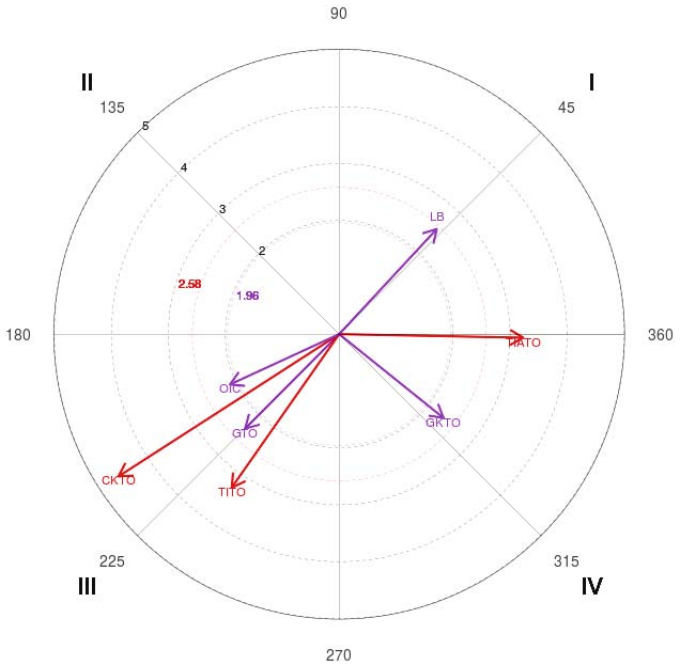

Figure 7. Representation of the behavioumap establishing the category P3 as focal behaviour in relation to the regulated intons and interceptions during play.

e) Gerard Piqué's interaction with the skill move that he performs.

For this analysis, the focal behaviour P3 was associated with the matching categories related to the established skill moves (C1, C12, C2, C23, C24, C3, C4 and C5). It intends to verify the frequency of the different skill moves when this player participates in the play.

The results (Table 7 & Figure 8) show the focal categories C1 with a radius of 2.98 and an angle of 138.52º and C23 with a radius of 2.58 and an angle of 153.92º in quadrant II, where the focal behaviour inhibits the presence of the matching behaviour at the prospective level while it activates it at the retrospective level.

In relation to quadrant III, where the focal behaviour inhibits the presence of the matching behaviour at both the prospective and retrospective levels, the matching category C4 with a radius of 3.44 and an angle of 226.37º is identified.

Finally, the results reveal the surprising presence of the category C3 with a radius of 2.44 and an angle of 328.55º in quadrant IV, where the focal behaviour activates the presence of the matching behaviour at the prospective but not retrospective level.

Table 7. Results from the polar coodinate analysis for the focal category P3 in relation to the type of contact with the ball.

Category	Quadrant	Prospective Z_{sum}	Retrospective Z_{sum}	Radius	Angle
C1	II	-2.24	1.98	2.98 (*)	138.52
C12	III	-0.47	-0.27	0.54	210.15
C2	IV	1.74	-0.67	1.87	339.09
C23	II	-2.32	1.14	2.58 (*)	153.92
C24	II	-0.59	1.75	1.84	108.52
C3	IV	2.08	-1.27	2.44 (*)	328.55
C4	III	-2.37	-2.49	3.44 (*)	226.37
C5	IV	0.66	-0.06	0.66	354.98

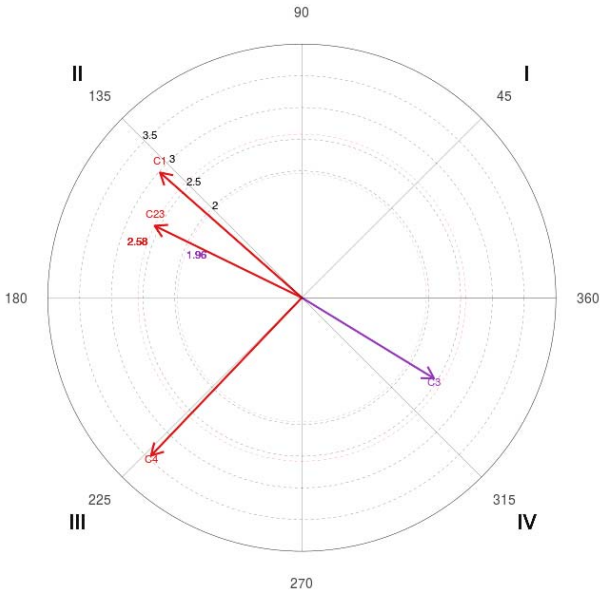

Figure 8. Representation of the behavioural map establishing the category P3 as focal behaviour in relation to the type of contact with the ball.

f) Gerard Piqué's interaction with the type of shot he performs.

For this analysis, the focal behaviour P3 was associated with the matching categories related to performed finishing actions (SG, IS, SP, SO, ST, HG, HP, HO and HS). The analysis intends to verify the performance frequency of the different types of finishing actions (shots) that are produced during the game when this player participates in the play.

Table 8 shows the results obtained from the analysis, which are not so relevant.

Table 8. Results from the polar coordinate analysis for the focal behaviour P3 in relation to the type of finishing action (shot).

Category	Quadrant	Prospective Z_{sum}	Retrospective Z_{sum}	Radius	Angle
SG	III	-0.94	-0.94	1.33	224.86
SI	II	-1.18	1.14	1.64	136.11
SBP	I	0.48	0.53	0.71	47.8
SWP	IV	1.16	-0.72	1.37	328.07
SSG	III	-0.65	-0.66	0.93	225.39
HEG	III	-0.42	-0.4	0.58	223.75
HIG	I	1.23	0.51	1.33	22.34
HWP	III	-0.4	-0.43	0.59	227.17

Next, the results are presented comparing the initial match of the championship, with the final one, the rival has been the same: the Italian soccer team.

Tables 9a and 9b, and figures 9a and 9b shows the relationships established by J3 focal behavior with the other categories that make up the team's squad, in the first match of the group stage, and in the final of the championship.

Table 9. Gerard Piqué's interaction with the other players of Spain's national football team

Group phase (table 8a & figure 9a)

Table 9a. Piqué's interaction in the first match

Category	Quadrant	Prospect	Retrosp	Radius	Angle
J1	IV	1.37	-0.47	1.45	341.06
J6	III	-2.55	-2.4	3.51 (*)	223.24
J8	II	-1.01	0.88	1.34	138.8
J9	II	-1.48	0.1	1.49	176.21
J10	II	-1.55	0.95	1.82	148.38
J14	IV	1.58	-0.59	1.69	339.41
J15	IV	3.76	-1.25	3.96 (*)	341.59
J16	I	1	1.07	1.46	46.98
J17	I	2.53	2.24	3.37 (*)	41.51
J18	III	-0.39	-0.72	0.82	241.49
J21	III	-1.92	-2.13	2.87 (*)	227.91
J22	II	-0.08	0.37	0.38	102.24
JR	II	-2.34	2.02	3.09 (*)	139.28

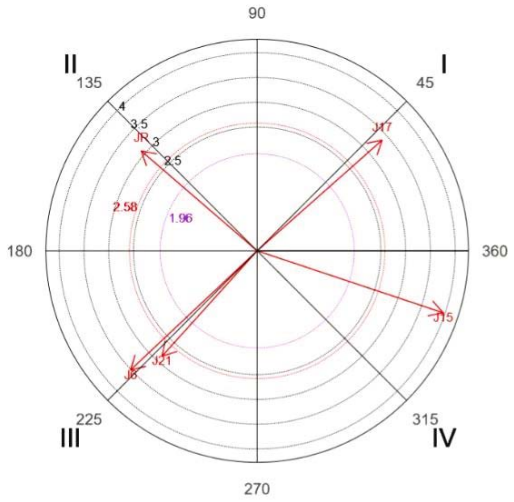

Figure 9a. Piqué's interaction in the first match

Championship final

Table 9b. Piqué's interaction in the final

Category	Quadrant	Prospec	Retrosp	Radius	Angle
J1	I	4.15	0.79	4.22 (*)	10.75
J6	III	-2.14	-1.24	2.47 (*)	210.04
J7	I	1.32	1.02	1.67	37.73
J8	III	-0.22	-1.13	1.15	259.04
J9	II	-0.08	2.17	2.17 (*)	92.12
J10	III	-1.61	-0.19	1.62	186.67
J13	IV	2.38	-1.15	2.64 (*)	334.13
J14	III	-0.11	-1.1	1.1	264.17
J15	I	1.74	1.36	2.21 (*)	37.92
J16	III	-0.43	-0.41	0.59	223.78
J17	I	0.71	2.29	2.4 (*)	72.88
J18	II	-0.48	0.31	0.58	147.05
J21	III	-1.12	-1.02	1.51	222.36
JR	III	-1.28	-1.42	1.92	227.93

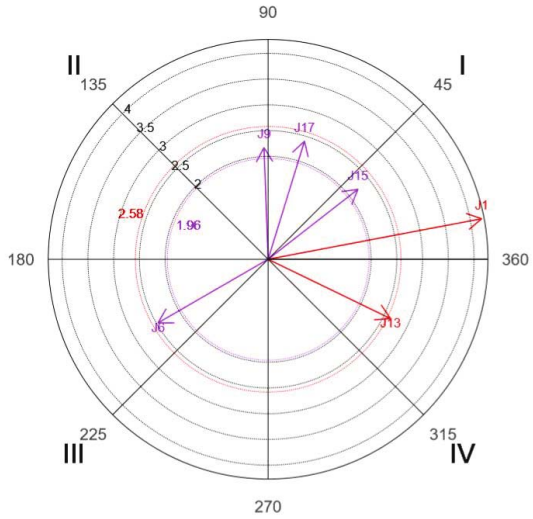

Figure 9b. Piqué's interaction in the final

On the other hand, tables 10a and 10b, and figures 10a and 10b shows the predisposition of player Gerard Piqué in reference to the starting area of the different actions he performed during both matches.

Table 10. Gerard Piqué's interaction with the zone or area where the actions are started

Group phase

Tabla 10a. Piqué's interaction in the first match

Category	Quadrant	Prospec	Retrosp	Radius	Angle
ZI10	IV	0.47	-2.31	2.35 (*)	281.4
ZI20	IV	1.55	-2.77	3.17 (*)	299.27
ZI30	I	1.86	0.01	1.86	0.41
ZI40	I	0.84	2.99	3.11 (*)	74.3
ZI50	IV	4.38	-1.34	4.58 (*)	342.96
ZI60	IV	0.78	-0.73	1.07	316.86
ZI70	I	2.31	2.34	3.29 (*)	45.33
ZI80	I	2.03	0.49	2.09 (*)	13.62
ZI51	II	-2.16	0.14	2.17 (*)	176.34
ZI61	III	-2.08	-1.1	2.35 (*)	207.93
ZI71	I	1.02	2.17	2.4 (*)	64.72
ZI81	I	2.4	1.13	2.65 (*)	25.14
ZI90	II	-3.44	1.63	3.81 (*)	154.64
ZI100	III	-3.67	-1.47	3.96 (*)	201.84
ZI110	III	-1.9	-1.51	2.43 (*)	218.5
ZI120	II	-1.4	0.22	1.42	170.95
ZI130	III	-1.96	-0.63	2.06 (*)	197.69

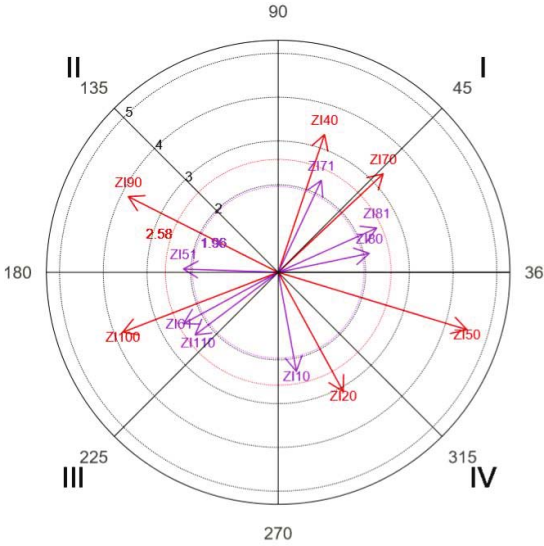

Figure 10a. Piqué's interaction in the first match

Championship final

Tabla 10b. Piqué's interaction in the final

Category	Quadrant	Prospec	Retrosp	Radius	Angle
ZI10	II	-1.54	0.31	1.57	168.5
ZI20	I	2.29	0.46	2.33 (*)	11.29
ZI30	I	6.01	3.68	7.04 (*)	31.47
ZI40	I	1.47	2.8	3.16 (*)	62.35
ZI50	IV	3.25	-1.31	3.5 (*)	338.12
ZI60	IV	0.24	-1.32	1.34	280.37
ZI70	IV	4.35	-0.06	4.35 (*)	359.23
ZI80	I	2.4	1.89	3.05 (*)	38.28
ZI51	II	-2.43	0.71	2.53 (*)	163.71
ZI61	III	-3.13	-0.47	3.16 (*)	188.46
ZI71	III	-0.64	-3.77	3.83 (*)	260.45
ZI81	I	0.3	1.83	1.85	80.7
ZI90	II	-1.9	1.02	2.16 (*)	151.63
ZI100	III	-2.89	-0.51	2.94 (*)	189.99
ZI110	III	-0.56	-0.66	0.86	229.62
ZI120	II	-1.57	0.01	1.57	179.51
ZI130	III	-1.33	-1.06	1.7	218.59

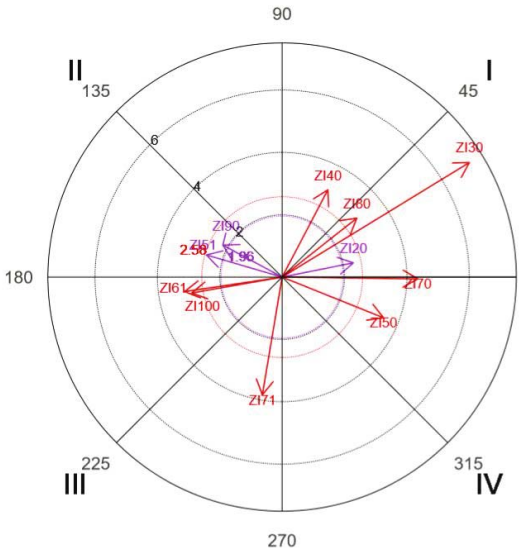

Figure 10b. Piqué's interaction in the final

Tables 11a and 11b, and figures 11a and 11b, shows the predisposition of player Gerard Piqué in reference to the finishing zone of the different actions he performed during both matches.

Table 11. Gerard Piqué's interaction with the zone or area where the actions are finished

Group phase

Tabla 11a. Piqué's interaction in the first match

Category	Quadrant	Prospec	Retrosp	Radius	Angle
ZF10	IV	0.93	-2.01	-0.91	2.21 (*)
ZF20	IV	1.49	-2.93	-0.89	3.29 (*)
ZF30	I	1.38	1.6	0.76	2.11 (*)
ZF40	II	-0.26	4.03	1	4.04 (*)
ZF50	IV	3.79	-2.08	-0.48	4.32 (*)
ZF60	IV	1.35	-1.78	-0.8	2.23 (*)
ZF70	I	1.36	6.8	0.98	6.94 (*)
ZF80	IV	1.91	-0.02	-0.01	1.91
ZF51	III	-1.27	-1.28	-0.71	1.81
ZF61	III	-0.6	-2.39	-0.97	2.46 (*)
ZF71	I	1.14	1.2	0.72	1.65
ZF81	I	2.26	1.03	0.42	2.48 (*)
ZF90	II	-3.47	0.61	0.17	3.52 (*)
ZF100	III	-3.58	-0.76	-0.21	3.66 (*)
ZF110	III	-2.45	-1.08	-0.4	2.67 (*)
ZF120	III	-0.61	-1.23	-0.89	1.37
ZF130	III	-2.16	-0.42	-0.19	2.2 (*)

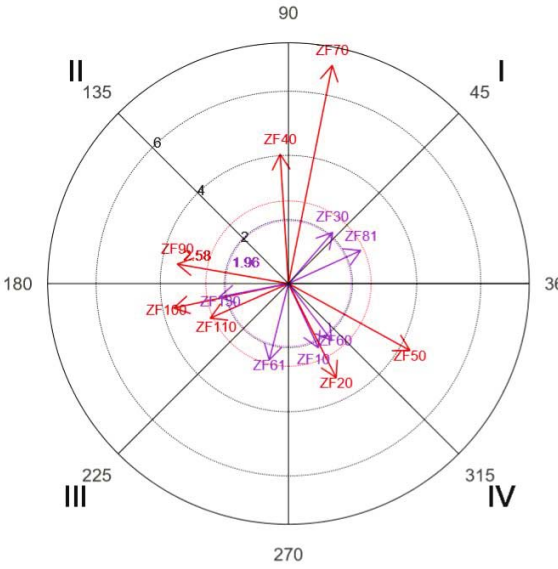

Figure 11a. Piqué's interaction in the first match

Championship final

Tabla 21b. Piqué's interaction in the final

Category	Quadrant	Prospec	Retrosp	Radius	Angle
ZF10	III	-1.49	-0.25	1.51	189.52
ZF20	I	1.09	0.34	1.14	17.15
ZF30	I	2.27	3.6	4.25 (*)	57.71
ZF40	I	2.31	6.43	6.83 (*)	70.23
ZF50	IV	4.61	-1.37	4.81 (*)	343.47
ZF60	IV	0.91	-1.29	1.58	305.22
ZF70	I	6.08	1.31	6.22 (*)	12.12
ZF80	I	1.97	3.66	4.16 (*)	61.67
ZF51	III	-2.46	-0.96	2.65 (*)	201.32
ZF61	III	-2.58	-1.85	3.17 (*)	215.71
ZF71	III	-0.82	-3.04	3.14 (*)	254.92
ZF81	II	-0.47	2.39	2.43 (*)	101.02
ZF90	II	-0.75	1.27	1.48	120.37
ZF100	III	-2.3	-0.92	2.48 (*)	201.71
ZF110	III	-0.31	-0.45	0.55	235.66
ZF120	II	-1.44	0.09	1.44	176.26
ZF130	III	-2.16	-1.82	2.82 (*)	220.12

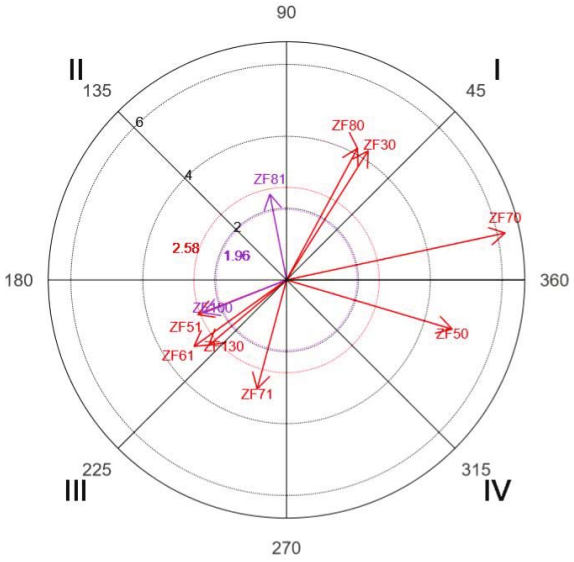

Figure 11b. Piqué's interaction in the final

On the other hand, tables 12a and 12b, and figures 12a and 12b shows the results of the focal behavior –J3-, with the pairing categories related to regulatory interruption situations, as well as the different interceptions that occur during the first and last match of the championship.

Table 12. Gerard Piqué's interaction with the situations of play (regulated interruptions and interceptions

Tabla 32a. Piqué's interaction in the first match

Group phase	Category	Quadrant	Prospec	Retrosp	Radius	Angle
	GTO	III	-0.54	-0.36	0.65	214.02
	FKTO	IV	1.37	-0.51	1.47	339.46
	OTO	III	-0.66	-0.14	0.67	192.28
	TITO	III	-0.56	-0.41	0.7	216.14
	CKTO	II	-1.19	0.7	1.38	149.36
	GKTO	IV	0.21	-0.05	0.22	345.96
	FKATO	IV	1.78	-0.97	2.03 (*)	331.23
	OATO	III	-0.72	-0.65	0.97	222.2
	TIATO	IV	4.76	-1.13	4.9 (*)	346.64
	GKATO	II	-1.05	0.64	1.23	148.57
	KO	I	0	1.27	1.27	90
	EFH	III	-0.41	-0.38	0.56	223.38
	LB	IV	0.65	-0.08	0.66	352.97
	RB	III	-0.05	-0.07	0.08	233.75
	IOC	II	-2.2	1.32	2.57 (*)	149.05

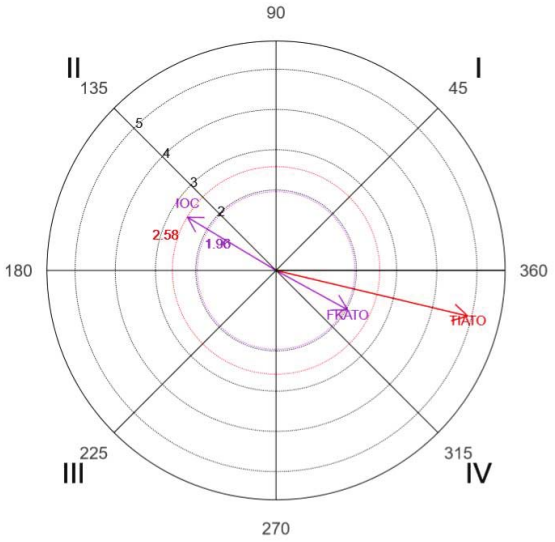

Figure 12a. Piqué's interaction in the first match

Championship final

Tabla 42b. Piqué's interaction in the final

Category	Quadrant	Prospec	Retrosp	Radius	Angle
GTO	III	-0.76	-0.77	1.1	223.85
FKTO	IV	3,83	-0,89	3.93 (*)	346.93
OTO	IV	2,11	-0,57	2.18 (*)	344.8
TITO	III	-0.62	-0.14	1.19	179.78
CKTO	III	-0.72	-1.16	1.11	280.95
GKTO	IV	2,32	-1,22	2.62 (*)	332.21
FKATO	IV	2.19	-0.21	1.23	335.21
OATO	III	-0.69	-0.68	1.01	224.28
TIATO	I	1,1	1,66	1.99 (*)	56.45
GKATO	II	-0.84	0.01	0.87	183.23
NK	III	-0.26	-0.21	0.33	220.1
KO	III	0	-0.53	0.54	270
EFH	III	-0.25	-0.21	0.34	219.13
LB	I	0.6	2.32	1.65	91.08
RB	II	-1,95	1,46	2.44 (*)	143.13
IOC	III	-0,97	-2,14	2.35 (*)	245.73

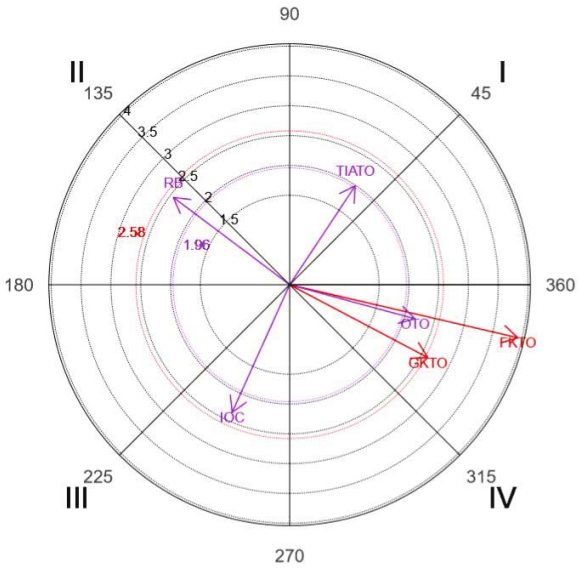

Figure 12b. Piqué's interaction in the final

In tables 13a and 13b, and figure 13a has related the focal behavior –J3-, with the matching categories related to the technical actions established (C1, C12, C2, C23, C24, C3, C4 and C5), in both games against the italian team.

Table 13. Results from the polar coodinate analysis for the focal category P3 in relation to the type of contact with the ball.

Group phase

Tabla 53a. Piqué's interaction in the first match

Category	Quadrant	Prospec	Retrosp	Radius	Angle
C1	II	-3.05	0.39	3.08 (*)	172.66
C12	IV	1.23	-0.63	1.38	333.1
C2	IV	2.11	-0.42	2.15 (*)	348.83
C23	III	-1.33	-0.85	1.58	212.74
C24	II	-0.42	0.65	0.78	123.05
C3	IV	0.17	-0.22	0.28	307.23
C4	III	-0.72	-0.37	0.81	206.85
C5	I	3.56	0.98	3.7 (*)	15.36

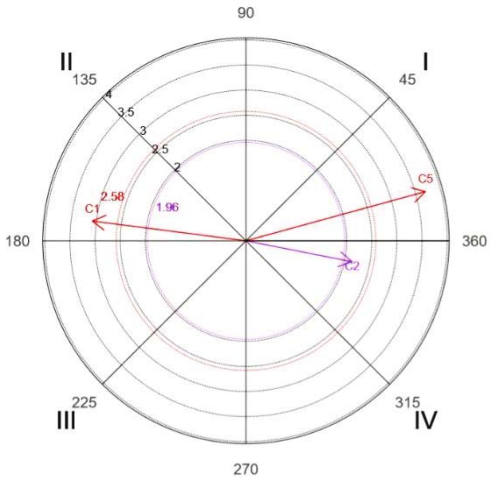

Figure 13. Piqué's interaction in the first match

Championship final

Tabla 63b. Piqué's interaction in the final

Category	Quadrant	Prospec	Retrosp	Radius	Angle
C1	II	-0.2	1.3	1.31	98.63
C12	II	-1.21	0.06	1.21	177.04
C2	IV	1.26	-0.83	1.51	326.73
C23	II	-1.21	1.25	1.74	134.06
C24	II	-0.16	1.58	1.59	95.82
C3	III	-0.53	-0.29	0.6	208.27
C4	III	-0.09	-1.34	1.34	266
C5	III	-0.42	-0.92	1.01	245.14

No significant results

$Z > 1.96$; $p < 0.05$

Finally, tables 14a and 14b shows the results for the type of shot the player takes, during the first match, and the final one played. As you can see, there are no significant relationships of the player with the shot to goal.

Table 14. Gerard Piqué's interaction with the type of shot that he performs

Tabla 74a. Piqué's interaction in the first match

	Category	Quadrant	Prospec	Retrosp	Radius	Angle	
Group phase	SG	III	-0.13	-0.15	0.19	229.69	No significant results $Z > 1.96$; $p < 0.05$
	SI	III	-0.28	-0.42	0.5	236.31	
	SBP	IV	0.5	-0.04	0.5	354.85	
	SWP	II	-0.23	0.9	0.93	104.5	
	SSG	III	0	-0.2	0.2	270	
	HEG	III	-0.13	-0.15	0.19	229.69	
	SI	III	-0.28	-0.42	0.5	236.31	
	SSG	IV	0.5	-0.04	0.5	354.85	

Tabla 84b. Piqué's interaction in the final

	Category	Quadrant	Prospec	Retrosp	Radius	Angle	
Championship final	SG	IV	0	0	0	NeuN	No significant results $Z > 1.96$; $p < 0.05$
	SI	IV	0	0	0	NeuN	
	SBP	IV	0	0	0	NeuN	
	SWP	IV	0	0	0	NeuN	
	SSG	IV	0	0	0	NeuN	
	HEG	IV	0	0	0	NeuN	
	HIG	IV	0	0	0	NeuN	
	HBG	IV	0	0	0	NeuN	
	SWP	IV	0	0	0	NeuN	

Discussion

The polar coordinate technique, which is highly effective for reducing the amount of data while maintaining a great informative capacity, was used to analyse Gerard Piqué's interactions with his teammates, the field of play and the different technical as well as tactical behaviours. The polar coordinate technique allowed for the creation of vector maps regarding the relations found between the focal behaviour and the different matching categories that were designed ad hoc in connection with its forward (prospective, with positive lags) and backward (retrospective, with negative lags) diachronism during play.

The need for an analysis of the tactical patterns (association and mutual activation) beyond the mere numerical data has gained increasing popularity among researchers for years (Duarte et al., 2012; Memmert, Lemmink & Sampaio, 2017; Sampaio & Maçãs, 2012).

This study also aimed to provide a solution to Gréhaigne et al., (1997) regarding what they considered the main challenge in football: to evaluate how players coordinate their actions in order to overcome obstacles or opponents, progress and keep ball possession.

a) Gerard Piqué's interaction with the other players of Spain's national football team:

As seen in the polar coordinate map (Figure 4), Gerard Piqué presents mutual excitatory interactions, established in quadrant I, with the other defenders in the same team (P17 Arbeloa and P15 Sergio Ramos) as well as the player from the rear line (P1 Iker Casillas), i.e. the goalkeeper. Moreover, the great intensity of these interactions (radius of 6.04, 5.67 and 6.09 respectively) reveals the intense coordination between those two lines, which is a vital aspect among scientists (Gréhaigne et al., 2013). These results are also supported by Folgado, Duarte, Fernandes & Sampaio (2014) who believe that defenders and miedfielders display the highest levels of coordination. The activation of the matching behaviour P20 (Cazorla) in quadrant I and the behaviour P14 (Xavi Alonso) in quadrant IV, both midfielders, suggests that. Spain's style of play, based on continuous passes searching for a step-by-step progressive build up towards the other team's goal, requires advanced levels of organisation and coordination not only within the same line but also with the back line. According to Dawon & Dobson (2002), central defenders and miedfielders are the players who better put tactical concepts into practice. Gerard Piqué, Cazorla and Xavi Alonso use specific tactical mechanisms for creation of optimal progression situations by either establishing motor communication interactions through the ball or opening up strategic spaces.

In addition, the interesting excitatory presence is found at the retrospective level in quadrant II of the category P9 (Fernando Torres) together with the category OP (opponent). This may result from the fact that the Spanish football team react to the loss of possession in offensive zones of the pitch resorting to the tactical rule of collective pressure, which proved to be a successful defensive strategy for winning back the ball (Pan, Huang, Ding, Zhang & Tomlin, 2012; Headrick et al., 2012). The behaviour is based reducing the other team's time and space as a way to trigger panick and hasty decisions in them. Consequently, the other team use long aerial passes commonly known as direct play in an attempt to avoid this pressure. Therefore, the data obtained shows that Gerard Piqué is the immediate receiver of the ball, who resumes the progressive build-up structure mentioned earlier.

In practice, coaches must prevent the beginning of the Spanish team's associative play in the initial build-up stages where the observed player is mainly involved. The use of pressure, which reduces time for decision-making, will produce a greater defensive performance.

b) Gerard Piqué's interaction with the zone or area where the actions are started and finished.

The observed player establishes mutually excitatory interactions in quadrant I with the same matching behaviour both when starting and finishing his actions. First of all, these interactions indicate that Gerard Piqué presents a radius including all the defensive and central zones of the field. This, un turn, reveals that he is a versatile player who covers a large area of the pitch with different reactions through the ball or the strategic explotation of space. Taki & Hasegawa (1998), refer to it as dominance zone where the player displays his behaviour. As reinforced by Kannekens, et al., (2010), this encourages the player to be a prolific decision-maker. Hence, the player must adapt individually and collectively to the changing patterns of play while keeping the tactical concepts in mind. Additionally, the players occupying the central area of the field prove highly responsible and committed (Fransen, Haslam, Mallet, Steffan, Peters & Boen, 2016), from where they can interact with their teammates and opponents in turning

radiuss of 360º. This is vital in teams which adopt an associative style of play, where the player constantly creates and strategically controls the space.

On the other hand, there is a robust presence of the behaviours ZI60 and ZI70 (radius of 4.53 and 7.17 respetively), which are zones located away from the observed player's own goal. This implies that the observed player needs to perform one of the most tactically important aspects of the game with great precision, i.e. the off-side (Oudejans, Verheijen, Bakker, Gerrits, Steinbrückner & Beek, 2000; Maneiro, Casal, Álvarez, Moral, López, Ardá& Losada, 2019).

The data presented in quadrant IV, where the focal behaviour activates the matching behaviour at the prospective level, also reveals that Gerard Piqué has an alternative reaction. The horizontal (ZF50 and ZF10) and vertical (ZI10) behaviours, both of which appear away from his natural area of influence, indicate that he has control over distant areas of the pitch. Grund (2012) demonstrated that the teams that decentralise their actions in favor of playing the ball in peripheral sections of the field have more probability of scoring a goal. In this case, Piqué and his teammates use the ball as a magnet to pull them away from that critical area of the pitch. Their main objective is to move forward creating spaces in strategic areas in order to perform a long pass or change of direction to those scarcely populated areas at the right moment. One of Piqué's resources is the creation of fake clues in order to confuse his opponents.

Finally, the presence of the behaviour ZI110 in quadrant II at the retrospective level in very interesting. It confirms what was mentioned earlier regarding the category P9 (Fernando Torres) and the pressing tactical mechanism carried out by the team when the ball possession is lost.

Coaches must pay attention to the zones where the player starts and finishes their actions, preferably in the defence and midfield of the observed team. It could be very helpful to stop the progression of play right from the beginning through the reduction of spaces to the player with the ball as well as the likely receivers.

c) Gerard Piqué's interaction with the situations of play (regulated interruptions and interceptions).

As described in the polar coordinate map in Figure 7, the appearance of the behaviour LB (loss of possession) at both the prospective and retrospective levels indicate that the player is highly participative when his team has the possession. It was found that the leading player in the team (Fransen, et al., 2016), maintains a direct causal connection with the loss of possession. The major tactical responsibility during the build-up of play (change of direction, outnumbering, dealing with defensive tasks of one against one) implies possible losses of possession that another defender exclusively dedicated to defending does not have to face. This is confirmed by the very low intensity of the interaction (radius of 2.11). In contrast, the appearance of that behaviour at the retrospective level suggests that Piqué causes losses of possession in the other team, through challenges, pressure and good timings, from which his own team may take advantge. That idea is justified by the absence of the behaviour FKATO in conjunction with the appearance of the behaviours GKTO and TIATO in quadrant IV.

In practice, coaches must prioritise the situations where the observed player is outnumbered forcing him to execute his actions on the sides of the field where his area of activity is reduced resulting in more losses of possession. Therefore, deploying the team so as to perform high pressure on both defense and midfield lines could help the other teams achieve greater success (Maneiro, Casal, Losada y Ardá, 2017).

d) Gerard Piqué's interaction with the skill move that he performs.

Concerning the skill or technical moves used by the player as the foundation of his tactical behaviour, the obtained results confirm his intense tactical output. As a matter of fact, the appearance of the behaviours C1 and C23 in quadrant II, both related to control and passes at the expense of traditional behaviours from defenders (Bloomfield et al., 2007; Taylor, Mellalieu & James, 2005) is just a confirmation of that aspect. The appearance of the behaviour C3 (control+ball-carrying+pass) in quadrant IV at the prospective level is equally interesting. It is an indication that Piqué uses his ball carrying ability as a tool to move the ball to the next line. In order to create the best possible conditions of delivery and expansion of the action, the vertical carrying of the ball is likely to produce situations where the opponents are outnumbered in the next line. This generates confusion in the midfielders from the other team as they have to decide whether to leave their position to defend against the player or maintain their initial game plan. In both cases, the defending team's tactical and defensive strategy is compromised. As a consequence, the observed team have a major advantage as they rely on more players to interact with ball when it is in the midfield.

This revolutionary tactical organisation, based on the creation of situations where the other team are outnumbered in the midfield by carrying the ball starting from the preceding defence line, seriously jeopardises the defensive structure of the other team. Coaches will have to dedicate their efforts to designing training exercises based on changing situations where players are forced to adopt to flexible behavioural patterns, which clearly reflects the changing reality of football (Balague, et al., 2013; Camerino, Chaverri, Anguera & Jonsson, 2012).

Finally, and with the purpose of knowing the differences in the tactical, technical and spatial performance of the focal player -J3- (Gerard Piqué), the two matches where this player has competed against the Italian national football team have been analyzed. The first match was in the group stage, and the second in the final of the championship.

Table 9 shows the results of the focal behavior relationships -J3- with the rest of the players that make up the squad. As you can see, there are significant differences between the first match and the second. Specifically, Piqué establishes significant relationships with P17 (Arbeloa) in both matches, indicating that this player is related to players close to him, trying to ensure the conservation of the ball from his location on the field. In addition, this idea is corroborated by the inclusion of the behaviors of P15 -Sergio Ramos- and P1 -Iker Casillas- in the final of the championship. In view of these results, it is plausible to think that Gerard Piqué, opts for safety behaviors, not taking risks in any of the matches and ensuring possession of the ball. On the other hand, the activation of the P9 behavior - Fernando Torres - in quadrant II during the final of the championship demonstrates a previous tactical work, since this activation had not previously occurred.

With regard to the start and finishing areas of their actions (Table 10 and Table 11), again there are significant differences between both matches. Specifically, it is possible to affirm that the radius of action of Gerard Piqué has been broader during the final than in the first match, both in the starting and finishing areas of his actions. Specifically, the player activates central defensive zones and the entire right side of the field. These differences between both matches could have their explanation in corrections and tactical adjustments with respect to the first match, to correct own deficiencies or to exploit weaknesses of the rival game. In the final of the championship, the player has been responsible for more field than in the first game.

Gerard Piqué has also played an important role during both games in aspects related to interruptions and interceptions of the game. Specifically, the player presents significant relationships with favourable static ball actions in the first match (radius of 2.06). However,

this behavior is not significant in the match of the final of the championship, where the behavior of loss and recovery of the ball does appear as significant. Specifically, it is possible to affirm that due to its position in the field, its technical reliability (table 7) and its wide range of action (table 11), Piqué is one of the players responsible for recovering the ball and initiating offensive tactics. This is a very important thing in the Spanish football team, where the gradual construction of the attack has been shown to be significant (Amatria, Maneiro and Anguera, 2019; Amatria, Maneiro, Pérez-Turpin, Gomis-Gomis, Elvira and Suarez, 2019).

Finally, regarding the type of contact made with the ball, again there are significant differences between the match of the group stage and the final. Specifically, the appearance of C5 conduct in Quadrant I indicates that the Gerard Piqué focal conduct presents a significant relationship with the head-to-ball hits in the first match, something that does not happen in the second. This is likely due to different tactical approaches on both teams. Given the results of Table 12, Piqué is likely to be an offensive reference in offensive static ball actions. In this sense, it is important to note that the goals resulting from static ball actions provide points or victory for the teams (Casal, Maneiro, Ardá, Losada & Rial, 2015; Maneiro, Casal, Ardá & Losada, 2019).

Finally, it is not possible to refer results on the pitches you make at goal.

Conclusions and future lines of research

The main purpose of this study was the analysis of the different interactions that Gerard Piqué maintain with his teammates within the general context of the team as well as the description of his spatial, technical and tactical output during his participation in the play. The discussion section introduced avove includes a series of practical recommendations for coaches. The study also highlights the effectiveness of the observational instrument, including powerful techniques such as the polar coordinate analysis, as an optimal methodology filter for the study of players' spontaneous behaviour. Future research projects should focus on the player's individual experience from the contextual perspective and later design the complex structure which accounts for the interactions between the different members of a team. As a result of this, new tactical alternatives will be suggested which may assist coaches in their jobs.

Acknowledgements

The authors gratefully acknowledge the support of the Spanish government subprojects Integration ways between qualitative and quantitative data, multiple case development, and synthesis review as main axis for an innovative future in physical activity and sports research [PGC2018-098742-B-C31] and Mixed method approach on performance analysis (in training and competition) in elite and academy sport [PGC2018-098742-B-C33] (Ministerio de Ciencia, Innovación y Universidades, Programa Estatal de Generación de Conocimiento y Fortalecimiento Científico y Tecnológico del Sistema I+D+i) (2019-2021), that are part of the coordinated project New approach of research in physical activity and sport from mixed methods perspective (NARPAS_MM) [SPGC201800X098742CV0].

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