Mastery in goal scoring, T-pattern detection and polar coordinate analysis of motor skills used by Lionel Messi and Cristiano Ronaldo

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The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest

Author contribution statement

MC developed the project, supervised the design of the study and drafting of the manuscript- DB was responsible for the review of the literature and the drafting of the manuscript. OC was responsible for the T-pattern detection, data collection/handling and revised the content critically. MT performed the polar coordinate analysis and the method section. TF collected and codified the data. RH supervised the drafting of the manuscript. All authors approved the final, submitted version of the manuscript.

Keywords

Soccer, Goal scoring, Motor Skills, Pattern detection, polar coordinate analysis

Abstract

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Research in soccer has traditionally given more weight to players' technical and tactical skills, but few have analyzed the motor skills that underpin specific motor actions. The objective of this study was to investigate the style of play of the world's top soccer players, Cristiano Ronaldo and Lionel Messi, and how use their motor skills in attacking actions that result in a goal. We used and improved the easy-to-use observation instrument (OSMOS-soccer player) with 11 criteria, each one expanded to build 50 categories. Associations between these categories were investigated by T-pattern detection and polar coordinate analysis. The T-pattern showed that for both players the combined criteria were mainly between the different aspects of motor skills, namely use of lower limbs, the outside foot contact with the ball, locomotion, the body orientation towards the opponent goal line and the criteria of technical actions and the right midfield. Polar coordinate analysis detected significant associations between the same criteria included in the T-patterns and the criteria turn of the body and being in numerical equality with no pressure and relative numerical superiority.

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Ethics statements

(Authors are required to state the ethical considerations of their study in the manuscript, including for cases where the study was exempt from ethical approval procedures)

Does the study presented in the manuscript involve human or animal subjects: No

Introduction

Soccer performance research is broadly developed and implemented (Ali, 2011), contributing to a rapid and continuous enhancement of players' performance in the last few years (Lago-Ballesteros et al., 2012). For that, in regards of soccer complexities and dynamic nature, observation and measurement processes throughout the design of match analysis systems, have been permitting to collect data embracing technical, behavioral, physical and tactical factors (Carling et al., 2005).

Due to soccer game high complexity it is known that general research in soccer present some flaws, namely (i) lack of context; (ii) missed operational definitions (Mackenzie and Cushion, 2013); and (iii) incapacity of parameters such as official match statistics, physiological and performance data to provide information for a comprehensive evaluation of the soccer players (Perić et al., 2013). The idiosyncrasies of the dynamic systems theory permit to overcome these limitations (Glazier and Robins, 2013), supposing that mathematical models of analysis must incorporate a wider range of organismic, environmental and task constraint (Glazier and Davids, 2009). In specific, dynamical systems theory assumes an important role with its multidisciplinary theoretical framework for sports performance analysis (i) facilitating the linkage of behaviors to outcomes due to its process-oriented than product-oriented focus, and (ii) stabilizing the same principles and concepts governing patterns in intra and inter individual levels of sports performance (Glazier and Robins, 2013).

There is a general belief that talented people display superior performance in a wide range of activities, such as having superior athletic ability and mental abilities (Feltovich et al., 2006). Notwithstanding to understand sport expertise multi-scale and multi-disciplinary theoretical descriptions are needed (Araújo et al., 2010), in the domain of team play analysis McGarry et al. (2002) mention that tactical and technical lead the main soccer research. Technical analysis includes the testing of sport key skills, that include the mechanical aspects of technique and is concerned to the way skill is performed in terms of kinetic and kinematic detail of the movement involved (O'Donoghue, 2010). In Ali (2011) perspective it becomes useless if the player does not perform the right action at the right time, i.e., if does not exist a tactical approach of the players' behavior. This is explained by how dynamical movement systems exploit surrounding constraints to shape the functional, self-sustaining patterns of behaviors emerging in specific performance contexts. Thus, specific information plays an important role in constraining the number of biomechanical degrees of freedom of the motor system that the central nervous system needs to regulate during functional behavior. So, more critical than controlling each degree of freedom separately during goal-directed movement, central nervous system exploits self-organization in movement systems to form and to develop functional synergies that emerge between parts of the body used to achieve movement goals (Davids et al., 2006).

However, with the application of styles of play that incorporate and encourage individual actions and skills, that improve overall game strategies and outcomes (Carling et al., 2008), individual relevant behaviors in soccer, such as goal-scoring, need to be analyzed in regards of the motor skills (Castañer et al., 2016). Nevertheless goal-scoring, the ultimate objective of attacking effectiveness in competition settings has been extensively used in match performance research (Lago-Ballesteros et al., 2012; Tenga et al., 2010), the objectivity of its research remains insufficient in regards of the motor skills that support goal-scoring patterns (Castañer et al., 2016).

Indeed, in elite soccer the use of motor skills has largely been studied from a subjective perspective (Duch et al., 2010), but mastery of these skills (Castañer et al., 2009, 2016;

Wallace and Norton, 2014) is directly linked to motor versatility (Bishop et al., 2013) and consequently to the ability to execute complex intentional actions (Memmert et al., 2013). Motor versatility in both, individual and team sports require the integration of multiple skills (Bishop et al., 2013); it is a particular important quality in attackers such as strikers and wingers, and is closely linked to motor action anticipation (Murgia et al., 2014). In fact the ability to execute skilled movement patterns efficiently and effectively is the most important aspect of soccer performance and players must apply cognitive, perceptual and motor skills to rapidly changing situations (Ali, 2011). These multiple skills are essential to the execution of soccer moves, such as ball control, dribbling, and shots. Motor skills involve axial movements in the form of turns and pivots, spatial orientation of the player's body in relation to the side lines and goal line, and use of one limb or another (laterality). These movements not only underpin all soccer moves, but also contribute to the uniqueness of each player (Castañer et al., 2016). In addition, most of these movements are interlinked, as laterality (Bishop et al., 2013; Teixeira et al., 2011), for example, refers not only to left-right preference but also to how a player orientates his body spatially (Bishop et al., 2013; Loffing et al., 2015). In previous researches (Castañer et al., 2016) has been demonstrated that Lionel Messi is a good example in relation to the laterality aspect, as he is a left-footed player who has achieved some of his best results playing on the right wing. As Cristiano Ronaldo has not the singularized aspect of been left footed in goal scoring, he is also an exponent of motor skills versatility, the main aspect of our research, the motor skills that configures the uniqueness as a striker.

Cristiano Ronaldo and Lionel Messi are considered the best world's top soccer players ever existed as they evidence singular performances. Since 2008 no other players won FIFA best player award: Lionel Messi won for 5 times and Cristiano Ronaldo for 4 times. In a comparison of Ronaldo and Messi goal-scoring in *La Liga* since 2009-2010 season, Shergold (2016) found that Messi scored 270 goals in 252 matches, playing 21218 minutes and performing 953 shots and Ronaldo scored 270 goals in 247 matches, 21206 minutes played and 1318 shots performed; evidencing that Messi has 28,77% shot conversion and Ronaldo 20,03%. Additionally, statistics show that Ronaldo, as senior player (before 9th October 2016), scored 541 goals in 27 different countries, most of the goals in Spain (326) and in England (112) (Sousa, 2016). Nevertheless, both players show uniqueness and skilled, Jafari and Smith (2016) hypothesized that Lionel Messi has acquired higher motor skills than most other players, and that frees up so much cognitive capacity. On the other hand, Hong et al. (2012) relate the "knuckling shot" as one of the characteristics of Ronaldo.

To us, the above-referred attributes describes two singular styles of soccer playing, however, have not been analyzed from an objective, scientific perspective. Such analysis is challenging, as soccer is a complex game that requires a wide repertoire of individual skills used to the benefit of the team and is characterized by constant interactions between technical, tactical, psychological, and physical factors. To identify an exceptional expert there are diverse methods that can be applied — retrospective method is one. That is, by looking at how well an outcome or product is received, one can determine who is an expert (Chi, 2006). Here we followed Hodges et al. (2006) clue that assume focus may be the development of tasks that possibly elucidate the underlying mechanisms that afford consistent expert performance.

Thus, the overall objective of this study was to perform an objective analysis of Lionel Messi's and Cristiano Ronaldo's use of motor skills prior to scoring a goal using two complementary methods: T-pattern detection (temporal pattern) and polar coordinate analysis. The methodological aim was to identify hidden temporal patterns underlying the two players' styles and to provide a vectorial representation of the associations detected

between behaviors using polar coordinate analysis, whose powerful data reduction feature facilitates the interpretation of data.

Method

We employed systematic observation (Anguera, 1979), as our study fulfilled the requisites established by Anguera (2003) for a study of perceivable regular behaviors in a natural setting. The choice of methodology is also justified as we used an *ad hoc* observation instrument to record, analyze, and interpret the behaviors exhibited by Messi and Ronaldo in the goals analyzed.

Observational methodology offers eight types of observational designs (Anguera and Hernández-Mendo, 2014; Blanco-Villaseñor et al., 2003; Portell et al., 2015; Sánchez-Algarra and Anguera, 2013) depending on how to merge to the number of participants, the continuity of the recording and the number of criteria to observe. Those designs have been widely applied in the analysis of team sports (Camerino et al., 2012b; Castañer et al., 2016; Jonsson et al., 2006; Fernández et al., 2009; Lapresa et al., 2013) and in the analysis of motor skills in physical activity and sport (Castañer et al., 2009, 2016). We chosed a N/S/M design, where N refers to nomothetic (focusing on two players), S refers to intersessional follow-up (recording of numerous matches analyzing specific motor skills and contextual aspects recorded from the beginning to end of different sequences), and M refers to multidimensional (addressed multiple criteria and responses included in the ad hoc observation instrument we have designed for this study).

Two particularly fitting techniques for analyzing such complexity are T-pattern (temporal pattern) detection (Magnusson et al., 2016) and polar coordinate analysis (Sackett, 1980).T-pattern detection has been successfully used in numerous studies to reveal hidden patterns underlying different soccer actions (Anguera and Jonsson, 2003; Barreira et al., 2014; Escolano-Pérez et al., 2014; Fernández et al., 2009; Garzón et al., 2011; Jonsson et al., 2006; Lapresa et al., 2013, 2014; Magnusson et al., 2016; Sarmento et al., 2013; Zurloni et al., 2014).). Polar coordinate analysis, in turn, is a powerful data reduction technique that is being increasingly used in studies of team sports (Aragón et al., 2016; Castañer et al., 2016; Echeazarra et al., 2015; López-López et al., 2015; López et al., 2016; Morillo-Baro et al., 2015; Perea et al., 2012; Robles et al., 2014; Sousa et al., 2015). The technique provides a vectorial representation of the complex network of interrelations between carefully chosen, exhaustive and mutually exclusive defined criteria.

Participants

A total of 181 goals were analyzed — 83 scored by Lionel Messi and 98 scored by Cristiano Ronaldo (Table1) — in respect to the following criteria:

i. Clear observability of the sequence leading up to the goal (Anguera and Hernández-Mendo, 2015);
ii. Availability of at least two recordings of each sequence from a different angle;
iii. Goals scored in Champions League, *La Liga* and *Copa del Rey*;
iv. The last three seasons goals were considered, namely 2013-2014, 2014-2015 and 2015-2016;
v. Opponent quality criterion: Champions League is known as the most elite Union of European Football Associations (UEFA) competition, so all goals scored in this were considered; in *La Liga*, following Bradley et al. (2013) criteria, only goals scored against non-successful clubs — the last fourth classified in the end of each season — were not included;

vi. Goals resulting directly from set pieces, including the recharge of a penalty, were not considered;
vii. Goals scored in regular time were included.

Our study can thus be considered case-oriented (Sandelowski, 1996; Yin, 2014). The goals were analyzed using public television footage, in compliance with the ethical principles of the Declaration of Helsinki.

**** Table I near here****

Materials

Observational instrument. We used the *ad hoc* observation instrument (OSMOS-soccer player) (Castañer et al., 2016) with a minimum optimization in the criteria referred to Number of Opponents that has been substituted by Center of the Game adapted from Barreira et al. (2012, 2014, 2015). The instrument (see Table 2) comprised eleven criteria: 1) Body Part (part of the body that the players uses to make contact with the ball); 2) Foot Contact Zone (part of the foot used to touch the ball); 3) Body Orientation (angling of the chest with respect to the side line or goal line); 4) Turn Direction (right *vs* left); 5) Pivot Foot (right *vs* left); 6) Stability (elevation of the body); 7) Locomotion (number of steps between touches of the ball); 8) Action (common technical soccer actions); 9) Center of the Game (number of players of both teams interacting during the striker's action); 10) Side (position of the player on the pitch); 11) Zone (area where the player moves). Each of these criteria was expanded to build an exhaustive and mutually exclusive observation system that included, in a total, 50 categories.

**** Table II near here****

Recording instrument. Goal-scoring sequences were coded using LINCE (v.1.2.1) (Gabín et al., 2012). This software program was also used for the data quality check.

Data analysis software. Two programs were used: a) Theme software package (Magnusson et al., 2016) for T-pattern detection; b) HOISAN v1.6.3.2 (Hernández-Mendo et al., 2012, 2014) for the polar coordinate analysis.

Procedure

Goal-scoring sequences were analyzed from the moment the players received the last pass up to the moment he scored a goal. After appropriate training in OSMOS-soccer player use, two expert observers — a soccer analyst expert and a motor skills expert —, recorded 30% of the total goals included for each player (Table 3). Intraobserver and interobserver reliability was calculated in LINCE software before coding the full data set using a preliminary dataset of 55 and 30 goal-scoring sequences, respectively. Goals used to calculate data quality were from the 2012-2013 season, so not included in the final sample. The resulting kappa statistic was 0.95 for interobserver and 0.98 for intraobserver analysis, which guarantees the interpretative rigor of the coding process.

**** Table III near here****

Data analysis

T-pattern detection. T-pattern detection is a relevant data analysis technique in systematic observation (Anguera and Hernández-Mendo, 2015), and THEME software constitutes a

powerful research tool to obtain T-patterns. Indeed it is able to explore behavioral structures in detail by revealing stronger connections between successive recorded behaviors in goals than would be expected by chance. In this sense, the critical interval is the key concept that enables the admissible temporal distances between successive identical or similar occurrences to be delimited in order to consider the existence of a temporal pattern. Obtaining T-patterns is of great importance both theoretically and empirically, and deriving their algorithm has involved the development of new and powerful analytic techniques based on probability theory and, more specifically, the binomial distribution (Magnusson, 2000).Three criteria were applied to guarantee that any T-patterns detected were not due to random events: a) presence of a given T-pattern in at least 25% of all sequences, b) significance level of 0.005, and c) redundancy reduction setting of 90% for occurrences of similar T-patterns. As Magnusson states (Magnusson, et al., 2016), the idea of T-pattern analysis is to detect repeated behavioral patterns that are invisible to unaided observers. The temporal structure of complex behavioral sequences is composed of simpler or directly distinguishable event-types. Each T-data set subject to analysis consists of series of behaviors coded as occurrence times (beginning and end points) within specified observation periods (time point series) (Magnusson, 1996).

More specifically, within a given observation period, two actions, A and B, that are repeated, either in this same order or simultaneously, form a minimal T-pattern (AB) if they are found more often than would be expected by chance, and if, assuming the null hypothesis of independent distributions for A and B, they are separated by approximately the same distance (time). Instances of A and B separated by this approximate distance constitute an (AB) T-pattern and their occurrence times are added to the original data. More complex T-patterns consisting of simpler, already-detected patterns, are subsequently added through a bottom-up detection procedure. Pairs or series of patterns can thus be detected, for example (((AB)C)(DE)). The Theme software package features algorithms for dealing with potential combinatorial explosions due to redundant and partial detection of patterns using an evolution algorithm (completeness competition), which compares all patterns and retains only the most complete ones. As any basic time unit can be used, T-patterns are, in principle, scale-independent, although only a limited range of basic unit sizes is relevant in any study. Thus, it would be fruitful in the study of goal consecution from Messi and Ronaldo.

Polar coordinate analysis. Polar coordinate analysis involves the detection of significant associations between a focal behavior (the behavior of interest) and conditional behaviors (the other behaviors analyzed).

The structure of polar coordinate analysis, which is a technique that complements prospective and retrospective sequential analysis (Bakeman, 1978), is based on the complementarity between two analytical perspectives: prospective and retrospective. To conduct the prospective analysis, it is first necessary to define a behavior, known as the focal behavior, which, depending on the aims of the study, is believed to generate or trigger a series of connections with other categories, known as conditioned behaviors. The retrospective, or “backward” perspective, which incorporates what Anguera (1997) referred to as the concept of “genuine retrospectivity”, reveals significant associations between the focal behavior and behaviors that occur before this behavior.

Polar coordinate analysis can be applied to a series of values that are independent of each other, which is the case of adjusted residuals, whether prospective or retrospective, as they are calculated separately for each lag. Standardized Z statistics derived from adjusted residuals (Bakeman 1978, 1991) corresponding to both prospective and retrospective lags are needed to compute prospective and retrospective Zsum statistics. These values, which can be positive or negative and are located in one of four quadrants, are then used to build

maps showing the relationships between a focal behavior (Gorospe and Anguera, 2000) (or a criterion behavior as it is known in lag sequential analysis) and one or more conditional behaviors. Polar coordinate analysis involves the application of a complex procedure to provide a vector map of interrelated behaviors. The same number of prospective and retrospective lags is analyzed in each case. Prospective lags shows which conditional behaviors precede the given behavior, while retrospective lags show which behaviors follow it.

Polar coordinate analysis merges the prospective and retrospective approaches to achieve a powerful reduction of data through the calculation of the *Zsum* statistic $\left(\frac{\Sigma z}{\sqrt{n}}\right)$ described by Cochran (1954) and later developed by Sackett (1980). In both the prospective approach ($Z_{sum}P$) and the retrospective approach ($Z_{sum}R$), calculations are based on the frequency of the given behavior, *n*, and a series of mutually independent *z* values for each lag. Each of these values is obtained by applying the binomial test to compute conditional probabilities (based on the number of codes recorded for each goal sequence) and unconditional probabilities (due to random effects). The length of each vector is obtained from $\sqrt{(Z_{sum}P)^2 + (Z_{sum}R)^2}$, while its angle is calculated by dividing the retrospective *Zsum* arcsine by the radius (φ = arcsine of Y/radius). Prospective and retrospective Zsum values (lags 1 to 5 and lags -1 to -5, respectively) can carry a positive or negative sign; these signs determine in which quadrant the resulting vectors (behaviors) are placed. There are four possible quadrants and these indicate the relationship between the behaviors (inhibitory vs excitatory), as shown below:

Quadrant I (++). The given and conditional behaviors are mutually excitatory.
Quadrant II (- +). The given behavior is inhibitory and the conditional behavior is excitatory.
Quadrant III (- -). The given and conditional behaviors are mutually inhibitory.
Quadrant IV (+ -). The given behavior is excitatory and the conditional behavior is inhibitory.

As in previous research (Castañer et al., 2016), Figure 1 gives a graphical explanation of how to interpret the associations between given and conditional behaviors depending for each quadrant.

**** Figure 1 near here****

Depending on the quadrant in which the conditional behavior is placed, the angle of the vector is transformed as follows: quadrant I ($0 < \varphi < 90$) = φ; quadrant II ($90 < \varphi < 180$) = $180 - \varphi$; quadrant III ($180 < \varphi < 270$) = $180 + \varphi$; quadrant IV ($270^o < \varphi < 360^o$) = $360^o - \varphi$.

HOISAN v1.6.3.2 was used to calculate the prospective and retrospective adjusted residuals and the length and angle of the vectors and to produce a graphical representation of the results.

Results

T-pattern detection

T-pattern detection was obtained by means of THEME free software. Firstly we explored the frequency of events and event sequences (Figure 2). The box in Figure 2 shows the first 25 event-types with more than 2 occurrences, in the left chart for Messi and in the right chart for Ronaldo.

The common event-types with more frequency for both players were a total of nine configurations of codes. These were: facing goal, three steps between touches in the left midfield (FG,THR,CL) (Messi, n=16; Ronaldo, n=15); facing goal, more than five steps in the left midfield (FG,MOR,CL) (Messi, n=12; Ronaldo, n=14); facing goal, more than five

steps in the right midfield (FG,MOR,CR) (Messi, n=12; Ronaldo, n=6); left orientation of the body respect to the rival goal line with three steps in the right midfield (OL,THR,CR) (Messi, n=12; Ronaldo, n=11); facing goal, four steps between touches and left midfield (FG,FOU,CL) (Messi, n=8; Ronaldo, n=10); Left orientation of the body in the midfield (OL,CR) (Messi, n=8; Ronaldo, n=8); facing goal with right midfield (FG,CR) (Messi, n=7; Ronaldo n=10); facing goal, five steps and right midfield (FG,FIV,CR) (Messi, n=6, Ronaldo, n=6) and facing goal, three steps and right midfield (FG,THR,CR) (Messi, n=7, Ronaldo, n=10).

Complementary, other detectable aspects the frequency chart shows were that Messi used his left foot (LF) in 8 configurations while the use of his right foot (RF) appears in one configuration. Contrarily, Ronaldo uses his right foot (RF) in 8 configurations while his left foot (LF) do not appear in any configuration of codes. Messi uses his left orientation of the body (OL) respect to the rival goal line in 7 configurations of codes and in any configuration appears the right orientation of the body (OR). In his turn, Ronaldo uses his right orientation of the body (RT) respect to the rival goal in 7 configurations and his left body orientation (OL) appear in 2 configurations.

**** Figure 2 near here****

Obtaining T-patterns allow us to show a broad view of the main sequences that both players use in the process of goal scoring. As any basic time unit can be used, T-patterns technique selects the range of basic unit sizes that are relevant in any study. For this study the categories that appeared in the T-patterns were: body part, foot contact zone, body orientation of the body, technical actions and side. Figures 3 and 4 shows the most complete T-pattern detected from Messi and Ronaldo respectively.

**** Figures 3 and 4 near here****

Polar coordinate analysis

Over the clear comprehension that the previous figure 1 provides related to the associations between focal and conditional behaviors, we selected the quadrant II (QII) that contains the conditional categories that activates the focal category and the quadrant I (QI) that contains the categories that have mutual activation with the focal category. The maps in figure 4 show both quadrants with the length and angle of the vectors with a length of > 1.96 ($p < 0.05$) for the behaviors that show the statistically significant associations (activation).

Figures 5, 6, 7, 8, 9, 10, 11 and 12 show Messi and Ronaldo results of polar coordinates analysis concerning to categories in quadrant II (QII) that activates the focal category and the quadrant I (QI) that contain the categories that the focal one activates. We include below each semicircle map the table of values statistically obtained. Firstly we expose the categories that appear in the T-patterns corresponding to the criteria: Body part, Foot contact zone, Body orientation respect to the rival goal line, Locomotion and side. Complementarily, we offer the polar coordinate analysis for the criteria Turn direction and Center of the game that have also shown statistically significant activation between them.

**** Figures 5, 6, 7, 8, 9, 10, 11 and 12 near here****

Discussion

The objective of this study was to perform an objective analysis of Lionel Messi's and Cristiano Ronaldo's use of motor skills prior to scoring a goal using T-pattern and polar coordinate analysis complementary methods.

To structure the discussion section we firstly commented the polar coordinate analysis results following the order of OSMOS soccer player instrument criteria; and secondly, we commented the findings of the T-patterns analysis. We complete each section offering clues about how experts can understand the findings to improve their professional work.

Body contact with the ball

Polar coordinate maps show great differences between both players concerning to the use of the right foot. While there are not behaviors that activate the use of the right foot by Messi, Ronaldo's use of the right foot is promoted in situations of relative numerical superiority and numerical equality with pressure and is mutually activated by the use of the external zone of the foot and doing three steps between touches of the ball. In opposition, maps related to the use of the left foot show more mutual activations between behavior for Messi and less for Ronaldo. Moreover, the use of Messi's left foot and his body orientation to the left in respect to the opponent goal line is induced by turning the body into the left. The use of three steps between touches and the numerical equality with no pressure seems behaviors mutually activated with left feet's uses. These maps reinforces that Ronaldo and Messi tend to use preferred foot, right and left respectively, in situations of no high pressure and while in dribbling to create advantage in attacking zones and in 1x1 situations. Moreover, Castañer et el. 2016) findings related to contralateral dominance of Messi's body orientation are corroborated. Results also verify Carey et al. (2001) results that showed players were most asymmetrical for set pieces; but in technical actions first touches, passes, dribbles and tackles were rarely performed with the non-preferred foot as well.

The use of the inside of the foot activates Ronaldo's left foot use and this is mutually activated with numerical equality with pressure (PE) and, as Messi, the left orientation of the body respect to the opponent goal line.

Likewise, T-pattern analysis evidences clearly the predominance use of the left foot by Messi and the right foot by Ronaldo. Instead the great differences between both players related to right and left foot uses, the polar coordinate maps and the frequency chart also show their versatility and adaptability using both feet with other behaviors when necessary. Carey et al. (2001) refer that very few players used each foot with equal frequency but on the rare occasions they used preferred and non-preferred feet showed similar performance. In this sense, we advise experts that the use of both feet with success, notwithstanding with different frequency, thus evidencing versatility, is an indicator of expertise in soccer, and for that it may be included as a coaching task to develop symmetries in the use of both feet during dynamical relation with the ball.

Foot contact zone

For Messi the use of the outside of the foot is activated by the absolute numerical inferiority and activates using three steps between touches of the ball. In his turn, the use of the outside of the foot by Ronaldo is activated for the use of the head, being back facing the opponent goal line and pivoting over the right leg and is mutually activated with the use of the external zone of the foot and right foot and the orientation to the right of the body respect to the rival goal line (OR). In fact, this finding fits with the logic of soccer play that usually players use their exterior part to run with the ball faster.

Body orientation respect to the goal line

As the main task of strikers is goal scoring our findings point on facing goal as the body orientation in respect to the opponent goal line that both players use in interaction with other behaviors. We emphasize that contexts with no pressure induces both players facing goal; in Messi's case the context of numerical equality without pressure while in Ronaldo's the relative numerical superiority. This result show that expert players have great anticipation capacities, corroborating Ericsson (2003) that refers that experts seem better at catching early relevant indicators of the specific task. In our study, Messi and Ronaldo seems to create positional advantages in relation to opponent goal using their attention abilities to better anticipate the outcomes of their actions and the actions of opponents (Afonso, et al.,, 2012). So, in direct relation with the ball they have already prepared conditions to have higher success in attacking situations.

Messi's facing goal is mutually activated mainly with remaining facing goal line, with the use of the right leg and with the right foot. As Messi is left footed, the use of the right foot and leg while facing rival goal lines do not seems to us a paradox if not its versatility in his contralateral inferior limbs uses noticing that the values of polar coordinate analysis are very low. These findings are coincident with the findings of previous research (Castañer et al., 2016).

Locomotion

Between two touches of the ball, doing three steps is the locomotion behavior the results have point on in both, polar coordinate analysis and T-pattern detection. In both players it is activated by the relative numerical superiority. Also, we found that Messi and Ronaldo use their outside part of the foot, that was activated in Ronaldo's map and mutually activated in Messi's map. These results could be interpreted that in no pressure conditions of play the exterior part of players' foot is the most used in dribbling because with this ability they create more speed conditions to get advantage in space in relation to opponents. The singular contralateral use of the feet of both players is again reinforced from the view of these maps that show the mutual activation of doing three steps with the left foot by Messi and with the right foot by Ronaldo.

Side

The right and left midfield are the category of the criteria side that is shown by polar coordinate analysis and T-pattern detection. T-patterns show clearly the difference between both players related to the main uses of the midfields, the right one by Messi and the left one by Ronaldo. Being Messi in the right midfield is activated by the orientation of the body facing the rival goal line and it is mutually activated by the turn of the body to the left and the use of the outside of the foot. In his turn, being Ronaldo in the left midfield is activated by the numerical equality without pressure, the use of the outside of the foot, the chest and facing goal respect to the rival goal line. These results corroborate statistics presented by InStat Scout software about Messi and Ronaldo patterns of play in regards of where the players touch the ball all over the matches: 84% of Messi touches occur in the right wing, 8% in the mid offensive zone and 8% in central attacking zones; Ronaldo touch the ball mostly in left wing (57%), but in balance with central attacking zones (42%), data that evidence a greater trend by Ronaldo to play in interior zones of the field in comparison to Messi.

Technical actions

T-pattern detection and frequency chart shows more use of dribbling and feint of change of directions in Messi goal scoring than in Ronaldo. Polar coordinate maps show also non-statistically significant activation between dribbling and other behaviors. Contrarily, Messi's dribbling is activated by control of the ball and is mutually activated with remaining ball dribbling, the use of the feint of pass and the feint of change of direction. The T-pattern detection also reinforces this behavior (figure 3): Messi touches the ball with his left foot with its outside part while facing goal respect to opponent goal line. For this, Messi tricks defenders by changing direction in the right midfield and then he maintains touching the ball with his left foot with left body angle respect to the rival goal line, dribbling the ball while continues to retain the right midfield. With this, we conclude that Messi tend to create a great diversity of individual attacking situations, result that corroborate Serrado (2015) statement: Messi is considered the most World unpredictable player. Morris (2014), studying Messi between 2010 and 2014, reported he has 50% of efficacy in dribbling and tries to perform feints in average 8 times per game. Also, showed that Messi was the most successful player in assistances and goals scored, having the best relation goals / assistances with 1,30 goals and 0,40 assistances per game. In the same period of analysis, in passing situations Messi was the striker with more passes performed (11120), 84% of them with success. 47% of these were completed to attacking zones, with 450 ruptures passing, 30 of them permitted a goal (Morris, 2014).

On the other hand, maps show that feint of change of direction is more similar in both players. This behavior is activated by the control of the ball and is mutually activated with dribbling. For Ronaldo it is also mutually activated by the shot feint, which corroborates Ronaldo is the top shooter in the period between 2010-2014, with 1018 shots performed (Morris, 2014).

Turn direction

The maps shows for Messi that the right turn of the body is the use of the left leg and being back orientated towards the rival goal line and is mutually activated with the orientation to the right of the body respect to the rival goal line and the relative numerical superiority. This finding reinforces again the contralateral actions of stasis and precision of the laterality uses of the limbs (Teixeira et al., 2011) For Messi and also for Ronaldo which map shows that The right turn of the body is activated by being back orientated towards the rival goal line and is mutually activated with the orientation to the left of the body respect to the rival goal line and the numerical equality with pressure. In this line, Castañer et al., 2016) reported that the right turn of the body showed that Messi goal scoring was directly related to the use of the left leg because he stasis over his right leg to turn the body which allows the left leg to do precise actions.

Centre of the game

The aspect most relevant that can be seen for the behavior of numerical equality with no pressure is that in the both players it is mutually activated by remaining numerical equality with no pressure. We conclude that expert players frequently create conditions, in time and space, to play in no pressure conditions, in this case in goal-scoring situations. Anticipation is generally considered a mark of experts, so it should be attended on the basis of the specific tasks and contexts with knowledge of their advantages and disadvantages (Gold and Shadlen, 2007),.Messi and Ronaldo, as the most expert goal scorers, seems to create better conditions to apply shooting technique.

Conclusions and Future Lines of Study

The objective of this study was to describe objectively the singular style in goal scoring of the world's top soccer players, Cristiano Ronaldo and Lionel Messi. Observational methodology allows to sports scientists obtain objective data to complement subjective judgments of motor skill use of soccer players. To proceed we used the OSMOS soccer player observational system (Castañer et al., 2016) that points on 8 criteria related to player's motor skills and 3 criteria related to tactics and contextual aspects. This instrument fits to our study because we consider that going deeply into the motor skills that players use could be of interest to soccer studies that traditionally are more focused on teams' tactical and technical analysis. The combination of two powerful observational techniques, namely T-pattern detection and polar coordinate analysis allowed us to compose the "mosaic" of motor skills besides contextual aspects that make the singular style of play of Messi and Ronaldo world. We indicated in the discussion section which findings could be of interest for coaches and for further related studies.

Author Contribution

MC developed the project, supervised the design of the study and drafting of the manuscript- DB was responsible for the review of the literature and the drafting of the manuscript. OC was responsible for the T-pattern detection, data collection/handling and revised the content critically. MT performed the polar coordinate analysis and the method section. TF collected and codified the data. RH supervised the drafting of the manuscript. All authors approved the final, submitted version of the manuscript.

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739 Table I caption.
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Table 1. Goals scored by Lionel Messi and Cristiano Ronaldo considered.

Competition	Season	Lionel Messi	Cristiano Ronaldo	Total
Champions League	2013-2014	5	13	18
	2014-2015	10	7	17
	2015-2016	5	12	17
	Total	20	32	52
La Liga	2013-2014	15	17	32
	2014-2015	26	26	52
	2015-2016	11	22	33
	Total	52	65	117
Copa del Rey	2013-2014	4	0	4
	2014-2015	3	1	4
	2015-2016	4	0	4
	Total	11	1	12
	Total	83	98	181

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743 Table II caption.
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Table 2. OSMOS-soccer player. Observation System for Motor Skills in Soccer.

Criterion	Category	Code	Description
1. Body part	Left foot	LF	Player touches the ball with left foot
	Right foot	RF	Player touches the ball with right foot
	Left leg	LL	Player touches the ball with left leg (not including foot)
	Right leg	RL	Player touches the ball with right leg (not including foot)
	Chest	CH	Player touches the ball with chest
	Back	BA	Player touches the ball with back
	Head	HD	Player touches the ball with head
2. Foot contact zone	Tip	TI	Player touches the ball with tip of foot
	Outside	OU	Player touches the ball with outside of foot
	Inside	ID	Player touches the ball with inside of foot
	Heel	HL	Player touches the ball with heel
	Sole	SO	Player touches the ball with sole
	Instep	IT	Player touches the ball with instep
	Non-observable	NON	No clear contact zone between player and ball
3. Body orientation to rival goal line	Facing goal	FG	Player's chest facing rival goal line
	Facing right	OR	Player's chest facing right side line
	Back to goal	BT	Player's back facing rival goal line
	Facing left	OL	Player's chest facing left side line
4. Turn direction	Right turn	RT	Player makes a full or half turn to the right (vertical axis)
	Left turn	LT	Player makes a full or half turn to the left (vertical axis)
5. Pivot foot	Right foot pivot	RFP	Player pivots to the right on right foot
	Left foot pivot	LFP	Player pivots to the left on left foot
6. Stability	Jump	JUM	Elevation of the body
7. Locomotion	One	ONE	Player takes one step without touching the ball
	Two	TWO	Player takes two steps without touching the ball
	Three	THR	Player takes three steps without touching the ball
	Four	FOU	Player takes four steps without touching the ball
	Five	FIV	Player takes five steps without touching the ball
	More	MOR	Player takes more than five steps without touching the ball
8. Technical actions	Control	CT	Player gains control of the ball following diverse actions
	Dribbling	CD	Player dribbles the ball
	Shot	SH	Player shoots
	Feint (shot)	SHF	Player pretends to shoot
	Feint (pass)	PAF	Player pretends to pass
	Feint (change of dir.)	DIF	Player tricks a defender by changing direction
	Volley	VO	Player makes contact with the ball before it touches the ground
9. Centre of the game	Relative numerical inferiority	PR	Attacking team has one or two influent players less than the opponent in the centre of the game
	Absolute numerical inferiority	PA	Attacking team has at least less three or more influent players in relation with the opponent in the centre of the game
	Numerical equality with pressure	PE	Attacking team has the same number of players than the opponent in the centre of the game. The ball carrier has his back oriented to the opponent's goal and an opponent is marking from behind
	Numerical equality with no pressure	NPE	Attacking team has the same number of players than the opponent in the centre of the game. The ball carrier has his chest oriented to the opponent's goal, with conditions to progress into the pitch offensive zones
	Relative numerical superiority	NPR	Attacking has one or two influent players more than the opponent in the centre of the game
	Absolute numerical superiority	NPA	Attacking team has three or more influent players than the opponent in the centre of the game

10. Side	Right wing	RW	Part of the pitch between the right side line and the right midfield
	Right midfield	CR	Part of the pitch between the left midfield and the right side line
	Left midfield	CL	Part of the pitch between the right midfield and the left side line
	Left wing	LW	Part of the pitch between the left side line and the left midfield
11. Zones	Ultraoffensive 1	UOO	Between the goal line and the front of the goal area
	Ultraoffensive 2	UOT	Between the front of the goal area and the penalty box
	Offensive	OFF	Between the front of the penalty box and the half-way line (excl circle)
	Central	CEN	Centre circle

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748 Table III caption.
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Table 3. Reliability: sample and values per player and for both the players.

	Lionel Messi			Cristiano Ronaldo			Total		
	n	**%[1]**	**Kappa**	***n***	**%[1]**	**Kappa**	***n***	**%[1]**	**Kappa**
Interobserver	25	30	0.95	30	31	0.94	55	30	0.95
Intraobserver	15	18	0.98	15	15	0.97	30	17	0.98

n = number of goals.
[1] Percentage of goals in regards of the final sample (see table 1) for both players.

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754 Figure 1 caption.
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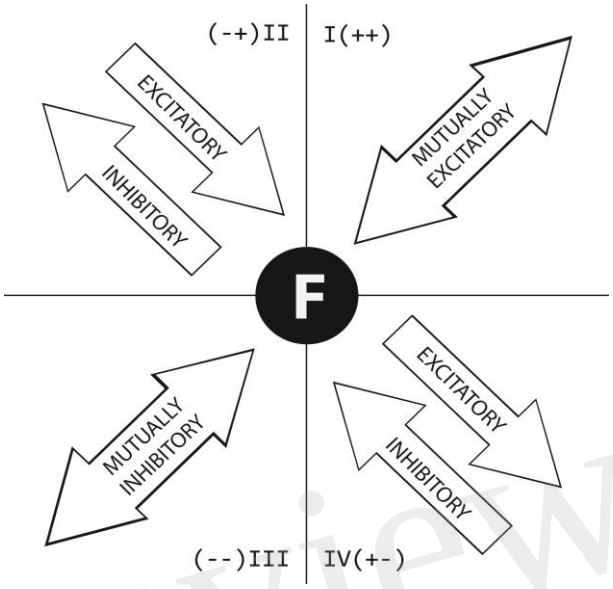

759
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761 Figure 1. Graphic depiction of relationships between conditional and given behaviors in polar coordinate maps
762 according to quadrant in which vector is located (Castañer et al., 2016, p. 5.)
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766 Figure 2 caption.
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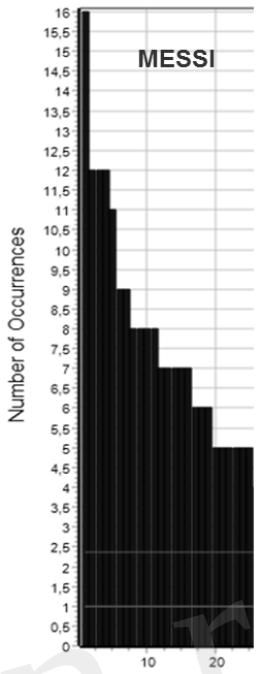
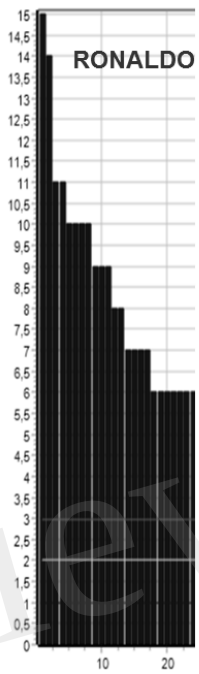


Event-Type	Fr.
1. FG,THR,CL	16
2. FG,MOR,CL	12
3. FG,MOR,CR	12
4. OL,THR,CR	12
5. LF,ID,FG,SH,CL	11
6. FG,FIV,CL	9
7. FG,FOU,CR	9
8. FG,CL	8
9. FG,FOU,CL	8
10. LF,FG,SH,CL	8
11. OL,CR	8
12. FG,CR	7
13. FG,THR,CR	7
14. LF,OU,FG,DIF,CR	7
15. OL,THR,CL	7
16. RF,ID,FG,SH,CR	7
17. FG,FIV,CR	6
18. LF,ID,FG,CL	6
19. OL,CL	6
20. LF,FG,CD,CR	5
21. LF,ID,FG,CR	5
22. LF,ID,FG,SH,CR	5
23. LF,ID,OL,SH,CR	5
24. OL,FIV,CR	5
25. OL,FOU,CL	5



Event-Type	Fr.
1. FG,THR,CL	15
2. FG,MOR,CL	14
3. OL,THR,CR	11
4. RF,OU,FG,CL	11
5. FG,CR	10
6. FG,FOU,CL	10
7. FG,THR,CR	10
8. OR,THR,CL	10
9. HD,FG,CR	9
10. RF,FG,CR	9
11. RF,ID,OR,CL	9
12. OL,CR	8
13. RF,ID,FG,CL	8
14. OR,CL	7
15. OR,FIV,CL	7
16. OR,FOU,CL	7
17. RF,ID,FG,CR	7
18. FG,FIV,CR	6
19. FG,MOR,CR	6
20. LF,FG,CL	6
21. OR,CR	6
22. RF,FG,CL	6
23. RF,FG,LT,CR	6
24. RF,OR,LT,CL	6
25. FG,RT,CL	5

771
772
773 Figure 2. Messi and Ronaldo event-type frequency chart.
774

775 Figure 3 caption.
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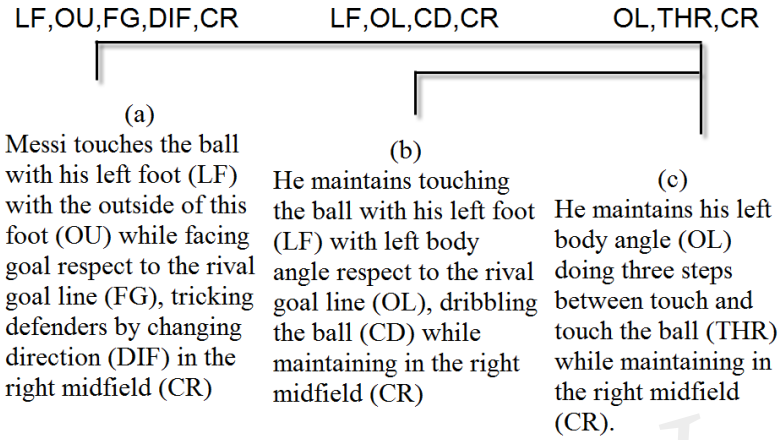

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784 Figure 3. T-pattern shows that (a) after Messi touches the ball with his left foot (LF) with the outside of this
785 foot (OU) while facing goal respect to the rival goal line (FG), tricking defenders by changing direction (DIF)
786 in the right midfield (CR); then, (b) he maintains touching the ball with his left foot (LF) with left body angle
787 respect to the rival goal line (OL), dribbling the ball (CD) while maintains in the right midfield (CR), and (c)
788 maintains his left body angle (OL) doing three steps between touch and touch the ball (THR) while maintains
789 in the right midfield (CR).

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792 Figure 4. caption.

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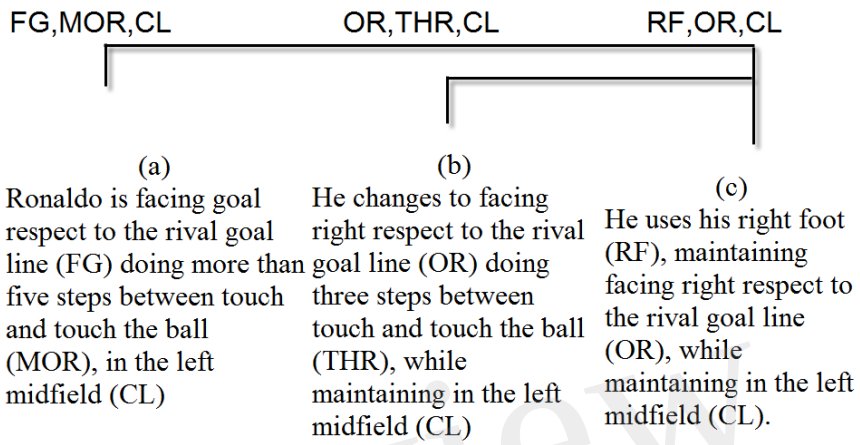

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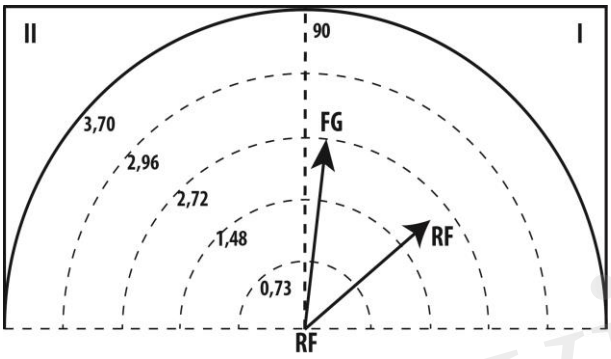
798 Figure 4. T-pattern shows that (a) Ronaldo is facing goal respect to the rival goal line (FG) doing more than
799 five steps between touch and touch the ball (MOR), in the left midfield (CL); then, (b) he changes to facing
800 right respect to the rival goal line (OR) doing three steps between touch and touch the ball (THR), while
801 maintaining in the left midfield (CL) and (c) he uses his right foot (RF), maintaining facing right respect to the
802 rival goal line (OR), while maintaining in the left midfield (CL).
803

804 Figure 5 caption

BODY PART

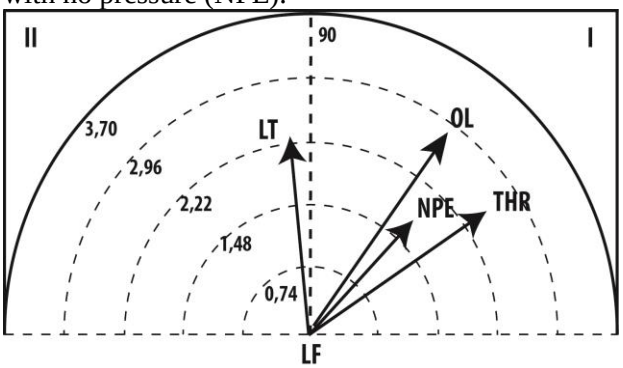
MESSI

Focal category: RF (right foot)
The use of the right foot (RF) activates (QI) following using the right foot (RF) and facing his chest to the rival goal line (FG).



Category	Q	P.Prosp.	P.Retro.	Radius	Angle
Bodypart_RF	I	1.41	1.41	1.99 (*)	45
Bodyorient_FG	I	0.13	2.72	2.72 (*)	87.17

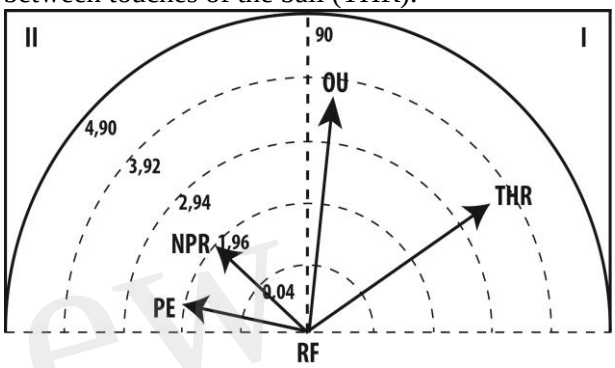
Focal category: LF (left foot)
The use of the left foot (LF) is activated (QII) if the player makes a full or half turn to the left (vertical axis) (LT) and is mutually activated (QI) with the use of three steps between touches (THR), the orientation of the body to the left respect to the rival goal line (OL) and the numerical equality with no pressure (NPE).



Category	Q	P.Prosp.	P.Retro.	Radius	Angle
Turn_dir_LT	II	-0.29	2.31	2.33 (*)	97.22
Bodyorient_OL	I	1.68	2.27	2.83 (*)	53.59
Locomot_THR	I	2.16	1.27	2.50 (*)	30.41
Centre_NPE	I	1.29	1.55	2.02 (*)	50.08

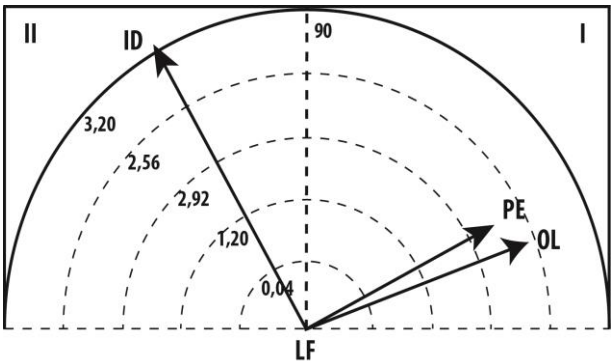
RONALDO

Focal category: RF (right foot)
The use of the right foot (RF) is activated (QII) for the relative numerical superiority (NPR) and for the numerical equality with pressure (PE) and is mutually activated (QI) with the use of the external zone of the foot (OU) and doing three steps between touches of the ball (THR).



Category	Q	P.Prosp.	P.Retro.	Radius	Angle
Centre_PE	II	-1.88	0.59	1.97 (*)	162.67
Centre_NPR	II	-1.22	1.54	1.96 (*)	128.43
Footczone_OU	I	0.46	3.65	3.68 (*)	82.87
Locomot_THR	I	2.94	1.98	3.54 (*)	33.98

Focal category: LF (left foot)
The use of the left foot (LF) is activated (QII) by the use of the inside of the foot (ID) and is mutually activated (QI) with the left orientation of the body respect to the rival goal line (OL) and the numerical equality with pressure (PE).



Category	Q	P.Prosp.	P.Retro.	Radius	Angle
Footczone_ID	II	-2.01	2.70	3.36 (*)	126.71
Bodyorient_OL	I	2.35	0.95	2.54 (*)	21.96
Centre_PE	I	2.07	1.22	2.41 (*)	30.56

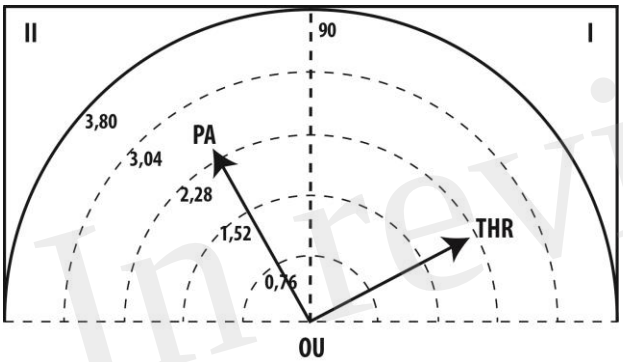
805
806
807 Figure 5. Maps of polar coordinate analysis for Body Part criterion.

Figure 6 caption.

FOOT CONTACT ZONE

MESSI

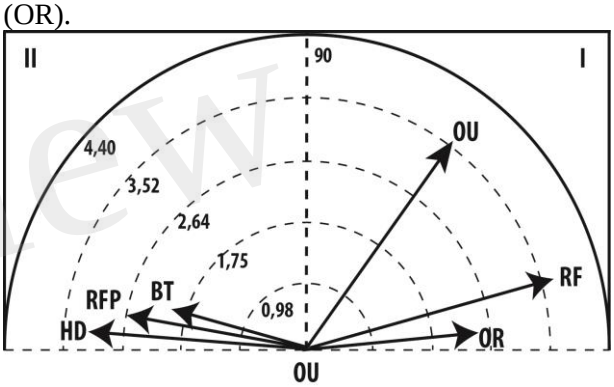
Focal category: OU (outside of the foot)
The use of the outside of the foot (OU) is activated (QII) by the absolute numerical inferiority (PA) and activates (QI) using three steps between touches of the ball. (THR).



Category	Q	P.Prosp.	P.Retro.	Radius	Angle
Centre_PA	II	-1.19	2.10	2.42 (*)	119.60
Locomot_THR	I	2.13	0.72	2.25 (*)	18.74

RONALDO

Focal category: OU (outside of the foot)
The use of the outside of the foot (OU) is activated (QII) for the use of the head (HD), being back facing the rival goal line (BT) and pivoting over the right leg (RFP) and is mutually activated (QI) with the use of the external zone of the foot (OU) and right foot (RF) and the orientation to the right of the body respect to the rival goal line (OR).



Category	Q	P.Prosp.	P.Retro.	Radius	Angle
Bodypart_HD	II	-3.16	0.12	3.16 (*)	177.80
Bodyorient_BT	II	-1.96	0.30	1.98 (*)	171.34
Pivot_foot_RFP	II	-2.72	0.25	2.73 (*)	174.72
Footczone_OU	I	2.50	2.50	3.54 (*)	45
Bodypart_RF	I	3.65	0.46	3.68 (*)	7.13
Bodyorient_OR	I	2.38	0.16	2.39 (*)	3.80

Figure 6. Maps of polar coordinate analysis for Foot Contact Zone criterion.

818 Figure 7 caption
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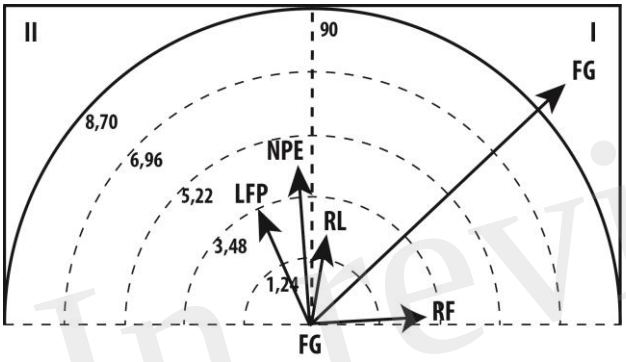
BODY ORIENTATION

MESSI

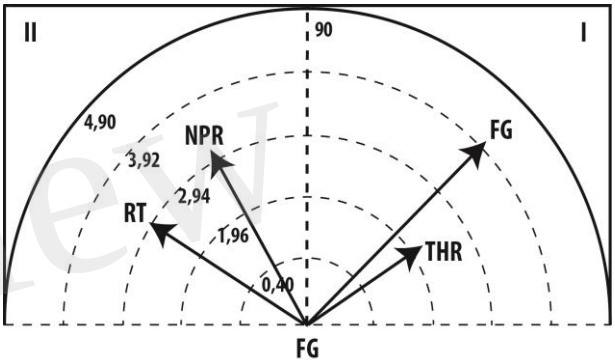
Focal category: FG (chest facing rival goal line)
The facing orientation of the body respect to the rival goal line (FG) is activated (QII) by the numerical equality without pressure (NPE) and pivoting over the left leg (LFP) and activates (QI) remaining facing goal line (FG), the use of the right leg (RL) and right foot (RF).



Category	Q	P.Prosp.	P.Retro.	Radius	Angle
Centre_NPE	II	-0.46	4.36	4.39 (*)	95.97
Pivot_foot_LFP	II	-1.87	2.73	3.31 (*)	124.47
Bodypart_RF	I	2.72	0.13	2.72 (*)	2.83
Bodypart_RL	I	0.18	1.96	1.97 (*)	84.74
Bodyorient_FG	I	6.30	6.30	8.91 (*)	45.00

RONALDO

Focal category: FG (chest facing rival goal line)
The facing orientation of the body respect to the rival goal line (FG) is activated (QII) by the relative numerical superiority (NPR) and turning to the right (RT) and activates (QI) remaining facing goal line (FG), the use of three steps between touches (THR).



Category	Q	P.Prosp.	P.Retro.	Radius	Angle
Turn_dir_RT	II	-2.86	0.82	2.98 (*)	163.92
Centre_NPR	II	-1.80	2.60	3.17 (*)	124.73
Locomot_THR	I	1.50	1.61	2.20 (*)	47.11
Bodyorient_FG	I	2.82	2.82	3.98 (*)	45

823
824 Figure 7. Maps of polar coordinate analysis for Body Orientation criterion.
825

826 Figure 8 caption.
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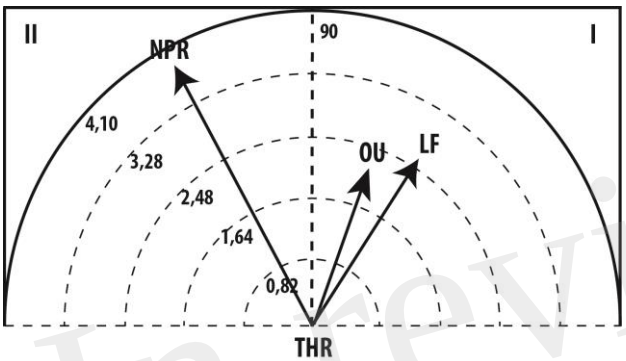
LOCOMOTION

MESSI

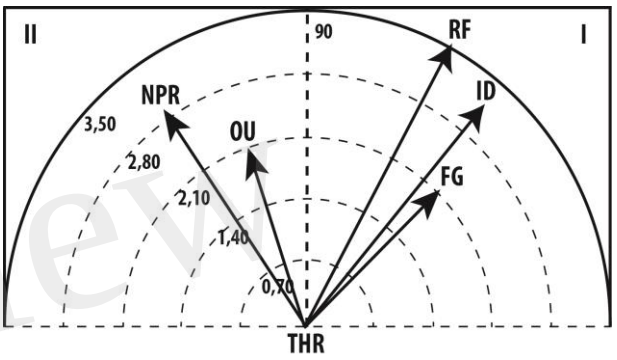
Focal category: THR (three steps)
Using three steps between touches of the ball (THR) is activated (QII) by the relative numerical superiority (NPR) and activates (QI) the use of the left foot (LF) and the outside of the foot (OU).



Category	Q	P.Prosp.	P.Retro.	Radius	Angle
Centre_NPR	II	-1.77	3.39	3.82 (*)	117.62
Bodypart_LF	I	1.27	2.16	2.50 (*)	59.59
Footczone_OU	I	0.72	2.13	2.25 (*)	71.26

RONALDO

Focal category: THR (three steps)
Using three steps between touches of the ball (THR) is activated (QII) by the relative numerical superiority (NPR) and the use of the outside of the foot (OU) and activates (QI) the use of the right foot (RF) being faced to the rival goal line (FG).



Category	Q	P.Prosp.	P.Retro.	Radius	Angle
Centre_NPR	II	-1.44	2.55	2.93 (*)	119.41
Footczone_OU	II	-0.85	1.99	2.17 (*)	113.03
Footczone_ID	I	2.20	2.52	3.34 (*)	48.91
Bodyorient_FG	I	1.61	1.50	2.20 (*)	42.89
Bodypart_RF	I	1.98	2.94	3.54 (*)	56.02

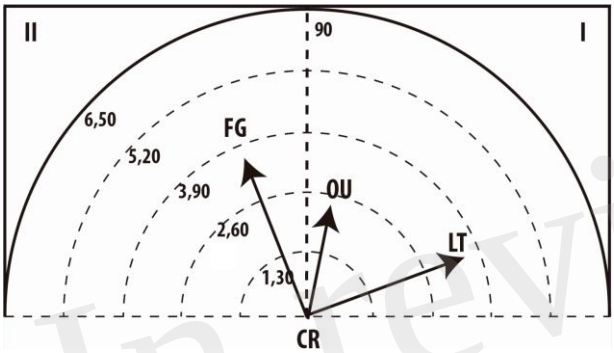
831
832 Figure 8. Maps of polar coordinate analysis for Locomotion criterion.
833

Figure 9 caption

SIDE

MESSI

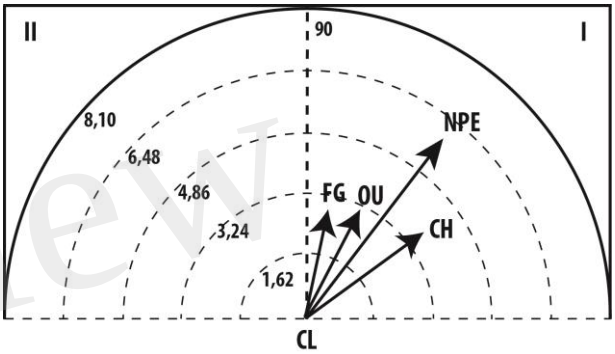
Focal category: CR (right midfield)
Being in the right midfield (CR) is activated (QII) by the orientation of the body facing the rival goal line (FG) and activates (QI) the turn of the body to the left (LT) and the use of the outside of the foot (OU).



Category	Q	P.Prosp.	P.Retro.	Radius	Angle
Bodyorient_FG	II	-1.41	3.44	3.72 (*)	112.38
Footczone_OU	I	0.50	2.27	2.32 (*)	77.61
Turn_dir_LT	I	3.22	1.19	3.43 (*)	20.29

RONALDO

Focal category: CL (left midfield)
Being in the left midfield (CL) is activated (QI) by the numerical equality without pressure (NPE), the use of the outside of the foot (OU), the chest (CH) and facing goal respect to the rival goal line (FG).



Category	Q	P.Prosp.	P.Retro.	Radius	Angle
Bodypart_CH	I	3.13	1.86	3.64 (*)	30.74
Footczone_OU	I	0.93	2.93	3.08 (*)	72.35
Bodyorient_FG	I	0.38	2.88	2.90 (*)	82.47
Centre_NPE	I	3.60	4.43	5.70 (*)	50.90

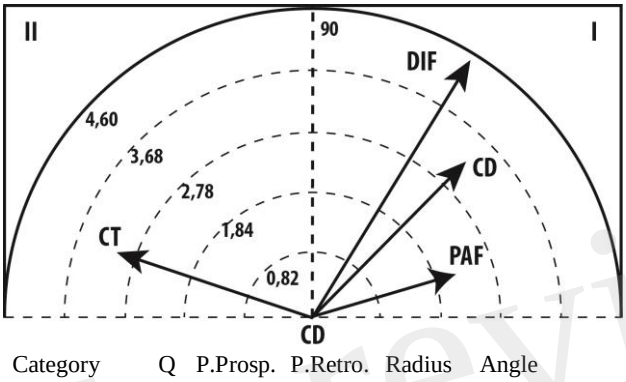
Figure 9. Maps of polar coordinate analysis for Side criterion.

Figure 10 caption.

TECHNICAL ACTIONS

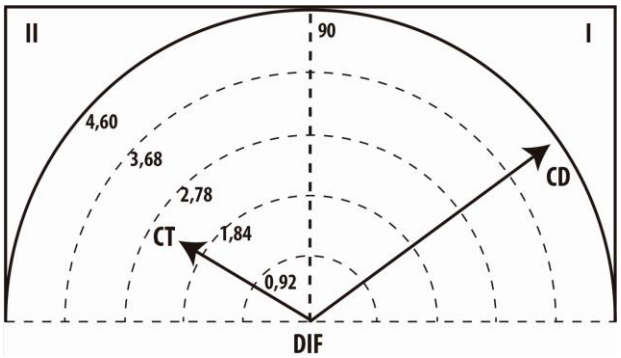
MESSI

Focal category: CD (dribbling the ball)
Dribbling the ball (CD) is activated (QII) by the control of the ball (CT) and activates (QI) remaining dribble the ball (CD), the use of the feint of the pass (PAF) and the feint of change of direction (DIF).



Category	Q	P.Prosp.	P.Retro.	Radius	Angle
Action_CT	II	-2.96	0.79	3.06 (*)	165.06
Action_CD	I	2.41	2.41	3.41 (*)	45
Action_PAF	I	2.25	0.71	2.35 (*)	17.44
Action_DIF	I	2.47	3.87	4.59 (*)	57.50

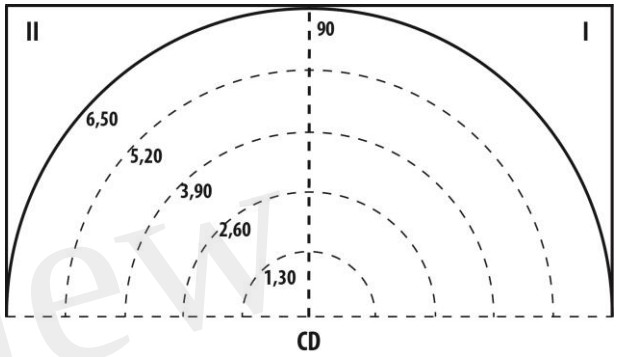
Focal category: DIF (feint change of direction)
The feint of change of direction is activated (QII) by the control of the ball (CT) and activates (QI) dribbling the ball (CD).



Category	Q	P.Prosp.	P.Retro.	Radius	Angle
Action_CT	II	-1.95	1.43	2.42 (*)	143.69
Action_CD	I	3.87	2.47	4.59 (*)	32.50

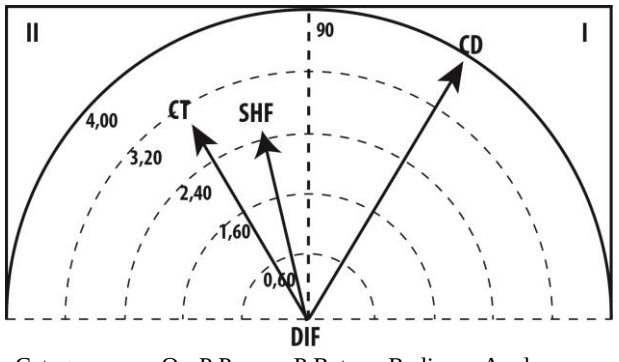
RONALDO

Focal category: CD (dribbling the ball)
Dribbling the ball (CD) is not being activated (QII) by any behavior and is not mutually activated (QI) by any behavior.



Category	Q	P.Prosp.	P.Retro.	Radius	Angle
Action_SHF	II	-0.75	0.66	1	138.84
Action_PAF	II	-0.75	0.66	1	138.94
Action_DIF	II	-1.25	0.23	1.27	169.48
Action_SH	I	0.57	1.08	1.22	62.02
Action_VO	I	0.47	1.05	1,15	65.97

Focal category: DIF (feint change of direction)
The feint of change of direction is activated (QII) by the control of the ball (CT) and the shot feint (SHF) and activates (QI) dribbling the ball (CD).



Category	Q	P.Prosp.	P.Retro.	Radius	Angle
Action_CT	II	-1.56	2.54	2.98 (*)	121.49
Action_SHF	II	-0.69	2.36	2.46 (*)	106.29
Action_CD	I	1.42	3.31	3.61 (*)	66.77

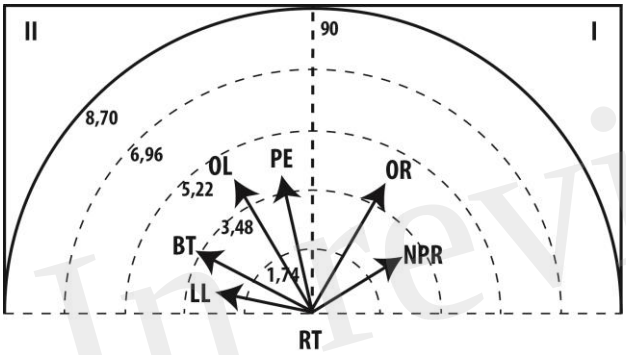
Figure 10. Maps of polar coordinate analysis for Technical Actions criterion.

Figure 11 caption.

TURN DIRECTION

MESSI

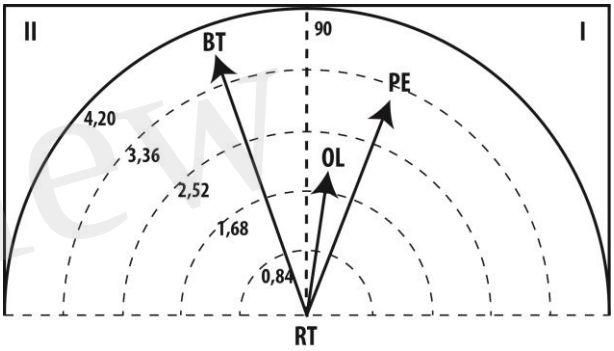
Focal category: RT (right turn)
The right turn of the body (RT) is activated (QII) by the numerical equality with pressure (PE), the use of the left leg (LL) and being back orientated towards the rival goal line (BT) and activates (QI) the orientation to the right of the body respect to the rival goal line (OR) and the relative numerical superiority (NPR).



Category	Q	P.Prosp.	P.Retro.	Radius	Angle
Bodypart_LL	II	-0.94	2.58	2.75 (*)	109.96
Bodyorient_BT	II	-0.65	3.51	3.57 (*)	100.43
Bodyorient_OL	II	-0.05	3.87	3.87 (*)	90.78
Centre_PE	II	-1.14	3.68	3.86 (*)	107.16
Bodyorient_BT	II	-0.65	3.51	3.57 (*)	100.43
Bodyorient_OL	II	-0.05	3.87	3.87 (*)	90.78
Centre_PE	II	-1.14	3.68	3.86 (*)	107.16
Bodyorient_OR	I	1.61	3.34	3.71 (*)	64.22
Centre_NPR	I	1.27	2.34	2.66 (*)	61.46

RONALDO

Focal category: RT (right turn)
The right turn of the body (RT) is activated (QII) by being back orientated towards the rival goal line (BT) and activates (QI) the orientation to the left of the body respect to the rival goal line (OL) and numerical equality with pressure (PE).



Category	Q	P.Prosp.	P.Retro.	Radius	Angle
Bodyorient_BT	II	-1.49	3.52	3.83 (*)	112.91
Bodyorient_OL	I	-0.10	2.03	2.04 (*)	87.27
Centre_PE	I	0.44	3.09	3.12 (*)	81,93

Figure 11. Maps of polar coordinate analysis for Turn Direction criterion.

858 Figure 12 caption
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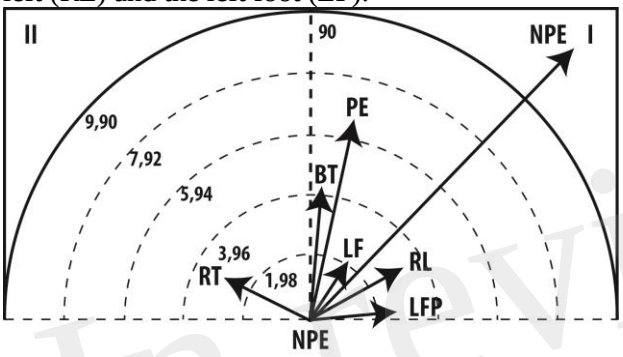
CENTRE OF THE GAME

MESSI

Focal category: NPE (Numerical equality with no pressure)

Numerical equality with no pressure (NPE) is activated (QII) by the turn to the right of the body (RT) and activates (QI) remaining in the numerical equality with no pressure (NPE), the numerical equality with pressure (PE), being back orientated towards the rival goal line (BT), the use of the right left (RL) and the left foot (LF).

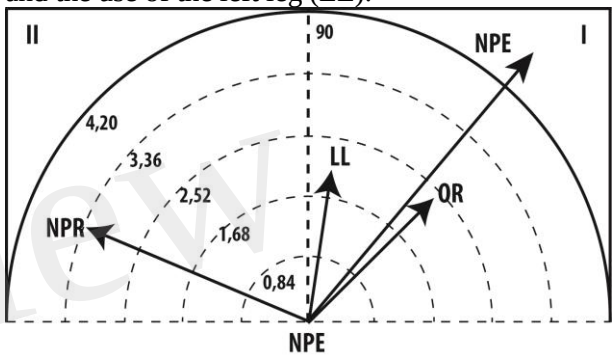


Category	Q	P.Prosp.	P.Retro.	Radius	Angle
Turn_dir_RT	II	-2.73	1.24	2.99 (*)	155.62
Bodypart_LF	I	1.55	1.29	2.02 (*)	39.92
Bodypart_RL	I	2.73	1.68	3.21 (*)	31.57
Bodyorient_BT	I	0.17	4.13	4.14 (*)	87.71
Pivot_foot_LFP	I	2.97	0.09	2.97 (*)	1.68
Centre_PE	I	1.05	6.42	6.51 (*)	80.71
Centre_NPE	I	8.24	8.24	11.66 (*)	45

RONALDO

Focal category: NPE (Numerical equality with no pressure)

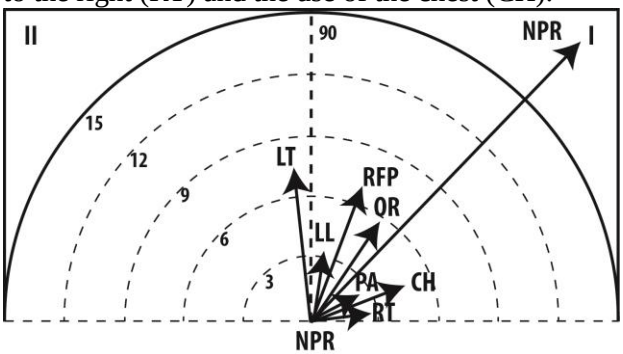
Numerical equality with no pressure (NPE) is activated (QII) by the relative numerical superiority (NPR) and activates (QI) remaining in the numerical equality with no pressure (NPE), the numerical equality with pressure (PE), being right orientated towards the rival goal line (OR) and the use of the left leg (LL).



Category	Q	P.Prosp.	P.Retro.	Radius	Angle
Centre_NPR	II	-3.03	1.30	3.30 (*)	156.75
Bodypart_LL	I	0.24	2.12	2.13 (*)	83.53
Bodyorient_OR	I	1.83	1.62	2.44 (*)	41.46
Centre_NPE	I	3.51	3.51	4.96 (*)	..45

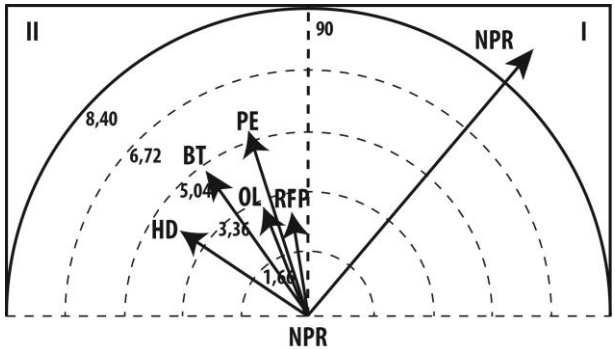
Focal category: NPR (Relative numerical superiority)

The relative numerical superiority (NPR) is activated (QII) by the turn of the body to the right (RT) and activates (QI) relative numerical superiority (NPR), the absolute numerical inferiority (PA), being right orientated towards the rival goal line (OR), pivoting over the right foot (RFP), the use of the left leg (LL), turning the body to the right (RT) and the use of the chest (CH).



Focal category: NPR (Relative numerical superiority)

The relative numerical superiority (NPR) is activated (QII) by the numerical equality with pressure (PE), being left orientated respect to the rival goal line (OL) and back orientated (BT), the use of the chest (CH) and pivoting over the right foot (RFP) and activates (QI) the relative numerical superiority (NPR).



Category	Q	P.Prosp.	P.Retro.	Radius	Angle	Category	Q	P.Prosp.	P.Retro.	Radius	Angle
Turn_dir_LT	II	-0.27	7.08	7.09 (*)	92.21	Bodypart_HD	II	-1.97	3.95	4.42 (*)	116.51
Bodypart_LL	I	0.55	3.28	3.33 (*)	80.48	Bodyorient_BT	II	-0.67	4.84	4.89 (*)	97.91
Bodypart_CH	I	4.26	0.39	4.28 (*)	5.20	Bodyorient_OL	II	-1.29	2.76	3.05 (*)	115.1
Bodyorient_OR	I	4.10	4.29	5.94 (*)	46.29	Pivot_foot_RFP	II	-1.85	2.08	2.79 (*)	131.6
Turn_dir_RT	I	2.34	1.27	2.66 (*)	28.54	Centre_PE	II	-1.58	4.91	5.15 (*)	107.8
Pivot_foot_RFP	I	2.72	6.16	6.74 (*)	66.18	Centre_NPR	I	7.02	7.02	9.93 (*)	45
Centre_PA	I	1.42	1.77	2.27 (*)	51.2						
Centre_NPR	I	12.54	12.54	17.74 (*)	45						

Figure 12. Maps of polar coordinate analysis for Centre of the Game criterion.