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A SCALE TO MEASURE THE COMPLEXITY AND PERCEPTUAL-COGNITIVE SKILLS IN SOCCER

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By

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AN ABSTRACT OF THE THESIS OF

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The complexity of dynamical systems (spanning brain, body and environment) can yield complex adaptive behaviors from non-linear interactions of individuals in space and time. A lack of reliable instruments to assess these varying behaviors results in inferences of how changes in behavior occurred over an extended period of time rather than being based on direct scientific measures. The aim of this study was to develop a scale of complexity and perceptual-cognitive skills' assessment in the sport soccer and to evaluate structural and criterion reliability. Based on the embodied cognition literature, the construct of this scale was identified with three dimensions to assess perceptual-cognitive performance of players when acting within different levels of complex team synergies. A sample of 10 soccer coaches – group A (n = 5 coaches; M = 24 yrs professional coaching experience) and group B (n = 5 coaches; M = 1 year of amateur coaching experience) were recruited to participate in the study. A total of 100 clips of 10 previously recorded soccer matches were analyzed in two assessment periods with one month between the end of the first assessment and the beginning of the second. This resulted in a combined total of 1000 measures used for the study. The results demonstrated that high skilled coaches were more reliable in the complexity dimension (r = 0.87) and also in the decision making dimension (r = 0.79) than low qualified coaches (r = 0.79) and (r = 0.71) respectively; and the complexity dimension was more stable across trials between professional and amateur coaches in the first data collection

(r = 0.79) and second data collection (r = 0 .73) than the decision making dimension (r = 0.50) and (r = 0.43) respectively. These findings indicate that this scale is reliable across applications and at different times with high and low qualified coaches.

The use of the scale may be useful for identifying elements of emerging complexity at the team-fractal-player level; determine a perceptual-cognitive profile in athletes; and to better understand complex tactical dynamics in soccer.

DEDICATION

I would like to dedicate this thesis to my newborn son Guillem who has become part of this process. Every single word, phrase, paragraph, page, chapter written of this thesis grew with you.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

LITERATURE REVIEW AND INTRODUCTION

Introduction

Enhancing sport performance of an athlete, a group of athletes, or a team is an everyday concern for coaches. Moreover, skill learning in sports is of crucial importance for distinctive and successful performance (Williams & Ford, 2009). Since research shows that providing information in the form of augmented feedback enhances skill learning (e.g., Schmidt & Lee, 1999), coaches must obtain information about the athletes' actual performance as a basis to provide the prescribed feedback.

Franks and Miller (1986) suggest that direct observation and memory are not reliable enough to provide accurate and objective information on complex sports such as soccer. These authors used a technique of applied memory research to test the ability of soccer coaches in observing and recalling critical technical events occurred during the first half of an international soccer game. They showed that soccer coaches could retain in their memory only 30% of the key factors that determined success during one match and from that information only 42% was correct (Franks & Miller, 1986). These data suggested that coaches need to use reliable instruments apart from their memory as a basis to provide feedback.

Another study that provided evidence of inaccuracy in human information processing by coaches was conducted by Franks (1993). The results detected that expert gymnastics coaches were not significantly better than novice gymnastics coaches in detecting differences in sequentially presented handspring performances. Further, O'Donghue (2010) suggested that coach's observations when analyzing sport performance have inaccuracies due to:

1. Memory overload (trying to retain too many items of information).

2. Subjective bias (despite efforts at objectivity, coaches' decisions will always be influenced by subjectivity).
3. Halo effect (performances will be rated higher or lower, if performer starts the activity well or poorly).
4. Leniency error (a performance appraisal error which occurs when coaches over-rate a very poor performance and vice versa).
5. Highlighting (coaches will remember key elements of performance but not the essential sustaining elements)
6. Increased arousal level (non-regulation of consciousness, attention, and information processing as a consequence of high stress and anxiety).
7. Errors in attention focus (directing the attention to non-relevant information).

With this lack of reliability in the data collected by self-observation processes, there is a clear need to document and quantify sports performance by creating assessment tools and instruments that facilitate the needed observation and feedback process for coaches (e.g., Franks & Goodman, 1986; Hughes, 1984). Thus, the use of an assessment instrument to provide feedback with the goal of enhancing motor performance is apparent. For the last thirty years, performance analysis has become a growing field of study in which several areas have emerged to assess sport performance. Within one of these areas of study, an innovative assessment instrument is presented in this thesis that might be used to provide accurate feedback and enhance performance of soccer players. The literature review provided in the section below provides an in-depth background of the performance analyses literature as an independent sub-discipline of sport science. The literature review begins with a discussion of present body of literature continuing with a chronological discussion of the investigation of team sports

using a dynamical systems conceptual framework. Finally a scale to measure the complexity and perceptual-cognitive skills in soccer is presented.

Performance analyses

History and background

Performance analysis in sports has been generally characterized by the use of notational analysis and sport biomechanics (Hughes & Bartlett, 2002; Hughes & Franks, 2005). The links of these two areas of study in sport sciences are various. They both aim 1) to enhance performance; 2) to analyze movements of sport performers; 3) the extensive use of information technology and communications equipment; 4) the provision of objective feedback to sport performers and their coaches; 5) the importance of producing valid and reliable data; 6) the need to normalize, scale or non-dimensionalize data; 7) the use of performance indicators that are derived from theoretical models of performance; and finally 8) provide the opportunity to exploit and apply more fully recent developments in artificial intelligence (Glazier, 2010). Therefore, the disciplines of sports biomechanics and notational analyses emphasize the development of systematic techniques of observation and have key events as important features of their theoretical foundations (Hughes & Bartlett, 2002). In addition, both disciplines aim to provide accurate key performance outcomes to coaches and practitioners to improve future performance approaching their theoretical grounding by identifying performance indicators (Vilar, Araújo, Davids, & Button, 2012). According to Hughes and Bartlett (2002) “a performance indicator is a selection or a combination of action variables that aims to define some or all aspects of a performance” (p. 179).

Sport biomechanics

In sport biomechanics performance indicators are commonly based on hierarchical technique models that evaluate movement related details within individual

sports with closed skills such as gymnastics or track and field in detriment of team sports (e.g., Glazier, 2010; Hughes and Barlette, 2002). However there are some exceptions to this, such as analyses of fast bowling in cricket (Bartlett, Stockill, Elliott & Burnett, 1996) or studies of soccer skills (Lees & Nolan, 1998). For instance, the hierarchical model of a biomechanical performance analyses in team sports might take into consideration performance parameters such as the approach in a soccer kick. This parameter is initially portioned into secondary performance parameters such as speed, approach angle, and distance. In this example, the approach consists of several steps and can be performed at an angle relative to the ball. Isokawa and Lees (1988) investigated the effects of approach angle on kick kinematics in soccer players. Six male subjects took a one step run up to kick a stationary ball using approach angles of 0º, 15º, 30º, 45º, 60º and 90º. They found an approach angle of 30º to 45º to be optimal, with maximum velocity of the shank achieved with an approach angle of 30º and the maximum ball speed achieved with an approach of 45º. These types of analyses allow performance parameters to be related to the movements of the athlete that contribute to successful execution of the skill. Thus, feedback and training of these performance indicators contribute to enhancement of performance (Bartlett, 2000).

However, the importance of these performance indicators on the actual performance of a team or an athlete is somewhat controversial due to the fact that they provide information regarding isolated aspects of technique. This technique is believed to mechanically contribute in a successful performance, but at the same time, it is challenged by the evidence of how the interaction of the athlete's technique with the different constraints influences performance (Newell, 1986). Based on Newell's findings there are at least three sources from where constraints can be originated and

affect performance: the organism, the environment, and/or the task. These factors will be discussed in more detail in a later section of this review.

Notational analysis

Hughes and Franks (1997) defined notational analysis in sport as an objective way of quantifying key elements of performance in a valid and consistent manner. In contrast to sport biomechanics, notational analyses are more concerned with gross movements or movement patterns in games or teams such as strategic and tactical issues in sport (e.g., Glazier, 2010; Hughes & Barlette, 2002). There are just a few studies of notational analyses in regards to individual sports due to the poor relevance of the information obtained for these sports. The performance indicators that notational analyses have paid more attention to are related to the tactical and technical aspects of the game to better understand the physiological, psychological, tactical and technical demands of many sports. Often, these types of indicators are used solely or in a comparative way to measure different levels of performance such as a team, elements of a team, or individual's team members (Hughes & Bartlett, 2002). For instance, at the level of an entire soccer team, there is a large amount of data gathered in regards to ball possession. This indicator has been largely studied from its relation to other different indicators such as the outcome after a possession of a team (Hughes & Frank, 2005). This study reported that the strike ratio of goals from shots is better for direct play than for possession play.

There are also studies that analyze performance at the level of fractals (i.e., group of peers of a team). According to the principle of universality, local interactions of social neurobiological systems (e.g., the play line established by soccer midfielders) can emulate the global interactions of the whole system such as a team (Bak & Chialvo, 2001; Van Orden, Holden & Turvey, 2003). These local interactions among social

neurobiological systems are characteristic of fractal properties (Solé, Manrubia, Benton, Kauffman, & Bak, 1999). For example, Lago and Anguera (2003a) studied the interaction process that is established in a soccer team by the passes among players and their characteristics. In the same lines, Passos, Araujo, Davids, Gouveia, Serpa, Milho, et al. (2009) studied the relations of the players of a water polo team by the number of passes among them and the success of these passes. Such studies demonstrate that there is a higher opportunity that some players have a better connection and establish a more successful network than others.

When analyzing performance at the level of individuals alone, in order to ensure peak performance during competition and provide adequate feedback, data collected must be relative to several indicators for each player (Hopkins, 1991). For instance, in ice hockey performance indicators such as number of goals scored, number of passes leading to goals, amount of time on the ice, etc. have become so important, not only for coaches aiming to enhance performance, but also for players industry as well. This variety of statistics that performance analysis in ice hockey runs allow coaches, managers and clubs to have players' performance profiles at the end of the competitive season and based on their efficiency a player for example, might increase his or her value in the market (Renger, 1994).

In notational analysis, independently of the type of data (whether it is from a team, a fractal or a player), four major areas of study have emerged to analyze sport performance. These different research areas are discussed in the below sections and some examples are provided.

Technical performance. Technical performance investigates the success of the actions of a team or players of a team during the game. Some of the first studies in technical skills in soccer are dated back to 1960's by the early contribution of Reep and

Benjamin (1968) which influenced not only researchers interested in that field but also coaches. In this study, Reep and Benjamin (1968) analyzed the passing sequence distribution in 578 different soccer matches played between 1953 and 1967. The magnitude of the data collected in this work lead to various findings. However, the most remarkable contributions that had a major impact for research in the following decades were related to ball possession. For example, some of the findings reported were 1) it takes an average of ten shots to get one goal; 2) regaining possession in the opponent's half provides many goal scoring opportunities; 3) most goals come from short possessions; 50% of goals are scored from possessions that involve one pass or less (zero pass possessions include penalties and free kicks) and 80% with three or less. However, other studies (Hughes, Robertson, & Nicholson, 1988) found some different findings regarding ball possession and successful outcomes. In this study the finals of the 1986 World Cup held in Mexico were analyzed to assess patterns of play of successful teams (those teams that reached the semi-finals), in comparison to unsuccessful teams (teams that were eliminated at the end of the first round). The main findings were that successful teams played significantly more touches of ball per possession than unsuccessful teams. It was also observed that successful teams played predominantly in the central areas while unsuccessful teams spent more time in the periphery and lost ball possession more often in the final 16 meters of the field

In the 21st century, research on the same lines has been conducted, and for example, Hughes and Franks (2005) even replicated the study of Reep and Benjamin (1968) to see if their findings were still applicable, by analyzing all the matches from 1990 and 1994 of the Fédération Internationale de Football Association (FIFA) World Cup finals. The initial results were very similar to those reported by Reep and Benjamin (1968) with approximately 80% of goals occurring from possessions containing four

passes or less. Nevertheless, since the authors admitted that most of the possessions were zero pass possessions and that there were more one pass possessions than two pass possessions and so on, Reep's finding that 50% of goals are scored from short (one pass or less) possessions it is due to the fact that the majority of the possessions of the games analyzed were one pass or less.

Thus, Hughes and Franks (2005) removed this inequality by comparing the number of goals scored for each possession length (e.g., one pass, two passes, etc) rounded to a common 1000 possessions. After this statistical adjustment, the data presented showed that possessions of three to seven passes were more likely to end with a goal than possessions involving less touches of the ball.

When analyzing technical performance in individuals, technical skills such as shots, passing or dribbling have been the target of study and the degree in which they are successfully performed has been the primary way to assess performance. For example, accuracy has been declared to be a good performance indicator for passing (Carter 1996; Hughes, Robertson, & Nicholson, 1988). Another study that investigated performance in the level of players alone, suggested that dribbling was the most important skill, followed by first touch, passing and individual defense in the list of most important skills for creating scoring opportunities (Coleman, 1998). This author studied the frequency in which successful outcomes occurred right after specific skills during a game. Although, dribbling skills only occurred 8% of the total time of the discrete actions, it had the greatest correlation between technical actions associated with better outcomes for the team.

Tactical performance. Research on tactical performance investigates how players, a group of players or a team manage their abilities (e.g., teamwork, technical skills, pace, space, fitness, movement) of themselves and their opponents, targeting the

technical strengths and weaknesses of the respective performers (Hughes & Barlette, 2002). For example, tactical performance indicators are related to how teams play and score and whether patterns exist or not. These will be reflected in the ways that individuals and teams attack and defend how they use the spaces in the playing surface and the variety of playing actions. The familiarity with the game structure includes understanding of various phases of the game and individual players' positions, which leads to the recognition of specific game situations (Lanham, 1993). Wade (1996) established three main phases during the course of a soccer game (attacking, defense and preparation or midfield play phase). Within these phases the success of a team relies on the ability to manipulate the underlying principles of play, which will serve as guidelines of team efficiency (Garganta, Maio, & Basto, 1997). Analyses in these principles show that during the attacking phase players try to extend their movements and use the space effectively to attack in width and length (Costa, Garganta, Greco, Mesquita & Saebra, 2010). On the other hand, during the defense phase the tactical principles focus on occupying crucial spaces and protecting the scoring area (Costa, Garganta, Greco, Mesquita, & Saebra-Afonso, 2010). Based on this information, depending on the tactical principles that a team has in each phase of the game a playing style (e.g., “direct play” or “indirect play - possession play”) can be identified in a team and this has been considered as one of the important factors to enhance team performance in team sports (Lago & Martin, 2007). Furthermore, these playing styles reflect individual style of coaching, the players’ characteristics, the team’s formation or also the team’s culture or particular philosophy (Hughes & Barlett, 2002). For example, the symbolic Italian system of play, well known as *catenaccio*, translates as “door-bolt” (Goldblatt, 2007). Its meaning has been corroborated with scientific studies that show that Italian league rankings are more highly correlated with measures of efficiency in

defense than attack (Dobson and Goddard, 2011). Another style that has been identified through research is the British football, which has been associated with the direct method of play football (Pollard & Hartley, 1988; Yamanaka, Hughes & Lott, 1993).

Although the aforementioned studies report findings through the study of tactical behavior at the level of a team there is also research on tactical behaviors of individuals alone. For example, in 2003 Peñas and Anguera presented a model of sequential analysis in the study of players' interactions. The baseline of this model consisted in the elaboration of a taxonomic system based on each player's role and then a sequential analysis was carried out to detect behavior patterns between members of a team. The major contribution of this study was the identification of offensive patterns during the offensive phase and the network established between the possessor of the ball and the next player to receive the ball. However, this study did not include the cooperation and opposition situations that involve a soccer game.

In his thesis, Gil (2008) looked at the tactical behavior of players alone in a very specific position, the goalkeeper. In this case, the study focused on the relation of the dyad between a goalkeeper and a striker when shooting at goal. The method used consisted in codifying behaviors in these game situations according to the space that the goal keeper occupies during the time in which the shot was taken.

Movements' analyses. A widely cited paper in performance analyses in the area of movement's analyses in soccer was presented by Reilly and Thomas (1976). One of the major findings of this work was that the ability of a player to perform repeated maximal short-duration sprints during a game was an integral fitness component in team sports. The baseline followed in this work was to simply code the movements of the players during the game into several categories such as standing, walking, trotting, running and sprinting. Furthermore, they gathered information about the field positions

and time spans for each movement of the players. This information allowed the authors to calculate aspects of physical fitness and type of movements that had not been considered yet (e.g., distances and rates of the movements).

The aforementioned paper opened a new area of study in performance analysis that currently is one of the sources of information in soccer that has provided more knowledge in the movement characteristics and the physical demands needed for team sport players. For instance, it is well documented that soccer players run a mean average of 11393 ± 1016 meters independently of the field position (Bangsbo, Mhor, & Krustrup, 2006; Di Salvo, Baron, Tschan, Bachl, Calderon Monter & Pigozzi, 2007; Di Salvo, Gregson, Atkinson, Tordoff & Drust, 2009). Further, all these studies include precise values of the rates at which these distances are covered. For example, during a soccer match distances covered at high-speed running (19.1-23Km/h) are between 397–738 meters, and sprinting (>23Km/h) between 215–446 meters. Other authors reported that sprinting actions represented 10% of the total distance covered in a match (Buchheit, Mendez-Villanueva, Simpson & Bourdon, 2010). When taking into consideration that over the 90 minutes of a soccer match players are required to repeatedly produce maximal or near maximal efforts (i.e., sprints), interspersed with brief recovery intervals (consisting of complete rest or low to moderate intensity activity) and that this can be required at any interval of the match (Di Salvo et al., 2007), Repeated Sprint Ability (RSA) has become well accepted as an important fitness component in team-sport performance (Dawson, 2012).

Based on these findings, new physical training methods have been designed to enhance performance of team sports' athletes and several RSA training strategies have been tested (Chamari et al, 2005; Fenrandez, Zimek, Wiewelhov, & Ferrauti, 2012; Hill Hass, Coutts, Roswell, & Dawson, 2009; Ross & Taveritt, 2011). However, the latest

research in this area claims the need to integrate performance analyses including others than only movement's analyses to understand performance. For instance, Di Salvo, et al. (2009), pointed out that the key of success in soccer relies on the technical and tactical effectiveness rather than the movement's analyses alone.

Situational Variables. Research on situational variables has focused on the correlation between contextual factors (i.e., team location, match status and the quality of the opponent team) and a performance indicator. Since ball possession is the most popular performance indicator in soccer analysis research (Lago & Martín, 2007), most of the studies in this area have used it to investigate how context variables affect performance of a team. For instance, differences in ball possession depending on the match status, team location (home/away) and level of the opponent team have been observed (James, Jones & Mellalieu, 2004; Lago, Acero, Seirul·lo & Álvaro, 2006).

Jones and Mellalieu (2004) used forty matches of a British soccer team during two different seasons (2002-2003 and 2003-2004) to investigate the effects of situation variables on performance. The findings of this study suggested that winner teams have more ball possession when they are losing or tying. These results are in accordance with the results that Lago and colleagues (2006) found when studying the time of ball possession of Football Club Barcelona matches during the season 2004-2005 of the Spanish Soccer League. They reported that every 10 minutes a team is losing, their ball possession increases 1 % and 0.45% when they are tying. According to the results of this study and the interpretation of similar results from others, Lago et al. (2006) identified the need to find critical points from where the behavior of a player and a team was altered and therefore the manifestation of different and new goals during the course of the match seem to be evident. Thus, since a change in the situation variables affect the development of a match due to the change of behavior in players and teams, new

contexts within the same match are generated and these are called episodes of competition (EC). Lago and colleagues (2006) proposed three different episodes of competition as a result of changes in the situation variables (e.g., match status):

1. Episodes of competition of initiative: these episodes are those in which due to the match status, the time, the location of the match, etc. force the strategic individual and collective behavior to develop the need of the team to have ball possession targeting to bring the play to the opponent goal with a high number of players accompanying the play.
2. Episodes of competition of expectation: due to the context variables of the match the strategic behavior of players make the team to adopt a strategy in which they do not want the possession of the ball. In case they take the ball there is no intention of bringing the ball directly to the opponent goal but to slower the pace of the match. In addition, most of the ball possession occurs on the own side of the field rather than in the attacking side.
3. Episodes of competition of empty: are those episodes defined by the situation variables of a match in which behavior of players and teams will not affect the development of the final match status.

Other studies in this area, investigate the effects of the situation variables on physical performance of soccer players. For example, Lago, Casáis, Domínguez, Lago and Rey (2009) examined the effects of match location, quality of the opponent and match status on the work rate of elite soccer players. They used a total of twenty-seven Spanish Premier Soccer League to monitor the distances traveled by players of a team at different intensities. Through a linear regression, the major findings were that match location and match status were the contextual variables that more affected the work-rate of soccer players. For example, home teams covered a greater distance at low intensity

than away teams and winning teams showed less high intensity and more distance covered by walking and jogging.

Criticism of traditional performance analysis

Based on the current body of literature on the topic of performance analysis that was provided in the previous section, sport biomechanics and notational analysis have provided a valuable foundation in performance analysis. However, the amount of data gathered from these traditional methods offers a limited scope of information within sport sciences because other applied disciplines such as motor behavior, psychology or physiology also contribute to the effectiveness of performance analysis (Glazier, 2010). This raised some criticism and discrepancy from sport scientists concerned about the need for relying on theoretical principles and empirical data that helps to better explain how successful performance outcomes are achieved. Traditional methods present sets of data collected that can misrepresent performance, by ignoring other, more or less important variables that during the match interact together producing different comprehensions of the game than just knowing a single indicator alone (Hughes & Bartlett, 2002). For example, imagine that the performance of two players of the same team had to be compared (e.g., player A and player B) based on the total number of shots. If player A had a total of twelve shots and player B a total of six shots, one could infer that player A had a better performance than B. However if their performance had to be compared based on the ratio of shots on target by total number of shots, imagining that player A had four shots on target out of twelve total shots and player B had five shots on target out of six total shots, now player B would have greater performance in comparison to player A. Indicators used in traditional methods of sport performance analysis tend to describe the 4 W's (McGarry, 2009): Who performed the action (a specific player that performed the indicator analyzed, e.g., player A); what kind of

action is taken (e.g., shots executed by player A); when, the intervals of time the actions took place (e.g., shots of player A on the first half and second half); and where this action is taken (e.g., specific location on the field). This is why the use of data presented in single sets alone can misrepresent actual performance. At the same time, these data are strongly dependent on the perception and experience of the coach, who defines which variables should be brought into analysis and how to interpret them (Vilar et al., 2012). Since enhancing sport performance and producing valid and reliable data is a concern of the different disciplines of sport science, a more unified and holistic approach was claimed by sport scientists. Further, these sport scientists believed that this more unified approached should be based on dynamical systems theory to offer an even greater scope and potential for scientific endeavor in performance analysis. Since one of the problems that traditional methods had was that presented data emphasized the outcome rather than the causative mechanisms and processes underpinning those outcomes, McGarry and Franks (2006) endorsed the powerful role of dynamical systems theory in performance analysis to provide answers to the questions of "how" this play occurred and "why." Vilar and colleagues (2012) suggested that a notational analysis fails to provide an answer of these two questions. Thus, performance analysis should focus much more on the processes of coordination and control underpinning the performance outcome rather than the performance outcome alone.

Towards a new approach in performance analysis

In this section there is a review of research involving dynamical systems theory and where performance analysis is going after taking this challenging approach. This new perspective aims to understand sport phenomena at different levels to enhance performance and at the same time to provide accurate and reliable data.

General Systems Theory

The general systems theory described by Ludwing Von Bertalanffy (1976), spanned the systemic thinking to many scientific domains in which the need to establish universal principles to solve problems of organization and order was pivotal to take such approach. Hence, some of the first dynamical systems theories came from quantum physics where the importance of complex connections was an issue of interest; from biology, where reductionism was replaced by holism conceiving the essential properties of an organism as properties of the whole system (Capra, 1996); or from psychology, where the gestalt school adopted new organismic approaches of the brain as irreducible and with self-organizing tendencies (Köhler, 1941). According to Bertalanffy (1976), there are open and closed systems. Closed systems are those independent systems, isolated and that proceed spontaneously in the direction of increasing disorder or entropy. While open systems are in constant flow of matter and energy proceeding from the environment, entropy decreases. Within the category of open systems, Bertalanffy describes dynamic systems as those organisms that change over time and maintain constant interaction of flow of energy with its environment.

Cybernetics or Theory of information

Another influential theory that contributed to the current dynamical systems approach is the cybernetics or theory of information (Wiener, 1961). The paramount factor of this scientific branch focuses on the organization patterns and the capacities of a system to self regulate and keep itself in balance. Wiener (1974) pointed out the importance of the term feedback in the circular character of retroactive loops. These consist of a group of elements causally connected in which an initial cause spans around the different levels of the successive loops. Consequently, each of the elements has an effect on the next one, returning to the beginning of the process. However, the contemporary standpoint has modified this perspective of retroactive loops for a new

one in which all organisms have a large amount of loops since in open systems the same situations never truly repeats, and therefore, the starting point is never retrieved.

Non-linear dynamical systems theory

From all these theories, emerged the mathematical theory of dynamical systems (DST). Although Prigogine used DST to describe observable changes in thermo dynamical systems, the concepts and techniques of this mathematical theory could be applied in a wide range of domains (Capra, 1996). A dynamical system has been defined as a set of quantitative variables changing continually, concurrently, and interdependently over time (Van Gelder, 1998). These, variables are those physical, chemical, biological or social systems that exhibit many independent component parts or degrees of freedom that are free to vary over space and time (Glazier, 2010). Within sport sciences, dynamical systems can yield complex adaptive behaviors from non-linear interactions of athletes in space and time (Duarte et al., 2012). Therefore, the application of these theories in sport performance is utterly justified since all these concepts and principles aforementioned occurred in the nature of all dynamical systems (e.g., athletes) and at different scales (i.e., team-fractal-player).

Ecological psychology

From all the fields of study in which dynamical systems has been applied, ecological psychology is believed to be a viable approach to study human movement. Gibson was the exponent of this functionalist approach in which he developed the theory of direct perception and explains that humans and other animals perceive and act on what he called “affordances.” Thus, the paramount factor of the ecological approach is to conceive animal and environment as coupled systems, whose product results in affordances (Gibson, 1979). This perspective is typically referred to as the “Gibsonian” approach.

The Gibsonian approach presents four basic characteristics around affordances.

1. Affordances are meaningful: Affordances are possible actions determined by the action capabilities of an animal to interact with the physical properties of the environment (Withagen & Chemero, 2011). Gibson said: “the perception of what a thing is and the perception of what it means are not separate, either” (p.408). This opens a door to contemplate affordances not only as properties of the environment or animal, but also as relations ascertained during their exploration of the environment (Chemero, 2003).
2. Affordances present a myriad of action possibilities: If the environment and its agents have physical properties and meaning to animals, different animals can perceive different affordances with the same object (Chemero, 2003). At the same time, the wider the set of skills the animal possesses, more affordances will be encountered. Both relations and skills are sources of affordances allowing a myriad of action possibilities.
3. Events where affordances occur are not properties, but things in themselves (Bingham, 2000)**.** Thus, events can be static and dynamic properties of objects and surfaces and can exist without reference to behavior.
4. The last characteristic results in a combination of the first three. If affordances are relative to the animal-environment system and they can be conceived as relations (i.e., they have meaning to the animals), an event can present an unlimited set of affordances, which at the same time, each of them can afford a myriad of behaviors that differ from animal to animal.

Performance analysis and ecological psychology

Once affordances have been approached and the origin where they occur defined within the context of a sport, the ecological approach is used by researchers to gain

understanding in the intervention and assessment of human activity in skill acquisition (Davids, Button, Araújo, Renshaw, & Hristovski, 2006; Handford, et al, 1997;) and sports performance in specific environments where observable behavior emerges (Lago, & Martin R., 2007; McGarry, 2009; Passos, et al., 2008; Travassos, Araújo, Correia, & Esteves, 2010; Vilar, et al., 2012;). Theorists of ecological dynamics emphasize the importance of the relations between any individual and the environment in which this individual functions (Turvey & Shaw, 1999; Turvey, Shaw, Reed, & Mace, 1981) and explain that humans and other animals perceive and act on what Gibson (1979) called affordances (e.g., surfaces - grass or Astroturf; places – the field; objects- the ball/the goals; neurobiological systems - teammates/opponents; and events- the soccer competition).

This synergy (i.e., organism-environment interaction) of ecological dynamics in soccer is explained within the ecosystem that field invasion games present (i.e., composed of dynamical interacting parts including organisms and their changing states within and among ecosystems); it studies the relationships that neurobiological systems (i.e., athletes) and including social neurobiological systems (i.e., team) have with each other and with their environment in achieving successful performance outcomes (Vilar et al., 2012). In other words, this theoretical explanation of the viability of the ecological approach to study team sports and how its theoretical framework matches with soccer characteristics could be exemplified with any single match play in competition.

For instance, the ecosystem represents the field area in which systems of the environment interact. In this context, the neurobiological systems of this ecosystem are the possessor of the ball, a teammate placed closer and another one placed further away, as well as their respective defenders. The social neurobiological system would be

defined by the interaction among these six neurobiological systems (Passos et al., 2009). According to Turvey (1990), the interactions are spontaneous and emerge from some kind of mutual understanding in order to achieve a common goal. For example, the possessor of the ball knows that passing the ball to the further teammate will benefit the team. To accomplish this goal, the possessor can pass the ball to the nearer teammate and this one to the further teammate. However, this makes a very predictable procedure to achieve this goal and therefore quite likely for the defenders to get the ball back. In contrast, if the possessor of the ball dribbles towards the nearer teammate, this action would trigger the movement of his nearer teammate as well as the movement of the defender and the defender of the nearer teammate to re-adjust the interpersonal distance of the one-on-one matchup (e.g., Passos et al, 2008). While this is happening, the further teammate of the possessor of the ball would come closer to the space created due to these movements and here is when the possessor would be able to release the ball to the targeted player in a very different and unpredictable way. Within a dynamical systems framework, this interaction is known as self-organization. This term has been used in recent years to explain the emergence of certain behavioral patterns in complex social neurobiological systems (Sumpter, 2006). Furthermore, these interactions can become more complex patterns due to the ability of highly complex systems to follow basic behavioral rules (Nicolis & Prigogine, 1977). In the above example, the behavioral rules would be to maintain a certain distance between the possessor and the nearer teammate to keep the pass option and at the same time for the further player to occupy the created space to create a new optional pass line.

Contributions of ecological dynamics in performance analysis

Team sports with field invasion games are characterized by dynamic performance environments (Fajen, Riley, & Turvey, 2009). These environments present

a dynamic flux of informational variables in constant change that constrain and afford movements due to the complex interactions between performers and the properties of the field of play (Araújo & Davids, 2009). According to these characteristics, several authors have studied the relevant properties of team sports by using dynamical systems approaches (e.g.,Grehaigne, Bouthier & David, 1997; McGarry, Anderson, Wallace, Hughes & Franks, 2002).

Within an ecological dynamics stance Travassos, Araujo, Correia and Esteves (2010) distinguished different scales of analyses to describe and measure space-time patterns that emerge from the game. Based on the relations between players and teams they distinguished three main levels of analyses: 1) inter couplings; 2) intra and inter couplings between players and 3) intra and inter team couplings. Several reasons to support this classification of level of analyses in team sports are suggested as follows.

Gréhaigne and colleagues (1997) identified several sub-phases in invasive team ball sports that comprise the interaction between an attacker and a defender. Thus, the study of sub-phases includes from one-on-one game situations to the whole team (e.g., two-on-two; three-on-three; or two-on-four, etc.). McGarry (2005) also suggested the identification of several subsystems when studying complex systems in team sports characterized by the attacker and defender relationship. Within all the range of possible sub-phases there are phase attractors. These can be distinguished between in-phases or anti-phases. For instance, in studies where trajectories of attackers and defenders are studied (e.g., one-on-one), attractors identified as in-phase would be forward-forward trajectories or as anti-phase would be backwards-forward trajectories. When the two states of these coordinated movements occur it is said that the system observed (in this case attacking-defender dyad) is in an equilibrium state (McGarry et al., 2002; Vilar et al., 2012). The space where these interactions are studied is called the space of phases -

being the geometrical range of values of the variables of a system represented in one unique point. Based on the number of variables of a system at this point, the degrees of freedom of a system can be identified. That is, the components and the number of possibilities of that system to self-organize, as well as the number of constraints (Corbetta & Vereijken, 1999). This suggests that based on the degrees of freedom and constraints its complexity might be assessed (Kay, 1988).

In contrast, when the study of interpersonal interaction provides information about how the destabilization of a system results in symmetry breaking – emergence of new coordination patterns in performance such as getting an opponent passed (Davids, Button, Araujo, Renshaw, & Hristovski, 2006) it is called phase transition. The moments of phase transitions in which the equilibrium of the in-phase or anti-phase is broken, results in a mode change within the system (Davids et al., 2006).

Inter couplings level of analyses. This level of analyses includes all the playing situations of team sports in which a complex system is comprised by an attacking-defending dyad. The aim of studying these systems is to identify the nature and characteristics of the interpersonal interactions in situations of opposition (e.g., one-on-one competition). Gréhaigne and colleagues (1997) analyzed the attacking-defending dyad relationship in soccer. By using a dynamical system approach, the results of their study suggested that movements, positioning and speed of players were factors that influenced the decisions made by the player analyzed in possession of the ball.

Other studies have demonstrated that such complex systems establish non-linear behavior characteristics in which a synergy during the coordination pattern exists (e.g., Araújo, Davids, Bennett, Button & Chapman, 2004). Araujo and colleagues (2006) studied one-on-one dyads in basketball and suggested that attackers in possession of the ball tend to search a symmetry breaking of the system in order to increase their scoring

opportunities. However, other research conducted in the sport of futsal (which is similar to soccer) shows that attackers not only create scoring opportunities by symmetry breaking of the dyad, but also by creating a misalignment in a defender's positioning between the attacker and the goal (Vilar et al., 2012). Different characteristics of the relation between attackers and defenders in different sports have also been observed in other studies. For example, in Duarte et al. (2010b) interpersonal distance was measured, accompanied by players' displacement trajectories based on positioning and velocity. A player in possession of the ball had to get his opponent passed within an area of ten meters in length and eight meters in width. Different initial distances between the defender and the ball were used to identify potential constraints. The defender started all trials from the middle of the playing area while the attacker had to pass the defender and then take a shot at a goal with a goalkeeper. The results of this study suggested that when low interpersonal distance values and high relative velocity values happened resulted in phase transitions of the dyad. This is in accordance to the findings of Passos et al. (2008) in which within four meters of interpersonal distance the relative velocity between two rugby players was the major parameter leading the dyad system to a new state. However, in Duarte et al. (2010b), distances in soccer were established at less than 2.5 meters, which suggests there are potentially different constraints in different team sports.

Vilar and colleagues (2012) included relevant physical properties of the performance environment such as the goal area of a futsal court and the ball when studying coordination dynamics in dyads. By using the positioning of the possessor of the ball relative to the center of the goal, their results suggested that dyad emergence and constriction were ruled by distances and angles or the performers to the goal. During the in-phase patterns, dyad coordination emerged from changes of the values of

the attackers and defenders distance to the goal and angles to the goal. This suggests that in futsal, attackers break symmetry of the system by reducing their distance to the goal relative to the defender. It was also reported that defenders, in contrast, try to keep symmetry by placing themselves closer to the goal and between the goal and the possessor of the ball. Regarding the environmental properties, different constraints were found in a one-on-one dyad, such as: 1) the defender's angle to the goal and attacker; 2) the relative distance to the goal; 3) the interpersonal distance between the attacker and the defender; 4) the relative velocity between the attacker and the defender.

Studies in interpersonal level of analyses demonstrate that symmetry breaking occurs due to the emerging interpersonal relations between performers in space and time to achieve mutually exclusive performance goals (McGarry et al., 2002). Thus, the study of dynamical patterns of interpersonal interactions has been suggested to be relevant for determining preferred modes of coordination that characterize dyadic system interactions in sport (Araújo, Davids, & Hristovski, 2006). Further, Travassos, Araújo, Davids, Vilar, Esteves and Vanda (2012) studied the functional behavior of futsal players when intercepting the trajectory of a passing ball. The main finding of this research was that time to ball interception was constrained by the interdependent relationship between information and movement. All these studies in which sub-phases are modeled as attacker defender dyads aim to describe emergent decision-making and actions of performers based on the player's analysis of the adaptations of the environment (Davids, Araujo & Shuttleworth, 2005; Duarte et al., 2010).

Intra and inter couplings level of analyses. This level of analyses includes all the playing situations of team sports in which a complex system is comprised by a minimum number of players required to establish an attacking-defending system not only in opposition but also in cooperation. Hence, the aim of studying these systems is

to identify the nature and characteristics of the intercoupling and intracoupling interactions in situations of opposition and cooperation such as one-on-two; two-on-two; three-on-three, etc. Only a few published studies have been conducted at this level of analyses on coordination dynamics of systems comprised of more than two athletes (Duarte, Araújo, Freire, Folgado, Orlando & Davids, 2012). The main research on coordination dynamics in team sports has been focused on one-on-one dyads systems (Duarte, et al., 2012). However, it has been suggested that investigations into different levels of analysis of a complex system (e.g., individual behavior-group behaviors) is an important issue of study in team sports (Bar-Yam, 2003, 2004).

Duarte et al., (2012) reported that the measures used so far have failed to completely understand coordination dynamics within collective behaviors of a team. Duarte and colleagues point out that studies assessing coordination dynamics assume an equal contribution of players of a team, while they emphasize the possibility of being an erroneous proposition. McGarry (2009) also suggested that computations when measuring at the team-team level might include all players or may include them with different weights or levels of contribution. For example, at a team behavior scale, Lames, Erdmann and Walter (2010) provided information about the average position of the players of a team, as well as, the length and width of the team. The results demonstrated a tendency of teams to be tightly coupled in length and width during the course of a match.

Based on this average point representing the center of a team, Yue, Broich, Seifriz & Mester (2008), calculated the mean's player dispersion. Their results suggested that there are dynamical counter-phase relations between the two teams. As a result, when organization patterns of a team occurred, the other tended to expand and vice-versa. Further research on these expansion/contraction patterns supported that

these collective behaviors emerged as a result of changes in ball possession between teams (Bourbousson, Sève, & McGarry, 2010b).Other studies, have measured the team center and the surface area in four-on-four soccer games (Frencken & Lemmink, 2008; Frencken, Lemmink, Delleman, & Visscher, 2011). Data collected supported a lack of understanding of the interaction between opposing teams during a match to describe performance based on the surface area occupied and the center of a team.

In order to take a step further in this level of analysis, Duarte et al., (2012), investigated collective behavior in a three-on-three soccer game to assess the coordination tendencies of the center of the team and the surface area near the scoring goal. Furthermore, three key moments of play were used to assess the group-motion variables (ball control, assisted pass and crossing line). The major findings were that centroids of the sub-groups had a strong synchronization that describes behavior of three-on-three game situation near the scoring zones. Among the three key moments, the major loss of stability in sub-groups occurred before a crossing ball.

Inter and intra team coupling level of analyses. This level of analyses refers to all the performance phases in which the whole team is analyzed. At this level, inter and intra team couplings are considered to be the relations in a large scale between and within teams. Team coordination is a relatively recent field of research within sport sciences (Eccles & Johnson, 2009; Eccles & Tenenbaum, 2004; Jackson, Beauchamp, & Knapp, 2007; Poizat, Bourbousson, Saury, & Sève, 2009; Ward & Eccles, 2006). This concept refers to how the individual actions are coordinated and therefore define the properties of the interactions among members.

Team cognition (e.g., Cooke, Gorman, & Winner, 2007; MacMillan, Entin, & Serfaty, 2004); superorganisms (Duarte, Araújo, Correia & Davids, 2012); social neurobiological systems (Passos, Davids, Araújo, Paz, Minguéns & Mendes, 2011);

team networks (Fewell, Armbruster, Ingraham, Petersen & Waters, 2012), among others, are all terms used in team coordination dynamics research. From this body literature raises the need to study team synergies to understand, for example, why a team of experts is not necessarily an expert team (Cooke, et al., 2007). In team sports, the game is considered to be synergistic as a result of cooperation and competition actions within and between teams, respectively (Gréhaigne, et al., 1997; McGarry et al, 2002) rather than an aggregate result of individual playing behaviors (Araújo, Davids, & Hristovski, 2006).

A traditional approach used in sports sciences understands team cognition as perfect coordinated behaviors of a team in order to function harmoniously (Fiore & Salas, 2000). This approach focuses on the communication process that enables the regulation of shared knowledge of the performance environment internalized among all team members when coordination patterns occur (Cooke, Gorman & Rowe, 2004; Fiore & Salas, 2006; Salas, Cooke & Rosen, 2008). This theory takes an indirect realism approach (internal mental representations) that is questioned by ecological theories.

For example, in a recent publication, Silva, Garaganta, Araújo, Davids and Aguiar (2013), proposed an ecological perspective from where to study team coordination dynamics. Silva and colleagues underlined that team coordination is based on the “shared affordances” between members of a team, rather than shared knowledge. Therefore, knowledge of the environment is gained through a process of perception and action due to the relation between performers and environment as coupled dynamical systems (Araújo & Davids, 2009). From this perspective, coordination dynamics of a team is understood as the perception of collective affordances that cause collective behavior since there are common goals between players of the same team. Silva, et al., (2013) suggested that collective affordances are trainable and therefore, members of a

team can become perceptually attuned to affordances of others and affordances for others to more efficiently perform coordinated behaviors and adapt to other teammates or opponents (Vicente & Wang, 1998). According to this approach, team coordination is improved by focusing on communication, interaction, coordination and variability *in situ* (Cooke, Gorman & Rowe, 2004). Cooke and colleagues believe that having more than one theory to explain coordination dynamics of a team enhances team performance. These ecological ideas present the opportunity for new potential research areas, as well as, to review existing body literature in team cognition.

Early contributions in research on team coordination used relative phase to demonstrate general movement tendencies of a team within a spatiotemporal dimension (e.g., Lames, et al., 2010). This type of research aimed to characterize the coordination modes among players. Other studies assessed the number of interactions among members of a team, as well as the degree of success of each interaction (e.g., Passos, et al., 2011) to understand the network built during team coordination (Bourbosson, Poizat, Saury, & Seve, 2010). It has been suggested that these coordinated team behaviors emerge as a result of game constraints and information exchanges between players and teams (Marsh, Richardson, Baron, & Schmidt, 2006).

Vilar, Araújo, Davids and Bar-Yam (2012) employed a methodology to assess the stability and instability of attacking-defending sub-phases of the game, as well as, determining successful performance. A professional soccer match from the English Premier League 2010 was analyzed to assess team behaviors. By dividing the field of play in different squares, they could quantitatively analyze team behavior. Results showed that both teams had a greater stability on the center-back defensive areas (47% of match time for team A and 44% of match time for team B). Uncertainty measures showed the center-middle sub-areas of plays to be the most unpredictable areas with

more players running through (39% of match time for team A and 38% of match time for team B) since it is the main path to the other areas of play. By counting these numerical relationships in each sub-area of play and the stability and instability in each of them, team's competitive performance profiles was described based on the modes of coordination.

Duarte et al., (2013), assessed the synchronization dynamics within and between teams during one professional soccer match. A cluster phase method was adapted from the original version of Kuramoto order parameter (Kuramoto & Nishikawa, 1987) to calculate the mean, the continuous team synchrony and the individual's relative phase with the team measure. Results supported that a whole team synchrony was superior in the longitudinal direction of the field than the lateral direction, suggesting that members of a team coordinate each other towards a common goal in a specific direction. In contrast, previous research examining ball possession did not observe an effect on team synchronization with values of 0.70 and 0.89 in all the mean values of cluster amplitude including lateral and longitudinal directions. Thus, high synchronization of both teams occurred in contraction and expansion phases.

Performance analysis of team sports (e.g., soccer) at these three different levels have provided a greater understanding of how teams evolve in changing performance environments. Further, using dynamical systems tools has provided a deeper understanding of how athletes satisfy the demanding spatial and temporal constraints of these changing performance environments on the playing field (Fajen et al., 2009).

Importance of the present study

The presented literature review involving performance analysis has provided information in regards to different types of methods of analysis used in team sports. The notational analysis body of research suggested that a lack of process understanding from

the game raised the need to explain why and how these discrete numerical changes occurred. Furthermore, these behaviors are strongly dependent on the perception and experience of the coach, who defines which variables should be included in the analysis and how to interpret their value (Vilar, et al., 2012).

In contrast, the ecological dynamics approach provides the notion that process understanding is gained by the use of dynamical systems tools. This is supported by an increasing body of research investigating different levels of a system (e.g., team-fractal-player). In addition, from a complex science standpoint, ecological dynamics has been suggested to be a consistent approach in understanding complexity and the emergence of complex systems. Thus, the study of complex systems (i.e., teams-players or group of players) by using concepts and tools of ecological psychology and dynamical systems theory have contributed to gain further knowledge about interpersonal coordination at the aforementioned levels and observing different technical skills (e.g., passing, intercepting, crossing, dribbling, shooting, etc.). However, from a perceptual-cognitive focus of study (i.e., composed of brain, body, and environment, nonlinearly coupled to one another), there are no studies that challenge the nature of the game (tactical principles of soccer) to investigate how players solve motor-perceptually and cognitively tactical game situations that are crucial for emergent collective behavior and team stability. Bardy and Laurent (1998) suggested that professional athletes are prone to exploit and use more local variability to increase stability in behavior at a higher level of organization. This is in accordance with the results of a study by Duarte et al., (2013) where SampEn values for each individual's relative phase with the group (ranging from .06 to .07) showed how local variability increases stability at a higher spatio-temporal dimension of a system (Davids, Glazier, Araújo, & Bartlett, 2003; Torre & Balasubramaniam, 2010). For example, from a complex science standpoint, where

individual tactical fundamentals are the local emergent behaviors that form out of the global emergent behavior of the whole, a good example would be: an attacking soccer midfielder perceives difficulties in building the game and decides to offer support. To do that, he moves from a deeper support to a support in the defensive midfielders' line to guarantee game building of the team (figure 1).

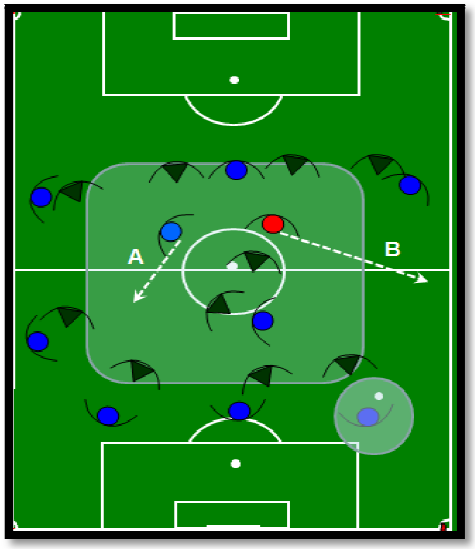

Figure 1. This figure illustrates how an attacking midfielder guarantees the building of the game by moving from a deeper support to a support within the defensive midfielders' line. In case there are no difficulties of game building, the attacking midfielder keeps a deeper support. The red player is the player analyzed, the blue player in the circle is the possessor of the ball and the greens are the opponent players.

Although the important role of skill acquisition has been acknowledged within the sport sciences to develop tactical behaviors in athletes, investigations into the perceptive-cognitive skills training and decision-making ability have been frequently based on anecdotal evidence and practical game play results rather than on empirical tests (Carvalho, Araújo, García González, & Iglesias, 2011). A lack of valid and reliable instruments to assess these variables results in inferences being made about how changes in behavior occurred over an extended period of time rather than being based on direct scientific measures (Williams & Ford, 2009). Thus, the necessity to create an

instrument to effectively evaluate motor-perceptual and cognitive skills when applying individual tactical fundamentals underpinning performance may enhance performance analysis.

Williams, Davids, Burwitz, and Williams (1993) suggested that soccer is ideally suitable for studying the role of perceptive-cognitive skill performance because it demands important tactical and strategic requirements due to the complex activity that involves the interactions of team-mates, opponents, the field of play, and the ball. Furthermore, Vilar et al. (2012) suggests that uncertainty measures are higher in the center-middle sub-areas of play suggesting that midfielders play in the most unpredictable areas with more players running through (39% of match time for team A and 38% of match time for team B). Since center areas are the main paths to other areas of play, it is implied that players with more attuned motor-perceptual cognitive skills are the midfielders.

Presumably, soccer coaches must also understand the same fundamentals of the game. It is likely that coaches possessing this knowledge not only coach more effectively, but are also able to effectively assess game performances and understand how they relate to the ultimate outcome of the executed skills (Carvalho et al., 2011). According to Brack (2002), coaches have a multifaceted role that involves several abilities such as field competence and strategic knowledge. Furthermore, Grundel, Schorer, Strauss, and Baker (2013) recently published a study that investigated whether the perceptual- cognitive skills developed by elite athletes over the course of their career had any relevance to being an exceptional coach. Their results showed there were some similarities between the perceptual-cognitive skills used by athletes and those used by coaches. However, their findings also demonstrated that being a skilled athlete did not develop many of the needed skills that are necessary to be an effective high-level coach.

These findings suggest that skilled coaches do posses knowledge that is very specific to the sport they are coaching.

Therefore, the purposes of this study were:

- To design a scale composed of three dimensions to measure emergent complexity of game situations in team sports (e.g., soccer) and perceptual-cognitive skills of soccer players when applying individual tactical fundamentals.
- To test the reliability of a scale by comparing high and low skilled coaches' ability to assess complexity and perceptual-cognitive skills in soccer.

The following hypotheses were investigated:

- High skilled coaches would have a higher stability between assessment periods in the complexity and perceptual-cognitive skills dimension.
- The complexity dimension would be more stable between and within groups of coaches than the perceptual-cognitive skills dimension.

The scale is designed to accurately measure the local and global emergent complexity of basic tactical game fundamentals. This instrument is unique because there is no current scale that effectively determines a perceptual-cognitive profile in players under an assessed emergent complexity. This is a meaningful pursuit because it would allow for a better understanding of the complex tactical coordination dynamics utilized in soccer.

The scale to measure the complexity and perceptual-cognitive skills in soccer

Historical background of complex sciences

The study of complex systems has been an issue of interest in different scientific disciplines for several decades (Bar-Yam, 2003). For centuries, Sir Isaac Newton's model was the prevalence and used in physics to study particle's states. Thus, Newton established a modeling relation in which the particle's state characteristics are

dependent. That is, the characteristics of a particle's state are defined by its position *x* at time *t*, which establishes a dependent relation of *x*(*t*) in which its motion (*x*) varies at time (*t*). Since (x) varies according to (t), this expresses a simple system because according to Rosen (1991) it is computable. However, the presence of more variables affecting the particle's state remained unsolved at that époque because the relations that occur were impossible to decipher.

Weaver (1949) classified scientific research in three main areas. The first two are the study of simple systems and the study of disorganized complexity. The final area is classified as organized complexity. Weaver said that the most important thing of a mere number of variables was the fact that they are interrelated. In contrast of those variables from disorganized situations that statistics can cope, this manifest an organized feature (i.e., organized complexity) that results in a macro conduct (Sahnnon & Weaver, 1964). However, advancement in this field was not possible until Turing published his seminal work entitled *The chemical basis of morphogenesis* (1952), which greatly contributed to the creation of digital computers and the study of development as a problem of organized complexity.

After Turing's contribution the study of complex systems formed out of many components with emergent behavior was launched to investigate the emergence patterns in different domains. For example, Jacobs (1961) studied the formation of urban neighborhoods; Keller and Segel (1971) studied slime mold dynamics, which established the first model of emergent behavior; Minsky (1985) investigated the different networks of the human brain; and Gordon (1999) studied the behavior of a colony of ants. Therefore, the scale designed and proposed in this study aims to better understand collective behavior that arises from complex interactions of systems that results in an observable macro conduct in team sports (i.e., soccer).

In 1977, Prigogine employed mathematical non-linear equations to understand and predict the behavior of complex dynamical systems in thermodynamics. The findings of his studies are worth noting because Prigogine changed the paradigm in science proving that not only equilibrium is organized but also, the non-equilibrium manifests organization. The assessment tool presented in this thesis, proposes parameters with dynamic behaviors to study soccer that can be described by a set of equations to address dynamic behaviors such as Prigogine did with thermodynamics.

Presently, complex sciences are a recognized as an independent scientific field of study that applies its knowledge to many different domains. According to Bar-Yam (2003), team sports provide a wide range of meaningful examples of complex systems because they express the complexity of emergent behaviors, not only of the parts (i.e., players) but also of the behaviors of the whole team. Thus the study of complexity and emergent behavior in sports science are embraced within the scientific field of complex science.

Dimensions of Complexity

Complexity assessment is the first of three dimensions that the scale designed in this study consists of. Thus, there is the need to 1) explain the characteristics of the scale designed and to define what this word means in the context of this study; and 2) explain the items that a scale presented in this study includes to evaluate complexity.

Conception of complexity. One characteristic of complexity is that it is a contextual property related to the observations of systems interacting with other systems and their environment at a certain space-time scale (e.g., Nicolis & Nicolis, 2007; Solomon & Shir, 2003). Specifically, it is not an intrinsic property of the individuals (e.g., players on a sport team) or the objects (e.g., ball, goals, etc.) within a certain event (Allen, 2001). Another characteristic is that at the same time, the context can present

different models of complexity such as low, middle, or high (Morin, 1990). These levels of complexity are determined by the degree of functional disorder emerging from the events, uncertainty, randomness, actions and retroactions that occur as adaptive responses in any system regarding the environmental conditions (Atlan, 1990). In addition, the lack of information in a specific game situation is also a characteristic that will decrease or increase the level of complexity (Atlan, 1990).

The American physicist Gell-Mann (1995) said that possibly there is no universal definition for complexity adequate to all scientist and researchers. Thus, although complexity is a very arduous term to define, according to these characteristics, I have approached a meaning for this proposed assessment tool. Complexity is a context dependent property based on the interactions among sub-systems of a team, which depending on their level of functionality and the level of information the other observed system possesses about them. This interaction can then result in a game situation presenting a higher or lower model of complexity based on these specific parameters.

According to Rosen (2000), the complexity of a dynamical system is associated to our capacity to obtain different computational models of this unique system. Its complexity depends, not only on the organization of the system itself, but also on our capacity to interact with it. In this way, from a system we can obtain different representations (models) in regards to the perspective we adopt towards this one. This does not modify the system studied, but depending on the standpoint of study it can result in multiple interpretations. Obviously we are limited by our conceptions of what is significantly relevant to understand human behavior in different domains, such as in team sports (e.g., soccer).

For this proposed assessment tool, the initial behavior of the agent (i.e., soccer player) in its environment (i.e., soccer field) serve as coupled systems, which was

explained by establishing parameters of the organism and its environment. Then, factorial functions of these parameters were applied from environmental variables to organismic parameters (e.g., zone on the field based on position of the player) and from organismic variables to environmental parameters (e.g., orientation of a soccer player based on goal location).

Items to assess complexity. Since the goal of this assessment tool proposed is to assess the complexity of a game situation based on the possessor of the ball and the opponent players, three different sub-systems will be categorized to determine the variables that affect complexity.

1. Possessor of the ball. The initial state of the possessor of the ball is assessed by two items.

a. Space. Since soccer is a field invasive game, the space of an event is where all the interactions of the social neurobiological systems take place. These interactions can represent situations of opposition and cooperation at any point of the field (Acero & Lago, 2005). However, these interactions are ruled by the location of the goals and the ball (Davids, Button, & Bennet, 2008). Thus, taking into consideration that players of both teams interact in the same spatio-temporal dimension to defend their space and attack the opponent space, different zones of the field (see Figure 2) have been created to assess the degree of complexity in which the possessor of the ball (e.g., midfield) has his initial state regarding his attacking goal.

According to Vilar et al. (2012), when studying a one-on-one situation the defender always appeared to be closer to the goal than the attackers. As the play evolved, the interpersonal distance between attacking and defending player was reduced. Therefore, the closer the possessor of the ball is in regards to the attacking goal, the degree of complexity is higher due to the characteristics of the one-on-one

dynamics shown in studies such as Vilar et al., (2012a) and Vilar, et. al., (2012b). Following this criteria, the soccer field has been divided into four symmetric parts (see Figure 2) that according to the location of the own and attacking goal the models of complexity will be lower (A) or higher (D). The division of the field into four parts is based on the work of Acero and Lago (2005), whom reported the correlation of passes among similar zones on a soccer field.

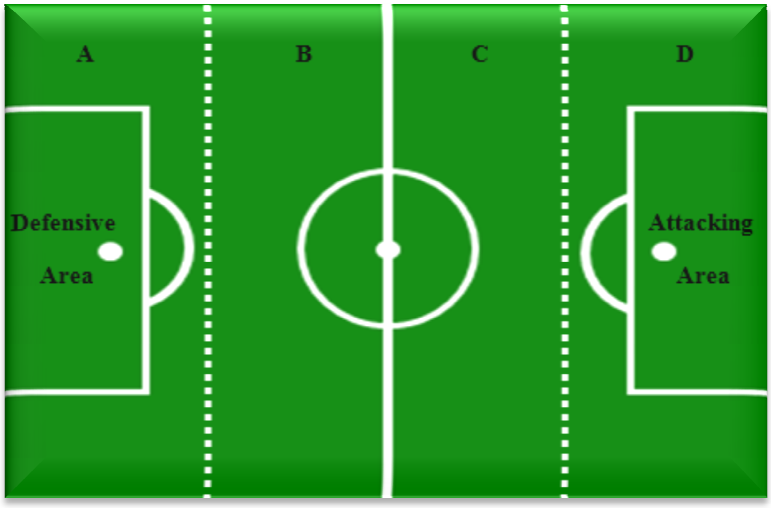

Figure 2. This figure illustrates how the soccer field has been divided in four different zones that determine the levels of complexity from A (low complexity) to D (high complexity).

b. *Orientation.* Since one of the characteristics of complexity is the lack of information when performing a task or describing an object (Atlan, 1990), orientation of the player plays a key role in the informational constraints of any athlete. Specifically, the player in possession of the ball who is forward to the attacking goal will be in a lower complex situation than a player who is in the same situation but with a lateral position (moderate complexity) or backwards from the attacking goal (high complexity).

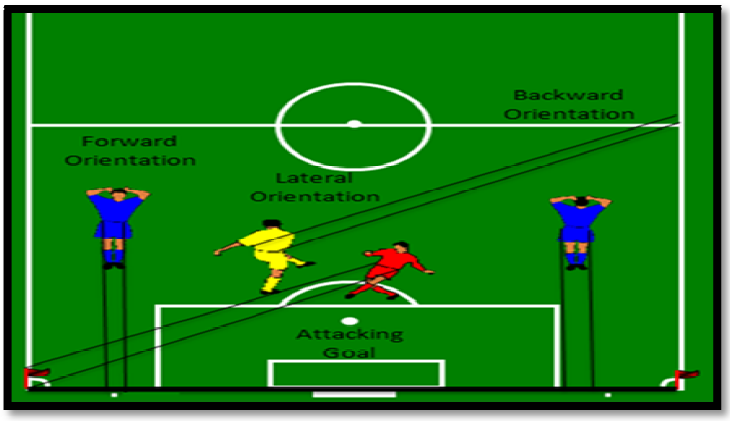

Figure 3. This figure illustrates how the orientation of the players will be analyzed based on the location of the attacking goal of the possessor of the ball.

2. ***Opponent players.*** Since in soccer there are 11 players for each team, the number of opponent players that this scale takes into consideration is limited by using a space distribution criterion. Some authors consider the attacking player with the ball to be the center of the game (Acero & Lago, 2005). All those players who can participate either with an attacking or defending role, are included in this small context of the play considered the center of the game (Acero & Lago, 2005). In an effort to assess the various states of the observed system and establish parameters with dynamic behavior; two different zones were created to distinguish where a player can be identified: intervention zone, and mutual help zone.

Intervention zone.

- It is defined by the ball and all those players who are about to participate in the play.
- Approximately all those players who are between two to four meters from the possessor of the ball will be included in the intervention zone.
- Another criteria that helps to determine whether players are inside of the intervention zone is the direction in which the defender is running (either towards the possessor of the ball or moving away from him).

Mutual help zone.

- All those players who surround the intervention zone no further than approximately sixteen meters from the possessor of the ball. Imagine two concentric rings with the intervention zone serving as the center ring, the mutual help zone then becomes the next outermost ring (see Figure 4 below).
- Players who are located outside the first line from where the possessor of the ball is located. The first line refers to the players that are close to the intervention zone when no other teammates are present and whose role is to help the player in the intervention zone (if there are any).
    - Players in this zone may block a potential line pass.
    - Players in this zone may also block any possible open space.
- Any other player located over sixteen yards from the possessor of the ball is out of the mutual help zone.

The combination of these criteria determines the players that belong to the intervention zone or mutual help zone (see Figure 4 below).

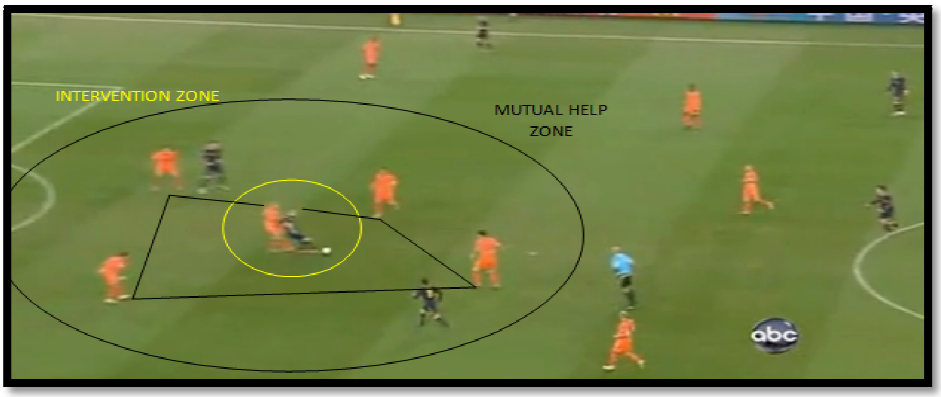

Figure 4. This figure illustrates the two situations that defenders can be placed at the analyses of the plays: Intervention zone (yellow circle) and Mutual Help Zone (black circle).

There are two possible situations of the opponent players in which the complexity generated will be higher or lower depending on which zone they are. If an opposing player is placed within the intervention zone, the complexity will be higher than if the same player was placed in the mutual help zone. Once the different zones are established, there is the need to identify the items used to assess the complexity generated for the opponent players in each zone. These are the position where the defending player is located in regards to the possessor of the ball and zone D (own goal) and the orientation.

For the location, defenders closer to zone D than the possessor of the ball will create higher degrees of complexity; defenders at the same distance (in parallel) will generate moderate levels of complexity and players further than the possessor of the ball to zone D will generate low levels of complexity. On the other hand, the orientation of the opponent players will use the same criteria explained for the possessor of the ball.

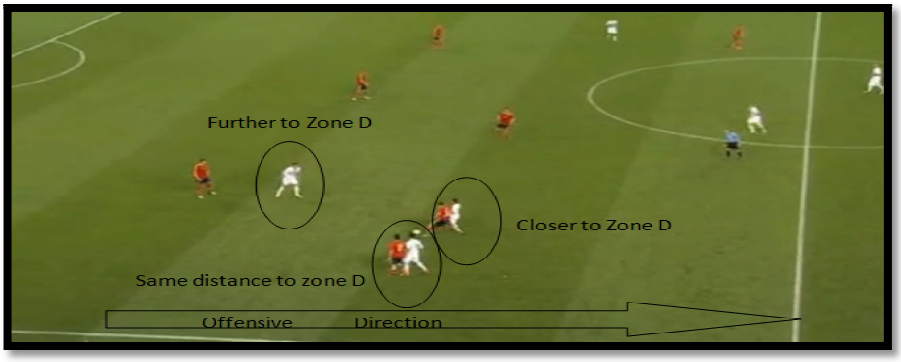

Figure 5. This figure illustrates how the location of the players will be analyzed based on the location of the attacking goal of the possessor of the location of the possessor of the ball. In this image, white players are the defenders while the red team is in possession of the ball.

Hence, the combinations of the defenders in each zone are various and depending on the location of the defender and his orientation, the degree of complexity varies. For example, when the defender is closer than the possessor of the ball to zone D and has a lateral orientation regarding the attacking and the defensive goal will generate

a higher degree of complexity to the possessor of the ball. Vilar et al. (2012) highlighted the importance of considering the goals and the relative angles when analyzing dyads of one-on-one situations in team sports. Therefore, the defender limits the range of possibilities by leading the attacking player to one of the sides and keeping this relative angle between the ball and goal to better defend the space. The lateral position is also believed to generate a higher degree of complexity since the lateral displacement allows the players to move faster than running backwards, while at the same time limits the possibilities of the player with the ball to only one direction. A moderate model of complexity will be generated by those opposing players who are forward to their attacking goal. This position allows the defenders to see the possessor of the ball. In spite of it, the player with the ball has a better chance to break the symmetry of the dyadic one-on-one and get his opponent passed (Vilar et al., 2012). The lower degree of complexity is generated when the defending players are backwards from the possessor of the ball. This is because these players have no information about the possessor of the ball and therefore, the complexity that generates this situation to the possessor of the ball is lower than those described in the previous scenarios. When the defenders are placed at the same distance than the possessor of the ball from zone D, lower levels of complexity will be generated by a backwards orientation towards the attacking goal of the possessor of the ball. Moderate amounts of complexity will be generated when the defenders' orientation is forward towards the attacking goal of the possessor of the ball, while the highest levels of complexity will be when they have a lateral orientation (see Figure 3 above). When they are placed further than the possessor to zone D, a backwards orientation will represent lower levels of complexity; lateral orientation will generate moderate levels of complexity, while a forward orientation towards their own goal will give higher levels of complexity for the possessor of the ball.

In table 1 below there is a classification of the variables and their corresponding values that represent all these aforementioned possible relations of the opponent players based on the attacking goal of the possessor of the ball and their orientation.

Table 1

Orientation of the Players

LOCATION	FURTHER			PARALEL			CLOSER		
ORIENTATION	**B**	**L**	**F**	**B**	**F**	**L**	**B**	**F**	**L**
VALUES	11	22	33	44	55	66	77	88	100

Note. The orientation of the players are represented as forward (F); lateral (L) and backwards (B). Further, the complexity values for each of the possible locations and orientations where a player can be identified are also depicted.

Mathematical modeling for the assessment of complexity

In order to assess two or more variables that are believed to be of relevance for the study of soccer, a factorial design has been created to assess the initial complexity in a specific game situation. The reason to choose such a mathematical strategy is because in a factorial design each variable can have two or more values and each game situation consists of a combination of the values chosen for the respective variables. When all the possible combinations are used, a complete factorial design is represented.

Variables. For assessing the complexity of a game situation, the variables chosen in the assessment tool proposed are:

- Space
- Orientation
- Location of the system observed in regards to the attacking goal and the possessor
- Intervention zone
- Mutual help zone

This choice of variables is not random, but they have been selected because they are believed to be easily recognized when observing soccer players. Further, their natural evolution during the course of a soccer game is representative of the dynamical system in soccer because they reflect the various influences that impact the emergent complexity of game situations.

The factorial design. The main goal of this dimension is to relate the previously mentioned variables (i.e., space, orientation and location of the opponent players within the intervention zone, and the mutual help zone) with the complexity emerged from a game situation. To do this, the factorial design to assess complexity consists of:

1. Factors observed system:

$$Å = \boldsymbol{f}\ (Ʈ, Š) \qquad \text{(Eq. 1)}$$

Being,

Å = Observed system

Š = Space

Ʈ = Orientation of the trajectory

Table 2

Values of Complexity

SPACE (Ł)	**A**			**B**			**C**			**D**		
ORIENTATION (Ʈ)	**F**	**L**	**B**	**F**	**L**	**B**	**F**	**L**	**B**	**F**	**L**	**B**
VALUES	8.3	16.6	25	33.3	41.6	50	58.3	66.6	74.9	83.2	91.5	100

Note. A scale of complexity values appear here based on the relation between the orientations of the player depending on the space occupied on the field and the distance with the attacking goal. The character (F) stands for forward; (L) for lateral and (B) for backwards.

2. Factors secondary systems:

To calculate the variables that affect complexity among the secondary observed systems two potential zones where they can be identified are distinguished (i.e., Intervention zone and Mutual help zone). In order to limit the complexity emerging from each of the systems in each zone, the surface area of the zone where they are identified has been calculated.

Thus, if the intervention zone has a radius of 4 meters and the mutual help zone has a radius of 16 meters (see figure 6 below), the correspondent area is calculated by:

$$A_{\text{O}} = \pi r^2$$

$$A_{\text{Ï}} = \pi 4^2$$

$$A_{\text{Ï}} = 50.\,26548 m^2 \qquad \text{(Eq. 2)}$$

Being,

A_{O} = Total Area of the circle of game

$A_{\text{Ï}}$ = Area of intervention zone

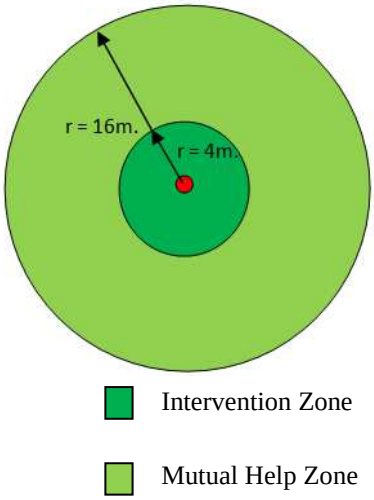

Figure 6, depicts the two zones of game play and the linear distance from the ball (red point) to the end of the mutual help zone.

Once the area of the intervention zone has been calculated, the area of the circle that determines the zones of game will be determined in order to calculate the area of the surface area in the mutual help zone.

$$A_{О} = \pi r^2$$

$$A_{О} = \pi 16^2$$

$$A_{О} = 804.24772m^2 \quad \text{(Eq. 3)}$$

To have the area of the mutual help zone, the area of the intervention zone is subtracted from the total area of the circle of game.

$$A_{Щ} = A_{О} - A_{Ї}$$

$$A_{Щ} = 804.24772 - 50.26548$$

$$A_{Щ} = 753.98224m^2 \quad \text{(Eq. 4)}$$

Being,

$A_{Щ}$ = Area of mutual help zone

Once the surface area for each of the zones is identified, the variables for each of the systems that will interact in each zone are reduced to the space that occupies the whole system that will determine the size of the system itself. Thus the emergent complexity in each zone is determined by:

a. Secondary systems intervention zone

$$Ö_{Ї} = \frac{\sum_{ij=11}^{ij=ij} n_{ij(\tau,Ł)}}{A_{Ї}} \quad \text{(Eq. 5)}$$

b. Secondary systems Mutual help zone

$$Ö_{Щ} = \frac{\sum_{ij=11}^{ij=ij} n_{ij(\tau,Ł)}}{A_{Щ}} \quad \text{(Eq. 6)}$$

Being,

$Ö_{Ї}$ = Secondary observed systems in the intervention zone

$Ö_{Щ}$ = Secondary observed systems in the mutual help zone

Ꞇ = Orientation of the trajectory

Ł = Location of the secondary observed systems

$A_{Ї}$ = Surface area in the Intervention zone

$A_{Щ}$ = Surface area of the mutual help zone

Table 3

Values of Complexity

LOCATION (Ł)	FURTHER			PARALEL			CLOSER		
ORIENTATION (Ꞇ)	**B**	**F**	**L**	**B**	**F**	**L**	**B**	**F**	**L**
VALUES	11	22	33	44	55	66	77	88	100
Player 1									
Player 2									
Player 3									
Player 4									
Player 5									
Player 6									
Player 7									
Player 8									
Player 9									
Player 10									
Player 11									

Note. A scale of complexity values appear here based on the relation between the orientation of the secondary players based on the location occupied on the field regarding the distance with the attacking goal and the system observed. The characters (F) stands for forward; (L) for lateral and (B) for backwards. The exact same values are applied for both zones.

3. Complexity score:

$$C = (Å)\alpha_1 + (Öї)\,\alpha_2 + (ÖЩ)\,\alpha_3 \qquad \text{(Eq. 7)}$$

Being,

C = Complexity

$(Å)\alpha_1$ = Complexity from the system observed with α_1 of 30%.

(Öї) α_2 = Complexity from the secondary observed systems in the intervention zone α_2 of 30%.

(ÖIII) α_3 = Complexity from the secondary observed systems in the mutual help zone α_3 of 40%.

Table 4

Factorial Design

Factor observed system (Å)	**Factor secondary systems (Ö ï)**	**Factor secondary systems (ÖIII)**	**Complexity score**
(Å) = f(Ţ, Š)	$\frac{\sum_{ij=11}^{ij=ij} n_{ij(\tau,ŀ)}}{A_{ï}}$	$\frac{\sum_{ij=11}^{ij=ij} n_{ij(\tau,ŀ)}}{A_{III}}$	C = (Å)α_1+(Ö Ï) α_2+(Ö IIĮ) α_3

Note. The factorial design to assess the initial emergent complexity from a game situation in soccer used in this proposed assessment tool is summarized.

Rationale for the dimensions of individual tactical fundamentals and decision making. One of the purposes of this scale is to assess the ability of coaches to assess the complexity of a situation and the decision the athlete makes. The next two dimensions of the scale are designed to assess perceptual-cognitive skills of soccer athletes. First, the information that coaches perceived surrounding the player when he executed the adequate individual tactical fundamental was considered. Second, based on the five most likely skill execution options for the soccer player were established by coaches. Coaches also assessed, according to the information identified, how successfully the player executed those actions.

Although the important role of skill acquisition has been acknowledged within the sport sciences, investigations into perceptive-cognitive skills training and the decision-making ability of athletes have been frequently based on anecdotal evidence and practical game play results rather than on empirical tests (Carvalho, et al., 2011). A lack of valid and reliable instruments to assess these variables results in inferences being made about how changes in behavior occurred over an extended period of time (Williams & Ford, 2009). Therefore, two dimensions are presented below to test the

reliability of coaches' inferences about athletes' perceptual-cognitive skills using an ecological approach framework.

Comprehension Dimension: The Individual Tactical Fundamentals.

According to the *continuum of complexity* in a game there is a tendency to think that all the initial situations of episodes of a game are infinites- without limits in space or time – (e.g., no time limits of ball possession, no restrictions of zones of play, etc.) (Acero & Lago, 2005). These episodes start from a recognized beginning with an initial instable equilibrium, such as having possession of the ball or not, with an uncertain end. Within these episodes space-time patterns emerge due to the dynamics of complex systems (e.g., soccer team). Within all these patterns, Lago and Anguera (2003a) stated that the tactical aspects constitute the essential nature of the game.

As discussed by Gréhaigne and colleagues (1994) tactics are effective positions that are taken in reaction to an adversary in game situation, and the adaptation of the team to the condition of play. From this definition it can be inferred that there are individual tactics and team tactics. Hence, for the purpose of this study, only the individual tactical fundamentals of the midfielders possessing the ball were analyzed to study player's behavior in different levels of complexity. The importance of this dimension is pivotal to determine perceptual-cognitive skills of soccer players alone. These individual tactical fundamentals represent the interdependent parts (tactical behavior of a player) that form out the whole system (emerging tactical behavior of the team). That is, players recognize patterns of the collective behavior and they interact between teammates while applying tactical individual fundamentals to produce a global emergent behavior of the team which is more complex than the behavior of each individual system agent alone (Bar-Yam, 1997; Bonabeau, Theraulaz, & Deneubourg,

1997; Couzin, Krause, Franks, et al., 2005). In this proposed scale, these behavioral rules at a local level will be considered as individual tactical fundamentals of the game.

The proposed individual tactical fundamentals are organized in three different categories. There are the individual tactical fundamentals of perception; the individual tactical fundamentals of organization of the game; and the individual tactical fundamentals of support. However, independent of the category in which the individual tactical fundamentals are organized in this study, there are tactical behaviors that players apply during the course of the game that build a system where the macro intelligence and the adaptability are derived from the local information. As a result, the general characteristics of these tactical individual fundamentals are:

- The nature of the interactions of a player needs a minimum amount of other players (teammates and opponents) to have intelligent appreciations of the global state of the team.
- A dense system interconnected with simple elements needs to be built in order to make emerge this more complex behavior gradually.
- Players' awareness of the encounters with other teammates. Since soccer players are network dependent among teammates, these encounters allow players to alternate the macro conduct of the system and have a better understanding of the state of the global system.
- At all times, players must pay attention of their teammates in order to recognize when they can apply the individual tactical fundamentals. This ability of team players to recognize patterns allows a more fluid circulation of meta information and increases the cognition level of the team.

Decision making dimension

Decision making is the ability of the performer to select and execute an appropriate action in a given situation (Williams, Ford, Eccles, & Ward, 2011; Williams & Ward, 2007). Some authors have highlighted the importance of the ability to anticipate and make decisions at the elite level as a component performance to discriminate soccer players (Reilly, Williams, Nevill, & Franks, 2000; Williams & Reilly, 2000). This dimension is created as a result of the analyses of the previous dimensions, allowing the observer using the scale to assess the decision making of the player analyzed in that specific game situation.

Since one of the characteristics of complexity is that it is a measure of the number of possibilities of a system (Bar-Yam, 2003), in this dimension the assessment of the decision making is based on the number of ways that one can act or react to environmental conditions. That is, the coaches using the decision making dimension of this assessment tool will analyze the set of possible actions that a player can do. This is of great importance because this reflects the complexity of the situation that this player must solve.

In this dimension the successfulness of the decision made by the player is assessed too. First, the observer identifies the resources that the player has access to in order to solve the game situation (i.e., complexity dimension). Second, the task to be solved in the game situation is determined (i.e., comprehension dimension); third, the observer determines how the player can assemble these resources to solve the game situation (i.e., first part of the decision making dimension). Finally, the scale presented here proposes to determine the degree of successfulness based on whether the player assembles and uses the resources identified in the previous dimensions.

From this perspective, this assessment tool considers the study of decision making at the level of the performer–environment relationship and is viewed as a result

of the interactions of individuals with environmental constraints towards specific goals. In the next section, the methods used to assess the reliability of the coaches' abilities to assess complexity and decision making by using the scale are presented.

CHAPTER 2

METHOD

Pilot testing

Twenty undergraduate and graduate students came to the Motor Behavior Lab at Southern Illinois University. Their level of experience in soccer varied from moderately to highly experience or even with no experience. The primary purpose of pilot testing was to test comprehension of the video tutorial. Prior to assessing a clip of an extra player that was excluded from the primary study, participants watched a video tutorial. After watching the tutorial and assessing the clip, a few questions were asked regarding the level of comprehension and clarity of the tutorial for using the scale. For example, participants were asked exactly how the tutorial was useful and also how the tutorial could be improved. Additionally, participants were encouraged to provide feedback about problems that were encountered and possible ways to improve the tutorial and measurement system. As an illustration of the usefulness of pilot testing, part of the audio from the general instructions was removed based on feedback from the pilot participants.

The primary study

Participants

To test the reliability of the scale, five highly qualified and experienced coaches and five low qualified and inexperienced coaches were recruited to participate in this study. The recruitment process started with the delivery of an online questionnaire (see appendix A) that established the criteria to be assigned as a highly or low qualified and experienced coach. Coaches had to meet the following criteria to be classified as a highly qualified and experienced coach. First, the coach had to possess a minimum of five years of experience as a professional coach, consultant, or have developed a

professional task related to soccer coaching. A professional task was considered those labor activities in which his primary income was from coaching. Secondly, during their coaching careers all of the participants of the highly qualified and experienced group had to have coached or advised at least one player recruited to play at least once in an official match of either the Union of European Football Associations (UEFA) or the Federation International of Football Association (FIFA) for their national team (Layla, Morales, & Greco, 2013). The email addresses for potential participants were obtained from national and international soccer coaching associations with whom the primary researcher is affiliated with. This allowed the researcher to recruit the international highly qualified and experienced professional coaches directly through email. Additionally, low qualified coaches were recruited from amateur clubs and schools from the Midwest of the United States of America. The criterion for this group was to have a maximum of one-year of coaching experience at the elementary school, middle school or high school level. In order to have a standard criterion for years of experience of both groups of coaches, based on the duration of the professional European soccer leagues, a year or season of experience was counted for nine months. Since an elementary school, middle school or high school amateur soccer season lasts for three months, a year of experience was counted as the sum of three seasons in an American soccer school tournament.

The characteristics of the coaches are depicted in Table 5, below:

Table 5

Characteristics of the Participants

	Group A	Group B
Years of experience	*M* = 24.1; *SD* +-2.24	*M* = 1.1; *SD* +-2.04
Coaching level	Professional	Amateur
Hours per week involved in coaching	*M*=38	*M*=7
Total # of top players in FIFA world ranking they have coached	106	0
Years of experiences as soccer player	19.2	20.8

Note. Relevant characteristics of the two groups of coaches. The information depicted was obtained through the administration of a questionnaire adapted from Wu, Porter, Partridge, Young & Newman (2012).

All ten coaches analyzed ten previously recorded live soccer matches of ten different midfielders. For each midfielder five clips with different individual tactical fundamentals were selected. The midfielders that were analyzed had between 5-10 years of experience as professional soccer players (Farrow, Baker & MacMahon, 2008; Williams & Ford, 2009). It is worth noting that four of the professional soccer players that were in the video clips were coached by some of the professional coaches that participated in the study. In addition, all the professional coaches were from the same country.

Instruments

Questionnaire. The questionnaire used by Wu et al., (2012) to recruit long jump coaches was adapted for the present study. The use of this adaptation allowed the researchers to recruit participants that strictly met the criteria of one of the two groups of this study. To see the answers of each coach refer to appendix A. The questionnaires were provided in English and Spanish.

The investigators collected information by asking the following questions:

1. Years of experience as a soccer coach/consultant or any task related. Please, specify what activity and for how long.
2. Are you a professional soccer coach?
3. How many hours a week are you involved in coaching, advising, scouting, teaching or doing any task related to soccer coaching?
4. List the name of the players you have ever coached or advised to play at least once in an official match of UEFA or FIFA with the national team of their country:
5. List the formal training you have had for coaching at your current level or for developing the duties you are developing in your position (this may include but is not limited to: certification courses, sport science seminars, mentorships, associate degrees, bachelor, master's degrees, doctorates, etc.).
6. How often do you usually attend conferences, courses or any kind of meetings to learn more about soccer or get any coaching strategies to improve and update your knowledge?
7. Please, indicate the total number of years you played soccer and write down the highest level you played:
8. What was your position on the field?

The Scale for the Complexity and Decision Making Assessment in Individual Tactical Fundamentals. The scale proposed in this thesis has been designed specifically for the purpose of assessing the complexity in episodes of game where soccer midfielders apply individual tactical fundamentals and make decisions. To analyze a game situation each play had two clips: the first clip (e.g., 1.1; 2.1; 3.1, etc.) showed the prior seconds before the analyzed player received the ball and it automatically froze the image when the player was about to touch the ball. This clip

allowed coaches to complete the complexity dimension, the comprehension dimension, and the first section of the decision making dimension. The second clip (e.g., 1.2; 2.2; 3.2; etc.) showed the whole play from the prior seconds before the analyzed player received the ball through the duration of the play. This second clip allowed coaches to complete the second section of the decision making dimension.

Procedures

In order to design and test the reliability of the scale, the following steps were taken:

Match selection. First, a total of ten matches were chosen to reflect the Individual Tactical Fundamentals of the ten midfielders selected for this study. The matches belonged to the elimination phases of the World Soccer Cup 2006, European Soccer Cup 2008, World Soccer Cup 2010, and European Soccer Cup 2012. Consistent with previous research, half of the midfielders being analyzed were on the team that ultimately won the recorded match and the other half of the midfielder analyzed were on the losing team (Grant, Williams, & Reilly, 1999; Hughes, & Churchill, 2005; Lago, et al., 2006; Reza, Hossini, & Afsanepurak, 2012). This helped to reduce the possible influence of performance features that distinguish between winning and losing teams (Lago, Casáis, Domínguez, Acero, & Seirul·lo, 2010). From each match, five clips for each player were edited in duration and frame speed using the fourth version of Final Cut Express (Apple Inc., California, USA). In order to control for possible order effects, the ordering of the viewings were counterbalanced across the participants as well as in the first and second data collection. All calculations for ordering of the clips were counterbalanced using a randomized Latin square design for each participant.

Online platform. Moodle 2.0 (Moodle Pty Ltd, Perth, Australia) was used for the design of the online scale and allowed the researchers to conduct the test retest

calculation of reliability. Using this customizable software allowed the researches to create an online account for each of the participants as well as for each period of analysis. Therefore, coaches from group A had one account for the first period of analysis (e.g., coach 1A) and a different account for the second period of analysis (e.g., coach 1A_2). This procedure was used to ensure coaches did not go back to view the scores they submitted on their previous viewing of the assigned clip.

Using Moodle 2.0 allowed the researchers to include a video tutorial of fifteen minutes of detailed explanation about how to properly use the scale**.** The concepts of that video tutorial were related to the dimensions of the scale and the procedures that needed to be used. In order to record the video tutorial Camtasia Studio (TechSmith, Okemos, Michigan) was used and a native English speaker and a native Spanish speaker were given a script that had to read by following the images displayed on the screen while recording the video tutorial (see Appendix B) for the narrative script in the video tutorial.

All relevant terms were defined, and the procedures needed to complete the scale were provided within a coach's Moodle instruction' section (see Appendix B). This allowed coaches to use the video tutorial or the instruction' section guidelines to complete the scale.

Another method that Moodle facilitated was that researchers could attach all the clips to the corresponding scale that coaches had to complete for that specific clip. That is, since each play had two clips (i.e., clip 1.1 and clip 1.2 of player 1), the scale had two different sections, and each section included the corresponding clip. Moodle also allowed the researchers to track when coaches moved from section one to section two of the online scale, and therefore that was a control measure of compliance when evaluating the decision making dimension.

Prior to data collection. Before starting the first and second data collection sessions, each group of coaches watched the fifteen minutes video tutorial (see appendix C for script). In order to ensure that low-skilled coaches were familiarized with the use of the scale, a mandatory tutorial was given at the Motor Behavior Lab at Southern Illinois University. This tutorial talked about concepts of the dimensions of the scale and the procedures that were used to complete it. In addition, questions were answered by the researcher in an attempt to clarify any confusion about the scale. Due to the distance between the researcher and the high skilled coaches, this face-to-face tutorial was not given in the Motor Behavior Lab at Southern Illinois University. However through a video conference with each of the professional coaches, concepts of the dimensions of the scale and the procedures needed to complete it were reviewed.

These steps before the data collection were of relevant importance because there was the need to familiarize the coaches with the scale due to the interactive usage of the clips and the completion of the instrument. The nature of the points explained in the video tutorial was derived from questions, problems or misunderstandings that emerged from the designing and piloting phase of the scale.

First assessment with the scale. The first period of analyses began when each coach logged into the Moodle account with a user name and provided password. These accounts were specifically created for this study and only the participants and researchers had access. Prior to this access, each coach was emailed with a specific number assigned (e.g. coach 1A; coach 1B; coach 2A, coach 2B, etc.). This identification number was the user name that the coach used to log into the moodle session (e.g. coach 1A). Coaches had to set up their own passwords the first time they logged in. The investigators were notified about which coach had submitted his analyses

and whether they followed the established order. The researchers were able to analyze the results of each clip analyzed by the use of the scale.

The first data collection was carried out during a period of six weeks. During this initial testing period, the primary researcher sent a friendly reminder to each coach every two weeks. In case there were technological or operator induced problems, coaches contacted the primary investigator in order to solve the matter immediately.

After the first data collection, the researcher and participants scheduled a mandatory meeting to again watch the video tutorial and ensure the understanding of the use of the scale. There was one month between first and second data collection. Therefore, if a coach finished the first period of analyses in October 1st, the soonest he could start the second period of analyses was November 1st.

Second assessment with the scale. For the second period of analyses, a mandatory tutorial was given at the Motor Behavior Lab at Southern Illinois University. A video conference with each of the professional coaches was carried out as well to again clarify concepts of the dimensions of the scale and to address any questions about the experimental procedures. The second period of analyses began when each coach logged into the Moodle account with a user name and provided password. These accounts were different from the ones utilized in the first wave of data collection. Therefore, each coach was emailed with a specific number assigned (e.g., coach 1A_2; coach 1B_2; coach 2A_2, coach 2B_2, etc.). This identification number was the user name that the coach used to log into the Moodle session (e.g. coach 1A_2). Coaches had to set up their own passwords again. The investigators had the same account used for the first analyses. Therefore, the new accounts were created by the investigators within the same Moodle course designed for this study. From this account the investigators were notified about which coach had submitted his analyses and whether they followed

the established order for this second period. Both groups assessed the same game situations of the same ten soccer players, and followed the same procedures used in the first wave of data collection. However, as discussed above, the order of the viewings was counterbalanced across the participants to control for possible order effects. After the second data collection, the researcher notified the participants that they had completed all the analyses and therefore they had finished their participation in this study.

Data analyses

Evaluation of reliability. A test-retest correlation coefficient was determined to evaluate the reliability of the scale *between* and *within* assessments (Baumgartner & Hensley, 2006). SPSS Version 16.0, 2007 (IBM SPSS for Windows, Chicago, USA) was used to calculate the correlation of the scores.

Complexity Assessment. By applying the complexity values for each of the variables used in the complexity dimension in the factorial design proposed, initial complexity of game situations were assessed (see table 4).

Decision making assessment. By collecting ordinal information of the coaches, the researchers were able to measure the difference between the coach assessment and the decision made by the player. A difference of zero meant there was a high degree of success in the decision while a difference of four meant there was a low degree of success in the decision made.

CHAPTER 3

RESULTS

The purpose of this study was to test the reliability of a scale designed to measure complexity and decision making ability of soccer players by comparing high and low skilled coaches' ability to assess complexity and perceptual-cognitive skills in soccer matches. The hypothesis investigated were that 1) high skilled coaches would have a higher stability between and within trials in the complexity and the decision making dimension; 2) and that complexity dimension would be more stable between and within groups of coaches than perceptual-cognitive skills dimension.

In the section below, the findings that support the initial predictions are presented through several analyses of test-retest correlations. The first hypothesis supported for both dimensions where professional coaches had higher reliability. The second hypothesis was also supported, since the highest reliability in both groups of coaches was in the complexity dimension. Please refer to Appendix C for all statistics outputs.

Complexity dimension

Test-retest coefficient correlation within groups

The first data shown (see Table 7 below) is the reliability within groups. This is a measure that often works well to test the reliability within blocks of trials (e.g., Trafimow & Rice, 2009). The scores obtained for highly qualified coaches in the first data collection (A1) and for the second (A2) were correlated. The same correlation was calculated for low qualified coaches in the first data collection (B1) and for the second data collection (A2). In this study, the blocks were divided based on the selection criteria of the participants and a retest situation allowed a comparison across trials (e.g, A1_A2).

The results of this analysis showed that there was a higher correlation within professional coaches (r=0.87) than in amateur coaches (r=0.79) in the complexity dimension (see table 6). In the correlation within groups the number of items included in the data analyses varied due to software malfunctioning. From a total of 250 clips, 2% of these were not available for the correlation A1_A2 and 3.6% for the correlation B1_B2.

Table 6

Correlations Within Groups

COEFFICIENT CORRELATION WITHIN GROUPS			
	N	Correlation	T-value
A1_A2	245	0.869	t(244) = 1.145, p = 0.253
B1_B2	241	0.794	t(240) = 0.059, p = 0.953

Note. The reliability within groups in the complexity dimension for both groups of coaches is shown.

A paired-samples *t* test was conducted to evaluate whether there was a significant difference within high and low skilled coaches. The results indicated that the mean between professional coaches was not significantly different in the first data collection (M = 15.5921, SD = 4.08102) and in the second data collection (M = 15.4372, SD = 4.17038), t(244) = 1.145, p = 0.253. The 95% confidence interval for the difference between the two ratings was -0.11147 to 0.42107. The results for the amateur coaches indicated that the mean was not significantly different between the first data collection (M = 15.7435, SD = 4.16736) and their second data collection (M = 15.7324, SD = 4.72826), t(240) = 0.059, p = 0.953. The 95% confidence interval for the mean difference between the two ratings was -0.35768 to 0.37985.

Test-retest coefficient correlation between groups

The reliability between groups of coaches showed that there was a high correlation between the scores of the professional coaches and the scores of the amateur coaches in the complexity dimension between first and second data collection ($r = 0.79$). In the second data collection, the correlation score for the complexity dimension slightly decreased ($r = 0.73$).

In both periods of data collection, high and low skilled coaches were reliable in the complexity dimension (see table 7 below). This indicates that professional and amateur coaches were able to identify the variables proposed for the study of complexity with an acceptable reliability. It is worth noting that the number of items included in the data analyses varied due to software malfunctioning. From a total of 250 clips, 1.6% of these were not available for the correlation A1_B1 and 5.2% for the correlation A2_B2.

Table 7

Correlations Between Groups

COEFFICIENT CORRELATION BETWEEN GROUPS			
	N	Correlation	T-value
A1_B1	246	0.791	t(245) = -0.141, $p = 0.888$
A2_B2	237	0.725	t(236) = -1.326, $p = 0.186$

Note. The reliability between groups for the complexity dimension for each of the two periods of data collection is shown.

A paired-samples *t* test was conducted to evaluate whether there was a significant difference between first and second data collection between the high and low skilled coaches (see table 7). The results indicated that the mean of the first data collection for professional coaches ($M = 15.6266$, $SD = 4.09748$) and for amateur

coaches (*M* = 15.6508, *SD* = 4.22779) was not significantly different, t(245) = -0.141, *p* = 0.888. The 95% confidence interval for the mean difference between the two ratings was -0.36282 to 0.31441. The results for the second data collection indicated that the means were not significantly different between high skilled coaches (*M* = 15.4752, *SD* =4.16961) and low skilled coaches (*M* = 15.7622, *SD* = 4.71587), t(236) = -1.326, *p* = 0.186. The 95% confidence interval for the mean difference between the two ratings was -0.71333 to 0.13938.

Decision making dimension

Test-retest coefficient correlation within groups

The data obtained for the correlation within groups showed that there was a higher correlation within professional coaches (*r* = 0.79) than in amateur coaches(*r* = 0.71) within the decision making dimension (see table 8 below). In the correlation within groups analysis, the number of items included in the data analyses varied due to software malfunctioning. From a total of 250 clips, 2.4% of these were not available for the correlation A1_A2 and 3.2% for the correlation B1_B2.

Table 8

Correlations Within Groups

COEFFICIENT CORRELATION WITHIN GROUPS			
	N	Correlation	T-value
A1_A2	244	0.794	t(243) = 2.281, *p* = 0.023
B1_B2	242	0.705	t(241) = 1.941, *p* = 0.053

Note. The reliability within groups for the decision making dimension for each of the two periods of data collection is shown.

A paired-samples *t* test was conducted to evaluate whether there was a significant difference within high and low skilled coaches (see table 8). The results

indicated that the mean between professional coaches were significantly different between the first data collection (*M* = 1.3607, *SD* = 1.49658) and in the second data collection (*M* =1.2213, *SD* = 1.47970), t(243) = 2.281, *p* = 0.023. The 95% confidence interval for the mean difference between the two ratings was 0.01901 to 0.25967. The results for the amateur coaches indicated that the mean were marginally significantly different between the first data collection (*M* = 1.6033, *SD* =1.59084) and the second data collection (*M* = 1.4545, *SD* =1.50518), t(241) = 1.941, *p* = 0.053. The 95% confidence interval for the mean difference between the two ratings was -0.00223 to 0.29975.

Test-retest coefficient correlation between groups

The data obtained for the correlation between groups showed that there was a low correlation between professional coaches (*r* = 0.50) and amateur coaches (*r* = 0.43) in the decision making dimension (see table 9 below). In the correlation between groups the number of items included in the data analyses varied due to software malfunctioning. From a total of 250 clips, 1.6% of these were not available for the correlation A1_ B1 and 5.2% for the correlation A2_B2.

Table 9

Correlation Between Groups

COEFFICIENT CORRELATION BETWEEN GROUPS			
	N	Correlation	T-value
A1_B1	246	0.502	t(245) = -2.322, *p* = 0.021
A2_B2	237	0.434	t(236) = .-2.157, p = 0.032

Note. The reliability between groups for the decision making dimension for each of the two period of data collection is shown.

A paired-samples *t* test was conducted to evaluate whether there was a significant difference between first and second data collection scores of high and low skilled coaches. The results indicated that the mean of the first data collection for professional coaches (*M* = 1.3496, *SD* = 1.49548) and for amateur coaches (*M* = 1.5772, *SD* = 1.58312) was significantly different, t(245) = -2.322, *p* = 0.021. The 95% confidence interval for the mean difference between the two ratings was -0.42074 to -0.03454. The results for the second data collection indicated that the mean was significantly different between high skilled coaches (*M* = 1.2532, *SD* =1.48839) and low skilled coaches (*M* = 1.4768, *SD* =1.51143), t(236) = .-2.157, p = 0.032. The 95% confidence interval for the mean difference between the two ratings was -0.42787 to -0.01939.

CHAPTER 4

DISCUSSION

The purpose of this study was to test the reliability of a scale by comparing high and low skilled coaches' ability to assess complexity and perceptual-cognitive skills in soccer. It was hypothesized that 1) high skilled coaches would have a higher stability between and within trials in the complexity and the decision making dimensions; 2) and that the complexity dimension would be more stable between and within groups of coaches than the decision making dimension.

Respective to the experimental hypotheses the results demonstrated that 1) high skilled coaches were more reliable in the complexity dimension (r = 0.87) and decision making dimensions (r = 0.79) compared to the low qualified coaches (r = 0.79) and (r = 0.71) respectively; 2) and the complexity dimension was more stable across trials between professional and amateur coaches in the first data collection (r = 0.79) and second data collection (r = 0 .73) than the decision making dimension (r = 0.50) and (r = 0.43) respectively.

Complexity Dimension

The first comparison that was made within the complexity dimension was between the first and second assessments within the high qualified coaches (i.e., A1_A2). As hypothesized, this comparison resulted in the highest correlation observed in this study (r = 0.87). The level of expertise within this group of participants might be one of the factors contributing to this high reliability. However, since the reliability for the correlation between the low qualified coaches (i.e., B1_B2) was also reasonably high (r = 0.79), level of expertise may not have been the prevailing factor contributing to the reliability of the proposed scale. Therefore, other factors such as the comprehension of the scale, and the support of the video tutorial or instructions given

might have been important factors that helped to maintain stability across both groups of participants. These measurement considerations are suggested to be of value to any researcher concerned with reliability or validity issues (Baumgartner & Hensley, 2006). In addition, the large number of clips that were analyzed likely assisted all participants in becoming familiarized with the use of the scale. As a result, they may have adopted similar patterns to complete the scale that made their behavior more stable (Ferguson & Takane, 1989).

The correlation between A1_B1 and A2_B2 showed that there was a strong reliability between high and low qualified coaches in both periods of data collection. This result was not hypothesized. Rather it was predicted that low qualified coaches would have a lower reliability than professional coaches. However, both groups of coaches obtained similar scores in the within calculated correlations which contributed to a high coefficient correlation between groups in both the first (r = 0.79) and second (r = 0 .73) data collection periods (see table 6).

Decision Making Dimension

Consistent with the complexity dimension discussed above, the same comparative correlations were calculated within the decision making dimension. The correlation between the A1_A2 assessments revealed that there was a strong relationship (r = 0.79) within professional coaches for both periods of data collection. This suggests that professional coaches were more stable across trials and gave similar answers for the decision making dimension compared to their amateur coaching counterparts which had a slightly lower correlation for the same assessments (r = 0.71). This finding is not too surprising considering previous studies that measured cognitive qualities of coaching expertise have found that more skilled coaches have more complex and extensive decision making strategies than low experienced coaches (Gründel, et al.,

2013; Vergeer & Lyle, 2009). Thus, expertise level might have been one of the factors contributing to this higher reliability of professional coaches in this dimension. However, it is worth pointing out that the correlations between B1_B2 (r = 0.71) and A1_A2 (r = 0.79) indicate that the behavior of both groups were stable across trials. According to Brack (2002), the capabilities of a team sport coach are developed over several years of experience. Since the group of professional coaches had a mean of 24 years of professional experience while the amateur group had a mean of one year of amateur coaching experience, the stability across trials among the professional group was expected. This is in accordance to research on years of experience and development of skill expertise (Ericsson, Krampe & Tesch-Römer, 1993). However, Schinke, Bloom and Shamela (1995) suggested that in addition to experience, coaching capabilities could also occur if they spent significant time as an athlete. Since the amateur group of coaches reported having a high experience level as soccer players, this might be an explanation of the high correlations in B1_B2 for the complexity dimension (r = 0.79) and the decision making dimension (r = 0.71). This conclusion suggest that the cognitive and decision making abilities of coaches may be effectively developed through playing experience and are not limited to only being the product of coaching experience.

Nevertheless, the correlation between groups of coaches across trials, (i.e., A1_B1 & A2_B2), showed that there is a very low reliability between high and low qualified coaches in the first (r = 0.50) and in the second (r = 0.43) data collection of the decision making dimension. The low values of reproducibility within the decision making dimension might be explained as a result of existing different game styles that have been identified in soccer (Hughes & Franks, 2005). Thus, tactical preferences between professional and amateur coaches may differ. Since it was observed that

professional coaches and amateur coaches are quite reliable within groups but not between; this may be a result of professional coaches possessing specific knowledge about the sport of soccer that amateur coaches do not possess. This possibility has been suggested in previous research (e.g., Brack, 2002).

Overall, the results of the present study were consistent with the experimental hypothesis. The only hypothesis that was not supported by the experimental findings was that the low qualified and high qualified coaches would have significantly different scores on the complexity dimension. Contrary to what was expected, the high qualified and low qualified coaches evaluated game play similarly. However this finding is consistent with data reported in a previous study. Gründel and colleagues (2013) found similarities between perceptual and cognitive skills used by high and low skilled coaches. These authors reported that the coaches they evaluated relied not only on their years of coaching experience for performance evaluation but they found that they relied on their years of being an athlete to help them make decisions. Consequently, in this study it was not possible to determine whether these reliability scores from both groups were a result of the coaching experience or playing experience. This is an issue that needs to be addressed in future research.

Limitations and Possible Solutions

The first limitation to this study is that the number of participants for each group of coaches was relatively small. According to Baumgartner and Hensley (2006), a small number of participants for a test-retest assessment would be to have 30 respondents. The present study only included 10 respondents. In measurement, the characteristics of a test or instrument and the group tested are major influences of the magnitude of the reliability coefficient (Baumgartner & Hensley, 2006). The larger the number of respondents improves the measure of reliability and increases the possibility of

obtaining more dispersed scores. Moreover, if the groups of respondents have similar characteristics, there is a lack of objectivity. Thus, the more diverse and contrasted the characteristics of the groups will improve objectivity in the measures of reliability (Baumgartner & Hensley, 2006). Despite the small number of respondents used in the present study, the characteristics of the two groups of coaches were highly contrasted, which made the establishment of objectivity in the proposed scale inherently challenging. It is recommend that future studies not only increase the sample size of the participants, but it is also recommend that a more diverse experience level of coaches also be incorporated into the experimental design.

Another limitation of this study was the software that was used to provide the coaches with the appropriate clips and analyses periodically malfunctioned. As a result, a total of 13 clips out of 1000 were not available at the time of data collection. This represented a total of 1.3% of the clips not being analyzed. In order to address this problem, future research should use a customized program where all the files and documents are available in this software rather than being online. Doing this will help ensure that all behaviors are recorded, stored, and available for later analysis.

Another potential limitation is that the utilized soccer match clips were edited from previous recorded matches from television. Thus, the angle of the views in some cases did not provide the whole view of the field and might have limited the answers provided by the coaches in the decision making dimension. In other studies, such as Mulligan and colleagues (2012), ice hockey players were filmed from an area adjacent to the player's bench. In future studies it would be useful to conduct a similar game play analysis from the coaches' perspective on the sideline of the match. In addition, another camera recorded the play from a first person perspective using small video cameras attached to the players' helmet providing another perspective from the one obtained in

this study. Soccer players cannot wear cameras incorporated while playing in official soccer games. This is why, during the selection process, the clips that provided the highest and widest viewing angles were carefully selected. Additionally, it would be valuable to use a camera attached to a soccer players head during practice so a video could be captured from this perspective. This additional information would provide valuable insight into what the soccer player is looking at on the field, and how that information helps guide them to specific decisions.

Future directions

There is a need in future research to investigate whether individual tactical fundamentals were identified by coaches, and whether identifying those fundamentals might be a criterion to measure coaches' tactical knowledge. Another aspect that should be addressed in the future is to identify the correlation between individual tactical fundamentals selected in this dimension and the decision making reported in the decision making dimension. This would allow the opportunity to see whether possessing knowledge of these tactical fundamentals provides coaches with more accurate answers in the decision making dimension than those coaches that do not possess this tactical knowledge of the game.

In the present study, high and low qualified coaches identified three different zones of game play (i.e., intervention zone, mutual help zone, and cooperation zone). In these zones, soccer players developed different tactical roles that represented the interdependent parts that contributed to a whole system in the creation of a global emergent behavior. Bar-Yam (2003) explained the meaning of complexity as a measure of the number of possibilities of a system determined by the interactions of its subsystems. Therefore, since different tactical roles were identified within different zones of game play, the next step to extend research on assessing the emergent

complexity generated in team sports would be studying team coordination dynamics that occur *within* and *between* the different zones of game play. This would provide a better understanding of the emergent complexities with continuous data based on the coordination dynamics of a team at different zones. To achieve this objective, future investigations might use parameters with dynamic behavior that have been identified in this thesis, such as trajectory in regards to the attacking goal, angular location regarding the possessor of the ball in relation to the attacking goal, and information about the space between the ball and the attacking goal. Furthermore, this would also allow the modeling of fractals of players at the different zones of the game to be applied in the team coordination dynamics *within* and *between* the three different zones allowing the measurement of the emergent complexity that this fractal generates.

In addition, perceptual-cognitive skills from an individual on the defending team can be analyzed based on the emergent complexity coming from the coordination dynamics of the offensive team. Consequently, another aspect worthwhile of investigation in future research is to evaluate how intentional behavior would be impacted when the analyzed individual breaks symmetry in regards to the coordination dynamics of the defending team. Specifically, this should be investigated by designing equations to fit the parameters identified to study intentional behaviors of a player (e.g., possessor of the ball). This would allow researchers to embark on the study of intentional dynamics to develop a model to explain how the decision-making process might be better understood as a result of perceiving the complexity that emerges from interactions and constraints (i.e., affordances) of the actor-environment system (e.g., team-opponent and team-soccer field) and how behavior modes unfold during the completion of a task (i.e., applying an individual tactical fundamental).

The effectiveness of a player or a team is generally not related to a single possible action, but rather the set of all possible actions that one can complete. This set of possible actions is therefore of great importance in all of complex systems research as well as in sports because the number of possible outcomes within a system is the measure of complexity (Bar-Yam, 2003). Furthermore, studies conceiving cognition as a continuous dynamical process have explained how cognitive processes unfold over time during the production of a response by tracking movements (e.g., Spivey, Grosjean & Knoblich, 2005). In this study it was observed that movements have different trajectories for alternative option choices. Since, in team sports, the number of the possible actions are infinite as well as the number of distracters creating ambiguity, intentional behaviors might be better understood by tracking whole body trajectories. Then, by following the procedures established in the scale proposed in this thesis, a set of desired options should be established. Once the desirable goals are set, trajectories of whole body movements should be tracked to identify when intentional behaviors show ambiguity in action responses towards the desirable goal of the athlete. This measurement may lead to the identification of predictive judgments that soccer players use to make decisions. The study of perceptual-cognitive skills under certain levels of emergent complexity might provide a better assessment of how the process evolves rather than only evaluating the success or failure of the outcome process. This would also allow the study of intentional behavior based on direct scientific measures from an ecological approach rather than making inferences about how changes in behavior occur over an extended period of time (Williams & Ford, 2009).

This study presents a reliable assessment tool that was used by high and low qualified soccer coaches to evaluate the in-game complexity and decision making ability of skilled soccer players. Additionally, this thesis provides insight about the

theoretical background for each of the dimensions of this proposed scale. This scale was specifically designed to measure emergent complexity of game situations in team sports (e.g., soccer) and perceptual-cognitive skills of soccer players when applying individual tactical fundamentals. Since the ability to assess complexity and perceptual-cognitive skills in soccer of high and low qualified coaches was correlated, the findings of this study suggest that the variables used to assess complexity are observable and measurable. This finding further suggests that these observable parameters are representative of dynamical systems within team sports and can be evaluated based on these prescribed variables. Furthermore, the high reliability of the complexity dimension indicates that the concepts of this scale can be used for further studying the intra and inter player-team coordination dynamics. This would help to better understand the properties of social complex systems by describing the processes of cooperation and/or opposition through goal-directed behaviors within different aspects of the game.

CONCLUSION

The final chapter provided a discussion of the findings, implications, and recommendations that emerged from the present study. Test-retest reliability showed that highly and low qualified coaches were highly reliable in the complexity dimension within and between groups. However, results from the decision making dimension were only stable within groups and had low reliability between groups. Although it was discussed that testing the reliability of a scale presented across a larger number of coaches and with different levels of coaching experience would give more reliability and validity, these findings suggested that the parameters used to assess emergent complexity from game situations can be identified by a contrasted group of coaches. By discussing the use of these parameters as representative of dynamical systems, the present study brought to light an important construct that future research in coordination

dynamics may apply for understanding emergent complexity at different scales of a team. The practical applications, for example, will include having the ability to predict team behaviors at different levels (e.g., player, fractal, or team) taking into consideration the players that compose the team and their tactical movements based on their playing position. In addition, the establishment of these parameters might be used to study and ultimately predict the perceptual-cognitive skills of an individual player.

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APPENDICES

APPENDIX A

1. Years of experience as a soccer coach/consultant or any task related with coaching or teaching soccer. Please, specify the activity performed and for how long:

1.-ActicityAnswer

Years of experience Answer

2.- ActicityAnswer

Years of experience Answer

3.-ActivityAnswer

Years of experience Answer

4.-ActivityAnswer

Years of experience Answer

5.-ActivityAnswer

Years of experience Answer

2. Are you a professional soccer coach?

*Professional: if your major income comes from this profession and coaching requires you to spend most of your job time in this.
Select one:

- a. YES
- b. NO

3. How many hours a week are you involved in coaching, advising, scouting, teaching or doing any task related to soccer coaching?

Approximate number of hours Answer

4. List the name of the players you have ever coached or advised to play at least once in an official match of UEFA or FIFA with an absolute national team of their country:

5. List the formal training you have had for coaching at your current level or for developing the duties you are developing in your position (this may include but is not limited to: certification courses, sport science seminars, mentorships, associate degrees, bachelor, master's degrees, doctorates, etc.):

6. How often do you usually attend conferences, courses or any kind of meetings to learn more about soccer or get more advise about any kind of activity related to soccer to improve and update your knowledge?

Select one:

- a. Once every day
- b. Once every week
- c. Once every month
- d. Once every 6 months
- e. Once every year
- f. Never

7. Please, indicate the total number of years you played soccer and write down the highest level you played:

1.-Years of experience Answer

The highest category you have ever played as a soccer player isAnswer

8. What was your position on the field?

Select one or more:

- a. Goalkeeper
- b. Center Back
- c. Full back right or left
- d. Midfielder (defensive)
- e. Midfielder (attacking)
- f. Wing
- g. Forward

 Coach 1A

Pregunta 1

Indique la actividad y los años de experiencia como entrenador o consultor de fútbol o cualquier otra actividad relacionada con el entrenamiento y la enseñanza del fútbol:

1.-Actividad ENTRENADOR FUTBOL

Años de experiencia 40

2.-Actividad

Años de experiencia

3.-Actividad

Años de experiencia

4.-Actividad

Años de experiencia

5.-Actividad

Años de experiencia

Pregunta 2

Es usted entrenador o experto profesional de fútbol?

*Profesional: cuando la mayor parte de sus ingresos provienen de su trabajo como entrenador o experto en fútbol. Y además esta actividad te requiere la mayor parte del tiempo que destinas a tu horario laboral.

Select one:

- [x] a. SI
- [ ] b. NO

Pregunta 3

¿Cuántas horas a la semana dedicas a tareas relacionadas con el entrenamiento, asesoramiento, enseñanza o cualquier otra actividad relacionada con el entrenamiento de fútbol?

1.- El número aproximado de horas es 40

Pregunta 4

Haz una lista de los nombres de jugadores que has entrenado y que han jugado al menos un partido oficial de la UEFA o la FIFA con sus respectivas selecciones nacionales absolutas:

40 JUGADORS

Pregunta 5

Haga una lista de la formación que ha recibido para entrenar o ejercer el cargo que desarrolla en la actualidad (esto podría incluir los siguientes ejemplos, aunque no se limita solo a estos: certificados de entrenador, seminarios de ciencia y deporte, tutorías, diplomaturas, licenciaturas, másters, doctorados, etc.):

ENTRENADOR TERCER NIVEL I FIFA

HABILITACION ED. FI.

Pregunta 6

Indique la frecuencia con la que asiste a cursos, conferencias, seminarios o cualquier otro tipo de reuniones de caracter organizado cuyo objetivo sea el aprendizaje, el asesoramiento y/o la mejora y actualización de su conocimiento en relación al rendimiento en fútbol:

Select one:

- [ ] a. Una vez al día
- [ ] b. Una vez a la semana
- [ ] c. Una vez al mes
- [x] d. Una vez cada 6 meses
- [ ] e. Una vez al año

Pregunta 7

Por favor, indique el número total de años que ha jugado como jugador e indique el nivel más alto al que ha jugado:

1.- Años de experiencia 32

El nivel más alto al que he jugado como jugador es

TERCERA DIVISION

Pregunta 8

¿Cuál era su posición habitual como jugador de fútbol?

Select one or more:

- [ ] a. Portero
- [x] b. Central
- [ ] c. Lateral
- [ ] d. Mediocampista defensivo
- [ ] e. Mediocampista ofensivo
- [ ] f. Extremo
- [x] g. Delantero

Coach 2A

Pregunta 1

Indique la actividad y los años de experiencia como entrenador o consultor de fútbol o cualquier otra actividad relacionada con el entrenamiento y la enseñanza

del fútbol:

1.-Actividad Entrenador

Años de experiencia 10

2.-Actividad Preparador Físico

Años de experiencia 13

3.-Actividad

Años de experiencia

4.-Actividad

Años de experiencia

5.-Actividad

Años de experiencia

Pregunta 2

Es usted entrenador o experto profesional de fútbol?

*Profesional: cuando la mayor parte de sus ingresos provienen de su trabajo como entrenador o experto en fútbol. Y además esta actividad te requiere la mayor parte del tiempo que destinas a tu horario laboral.

Select one:

- (●) a. SI
- ( ) b. NO

Pregunta 3

¿Cuántas horas a la semana dedicas a tareas relacionadas con el entrenamiento, asesoramiento, enseñanza o cualquier otra actividad relacionada con el entrenamiento de fútbol?

1.- El número aproximado de horas es 35

Pregunta 4

Haz una lista de los nombres de jugadores que has entrenado y que han jugado al menos un partido oficial de la UEFA o la FIFA con sus respectivas selecciones nacionales absolutas:

Víctor valdés, puyol, xavi, iniesta, messi, pique, ronaldinho, henry, thuram, zambrotta, motta, abidal, toure yaya, milito, eto'o, rafa marquez, edmilson, deco, giovani dos santos, pires, cazorla, capdevila, diego lópez, rossi, godin, senna, djorjevic, nikopolidis, torosidis, kovacevic, pereira, costa, rami, guardado, banega, soldado, albelda, diego alves, jonas, iraola, canales.

Pregunta 5

Haga una lista de la formación que ha recibido para entrenar o ejercer el cargo que desarrolla en la actualidad (esto podría incluir los siguientes ejemplos, aunque no se limita solo a estos: certificados de entrenador, seminarios de ciencia y deporte, tutorías, diplomaturas, licenciaturas, másters, doctorados, etc.):

Licenciado en educación física

Certificado entrenador nivel 2

Máster en deportes equipo

Pregunta 6

Indique la frecuencia con la que asiste a cursos, conferencias, seminarios o cualquier otro tipo de reuniones de carácter organizado cuyo objetivo sea el aprendizaje, el asesoramiento y/o la mejora y actualización de su conocimiento en relación al rendimiento en fútbol:

Select one:

- a. Una vez al día
- b. Una vez a la semana
- c. Una vez al mes
- d. Una vez cada 6 meses
- e. Una vez al año

Pregunta 7

Por favor, indique el número total de años que ha jugado como jugador e indique el nivel más alto al que ha jugado:

1.- Años de experiencia 15

El nivel más alto al que he jugado como jugador es

Segunda division

Pregunta 8

¿Cuál era su posición habitual como jugador de fútbol?

Select one or more:

- [ ] a. Portero
- [ ] b. Central
- [ ] c. Lateral
- [ ] d. Mediocampista defensivo
- [x] e. Mediocampista ofensivo
- [ ] f. Extremo
- [ ] g. Delantero

Coach 3A

Pregunta 1

Indique la actividad y los años de experiencia como entrenador o consultor de fútbol o cualquier otra actividad relacionada con el entrenamiento y la enseñanza del fútbol:

1.-Actividad Entrenador de fútbol diferentes categorías

Años de experiencia 11

2.-Actividad Profesor del curso de entrenadores de fútbol

Años de experiencia 2

3.-Actividad Profesor de CFGS asignatura de fútbol

Años de experiencia 2

4.-Actividad Analista técnico categoría U-19 y U-17

Años de experiencia 1

5.-Actividad Coordinador Área de Metodología de fútbol

Años de experiencia 2

Pregunta 2

Es usted entrenador o experto profesional de fútbol?

*Profesional: cuando la mayor parte de sus ingresos provienen de su trabajo como entrenador o experto en fútbol. Y además esta actividad te requiere la mayor parte del tiempo que destinas a tu horario laboral.

Select one:

- a. SI
- b. NO

Pregunta 3

¿Cuántas horas a la semana dedicas a tareas relacionadas con el entrenamiento, asesoramiento, enseñanza o cualquier otra actividad relacionada con el entrenamiento de fútbol?

1.- El número aproximado de horas es 30

Pregunta 4

Haz una lista de los nombres de jugadores que has entrenado y que han jugado al menos un partido oficial de la UEFA o la FIFA con sus respectivas selecciones nacionales absolutas:

Partidos oficiales de UEFA: Marc Muniesa; Sergi Roberto; Sergi Gómez; Jean Marie Dongou (internacional por camerun);

(internacinales por Israel): Eran Zahavi; Sheran Yeini; Eitan Tibi; Tal Ben Haim; Gal ALberman; Maharan Radi; Omri Ben Harus; Barak Itzhaki

Pregunta 5

Haga una lista de la formación que ha recibido para entrenar o ejercer el cargo que desarrolla en la actualidad (esto podría incluir los siguientes ejemplos, aunque no se limita solo a estos: certificados de entrenador, seminarios de ciencia y deporte, tutorías, diplomaturas, licenciaturas, másters, doctorados, etc.):

- Técnico superior en animación de actividades físicas y deportivas

- Licenciado en Ciencias de la actividad física y el deporte

- Master profesional en deportes de equipo

- Entrenador de fútbol con titulación UEFA Pro

- Cursos (reglados y no reglados) de: Coaching (400 horas); PNL (2 de 45 horas); Wellnes y nuevas tendencias del fitnes (20 horas); Control emocional (6 horas); Planificación (6 horas).

- Diferentes seminarios y congresos de como ponente y oyente.

Pregunta 6

Indique la frecuencia con la que asiste a cursos, conferencias, seminarios o cualquier otro tipo de reuniones de caracter organizado cuyo objetivo sea el aprendizaje, el asesoramiento y/o la mejora y actualización de su conocimiento en relación al rendimiento en fútbol:

Select one:

- a. Una vez al día
- b. Una vez a la semana
- c. Una vez al mes
- d. Una vez cada 6 meses
- e. Una vez al año

Pregunta 7

Por favor, indique el número total de años que ha jugado como jugador e indique el nivel más alto al que ha jugado:

1.- Años de experiencia 15

El nivel más alto al que he jugado como jugador es

Nivel de 5a categoría en España

Pregunta 8

¿Cuál era su posición habitual como jugador de fútbol?

Select one or more:

- [ ] a. Portero
- [ ] b. Central
- [ ] c. Lateral
- [ ] d. Mediocampista defensivo
- [x] e. Mediocampista ofensivo
- [ ] f. Extremo
- [ ] g. Delantero

Coach 4A

Pregunta 1

Indique la actividad y los años de experiencia como entrenador o consultor de fútbol o cualquier otra actividad relacionada con el entrenamiento y la enseñanza del fútbol:

1.-Actividad ENTRENADOR

Años de experiencia 25

2.-Actividad DIRECTOR TÉCNICO DE FEDEREACIÓN DE FUTBOL

Años de experiencia 2

3.-Actividad DIRECTOR DEL ÁREA DE METODOLOGÍA

Años de experiencia 3

4.-Actividad PROFESOR DE ESCUELA DE ENTRENADORES

Años de experiencia 2

5.-Actividad

Años de experiencia

Pregunta 2

Es usted entrenador o experto profesional de fútbol?

*Profesional: cuando la mayor parte de sus ingresos provienen de su trabajo como entrenador o experto en fútbol. Y además esta actividad te requiere la mayor parte del tiempo que destinas a tu horario laboral.

Select one:

- [x] a. SI
- [ ] b. NO

Pregunta 3

¿Cuántas horas a la semana dedicas a tareas relacionadas con el entrenamiento, asesoramiento, enseñanza o cualquier otra actividad relacionada con el entrenamiento de fútbol?

1.- El número aproximado de horas es 60 HORAS

Pregunta 4

Haz una lista de los nombres de jugadores que has entrenado y que han jugado al menos un partido oficial de la UEFA o la FIFA con sus respectivas selecciones nacionales absolutas:

XAVI HERNÁNDEZ (F.C. BARCELONA), ALBERT CELADES (F.C. BARCELONA Y REAL MADRID), ROGER GARCÍA (F.C. BARCELONA Y AJAX DE AMSTERDAM), GERARD LÓPEZ (F.C. BARCELONA),

CARLES PUYOL (F.C. BARCELONA), TONI JIMÉNEZ (F.C. BARCELONA, AT. MADRID Y RCDE ESPAÑOL), VÍCTOR VALDÉS (F.C. BARCELONA), IVÁN DE LA PEÑA (F.C. BARCELONA Y RCDE ESPAÑOL), LUIS GARCÍA (F.C. BARCELONA, AT. MADRID Y LIVERPOOL), ÓSCAR GARCÍA (F.C. BARCELONA)

Pregunta 5

Haga una lista de la formación que ha recibido para entrenar o ejercer el cargo que desarrolla en la actualidad (esto podría incluir los siguientes ejemplos, aunque no se limita solo a estos: certificados de entrenador, seminarios de ciencia y deporte, tutorías, diplomaturas, licenciaturas, másters, doctorados, etc.):

ENTRENADOR NACIONAL DE FÚTBOL (REAL FEDERACIÓN ESPAÑOLA DE FÚTBOL), TÉCNICO DEPORTIVO SUPERIOR EN FÚTBOL CON LICENCIA UEFA PRO LICENCE, PONENTE EN CONGRESOS NACIONALES E INTERNACIONALES DE ENTRENADORES EN LOS ÚLTIMOS 3 AÑOS

Pregunta 6

Indique la frecuencia con la que asiste a cursos, conferencias, seminarios o cualquier otro tipo de reuniones de caracter organizado cuyo objetivo sea el aprendizaje, el asesoramiento y/o la mejora y actualización de su conocimiento en relación al rendimiento en fútbol:

Select one:

- ☐ a. Una vez al día
- ☐ b. Una vez a la semana
- ☉ c. Una vez al mes
- ☐ d. Una vez cada 6 meses
- ☐ e. Una vez al año

Pregunta 7

Por favor, indique el número total de años que ha jugado como jugador e indique el nivel más alto al que ha jugado:

1.- Años de experiencia 14 AÑOS

El nivel más alto al que he jugado como jugador es

1ª DIVISIÓN NACIONAL (ESPAÑA)

Pregunta 8

¿Cuál era su posición habitual como jugador de fútbol?

- [ ] a. Portero
- [ ] b. Central
- [ ] c. Lateral
- [ ] d. Mediocampista defensivo
- [x] e. Mediocampista ofensivo
- [ ] f. Extremo
- [ ] g. Delantero

Coach 5A

Pregunta 1

Indique la actividad y los años de experiencia como entrenador o consultor de fútbol o cualquier otra actividad relacionada con el entrenamiento y la enseñanza del fútbol:

1.-Actividad entrenador de fútbol

Años de experiencia 5

2.-Actividad Asesor de jugadores profesionales

Años de experiencia 3

3.-Actividad

Años de experiencia

4.-Actividad

Años de experiencia

5.-Actividad

Años de experiencia

Pregunta 2

Es usted entrenador o experto profesional de fútbol?

*Profesional: cuando la mayor parte de sus ingresos provienen de su trabajo como entrenador o experto en fútbol. Y además esta actividad te requiere la mayor parte del tiempo que destinas a tu horario laboral.

Select one:

- a. SI
- b. NO

Pregunta 3

¿Cuántas horas a la semana dedicas a tareas relacionadas con el entrenamiento, asesoramiento, enseñanza o cualquier otra actividad relacionada con el entrenamiento de fútbol?

1.- El número aproximado de horas es 15 o 20

Pregunta 4

Haz una lista de los nombres de jugadores que has entrenado y que han jugado al menos un partido oficial de la UEFA o la FIFA con sus respectivas selecciones nacionales absolutas:

Hideto Takahashi

Daiki Iwamasa

Pregunta 5

Haga una lista de la formación que ha recibido para entrenar o ejercer el cargo que desarrolla en la actualidad (esto podría incluir los siguientes ejemplos, aunque no se limita solo a estos: certificados de entrenador, seminarios de ciencia y deporte, tutorías, diplomaturas, licenciaturas, másters, doctorados, etc.):

Certificado de entrenador: 1r y 2º nivel (actualmente cursando el 3r nivel)

Actualmente cursando la carrera en Ciencias de la Actividad Física y el Deporte

Máster: Máster en márketing y comunicación

Asistencia a cursos: Seminarios y cursos: Congreso Nacional de Entrenadores (Organizado por la Real Federación Española de Futbol en Toledo), Congreso de futbol (Organizado por el RCD Español y INEFC), Congreso Catalán de Entrenadores (Organizado por el Congreso de entrenadores organizado por la Federación Aragonesa de Futbol, Jornadas técnicas de entrenadores (Organizado por el comité Técnico de Entrenadores de Aragón), Congreso de Futbol (Organizado por la escuela de Futbol Peloteros de Sevilla), 31 curso de verano de la Universidad del País Vasco (Organizado por la Universidad del País Vasco), Conferencia en el postgrado de periodismo deportivo (Organizado por la Universidad Blanquerna).

Realización: Cursos de formación ADN Barça a exjugadores del FCBarcelona (Organizado por la Agrupació Barça Veterans), clínic para entrenadores japoneses (Organizado por la Federación de la prefectura de Kanazawa)

Pregunta 6

Indique la frecuencia con la que asiste a cursos, conferencias, seminarios o cualquier otro tipo de reuniones de caracter organizado cuyo objetivo sea el aprendizaje, el asesoramiento y/o la mejora y actualización de su conocimiento en relación al rendimiento en fútbol:

Select one:

- ☐ a. Una vez al día
- ☐ b. Una vez a la semana
- ☐ c. Una vez al mes
- ☐ d. Una vez cada 6 meses
- ◉ e. Una vez al año

Pregunta 7

Por favor, indique el número total de años que ha jugado como jugador e indique el nivel más alto al que ha jugado:

1.- Años de experiencia 20

El nivel más alto al que he jugado como jugador es

División de Honor en edad juvenil y Primera Catalana en edad a

Pregunta 8

¿Cuál era su posición habitual como jugador de fútbol?

Select one or more:

- [ ] a. Portero
- [ ] b. Central
- [ ] c. Lateral
- [ ] d. Mediocampista defensivo
- [x] e. Mediocampista ofensivo
- [ ] f. Extremo
- [ ] g. Delantero

 Coach 1B

Question 1

Years of experience as a soccer coach/consultant or any task related with coaching or teaching soccer. Please, specify the activity performed and for how long:

1.-Acticity Soccer Coach

Years of experience 1

2.- Acticity Assistant coach

Years of experience 1

3.-Activity

Years of experience

4.-Activity

Years of experience

5.-Activity

Years of experience

Question 2

Are you a professional soccer coach?

*Professional: if your major income comes from this profession and coaching requires you to spend most of your job time in this.
Select one:

- a. YES
- b. NO

Question 3

How many hours a week are you involved in coaching, advising, scouting, teaching or doing any task related to soccer coaching?

1.- Approximate number of hours 6

Question 4

List the name of the players you have ever coached or advised to play at least once in an official match of UEFA or FIFA with an absolute national team of their country:

None.

Question 5

List the formal training you have had for coaching at your current level or for developing the duties you are developing in your position (this may include but is not limited to: certification courses, sport science seminars, mentorships, associate degrees, bachelor, master's degrees, doctorates, etc.):

NATIONAL "E" LICENSE

Question 6

How often do you usually attend conferences, courses or any kind of meetings to learn more about soccer or get more advice about any kind of activity related to soccer to improve and update your knowledge?

Select one:

- ☐ a. Once every day
- ☐ b. Once every week
- ☐ c. Once every month
- ☐ d. Once every 6 months
- ☐ e. Once every year
- ☉ f. Never

Question 7

Please, indicate the total number of years you played soccer and write down the highest level you played:

1.-Years of experience 28

The highest category you have ever played as a soccer player is Second Division College

Question 8

What was your position on the field?

Select one or more:

- ☐ a. Goalkeeper
- ☐ b. Center Back
- ☐ c. Full back right or left
- ☐ d. Midfielder (defensive)

- [x] e. Midfielder (attacking)
- [x] f. Wing
- [x] g. Forward

Coach 2B

Question 1

Years of experience as a soccer coach/consultant or any task related with coaching or teaching soccer. Please, specify the activity performed and for how long:

1.-Acticity: High School Head Coach

Years of experience: 2

2.- Acticity: High School Assistant Coach

Years of experience: 1

3.-Activity: Club Soccer Coach/Trainer

Years of experience: 1

4.-Activity: Assistant College Coach

Years of experience: 1

5.-Activity: volunteer youth coach

Years of experience 1

Question 2

Are you a professional soccer coach?

*Professional: if your major income comes from this profession and coaching requires you to spend most of your job time in this.
Select one:

- ☐ a. YES
- ◉ b. NO

Question 3

How many hours a week are you involved in coaching, advising, scouting, teaching or doing any task related to soccer coaching?

1.- Approximate number of hours 20

Question 4

List the name of the players you have ever coached or advised to play at least once in an official match of UEFA or FIFA with an absolute national team of their country:

None.

Question 5

List the formal training you have had for coaching at your current level or for developing the duties you are developing in your position (this may include but is not limited to: certification courses, sport science seminars, mentorships, associate degrees, bachelor, master's degrees, doctorates, etc.):

Team Sports: Soccer, Bachelors in Physical education

Question 6

How often do you usually attend conferences, courses or any kind of meetings to learn more about soccer or get more advice about any kind of activity related to soccer to improve and update your knowledge?

Select one:

- ☐ a. Once every day
- ☐ b. Once every week
- ☐ c. Once every month
- ☐ d. Once every 6 months
- ◉ e. Once every year
- ☐ f. Never

Question 7

Please, indicate the total number of years you played soccer and write down the highest level you played:

1.-Years of experience 23

The highest category you have ever played as a soccer player is Semi-professional Indoor

Question 8

What was your position on the field?

Select one or more:

- ☐ a. Goalkeeper
- ☐ b. Center Back
- ☑ c. Full back right or left
- ☑ d. Midfielder (defensive)
- ☑ e. Midfielder (attacking)
- ☑ f. Wing
- ☑ g. Forward

 Coach 3B

Question 1

Years of experience as a soccer coach/consultant or any task related with coaching or teaching soccer. Please, specify the activity performed and for how long:

1.-Acticity Coaching Clinics and Camps

Years of experience 1

2.- Acticity Club or Select Coaching

Years of experience 2

3.-Activity Parks and Rec League Coaching

Years of experience 1

4.-Activity High School Coaching

Years of experience .1

5.-Activity College Club Coaching

Years of experience 1

Question 2

Are you a professional soccer coach?

*Professional: if your major income comes from this profession and coaching requires you to spend most of your job time in this.
Select one:

- [ ] a. YES
- [x] b. NO

Question 3

How many hours a week are you involved in coaching, advising, scouting, teaching or doing any task related to soccer coaching?

1.- Approximate number of hours 4

Question 4

List the name of the players you have ever coached or advised to play at least once in an official match of UEFA or FIFA with an absolute national team of their country:

None

Question 5

List the formal training you have had for coaching at your current level or for developing the duties you are developing in your position (this may include but is not limited to: certification courses, sport science seminars, mentorships, associate degrees, bachelor, master's degrees, doctorates, etc.):

Bachelors Degree in Physical Education; Masters Degree in Recreation

Question 6

How often do you usually attend conferences, courses or any kind of meetings to learn more about soccer or get more advise about any kind of activity related to soccer to improve and update your knowledge?

Select one:

- [ ] a. Once every day
- [ ] b. Once every week
- [ ] c. Once every month
- [ ] d. Once every 6 months

- [ ] e. Once every year
- [x] f. Never

Question 7

Please, indicate the total number of years you played soccer and write down the highest level you played:

1.-Years of experience 23

The highest category you have ever played as a soccer player is College: NCAA Division II

Question 8

What was your position on the field?

Select one or more:

- [ ] a. Goalkeeper
- [ ] b. Center Back
- [x] c. Full back right or left
- [ ] d. Midfielder (defensive)
- [x] e. Midfielder (attacking)
- [x] f. Wing
- [x] g. Forward

Coach 4B

Question 1

Years of experience as a soccer coach/consultant or any task related with coaching or teaching soccer. Please, specify the activity performed and for how long:

1.-Acticity High School Coach

Years of experience 2

2.- Acticity

Years of experience

3.-Activity

Years of experience

4.-Activity

Years of experience

5.-Activity

Years of experience

Question 2

Are you a professional soccer coach?

*Professional: if your major income comes from this profession and coaching requires you to spend most of your job time in this.

Select one:

- a. YES
- b. NO

Question 3

How many hours a week are you involved in coaching, advising, scouting, teaching or doing any task related to soccer coaching?

1.- Approximate number of hours 4

Question 4

List the name of the players you have ever coached or advised to play at least once in an official match of UEFA or FIFA with an absolute national team of their country:

None.

Question 5

List the formal training you have had for coaching at your current level or for developing the duties you are developing in your position (this may include but is not limited to: certification courses, sport science seminars, mentorships, associate degrees, bachelor, master's degrees, doctorates, etc.):

None

Question 6

How often do you usually attend conferences, courses or any kind of meetings to learn more about soccer or get more advice about any kind of activity related to soccer to improve and update your knowledge?

Select one:

- a. Once every day
- b. Once every week
- c. Once every month
- d. Once every 6 months
- e. Once every year
- f. Never

Question 7

Please, indicate the total number of years you played soccer and write down the highest level you played:

1.-Years of experience 18

The highest category you have ever played as a soccer player is Amateur

Question 8

What was your position on the field?

Select one or more:

- [ ] a. Goalkeeper
- [x] b. Center Back
- [x] c. Full back right or left
- [ ] d. Midfielder (defensive)
- [ ] e. Midfielder (attacking)
- [x] f. Wing
- [x] g. Forward

Coach 5B

Question 1

Years of experience as a soccer coach/consultant or any task related with coaching or teaching soccer. Please, specify the activity performed and for how long:

1.-Acticity Coaching

Years of experience 2

2.- Acticity

Years of experience

3.-Activity

Years of experience

4.-Activity

Years of experience

5.-Activity

Years of experience

Question 2

Are you a professional soccer coach?

*Professional: if your major income comes from this profession and coaching requires you to spend most of your job time in this.

Select one:

- a. YES
- b. NO

Question 3

How many hours a week are you involved in coaching, advising, scouting, teaching or doing any task related to soccer coaching?

1.- Approximate number of hours 1

Question 4

List the name of the players you have ever coached or advised to play at least once in an official match of UEFA or FIFA with an absolute national team of their country:

None.

Question 5

List the formal training you have had for coaching at your current level or for developing the duties you are developing in your position (this may include but is not limited to: certification courses, sport science seminars, mentorships, associate degrees, bachelor, master's degrees, doctorates, etc.):

None

Question 6

How often do you usually attend conferences, courses or any kind of meetings to learn more about soccer or get more advice about any kind of activity related to soccer to improve and update your knowledge?

Select one:

- a. Once every day
- b. Once every week
- c. Once every month
- d. Once every 6 months
- e. Once every year
- f. Never

Question 7

Please, indicate the total number of years you played soccer and write down the highest level you played:

1.-Years of experience 12

The highest category you have ever played as a soccer player is Adult Recreational League

Question 8

What was your position on the field?

Select one or more:

- [ ] a. Goalkeeper
- [x] b. Center Back
- [x] c. Full back right or left
- [ ] d. Midfielder (defensive)
- [ ] e. Midfielder (attacking)
- [ ] f. Wing
- [ ] g. Forward

APPENDIX B

Transcripts of the English video tutorial

Hello, welcome to the video tutorial for completing the scale and using the moodle platform.

The first thing to do after logging in to the moodle website is to watch the video tutorial and read the instructions carefully.

In order to go to the instructions we go to folder called “English instructions”. From all these documents we will focus first on the general instructions.

You must take into consideration:

- to have a good internet connection.
- To watch the video tutorial and read the instructions carefully.
- Once you understand the procedures you can start analyzing the players. It is very important to follow the same order established by the researcher. You will find this order in a list attached in the contact mail the researcher sent you to log into the moodle website.
- In 0rder to keep quality of the answers, there are two criteria:
    - To keep a regular frequency
    - Avoiding to get overwhelm by analyzing large amounts of clips in a short period of time.

This is why it is suggested to analyze a median of 2 players a week.

Once you understand the general instructions we move to the space instructions.

The space instructions tell us the different spaces where a player can be found in a play.

We will call zone A to the closest from the defending goal and Zone D the closest from the attacking goal.

The difficulty in determining one zone or another is to differentiate zone A from zone B and zone C from zone D. For this reason, we establish that zone A is the one that goes from the goal line to the second grass stripe counting from the edge of the box (in the picture above the red line marks the edge of the second stripe grass after the box which separates zone A from zone B).

The same thing happens with zone D, that goes from the goal line to the second grass stripe counting from the edge of the attacking goal to the goal line of the attacking side of the player analyzed (again, if you look at the picture, the red line marks the edge of the second grass stripe that differentiates between zone A and zone B).

Moving on to the following document, the orientation instructions.

To understand the orientatcion of the player we will focus on the next document.

The purpose of this section is to determine the orientation of the player when the image freezes. At this moment is when you have to determine the orientation.

What determine the orientation (forward, backwards or lateral) are the hips. If we draw a straight line from the left to the right hip (waist) and compare it with the line of one of the sides of the field (e.g. attacking goal) this determine the orientation. For example if the line of our hips is parallel to the attacking goal, the player is either backwards or forward, depending on the goal he is facing. If the line is not parallel, then the player has a lateral orientation.

Finally, the last document of instructions tells us how to evaluate the defenders of the possessor of the ball. We can differenciate between the defenders in the intervention zone and the defenders in the mutual help zone.

The intervention is defined by the ball and the players that are likely to participate immediately in the play.

1. Another criteria will be to include all those players who are between 6 to 13 feet approximately, from the possessor of the ball.
2. Another criterion that will help coaches to determine whether players are inside of the intervention zone or not will be the direction where the defender is running (either towards the possessor of the ball or moving away from him).

If you observe the picture on the left handside, the yellow circle represents the intervention zone. In this zone, the possessor of the ball is the white player and the two blue players are about to participate in the play. These players are 6 to 13 feet approximately.

Another zone where we can identify the defenders is the mutual help zone. This is the zone that surrounds the intervention zone and involves players that are close to others of the intervention zone or where the ball is.

Other criteria to determine the players in the mutual help zone are:

3. All those players who surround the intervention zone no further than 49 feet from the possessor of the ball. Again this distance will be approximate.

4. Another criterion will be only to include those players in the First line who do not have teammates between them and the possessor of the ball.

On the left hand side picture one can observe two players in the mutual help zone marked by the red circle. They are no further than 49 feet from the possessor and they are in the first line because there are no other teammates between them and the possessor of the ball.

The center of both zones is the possessor of the ball.

ORIENTATION of the defenders. See the instructions of the orientation of the players. The orientation will be analyzed suing the same criteria for both, attacking and defending players.

The last criterion is the location of the defenders regarding the possessor of the ball and zone D or defending goal. On the right hand side image you can see one player on the same line than the possessor of the ball regarding zone D, one closer to zone D and one further to zone D.

Once we have talked about all the instructions we come back to the main page of moodle.

Before analyzing the players, we have to check who the first player to analyze is. To do this we have the list of the players attached in the email sent by the researcher. Once we have the document open we will see who the first player we have to analyze is. In this case we have Xavi Alonso as the first player.

Once we know the first player to analyze, we will go to the main page of moodle and we will look for him. Once we identify him, we select the clips in the established order. From 1 to 5, one being the first clip to analyze. In this case, Alonso only has three clips, from 8 to 10 because he is a player taken as example for this tutorial. In all the other players you will find from clip 1 to 5 and will have to follow the order.

After selecting the clip to analyze, a new page will be open, that says attempt quiz now. If you click on this tab the scale will be open.

Once we are inside of the questionnaire and before answering the questions we need to watch the first clip.

To play the video it is suggested to use the Media player classic program, because it allows you to freeze the image at the end of the clip. If you do not have this specific program you can open the video with any other program, but in this case it is not certain that at the end of the clip the image will freeze. Then, you will have to pause the image manually.

In question 1, according to the space instructions the player analyzed is located at zone C.

For question 2, if we check the frozen image, we can see that his orientation is lateral.

In the third question you need to identify the players that belong to the intervention zone.

Lets watch the VIDEO

If we observe the situation of the play of the possessor of the ball at the moment the image freeze, there are 2 players in the intervention zone.

One is the closest one to the throw-in line and the other is on his right hand side.

If we remember the instructions for determining players in the intervention zone they must be:

- Likely to participate immediately in the play.
- Between 6 to 13 feet from the possessor of the ball approximately.
- And their direction towards the possessor must be as well a determining factor for considering if they are about to participate immediately of the play or not.

In this clip, these two players accomplish all these three criteria. This is why , there are 2 players in the intervention zone.

Once we have identified the, we answer the question. For example, starting with the player closer to the throw-in line we put that there is one player in the intervention zone, his orientation is lateral and he is at the same line.

The second player is in lateral orientation, and he is closer to the zone D.

The next question refers to the mutual help zone. If we observe the situation of the play of the possessor of the ball at the moment the image freeze, there are 3players in the mutual help zone. We will refer to the video to watch these three players.

For the first player, we will analyze the most advance player. We mark that there is 1 player in the intervention zone. Then, in this case it is a bit difficult to determine his orientation with the image frozen, so we can watch the video again:

Watching the video again and focusing only on one thing allows us to have a crystal clear answer. In this case, since the player has already turned, he is in frontal orientation. And he is further than the possessor of the ball regarding zone D.

Next we will analyze the player in the middle of the field.

He is in a lateral orientation and he is at the same line. The final player in the mutual help zone is with forward orientation and is also further D.

To answer the question of the individual fundamentals we have 14 different individual tatctical fundamentals represented by images. In this way we can identify very easily which situation is applied to the play analyzed. Take into consideration that there might be more than one fundamental applied in each play.

In this case only the fundamental 2 A is applied. Once we know the answer we mark it below. In the case we are not sure whether one of the fundamentals is being applied or not, we can obtain further information by clicking on the image of that specific fundamental. If we click on the image, the information will pop up in a new tab. Once we have read the information we can go back to the questionnaire.

In question number 6, you have to write the different options identified from the best to the worst by the coach,

Being one the best and 4 the worst one.

Before writing the answers you must be aware that we do not look for your ability to anticipate what the player will do next, but what you consider as the best decisions the player can make based upon the context of his surroundings.

Based on watching the video we believe that number 1 the best option is

1.- To pass the ball to the player on the left hand side a bit further.

While referring to the frozen image we can decide on the second best option for this player which we have determined to be:

2. To passs the ball to the player a bit forward from the left handside.

For options 3 and 4 I need to watch the video again:

Based on what we have seen in the video, we determine that the third best option would be:

3. To control the ball and pass it back to the first midfielder.

Refering back to the frozen image we determine that the fourth best option for this player would be

4.- to control the ball stepping the space to reach the attacking goal.

You must take into consideration that the more complex the situation of the play, a small range of alternatives you will have available. Nevertheless, it is required that participants give at least 4 options.

To continue with the questionnaire, we go to the bottom of the page and click on next.

In this 2nd section we need to watch this second video. This one shows the whole play analyzed.

Once we have watched the video, question 7 asks us to select the number of the decision that you wrote in question 6 and that corresponds with the decision taken by the player. In this case the answer is decision 1, because the possessor passed the ball to the player on the left hand side a bit further.

If we do not remember, we can check the answer going back to question 6 by going on the top left hand side on the quiz navigation and clicking on the number of the question we want to check. In this case number 6.

Once we confirm the answer, we go back to the second part of the questionnaire and we answer to the last question that refers to the outcome performance.

In order to do this, please focus on the outcome performance and do not think about the decisions you wrote and the decision taken by the player.

In this case we mark a successful outcome performance.

Once we have answered all the questions we will click next and a new page will be opened before submitting the questionnaire.

In this one we can see the status of the questions and by selecting submit and finish, the result of clip 1 will be sent.

After doing this, we can start analyzing the next clip. To do this go to tactical fundamental and once you are in the main page of moodle, you will look for the player you are analyzing, in this case, Xabi Alonso, and you will follow with the next clip.

You have to follow these instructions once again with all the players until you have completed all the analyses.

General Instructions

Please, follow these steps before completing the scale:

1.- Make sure your that your internet connection (in your computer, tablet or cellphone) is working. To have a good internet connection in your computer, tablet or cell phone to complete the scale.

2.- Choose a quiet and calm place where you can focus on completing the scale.

3.- Complete the coaching profile questionnaire.

4.-Watch the video tutorial before completing the scale.

5.- Read the instructions in the folder “English Instructions” carefully.

6.- Make sure you understand the instructions before starting with the analysis of the players.

7.- Follow the order to analyze established by the researcher. You will receive contact email containing a list with the order of players to analyze.

8.- Respond to the question to the best of your knowledge. In order to do this:

1. Keep a **regular frequency**.

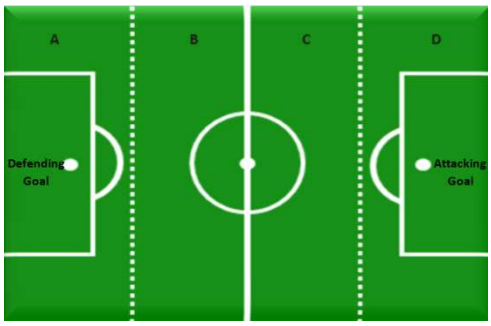
2. **Avoid becoming overwhelmed** by analyzing large amounts of clips in a short period of time.

After several trials in pilot tests, it is recommended that you analyze **2 players per week**. It takes an estimated 30 to 40 minutes to analyze the 5 clips and complete the analysis of 1 player.

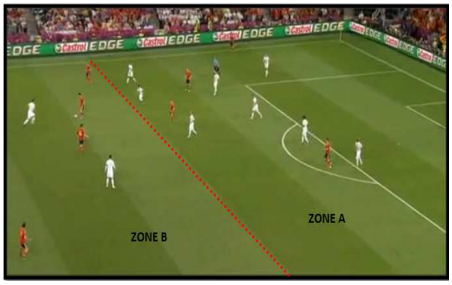
THANK YOU FOR YOUR PARTICIPATION

SPACE INSTRUCTIONS

Identify the zone of the field where the play analyzed is when the image freezes according to the attacking and defending areas.

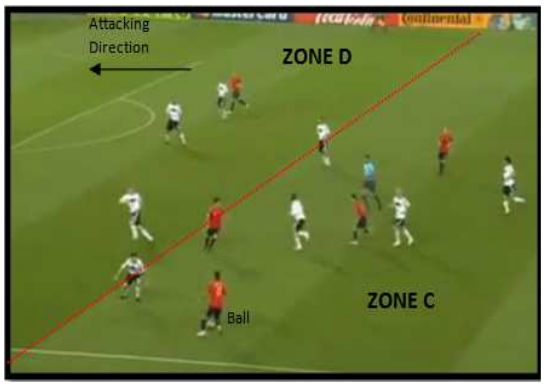


HOW TO DISTINGUISH ZONE A FROM ZONE B AND ZONE C FROM ZONE D?



Zone A will always be the **nearest** one to the **defending goal** for the player analyzed, while **zone D** will always be **the nearest** one to the **attacking goal**. Thus, **zone A** is the one that goes from the goal line to the second grass stripe counting from the edge of the box (see picture above). Then, **zone B** starts. This zone goes from this parallel second

grass stripe to the halfway line where zone C starts. Place where it starts **zone C**. This one goes from the halfway line to the second grass stripe before the edge of the attacking box. Finally, there is **zone D**, that goes from the second grass stripe, counting from the edge of the attacking goal, up to the goal line of the attacking side of the player analyzed (see picture on the right).



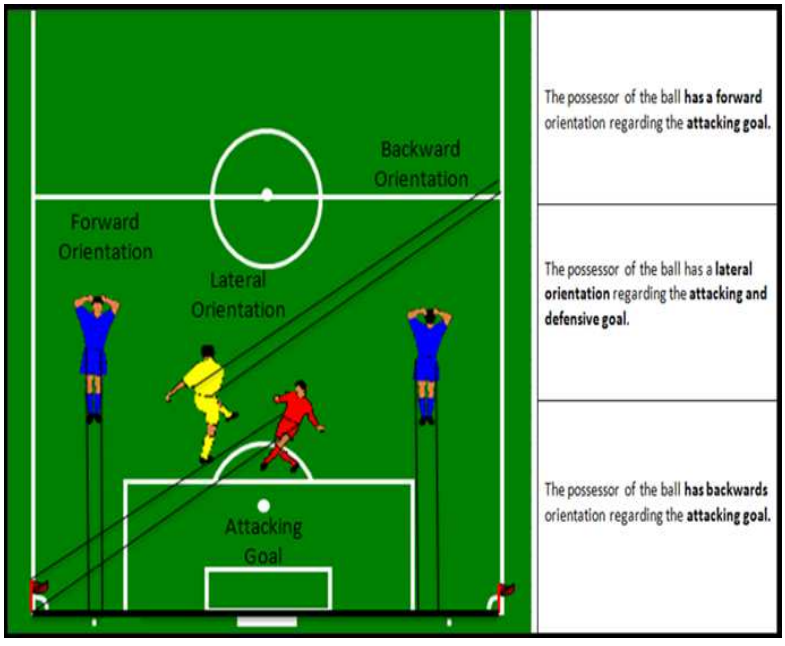
Take into consideration that the grass stripes may change in each match. However, these criteria will be strictly the same in each of the matches analyzed.

ORIENTATION INSTRUCTIONS

Choose the appropiate orientation of the player analyzed regarding the attacking and the defending goal at the moment the image freezes.

HOW TO TELL APART THE PLAYER ORIENTATION WHEN IT IS NOT CLEAR ENOUGH?

In some plays some coaches might have problems to determine the orientation of the player when the image freezes. This is because sometimes the image loses quality when it freezes or because the players are waiting for the ball backwards, for example, and right before controlling the ball they change their orientation. To avoid misunderstandings some



tips to help coaches to determine orientation are as follows:

1. The purpose of this section is to determine **the orientation of the player when the image freezes**. Therefore at this moment is when you have to determine the orientation.

2. What determines the orientation (forward, backwards or lateral) are **the hips**. If we draw a straight line from the left to the right hip (waist) and compare it to the line of one of the sides of the field (e.g. attacking goal) this determines the orientation. For example, if the line of our hips is parallel to the attacking goal, the player is either backwards or forward, depending on the goal he is facing. If the line is not parallel, then the player has a lateral orientation.

DEFENDERS OF THE POSSESSOR OF THE BALL	
Intervention Zone	**Mutual Help Zone**
It is defined by the ball and the players that are likely to participate immediately in the play.	It is the zone that surrounds the intervention zone and involves players that are close to others of the intervention zone or the location of the ball.
CLUES TO HELP COACHES	

INTERVENTION ZONE:

1.- It is defined by the ball and all those players who are about to participate in the play.

2.- Approximately all those players who are between **2-4 yards** from the possessor of the ball will be included in the intervention zone. These 6-13 feet will be established approximately by coaches.

3.- Another criteria that will help coaches to determine whether players are inside of the intervention zone will be the **direction in** which the defender is running (either towards the possessor of the ball or moving away from him).

The combination of these criteria will determine the players who belong to the intervention zone or mutual help zone.

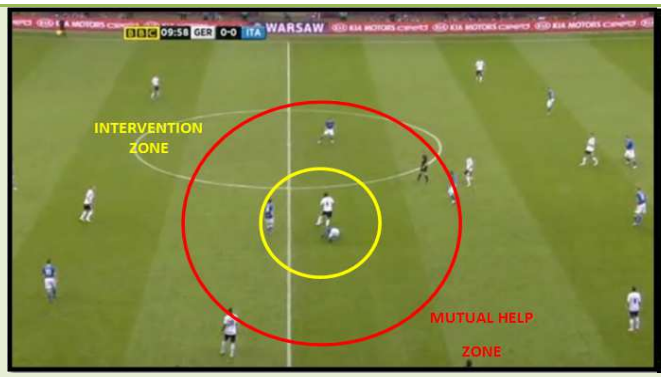
MUTUAL HELP ZONE:

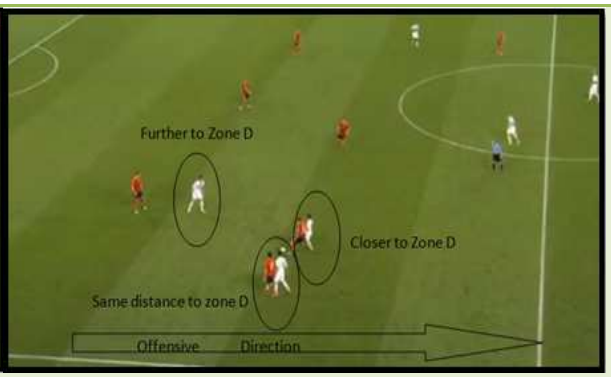
1. All those players who surround the intervention zone no further than **16 yards** from the possessor of the ball. Again this distance will be approximate. Imagine a bull's-eye, being the intervention zone the center of it and the mutual help zone the next circle.

2. Players who are located at the first line from where the possessor of the ball is located. **First line**: refers to the players that are close to the intervention zone when no other teammates are present and whose role is to help the player in the intervention zone (if there is one).

2.1 They block a potential line pass. 2.2They block any possible space.

3. Any other player located over 16 yards from the possessor of the ball is out of the mutual help zone (see graphic below).





2. ORIENATTION OF THE DEFENDERS

See instructions of the orientation. Orientation will be analyzed using the same criteria for both attackers and defenders.

3. LOCATION OF THE DEFENDERS REGARDING POSSESSOR OF THE BALL AND ZONE D

The defender can be nearer than the possessor of the ball regarding zone D.

The defender is at the same distance than the possessor of the ball regarding zone D.

The defender is further than the possessor of the ball regarding zone D.

Transcripto del video tutorial en español

Hola, le doy la bienvenida a las instrucciones audiovisuales para el uso de la escala y la herramienta moodle.

Lo primero que hay que hacer una vez haya accedido a la página principal de moodle es completar el cuestionario del perfil de entrenador. Una vez respondido el cuestionario, por favor, mire el video tutorial y lea las instrucciones detalladamente. Para acceder a las instrucciones nos dirigiremos a la carpeta de instrucciones en español. De los diversos documentos, por ahora nos centraremos en las instrucciones generales.

Hay que tener en cuenta: una buena conexión a internet, completar el cuestionario del perfil del entrenador, ver el video de las instrucciones y leerlas detalladamente. Una vez entendidos los pasos a seguir se empieza el análisis de los jugadores. Es muy importante seguir el orden marcado por el investigador. Este orden se encuentra en una lista adjunta en el correo de contacto para acceder a la página moodle. Para mantener la calidad en las respuestas hay dos criterios que se deben cumplir: mantener una frecuencia regular y evitar agobiarse con la realización de análisis de muchos jugadores en un período corto de tiempo. Es por eso que se sugiere analizar una media de 2 jugadores a la semana.

Después de entender las instrucciones generales, pasamos a las instrucciones de espacio. Las instrucciones de espacio nos explican los diferentes espacios donde puede encontrarse un jugador. En los espacios nombraremos “A” a la zona más cercana a la portería defendida, y zona “D” a la zona más cercana a la portería de ataque. La dificultad para determinar una zona u otra, es diferenciar la zona “A” de la zona ”B”, y la zona “C” de la zona “D”. Para ello nos regiremos que la zona “A” es la que abarca desde la línea de fondo de la portería defendida hasta la segunda línea de hierba paralela después del borde del área. Si observa la fotografía, la línea roja representa el borde de la segunda línea de hierba, contando desde el área, y que marca la separación entre zona

“A” y zona “B”. Esto mismo ocurre en la zona “D”, que abarca desde la línea de fondo de la portería atacada, hasta la segunda línea de hierba paralela, después del borde del área. Si observa la fotografía, la línea roja representa el borde de la segunda línea de hierba, contando desde el área atacante, y separa la zona “C” de la zona “D”.

A continuación vamos a ver el documento e instrucciones de la orientación del jugador. La pregunta del análisis del jugador dice que escoja la orientación correspondiente del jugador analizado, en relación a las porterías atacada y defendida, cuando la imagen se detenga. Para determinar la orientación, hay que fijarse en las caderas. Por lo tanto, si la línea de las caderas es paralela a la portería de ataque, el jugador está en orientación frontal o de espaldas respecto a la portería atacante. Si la línea no es paralela, entonces el jugador tiene una orientación lateral, por ejemplo en la imagen se observa el jugador azul, tanto de la derecha como de la izquierda, con la línea de la cadera paralela a la línea de fondo. La única diferencia es que uno está mirando a la portería rival y el otro a la portería que defiende. En cambio si la línea no es paralela, el jugador tiene una orientación lateral, como es el caso de los jugadores amarillo y rojo.

Para terminar, el último documento de instrucciones nos explica cómo evaluar a los jugadores defensas y al jugador en posición del balón. Para ello, podemos identificar a los jugadores defensas en dos zonas distintas.

Una es la zona de intervención que se define por el balón y aquellos jugadores que intervienen de manera inmediata en la jugada. Y otro criterio para determinar esta zona es tener presente aquellos jugadores que estén entre 2 y 4 metros del jugador que se encuentra con el balón. Además la dirección de carrera de los defensas hacia el jugador con balón también puede ayudar a determinar si esos están a punto de intervenir en el juego o no. Si observa la fotografía de la izquierda, el círculo amarillo corresponde a la

zona de intervención en la que el jugador de blanco en posesión del balón tiene a dos defensas que están interviniendo o van a intervenir inmediatamente en la jugada. En ellos podemos observar un espacio de 2 a 4 metros aproximadamente.

Otra zona donde podemos ubicar a los jugadores es la zona de ayuda mutua la cual rodea a la zona de intervención e incluye aquellos jugadores cercanos de dicha zona. Otros criterios para determinar los jugadores que se encuentran en la zona de ayuda mutua son : no están más lejos de 15 metros en relación al jugador que posee el balón, incluye sólo jugadores que se encuentran en la primera línea en relación al posesor del balón, por lo que no tienen otros compañeros entre él y el posesor del balón. En la fotografía de la izquierda, se pueden ver dos jugadores en la zona de ayuda mutua, los cuales están a una distancia de menos de 15 metros aproximadamente, y al mismo tiempo están en primera línea. Cómo se puede observar el centro de ambas zonas, la de intervención y ayuda mutua, es el jugador posesor del balón.

Orientación de los defensas. Vea el documento 3 de instrucciones se analiza la orientación del los jugadores defensas de la misma manera que analizamos el posesor del balón.

Y el último criterio es la localización de los defensas respecto al posesor del balón y la zona “D “o portería defendida. Si observamos la fotografía de la derecha, podernos ver a un jugador más cercano a la zona “D” respecto al jugador con balón, otro jugador que se encuentra en la misma línea y finalmente un tercer jugador que está más lejos de la zona “D” respecto al posesor del balón.

Una vez comentados todos los documentos de las instrucciones volvamos a la página principal del moodle haciendo clic en “tactical funtdamentals”.

Antes de empezar el análisis de los jugadores hay que comprobar cuál es el primer jugador al que hay que analizar. Para ello, disponemos de la lista adjunta en el correo enviado por el investigador. Una vez abierto el documento adjunto, veremos cuál es el jugador al que hay que analizar, en este caso tenemos a Xabi Alonso como el primer jugador. Una vez identificado el primer jugador que se debe analizar iremos a la página principal de moodle y lo buscaremos. Una vez localizado seleccionaremos los clips por el orden establecido del 1 al 5, siendo 1 el primero. En este caso, Xabi Alonso no será un jugador analizado por los participantes, sino que sólo es un jugador seleccionador para poner de ejemplo de cómo completar la escala. Es por eso que solo tiene 3 clips numerados del 8 al 10.

En los jugadores a analizar los clips van del 1 al 5, y se tendrán que completar en este orden. Después de seleccionar el clip a analizar, se abre una página con un recuadro en naranja, attempt quiz now, donde seleccionándolo se nos abrirá el cuestionario.

Una vez dentro del cuestionario y antes de responder a las preguntas es necesario ver el primer video. Para reproducir el video se recomienda el uso del programa Media Player Classic, ya que éste nos congela la imagen una vez finalizado el video. Sino es así, se puede abrir desde cualquier otro programa, pero en este caso no es seguro que se detenga la imagen. Entonces se tendrá que pausar de forma manual. En la pregunta 1 de acuerdo con las instrucciones de espacio, el jugador analizado se encuentra en la zona "C". En la pregunta 2 observando la imagen detenida al final del clip, podemos determinar que la orientación del posesor del balón es lateral. En la pregunta 3 se deben identificar a los jugadores que se encuentran en la zona de intervención, para ello miraremos el video. Si observamos la situación del juego del posesor del balón en el momento que se congela la imagen, hay dos jugadores en la zona de intervención Uno de ellos se encuentra cercano a la banda izquierda mientras que el otro está situado a su

derecha. De acuerdo con las instrucciones de los defensas que se encuentran en la zona de intervención, ellos deben participar de forma inmediata en el juego, se encuentran entre 2 y 4 metros aproximadamente del posesor del balón, y la dirección también nos ayuda a determinar si el jugador va a participar directamente o no en la jugada, ambos jugadores mencionados cumplen con estos 3 requisitos, esa es la razón por la que hay 2 jugadores en la zona de intervención, una vez los hemos identificado nos disponemos a responder la `pregunta.

Fíjese que hay 11 posibles respuestas para los jugadores analizados, no obstante usted solo debe responder el número de jugadores identificados, en este caso son dos jugadores. Si empezamos con el jugador más cercano a la línea de banda, marcamos que hay un jugador en la zona de intervención, marcamos que su orientación es lateral, y que se encuentra en la misma línea que el jugador posesor del balón respecto a la zona "D". Para el segundo jugador respondemos igual, marcamos 1 jugador en la zona de intervención, su orientación es lateral y está más cerca de la zona "D". La siguiente pregunta hace referencia a la zona de ayuda mutua, fíjese que normalmente hay 11 posibles respuestas pero solo necesita identificar aquellos jugadores que se encuentren en la zona de ayuda mutua. Si observamos la situación de juego del posesor del balón cuando se detiene la imagen, hay tres jugadores en la zona de ayuda mutua. Volvamos a ver el video para identificar estos 3 jugadores.

Primero analizaremos al jugador más avanzado. Para ello marcamos que hay un jugador en la zona de intervención. En este caso es muy difícil determinar la orientación del jugador con la imagen detenida, por lo tanto volvamos a mirar el video. Mirando nuevamente el video y fijándonos solo en la orientación de este jugador más avanzado, se nos permite obtener una respuesta más clara. En este caso, dado que el jugador se ha

girado por completo durante la carrera, su orientación es frontal. Él está más cercano del posesor del balón respeto de la zona “D”.

El siguiente jugador a analizar es el que se encuentra más cerca del medio campo. Este tiene una orientación lateral, se encuentra más lejos del posesor del balón.

El 3r jugador a analizar tiene una orientación frontal y se encuentra más lejos del posesor del balón respecto a la zona “D”.

Para responder a la pregunta sobre los fundamentos individuales disponemos de 14 fundamentos tácticos diferentes, representado por imágenes. De esta manera podemos identificar fácilmente cual es la situación que se produce en la jugada analizada. Hay que tener presente que puede haber más de un fundamento aplicado en la misma jugada. En este caso, solo se produce el fundamento 2A. Una vez tenemos clara la respuesta la marcamos abajo.

En el caso de dudas sobre la aplicación de un fundamento podemos obtener una información más detallada haciendo clic encima de la imagen, esto conlleva que se nos abra la información en otra pestaña. Una vez utilizada esta fuente de información podemos volver al cuestionario. En la pregunta número 6 hay que escribir las mejores opciones que el entrenador puede identificar de mejor a peor, siendo 1 la mejor y 4 la peor. La opción 5 siempre serán otras decisiones haciendo referencia a todas aquellas que el jugador pueda tomar y que el entrenador no haya considerado tan buenas como las anteriores.

Antes de responder debe ser consciente que no se busca la capacidad del entrenador de anticipar la decisión que va a tomar el jugador, sino que debe responder a las mejores decisiones que pueda tomar el jugador de acuerdo con el contexto de la situación del juego. Es muy importante que procure ser lo más explícito posible al dar su respuesta.

Una vez visto el video creemos que la mejor opción es: 1- pasar el balón al jugador de la izquierda más atrasado, mirando la imagen detenida determino que la segunda mejor opción que puede tomar el jugador es: 2- pasar el balón al jugador avanzado de la banda izquierda. Para las opciones 2 y 4 necesito volver a ver el video. De acuerdo con el video mi 3ª mejor opción es: controlar el balón y atrasarlo al primer medio campista. Volviendo a mirar la imagen detenida, la siguiente mejor decisión para mí es: 4- controlar el balón hacia adelante para avanzar él mismo hacia la portería contraria.

Hay que tener en cuenta que cuánto más compleja sea la situación de juego menos alternativas habrá. Aun así se requiere a los participantes que sean capaces de dar respuestas al menos a estas 4 opciones.

Para seguir con el cuestionario nos vamos al final de la página y seleccionamos “Next”. En esta segunda parte es necesario ver el segundo video el cual corresponde a la jugada completa que analizamos. Una vez visto el video, en la pregunta 7 indique el número de la decisión que usted escribió y que corresponda con la decisión tomada por el jugador. En este caso la respuesta es la opción 1, porque el jugador pasa el balón al jugador de la izquierda más atrasado. Para asegurarlo podemos confirmar nuestra respuesta a la pregunta anterior. Parea retroceder las preguntas seleccionaremos en la parte superior de la página “quizz navigation”, la pregunta que queremos revisar, en este caso la número 6. Una vez confirmada la respuesta, volvemos a la segunda parte del cuestionario y respondemos a la última pregunta, la cual hace referencia a si el resultado se desarrolló con éxito o sin éxito. Para ello debe concentrarse en el resultado de la jugada y no en la decisión anteriormente tomada por el jugador o escritos por usted. En este caso marcaremos que fue una jugada con éxito.

Una vez hemos respondido todas las preguntas seleccionamos “next” y se nos abre una nueva página, previa al envío del cuestionario, en ella observaremos el estatus de las preguntas. Seguidamente seleccionando “Submit all and finish”, el resultado del clip 1 habrá sido enviado, lo que conlleva a proceder con el clip número 2. Para ello, vaya a “tactical fundamental” y nuevamente en la página principial de moodle buscaremos el jugador que estábamos analizando, en este casi Xabi Alonso, y seguiremos con el clip siguiente. Debe seguir estas instrucciones una y otra vez hasta que haya completado todos los análisis.

Instrucciones generales

Por favor, siga los siguientes pasos antes de completar el análisis:

1.- Asegurarse que se tiene conexión a internet ya sea en el ordenador, tableta o móvil.

2.- Escoger un lugar tranquilo donde se pueda concentrar para hacer el análisis.

3.- Responder el cuestionario del perfil de entrenador.

4.- Ver el vídeo de instrucciones antes de empezar el análisis de jugadas y responder a las preguntas.

5.- Leer con atención las instrucciones que se encuentran en el moodle en la carpeta “Instrucciones en Español”.

6.- Asegurase de que entienda el procedimiento a seguir, por favor intente hacer el análisis de los jugadores.

7.- Seguir el orden del análisis de los jugadores lo establece el investigador quien le va a proporcionar una lista con el orden de los jugadores en el correo de contacto para acceder a la página de moodle.

8.- Responda las preguntas lo mejor que pueda. Para poder mantener este criterio se deben cumplir dos cosas: 1) Mantener una **frecuencia regular** 2) **evitar agobiarse** realizando muchos análisis en un período corto de tiempo.

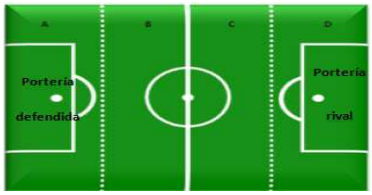
Por lo tanto, después de muchas pruebas en el estudio piloto, se recomienda que se haga una media de **2 jugadores analizados por semana**. El tiempo estimado para el análisis completo de un jugador es de entre 30 y 40 minutos.

MUCHAS GRACIAS POR SU PARTICPACIÓN

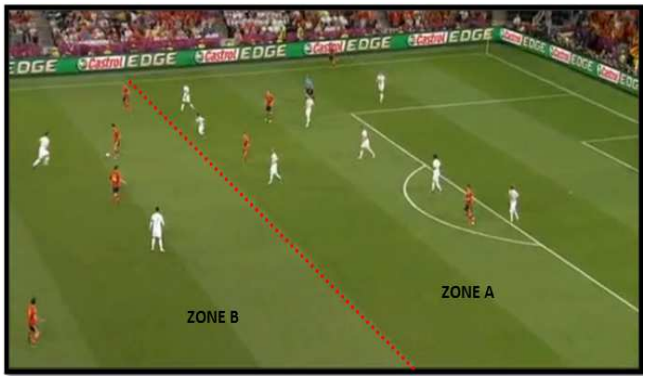
INSTRUCCIONES DEL ESPACIO

¿COMO DIFERENCIAR LA DIVISIÓN DE LAS ZONAS DEL CAMPO?

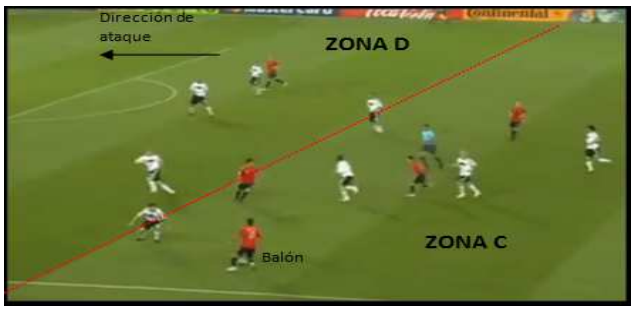
Disponemos de las siguientes zonas:



La **zona A** siempre será la **más cercana a la portería defendida** por el jugador analizado, mientras que la **zona D** siempre será la **más cercana a la portería de ataque**. Así, nombraremos **zona A,** la que abarca desde la línea de fondo de la portería defendida (portería propia) hasta la segunda línea de hierba paralela después del borde del área. Seguidamente, haremos referencia a la **zona B,** que va desde la segunda línea de hierba contando desde el borde del área hasta la línea de medio campo, lugar donde empieza la **zona C**.



Esta abarca desde la línea de medio campo hasta la segunda línea de hierba paralela que hay antes del borde del área de ataque. Finalmente, la **zona D** va des



de la segunda línea de hierba contando desde el borde del área de la portería de ataque hasta la línea de fondo de dicha portería, tal y como se observa en la fotografía superior derecha (línea roja).

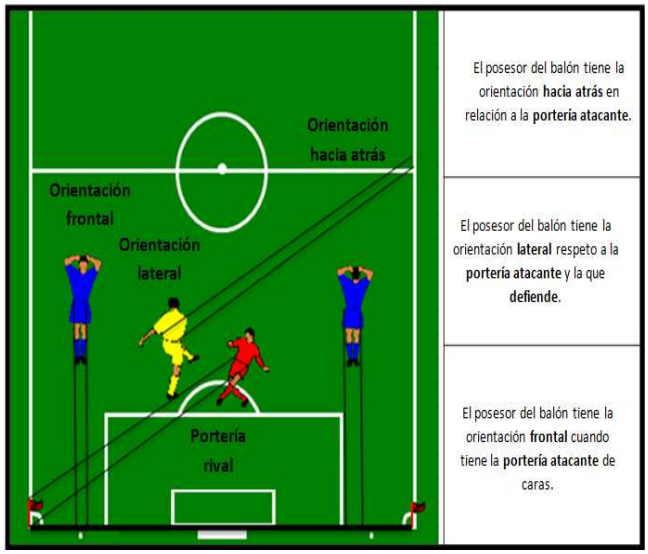
Tenga en cuenta que en cada partido las líneas de hierba serán diferentes, pero estos criterios se mantendrán de forma estricta tal y como se explican en este documento.

INSTRUCCIONES DE LA ORIENTACIÓN DEL JUGADOR

Escoja la orientación correspondiente del jugador analizado en relación a la portería atacada y defendida cuando la imagen se detenga.

¿COMO DIFERENCIAR LAS ORIENTACIONES CUANDO NO SON SUFICIENTEMENTE CLARAS?

En algunas jugadas algunos entrenadores podrían tener problemas para determinar la orientación del jugador cuando la imagen se detiene. Esto se debe a que a veces la imagen pierde calidad cuando se detiene o a que los jugadores están esperando el balón de espaldas a la portería que atacan, por ejemplo, y justo antes de controlar el balón el jugador cambia de orientación. Para evitar confusiones a continuación se muestran algunos consejos para ayudar a los entrenadores a determinar la orientación:



1. El propósito de esta sección es determinar **la orientación del jugador cuando la imagen se detiene.** Por lo tanto, en este momento es cuando se tiene que determinar la orientación.

2. Lo que determina la orientación (hacia delante, hacia atrás o lateral) **son las caderas.** Si trazamos una línea recta desde la cadera izquierda a la derecha (cintura) y la comparamos con la línea de uno de los lados del campo (por ejemplo la portería de ataque) eso determina la

orientación. Es decir, si la **línea de las caderas es paralela** a la **portería de ataque**, el jugador está en orientación frontal u orientado de espaldas respecto a la portería atacante. Si la línea no es paralela, entonces el jugador tiene una orientación lateral.

<table>
<tr><th colspan="2">INSTRUCCIONES DE LA SITUACIÓN DE ZONAS DE JUEGO</th></tr>
<tr><th>Zona de Intervención</th><th>Zona de ayuda mutua</th></tr>
<tr><td>Se define por el balón y aquellos jugadores que intervienen de manera inmediata en la jugada.</td><td>Es la zona que rodea la zona de intervención e incluye aquellos jugadores cercanos a dicha zona.</td></tr>
<tr><th colspan="2">PISTAS DE AYUDA A LOS ENTRENADORES</th></tr>
<tr><td colspan="2"><u>ZONA DE INTERVENCIÓN:</u>
1.- Se define por el balón y aquellos jugadores que intervienen o tienen intención de intervenir en la jugada de manera inmediata.
2.- Aproximadamente, aquellos jugadores que están a una distancia de 2 y 4 metros del jugador que se encuentra con el balón se incluirán en la zona de intervención.
3.- Otro criterio que ayudará a los entrenadores a determinar si los jugadores están dentro de la zona de intervención o no será la dirección hacia la que se dirigen (ya sea hacia el posesor del balón o alejándose de este).
La combinación de estos criterios determinará qué jugadores pertenecen a la zona de intervención y qué jugadores pertenecen a la zona de ayuda mutua.
<u>ZONA DE AYUDA MUTUA:</u>
1. Son los jugadores que se encuentran alrededor de la zona de intervención y no más lejos de 15 metros del jugador que posee el balón (imagínese los círculos de una diana, siendo el círculo central la zona de intervención y el siguiente círculo la zona de ayuda mutua).
2. Los jugadores que se encuentran en la primera línea respeto al posesor del balón.
<u>Primera línea</u>: jugadores que están alrededor de la zona de intervención, que no tienen otros compañeros entre ellos y el posesor del balón y cuyos roles consisten en ayudar al jugador de la zona de intervención (si hubiera alguno):
2.1 Ellos tapan una línea de pase (rol defensivo).
2.2 Ellos tapan un espacio (rol defensivo).
3. Cualquier otro jugador que no tenga compañeros entre él y el posesor del balón y no se encuentre en la primera línea y además esté más lejos de los 15 metros aproximados para la zona de ayuda mutua, es excluido de esta misma (vea el grafico de la parte inferior izquierda).</td></tr>
</table>

2. ORIENTACIÓN DE LOS DEFENSAS

Vea las instrucciones de la orientación de los jugadores. La orientación será analizada con los mismos criterios en defensas como en atacantes.

3. LOCALIZACIÓN DE LOS DEFENSAS EN RELACIÓN AL BALÓN Y LA ZONA D

El defensa puede estar más cercano que el posesor del balón en relación a la zona D.

El defensa puede estar en la misma línea que el posesor del balón.

El defensa puede estar más lejano al posesor del balón en relación a la zona D (vea el gráfico de la parte superior derecha).

APPENDIX C

T-Test

Complexity dimension

Test retest coefficient correlation within groups

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	A1	15.5921	245	4.08102	.26073
	A2	15.4372	245	4.17038	.26644
Pair 2	B1	15.7435	241	4.16736	.26844
	B2	15.7324	241	4.72826	.30457

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	A1 & A2	245	.869	.000
Pair 2	B1 & B2	241	.794	.000

Paired Samples Test

		Paired Differences					t
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		
					Lower	Upper	
Pair 1	A1 - A2	.15480	2.11592	.13518	-.11147	.42107	1.145
Pair 2	B1 - B2	.01108	2.90611	.18720	-.35768	.37985	.059

Paired Samples Test

		df	Sig. (2-tailed)
Pair 1	A1 - A2	244	.253
Pair 2	B1 - B2	240	.953

Test retest coefficient correlation between groups

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	A1B1	15.6671	486	4.12050	.18691
	A2B2	15.5836	486	4.45361	.20202

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	A1B1 & A2B2	486	.828	.000

Paired Samples Test

		Paired Differences				
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference	
					Lower	Upper
Pair 1	A1B1 - A2B2	.08353	2.53708	.11508	-.14259	.30966

Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	A1B1 - A2B2	.726	485	.468

Decision making dimension

Test retest coefficient correlation within groups

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	A1	1.3607	244	1.49658	.09581
	A2	1.2213	244	1.47970	.09473
Pair 2	B1	1.6033	242	1.59084	.10226
	B2	1.4545	242	1.50518	.09676

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	A1 & A2	244	.794	.000
Pair 2	B1 & B2	242	.705	.000

Paired Samples Test

		Paired Differences					t
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		
					Lower	Upper	
Pair 1	A1 - A2	.13934	.95422	.06109	.01901	.25967	2.281
Pair 2	B1 - B2	.14876	1.19238	.07665	-.00223	.29975	1.941

Paired Samples Test

		df	Sig. (2-tailed)
Pair 1	A1 - A2	243	.023
Pair 2	B1 - B2	241	.053

Test retest coefficient correlation between groups

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	A1	1.3496	246	1.49548	.09535
	B1	1.5772	246	1.58312	.10094
Pair 2	A2	1.2532	237	1.48839	.09668
	B2	1.4768	237	1.51143	.09818

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	A1 & B1	246	.502	.000
Pair 2	A2 & B2	237	.434	.000

Paired Samples Test

		Paired Differences					t
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		
					Lower	Upper	
Pair 1	A1 - B1	-.22764	1.53763	.09804	-.42074	-.03454	-2.322
Pair 2	A2 - B2	-.22363	1.59601	.10367	-.42787	-.01939	-2.157

Paired Samples Test

		df	Sig. (2-tailed)
Pair 1	A1 - B1	245	.021
Pair 2	A2 - B2	236	.032

		FIRST DATA COLLECTION																				SECOND DATA COLLECTION																			
		coach 1 A		coach 2 A		coach 3 A		coach 4 A		coach 5 A		coach 1 B		coach 2 B		coach 3 B		coach 4 B		coach 5 B		coach 1 A		coach 2 A		coach 3 A		coach 4 A		coach 5 A		coach 1 B		coach 2 B		coach 3 B		coach 4 B		coach 5 B	
		complexity	DM	complexity	DM	complexity	DM	complexity	DM	complexity	DM	complexity	DM	complexity	DM	complexity	DM	complexity	DM	complexity	DM	complexity	DM	complexity	DM	complexity	DM	complexity	DM	complexity	DM	complexity	DM	complexity	DM	complexity	DM	complexity	DM	complexity	DM
Busquets	clip 1	17,59	3,00	16,74	3,00	17,64	2,00	16,81	4,00	16,75	3,00	16,73	1,00	10,43	2,00	17,53	2,00	16,72	2,00	16,76	4,00	17,59	3,00	16,70	3,00	17,64	2,00	16,81	3,00	16,75	2,00	16,73	1,00	16,69	2,00	17,53	2,00	16,74	3,00	16,75	3,00
	clip 2	19,00	1,00	18,80	4,00	19,04	4,00	16,84	2,00	16,82	4,00	16,75	4,00	25,01	2,00	19,68	3,00	18,76	1,00	16,76	4,00	18,90	1,00	16,72	4,00	19,04	4,00	19,05	0,00	16,72	4,00	16,75	4,00	25,01	2,00	19,68	3,00	18,73	4,00	16,72	3,00
	clip 3	11,34	0,00	12,58	0,00	13,24	4,00	12,64	2,00	12,57	0,00	12,58	1,00	13,33	0,00	12,58	1,00	10,48	3,00	12,57	0,00	11,34	0,00	12,58	0,00	13,24	4,00	12,64	1,00	12,57	0,00	12,58	1,00	13,33	0,00	12,58	1,00	12,58	0,00	12,58	2,00
	clip 4	13,43	0,00	13,43	0,00	11,17	0,00	19,23	1,00	13,24	0,00			9,25	0,00	10,96	0,00	13,33	0,00	13,05	0,00	13,43	0,00	13,05	0,00	10,87	0,00	13,21	3,00	13,24	0,00					10,94	0,00	12,50	0,00	13,34	3,00
	clip 5	15,56	0,00	15,55	0,00	15,55	2,00	15,46	0,00	15,54	0,00	15,55	0,00	15,51	0,00	15,58	0,00	15,55	0,00	15,55	0,00	17,63	0,00	15,55	0,00	15,55	0,00	15,46	0,00	15,58	0,00	15,55	0,00	15,51	0,00	15,58	0,00	15,55	1,00	15,23	0,00
Gerrard	clip 6	17,62	3,00	18,78	4,00	16,88	0,00	18,03	2,00	18,79	4,00	16,70	4,00	16,70	4,00	18,79	2,00	16,71	1,00	16,70	4,00	17,00	3,00	10,45	4,00	17,17	0,00	16,70	3,00	18,79	4,00	16,70	4,00	16,70	4,00	18,79	2,00	16,70	3,00	16,71	1,00
	clip 7	10,44	1,00	10,43	0,00	10,41	4,00	16,80	1,00	8,34	1,00	10,42	3,00	8,34	1,00	8,35	3,00	16,68	4,00	16,67	4,00	10,43	1,00	10,43	0,00	10,41	1,00	8,39	2,00	8,38	1,00	10,42	3,00			8,35	3,00	8,33	0,00	10,46	1,00
	clip 8	11,32	3,00	10,46	2,00	10,46	1,00	10,47	3,00	8,39	3,00	10,40	4,00	10,47	2,00	8,42	4,00	16,71	4,00	10,46	2,00	11,32	3,00	10,46	1,00	10,46	1,00	8,38	2,00	10,50	1,00	10,40	4,00	10,47	2,00	8,42	1,00	8,39	4,00	10,46	2,00
	clip 9	19,34	0,00	18,78	1,00	19,81	1,00	20,07	3,00	8,39	3,00	19,93	1,00	19,91	0,00	20,00	1,00	19,94	2,00	18,78	2,00	19,34	0,00	18,78	0,00	19,81	1,00	20,07	2,00	8,39	0,00	19,93	1,00	19,91	0,00	20,00	1,00	18,78	2,00	18,78	2,00
	clip 10	20,88	0,00	22,91	0,00	20,84	0,00	21,17	0,00	20,84	0,00	20,87	0,00	20,80	0,00	20,88	2,00	20,87	1,00	20,81	4,00	20,88	0,00	20,84	0,00	20,84	0,00	21,02	0,00	20,84	1,00	20,87	0,00	20,80	0,00	20,88	2,00	20,80	0,00	20,84	1,00
Iniesta	clip 11	10,47	2,00	10,80	0,00	10,47	4,00	12,13	0,00	10,47	2,00	10,46	4,00	10,47	0,00	11,60	4,00	10,76	4,00	12,59	1,00	10,47	2,00	10,44	2,00	10,47	4,00	10,47	0,00	10,47	0,00	10,46	1,00	10,47	0,00	11,60	4,00	10,41	4,00	10,49	4,00
	clip 12	16,70	0,00	16,76	0,00	16,73	1,00	16,79	1,00	14,62	2,00	14,75	1,00	16,70	0,00	14,69	0,00	16,69	4,00	16,91	0,00	14,63	0,00	16,70	0,00	16,73	1,00	14,69	3,00	14,63	0,00	14,75	1,00	16,70	0,00	14,66	4,00	14,58	0,00	16,69	0,00
	clip 13	17,00	0,00	17,85	0,00	16,99	0,00	17,91	1,00	18,14	0,00	19,36	0,00	16,99	2,00	18,07	0,00	17,85	0,00	15,73	1,00	17,59	0,00	17,85	0,00	16,79	0,00	17,91	1,00	17,84	0,00	19,36	0,00	16,99	2,00	18,07	0,00	16,70	0,00	18,78	0,00
	clip 14	14,63	2,00	20,87	3,00	20,87	3,00	20,92	0,00	20,84	1,00	20,86	0,00	20,85	0,00	25,04	2,00	20,84	1,00	14,69	3,00	23,79	2,00	20,87	3,00	20,87	3,00	14,65	0,00	20,84	1,00	20,86	0,00	20,85	0,00	22,92	2,00	21,29	2,00	20,85	3,00
	clip 15	17,52	0,00	19,88	0,00	19,61	0,00	20,13	0,00	20,27	1,00	19,50	0,00	26,00	0,00	19,80	1,00	19,65	0,00	19,95	0,00	17,52	0,00	19,57	1,00	19,61	0,00	18,93	0,00	20,18	0,00	19,50	0,00	26,02	0,00	19,80	1,00	19,60	0,00	19,58	0,00
Khedira	clip 16	16,71	4,00	20,84	2,00	14,61	1,00	20,94	0,00	20,84	3,00	8,39	1,00	22,91	0,00	16,68	3,00	14,61	1,00	18,79	3,00	16,72	4,00	8,36	0,00	14,61	1,00	20,94	0,00	20,83	0,00	20,86	1,00	22,88	1,00	16,68	3,00	14,61	0,00	14,61	0,00
	clip 17	14,65	3,00			14,69	2,00	14,70	2,00	8,36	2,00	14,65	4,00	14,61	4,00	14,72	4,00	14,61	4,00	14,61	4,00	14,65	4,00	16,69	1,00	14,69	2,00	14,70	1,00	10,46	2,00	14,65	4,00	8,36	4,00	14,68	4,00	14,65	2,00	16,72	1,00
	clip 18	16,73	0,00	16,72	4,00	14,65	4,00	16,80	4,00	14,65	4,00	16,76	1,00	16,72	4,00	14,65	4,00	14,65	4,00	14,68	3,00	10,48	4,00	16,72	4,00	14,65	4,00	16,74	4,00	14,65	4,00	16,76	4,00	16,72	4,00	14,65	4,00	14,65	4,00	14,64	4,00
	clip 19	17,02	3,00	16,85	4,00	16,81	4,00	16,96	3,00	16,78	4,00	17,02	4,00	16,98	4,00	16,96	4,00	16,85	3,00	16,81	4,00	17,02	4,00	16,81	0,00	16,81	4,00	17,01	4,00	18,89	4,00	17,02	4,00	16,81	2,00	16,94	4,00	16,79	0,00	17,01	4,00
	clip 20	17,60	4,00	17,60	3,00	17,46	4,00	18,39	2,00	17,61	4,00	17,61	4,00	17,62	4,00	17,60	1,00	17,59	4,00	17,50	4,00	17,60	4,00	17,62	4,00	18,35	4,00	18,39	2,00	18,36	4,00	17,62	4,00	17,62	4,00	17,60	1,00	15,55	4,00	17,50	1,00
Mascherano	clip 21	10,48	2,00	10,44	0,00	8,40	0,00	10,56	0,00	8,40	2,00	10,44	3,00	8,36	2,00	8,36	3,00	8,36	1,00	8,33	1,00	13,96	2,00	10,47	0,00	8,40	0,00	8,39	2,00	8,40	0,00	14,35	3,00	8,36	2,00	8,35	3,00	8,40	1,00	8,33	1,00
	clip 22	10,45	0,00	4,19	0,00	10,44	0,00	10,51	1,00	10,44	0,00	4,23	0,00	10,41	0,00	10,45	0,00	10,41	0,00	10,44	0,00	10,45	0,00	4,19	0,00	13,92	0,00	10,49	1,00	10,46	0,00	4,23	0,00	4,23	0,00	10,45	0,00	10,41	0,00	10,44	0,00
	clip 23	16,72	0,00	16,72	2,00	14,65	3,00	12,60	1,00	14,65	1,00	16,67	1,00	22,95	0,00	16,72	0,00	16,72	2,00	16,72	0,00	16,72	1,00	22,95	1,00	14,65	3,00	12,60	1,00	14,65	0,00	16,67	1,00	22,95	0,00	16,72	0,00	14,65	0,00	16,72	2,00
	clip 24	10,52	0,00	8,33	0,00	8,43	0,00	8,48	0,00	8,33	1,00	8,33	3,00	8,33	0,00	8,46	2,00	8,36	1,00	8,33	2,00	10,52	0,00	8,34	0,00	8,43	0,00	8,34	0,00	8,33	1,00	8,33	3,00	8,33	0,00	8,46	2,00	10,40	0,00	8,33	1,00
	clip 25	16,77	2,00	14,58	0,00	14,72	2,00	14,77	0,00	14,61	1,00	16,73	1,00	14,61	0,00	14,72	3,00	14,65	1,00	14,61	4,00	14,69	2,00	14,58	0,00	14,69	2,00	14,67	2,00	14,68	0,00	16,73	1,00	14,61	0,00	14,72	3,00	14,68	0,00	14,58	1,00
Pirlo	clip 26	8,36	3,00	10,44	2,00	8,36	3,00	8,38	4,00	8,36	4,00	10,44	3,00	8,36	2,00	8,36	1,00	8,36	3,00	10,44	3,00	8,36	3,00	8,36	4,00	8,36	3,00	8,36	4,00	10,44	3,00	10,44	3,00	10,44	2,00	8,36	1,00	8,36	4,00	10,43	1,00
	clip 27	13,09	0,00	6,87	0,00	13,29	0,00	6,94	0,00	13,09	0,00	7,18	0,00	13,10	0,00	13,43	2,00	13,43	0,00	13,12	0,00	13,09	0,00	13,40	1,00	13,29	0,00	13,15	0,00	13,09	0,00	7,18	0,00	7,18	2,00	13,43	2,00	13,09	1,00	6,87	0,00
	clip 28	14,64	1,00	16,69	2,00	14,61	4,00	14,73	0,00	14,64	4,00	14,64	4,00	14,60	4,00	14,68	4,00	14,64	4,00	8,39	1,00	14,64	1,00	14,65	0,00	14,61	4,00	14,64	0,00	8,41	3,00	14,64	4,00	14,58	1,00	14,68	4,00	14,61	2,00	8,39	0,00
	clip 29	14,65	0,00	14,61	2,00	14,65	4,00	15,44	1,00	14,61	4,00	14,65	4,00	14,61	1,00	14,65	4,00	14,61	4,00	14,61	4,00	14,65	0,00	14,65	2,00	14,65	4,00	14,61	0,00	14,61	0,00	14,65	4,00	14,61	0,00	14,65	4,00	14,61	4,00	14,61	3,00
	clip 30	11,38	4,00	11,25	2,00	11,25	4,00	13,31	4,00	13,38	4,00	11,36	4,00	13,29	4,00	11,17	4,00	11,30	3,00	13,35	3,00	11,38	4,00	11,22	1,00	11,25	4,00	13,31	1,00	13,48	4,00	11,35	4,00	13,29	2,00	11,20	4,00	11,19	4,00	13,31	2,00
Schwensteiger	clip 31	11,35	2,00	10,47	1,00	10,47	0,00	9,85	1,00	10,47	3,00	10,48	1,00	10,45	2,00	10,51	0,00	10,47	0,00	10,47	0,00	11,35	2,00	10,47	0,00	10,47	0,00	11,36	1,00	10,47	2,00	10,48	1,00	11,34	3,00	10,51	0,00	10,47	1,00	11,32	0,00
	clip 32	11,40	2,00	8,46	4,00	8,41	4,00	15,68	2,00	9,32	4,00	8,48	4,00	11,12	4,00	11,37	2,00	9,32	0,00	10,53	3,00	11,40	4,00	10,55	2,00	8,41	4,00	9,31	1,00	8,46	4,00	12,66	4,00	11,12	4,00	11,37	3,00	8,45	1,00	9,32	3,00
	clip 33	17,57	0,00	14,63	0,00	15,53	4,00	15,52	0,00	16,06	0,00	15,79	2,00	15,17	0,00	15,54	1,00	15,49	1,00	15,91	4,00	17,59	2,00	14,63	0,00	15,53	4,00	14,64	0,00	16,06	0,00	15,78	2,00	15,17	0,00	15,54	1,00	16,13	0,00	15,96	2,00
	clip 34	17,62	0,00	16,69	0,00	14,61	0,00	15,33	0,00	14,61	0,00	16,72	0,00	14,61	0,00	14,65	0,00	14,61	0,00	16,69	0,00	17,62	0,00	16,69	0,00	14,61	0,00	14,61	0,00	14,61	0,00	16,72	0,00			14,65	0,00	14,61	0,00	14,61	0,00
	clip 35	17,60	2,00	17,59	2,00	17,29	0,00	18,34	1,00	17,29	2,00	10,48	1,00	17,57	4,00	17,27	2,00	17,59	1,00	15,55	4,00	17,60	4,00	17,59	0,00	17,29	0,00	17,62	0,00	17,31	0,00	10,48	1,00	17,03	0,00	19,65	2,00	17,59	4,00	15,54	3,00
Sneijder	clip 36	22,98	0,00	20,81	1,00	20,87	0,00	23,05	1,00	23,02	1,00	22,91	0,00	20,84	0,00	23,01	0,00	22,91	0,00	20,87	2,00	22,98	0,00	20,84	1,00	20,87	0,00	20,86	0,00	20,94	3,00	22,91	0,00			23,01	0,00	20,84	0,00	20,84	0,00
	clip 37	15,52	0,00	16,72	0,00	14,66	0,00	15,30	0,00	16,72	3,00	17,77	2,00	16,73	0,00	16,76	1,00	17,28	3,00	16,74	2,00	15,52	1,00	16,75	1,00	14,66	0,00	16,75	0,00	16,76	1,00	17,77	2,00	16,73	0,00	16,73	1,00	17,60	3,00	16,74	2,00
	clip 38	24,34	0,00	24,26	0,00	24,30	0,00	24,26	0,00	24,10	1,00	24,21	0,00	24,17	0,00	24,30	0,00	24,32	0,00	24,30	0,00	24,34	0,00	24,26	0,00	24,30	0,00	24,20	0,00	24,31	1,00	24,21	0,00	24,16	0,00	24,20	0,00	24,30	1,00	24,30	0,00
	clip 39	17,00	0,00	14,73	4,00	16,79	1,00	15,03	0,00	17,10	1,00	23,51	4,00	17,18	0,00	16,79	4,00	14,73	1,00	14,72	4,00	17,00	0,00	16,79	1,00	16,79	0,00	16,90	0,00	16,71	3,00	23,51	4,00	17,28	2,00	16,79	4,00	16,79	1,00	14,72	3,00
	clip 40	16,80	1,00	22,91	0,00	20,94	0,00	23,10	0,00	14,72	0,00	22,95	0,00	22,91	3,00	23,06	0,00	14,61	1,00	22,91	1,00	16,74	0,00			20,94	0,00	23,10	0,00	20,94	1,00	23,55	0,00	16,65	1,00	23,06	0,00	14,61	1,00	22,90	0,00
Xavi	clip 41	17,60	0,00	17,91	0,00			19,54	0,00	17,51	0,00	17,39	0,00	17,40	0,00	17,59	0,00	18,35	0,00	17,62	0,00	17,60	0,00	17,50	0,00			17,39	0,00	19,58	0,00	17,39	0,00	17,40	0,00	16,70	0,00	17,50	0,00	17,60	0,00
	clip 42	23,80	0,00	23,67	0,00			17,59	0,00	17,75	0,00	17,06	0,00	17,35	0,00	21,90	0,00	24,08	1,00	17,47	0,00	23,69	0,00	23,67	0,00			17,55	0,00	16,69	0,00	17,06	0,00	5,13	2,00	21,90	0,00	23,76	2,00	23,69	0,00
	clip 43	22,95	1,00	20,87	0,00	14,68	3,00	20,91	0,00	20,87	1,00	16,73	0,00	20,88	0,00	20,91	4,00	20,87	1,00	14,71	2,00	22,95	1,00	20,87	1,00	14,68	3,00	20,87	0,00	20,88	1,00	16,73	0,00	20,88	0,00	20,91	4,00	20,87	0,00	20,87	3,00
	clip 44	17,03	1,00	18,73	0,00	16,87	0,00	20,05	0,00	19,04	0,00	18,76	0,00	16,89	0,00	17,06	2,00	17,03	4,00	16,98	1,00	17,03	1,00	16,67	0,00	23,09	0,00	17,02	0,00	16,77	0,00	18,76	0,00	16,89	0,00	17,06	2,00	16,95	0,00	18,77	0,00
	clip 45	16,74	0,00	14,62	0,00	14,62	0,00	14,77	0,00	14,62	1,00	16,70	0,00	16,66	1,00	14,66	0,00	16,69	1,00	16,69	0,00	16,74	0,00	16,69	0,00	14,62	0,00	14,77	0,00	14,62	0,00	16,70	0,00	16,65	1,00	14,66	0,00	14,61	0,00	16,68	2,00
Zidane	clip 46	16,72	1,00	14,60	0,00	14,69	1,00	14,72	1,00	14,63	0,00	14,61	1,00	16,68	2,00	14,64	0,00	16,72	0,00	16,72	1,00	16,72	1,00			14,69	1,00	14,63	0,00	14,65	0,00	14,61	1,00	16,68	1,00	14,64	0,00	14,59	0,00	14,64	0,00
	clip 47	11,37	3,00	11,33	1,00	11,37	4,00	11,23	3,00	11,33	4,00	11,33	1,00	11,03	1,00	11,37	4,00	11,33	2,00	11,41	1,00	11,37	3,00	11,22	0,00	11,37	4,00	11,23	1,00	13,32	1,00	11,33	1,00	11,34	1,00	11,37	4,00	11,33	4,00	12,57	1,00
	clip 48	17,03	1,00	16,69	3,00	19,03	1,00	17,79	3,00	19,15	0,00	16,71	0,00	17,22	0,00	16,75	1,00	19,07	1,00	16,74	0,00	19,11	1,00	4,32	2,00	19,03	1,00	19,84	3,00	18,81	0,00	33,76	0,00	16,67	0,00	16,75	1,00	18,79	2,00	22,93	3,00
	clip 49	14,63	0,00	14,58	0,00	14,69	2,00	14,79	2,00	14,63	0,00	14,63	0,00	14,61	0,00	14,70	0,00	14,73	0,00	14,65	0,00	14,67	1,00	14,58	0,00	14,62	2,00	14,69	1,00	14,65	0,00	14,63	0,00	14,61	0,00	14,67	0,00	14,58	0,00	14,67	0,00
	clip 50	21,14	0,00	20,85	0,00	21,03	0,00	21,81	1,00	20,94	0,00	22,92	0,00	21,39	3,00	20,88	0,00	21,19	0,00	21,15	0,00	21,14	1,00	20,85	0,00	21,01	0,00	21,09	1,00	20,86	0,00	20,85	0,00	21,39	3,00	20,88	0,00	20,94	0,00	20,86	1,00

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Thesis Title:

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Major Professor: Dr. Jared M. Porter