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World-Class Football Players' Visual Exploratory Behaviour

A close-up video analysis in UEFA Champions League matches

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Preface

I was first introduced to the world of perception in football when professor Geir Jordet had a presentation about it in my first year at the Norwegian School of Sport Sciences. My immediate thought was "why have I not heard about this before, this is essential to football performance, and I have played football for 18 years without knowing about this important skill." So when Geir asked me to join a project that was going to explore visual exploratory behaviour among some of the absolute best midfield and forward players in the world, the answer was easy, and I will never regret that answer. The task of selecting players and gaining access to these players started in the last year of my Bachelor degree—this process was difficult, time consuming, and at times I felt discouraged for not obtaining access. Fortunately, in my first year of my Master's degree, the Football Association of Norway (NFF), on behalf of this project, contacted UEFA who granted us access to film the players we wanted to analyse in UEFA Champions League matches.

In order to carry out this project, a lot of planning and organising was required: over 100 emails were sent between me, Geir, NFF, and UEFA during this project, arranging camera equipment, booking hotels and flights, accreditation pick-up, attending TV-meetings at the venues, and analysing the data material. This resulted in many late evenings with practical work, many hours traveling, and many hours filming. In addition, an attempt to write the thesis as a scientific article was carried out, where an almost complete article, and a complementary theory and method part was developed. However, 24 days before deadline my supervisor advised me to write the thesis as a traditional thesis and abandon the article format because of the vague guidelines as to how an article structured thesis should look like. So I abandoned the article and will come back to it after this assignment—the desire to publish several articles from this project is why I chose to write the thesis in English. That being said, the experiences I had in doing this project makes up for all the hours with work, and I see myself as very fortunate to have been given this opportunity to conduct a master thesis about something I believe is very interesting and essential in the sport of football. It is therefore with a mixture of relief and pride that I conclude this chapter of my life, and at the same time I am wondering what the next chapter will be.

Takk til bidragsytere!

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Til slutt, men aller viktigst, min samboer Hedda. Din støtte og tålmodighet har vært helt avgjørende og er høyst verdsatt, din evne til å gi meg energi og glede i hverdagen er uvurderlig, nå er det min tur til å lage middag og vaske leiligheten!

Abstract

The overall purpose of this study was to examine how football players explore the environment and use the information to prospectively control subsequent actions with the ball. A real world field study was conducted and Gibson's (1966; 1979) ecological approach to visual perception was used as conceptual framework. The relationship between visual exploratory behaviour (VEB) and performance, VEB and various situational characteristics, and the timing of the players' VEB were examined. Eight world-class midfield and forward players (*M* = 31.5 years, *SD* = 3.25) were filmed "close-up" in five matches of the 2014/2015 UEFA Champions League group stages (*M* = 56.13 minutes, *SD* = 40.36). These footages were edited together with the official UEFA match broadcast, creating a split screen video for further examination of a total of 269 situations and 851 visual exploratory behaviours (searches).

Results suggests a positive relationship between VEB prior to receiving the ball and performance, where players are more successful in their forward actions and complete more penetrating forward passes when exploring more compared to when exploring less. Further, when players perform extensive VEB, they execute more actions in the attacking direction, are more forward oriented when receiving, and are under less defensive pressure compared to when exploring less. Finally, the players' timing of each search suggests that they initiate significantly more searches than expected in the immediate moment the ball position and/or direction is determined. In conclusion, this study suggests a positive relationship between VEB and performance in football, and that VEB is used by players to get in a better position to execute their subsequent actions. In addition, a VEB timing pattern is proposed. The development of visual exploratory behaviour should be highly emphasised in football players' daily training, and some practical implications are presented.

Keywords: ***Visual perception; Affordances; Visual exploratory behaviour frequency***

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"I perceive the game in a different way. It is a question of viewpoints, of having a vide field of vision." Andrea Pirlo (Pirlo & Alciato, 2014, p. 12).

1. Introduction

Football (or soccer) is one of the most popular sports in the world—about 270 million people (4% of the worlds total population) play football regularly worldwide (FIFA, 2007). Only 0.04% (100,000 players) are playing in a professional league, indicating that the road to professional football is highly competitive and difficult (Haugaasen & Jordet, 2012). From a broader sport perspective, researchers have, in the last four decades, "developed the burgeoning field of human expertise to the point where it has become a legitimate field of specialization" (Baker & Farrow, 2015, p. 3). For football specifically, the growing interest in expertise research has expanded to a range of performance demand areas such as psychology, physiology, tactical and technical skills, player development, and talent identification (for overviews, see Haugaasen, 2015; Jordet, in press; Meylan, Cronin, Oliver, & Hughes, 2010; Stølen, Chamari, Castagna, & Wisløff, 2005). The broad area of expertise research is a result of the complexity in football, where players can compensate for shortcomings in one are with strength in another, in which expertise can be achieved trough an unique combination of skills (Haugaasen & Jordet, 2012). However, a growing consensus has emerged among researchers and coaches that the anthropometrical and physiological attributes among experts at the highest level of football is not the key factor distinguishing the best players from other players. Instead, researchers argue that psychological abilities (e.g., coping with pressure, mental toughness, and resilience), as well as technical (e.g. passing and dribbling) and tactical skills (e.g., decision making) are the key discriminating attributes between successful and less successful players (Williams & Ford, 2013). Specifically, several researches argued for the critical role of cognitive processes such as anticipation (Roca, Ford, McRobert, & Williams, 2011), perception (Jordet, Bloomfield, & Heijmerikx, 2013), attention (Savelsbergh, Van der Kamp, Williams, & Ward, 2005), decision making (Ward, Ericsson, & Williams, 2013), and intention, in high level football performance (Jordet, 2005a). Perception is an important determination of football expertise, and the ability to "read the game" distinguishes skilled from less skilled players (Williams, 2000). The demands of advanced perceptual skills is understandable, as professional football is played on a large playing field (up to 90x120 meters) and 22 players are constantly moving, making the game extremely dynamic, complex, and information rich (Jordet et al., 2013). Particularly visible for midfield and forward players that are constantly surrounded by other players, whose movements, positions, and intentions has to be detected in order to make effective and accurate decisions with the ball (Jordet et al., 2013). Perception of this ambient information is tightly connected to and dependent on players’ visual system, which, according to Gibson (1979), consists of the eyes, head, and body. As an example, Brazilian midfield players reported that they used the visual system to look around the pitch and used the perceived information to perform subsequent actions with the ball (Tedesqui & Orlick, 2015). However, sport and expertise psychologists have, for the most part, ignored studying athletes within the sport context (Vealey, 2006). Thus, most of our knowledge about cognitive processes in sport is based on research in laboratory settings (Pinder, Headrick, & Oudejans, 2015) in the absence of the real sport context (Jordet, 2005a). There is an urgent need to supplement laboratory paradigms with field (real world) research (Araujo, Davids, & Hristovski, 2006; Jordet et al., 2013). Real world research, or field studies, involve investigation a phenomenon in the context where it naturally occurs (Jordet, 2005a).

In the current study, the visual exploratory behaviour and performance of midfield and forward football players in real world game situations were examined. Eight world-class football players were filmed with the close-up function (solely focusing on one player at a time) in six UEFA Champions League matches. The visual exploratory behaviour (VEB) was registered and players’ subsequent actions with the ball was analysed. The intention was to provide detailed and comprehensive understanding of the relationship between VEB and performance in real game situations. Further, the relationship between VEB and environmental characteristics is addressed. Finally, the players’ timing of each VEB were registered and analysed.

2. Introduction to theory

Comprehensive research has been conducted to explain how skilled athletes perceive visual information from highly complex and dynamic environments in order to preform their consistent and timed actions (for reviews, see Williams, Davids, & Williams, 1999; Williams, Ford, Eccles, & Ward, 2011), and also to investigate the development of these skills (for a review, see Williams & Ward, 2003). Visual perception and attention has mainly been investigated trough the monitoring of athletes' eye movements in laboratory settings (Dicks, Button, & Davids, 2010; Savelsbergh, Haans, Kooijman, & van Kampen, 2010), often comparing skilled/elite performers and less-skilled/novice performers (Gorman, Abernethy, & Farrow, 2015; Roca et al., 2011; Roca, Ford, McRobert, & Williams, 2013; Savelsbergh et al., 2005). In contrast, Gibson's (1979) ecological approach to visual perception emphasised the importance of explaining the perception of the real world. Jordet (2005a) argues that most of the cognitive process frameworks used by cognitive psychologists is less functional and contextual than the ecological approach. However, most of the current knowledge about cognitive processes in sport is gained from laboratory settings (Pinder et al., 2015). In football specifically, laboratory research has contributed to a significantly amount of valuable knowledge about football players' cognitive processes (Jordet, 2005a). Having said that, Martens (1979) argued for the need to give laboratory research less attention and move the research to the field, trading the smocks with the "jocks" and focus on the context itself, namely the sport: "We have been so eager to test theories of the larger field of psychology in order to confirm our scientific respectability that we have not adequately observed, described, and theorized about our own thing—sport!" (Martens, 1979, p. 97). In line with this early attempt to push researchers out in the field, some researchers' have the last decade investigated the perceptual processes in football players in real game situations (Eldridge, Pulling, & Robins, 2013; Jordet, 2004, 2005b; Jordet et al., 2013). These studies are built on the ecological theoretical foundation of visual perception, where the link between perception and action in the real world is in focus (Gibson, 1979). The current study is mainly inspired by and developed on the basis of these earlier real world studies, but also influenced by the valuable knowledge gained from the laboratory studies. Hence, to provide a broader understanding of both the cognitive and ecological approach to visual perception the two theories are elaborated below. In addition, some important findings from the research that has emerged within the two theoretical traditions are further presented.

2.1 Cognitive theory of perception

> It has been said that beauty is in the eye of the beholder. As a hypothesis about localization of function, the statement is not quite right-the brain and not the eye is surely the most important organ involved. Nevertheless it points clearly enough toward the central problem of cognition. Whether beautiful or ugly or just conveniently at hand, the world of experience is produced by the man who experiences it. (Neisser, 1967, p. 3)

Cognition refers to all processes where the sensory input is elaborated, reduced, recovered, stored, transformed, and used (Neisser, 1967). In other words, the unstructured retinal pattern that observers perceive from the world most be processed and interpreted within the perceiver to make sense of it, which means that humans have no immediate or direct access to the world or its properties. Some aspects or hypothetical stages of cognition is perception, imagery, recall, thinking, and problem solving (Neisser, 1967). Perception is the process whereby observers construct meaning of the world—visual information is the source we rely most upon, and this is used by athletes to perceive the spatiotemporal structure of environmental information in order to successfully perform actions (Williams et al., 1999). The mind-body dualism provides the ideological basis for traditional cognitive psychology, where internalised devices carry out the information derivation and cue elaboration (Williams et al., 1999). The roots of the perceptual cognitive approach is that humans makes sense of the world from within, and that perception is the process of visually picking up the geometrical shapes of objects, with the end result of having the form understood within the perceiver (Cutting, 1986). In other words, the cognitive perspective of the perception-action relationship emphasizes that what we perceive is a kind of mental reconstruction of the environment and that perception can be studied separately from action (Williams et al., 1999).

> visual perception is the study of the mapping from perceptible external objects, trough optic information that represent them, to the observer who uses that information for his or her purposes. Geometry is the vehicle of this instillation. (Cutting, 1986, p. 4)

Cutting (1986) suggests that humans' visual system is a sophisticated geometry-analysing engine, and this internal representation of the world has been compared to the way computers works (Williams et al., 1999). Cognitive psychologists have argued that skilled performers use internally represented knowledge when planning motor responses, such as ignoring less relevant cues and attending to more relevant sources of environmental information; anticipating events before they actually happens in time-constrained sports; systematically and skilfully searching the visual field; and verifying limited environmental information received by their perceptual system (Williams et al., 1999). These cognitive control structures facilitate planning and execution of subsequent actions, and is thought to distinguish novice from expert performance (Beilock & Carr, 2004). The important cognitive activities involved when reconstructing the sport environment is remembering (long term memory) and attending (selective attention) (Williams et al., 1999). In addition, when players evolve trough practice and their skill level increases, the attentional demands and memorial substrate change (Beilock & Carr, 2004). To gain a deeper understanding of these processes among athletes, and how these behaviours typically are investigated, some laboratory studies are addressed below.

2.1.1 Laboratory research

Some of the first empirical evidence from laboratory studies showed that experts in ball sports better anticipate their opponents' actions, have better recall, and better recognize patterns of play than novice players do (Abernethy & Russell, 1987; Jones & Miles, 1978; Starkes, 1987; Williams, Davids, Burwitz, & Williams, 1994). In football specifically, researchers have used simulated football situations display on a large screen and eye-tracking technology to monitor players' visual fixation—duration, frequency, location, and order (Cañal-Bruland, Lotz, Hagemann, Schorer, & Strauss, 2011; Helsen & Starkes, 1999; Roca et al., 2011; Roca et al., 2013; Williams & Davids, 1998; Williams et al., 1994). These laboratory studies have provided an essential amount of knowledge in the field of perception in football, but the methodology often differs across studies. Hence, to provide a holistic understanding of the results and the methodology used, some laboratory studies are presented in a more comprehensive way in this section.

Williams et al. (1994) exposed inexperienced and experienced players to 11 on 11 football film sequences displayed on a large projection screen and found that experienced players exhibit more visual fixations of shorter duration, which were considered to be more advantageous for anticipating opponents' pass direction. In addition, expert players performed more fixations away from the ball and away from the player in possession of the ball, suggesting that experienced players employ a more pertinent and extensive search strategy facilitating their superior performance (Williams et al., 1994). Some years later Williams and Davids (1998) exposed players to 1-on-1 and 3-on-3 defensive situations, and found that experts performed more fixations of shorter duration in the one on one situations, while the search rate did not differ between the groups in the three on three situations. They suggested that lower search rates may be more beneficial in three on three situations as a result of the increased role of peripheral vision to pick up task specific information. In the one on one situations the players are more dependent on foveal vision to pick up information from key parts of the opponent's body, which results in increase in search rates. Finally, the experienced players showed superior anticipation abilities in both one on one and three on three situations. Recent research has supported these findings, where skilled players employed a search strategy with more fixations of shorter duration when exposed to life-size defensive 11 on 11 situations (Roca et al., 2011). Additionally, the skilled players fixated more towards information sources away from the ball while less skilled players spent more time fixating at the ball's movements and the player in possession of the ball. These results suggest that skilled players have a more relevant search strategy, which may explain their superior decision-making and ability to anticipate the opponents' actions (Roca et al., 2011; Williams et al., 1994).

Helsen and Starkes (1999) used a multidimensional approach (using both static slides and dynamic video films) to investigate expert and intermediates' perception and performance in offensive football simulated situations. In the static slide experiment there were no differences in the fixation location and duration, but experts used fewer fixations. Further, in the dynamic film experiment they found that experts performed fewer fixations of longer duration. Additionally, experts located more fixations towards free space away form the ball, while intermediates fixated more towards the ball. In the static slide experiment players reported verbally which action they found most suitable to execute, and in the dynamic video experiment they responded by performing what they believed was the best action with the ball. Experts were found to respond faster and more appropriate in both experiments. So, experts extract more relevant information with a single fixation, are quicker in the selection of an appropriate response, and are able to find the best decisions on the basis of fewer fixations (Helsen & Starkes, 1999). Cañal-Bruland et al. (2011) exposed skilled and less skilled football players to video of defensive, offensive, and unstructured football situations and found that skilled players perform significantly fewer fixations of longer duration, which supports earlier findings. To analyse players' response time, players were shown one original and one manipulated football video, where players responded as quick as possible when detecting the manipulated situation by pressing the spacebar and using the computer mouse to indicate where they thought the manipulated player was. Although experts applied a different search pattern than novices, they did not differ in decision time (i.e., performance) (Cañal-Bruland et al., 2011).

Roca et al. (2011) argued that the various findings in laboratory studies may be due to different use of realistic environmental stimuli (screens and monitors) and/or different use of stimuli responses (verbal, body movements, keyboard typing, computer mouse moving etc.). For example, Williams et al. (1994) used videos that were filmed behind (5m above) the goal displaying the whole width of the pitch, simulating the view of a central defender on a 3m x 3m screen. When the ball reached a highlighted opponent player, participants identified verbally as quickly as possible the anticipated final location of the opponent's pass, immediately after that response they used a computer mouse to mark the final pass destination on a pitch diagram. Helsen and Starkes (1999) used videos that were filmed from a player's perspective in offensive situations displayed on a 10m x 4m screen. The ball was played between teammates on the videos and at a specific moment an attacking player played the ball towards the participant that had to perform a tactical decision with the ball as quickly and accurate as possible, just as in real game situations. The screens and stimuli responses used in these two studies differ as well as the situational characteristics (defensive and offensive situations). However, both studies concluded that experienced players are superior in their decision-making, and had despite completely different results in terms of visual fixation patterns.

Another example, in the study of Helsen and Starkes (1999) and the study of Cañal-Bruland et al. (2011) they found the same visual fixation pattern among the expert players. However, the superior decision-making ability among expert players in Helsen and Starkes (1999) was not found among the experts in the study of Cañal-Bruland et al. (2011). A possible explanation for the different findings is provided by Roca, Williams, and Ford (2014). They examined if the cognitive strategies among football players who perceived a video stimuli when sitting or moved/interacted with it differed. The results indicated that the movement group verbalized more thoughts related to the prediction of further options as well as the planning of appropriate action responses. To better identify the processes and mechanisms mediating superior performance, researchers need to design experimental tasks that (more closely) recreate the constraints and movement possibilities found in the real performance setting (Roca et al., 2014). Therefore, the movement responses used in Helsen and Starkes (1999) study may have intensified the decision-making differences between expert and novice players while these differences becomes less prominent when performing non-sport specific responses like the keyboard typing and computer mouse movements used in the study of Cañal-Bruland et al. (2011).

Despite the empirical evidence and guidelines provided by Roca et al. (2014), recent studies have used new technology and taken the investigation of visual perception a step further into the laboratory environment. As an example, Romeas and Faubert (2015) placed the participants in a fully immersive virtual environment. Virtual figures called point-light, consisting of 15 black dots creating a dynamic representation of humans on a white surface were displayed to the participants (for illustration see Romeas & Faubert, 2015, p. 3). University football players and non-athletes were wearing stereoscopic goggles and were asked to fixate straight ahead on the display where a point-light walker and point-light football kicks was shown. Participants verbally reported if the non-sport point-light walker was walking to the left or to the right, in the same way they reported if the point-light football kick was directed to the right or the left. Researchers concluded that the football players were superior in accuracy and reaction time for both the point-light football kick and point-light walker, suggesting that athletes are better than non-athletes to recognize body kinematics that go beyond sport specific actions (Romeas & Faubert, 2015).

Further, a company called Neuro Tracker emerged in the field of visual perception in sport, and the technology is built on years of scientific research, developed by the well-known pioneer in the field of perception and cognitive performance, Dr. Faubert (NeuroTracker, 2016). The aim for both the company and the research conducted on this technology is to train the optimal performers processing of sport-related visual scenes at the perceptual cognitive-level, and prove that this capacity is trainable (Faubert & Sidebottom, 2012). A session takes place in an immersive 3D environment, where the participant is placed in front of a screen/display with 3D goggles on. A number of spheres (typically four out of eight) are highlighted in one second before all spheres move around in the 3D virtual volumetric space where they are constantly changing direction. Finally, the spheres stop and the observer has to identify the four spheres that initially were highlighted. If he/she identify all spheres the speed level increases, and if not, then the speed decreases in the next session (Faubert & Sidebottom, 2012). This exercise is built on multiple object tracking (MOT), as research has shown that observers are able to track up to four targets for several seconds simultaneously, seemingly with the ability to use more than one focus of attention (Cavanagh & Alvarez, 2005). This was recently tested on university football players to see if the effect of 3D training transfers to the field. Romeas, Guldner, and Faubert (2016) used a subjective performance measure to investigate 23 university-level football players development of essential skills (passing, dribbling and shooting) in small-sided games before and after training protocol. In 10 sessions, nine of the players (experimental group) used the 3D-MOT training environment (Neuro Tracker) and seven players (active control group) watch 3D real football videos from the 2010 FIFA world cup. The final seven players made up the passive control group who did not receive any particular training besides regular football training. Due to no statistical differences and small sample size the active and passive control group was merged and analysed as a single control group. Results revealed that only the experimental group hade a significantly improvement in decision-making by improving the passing accuracy, however no improvement was found for dribbling or shooting. No inter observer test was conducted on the subjective variables who measured the performance enhancement in the study. However, the researchers concluded that this study represent the first evidence of transfer between a laboratory perceptual-cognitive training and on-field performance improvement (Romeas et al., 2016). It is important to note that one of the authors in this research is Chief Science Officer of Cognisens Athletics Inc. who produces Neuro Tracker (the 3D training program) used in the study (Romeas et al., 2016).

Laboratory research of team ball sport has generated a significantly amount of valuable and reliable knowledge about perceptual expertise (Jordet, 2005a). However, the typical laboratory set-up and procedures have several shortcomings and do not fully capture the performers' expertise, knowledge, and sport-specific movements as it emerges in the real sport environment (Pinder et al., 2015). For example, the flat screens and frontally located information source have no immersive capabilities to simulate motion parallax, which severely compromises players' perception (Craig & Cummins, 2015). When observing skilled players in a football game, one can see them constantly moving their heads and eyes to 'look around' the pitch (Williams & Ford, 2013), which is not accounted for in the laboratory studies. Equally important, these studies do not take sport specific situational constrains (e.g., opponent pressure) and possibilities (e.g., pitch position and body orientation) into account when making assumptions of the participants' perceptual expertise (Jordet, 2005a). The absence of this relevant information to performance results in eroded expert performance advantages (Craig & Cummins, 2015). Finally, most of the researchers investigating decision-making and anticipation among football players have registered non-sport-specific movement responses such as writing with pencil on paper (Ward & Williams, 2003), verbal responses (Roca et al., 2013; Williams et al., 1994), computer mouse moving (Williams et al., 1994), stepping on response pads (Williams & Davids, 1998), and multiple spheres selection (Faubert & Sidebottom, 2012; Romeas et al., 2016). In real game situations, football players need to move their heads and bodies to perceive information and get in position to execute actions, and the choice of action is often a good predictor for what the player perceived as possible in that situation (Eldridge et al., 2013). In addition, some of the researchers who have published results from perceptual studies conducted without any link between perception and action in the laboratory, have now stated that the key principles in perception development are perception-action coupling and contextual information as closely related to the sport context as possible (Broadbent, Causer, Williams, & Ford, 2015).

Field research, or real-world research, involves investigating a phenomenon in the context in which it naturally occurs (Jordet, 2005a). There is an urgent need to provide research with high ecological and external validity by supplementing laboratorial paradigms with field research (Araujo et al., 2006; Jordet, 2005a; Jordet et al., 2013). An observational field based study was implemented in the current study to examine world-class football players' visual exploratory behaviour in real football games. In real football games it is not possible to monitor the players eye movements, analyse the response time to a given stimuli, conduct verbal reports before or immediately after a decision is made, or occlude parts of the visual stimuli perceived by the players. Hence, the mapping of the internal cognitive processes is highly difficult (nearly impossible) and the cognitive theory of visual perception is not adequate to use or lean on in real football game research. In contrast, the ecological approach to visual perception emphasises the perception of the real world and the strong relationship between perception and action (Gibson, 1979). According to Seifert, Button, and Davids (2013) it is highly important to use an ecological dynamic framework when describing and understanding expert performance because this framework looks at the relationship between the performer and the environment. This opinion is supported in the current study, and the ecological approach to visual perception is implemented as conceptual framework.

2.2 Ecological approach to visual perception

"perceiving is an act, not a response, an act of attention, not a trigger impression, an achievement, not a reflex.". (Gibson, 1979, p. 149)

Professional football is extremely dynamic, complex, and information rich (Jordet et al., 2013). In order to learn more about how expert players perceive and act in real world game situations, Gibson's (1979) ecological approach of visual perception was implemented. In this thesis, four main perspectives from the ecological approach; perception of the real world, direct perception, affordances, and the visual system, will be addressed and contextualised in relation to expertise performance. Gibson (1979) is known as the founder of the ecological approach of visual perception, in which he tries to provide an understanding of perception of the real world (the natural visual perception) (Jordet, 2005a). Expert performers in sport have to adapt to the dynamic and complex performance environment on the pitch by continuously perceiving information and regulate goal-directed actions in accordance to that information (Davids, Araújo, Seifert, & Orth, 2015). The following quote illustrates how Gibson (1979) emphasised the importance of investigating perception in the real world;

> Let us remember once again that it is the perception of the environment that we wish to explain. If we were content to explain only the perception of forms or pictures on a surface, of nonsense figures to which meanings must be attached, of discrete stimuli imposed on an observer willy-nilly, in short, the items most often presented to an observer in the laboratory, the traditional theories might prove to be adequate and would not have to be abandoned. (Gibson, 1979, p. 239)

A central theme in the ecological science is the study of the organism-environment systems, and the information-based behavioural transaction between individual organisms and relevant performance properties of a specific environment, which includes surfaces, objects, niches, and terrains that constitutes the physical surroundings (Davids et al., 2015). In other words, the context (environment) is primary, and the most important variable to study is the unique relationship between environmental information and the individual pick up of this information (Jordet, 2005a). Gibson's (1979) idea of direct perception is that individuals' directly—as opposed to mediated—pick up environmental information.

> Direct perception is what one gets from seeing Niagara Falls, say, as distinguished from seeing a picture of it. The latter kind of perception is *mediated.* So when I assert that perception of the environment is direct, I mean that it is not mediated by *retinal* pictures, *neural* pictures, or *mental* pictures. *Direct perception* is the activity of getting information from the ambient array of light. I call this a process of *information pickup* that involves the exploratory activity of looking around, getting around, and looking at things. This is quite different from the supposed activity of getting information from the inputs of the optic nerves, whatever they may prove to be. (Gibson, 1979, p. 147)

The conception of direct perception has in the last decades been applied to the study of how action and perception regulate sport performance (Araújo & Davids, 2009). Forward and midfield football players are constantly surrounded by opponents and teammates (Jordet et al., 2013), creating a ambient optic array with relevant information. Skilled football players are constantly looking around the pitch (the ambient optic array) by moving their heads and eyes to perceive movements of opponents, teammates, and the ball (Williams & Ford, 2013). The structure of the ambient light specifies what information we perceive, which is not characterised in the organism, but by the specific pattern in the energy fields of the environment (Gibson, 1979). In other words, humans perceive and act on substances (e.g., grass), surfaces (e.g., football pitch), places (e.g., a football stadium), objects (e.g., a ball), and events (e.g., football match) in the environment (Araujo et al., 2006). These possibilities or opportunities to act is known as affordances, which is made up by Gibson (1979);

> The *affordances* of the environment are what it *offers* the animal, what it *provides* or *furnishes*, either for good or ill. I mean by it something that refers to both the environment and the animal in a way that no existing term does. It implies the complementarity of the animal and the environment (Gibson, 1979, p. 127)

The conceptual pillar of the ecological approach to perception and action in sport is the theory of affordances (Fajen, Riley, & Turvey, 2008). Providing a functional and meaningful specification of the events and objects available to perceive and act upon (Jordet, 2004). Affordances are the starting point of the study of what humans perceive, how they decide, act, know, and learn (Turvey, 1992). An individual's action capabilities in relation to the physical properties of a performance environment provide a veritable landscape of affordances in sport (e.g., a gap to pass the ball trough or turning opportunities) (Davids et al., 2015). Athletes who evolve and/or acquire expertise becomes gradually attuned to affordances that can support the achievement of performance goals (Davids et al., 2015). Hence, experts are more likely to perceive affordances that lead to the ultimate goal in the activity (Vicente & Wang, 1998). The abstraction hierarchy model describe goal relevant constraint in a problem domain (e.g. football) as a nested hierarchy of affordances, where higher levels (e.g. to score) are less detailed than lover levels (e.g. penetrating pass) (Vicente & Wang, 1998). In other words, the higher levels contain fewer important affordances than lower levels where one needs to explore more. Hence, at higher levels (e.g. to score) of the hierarchy, exploration becomes more constrained and determined which results in a more constant, economical and successful decision-making (e.g. finishing) (Araújo, Davids, Bennett, Button, & Chapman, 2004). Other animals, specifically other people provides the richest and most elaborate affordances of the environment (Gibson, 1979); "The perceiving of these mutual affordances is enormously complex and is based on the pickup of information in touch, odor, taste and ambient light" (Gibson, 1979, p. 135) .

The visual world is not a projection of the ecological world, but a outcome of the picking up of information by an exploring visual system, and the observer's awareness of his/her own body in the world is part of that experience (Gibson, 1979). The visual system is the most important part of the perceptual system, consisting of body, head, and eyes, used by observers to actively obtain information (Gibson, 1979). The highest level of exploratory activity is when the observer moves the body to obtain information, the next level is head turning, and the lowest level is movement of the eyes (Gibson, 1966). Low level explorations (eye movements) can only be understood in relation to the posture and movements of the head and body (Jordet, 2005a). Hence, exploratory behaviour with head and body movements within the performance environment enables the players to perceive key constraining information (Tedesqui & Orlick, 2015).

Finally, the ecological approach emphasises the strong relationship between perception, action and intention in each individual (Davids et al., 2015). For example, information perceived by a football player on the pitch is constrained by specific actions (e.g., when shooting or defending) and by intentions (e.g., to score or to win the ball back). A player's movement continuously creates information about new action opportunities as a result of the changing relationship with the performance environment (Davids et al., 2015). Prospective control is based on the player's perception of her or his current relationship to the environment (Montagne, 2005), and the perception of affordances allows the performer to prospective control his actions (Turvey, 1992). Hence, exploration is the key to prospective control (Adolph, Eppler, Marin, Weise, & Wechsler Clearfield, 2000).

Jordet (2004) argues that the critiques against the term direct perception in the ecological approach has emerged as a result of a misunderstanding, in which many cognitive researchers have argued that the ecological approach does not take memory or other cognitive processes into account. As an example, Williams et al. (1999) stated that the radical ecological proposition of Gibson (1979) suggests that humans do not need internally-represented, expert systems to make sense of the world. However, most ecological researchers do not deny the existence of cognitive processes nor that indirect perception (resorted from memory) is impossible, they merely assume that direct perception could reveal more valuable and functional knowledge without memory structures and the muddle of representations (Jordet, 2004). As an example, Gibson (1979) stated that his intentions simply was to emphasise perception as direct instead of indirect; "I meant (or should have meant) that animals and people sense the environment, not in the meaning of having sensations but in the meaning of detection" (Gibson, 1979, p. 149). His intention was not to imply that perception is an automatic response to a stimulus in the same way as a sense impression is, but rather that perceiving is an act of attention, an achievement and not a reflex (Gibson, 1979). Seifert et al. (2013) explained the link between the processes of perception and action, where the causality between brain and behaviour is cyclical, not linear, because of the continuous performance of goal-directed interactions made by the individual within the performance environment. Davids et al. (2015) addressed the characteristics of expertise in sport as a complex interweavement between cognition, perception, and action, where performers switch between independence of and dependence on environmental sources of information in performance. In a way that makes the emergent actions an intertwined process of perception, intention, and action, that are neither completely dependent on nor completely independent of environmental information (Davids et al., 2015). Consequently, it is fair to say that the critique against the term (direct perception) is little nuanced and that the premises that it is built upon is vague (Jordet, 2004).

2.2.1 Real world research

In the last decade, some researchers investigated visual exploratory behaviour among football players in real world football situations (Eldridge et al., 2013; Jordet, 2004, 2005b; Jordet et al., 2013). The pioneer of this type of real game research is Geir Jordet, professor at the Norwegian School of Sport Sciences. In the first study Jordet (2004) investigated a total of eight elite midfield football players spread over four different studies, with the intention to address the perceptual expertise of performers in complex and dynamic competitive team contexts. First, four international level soccer players were filmed close up with a high zoom video camera, with the intention to map the players' visual exploratory behaviour, and to understand how they use this to prospective control their actions. However, no link between performance and exploratory behaviour was found. In the second study, three of the four players in the first study were interviewed to learn more about how these players experience perceiving in order to prospective control their actions. The players reported that they engaged in extensive visual exploratory behaviour, attending to dynamic and complex information in order to map action opportunities before receiving the ball. In addition, players reported stress, playing style, and the ball as constraining factors for visual exploration (Jordet, 2004). In the third study, a longitudinal study of one football player over three years was conducted to investigate if and how exploratory activity was related to increased performance. Results revealed that players engaged in more extensive visual exploratory behaviour in high-performance period, where they were more oriented toward the opponent goal and hade a higher visual exploratory behaviour than in the lower performance periods. Hence, one can infer that the players' exploratory behaviour, prospective control and performance are positive related (Jordet, 2004). The final study of Jordet (2004) was rewritten and published in 2005. In this study, three elite football players used imagery training over 10 to 14 weeks to see if it affected the players' visual exploratory behaviour and their prospective control of further actions (Jordet, 2005b). Two of the players increased their visual exploratory behaviour, but only one increased the performance with the ball. However, all participants reported that exploratory behaviour is highly important for performance in football, and that the intervention hade improved their perception and performance with the ball (Jordet, 2005b). A reason for the low degree of effect of visual exploratory behaviour on performance in these first studies conducted by Jordet (2004, 2005b) may be the use of a very subjective scale for performance, ranging from one (poor) to seven (good).

In the latest research Jordet et al. (2013) used close up footage from the Sky Sport player cam broadcast of English Premier League (EPL) players to investigate the relationship between visual exploratory behaviour and performance. A total of 118 midfield and forward players (1,279 situations) were analysed. Visual exploratory behaviour was counted in the 10 seconds period prior to receiving the ball and the following action was analysed. In this study Jordet et al. (2013) used a more objective measure for performance, pass, and forward pass completion. The results revealed that players who explore much completed more passes and forward passes than players who explore less. This remained largely significant under different game conditions (attacking half and defensive half), and across different positional roles (forwards and midfielders). Hence, it seems to be a positive relationship between visual exploratory behaviour and performance with the ball in one of the best football leagues in the world (Jordet et al., 2013).

Eldridge et al. (2013) investigated the relationship between visual exploratory behaviour and performance among three male youth midfield football players, when receiving the ball in the middle third of the pitch. The study used the same definition of visual exploratory behaviour as Jordet et al. (2013) but did not estimate the exploratory behaviour frequency, they only registered if the players executed exploratory behaviour or not. Players were filmed in 20 minutes in five nine versus nine training games, played on a 60 yard by 40 yard pitch. The results revealed that the players performed more turns, executed more passes into the attacking half, experienced less defensive pressure when receiving, and performed more forward passes when performing visual exploratory behaviour prior to receiving. Coaches should focus on visual exploratory behaviour in their daily work with young athletes, encouraging them to conduct this behaviour as it may enhance players' technical and tactical aspects of performance (Eldridge et al., 2013).

This study was conducted to examine how world-class midfield and forward players used their visual exploratory behaviour to prospective control their actions prior to receiving the ball from a teammate. A hypothesize is that these players' engage in visual exploratory behaviour to adapt and control movements in relation to the action opportunities, which leads to better performance with the ball. The aim is to examine the relationship between visual exploratory behaviour and subsequent performance with the ball among world-class players in UEFA Champions League group stage games. Second, the relationship between visual exploratory behaviour and environmental characteristics (opponent pressure, pitch position etc.,) was analysed. Finally, each of the visual exploratory behaviours (searches) were further analysed to examine the timing of the searches as well as the development of performance condition (opponent pressure, position in space, body orientation etc.) from one search to the next.

3. Method

3.1 Participants

The participants were eight male midfield and forward football players (M = 31.5 years, SD = 3.25). Consisting of five midfield players; Xavi Hernández, Andrés Iniesta, Luca Modrić, Ivan Rakitić, Steven Gerrard, and three forward players; Lionel Messi, Cristiano Ronaldo, and Zlatan Ibrahimović, A letter was sent to the players' respective clubs, containing information about the study, as well as an opportunity for the players to respond to the letter if they did not want their names to be published. None of the players responded. This letter was a requirement from the Norwegian Centre for Research Data (NSD) and was sent in order to ensure that the publication of the players' names and the research was carried out in line with the ethical guidelines (see Appendix D). Each year a total of 26 players are nominated (on the basis of their performances during that season) to the prestigious FIFA Ballon d'Or (best player in the world) award, representing the absolute best 0.00001% of the players worldwide. All participants' were nominated at least one time (see Table 1), and are considered to represent world-class level of football expertise in their respective playing positions. A total overview of their impressive merits is represented in Appendix A.

3.2 Real world field study

Real world research, or field studies, involves investigating a phenomenon in the context where it naturally occurs (Jordet, 2005a). It is important to explore where the "facts" came from, the baseline of the assumptions about these facts and the constructions we place on them (Vealey, 2006). Researchers' have argued for the need to conduct research with high external and ecological validity (Araujo et al., 2006; Jordet, 2004; Jordet et al., 2013). Hence, an observational field based study was implemented. This may result in some sacrifices of control, internal validity, and experimental elegance (Jordet, 2005a). Simultaneously it is a prevention of the low external validity in laboratory research, which at best is limited to predict behaviour in other laboratories (Martens, 1979). Another concern is the need to gain access to working environments where the agenda of gatekeepers may not be the same as that of researchers (Gray, 2013). The demanding road to gain access to the players in the current study is elaborated in the 'getting access to the players' section below.

Being a real-world study the external validity is often strong as a result of no manipulation of independent variables, which is important as a foundation for rigorous and systematic hypotheses testing (Gray, 2013). The problem in real-world (observational) studies is often weak control of confounding factors and low precision of measurement (Carlson & Morrison, 2009). As an example, UEFA Champions League (CL) games receive enormous media and publicity, and the clubs', coaches' and teammates' desire to advance to the knock out stage is high. This may lead to a higher experience of pressure prior to these matches than regular league games. As an example, Lionel Messi was asked before the CL final in 2015 what the CL hymn meant to him; *"it is actually pretty nice when you are on the pitch and you listen to it you then know that it is an important, different, and special match."* (UEFA, 2015). The players' experiences of pressure, excitement, anxiety, and focus beforehand and during these games are most likely not the same as in regular league games, which may be a confounding factors for visual exploratory behaviour, decision-making, and performance. In addition, the teams play one home and one away game against each opponent team in the group, which often results in long travels to other countries. To eliminate the confounding factor of playing away in other countries, a deliberate attempt was made to only film players at home. This resulted in six out of eight players' filmed at home.

3.3 Procedure

3.3.1 Multidimensional concept of expertise

The main aim of this project was to investigate some of the absolute best midfield and forward football players in the five best football leagues in the world (German Bundesliga, English Premier League, Spanish La Liga, Italian Serie A and French League 1). A multidimensional conception of expertise was implemented to select these players. This conception involved at least three components:

1) Experts have to compete and perform at the highest level of play, such as in the top five leagues, or in the UEFA Champions League (CL). High levels of play make it more difficult for players to compensate for shortcomings in one area with strengths in other areas (Jordet, 2005a). Hence, by investigating the players in CL matches we increase the likelihood that their level of perceptual expertise is at a sufficient level.

2) Level of expertise is dynamic, not static; It can change over time as a result of training, development and other factors (Jordet, 2005a).

3) Expertise involves specific and different sets of skills. Skills like dribbling, passing, and goal scoring are thought to be more related to perceptual and cognitive advantages than other skills (Jordet, 2005a).

For a player to be included in this study he hade to be nominated to the FIFA Ballon d'Or (FIFA player of the year) award at least one time in his career. This award was used as golden standard to ensure that the expertise level of the participants was as high as possible. In addition, top 20 player statistics based on performance the last two seasons (2012/2013 and 2013/2014) was obtained from the top five leagues. These lists were developed for the skills considered related to perceptual and cognitive advantages (Jordet, 2005a); total amount of passes, pass completion, key passes, total amount of goals and assists throughout each season, retrieved from WhoScored.com (2014). This webpage uses Opta data (one of the leading football analysis cooperation in the world) when representing the player statistic. All appearances made by the player on the different top 20 lists were registered and summed up (see Appendix B for overview table). By using these two parameters to elect the players, we have ensured that these players current level of performance represent the absolute highest level of expertise for their respective playing positions.

Table 1: *Overview of the included players appearances on FIFA Ballon d'Or (www.fifa.com), as well as the appearances on top 20 players statistics in the top five leagues over two seasons (www.whoscored.com).*

FIFA Ballon d'Or (FIFA Player of the Year) 2005-2015						
Player	1 place	2 place	3 place	Top 10	Nominated	Total
Messi	5	4	-	-	-	9
Ronaldo	3	4	1	1	-	9
Xavi	-	-	3	1	1	5
Iniesta	-	1	1	5	1	8
Gerrard	-	-	-	4	-	4
Zlatan	-	-	-	2	2	4
Modric	-	-	-	-	1	1
Rakitic	-	-	-	-	1	1
Sum	8	9	4	35	5	41

Appearances on top 20 player lists 2012-2014						
Player	Goals	Assist	Key passes	Pass accuracy	Total passes	Total
Messi	2	2	1	-	1	6
Ronaldo	2	2	1	-	-	5
Xavi	-	1	-	2	2	5
Iniesta	-	2	-	2	2	6
Gerrard	1	2	2	-	2	7
Zlatan	2	2	2	-	-	6
Modric	-	-	1	2	1	4
Rakitic	-	1	2	-	1	4
Sum	7	12	9	6	9	43

Note: FIFA Ballon d'Or table: Nominated = when the player was nominated lower than top 10.

3.3.2 Getting access to the players

Professional football is regarded as a notoriously closed world, hostile to outsiders who have not been involved in or played at a high level (Waddington, 2014). This was something the current study would experience first handed. World-class players are worldwide "superstars" and extremely difficult to get access to, which probably is the most important reason that really high level experts rarely have been examined (Jordet, 2004). The players in the current study play for the biggest football clubs, where confidentiality is high and little insight are provided for outside parties. A request to film the included players was sent via the Football Association of Norway, on behalf of the project, to the players' respective clubs. Most of the clubs rejected our request, while others referred to the National Football Association (NFA) that had the broadcast rights at all games. We contacted NFA where the response at first was more positive, but the process was very elaborate and it ended with no access. As a last resort, we sent a request to film the included players in eight UEFA Champions League (CL) group stage matches (2014/2015 season). The response was positive and the UEFA central board granted access to all the requested matches. Six months were spent between sending the first letter and the filming of the first player, which indicates how difficult it is to access these players.

Following the approval by the central board we were set in contact with the UEFA Club Competitions Commercial Operations Manager (CCCOM), which controls the media coverage of UEFA CL games. Two weeks prior to each game we contacted CCCOM to ensure that the space and accreditation needed to conduct the close-up footage was granted. In four of six games CCCOM was the chief Venue Operator and Broadcast Manager (VOMB). In the two other games another VOMB was instructed by the CCCOM to ensure that accreditation and space was granted at the match venue. When arriving at the venues the accreditation was collected at the main UEFA Office were the VOMB delegated another UEFA employee to guide me to the filming position. The position was close to the main broadcast camera, located on the midfield line (centrally) and high on the tribune. One and a half hour prior to kick off, I attended the UEFA TV Meeting, where all the media companies covering the game are gathered and the VOMB undergoes the camera logistics and the time schedule prior to, during, and after the game. Immediately after the meeting, the VOMB informed me about the starting line-ups for both teams. This was an important contribution to the project, enabling me to establish a priority list of players before kick off, ensuring that players were filmed chronologically in accordance to the list. The player on the home team who started the game with the highest amount of appearances on the inclusion criteria list (see Table 1) was filmed first. If the home team did not have any included players the player on the away team with the highest amount of appearances on the inclusion criteria list was filmed first. Thanks to the service and camera position provided by the VOMB's on the venues, the close-up videos are conducted with the highest possible quality.

Champions League group stage games receive a lot of media attention, and when some of the best teams play against one another to play for the advancement to the knock out phase the media pressure is tremendous. This resulted in some changes in the original match access granted by the central board because when the media pressure was too high, then the space needed to conduct the close-up video was unavailable. Hence, a total of six games were attended, three of these were on the original list and the remaining three was given as alternatives when the access was not granted at the original game. In five of the games this was not a problem in relation to which player to film because all five games contained players who were included in the study. However, in one game as a result of injuries no midfield or forward players met the inclusion criterion and in agreement with my supervisor the two players filmed in this game are excluded. The purpose with this study was to investigate VEB among only the best midfield and forward players in the world, so to ensure that the level of all included players was sufficiently high and to uphold the clean elegance of the study these two players was excluded.

3.4 Data Collection

A high zoom (10x optical and 2x digital zoom) Canon XA10 AVCHD video camera was focused solely on one player one half (45 minutes) at a time in order to obtain detailed close-up footage of the player's head and body movements (see Carling, Bloomfield, Nelsen, & Reilly, 2008; Eldridge et al., 2013; Jordet, 2005b; Jordet et al., 2013). Because of match factors such as substitution and lack of other included players on the pitch, the total minutes of close-up video footage of each player varies from 17 to 135 minutes (M = 56 minutes). The players were filmed from a high central position on the long side of the pitch, from the camera platform next to the main broadcast camera. After each game the broadcast video of the general game events was downloaded with the highest resolution possible (HD 1920 x 1080, 50i) from Wyscout.com (2014).

3.4.1 Split-screen footage

In order to analyse both the players behaviour/actions and the game events in each situation, the close-up video was synchronised and edited together with the broadcast footage from the game by using Sony Vegas Pro 13 video authoring application. This editing created a high definition (HD 1920 x 1080, 50i = 50 frames per second) split-screen video. Where the analysed player is depicted on the right side and the general game events (broadcast footage) is depicted on the left side (see Figure 1). Similar types of edited films have been used in several football research studies (see Carling et al., 2008; Eldridge et al., 2013; Jordet, 2005b; Jordet et al., 2013). This type of video is very convenient, enabling us to analyse the player's behaviour in relation to the game event simultaneously.

Figure 1: *Illustration of the split-screen images that where used to analyse visual exploratory behaviour. The overview footage (left side) and the close-up video (right side) was synchronised down to two hundreds of a second. This illustration is in line with the guidelines from NSD and does not violate the terms from UEFA.*

3.5 Situation inclusion criteria

The players were involved with the ball 338 times, and from these 269 situations were included for analysis. For a situation to be included, the participant had to receive the ball from a teammate. This is not the same inclusion criteria as used in Jordet (2005b, p. 146) and Jordet et al. (2013, p. 2) where "the player has to receive a pass from a teammate located closer to his team's own goal than the participant, which would make it relevant to engage in some type of exploratory behaviour to see what is behind his back" This inclusion criteria developed by Jordet (2005b) is logical and beneficial to use, because situations where the analysed player receives the ball with all relevant information located in front of him is excluded. It is hypothesized that it is less relevant for players' to engage in VEB to perform optimally in these situations (Jordet, 2005b; Jordet et al., 2013). However, this inclusion criterion has some implications and limitations. First, by using this inclusion criteria the researchers' hypothesize that some situations are more relevant to analyse than others and many situations have to be excluded. As an example, Jordet (2005b, p. 146) excluded 1033 (65,8%) of 1569 situations where the analysed players were involved with the ball. Second, researchers must support the method used with empirical evidence, and this inclusion criterion is not reasoned or justified on empirical evidence, it is simply developed by the authors' assumptions on when it is particularly beneficial for players' to engage in VEB. With the new inclusion criteria developed in the current study, over 80% of the players' ball involvements were included, and no assumptions about when it is beneficial to engage in visual exploratory behaviour limited the analysis. In addition, the earlier assumptions developed by Jordet (2005) is accounted for by registering the players' position when receiving the ball (see variable overview below). This makes it possible to analyse all the players' offensive ball involvements, and which receiving positions the players' perform most VEB. As an example, the results have provided empirical evidence that players' have a higher average (not significantly) visual exploratory behaviour frequency (VEBF) in situations where they perceive the ball closer to their own goal and in a neutral position compared to when they receive the ball closer to the opponent goal or towards the sidelines. This indicates that it is just as beneficial to engage in VEB in the situations with the new inclusion criterion as in situations with the inclusion criterion developed by Jordet (2005b). However, the situations that meet earlier inclusion criterion are also analysed in the current study to make it possible to compare some of the results with earlier findings. With Jordet's (2005b) inclusion criteria 163 of the original 269 situations were included. For both inclusion criteria, situations where the analysed players execute a set piece (n = 14 situations) or duels to win the ball (defensive situations) are excluded (n = 38 situations), because the visual exploratory behaviour is not analysed when the player is in possession of the ball (set piece) or when defending. Likewise, all situations where a teammate executed a clearance or a set piece that forced the analysed player to engage in a head duel against one/several opponent players are excluded (n = 6 situations). Head duel situations are excluded because of the player's limitation of action opportunities with the ball when "receiving" it (you either take the dual or you do not). In some situations the broadcast footage contains replay of game events, close-up of coaches and players, resulting in loss of game event information and are therefore excluded (n = 11 situations).

The main analysis is conducted on the two inclusion criteria described above. In addition, a secondary analysis was conducted, where the timing of each VEB (search) executed in the included situations (from the new inclusion criteria) was registered. The included situations where the player did not perform any VEB (0 searches) are not included in the search analysis (n = 20 situations). In addition, due to irregular broadcast footage (replay of situations etc.,) some of the general game events needed to register the timing of the player's search were missing (n = 33 searches). Hence, a total of 851 searches were registered in 249 situations.

3.6 Dependent Variables

An attempt to find a good objective performance measurement tool for midfield and forward players was made by searching in several databases (Web of Science, Sport Discuss, Scholar, Brage etc.), but was not found. Several football analysts with broad knowledge and experience were questioned and used as consultants in the proses of developing variables that were in line with the football performance guidelines provided by Mackenzie and Cushion (2012). Additionally, a set of objective performance and behavioural variables that has been used and tested was obtained from previous research. Two sets of variables were developed: i) one for the main analysis where VEB were registered and the situation was analysed in detail (performance with the ball, opponent pressure etc.,), and ii) one for the analysis of the players timing of each VEB. i) The main analysis variables (n = 82 variables, see Appendix F for overview) were developed to map the relationship between VEB and other variables which where applicable for each situation (performance, pitch position, action direction, opponent pressure etc.,). ii) The VEB (search) timing variables (n = 37 variables, see Appendix G for overview) were developed and used to analyse each search the players' executed in these situations with the intention to map the players' timing of each search in relation to the position of the ball. Additionally, in the moment a search was initiated different situational characteristics (pitch position, position in space, opponent pressure, body orientation etc.,) were registered. The total analysis (with both sets of variables) consisted of 119 variables resulting in a total of 53,730 variable registrations. For the present thesis only the variables related to the aims of the study are included and presented below. A complementary explanation for the large data material conducted in the analysis is presented in the introduction of the results.

Comprehensive operational definitions are provided to avoid high variance and subjective measurements of the variables investigated in the study (Mackenzie & Cushion, 2012). In addition, some established thresholds have been adopted from previous research, enabling comparability of findings (Mackenzie & Cushion, 2012). Visual exploratory behaviour is the main variable in the current study, and the definition and registration of this variable is first presented. Second, the variables from the main analysis are defined, followed by the VEB timing variables.

The definition of visual exploratory behaviour was adopted from Jordet et al. (2013), which was developed based on the original perceptual conceptions of Gibson (1979) and Adolph et al. (2000). This variable is defined in the same way in both sets of variables:

> A body and/or head movement in which the player's face is actively and temporarily directed away from the ball, seemingly with the intention of looking for teammates, opponents or other environmental objects or events, relevant to perform a subsequent action with the ball. (Jordet et al., 2013, p. 2)(see Figure 2).

Figure 2: Visual exploratory behaviour (search). *The player is looking at the ball in the first and last image and executes a visual exploratory behaviour in the three images in the middle. This illustration is in line with the guidelines from NSD and does not violate the terms from UEFA.*

Visual exploratory behaviour (VEB) was registered in the 10 seconds leading up to the player receiving the ball and one VEB is synonymous to one search. When the ball was put into play from a sett piece within that 10 second period, we started registering VEB four seconds prior to the execution of the sett piece, with the intention to register how the players' explore the ambient array when the ball was out of play. In the situations were the ball was turned within the 10 second period, we started registering VEB when the opponent player lost possession of the ball. Finally, if the analysed player passed the ball to a teammate and received it again within 10 seconds (without any opponent players intercepting) we started registering VEB when the analysed player passed the ball. For all situations we stopped registering the VEB of the player in the immediate time he received (touched) the ball.

<u>Main analysis variables (see appendix F for complete overview):</u>

1. **Visual exploratory behaviour frequency (VEBF)** was assessed by dividing the total number of exploratory searches registered in one situation with the total number of seconds in that situation (Jordet, 2005b; Jordet et al., 2013). The time interval varied from situation to situation, making it necessary to make the number of searches relative to time, which provided a fundamental measure of the extensive exploratory activity of the players'(Jordet, 2005b). The VEBF was later merged into three search categories; Little = 0.00-0.30 searches per second. Some = 0.31-0.59 searches per second. Much = 0.30-3.0 searches per second.
2. **Position when receiving from teammate** were registered as the analysed player's position when receiving the ball in relation to the position of the teammate that passes the ball to him, which was used as reference point. 1) Closer opponent goal = when the analysed player received the ball closer to the opponent goal. 2) Neutral position = if the distance to the opponent goal does not differ between the position to the passing teammate and the receiving position to the analysed player. 3) Closer own goal = when the analysed player receives the ball closer to his teams own goal. 4) Longer away from opponent goal = when the analysed player receives the ball longer away from the opponent goal but not closer to his teams own goal (typically situations where the player receives the ball towards the sidelines). This variable is inspired by and developed on the inclusion criteria used in Jordet (2005b, p. 146) and Jordet et al. (2013, p. 2).
3. **Body orientation** was registered as the direction of the anterior (frontal) side of the coronal plane of the player's body (thoracic/chest and coxa/hip) in relation to the attacking direction. Coxa was used as reference in case of doubt. The analysed player's body orientation was registered four times for each situation. 1) When the teammate passes the ball, 2) in the first touch of the ball, 3) in the second touch of the ball and 4) in the final touch of the ball. Definitions:
   a. Forward oriented is when the player's anterior side is directed toward the opponent goal line, with the back directed toward his own goal line.

b. Backward oriented is when the player's anterior side is directed toward his own goal line, with the back toward the opponent gaol line.

c. Sideward oriented is when the player's anterior side is directed toward one of the sidelines.

4. **Opponent pressure** was registered as the distance between the player and the closest opponent, measured in meters (Jordet, 2004, p. 129). Body contact between the player and an opponent was registered as 0 meter, and 0.5 meters when the pressure was tight but no body contact. From 0.5 meters the opponent pressure was estimated in whole meters. This was later categorised into; No pressure > 5m, loose pressure 3-5m and tight pressure 0-2m. Opponent pressure was registered four times for each situation. 1) When the teammate passes the ball, 2) in the analysed player's first touch of the ball, 3) in the second touch of the ball and 4) in the final touch of the ball.
5. **Pitch zones and corridors;** is the subdivisions (N = 18) of the football pitch, obtained from Tenga, Kanstad, Ronglan, and Bahr (2009, p. 16). These subdivisions were used to register the position; of the passing teammate, where the player receives the ball, where he executes the final action and where the ball ends up after the final action. These pitch zones and corridors were later categorized as first area own half (first third), midfield area own half (midfield 1), midfield area opponent half (midfield 2), assist area (final third excluded score box) and score box area (score box) (see right side of Figure 3, and Appendix F for definitions).
6. **In between opponent section;** The opponent sections consist of attacking line, midfield line, and defensive line. This variable registers the player's position in between these sections when he receives the ball and when he executed the final action (see left side of Figure 3, and Appendix F for definitions). This is an refined English version of the original version developed by Bergo, Johansen, Larsen, and Morisbak (2002, p. 125).
7. **Action;** The player's first (e.g. receiving) and final (e.g. passing) action, as well as the result of the final action (e.g. complete/not complete) is registered for each situation (see Appendix F for definitions).
8. **Action direction;** The player's action direction with the ball is registered as forward (toward opponent goal line), backward (toward own goal line) and sideward (toward the sidelines).

9. **Hierarchical choice of action;** The players' attempt with the final action was registered on a hierarchical football action scale developed by the authors. The intention to score (1) is defined as the top of the model, and the downward scale from there is; pass/dribble into score box (2), pass/dribble into assist area (3), penetrating pass/dribble (4), forward pass/dribble (5), maintain possession (see Appendix F for complementary explanation). The score box area is defined in figure three, and the assist area is the final third area in figure three (score box area excluded).

VEB timing variables (see appendix G for complete overview):

1. **Situation type:** is defined as the characteristics of the ball possession before the analysed player receives the ball. There are four types of situations that are included in the analysis.
   a. **10 seconds in team** is registered when the analysed players' team is in possession of the ball 10-seconds or more prior to receiving the ball. In these situations the analysis starts 10second prior to receiving, which is the standard situation.
   b. **Turn over (opponent lost possession)** is the situations where the opponent team looses the ball in play to one of the analysed players teammates, and the analysed player receives the ball from a teammate within 10 seconds. If the possession of the ball is maintained in the team for 10 seconds or more before the analysed player receives the ball, it's registered as situation one.
   c. **Wall pass with teammate** is the situations where the analysed player plays the ball to a teammate and gets it back from a teammate within 10 seconds, without loss of possession in between. If the possession of the ball is maintained in the team for 10 seconds or more before the analysed player gets it back it is registered as situation one.
   d. **Set piece** involves all situations where the analysed player receives the ball from one of his teammates set pieces (corner, throw-in, free-kick, goal kick etc.). If the set piece is taken 10 seconds or more before the analysed player receives the ball, it is registered as situation one. The time interval in the set piece situations starts four seconds before the set piece is taken.
2. **Timing of VEB (search):** is the registration of the player's initiation of each search in relation to the ball position. When the ball is not in touch with any

players, it is called a transfer phase, because the ball transfers from one player to another or from one touch to another touch. These phases are measured in time and are divided in three equal time intervals to investigate in which phase of the transfer the player decides to initiate a search. The player can initiate the search at several occasions, and a map of these occasions is described below. However, it is important to know that this map must be analysed in relation to variable 1 since some of these ball positions is not applicable across situations (see Appendix F for a complementary explanation). In total, a search can be initiated and registered in one out of 23 possible ball positions:

- **a.** Search (VEB) initiated when opponent loses possession of the ball, and the player's team wins the ball in the next ball contact
    - i. Search right after opponent player looses the ball (phase 1)
    - ii. Search in the middle of ball transfers from opponent to teammate (phase 2)
    - iii. Search right before teammate receives the ball (phase 3)
- **b.** Search (VEB) initiated in the four second period prior to the teammate's execution of the set piece, or search in the execution of the set-piece
    - i. Search early in the four second period (phase 1)
    - ii. Search in middle of four second period (phase 2)
    - iii. Search right before set piece execution (phase 3)
    - iv. Search in set piece execution
- **c.** Search (VEB) initiated when teammate is in touch with the ball:
    - i. Search in teammate's first touch
    - ii. Search in teammate's last touch
    - iii. Search in teammate touch (not first or last touch)
- **d.** Search (VEB) initiated when the ball transfers between a teammates touches
    - i. Search right after a teammate has touched the ball (phase 1)
    - ii. Search in middle of the ball transferring from one touch to the next (phase 2)
    - iii. Search right before teammate touches the ball again (phase 3)
- **e.** Search (VEB) initiated when the ball is passed (transfers) between teammates
    - i. Search right after teammate passes the ball (phase 1)

ii. Search in the middle of the pass (phase 2)
iii. Search right before another teammate receives the ball (phase 3)

f. Search (VEB) initiated when the ball is passed (transfers) between teammate and analysed player

i. Search right after teammates passes the ball (phase 1)
ii. Search in the middle of the pass (phase 2)
iii. Search right before analysed player touches the ball

g. Search (VEB) initiated when the analysed player receives the ball

h. Search (VEB) initiated when the ball is passed (transfers) from analysed player to another teammate

i. Search right after analysed player passes the ball (phase 1)
ii. Search in the middle of the pass (phase 2)
iii. Search right before teammate receives the ball (phase 3)

i. Search impossible to register due to incomplete broadcast footage.

3. Defensive pressure: was registered as the distance between the player and the closest opponent, measured in meters (Jordet, 2004, p. 129). Body contact between the player and an opponent was registered as 0 meter, and 0.5 meters when the pressure was tight but no body contact. This variable was registered in the immediate moment each search was imitated.

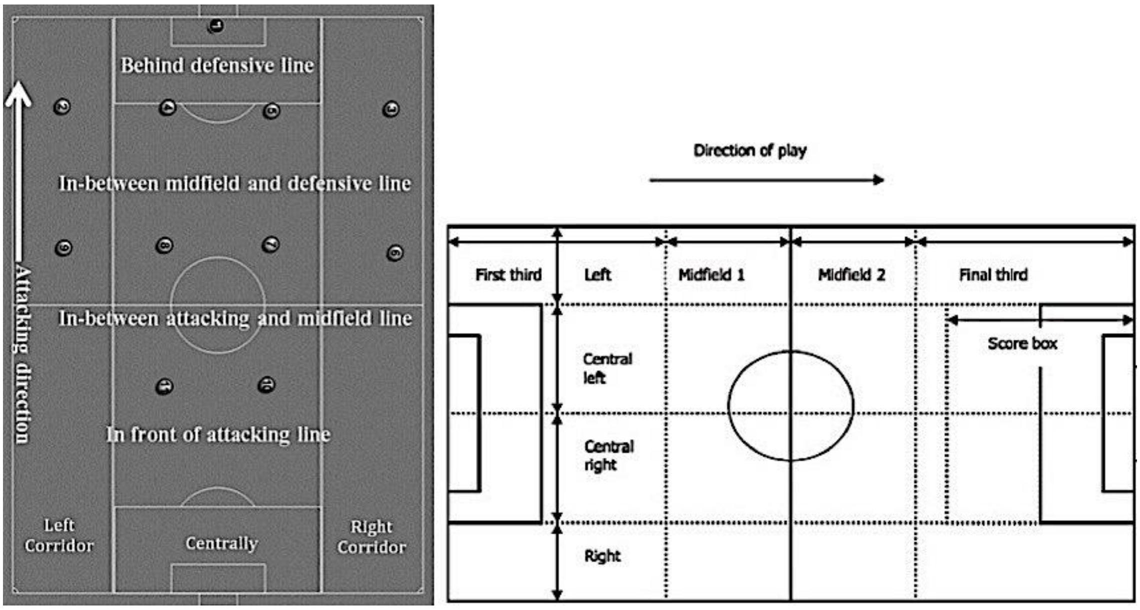

Figure 3: Left side: *Pitch illustration of the sections in-between, in front of and behind the opposition line-up (Exemplified with a 4-4-2 line-up).* ***Right side:*** *Subdivisions of the pitch, divided in five Zones: first third, midfield 1, midfield 2, final third and score box. While corridors included right, central right, central left and left.* Note. Right side of figure is retrieved from Developing a New Method for Team Match Performance Analysis in Professional Soccer and Testing its Reliability, by A. Tenga, D. Kanstad, L.T. Rongland & R. Bahr 2009, *International Journal of Performance Analysis in Sport, vol 9, s.16.* Reprinted with permission from Albin Tenga, see Appendix E.

3.7 Data analysis

The split-screen video was first edited in iMovie 10.1, where each included situation was cut into separate video files with the highest possible quality (HD, 1920 x 1080, 50i = 50 frames per second). These situations (video files) were further analysed in QuickTime Player 7, which made it possible to analyse the player's behaviour frame by frame with a two hundreds of a second accuracy (one frame equals 0.02 seconds). This was specifically helpful when analysing the player's timing of each search where time registration variables could be measured with a high accuracy. By typing the frame codes of specific events into Microsoft Excel, the algorithms calculated the exact timing of the search in relation to the ball position (see Appendix H for an illustrations of a small part of the Excel file). Two data files were developed in the statistical program IM SPSS version 21, one for the main analysis variables and one for the VEB timing analysis variables. The statistical analysis conducted on the two data files is addressed below. Further, inter-observer reliability test was conducted on the main analysis variables, but not for the VEB timing variables. Due to the magnitude of variables in the two data sets the inter-observer reliability test for 10% is extremely time consuming. The external analyst had only one week to conduct the inter-observer reliability test. Because of the limited time and since most of the variables in the VEB timing analysis is identical to the variables in the main analysis we decided to the test main analysis variables. Had the analyst completed the test on all variables in both data sets he would have used about three weeks. The inter-observer test is further elaborated below.

3.7.1 Inter-Observer reliability

The first author analysed all the situations and one analyst independently analysed 10% of these situations with the main analysis variables. The analyst was a UEFA B licence coach, with a Bachelor degree in Football Coaching and Psychology where he completed a football analysis course and wrote his Bachelor assignment about football match analysis. He was given a two day training session on how to use the technical tools and an introduction of the variables that were used in the data collection process, as well as an visual aid outlining the action variables (Eldridge et al., 2013). The analyst used five days to complete 10% of the situations. Due to the magnitude of variables and the time constrains of this thesis we considered the 10% Inter-Observer test to be adequate. Reliability of measurement in performance analysis is critically important in the area of sport science (Bloomfield, Polman, & O'Donoghue, 2007b). As long as a human is a part of the measurement instrument it can result in inaccurately data entering due to the subjective nature of movement recognition (Bloomfield et al., 2007b). It is therefore important to test the variables by calculating the inter-observer agreement. In addition, it is important to assess the most appropriate inter-observer reliability test to the different types of analysis (Caro, Roper, Young, & Dank, 1979). Two common Inter-Observer reliability (IOR) tests used in studies with observational data is the Cohen's Kappa for nominal variables and the Interclass Correlation Coefficient (ICC) for ordinal, interval and ratio variables (Hallgren, 2012). Hence, for the categorical (nominal) variables the Kappa coefficient of agreement between observers is assessed and for the continuous (ratio) data the interclass correlation coefficient (ICC) of agreement between observers is assessed in the current study. The Kappa coefficient corrects for the agreement of chance (Cohen, 1968), and is a measure of "true" agreement between two observers registrations of categorical data (Sim & Wright, 2005). The kappa coefficients (k) values strength of agreement was interpret as very good (0.81-1.00), good (0.60-0.80), moderate (0.41-0.60), fair (0.21-0.40) and poor (<0.20) (Altman, 1991, p. 404). This kappa scale is used in several football analysis studies the last decade (Bloomfield, Polman, & O'Donoghue, 2007a; Bloomfield et al., 2007b; Tenga et al., 2009). The ICC incorporate the magnitude of disagreement between two observers and is one of the most commonly used statistics for assessing IOR for interval, ordinal and ratio variables (Hallgren, 2012). Where small-magnitudes of disagreement between observers result in a higher ICCs than larger-magnitudes of disagreement, which result in lower ICCs. The ICCs values strength of agreement was interpret as very good (0.90-1.00), moderate (0.80-0.89), acceptable/fair (0.70-0.79) and questionable/poor (<0.70) (O'Donoghue, 2012, p. 364).

The inter-observer strength of agreement was very good for visual exploratory behaviour (*ICC* = 0.99), situation time interval (*ICC* = 1), visual exploratory behaviour frequency (*ICC* = 0.97), opponent pressure (*ICC* = 0.97), body orientation (k = 0.89), pitch zones and corridors (k = 0.92), first and final action with the ball (k = 1), result of final action (k = 0.93), action direction (k = 0.93) and hierarchically choice of action (k = 0.90). Position in opponent section when receiving (k = 0.76) and position in opponent section in last touch of the ball (k = 0.77) were considered moderate. Some of the situations contained extremely subtle and quick exploratory movements and/or complex game situation that potentially was difficult to follow, and the disagreement between the analyst and the first author was rarely more than one count or one point on the scale, which is considered adequate (Jordet, 2005b).

3.7.2 Statistical analysis

All variables were registered in the statistical program IM SPSS version 21. The frequency analysis revealed that the data was not normally distributed and nonparametric tests was implemented, these tests have no assumptions of the distribution of the dependent variable (O'Donoghue, 2012). The Mann-Whitney U and Kruskal-Wallis H test was used to explore differences between groups and conditions, significance level was set at $p < .05$. When different participants were used in each of the two conditions, Mann-Whitney U test were used to test the difference between the conditions (Field, 2009). The comparison is based on ranked data, where the original (ordinal, interval or ratio scale) data are ranked from lowest to highest (i.e. the lowest score is ranked 1 and the next lowest is ranked 2 and so on) and the sum of the ranks for each of the two independent samples is compared. To illustrate the difference between the two samples the test statistics (*U* values) and significance level (*p* value) was reported (Field, 2009). The Kruskal-Wallis H test uses the same ranking method (as the Mann-Whitney U test) to compare three or more independent samples in terms of some dependent (ordinal, interval or ratio scale) variable (O'Donoghue, 2012). A chi-square distribution and significance level is provided by the test to illustrate the differences between the independent samples (Field, 2009). In the Kruskal-Wallis test the original *p* value (.05) is adjusted by dividing it on the number of pairwise comparisons conducted in the test. This is done with the intention to restrict the probability of making a Type 1 Error (O'Donoghue, 2012). In SPSS this adjustment of the *p* value is automatically calculated and interpreted in the Kruskal-Wallis test. This is done in a way that makes it possible to still operate with the significance level set at *p* .05. So all the results provided in this thesis from Kruskal-Wallis tests are shown with the adjusted *p* value, where the difference is significant if the *p* value is below .05. Additionally, some results are presented without an adjusted *p* value, but these exceptions are noted in the text.

Binary logistic regression analysis is used to test the likelihood of a categorical outcome variable to belong in a continuous or categorical predictor variable (Field, 2009). Logistic regression have no assumptions about the distribution of the predictor variables (O'Donoghue, 2012). The Binary logistic regression directly describes the response probability in the outcome variable when the predictor is changed. Odds Ratio (*Exp(B)*) is often viewed as a useful measure of effect size for categorical data, and is an indicator of change in odds when the predictor changes with one unit (Field, 2009). Hence, the *p* values and the Odds Ratio (OR) provided by the Binary logistic test is presented in the results. Finally, chi square goodness of fit test was used to test if the players' distribution of each visual exploratory behaviour (timing of each search) differs from a theoretically distribution of searches. This test is used when analysing the distribution of one nominal variable up against an expected distribution of that variable, typically if two nominal variables are registered it is expected that the distribution of these is 50% each (O'Donoghue, 2012).

4. Results

The intention with the large data material is to gain a deeper understanding of the players' visual exploratory behaviour in real game situations and to develop several scientific articles (hopefully). By analysing this amount of data the potential quantity of results is too large for this thesis, so a hierarchically model of what to present in the thesis, which is in line with the intentions of the study was developed. First some descriptive statistics of the players' and the two inclusion criteria are presented. Then the results of the VEB and performance analysis are presented. Followed by the results from the VEB and contextual characteristics analysis. Finally, the results form the VEB timing analysis is presented. At the very end some empirical evidence for the new inclusion criterion is presented, this is not mentioned in the intentions with the study but is necessary to present and underline the logic of using the new inclusion criterion.

4.1 Descriptive statistics

The average visual exploratory behaviour frequency (VEBF) for the situations that meet Jordet's (2005b; 2013) inclusion criterion (closer opponent goal situations) was 0.46 searches per second (N = 163 situations, SD = .27). There were no differences in VEBF (U = 3026.0, p = .554) between forward (n = 66 situations, M = 0.46 searches/second, SD = .29) and midfield (n = 97 situations, M = 0.47 searcher/second, SD = .27) players (see Appendix I for descriptive table for each player in these situations).

The average VEBF in the situations that meets the new inclusion criterion (all situations) was 0.49 searches per second (N = 269 situations, SD = .32). No differences (U = 8188.5, p = .595) in VEBF were found between midfield (n = 167 situations, M = 0.49 searches/second, SD = .30) and forward (n = 102 situations, M = 0.49 searcher/second, SD = .34) players. See Table 2 for descriptive statistics for each player.

Table 2: *Descriptive statistics for each player. For descriptive statistics for players in Jordet's (2005b; 2013) inclusion criterion, see Appendix I.*

Player	Situations	Mean VEBF	SD	Pass completion	Forward pass completed	Maintain possession	Forward actions	Success forward action
P1	40	0.38	.24	100 %	100 %	95 %	47.5 %	94.7%
P2	40	0.56	.37	82.4 %	75 %	75.7 %	65 %	65.4%
P3	45	0.49	.34	90.5 %	91.3 %	75.7 %	64.4 %	82.8%
P4	16	0.46	.24	100 %	100 %	100 %	66.7 %	100%
P5	17	0.30	.22	85.7 %	66.7 %	81.3 %	52.9 %	44.4%
P6	22	0.45	.24	100 %	100 %	100 %	27.3 %	83.3%
P7	76	0.52	.34	81.4 %	72.7 %	78.9 %	67.1 %	72.6%
P8	14	0.75	.25	92.9 %	90.2 %	92.9 %	85.7 %	91.7%
Sum	269	0.49	.32	89.3%	84.2%	83.3%	60.2%	77.8%

Notes: Mean VEBF = mean visual exploratory behaviour frequency: SD = Standard Deviation: Forward action = how many percentage of the player's actions that were in the attacking directing: Success forward action = percentage success of forward actions.

4.2 Visual exploratory behaviour and performance

When only examine pass situations (n = 146 situations) in the situations that meet Jordet's (2005b; 2013) inclusion criterion, the results from the Binary Logistic Regression analysis shows a positive trend between VEBF and pass completion. When players explore less they complete 84% of the passes while when exploring much players complete 86.1% of the passes, but the findings was not significant (OR = 1.175, p = .78). When only looking at forward pass situations (n = 78 situations), when players explore less they complete 75% of the forward passes, while when exploring much they complete 86.7% of their forward passes, but the success rate was not significantly higher (OR = 2.17, p = .299).

From this point forward all presented results are from the analysis of the situations that meets the new inclusion criteria (all situations). Exceptions are noted in the text. When only examine pass situations (n = 244 situations) there is a positive trend between VEBF and pass completion, suggesting that when players explore more they are more successful in their passing than when exploring less, but not significant (OR = 1.97, p = .20) (see Figure 4, left side). The same applies to forward pass situations (n = 133 situations), where the relationship between VEBF and forward pass completion is positive, but not significant (OR = 3.43, p = .06) (see Figure 4, right side).

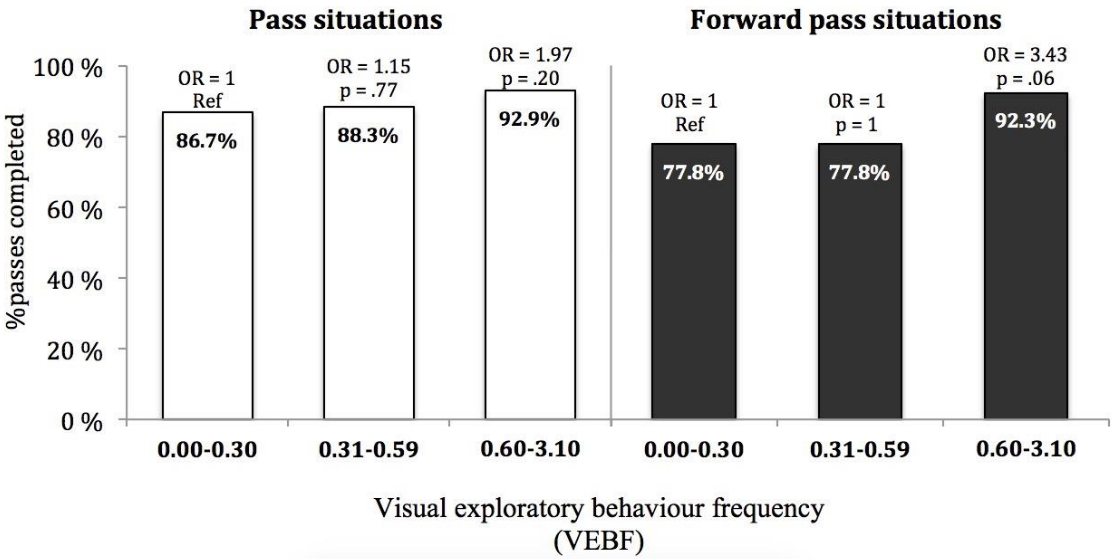

Figure 4: *Pass completion (n = 8 players/244 situations) (left side/white) and forward pass completion (n = 8 players/133 situations) (right side/black) for each of the visual exploratory behaviour frequency categories (little 0.00-0.30, some 0.31-0.59 and much 0.60-3.0).*

Pass completion across player positions. When examining midfield players in passing situations (n = 5 players/154 situations), the trend is positive, yet not significant between VEB and pass completion. When players explore little they complete 88% and when exploring much they complete 94.4% of their passes, which indicates a positive trend but not significantly (OR = 2.32, p = .25). A similar trend is found for forward players (n = 3 players/90 situations), where players complete 84.8% of their passes when exploring less compared to 90% when exploring much (OR = 1.61, p = .542). The trend is positive for both playing positions but the findings are not significant.

Pass completion across pitch areas. On the players' own half of the field (n = 92 situations), players complete 96% of the passes when exploring less compared to 96.8% when exploring much (OR = 1.25, p = .88). At the opponent half of the field (n = 152 situations) players complete 82.8% of the passes when exploring little compared to 90.6% when exploring much (OR = 2.0, p = .24). The trend is positive at both half of the pitch, especially at the opponent half of the pitch but the findings are not significant.

Forward pass completion across player positions. When examining midfield players (n = 5 players/84 situations), players have a forward pass success rate of 76.2% when engage in less explorations compared to 94.3% when exploring much, which indicates a positive trend between VEBF and forward pass success, however not significant (OR = 5.16, p = .065). For the forward players (n = 3 players/49 situations) the trend is in the same direction, players have a forward pass success rate of 80.0% when exploring less compared to 88.2% when exploring much (OR = 1.88, p = .526).

Forward pass completion across pitch areas. On the players' own half of the field (n = 55 situations) players have a forward pass success rate of 100% when exploring less and 100% when exploring much (OR = 1.0, p = 1.0). At the opponent half of the field (n = 177 situations) players have a forward pass success rate of 66.7% when exploring less compared to 87.1% when exploring much, which indicates a positive relationship but yet not significant (OR = 3.38, p = .08).

VEBF in relation to performance of different final actions. When analysing the visual exploratory behaviour frequency for several performance measurements, the trend indicates that players have a higher VEBF when their actions are successful compared to not successful, but the results are not significant (see Table 3) (see Appendix I for results from situations with Jordet's (2005b; 2013) inclusion criterion). However, as you can see in Table 3, the players is not far from having a significantly higher VEBF when executing successful forward and penetrating passes compared to the VEBF when they are not successful (not complete).

Table 3: *Mann-Whitney U test results when comparing VEBF between successful (complete) and not successful (not complete) actions in five different performance variables.*

Variable	Situations	VEBF Complete	SD Complete	VEBF not complete	SD not complete	*U*	*p.*
Possession	269	0.50	.33	0.46	.24	3947.0	.643
Pass	244	0.50	.33	0.43	.25	2521.5	.358
Forward pass	133	0.57	.34	0.42	.23	868.0	.057
Penetrating pass	97	0.59	.37	0.42	.23	579.5	.055
Forward action	162	0.54	.34	0.47	.24	2061.5	.405

Notes: VEBF = Visual exploratory behaviour frequency: SD = Standard deviation: *U* = test statistics from Mann-Whitney test: *p.* = significance level from Mann-Whitney U test.

VEB and success of forward actions (e.g. passing, dribbling, finishing). The results form the Binary Logistic Regression analysis showed a positive relationship between VEBF and successful forward actions, suggesting that when the players explore much they are more successful in their forward actions compared to when engage in little exploration (OR = 1.95, p = .026) (see Figure 5). However, no relationship was found between VEBF and not successful forward actions. Further, when exploring little the players execute significantly more sideward and backward actions (50% of the actions is not forward) (OR = 2.17, p = .012) compared to when exploring much (31.5% of the actions is not forward) (see Appendix I for total figure). The relationship between VEB and success in forward actions was in the same positive direction across playing positions and pitch locations, but remained significant only for the midfield players.

Success in forward actions across player positions. When examining midfield players (n = 5 players/167 situations), players have a forward success rate of 38.9% when exploring little compared to 62.7% when exploring much, which is significantly higher (OR = 2.64, p = .012). However, this is not found for forward players (n = 3 players/102 situations), where players have a forward success rate of 41.7% when exploring little compared to 45.5% when exploring much (OR = 1.17, p = .751).

Success in forward actions across pitch areas. On the players' own half of the pitch (n = 92 situations), players have a forward success rate of 52% when exploring little compared to 67.7% when exploring much (OR = 1.94, p = .23). At the opponent half of the pitch (n = 177 situations) players have a forward success rate of 35.4% when exploring little compared to 50.8% when exploring much (OR = 1.89, p = .08). The findings were not significant but a positive trend is shown.

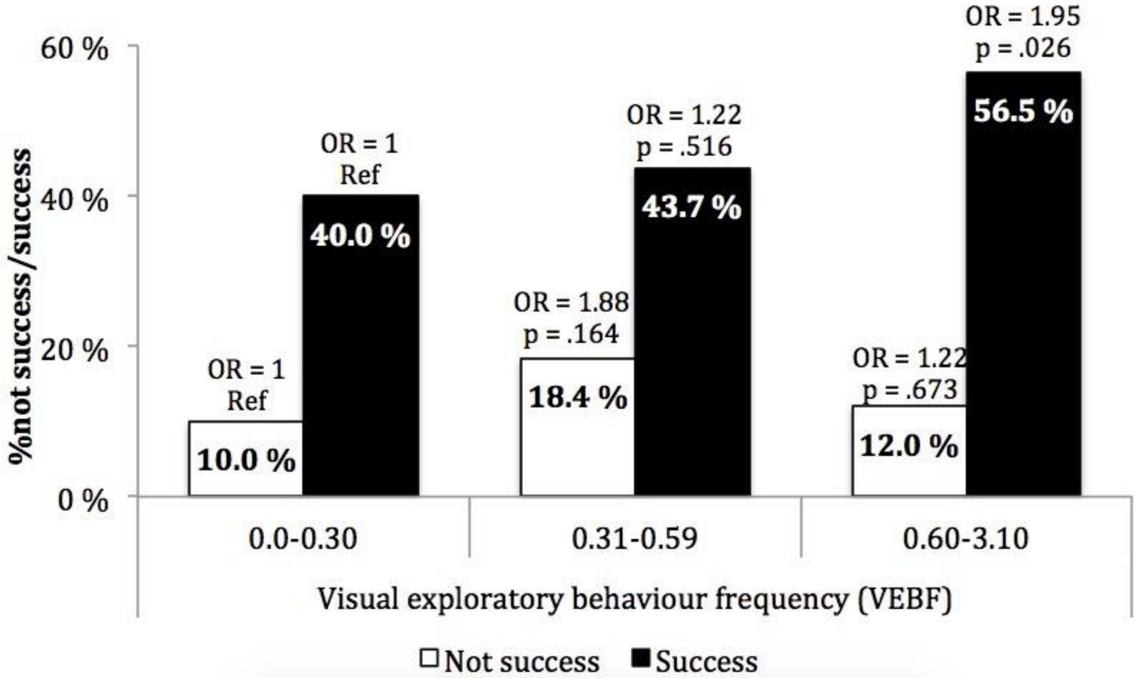

Figure 5: *Percentage not success and success of the players' forward actions (e.g., pass and/or dribble with the ball in the attacking direction), divided on three VEBF categories (little 0.00-0.30, some 0.31-0.59 and much 0.60-3.10) (N = 269 situations/8 players). Note. The low VEBF category was the reference category for the Binary Logistic Regression analysis. This figure has excluded forward action not used, which is why the sum of not success and success is not 100%, see Appendix I for total figure.*

Penetrating forward pass situations. When only looking at situations where the players try to penetrate the ball trough the opponents' team (n = 97 situations) a positive relationship between VEBF and penetrating forward pass completion was found (see Figure 6). Players are significantly more successful in their penetrating forward passes when engaging extensive exploratory behaviour compared to when exploring less (OR = 4.13, p = .038). This relationship was valid for one of the player positions, but not (yet closely) valid for different game conditions (player location).

Success in penetrating forward passes across player positions. When examine midfield players (n = 5 players/60 situations), players complete 58.3% of the penetrating forward passes when exploring little compared to 91.7% when exploring much, which is significantly higher (OR = 7.86, p = .029). However, this was not valid for forward players (n = 3 players/37 situations), where players complete 75% of the penetrating forward passes when exploring little compared to 84.6% when exploring much (OR = 1.83, p = .55). This shows a positive trend but the findings are not significant.

Success in penetrating forward passes across pitch areas. On the players' own half of the field (n = 38 situations), players complete 100% of the penetrating forward passes when exploring little and 100% when exploring much (OR = 1, p = 1). At the opponent half of the field (n = 59 situations) the players complete 63.2% of the penetrating forward passes when exploring little compared to 82.6% when exploring much (OR = 3.46, p = .09).

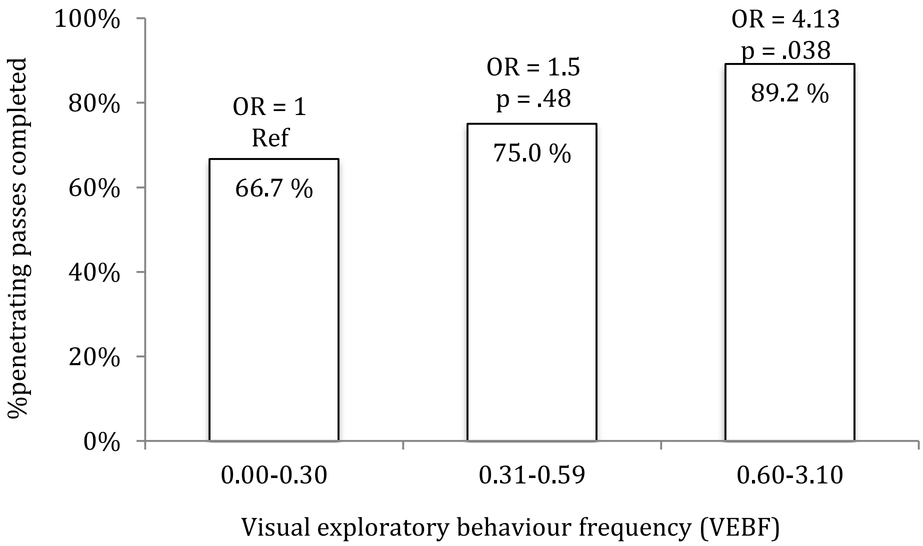

Figure 6: *Penetrating pass completion (n = 8 players/ 97 game situations) in each of the three VEBF categories (little 0.00-0.30, some 0.31-0.59 and much 0.60-3.0).*

4.3 Visual exploratory behaviour across actions

Hierarchical model. Results from the Kruskall Wallis H analysis suggest that the average visual exploratory behaviour frequency is significantly different for different attempted final actions (H (5) = 15.96, p = .007)(see Figure 7). Specifically, when players attempt to perform a penetrating pass and/or dribble they have a significantly higher (p = .005, r = 0.30) VEBF than when they attempt to maintain possession of the ball. No other attempted final actions were found to have significantly different VEBF. However, when not adjusting the significance level, the players have a significant higher VEBF prior to situations where they attempt to execute a penetrating pass and/or dribble, compared to all other actions (p < .05), except forward pass/dribble (U = 465.5, p = .148) and pass/dribble into assist area (U = 634, p = .057). No other actions had a significantly higher search frequency compared to the other actions.

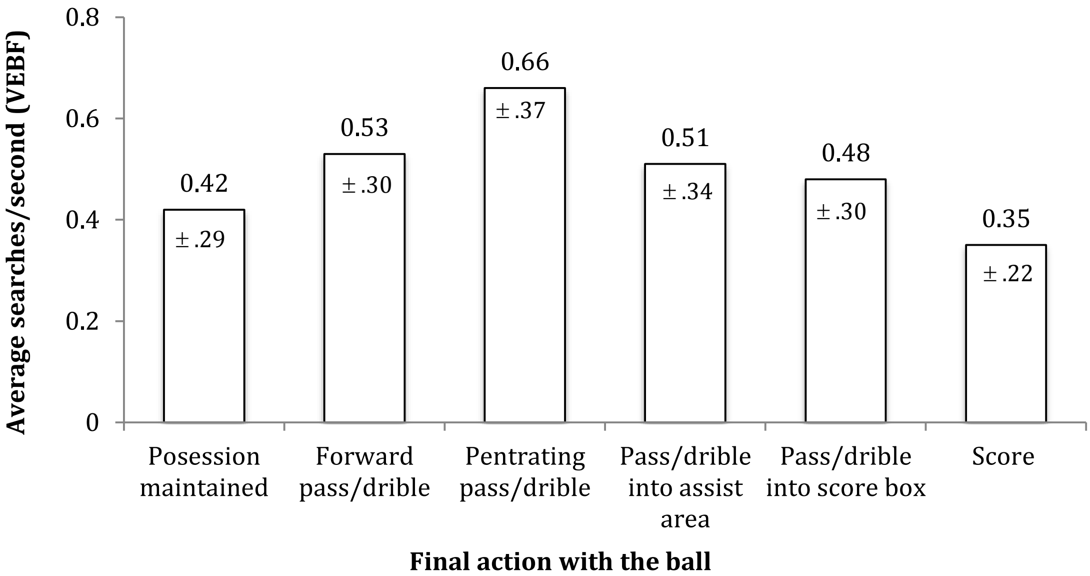

Figure 7: *Average visual exploratory behaviour frequency for each of the players attempted actions in the Hierarchically football action model (n = 8 players/269 situations). Note. The standard deviation is presented inside the bars (± values).*

VEB in relation to action direction. Results from the Kruskall Wallis H test suggest that players VEBF is significantly different for different action directions with the ball (H (2) = 7.46, p = .024). Players have a significantly higher (p = .021, r = 0.18) VEBF when performing actions in the attacking direction (n = 162 situations, M = .53 searchers/second, SD = .32), compared to when they perform actions toward their own goal (backward) (n = 68 situations, M = .41 searchers/second, SD = .31). However, this remained valid only for midfield players (p = .004) and not for forward players (p = .187). No significant differences was found between VEB prior to receiving the ball and action direction with the ball on the players own half (p = .193) or opponents' half (p = .115 of the pitch. For complementary results of the player position and pitch position analysis see Appendix I.

4.4 Visual exploratory behaviour across pitch areas

Results from the Kruskal Wallis H test suggested that the players mean VEBF prior to receiving the ball at different pitch areas were not significantly different (H (4) = 6.74, p = .150) (see Figure 8). However, when comparing the pitch positions pairwise by using Mann-Whitney U tests without adjusting the significance level, we found that players have a significantly lower average search frequency prior to receiving the ball in the score box area compared to when receiving the ball in the first area own half (U = 138.0, p = .042), midfield area own half (U = 619.0, p = .049) and midfield area opponent half (U = 900.5, p = .030). No significant differences in mean VEBF were found between any of the other pitch areas (see Figure 12).

Defensive pressure across pitch areas. First, we found that VEBF was significant related to the degree of opponent pressure when receiving the ball, r_s = .260 p < .001. Further, results suggests that the mean distance to the nearest opponent player when receiving the ball is significantly different at different pitch areas H (4) = 15.92, p = .003 (see Figure 8). Specifically, the mean distance to the nearest opponent player is significantly lower when receiving the ball in the score box area compared to the first area own half (p = .003, r = 0.56). However, when analysing the pitch areas pairwise by using Mann-Whitney U tests without adjusting the significance level, the mean distance to the closest opponent player is significantly lower when receiving the ball in the score box area compared to midfield area opponent half (U = 893.5, p = .033), midfield area own half (U = 537.0, p = .009) and first area own half (U = 88.5, p = .001). Additionally, the mean distance to the closest opponent player is significantly longer when receiving the ball in the first area own half compared to midfield area opponent half (U = 605.5, p = .004) and assist area (U = 248.0, p = .014) (see Figure 8).

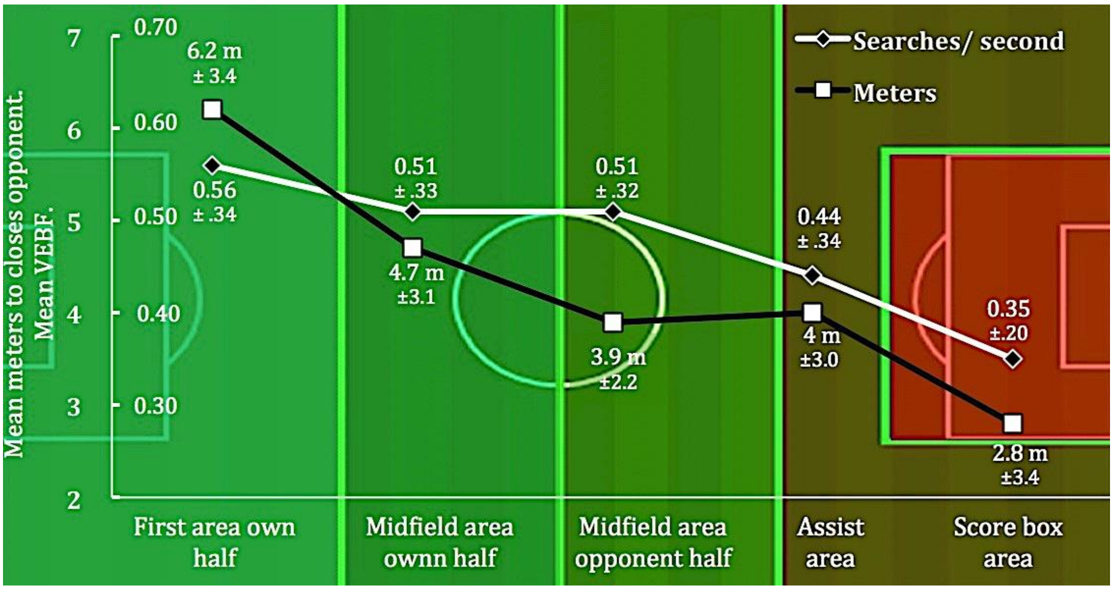

Figure 8: *Mean VEBF prior to receiving (white line) and mean distance to the nearest opponent when receiving (black line) for each pitch area. Note. First area own half (n =23 situations): Midfield are own half (n =74 situations): Midfield area opponent half (n = 110 situations): Assist area (n = 43 situations): Score box area (n = 23 situations): Mean VEBF = searchers/second: The standard deviation is presented with the ± values: The line linking the dots does not represent a continues development, but is used to illustrate how the VEBF drops and how the defensive pressures increases the closer the players gets to the opponent goal, a more correct figure with bars for each pitch area is presented in appendix I.*

4.5 Visual exploratory behaviour and defensive pressure

Defensive pressure for each initiated search. Results from the VEB timing analysis shows that the mean distance from the analysed player to the closest opponent player is longer for each initiated search (see Figure 9). The result suggests that the mean distance to the closest opponent player is longer between several of the initiated searches (H (9) = 51.66, p < .001). Table 4 provides an overview of which of the initiated searches that have significantly longer mean distance to the closest opponent player compared to the other searches.

Player location: The difference in mean distance to closest opponent player from one search to the next remains significant for situations on the players own half (n = 271 searches) (H (9) = 42.19, p < .001) and on the opponents half of the pitch (n = 512 searches) (H (9) = 20.65, p = .014). For pairwise comparisons and analysis from SPSS see Appendix I.

Player position: The differences in mean distance to closest opponent player from one search to the next are only significant for midfield players (n = 519 searches/ 5 players) (H (9) = 42.56, p < .001). For forward players (n = 264 searches/ 3 players) the trend was in the same positive direction, where the distance to the closest opponent increased for each initiated search but the relationship was not significant (H (8) = 10.10, p = .258). For test statistics from SPSS and pairwise comparisons see Appendix I.

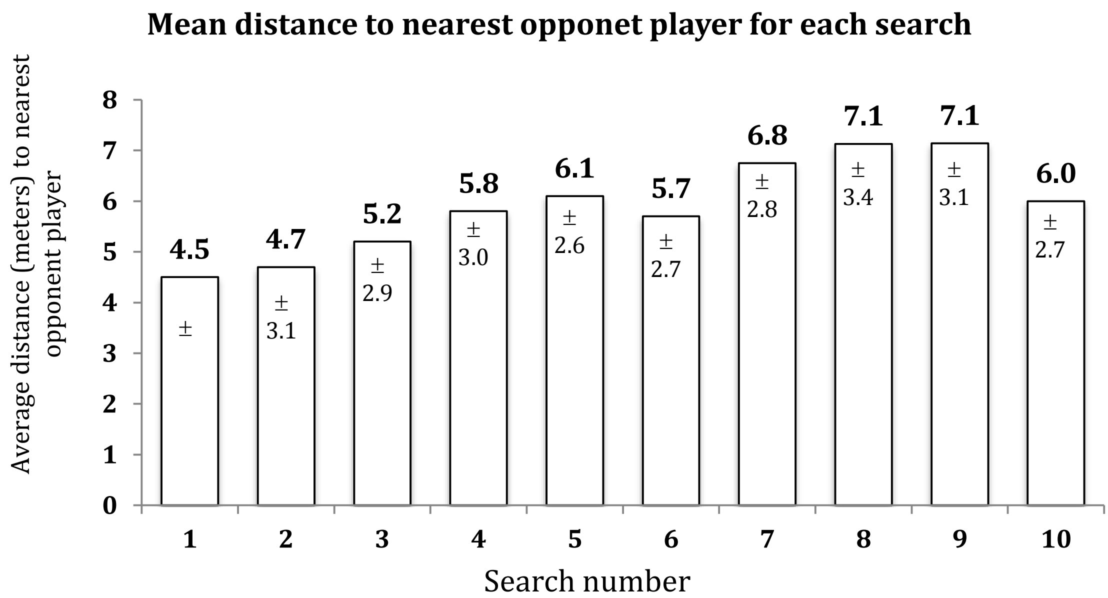

Figure 9: *Mean distance between analysed player and the closest opponent player when each search is initiated (n = 783 searches in 249 situations/8 players).*

Note. The standard deviation is presented inside the bars (± values). Search number 11 was excluded because this was only registered one time and no mean or SD was possible to calculate.

Table 4: *P values from the pairwise comparison of the mean distance to the closest opponent player for each search in the Kruskal-Wallis test (n = 783 searches in 249 situations/8 players).*

***P* Values for pairwise comparisons of defensive pressure in each initiated search**

Search Number	1	2	3	4	5	6	7	8	9	10
1	-	.476	.014	.000*	.000*	.003	.000*	.002	.023	.308
2	.476	-	.086	.001*	.000*	.011	.001*	.005	.038	.372
3	.014	.086	-	.091	.019	.184	.016	.037	.119	.578
4	.000*	.001*	.091	-	.449	.981	.176	.218	.331	.864
5	.000*	.000*	.019	.449	-	.549	.420	.430	.508	.976
6	.003	.011	.184	.981	.549	-	.228	.256	.354	.871
7	.000*	.001*	.016	.176	.420	.228	-	.917	.867	.734
8	.002	.005	.037	.218	.430	.256	.917	-	.934	.702
9	.023	.038	.119	.331	.508	.354	.867	.934	-	.685
10	.308	.372	.578	.864	.976	.871	.734	.702	.685	-

Notes. The orange p values indicate that the mean distance to the closest opponent player is significantly longer when these searches are initiated. The blue p values also indicate that the mean distance is significantly longer when these searches are initiated, but these p values are not adjusted.

VEB and defensive pressure in each situation. The results show that the mean distance between the analysed player and closest opponent player is significantly different across VEBF categories when the teammate passes the ball (H (2) = 10.16, p = .006), in the first (H (2) = 14.67, p = .001) and second touch of the ball (H (2) = 6.08, p = .033) (see Figure 10). The trend was similar but not significant for final actions (H (2) = 4.78, p = .092). This may suggest that when players engage in more visual exploratory behaviour the mean distance to the closest opponent player is longer than when exploring less, throughout the situation; when teammate passes (p = .006, r = -0.23) in the first touch (p < .000, r = -0.28) and second touch (p = .049, r = -0.22) of the ball. This was only significant for the final touch of the ball when the significant level was not adjusted (*U* = 380.5, *p* = .041) (see Appendix I for complementary analysis of player position and pitch position).

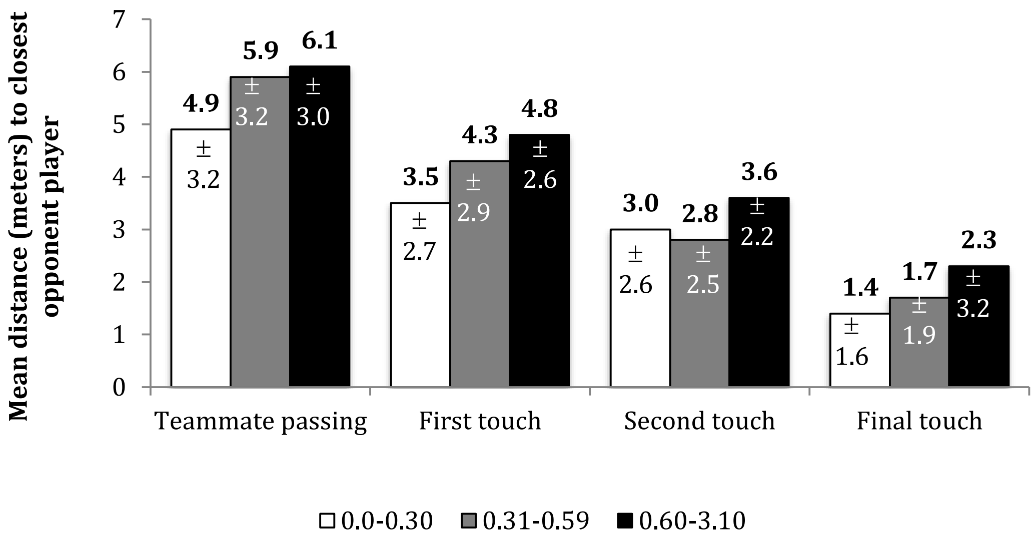

Figure 10: *Mean distance between analysed player and closest opponent player, measured in meters trough each situation (n = 8 players/269 situations).*
Notes. The second touch category included all situations where the player used more than one touch (n = 177 situations). The final touch category only included situations where the player used more than two or touches (n = 92 situations).

The change in defensive pressure. Figure10 illustrates that mean distance to closest opponent player decrease throughout the situation. To measure the difference in decreasing distance to the closest opponent player from the moment the teammate passes the ball to the moment the analysed player receives it, the distance to the opponent was merged into three categories; tight 0-2meters, loose 3-5 meters, and no pressure >5meters. The results show that the degree of defensive pressure was significantly different across the three VEBF categories. As this is a supplementing finding to Figure 10 the figures and test statistics is elaborated in Appendix I. Further, by calculating the change in defensive pressure from the moment the teammate passes the ball to the moment the analysed player receives it, one gets the development of pressure for each of the search categories shown in Figure 11. The figure illustrates that the defensive pressure increased for all search categories, and suggests that the increase in tight pressure is highest in the little exploratory category (24.4%) compared to the two other categories (some 17.6% and much 7.0%), but not significantly higher (OR = 1.69, p = .096) (see Figure 11).

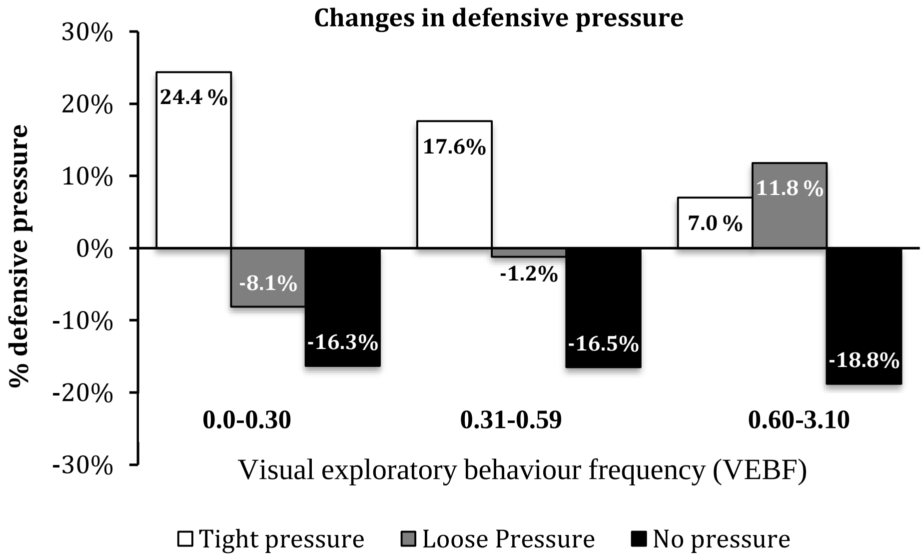

***Figure 11**: Change in tight (0-2metsres), loose (3-5meters) and no pressure (>5meters) from the moment a teammate passes the ball to the moment the analysed player receives that pass (N = 269 situations/8players).*
Note. VEBF = little (0.0-0.30), some (0.31-0.59) and much (0.60-3.10).

4.6 Visual exploratory behaviour and body orientation

The results show a positive relationship between VEBF and body orientation throughout each ball possession (from first to final touch). The results suggest a positive trend where players are more forward and less backward oriented when exploring more compared to when exploring less. The percentage backward and forward body orientation was not significantly different in the different search categories in the moment a teammate passed the ball towards the analysed player (see Figure 12, left side). However, when players' receive the ball, they are significantly more (OR = 2.27, p = .007) forward oriented when exploring much compared to when they explore little, and are significantly more (OR = 3.04, p = .003) backward oriented when exploring little compared to when exploring much (see Figure 12, right side). In the second touch of the ball, players are backward oriented 8.5% of the situations when exploring much compared to 20.8% of the situations when exploring little, which is almost significant (OR = 2.84, p = .056). Further, when players execute the touch on the ball they are significantly more (OR = 5.57, p = .043) backward oriented (24.1% of the situations) when exploring little compared when exploring much (5.4% of the situations) (see

Appendix I for total figure). The same relationship was found for situations where players received the ball closer to the opponent goal (Jordet (2005b; 2013) inclusion criteria). Players were significantly more forward oriented in the first touch (n = 163 situations, OR = 2.48, $p < .05$) when exploring much compared to when exploring less, and players were significantly more backward oriented in the first (n = 163 situations, OR = 4.56, $p < .05$), second (n = 102 situations, OR = 6.40, $p < .05$) and last touch of the ball (n = 59 situations, OR = 5.44, $p < .05$) when exploring little compared to when exploring much.

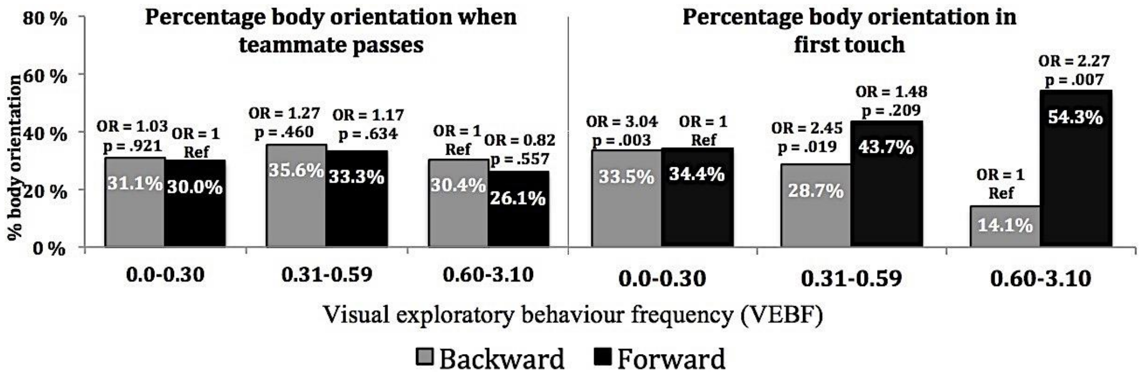

Figure 12: *Percentage backward (grey) and forward (black) body orientation when the teammate passes the ball to the analysed player (left side) and in the analysed players first touch of the ball (right side) (N = 269 situations/8 players). Notes. The little (0.0-0.30) VEBF category is used as reference for forward body orientation, and the much (0.60-3.10) VEBF category is reference for backward body orientation. The percentage sideward body orientation is not presented in this figure, and is the reason for why the sum of forward and backward body is not 100%. For a total overview of the body orientation throughout each situation, see Appendix I.*

Backward oriented when teammate passes. When investigating situations where the player is backward oriented when the ball is passed towards him (n = 87 situations), result suggests a positive relationship between VEBF and body orientation. Players are significantly more backward oriented when exploring little prior to receiving the ball compared to players who explore much (see Figure 13). Players who explore much are three times more forward oriented than players who explore little, but the difference was not significant (see Figure 13). For total figure of body orientation throughout the situation (from first to last touch) see Appendix I.

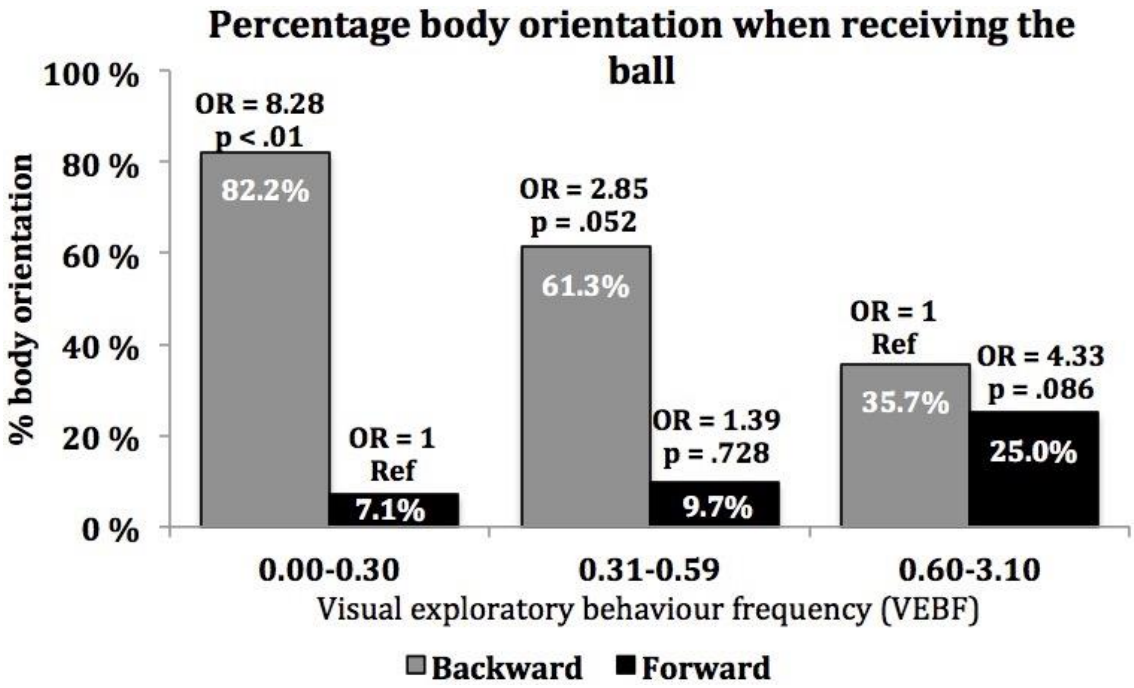

Figure 13: *Percentage backward and forward body orientation for each search category when players receive the ball in situations where they were backward oriented when teammate passed the ball towards them (n = 87 situations/8 players). Notes. The percentage sideward body orientation is not presented in this figure, which is the reason for why the sum of forward and backward body is not 100%. See Appendix I for figure with total body percentage development throughout each ball possession.*

VEB and body orientation under the same degree of defensive pressure. Results from a Binary Logistic Regression analysis suggests that when the degree of defensive pressure is the same in the moment the teammate passes the ball towards the analysed players, they are more forward (not significantly) and less backward (only significantly under loose pressure) oriented in their first touch of the ball when exploring much compared to when exploring little (se Figure 14).

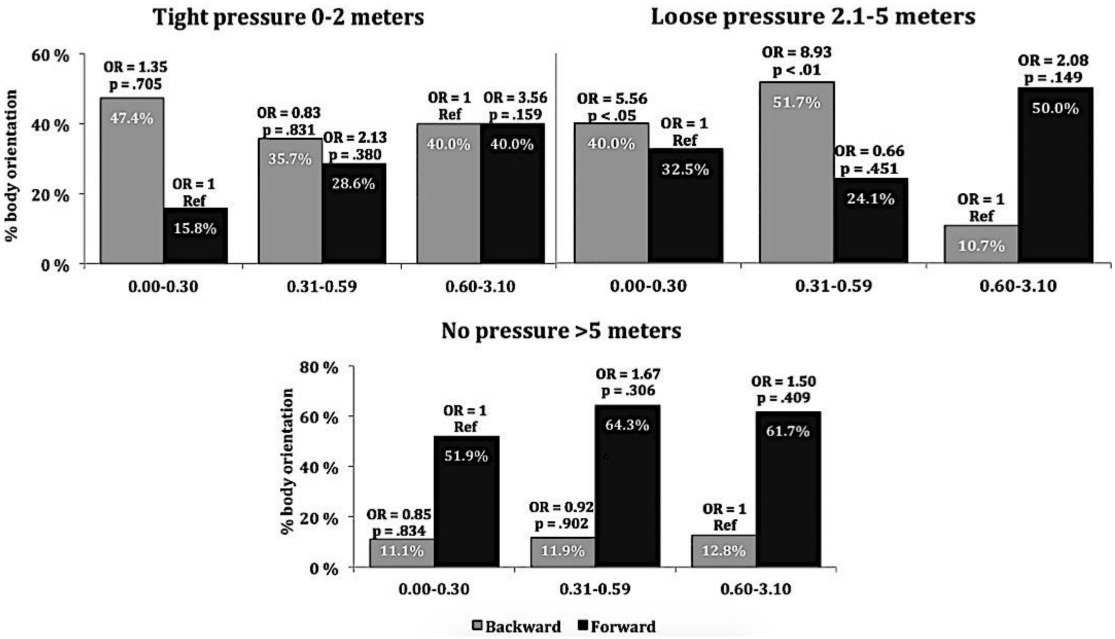

Figure 14: *Percentage forward and backward (sideward is excluded) body orientation when receiving the ball for each of the frequency categories when experiencing each of the three degrees of defensive pressure (tight = 43 situations, loose = 97 situations and no pressure = 116 situations) when the teammate passed the ball. The reference category for forward orientation is the low frequency category, and the high frequency category is the reference category for backward orientation when calculating OR*

Timing of search

Figure 15 shows the observed and expected distribution (timing) of the players' searches in each of the registered ball positions. The expected distribution of searches is based on the average time interval of the situations and the average VEBF in these situations. Proposing that there is no particular pattern in the players timing of their searches, one may expect that they initiates their searches randomly in the time interval. To estimate the expected timing of the searches the mean time the ball was located at each of the positions (see Figure 15 for positions) was calculated and used to calculate how many percentage of the average VEBF that one can expect to be initiated for each of the ball positions. In other words, expected timing assumes an equal chance of searching at different ball position in relation to the average amount of time the ball is located at each position. The observed search timing is significantly different from the expected timing assuming an unequal distribution (timing) of the initiated searches at different ball positions $x^2_{11} = 95.58$, p < .001 (see Figure 15).

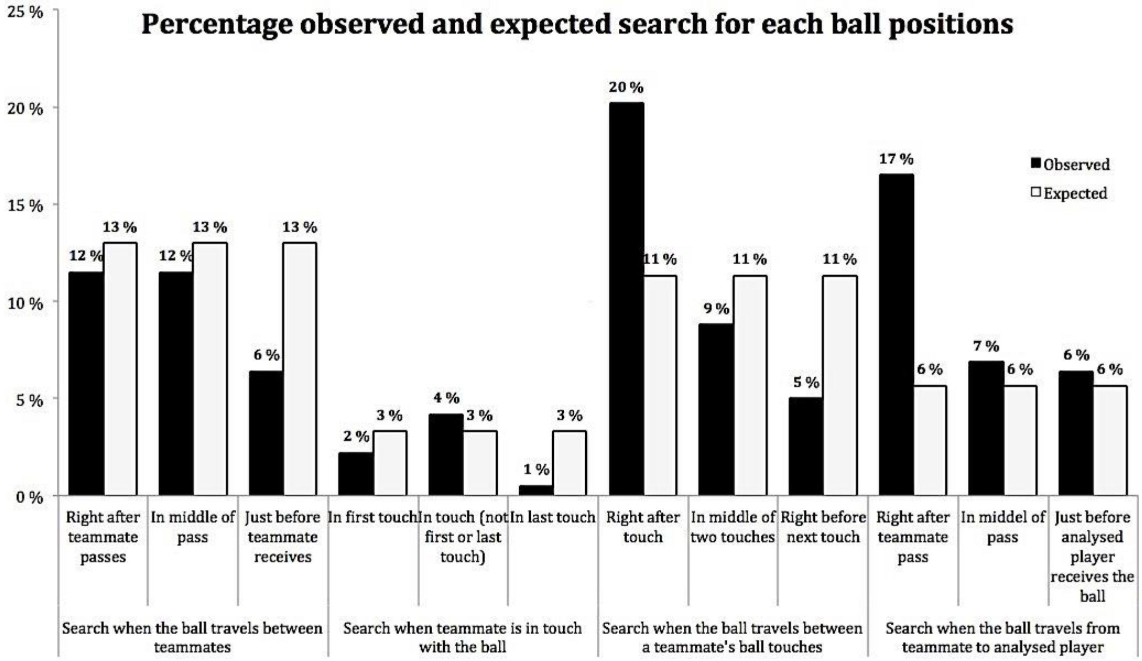

Figure 15: *Percentage observed and expected distribution of 739 searches in 249 situations (N = 8 players). Notes. Each ball position is represented with one observed (black) and one expected (white) bar. The observed bar shows how many searches (in percentage) players initiate in each ball position. The expected bar shows how many searches (in percentage) one may expect that players initiate for each of the ball positions, which is estimated by how many seconds the ball is located at the different positions. See Appendix I for test statistics.*

Empirical evidence for the new inclusion criteria

No significant differences in VEBF were found between the different player positions (in relation to the position of the passing teammate) when receiving the ball (H (3) = 4.69, p = .196). However, as shown in Figure 16 players have higher VEBF when they receive the ball in a neutral position or closer to his own goal than when receiving the ball closer to the opponent goal or towards the sidelines (see appendix I for same figure and test statistics for player position (midfield/forward) and pitch position (opponent half/own half)).

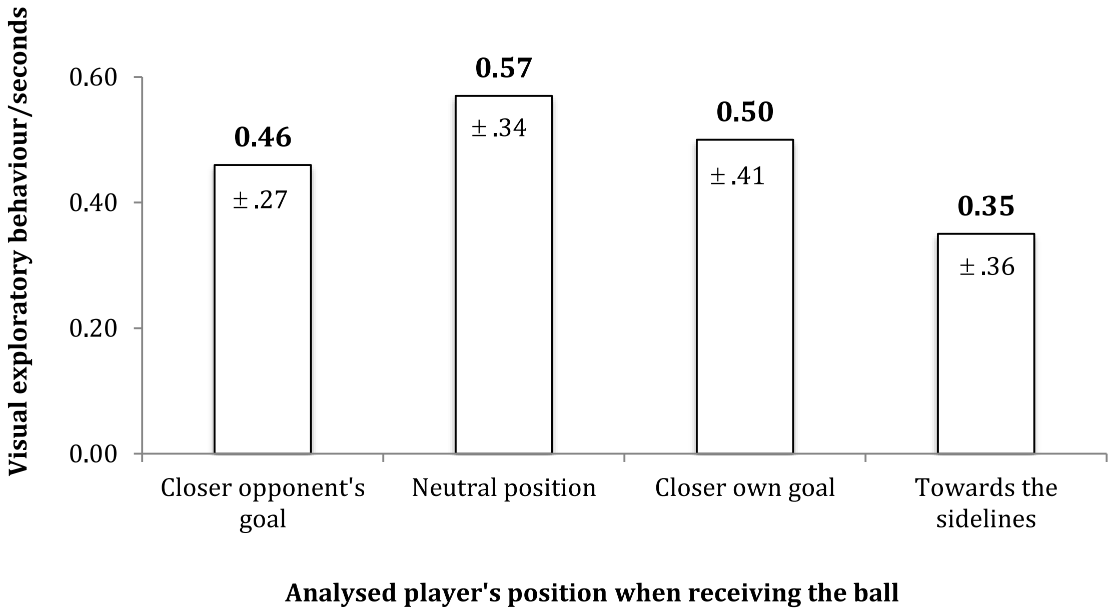

Figure 16*: The players' average visual exploratory behaviour per second for each of the players' receiving positions in relation to the position to the passing teammate. The standard deviation is presented inside the bars (± values).*

5. Discussion

The general purpose of this study was to examine the relationship between world-class football players' (N = 8) visual exploratory behaviour on performance with the ball in UEFA Champions League games. A secondary aim was to examine the relationship between VEBF and situational characteristics. The final aim was to examine players' timing of the visual exploratory behaviour (search) in relation to the position of the ball. A high zoom video camera was solely focused on one player at a time, in order to have high quality images of the player's head and body movements. The close up footage was synchronised together with the general game events footage, creating a split-screen video. This video made it possible to examine the players' visual exploratory behaviour in detail, and simultaneously recognize situational elements that may be important for exploratory behaviour (see Eldridge et al., 2013; Jordet, 2005b; Jordet et al., 2013).

In the current study, the hypothesis was that when world class players engage in extensive visual exploratory behaviour prior to receiving the ball they would be more successful with the ball than when exploring less. The findings revealed that when players performed more VEB they were more successful in their forward actions (e.g. passing and dribbling) and completed more penetrating passes compered to when exploring less. In addition, a positive trend was found between VEBF and several performance measurements; possession maintained, pass completion, forward pass completion and success of forward actions. The average VEBF was higher (yet not significantly) when players were successful compered to when they where unsuccessful in their final actions with the ball. Following the ecological approach, perceiving is an act of attention, where the visual system is used to explore the ambient array of information (Gibson, 1979), and the physical properties perceived in the environment in relation to the players' action capabilities provides a landscape of action opportunities (affordances) (Davids et al., 2015). More specifically, the results indicate that more explorations result in a more frequent spatial-temporal update of the affordances (opportunities) of the upcoming event, enabling the players to prospectively control further actions with higher success rates (Adolph et al., 2000; Montagne, 2005). This may provide a supplementing finding to Helsen and Starkes (1999) findings, where expert players spent more time viewing the ball possessor when making wrong decisions compared to when making the right decisions. The comparison most be taken with caution as the current study investigated visual exploratory behaviour and the laboratory study by Helsen and Starkes (1999) investigated eye fixations. This being said, the positive relationship between VEB and forward actions and penetrating pass completion remained significant only for midfield players and for situations on the opponent half of the pitch. Indicating that VEB is specifically important when players' perform forward actions on the opponent teams half, and for midfield players when attempting to execute creative forward actions, which is in line with the earlier findings in the EPL study of Jordet et al. (2013). However, since the average VEBF did not differ between the midfield and forward players in the current study, VEB may be just as important to engage in for both playing positions, but the performance measurements do not capture the performance advantages the forward players extract from it. Another explanation might also be that as a result of investigating three of the best attacking players in the world it might be difficult to reveal a relationship between different variables and optimal performance, since these players rarely make mistakes.

Further, Jordet et al. (2013) found that VEBF was positively related to pass and forward pass completion. When using the same inclusion criteria, the current study found that players who explore much have a slightly higher (yet not significantly) pass and forward pass completion than when exploring less. The reason for no significant relationship in the current study may be due to the superior performance and expertise level of the analysed players. As an example, the average pass completion was 86.3% and the average forward pass completion was 80.8% while the average pass completion was 62.43% in the EPL study (Jordet et al., 2013). In addition, when analysing player-by-player performances, the lowest forward pass completion was 60% (P5), and the lowest pass completion was 77.3% (P7). Four of the players (P1, P4, P6 and P8) did not miss any of their passes (100% pass and forward pass completed). Hence, to find a significant relationship between successful passes and any other variable would be difficult, and a larger number of participants and situations like in the EPL study would be beneficial to increase the likelihood of revealing a relationship between variables.

Researchers have found that expert football players engage in more extensive visual search behaviour, with more visual fixations away from the ball than less skilled players (Roca et al., 2011; Williams et al., 1994). By using the same inclusion criteria as in the

EPL study, we can look at the mean VEBF among award winning players (M = .33, SD = .22) and non award winning players (M = .27, SD = .25) found in the study by Jordet et al. (2013), and the mean VEBF (M = 0.46, SD = .27) in the current study. Even though no statistical test are conducted to compare these two studies, the visual differences in VEBF indicates that world-class forward and midfield players execute more searchers away from the ball than forward and midfield players in the EPL study. This indicates that world-class players attend more away from the ball than expert players, which may provide a supplementing finding to the findings in the earlier presented laboratory studies of Roca et al. (2011) and Williams et al. (1994). The laboratory research investigated eye fixations in defensive situations, and the current study investigated visual exploratory behaviour (head and body movements away from the ball) prior to offensive involvements with the ball, so the comparison most be taken with caution. It is also important to note that some of the players in the EPL study are players who potentially could have made the inclusion criterion in the current study. As an example, the two most decorated midfield players in the EPL study was Frank Lampard and Steven Gerrard, and the latter is analysed in the current study. These two players hade the highest average VEB in the EPL study (Jordet et al., 2013), which also provides evidence for the assumptions that more successful players perform more explorations compared to less successful players.

As an ecological founded study, the affordances are the starting point of what players perceive and act upon (Turvey, 1992). Results indicate that different actions are based on and dependent of various amounts of important affordances for the player to perceive and act upon. In line with the abstraction hierarchy of affordances (Vicente & Wang, 1998), the players in the current study explored more when attempting to execute actions at lower levels (e.g. penetrating pass/dribble) than when attempting to execute actions at higher levels (e.g. to score) of the football action hierarchy (developed in this study). Specifically, players' visual exploratory behaviour is highest when they attempt to penetrate the ball trough the opponents' team. In these situations the decisive affordances to perceive and act upon consist of; the ball, several opponents and teammates who are constantly moving creating and/or preventing spaces to act in. Hence, it is beneficial to engage in extensive visual exploratory behaviour to perceive these important affordances in order to hit these creative passes in the attacking direction (Jordet et al., 2013). In contrast, players' visual exploratory behaviour is lowest when they try to score. This is the highest level of the hierarchy and the decisive affordances are fewer as the decision making is more constant 'try to score' (Araújo et al., 2004). In these situations it is important to perform a clean kick in the direction of the stationary opponent goal. Hence, the ball is the most important affordance to perform the subsequent action and extensive VEB is less beneficial and is not essential to determine where the goal is. This finding supports ecological assumptions about the relationship between perception, action, and intention in sport (Davids et al., 2015; Gibson, 1979). Additionally, this may be a supplementing finding to the laboratory study of Roca et al. (2013), where skilled players underpinned their accurate decision-making and anticipation by differences in task-specific search behaviour. This comparison has to be taken with caution as the current study investigated visual exploratory behaviour (head and body movements away from the ball) in offensive situations, while the laboratory research investigated eye fixations in defensive situations. Finally, it is important to note that the VEB at the lowest level in the action hierarchy (maintaining possession) was significantly lower than when attempting to penetrate the pass (middle level of the hierarchy). This indicates that there are nuances to the assumptions provided above and that the hierarchical nest of affordances in the football action model is not truthfully in line with the assumptions of Vicente and Wang (1998). An explanation may be that the actions at the maintain possession level consist of backward or sideward passes and/or actions, where in most cases the difficulty and complexity to hit an teammate are lower as the amount of opponents that potentially can intercept the ball are fewer than when executing penetrating forward passes. Hence, the findings may indicate that when performing more complex actions involving more decisive affordances in the attacking direction it is more essential to perform extensive VEB compared to when performing less complex actions in order to perform optimally. This assumption most be taken with caution as this is the first time that results of this manner is presented and the nuances and causality has to be investigated in further research in order to say if this finding is valid across studies.

In relation to the discussion above it is also important to investigate the situational characteristics in relation to the VEB. Since players in a scoring position often are located closer to the opponents' goal with fewer players to take into account VEB is probably less needed (Williams et al., 1999). When not adjusting the p value the results from the current study show that players' VEBF decreases and defensive pressure increases (this was found with the adjusted p value) when receiving the ball clos to the opponent's goal. This findings most be taken with caution as the probability of making a type I error is larger when not adjusting the p value (O'Donoghue, 2012). However, the graphic representation of the changes in VEBF in the complex interactive setting (the pitch) is thought to be as good as any statistical test because large differences must be demonstrated to be visual in a graph (Sharpe & Koperwas, 2003). Players have a significantly higher VEBF at the first area own half, where the amount of relevant information to advance in the attacking direction towards the main goal (to score) is considerably high, compered to the VEBF in the score box area, where the relevant information to achieve the main goal (to score) is substantially lower. This was also found by Jordet (2004), where midfield players had lower VEBF when approaching the opponent goal. This is in line with the findings of Roca et al. (2013) where the skilled players conducted most searches and verbal statements of pattern recognition when the majority of relevant information (opponents and teammates) was located between the participant and the opponent player with the ball, where the main purpose (goal) of the action was to anticipate the opponents action. Further, when the opponent player with the ball was closer, less relevant information was located between the participant and the main goal of the activity. Hence, the players search frequency decreased (focusing more at the player in possession of the ball) and more verbal statements of situational probabilities and postural cues was registered (Roca et al., 2013). The findings in all three studies indicates that the closer the players gets to the main goal of the activity the action possibilities and decision making becomes gradually narrower and/or more constant, and the ball as an affordance becomes more decisive. This may constrain the exploration for other ambient affordances as these become less important to the performance, which supplements the discussion above and the assumptions of Vicente and Wang (1998) and Araújo et al. (2004). Hence, it seems like the perceptual expertise also involve timing an flexible adaption of the exploratory activity to each situation (Jordet, 2005a).

Another important environmental characteristic is the degree of defensive pressure briefly mentioned above. Gibson (1979) suggested that other people provide the richest and most elaborate affordances of the environment, which is supplemented by the studies of Jordet (2004) and Tedesqui and Orlick (2015), where players' stated that they mostly search for opponents and teammates who either created or prevented action opportunities. Further, Jordet (2004) argues that an increase in defensive pressure leads to a decrease in VEB as the stress factor increase and a poor first touch on the ball may lead to loosing possession which constrain the exploration by paying more attention to the ball. In the current study a correlation between VEBF and defensive pressure when receiving the ball was found just as in the study of Jordet (2004). However, the findings in the current study suggest a more nuanced picture of the relationship between VEB and the degree of defensive pressure. The VEB timing analysis shows that the mean distance to the closest opponent player decreases for each initiated search, indicating that players perceive the opponents (affordances) movement and uses each search to adapt their behaviours in a way that makes them more playable and gives them more time and space to perform goal-directed actions (Davids et al., 2015). This is supplemented in three ways: i) the players who explore more was less pressed when the teammate passes the ball towards him and in the first touch of the ball, which is similar to findings in earlier studies (see Eldridge et al., 2013; Jordet, 2005b), ii) the increase in pressure from the moment a teammate passes the ball to the moment the analysed player receives the ball was lower (not significantly) when players explore more, indicating that more explorations enables the players to perceive opponents movements and adapt his movements in a way that prevents the pressure to increase to much, iii) the two lines (VEBF and defensive pressure) is tightly connected trough Figure 17, except in midfield are opponent half. In this are the player have the same VEBF as in the midfield are own half but the average pressure has increased (not significantly). So despite the increase in defensive pressure the players' upholds the VEBF. A reason for this may be that in this particular pitch area the players' is more located (86% of the situations) in between the opponent attacking line and defensive line than at any other pitch area. In this position the action opportunities are many as the distance to the opponent goal is long and most of the relevant information to get there is still in-between the player and the goal, making it beneficial to engage in extensive VEB despite the increase in defensive pressure. These results in relation to the discussion above may suggest that the pitch position when receiving the ball is the key regulator of the degree of defensive pressure, while VEB may be less influenced by the defensive pressure and more determined by the action opportunities and amount of important affordances to perform optimally in the different situations. It also suggests that players use VEB to get in a more favourable position with longer distance from the opponent players to execute their goal directed actions. This is in line with the assumptions of both Jordet (2005b) and Eldridge et al.

(2013) that players use their VEB to receive the ball in spaces with less defensive pressure. Further, these findings are based on average measurements and the football context is highly complex, so to state that one behaviour might influence another must be done with caution. Hence, it is nuances to the discussed assumptions above and further research is needed to test how these variables interact with each other. As an example, it would have been interesting to conduct the same analysis on less skilled players to see if the ability to uphold the VEBF despite the increase in defensive pressure in the same pitch area as these world class players managed, and/or if the task specific VEB differed between world-class and less skilled players like it did in the study of Roca et al. (2013).

Further, the players in the study of Jordet (2005b) stated that the intervention period had improved their ability to explore the pitch for information, which provided a better overview of action possibilities making it easier to turn with the ball. Eldridge et al. (2013) found that players who conducted VEB were more likely to turn and perform forward passes compared to players who did not. Similarly, the player in the current study was more forward oriented and executed more forward actions when exploring more compared to when exploring less. First, the degree of backward and forward body orientation when the teammate passes the ball was similar for all the search categories. But when analysing the body orientation in the first touch, players who explore much were more forward and less backward oriented compared to players who explored less. Indicating that the players that explore more executes more turns than players who explore less. In addition, to test this relationship under the same conditions, only the situations where players were backward orientated when the teammate passed the ball was analysed. The results showed that when the players explored more they were significantly less backward oriented and three times more forward oriented in their first touch of the ball compared to when exploring less. An explanation for this is provided by one of the players in Jordet (2004, p. 196): "I can see that their pressure is kind of loose, one of them is backing, and I can see that, which makes me rather want to turn my self." The findings in the current study indicate that extensive VEB provides a more comprehensive overview of the environmental affordances, enabling the player to prospectively controlling his actions and utilize more turns. "The relationship between perception and context, and between perception and action, seem to be bidirectional and interactive rather than unidirectional and adaptive" (Jordet, 2004, p. 91). Hence, it is important to take the context into account when analysing perception and action. This was done by analysing the relationship between VEB and body orientation under the same degree of defensive pressure (context) when the teammate passed the ball. When players explored more frequently they were less backward and more forward oriented when receiving compared to when exploring less in each of the three degrees of defensive pressure. This may indicate that when players explore more they can anticipate opponents' movements with a higher accuracy and adapt their movements in a way that makes them more forward oriented in the first touch. This may provide a supplementing finding to the findings of Williams and Davids (1998), where the skilled players hade higher fixation rates and were better to anticipate the direction of an opponents dribble, making them more accurate in their decision making compared to less skilled players. As earlier mentioned these comparisons between field study and laboratory studies must be taken with caution. In addition, an element of caution is required when comparing the findings in this study to the findings of Eldridge et al. (2013), as the current study investigated high amounts of VEB to low amounts of VEB, whereas Eldridge et al. (2013) compared VEB to no VEB.

In the current study players have a significantly higher VEBF when acting in the attacking direction than when acting towards their own goal. However, this relationship only remained significant for midfield players. Eldridge et al. (2013) found that youth midfield players who execute exploratory behaviour were more likely to maintain possession trough forward passes than in situations where they did not execute exploratory activity prior to receiving the ball. Further, Jordet et al. (2013) concluded that extensive VEB was specifically beneficial for midfield players when passing in the attacking direction. All three studies and the results discussed above indicate that visual exploratory behaviour provides players' with essential information about their current relationship to the environment (e.g., pressure, body orientation, space to work in, free teammates) (Montagne, 2005), and this information underpins opportunities to act in the attacking direction. Hence, the findings in the current study may support Adolph et al. (2000) assumptions about exploration as the key to prospective control of further actions. This being said, the current study did not conduct any multivariate analysis when investigating the relationship between visual exploratory behaviour on other variables (performance, pressure, body orientation etc.,) because the submission date was too close when it was suggested. Further research should make an effort to use multivariate analysis when testing the relationship between VEB and other variables, as this analysis shows the interaction between variables an provide an overview of which of the variables that effect the test variable the most (O'Donoghue, 2012).

The essential parts of the athletes visual search strategy is generally thought to consist of the fixation location and search rates (number and duration of searches) presumed to reflect the information processing demands on the performer (Williams et al., 1999). As earlier mentioned this assumptions is adopted into the research of visual perception in football, whereas to my knowledge no research has investigated the timing of the players visual search strategies. So when it might seem to be most beneficial to scan (search) the ambient optic area for affordances to act upon is unknown. In Jordet (2004) players were asked which factors that influenced their VEB and the number of statements indicates that the ball is the key influential affordance. As one of the players in the study stated "It is difficult. All the time, you have to know where the ball is coming at the same time as you look behind your back. When moving your head to look around you lose track of where the ball is" (Jordet, 2004, p. 165). Since affordances are the starting point of how humans decide (Turvey, 1992), the ball position was used as reference when analysing the players timing of each VEB. By assuming that the player initiates his searches randomly from the moment a situation starts until the analysed player receives it an expected distribution of VEB was calculated by the average time the ball was located at the different possible positions. In other words, the expected distribution shows how many percentages of the searches that would be expected initiated at the specific ball positions in relation to how long the ball is located at that position. The results indicated that the players' timing of each VEB is significantly different than expected, assuming that the players have a specific VEB search pattern. Specifically, the players timing of the search in four ball positions was shown to differ especially much from the expected distribution (ranging from 6% less and 11% more than expected). In relation to what is expected the players initiate the least searches (7% less than expected) just before a teammate receives the ball and right before a teammate executes his next touch on the ball (6% less than expected). This indicates that when the ball direction or destination is likely to change in the next move (e.g., teammate passes the ball in first touch) players may experience it as less beneficial to explore other areas of the dynamic environment.   In contrast, players initiate most of their searches (20%) just after a teammate has touched the ball (9% more than expected) and (17%) right after a teammate passes the ball towards him (11% more than expected). This indicates that in the immediate time when the ball position and/or direction are determined, it becomes beneficial for the player to explore other areas of the dynamic and complex environment in order to adapt their goal directed actions (Davids et al., 2015). This assumption is supported by one elite Brazilian midfield player in the study of Tedesqui and Orlick (2015), who said "At the time it [the ball] is coming, you already know the way it's going, and you already have to take the look [to the sides]…You can control it without looking at it" (Tedesqui & Orlick, 2015, p. 44). As no inter observer reliability test is conducted on the VEB timing analysis this finding must be taken with caution. In addition, the chi square test conducted to find the differences between expected and observed distribution of the searches does only suggest that what we believed to be expected was wrong, as what we observed is actually what we could expect. This being said, a graphic representation of behaviour in complex interactive settings is thought to be as good as any statistical test, because a large differences most be demonstrated to be visual in a graph (Sharpe & Koperwas, 2003).

Finally, in the current study a new inclusion criterion was provided and emphasised. The assumptions behind the inclusion criterion used in earlier studies (see Jordet, 2005b; Jordet et al., 2013) are logical and understandable, yet not optimal. In real world research one would have to explain where the facts comes from and the baseline of the assumptions about these facts (Vealey, 2006). In the earlier inclusion criterion the assumptions about when it is beneficial for players to engage in VEB is not based on the investigation of these facts in the context where it occurs, it is simply an assumption created by the logical beliefs of the researchers. The intention behind this inclusion criterion was to exclude the situations where the analysed player hade all the relevant information to proceed in the attacking direction in front of him, where it was thought to be less necessary to engage in extensive VEB to perform optimally. Findings in the current study falsify this earlier assumption, where players conduct more (not significantly) VEB when receiving the ball closer to his own goal (M = 0.50 searches/second, SD = .41) compared to when receiving the ball closer to the opponent goal (M = 0.46 searches/second, SD = .27) (in relation to the passing teammate). In addition, it is in the neutral position the analysed players conduct most VEB (M = 0.57, SD = .35). Hence, the new inclusion criterion enables researchers' to gain a more comprehensive picture of in which receiving position it seems to be beneficial to engage in extensive VEB. As an example, the position where the players explore least is when receive the ball towards the sidelines (M = 0.35, SD = .35). This empirical finding makes it possible to assume that when players haw their backs towards the sidelines and no opponents can sneak up to intercept the ball it is not necessary the engage in extensive VEB, which may indicate that these situations should bee excluded or analysed separately. This is supported by the statement of one of the players in Jordet (2004), which stated that " If you are more centrally in the field, you have to look more to both sides. If you play more on one side, your body is often turned so you can see things forward in the field" (Jordet, 2004, p. 165). This indicates that different positions demands different degree of VEB and to investigate how VEB varies across receiving positions it is beneficial to use the new inclusion criterion. In other words, by narrowing the analysis of VEB in football down to only some included situations, like done in previous research (Jordet, 2005b; Jordet et al., 2013), one can not truthfully explain or understand the overall and complex picture of VEB among football players in real game situations. The empirical evidence in the current study supports the new method as a more comprehensive and optimal method to use when analysing VEB among midfield and forward football players in real game situations. This method enables researchers to look at the total picture and simultaneously to narrow the analysis down and investigate in detail the differences in VEB across contextual variables.

5.1 Limitations and further work

An observational field study was conducted with high ecological validity and high reliability of variables. However, some threats to the in internal validity, control and experimental elegance was shown (Jordet, 2005a). As an example, the players eye movements was not accounted for, as the close up footage only made it possible to analyse the players head and body movements (VEB). So what the players actually see, focus on, and looks at is not investigated (Eldridge et al., 2013; Jordet et al., 2013). Visual exploratory behaviour does not directly say anything about perceptual-cognitive processes such as information extraction, cue detection, anticipation, pattern recognition and can never be a sufficient explanation for why some players have better field vision than others (Jordet et al., 2013). However, Gibson (1979) argues that humans look with the head-eye system in which the eyes most follow the head. In other words, it is impossible for players to see information that their eyes are not directed towards and

VEB (the head direction) may be a good indicator of where they are looking (Jordet et al., 2013). New technology and methods for studying perception are constantly emerging in the world of sport science (Craig & Cummins, 2015). One example are the mobile Tobii Pro eye tracking glasses, enabling researches to investigate humans visual behaviour in the real world (Tobii.com, 2016). By placing mobile eye tracking glasses on a player and conduct close-up footage in real football situations, further research may be able to register the players VEB and eye movements simultaneously. This is off cores not possible in real football games, but could be conducted in training games or sessions to provide new knowledge and supplement the shortcomings of only investigating VEB and/or only investigating eye movements.

The downloaded broadcast footage of the general game events was occasionally incomplete, as a result of replay of situations, close up of coaches and/or fans etc., which resulted in incomplete information to conduct the analysis and exclusion of situations (in the main analysis) and searches (in the timing of VEB analysis). Further research should make an effort to use two video cameras, one to conduct the close up footage and one to conduct the footage of the general game events, ensuring that both videos are complete when creating the split-screen and when conducting the analysis.

Further, this study failed to demonstrate a relationship between VEB and performance for the forward players. There might bee several reasons for this. i) There were only three forward players, so the sample size was small which may have been a reason for no significant results even though in all cases the trend was in the same direction as for the midfield players. ii) the performance measurements used may have facilitated the midfield players more than the attacking players, indication that a more position specific performance measurement tool should be developed in future research.

Finally, considerably amounts of research is conducted on visual perception in sport generally and football specifically. Further research with high ecological validity is needed to test and analyse the visual exploratory behaviour on bigger sample sizes and across positions within the football team, in order to gain a broader understand of this behaviour in real game situations among expert players. Ultimately it is the players who have the answer about how these processes effect their performance, and researchers' should emphasise verbal involvement of the players in relation to the analysis.

5.2 Implications for practice

A number of techniques have been conducted to test how perceptual skills in sport can be trained. Most of these have been employed in video-based simulations (Williams et al., 2011; Williams & Ward, 2003). The majority of these studies aimed to improve players’ ability to pick up advanced visual cues in defensive situations by watching an opponent’s body posture on a flat screen, but no studies have tried to enhance pattern recognition or situational assessment (Williams et al., 2011). Further, the improvements found in the studies conducted on simulated training has yet failed to show if the improvement transfers to the pitch (Williams & Ford, 2013). Until recently, when Romeas et al. (2016) found that players improved their passing ability after training on tracking multiple 3D displayed spheres. However, as a result of the advanced exercise technology proposed by these studies most practitioners can not acquire the proposed training tools and the use of perceptual training programs in practise has not increased substantially (Jordet, 2004). Hence, two practical implications will be presented, one for the majority of practitioners and one for the top level clubs with higher financial means. The suggestions for the majority of participants are off curse also a relevant suggestion for the high level teams.

The main implication to practice in this thesis is that football players should be encouraged to engage in extensive exploratory behaviour, particularly in the period prior to receiving the ball. Coaches should emphasise the training and development of this skill in their daily work with players. The first step is to create awareness among players in which the ability to look around the pitch to perceive action opportunities is important for skilful performance and decision-making in football. As an example, in the imagery intervention study conducted by Jordet (2005b) players expressed that they became more aware of this part of their game as an result of the intervention. A strong tool to make players aware of this skill, is to show close-up videos of good players performing this behaviour in real games. Such videos are not to easy to find but one example is the movie about Zinedin Zidane where he was filmed close up from various angels, making it possible to see how independent he is of looking at the ball and how much he explores the pitch. Sequences of videos like this can easily bee shown for players before football practice to make them aware of this behaviour right before playing football. Haugaasen and Jordet (2012) stated that the most optimal way to enhance performance and football specific skills is to engage in football specific play as closely related to the individual position- and role-specific variations as possible. In the current study, the VEB timing analysis suggests that players initiate most of their searches (in relation to the expected) when the ball is passed from a teammate to the analysed player. A simple exercise to trigger this timing can be to place one passing teammate in front of and one teammate behind a player. Immediately after the passing player has executed the pass the player behind the receiving player points to the left or right, now the receiving player has to initiate a search in order to perceive in which direction the teammate is pointing and then turn with the ball in the opposite direction. This is a simple exercise but is beneficial to use in an early stage so that players gradually becomes more comfortable of not looking at the ball as it approaches. It is possible to expand this exercise by letting the player behind the back initiate an intercepting action when the pass is executed, so that the receiving player has to perceive and react on more sport like movements. This particular exercise may provide a role specific exercise for midfield and forward players. Further research should focus on investigate these processes among defenders and wingers, so that more knowledge on how these players explore the environment is gained and more positional adapted exercises can be developed.

Further, Broadbent et al. (2015) suggest that the key principles in perception development are perception-action coupling and contextual information as closely related to the sport context as possible. An exercise that upholds these principles is provided by playing 11-on-11 in training and give instructions to each of the playing positions to search for specific information on the pitch (e.g., midfielders have to explore after teammates to pass to in the attacking direction, and the wing-back have to explore after the offensive midfielder). By doing this exercise the players becomes more aware and at the same time they get the opportunity to adapt their exploratory behaviour to the context and to their own ability to look away from the ball. Occasionally the coach stops the game and everybody have to close their eyes immediately and stand still. As an example, the coach can then ask one midfield player where the closest teammate to pass to in the attacking direction is located. This exercise triggers the player to explore more and may simultaneously provide an experience of better overview and control of further actions, which potentially will motivate the player to gradually engage in more visual exploratory behaviour.

For high level teams, new technology has emerged and several football clubs have started using it. As an example, NeuroTracker have installed 3D immersive training rooms in several clubs. However, NeuroTracker does not take the earlier emphasised perception-action coupling into account. But the newest technology called immersive interactive virtual reality (i2VR) can potentially do just so (Craig & Cummins, 2015). By wearing a head-mounted display and control unit, athletes are placed in a virtual sport environment where they can interact with the upcoming events. This being said, the technology is far from optimal, is extremely expensive, and the transaction to the field is unknown. Thus, in the current thesis a more affordable suggestion to the practical field is emphasised. One of the players in Jordet (2005b, p. 152) stated that viewing himself on video had an effect on his exploratory development trough the intervention "I feel that the video part has had a better effect on me" High level clubs should emphasis obtaining high quality close-up footage of all players in game situations and merge this video together with the video of the general game events. Coaches can show this footage to players individually and use it as a development tool where sequences can be shown in slow motion and the findings in the current study of when to initiate searches can be used as guidance in the development process. In addition, the footage of each player can be analysed across games trough the season and used to investigate and work with the player's development of both visual exploratory behaviour and performance. As an final suggestion to the practical field, it is recommended that practitioners with high contextual knowledge is used when designing training programs for skills like attention and perception, as they are more likely to target the critical contextual features that may enhance the effectiveness of the intervention (Jordet, 2004).

5.3 Summary

This study has provided data suggesting that there is a positive relationship between world-class football players' visual exploratory behaviour and their performance of the subsequent actions. Specifically, players were more successful in their forward actions and completed more of their penetrating forward passes when engaging in extensive visual exploratory behaviour compared to when they explored less prior to receiving the ball. In addition, players performed more actions in the attacking direction, were more forward orientated in the first touch, and were put under less defensive pressure when exploring more compared to when exploring less. These results indicates that players perceptual system is likely to be exposed to more opportunities to act upon when players increase their explorations, which is in accordance with Gibson's (1979) theory of affordances. The hypothesis that midfield and forward players use exploratory behaviour to prospectively control further actions is supported by the results in this study, in accordance with the assumptions of Adolph et al. (2000). A new method to investigate football players' timing of their visual exploratory behaviours (searches) was presented. The results revealed that players initiate more searches than expected in the immediate moment the ball position and/or direction was determined: just after opponent touches the ball and when the ball transfers from teammate to analysed player.

The analysis conducted in the current study may have identified some nuanced characteristics in the players visual exploratory behaviour, suggesting that different actions contains different amounts of decisive affordances to be perceived. Specifically, players visual exploratory behaviour varies across attempted actions and across field positions, indicating that expert players flexible adapt their visual exploratory behaviour to the situation (Jordet, 2005a). This assumption may be related to the abstraction hierarchy hypothesis (Vicente & Wang, 1998) and may have some support from previous research (see Roca et al., 2013; Williams & Davids, 1998). However, further research is needed to replicable the findings in the currents study, and to test the nuances in the suggested findings across playing positions, on larger sample sizes and at different level of play. Additionally, contextual exercise and training sessions should be developed and tested to see its effect on players visual exploratory behaviour.

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Appendix

Appendix A:

Player merits table

Overview of the participants' football merits (www.UEFA.com, www.FIFA.com, www.wikipedia.com). Nom = Nominated to the FIFA Ballon d'Or at least one time. FIFPro World XI and UEFA Team of the Year are collected from 2005 to 2016. Total games and goals in top five leagues and for national team is collected 12.04.2016 (www.footballdatabase.eu).

Name	Age	Close-up video minutes	FIFA Ballon d'Or	Games (top 5 leagues)	Goals (top 5 leagues)	League titles (top 5 leagues)	UEFA CL Winners	National Team Games	Goals National Team	FIFA Club World Cup	FIFPro World XI	UEFA Team of the Year	FIFA World Cup Winners	UEFA European Winners	Homeland Player of the Year
Messi	28	74	5	338	307	7	4	105	49	2	9	7	-	-	9
Ronaldo	31	29	3	424	336	4	2	123	55	1	9	10	-	-	5
Zlatan	34	86	Nom	362	236	10	1	111	62	1	1	4	-	-	10
Xavi	36	18	Nom	505	58	8	4	137	13	2	6	5	1	2	1
Iniesta	31	45	Nom	380	34	7	4	108	13	2	7	5	1	2	1
Rakitić	27	45	Nom	274	49	1	1	74	10	1	-	-	-	-	1
Modrić	30	17	Nom	235	19	-	1	87	10	1	1	-	-	-	4
Gerrard	35	135	Nom	504	120	-	1	114	21	-	3	3	-	-	2
Sum	-	449	8	3022	1156	37	18	849	233	10	36	34	2	4	32

Appendix B:

Player inclusion table

Overview of the players appearances on the different top 20 lists conducted from www.whoscored.com. The table shows the appearances from the 2013/2014 season and the appearances for the 2012/2013 season is shown in the end and summed up.

Name	Assist rank	Total assist	Goals rank	Goals	Pass completion rank	Average pass completion %	Key passes rank	Average key passes	Total passes per game rank	Total passes per game	List of 2014	List of 2013	Sum
Yaya Toure	6	9	3	20	14	90,10			1	71,5	4	4	8
Steven Gerrard	1	13	14	13			11	2	7	65,3	4	2	6
Andrea Pirlo	16	6					6	2,3	2	69	3	3	6
Xavi Hernandez					1	93	20	1,6	1	86,2	3	3	6
Sergio Busquets					2	92,60			3	76,7	2	3	5
Xabi Alonso					12	88			5	65,6	2	3	5
Andres Iniesta	19	7			3	90,70			7	63,3	3	3	6
Cesc Fabregas	2	13			17	87	19	1,6	9	60,7	4	4	8
Luka Modric					6	89,7			12	58,4	2	4	6
Bastian Schweinsteiger					6	89,9			1	85	2	3	5
Philipp Lahm					2	91,70			2	79,5	2	2	4
Toni Kroos					1	91,90			4	75,6	2	3	5
Nigel de Jong					4	91,40			18	58,4	2	1	3
Javier Mascherano					9	88,90			15	54,4	2	2	4
Ivan Rakitic	9	10	19	12					19	51,2	3	2	5
Joao Moutinho	6	8					6	2	3	67,8	3	1	4
Jorge "Koke"	3	13					13	1,9			2	0	2

Appendix C:

Information letter to the players

NORWEGIAN SCHOOL OF SPORT SCIENCES

Geir Jordet, PhD
Director of Research and Development, Norwegian Centre of Football Excellence Professor of Psychology and Football, Norwegian School of Sport Sciences

To FC Barcelona, respectively Lionel Messi, Andrés Iniesta, Ivan Rakitić and Xavi Hernández.

Oslo, December 21, 2015

Request to use player names in research project

We, representing the *Norwegian Centre of Football Excellence*, in collaboration with the *Norwegian School of Sport Sciences (a Specialized University)* conduct scientific research on football. We are currently running a project where we have traveled around Europe to study how some of the best players collect information from their surroundings. We do this by following them with a high-zoom video camera throughout the match, to give us close-up images of everything they do in that game.

From UEFA, we have been given permission to film six games in the UEFA Champions League group stage (2014/2015). Two games in Paris, two games in Liverpool and two games in Barcelona. A total of 11 world-class players were followed with a high-zoom video camera, among these Lionel Messi, Andrés Iniesta, Ivan Rakitić and Xavi Hernández.

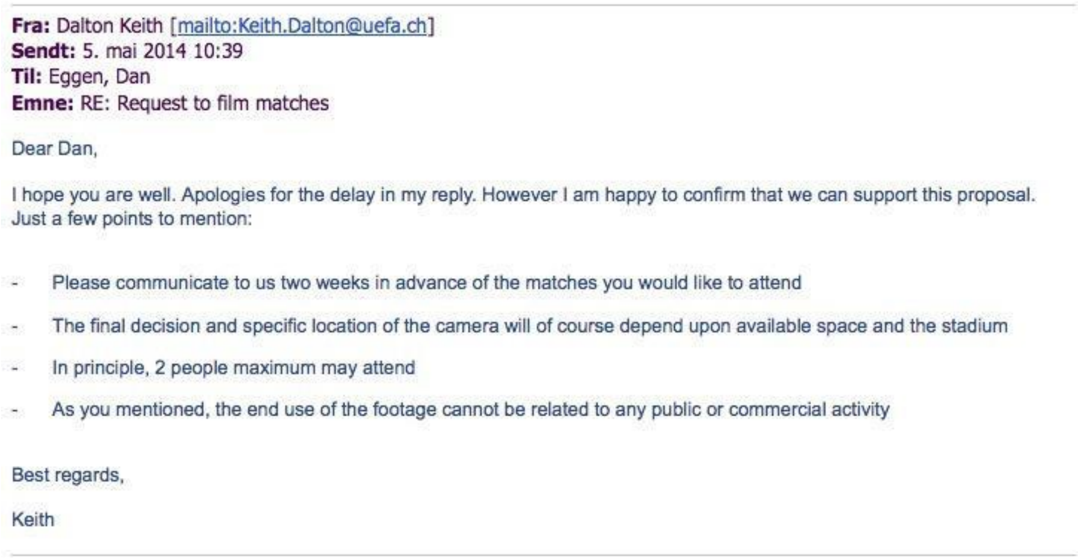
With this letter, we are humbly asking **Lionel, Andrés, Ivan** and **Xavi** for the permission to use their names in the publication. The purpose is to show the level of the players investigated. The players who were filmed in the four other games are also asked for permission to print their names.

The video images will be used for our research, for reports and presentations at seminars and meetings with scientists/coaches/players. The presentations will also contain data from the research, related to the player's name. The intention is to emphasize the high level of the players, and to show good examples of "best practice".

If interesting, we will give the club and the players full feedback about what we find in this project, related specifically to the four Barcelona players, but also the findings from the entire project.

Pleas let us know if one or all of the **players don't** want their names published, **only the player** him self or a person with a written authorization to speak on behalf of the player can answer to this request. If no answer is received from the players prior to the publishing date **30.02.2016**, the names will be printed.

The authorization to film the six UEFA Champions League matches was given to us by Keith Dalton, Senior Match Operations Manager at UEFA. This is the confirmation e-mail we received from Keith:



Fra: Dalton Keith [mailto:Keith.Dalton@uefa.ch]
Sendt: 5. mai 2014 10:39
Til: Eggen, Dan
Emne: RE: Request to film matches

Dear Dan,

I hope you are well. Apologies for the delay in my reply. However I am happy to confirm that we can support this proposal. Just a few points to mention:

- Please communicate to us two weeks in advance of the matches you would like to attend
- The final decision and specific location of the camera will of course depend upon available space and the stadium
- In principle, 2 people maximum may attend
- As you mentioned, the end use of the footage cannot be related to any public or commercial activity

Best regards,

Keith

We appreciate your time and consideration of this request.

Best regards

Geir Jordet, Norwegian School of Sport Sciences/Norwegian Centre of Football Excellence

Dan Eggen, Head of Coach Education Norwegian Football Association

Daniel Nordheim Pedersen, Norwegian School of Sport Sciences

Appendix D:

Approval letter from NSD

Norsk samfunnsvitenskapelig datatjeneste AS
NORWEGIAN SOCIAL SCIENCE DATA SERVICES

Harald Hårfagres gate 29
N-5007 Bergen
Norway
Tel: +47-55 58 21 17
Fax: +47-55 58 96 50
nsd@nsd.uib.no
www.nsd.uib.no
Org.nr. 985 321 884

Geir Jordet
Seksjon for coaching og psykologi Norges idrettshøgskole
Postboks 4014 Ullevål stadion
0806 OSLO

Vår dato: 08.12.2015 Vår ref: 44998 / 3 / MSS Deres dato: Deres ref:

TILBAKEMELDING PÅ MELDING OM BEHANDLING AV PERSONOPPLYSNINGER

Vi viser til melding om behandling av personopplysninger, mottatt 05.10.2015. Meldingen gjelder prosjektet:

44998	*World-Class and Norwegian National team players visual perception skills: A close-up video analysis in UEFA Champions League and UEFA European Qualifiers matches.*
Behandlingsansvarlig	*Norges idrettshøgskole, ved institusjonens øverste leder*
Daglig ansvarlig	*Geir Jordet*
Student	*Daniel Pedersen*

Personvernombudet har vurdert prosjektet og finner at behandlingen av personopplysninger er meldepliktig i henhold til personopplysningsloven § 31. Behandlingen tilfredsstiller kravene i personopplysningsloven.

Personvernombudets vurdering forutsetter at prosjektet gjennomføres i tråd med opplysningene gitt i meldeskjemaet, korrespondanse med ombudet, ombudets kommentarer samt personopplysningsloven og helseregisterloven med forskrifter. Behandlingen av personopplysninger kan settes i gang.

Det gjøres oppmerksom på at det skal gis ny melding dersom behandlingen endres i forhold til de opplysninger som ligger til grunn for personvernombudets vurdering. Endringsmeldinger gis via et eget skjema, http://www.nsd.uib.no/personvern/meldeplikt/skjema.html. Det skal også gis melding etter tre år dersom prosjektet fortsatt pågår. Meldinger skal skje skriftlig til ombudet.

Personvernombudet har lagt ut opplysninger om prosjektet i en offentlig database, http://pvo.nsd.no/prosjekt.

Personvernombudet vil ved prosjektets avslutning, 25.05.2016, rette en henvendelse angående status for behandlingen av personopplysninger.

Vennlig hilsen

Katrine Utaaker Segadal

Marie Strand Schildmann

Dokumentet er elektronisk produsert og godkjent ved NSDs rutiner for elektronisk godkjenning.

Avdelingskontorer / *District Offices*:
OSLO: NSD. Universitetet i Oslo, Postboks 1055 Blindern, 0316 Oslo. Tel: +47-22 85 52 11. nsd@uio.no
TRONDHEIM: NSD. Norges teknisk-naturvitenskapelige universitet, 7491 Trondheim. Tel: +47-73 59 19 07. kyrre.svarva@svt.ntnu.no
TROMSØ: NSD. SVF, Universitetet i Tromsø, 9037 Tromsø. Tel: +47-77 64 43 36. nsdmaa@sv.uit.no

Personvernombudet for forskning

Prosjektvurdering - Kommentar

Prosjektnr: 44998

Formålet med prosjektet er å kartlegge hvordan verdens beste midtbanespillere og norske A-landslagsspillere i fotball bruker hode og kroppsbevegelser for å hente inn informasjon fra miljøet rundt seg i ekte kampsituasjoner. Alle spillerne er filmet med det en kaller for close-up video. Close-up video innebærer at man zoomer helt inn på spillerne, slik at man får nærvideo av dem. Opptakene blir deretter kodet og analysert. Hensikten er å kartlegge hvordan eksplorerende søk påvirker prestasjonen med ball i ekte kampsituasjoner på det høyeste nivået internasjonalt og nasjonalt. Hovedmålet er også å kunne dra kunnskapen fra dette studiet ut i praksis for å bruke det til ferdighetsutvikling blant unge fotballspillere.

Prosjektet ble opprinnelig meldt inn som en internasjonal samarbeidsstudie hvor NiH, NFF og UEFA deltok. Slik vi forstår prosjektopplegget så er Norges idrettshøgskole behandlingsansvarlig institusjon, men samarbeider tett med Norges Fortballforbund. UEFA er ikke samarbeidspartner på annen måte enn at tillatelse til filming av Champions League kamper er innhentet fra organisasjonen. Personvernombudet forutsetter at ansvaret for behandlingen av personopplysninger er avklart mellom institusjonene. Vi anbefaler at det inngås en avtale som omfatter ansvarsfordeling, ansvarsstruktur, hvem som initierer prosjektet, bruk av data og eventuelt eierskap. Personvernombudet har mottatt kopi av tillatelse fra UEFA til filming av de aktuelle kampene i Champions League. Bruk av videomaterialet må skje i tråd med nevnte tillatelse, samt vår vurdering av prosjektet. Det er innhentet muntlig tillatelse fra landslagssjefen til filming av EM-kvalifiseringskamper for det norske landslaget.

Det meste av datamaterialet er allerede innhentet, og student har begrunnet hvorfor prosjektet ikke ble meldt i forkant av datainnsamlingen. Student er i forbindelse med vår vurdering av prosjektet gjort kjent med at behandlingen av personopplysninger skulle vært meldt i god tid og senest 30 dager før datainnsamlingen ble igangsatt.

Det innhentes ikke samtykker fra de registrerte til videre bruk av det allerede innsamlede videomaterialet. Dette begrunnes i at det vil være svært vanskelig om ikke umulig å komme i kontakt med spillerne. Student har ikke tilgang til kontaktopplysninger. Personvernombudet legger til grunn at personene som inngår i prosjektet mottar skriftlig informasjon om at det er innhentet et filmmateriale til bruk i forskningsprosjektet, og de opplyses om at de kan reservere seg fra dette innen publisering i mai 2016. Dette gjelder både norske og internasjonale spillere. Denne informasjonen sendes til spillernes klubber med anmodning om at henvendelsen videreformidles. Det informeres om at navn på spillere som er filmet ønskes benyttet i innledningen av forskningspublikasjonene. Vi viser her til informasjonsskriv mottatt den 26.11.2015. Kopi av tillatelsen fra UEFA er innlemmet i informasjonsskrivet til de internasjonale spillerne. Tilsvarende bør det nevnes i informasjonen til norske landslagsspillere at filmingen er avklart med landslagsledelsen. Personvernombudet understreker at spillere som henvender seg og som eventuelt ønsker å reservere seg helt fra å bli innlemmet i analysen, må respekteres.

Personvernombudet har vurdert hvorvidt forsker/student kan unntas fra samtykkekravet. En slik vurdering

innebærer en avveiing av samfunnsnytten og personvernulempen som de registrerte utsettes for. Vi legger student og daglig ansvarliges begrunnelser til grunn for vår vurdering. I begrunnelsen fremgår det blant annet at filmingen av de aktuelle fotballspillerne i forbindelse med prosjektet skjer i tillegg til den filmingen som allerede gjennomføres i forbindelse med
TV-produksjoner etc. Analysene som foretas av det foreliggende videomaterialet vil også være helt i tråd med de analysene som de fleste fotballinteresserte, TV-studioer og fagfolk innen fotball foretar på et eller annet nivå når de følger med på den aktuelle fotballkampen, eller i TV-sendte analyser underveis i en kamp. Slik sett foregår ikke noe annet enn det som normalt gjennomføres i forbindelse med fotballkamper på dette nivået. Personvernombudet anser at forskningsformålet i prosjektet ligger tett opp til formålet med all annen filming av de aktuelle fotballkampene, men at analysene i dette tilfellet vil foretas på et vitenskapelig nivå.

Personvernombudet legger til grunn at forsker etterfølger Norges idrettshøgskole sine interne rutiner for datasikkerhet. Dersom personopplysninger skal sendes elektronisk eller lagres på mobile enheter, bør opplysningene krypteres tilstrekkelig.

Det oppgis at personopplysninger skal publiseres. Navn innlemmes ikke i selve analysen, men vil utelukkende fremgå av innledningen. Personene vil være indirekte gjenkjennbare i analysen for personer som innehar noe kunnskap om spillernes kvaliteter og repertoar på fotballbanen. Student har redegjort for at forskningsresultatene vil presenteres i ulike fora, og at en da vil benytte ulike videoklipp for å illustrere såkalt 'best practice'. Dette fremgår av informasjonen til de registrerte spillerne. Personvernombudet legger til grunn at videomaterialet ikke publiseres, men kun vises i konkrete sammenhenger. Vi viser her også til vilkår i tillatelsen fra UEFA. Det innsamlede datamaterialet ønskes videre benyttet i undervisningssammenheng. Vi anser det som rimelig at vår vurdering også omfatter videre bruk til undervisning. Personvernombudet presiserer at videre bruk må være avtalt og skje i regi av NIH eller NFF og at bruk til undervisning for øvrig må være i tråd med tillatelse fra UEFA.

Forventet prosjektslutt er 25.05.2016. Personvernombudet vil da ta kontakt for å avklare status for prosjektet og eventuell videre bruk av personopplysninger/videomaterialet.

Kontaktperson: Marie Strand Schildmann tlf: 55 58 31 52
Vedlegg: Prosjektvurdering
Kopi: Daniel Pedersen daniel.n.pedersen@gmail.com

Appendix E:

Permission to use figure by original Author

Permission from original Author and licensee to use the pitch figure presented in Tenga et al. (2013, p.16) in master thesis and in the scientific article.

Brev til originalforfatter og rettighetshaver

Hei,

Mitt navn er Daniel Nordheim Pedersen. Jeg er masterstudent ved Norges Idrettshøyskole og spør herved om tillatelse til å benytte med av bane figuren på side 16 i deres artikkel om kamp analyse i fotball. Denne vil bli benyttet i både min master oppgave og i en vitenskapelig artikkel som skal sendes til publisering. Det blir i begge oppgaver henvist til dere under figuren. Håper på en positiv tilbakemelding fra dere.

Artikkel figuren er hentet fra;

A. Tenga, D. Kanstad, L.T. Rongland & R. Bahr (2009). Developing a new Method for Team Match Performance Analysis in Professional Soccer and Testing its Reliability. *International Journal of Performance Analysis of Sport. p. 8-25.*

Brevet fra master student er lest og jeg gir herved tillatelse til å bruke vår bane figur i master oppgave og i vitenskapelig artikkel:

Sted/Dato: /27/04/2016/

Underskrift: [illegible]

Appendix F:

Main analysis variable overview and definitions

This appendix consists of the variables developed for and used in the analysis of the included situations. First a table overview of all variables is represented. Second, the definitions of all variables and subvariables are outlined. This manual was given to the analyst who analysed 10% of the situations in the inter observer reliability test.

Table of contents

Table overview of variables

Overview of all variables and their respective subvariables used in the analysis.

1	2	3	4	5	6
Situation number	**Player situation number**	**Player number**	**General playing position**	**Primary foot**	**Role in the team**
1 2 3 *	1 2 3 *	P1 P2 P3 P4 P5 P6 P7 P8	Midfielder Attacker	Left Right Both	Captain Vice-captain Best player on the team Second best player Youngster Experienced player
7	**8**	**9**	**10**	**11**	**12**
Specific skill sett	**Player status**	**Playing style**	**Playing style opponent team**	**The players' team level**	**Opponent team level**
Goal scorer Assist king Passing expert Dribbling expert	In the starting line-up Substitute	4-3-3 4-4-2 4-1-3-2 4-4-1-1	4-3-3 4-4-2 4-1-3-2 4-4-1-1	C1 C2 C3	C1 C2 C3

13	14	15	16	17	18
Competition situation player team	**Competition situation opponent team**	**Game period**	**Game location for the analysed player**	**Score**	**Game status**
Playing-qualify Playing-not qualify Already qualified Already disqualified	Playing-qualify Playing-not qualify Already qualified Already disqualified	First half Second half	Home Away	0-0 Up by one Down by one *	Winning Losing Drawing
19	**20**	**21**	**22**	**23**	**24**
Weather conditions	**Player position in lineup**	**Player team possession**	**Opponent team possession**	**Game time**	**Player playtime**
Sunny Raining Windy Spotlight	Striker Left wing Right wing Attacking midfielder Defensive midfielder Left midfielder Right midfielder Centre midfielder Centre back right Centre back left Left back Right back Goalkeeper	30% 40% 50% 60% *	30% 40% 50% 60% *	00:01 min 00:02 min 00:03 min 00:04 min *	00:01 min 00:02 min 00:03 min 00:04 min *

25	26	27-30	31-34	35-38	39
Situation time interval	**Situation type**	**Pitch position, zones and corridors**	**Opponent pressure**	**Body orientation**	**Passing teammate**
00:02 sec 00:04 sec 00:06 sec 00:08 sec *	10 seconds in team Turn over (opponent lost possession) Wall pass with teammate Set piece	FT-L FT-CL FT-CR FT-R M1-L M1-CL M1-CR M1-R M2-L M2-CL M2-CR M2-R FIT-L FIT-CL FIT-CR FIT-R SB-L SB-R	0m 0.5m 1m 2m *	Forward Sideward Backward	Striker Left wing Right wing Attacking midfielder Defensive midfielder Left midfielder Right midfielder Centre midfielder Centre back right Centre back left Left back Right back Goalkeeper

40	41	42	43	44	45
Pass angle	**Passing length**	**Pass speed m/s**	**Pass speed km/h**	**Ball trajectory**	**Pass side**
From left From right Straight/no angle	0.5m 1m *	1 m/s 2 m/s *	1 km/h 2 km/h *	Ground ball Air ball Bouncy ball	Inside Outside Straight

46	47	48	49	50	51
Visual exploratory behaviour (VEB) types	**Other head movements**	**Total VEB**	**Left and Right VEB**	**Right VEB**	**Left VEB**
Brief 180 degree Sequential Long	Micro search Mental break	0 1 2 *	1 2 3 *	1 2 3 *	1 2 3 *
52	**53**	**54**	**55**	**56**	**57-58**
Straight VEB	**VEB Against opponent goal**	**VEB frequency**	**Position when receiving from teammate**	**Pitch position receiving**	**Position in opponent section**
1 2 3 *	1 2 3 *	0.0 searchers/second 0.1 searchers/second 0.2 searchers/second *	Closer opponent goal Closer own goal Farther away from opponent goal Neutral	Own half Opponent half	In front of AL In-between AL and ML In-between ML and DL Behind DL In AL In ML In DL
59	**60**	**61**	**62**	**63**	**64**
Position in space	**First action**	**Turns**	**Ball touches**	**Last action**	**Hierarchical model**
High position Mid position Low position	Clearance Finishing inside score box	Successful Not successful Not used	1 2 3	Clearance Finishing inside score box	Try to score Pass/dribble into score box

In-between opponent section In-front of all opponent players	Finishing outside score box Direct pas/flick Duel win Let the ball pass by Receiving Passing		4 *	Finishing outside score box Direct pas/flick Duel win Let the ball pass by Receiving Passing Dribbling Running with the ball	Pass/dribble into assist area Penetrating pass/dribble Forward pass/dribble Maintain possession
65	**66**	**67**	**68**	**69**	**70**
Result of action	**Action direction**	**Possession status after action**	**Pass direction**	**Forward pass**	**Penetrating pass**
Duel Leeds to finishing after duel Leeds to finishing without pressure Leeds to goal Free-kick Penetrating pass Not penetrating pass Corner Throw-in Retrieve the ball back Goal Lose the ball to opponent Offside	Forward Sideward Backward	Maintained Lost Other	Forward Sideward Backward	Complete Not Complete Not used	Complete Not Complete Not used

Penalty Goalkeeper kick Other					
71	**72**	**73**	**74**	**75**	**76**
Penetrating length	**Dribble/running with ball result**	**Dribble penetrating length**	**Receiving teammate**	**Pass accuracy**	**Team possession type**
Long Short Not used	Penetrating dribble success Penetrating dribble partial success Penetrating dribble not success Not penetrating dribble success Not penetrating dribble partial success Not penetrating dribble not success Not used	Long Short Not used	Striker Left wing Right wing Attacking midfielder Defensive midfielder Left midfielder Right midfielder Centre midfielder Centre back right Centre back left Left back Right back Goalkeeper	Complete Not Complete Not used	Counter attack Set Play Elaborate play Other
77	**78**	**79**	**80**	**81**	**82**
Set play start	**Elaborate attack start**	**Opponent balance**	**Pass number**	**Playing tempo**	**VEB ball contact time interval**
Delayed Fast Not applicable	Counter-attack start Set-play start Not applicable	High imbalance Imbalance Starting Imbalance	1-2 Very low 3 Low 4 High	High: 1-2 touches More high; more high then low	00:02 sec 00:04 sec 00:06 sec

Other	Other	Balance High degree of balance Other Impossible to see	4< Very high	Neutral: equal amount high and low More low; greater number of low than high Low; 3 or more touches	00:08 sec *

Definition of variables

1. Situation number

Situation number is operationally defined as the number of each situation, starting at one with the first situation and continuing with a gradient of one to the last situation included for analysis (N = 269).

2. Player situation number

Player situation number is operationally defined as the number of each situation for each player, starting at one for the first situation and continuing with a gradient of one for each situation included for analysis.

3. Player number

The eight analysed UEFA Champions League players in the study have been randomly coded from P1 to P8. The purpose is to ensure the players immunity both in the analysis material and in the presentation of the results of the study.

4. General playing position

General playing position is operationally defined as the analysed players playing position. Either registered as midfielder or attacking (forward) player.

5: Primary foot

The primary foot variable registers if the player is left or right footed, if he uses both feet equally much it is registered as both.

6: Role in the team

Role in the team is operationally defined as the analysed players role in the team, in terms of what he is known for in the team he is playing for (Jordet, 2004, p. 75). Registered as captain of the team, vice-captain, best player, second best player and if he is an experienced player.

7: Specific skill sett

Specific skill sett is operationally defined as which skill sett the analysed player is publicly known for (Jordet, 2004, p. 75). Registered as passing expert, goal scorer, assist king or dribbling expert.

8. Player status

Player status is operationally defined as whether the analysed player was in the starting lineup or if he was a substitute.

9-10. Playing style. Playing style opponent team

Playing style is operationally defined as the line up combination of both the opponent and the analysed players team (Jordet, 2004, p. 75). Two examples are 4-4-2 and 4-3-3.

11-12. The players' team level. Opponent team level

Quality of the players' team is operationally defined as a ranking of the analysed players' team in relation to the performance and achievements in UEFA Champions League 2014/2015. The same rank was given to the opponent team. The three ranked categories was:
CL1: this is the highest team ranking, and all the teams who played semi-finals and final in the UEFA Champions League 2014/15 is ranked in this group.
CL2: this is the second highest team ranking, and all the teams (except CL1 ranked teams) who qualified to the knockout phase of the UEFA Champions League 2014/15 is ranked in this group.

CL3: this is the lowest team ranking, and all the (except CL1, CL2 ranked) teams who played in the group stage, but didn't qualified to the knockout phase of the UEFA Champions League 2014/15 is ranked in this group.

13. Competition situation player team.

Competition situation player team is operationally defined as what the analysed players team current competition status is. For each included situation this variable registers if the player team is; playing to qualify, playing and not qualifying, already before the game qualified or not qualified. As an example, if the analysed player team is down by one goal they are at the moment playing the game and they know that if the result stays this way they will not qualify, this is registered as not qualify. Another example is when the team already before the game regardless of any outcome of this game or other games is qualified or not qualified to the knockout phase.

14. Competition situation opponent team.

Competition situation opponent team is operationally defined as variable 13, but registers the competition status of the opponent team in each situation. This makes it possible to investigate how the competition status as for both teams in each situation.

15. Game period

Game period is operationally defined as the two innings of the game. Registered as first half or second half.

16. Match location

Match location registers if the analysed player is playing home or away. It is recommended to always take the match location into account when conducting a performance analysis in soccer (Mackenzie & Cushion, 2012).

17. Score

Score is operationally defined as the score in the match at the start of each situation included in the analysis. As an example, if the score is 0-0 when the player receives the ball and the end product of the players' action is a goal, the score is registered as 0-0 in that situation. It is recommended to always take the game score into account when conducting a performance analysis in soccer (Mackenzie & Cushion, 2012). The score is registered as down by or up by one/two/three/four goals, if the score is even (except when it is 0-0) it is registered as draw.

18. Game status

Match status is operationally defined as if the analysed players team is winning, loosing or drawing at the moment the situation starts. The intention is to take into count that the match development and score may influence the team tactics and consequently the players' actions, which may influence the visual exploratory behaviour. The match status variable is conducted from Lago (2009), recommended as an necessary variable in performance analyses by Mackenzie and Cushion (2012).

19. Weather condition

Weather condition is operationally defined as the weather conditions during each situation. This is registered due to the findings in Jordet (2004) PhD dissertation, where the players stated that the weather could influence the visual exploratory activity. The weather was registered as: sunny, windy, raining, or if it was dark and the spotlights in the stadium was on.

20, 39 and 74. Player position. Passing teammate. Receiving Teammate

Player position is operationally defined as the playing position of the players who played the match. The playing position was determined by the line-up represented prior to match start, and this was registered three times in each situation. First the position of the analysed player, then the position of the teammate who passed the ball to the analysed player, finally the position of the teammate who receives the ball from the analysed player is registered. If the analysed players' last action is not a pass to another teammate, the last player position is not registered. The intention of this mapping is to investigate the playing pattern between the teammates and the participant, and whether this may influence the visual exploratory activity.

21-22. Player team possession. Opponent team possession.

Overall team possession is obtained from the UEFA Champions League webpage (www.uefa.com), where the game statistics from each game hade calculated the ball possession (measured in percentage) for each team. This was registered for both teams, in order to investigate if there is a correlation between ball possession and other variables in this analysis, especially the visual exploratory activity among the players investigated.

23. Game time

Game time is operationally defined as the time on the scoreboard when the analysed situation starts. This makes it possible to investigate the development of the players' behaviours and actions throughout the game.

24. Player playtime

Player playtime is operationally defined as the total minutes and seconds the player has played in the game. This makes it possible to investigate the development of the players' behaviours and actions throughout the game, and see if the visual exploratory behaviour changes in line with the total amount of minutes played.

25. Situation time interval

Situation time interval is operationally defined as how many seconds each situation leading up to the receiving of the ball consists of, with the following restrictions: The number of visual explorations was counted in the 10 seconds leading up to a player receiving the ball (if the ball was turned over to the player's team or put into play from a set piece within that 10-second period, the counting started from that moment that the ball was turned over, and four seconds prior to the execution of the set piece).

26. Situation type

Situation type is operationally defined as the characteristics of the ball possession before the analysed player receives the ball. There are four types of situations that are included in the analysis.

10 seconds in team is operationally defined as the situations where the analysed players' team is in possession of the ball 10-seconds or more prior to receiving the ball. In these situations the analysis starts 10second prior to receiving, and variable 25 will therefore always be 10 seconds for these situations.

Turn over (opponent lost possession) is operationally defined as the situations where the opponent team looses the ball in play to one of the analysed players teammates, and the analysed player receives the ball from a teammate inside the 10-second interval. If the possession of the ball is maintained in the team for 10 seconds or more before the analysed player receives the ball, it's registered as situation one.

Wall pass with teammate is operationally defined as the situations where the analysed player plays the ball to a teammate and the possession of the ball is maintained in the team and the analysed player receives the ball back inside the 10 second interval it is registered as wall pass with teammate. If the possession of the ball is maintained in the team for 10 seconds or more before the analysed player gets it back it is registered as situation one.

Set piece is operationally defined as all the situations where the analysed player receives the ball from one of his teammates set pieces (corner, throw-in, free-kick, goal kick etc.). If the set piece is taken 10 seconds or more before the analysed player receives the ball, it is registered as situation one. The time interval in the set piece situations starts four seconds before the set piece is taken, and the analysis of the searches is registered for the whole time interval.

27-30. Pitch position, zones and corridors.

Pitch position is operationally defined as the subdivisions of the football pitch, obtained from Tenga, Kanstad, Ronglan, and Bahr (2009, p. 12). These subdivisions are used four times in each situation to register the position; of the passing teammate, where the participant receives the ball, where he execute the final action and where the ball ends up after the final action (see figure below). The definitions of the zones and corridors is obtained from Tenga et al. (2009, p. 12):

1. Pitch Zones (six categories, five ordered)

Def. Area across the playing field (see figure 1).

A. First third (FT): 1/3 of the playing field estimated from own goal line to middle third 1.

B. Middle third 1 (M1): first half of the middle third area estimated from end of the first third to midline.

C. Middle third 2 (M2): second half of the middle third area estimated from midline to final third.

D. Final third (FIT): 1/3 of the playing field estimated from end of the middle third 2 to opponent's goal line, excluding score box.

E. Score box: Area in front of the opponent's goal defined as an imaginary prolongation of the penalty area from 16 m to 30 m line estimated distance from opponent's goal line.

F. Other

2. Pitch corridors (five categories, four ordered)

Def. Area along the playing field (see figure 1).

A. Right (R): Area from imaginary line joining right sides of the penalty areas when facing the opponent's goal to right sideline.

B. Central right (CR): Area from imaginary midline along the field to imaginary line joining right sides of the penalty areas when facing the opponent's goal.

C. Central left (CL): Area from imaginary line joining left sides of the penalty areas when facing the opponent's goal to imaginary midline along the field.

D. Left (L): Area from left sideline to imaginary line joining left sides of the penalty areas when facing the opponent's goal.

E. Other

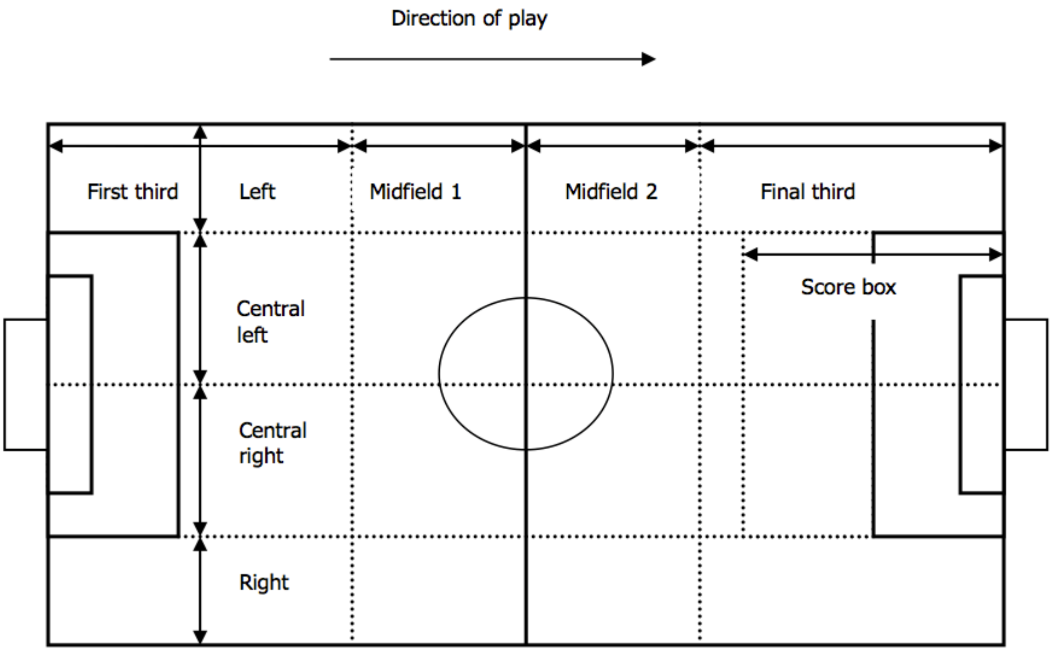


Figure explanation: Zones and corridors of the playing field. Zones included first third, midfield 1, midfield 2, final third and score box, while corridors included right, central right, central right, central left and left corridor. Note. Right side of figure is retrieved from Developing a New Method for Team Match Performance Analysis in Professional Soccer and Testing its Reliability, by A. Tenga, D. Kanstad, L.T. Rongland & R. Bahr 2009, *International Journal of Performance Analysis in Sport, vol 9, s.16.* Reprinted with permission from Albin Tenga, see Appendix E.

31-34: Opponent pressure

Opponent pressure was operationally defined as the distance between the analysed player and the closest opponent player, measured in meters (Jordet, 2004, p. 129). Opponent pressure was registered four times for each situation; when the teammate passed the ball, when the participant received the ball, in the second touch and in the final touch with the ball. Opponent pressure estimated as 0 meters means that there is body contact between the analysed player end the opponent player, and 0,5 meters means extremely close pressure with no body contact. From 0,5 meters and up, the pressure is estimated in whole meters (1m, 2m, 3m, and so on).

35-38. Body orientation

Body orientation is operationally defined as the direction of the frontal (anterior) side of the players' body (thoracic/chest and coxa/hip). If the frontal side is directed toward the opponent goal line, the player is forward orientated. When directed towards the sideline he is sideward orientated, and when directed towards his own goal line he is backward orientated. In doubtful situations the direction of the lower body was used as reference. The body orientation was registered four times for each situation; when the teammate passed the ball, when the participant received the ball, in the second touch and in the final touch of the ball.

40. Passing angle

Passing angle is operationally defined as the angle of the pass from the teammate to the analysed player. This is registered as from left side, right side or straight/no angle in relation to the frontal side of the body to the analysed player. The intention is to se if there is a link between direction of pass and direction of the visual exploratory behaviour that the analysed player performs.

41. Passing length

Passing length is operationally defined as the distance (measured in meters) between the position where the teammate passes the ball and the position where the analysed player receives the ball.

42-43. Pass speed m/s. Pass speed km/h

Pass speed m/s is operationally defined as the average speed (m/s) of the pass from the teammate to the analysed player. Additionally this speed was calculated in km/h.

44. Ball trajectory

Ball trajectory is operationally defined as the trajectory of the ball between the passing teammate and the analysed player. If the ball is played from the passing player in the air without touching the ground or just touching the ground one time before the analysed player touches the ball, it is registered as an “air ball”. If the ball is passed along the ground, it is registered as a “ground ball”. When the ball is not an “air ball” and not a “ground ball”, but something in-between it is registered as a “bouncy ball“.

45. Pass side

Pass side is operationally defined as the direction of the pass from the teammate to the analysed player, in terms of if it is directed towards the centre of the pitch (inside), or towards the sidelines (outside), or if it has no particular angel in or out and is therefore registered as straight.

46. Visual exploratory behaviour (VEB) types

Visual exploratory behaviour was operationally defined as:

> A body and/or head movement in which the player's face is actively and temporarily directed away from the ball, seemingly with the intention of looking for teammates, opponents or other environmental objects or events, relevant to perform a subsequent action with the ball (Jordet, Bloomfield, & Heijmerikx, 2013, p. 2).

Visual exploratory behaviour (VEB) types are operationally defined as four different types of visual exploratory behaviour performed by the analysed player. The total amount of each type was counted in each situation. The four exploratory activity types are operationally defined as:

> **1. Sequential** exploratory behaviour (a compounded continuous sequence of exploratory searches in which the player's face is clearly directed towards several distinct areas of the field, before the face is redirected towards the ball);
>
> **2. Long** exploratory behaviour (an exploratory search in which the player's face clearly is directed away from the ball for the duration of a second or more before it is redirected towards the ball); and
>
> **3. 180-Degree** exploratory behaviour (the player's face is clearly directed in the opposite direction of the ball viewed trough an axis from the ball straight trough the players body).
>
> **4. Brief** exploratory behaviour (regular exploratory search, not sequential, not long, and not 180 degree).

VEB type 1 to 4 is defined and used by Jordet (2004, pp. 128-129). Additionally, type 1 to 3 is defined and used by Jordet (2005, p. 144).

47. Other head movements

Other head movements are operationally defined as head movements that are not one of the four types defined in variable 46. Micro search is a small head movement where the player executes small rapid scans of the nearest surroundings, and was registered to try to see if this registration could have contributed to a fifth VEB type. All of the micro searchers are also registered as brief searchers. Mental break was head movements away from the ball that was not registered as visual exploratory behaviour. This was behaviour where the player looked straight down on the ground without any vision towards other areas of the pitch before returning the head to the ball.

48. Total VEB

Total VEB is operationally defined as a numeric registration of the total amount of visual exploratory searches, executed by the analysed player from the start of the time interval (see variable 25) to the first touch on the ball. The purpose is to estimate the Visual exploratory behaviour frequency in the same way that has been done in Eldridge, Pulling, and Robins (2013); Jordet (2004, 2005); Jordet et al. (2013).

49. Left and Right VEB

Left and right VEB is operationally defined as; a compounded continuous sequence of exploratory searches in which the players face is clearly directed towards both left and right sides, relative to their own bodies, before the face is redirected towards the ball again. The total number of left and right searches is counted in the time interval (see variable 25) prior to receiving the ball (Jordet, 2004, p. 128).

50. Right VEB

Right VEB is operationally defined as the total amount of visual explorations to the right side relative to the players' frontal side of the body, in the time interval (see variable 25) prior to receiving the ball.

51. Left VEB

Left VEB is defined as the total amount of visual explorations to the left side relative to players’ frontal side of the body, in the time interval (see variable 25) prior to receiving the ball.

52. Straight VEB

Straight VEB is defined as the total amount of visual explorations that is not directed towards left or right, but straight ahead in relation to their own bodies, in the time interval (see variable 25) prior to receiving the ball.

53. VEB Against opponent goal

VEB Against opponent goal is operationally defined as the total amount of the VEB that are directed toward the opponent goal.

54. VEB frequency

VEB frequency was assessed by dividing the number of VEB counted in one situation with the total number of seconds in the time interval of that situation. Because the time intervals varied from situation to situation, it was necessary not only to count the searches but also make the number of searches relative to time. The frequency provided a fundamental measure of the extent to which the participants engaged in exploratory activity. The number of visual explorations was counted in the 10 seconds leading up to a player receiving the ball (if the ball was turned over to the player’s team or put into play from a set piece within that 10-second period, the counting started from that moment that the ball was turned over/set into play). This 10 second period was developed by Jordet et al. (2013, pp. 2-3) on the basis of the original of 2 second period that Jordet (2005) used.

55. Position when receiving from teammate

Position when receiving from teammate is operationally defined as the analysed player position in relation to the passing teammate. When the analysed player received the ball closer to the opponent goal in relation to the passing teammate it was registered as closer opponent goal. When the analysed player was closer to his teams own goal than the passing teammate it was registered as closer own goal. If the distance to the players own goal or opponent goal did not differ between the passing player and the analysed player it was registered as neutral. Finally, if the analysed player receives the ball farther away from the opponent goal but not closer to his teams on goal in relation to the passing teammate it is registered as “farther away from opponent goal”. This variable is based and developed from the included game situation definition by Jordet (2005, p. 146) and Jordet et al. (2013, p. 2).

56. Pitch position when receiving

This was registered as whether the analysed player received the ball on his teams half or the opponent teams half of the pitch..

57-58. Position in opponent section

Position in opponent section is operationally defined as the participant’s position in relation to the opponent teams line-up sections (see figure below). This was registered two times, when the player received the ball and in the final touch of the ball. This variable is an English refined version of the original ideas developed by Bergo, Johansen, Larsen, and Morisbak (2002, p. 125). The different positions in the opponent sections is defined as:

- **Behind DL** (defensive line) – space in-between the opponent defensive line and the opponent goal line.

- **In DL** (Space in defensive section) - in-between the players in the opponent defensive section.

- **In-between ML and DL** (midfield line and defensive line) - space in-between the opponent midfield and defensive section.

- **In ML** (Space in the midfield section) - in-between the players in the opponent midfield section.

- **In-between AL and ML** (attacking line and midfield line) - space in-between the opponent attacking and midfield section.

- **In AL** (Space in the attacking line) - in-between the players in the opponent attacking section.

- **In front of AL** (attacking line) - space in between the opponent attacking line and the participant's own goal line.

- **Corridor** – when the player is positioned in one of the four corridors wide in the field, between the sixteen-meter line and the sideline as illustrated on the figure below.

- **Centrally**- when the player is positioned in one of the four spaces centrally on the pitch, which are in-between the two sixteen-meter lines, as illustrated on the figure below.

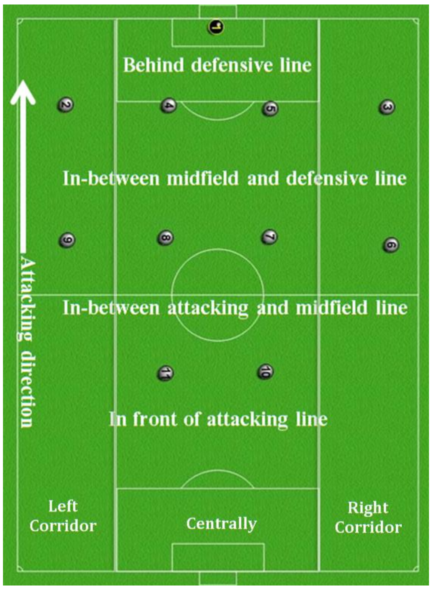


Figure Explanation: Pitch illustration of the sections in-between, in front of and behind the opposition line-up. Exemplified with a 4-4-2 line-up.

59. Position in space

Position in space is operationally defined as the analysed players' position in the space in-between the opposition line-up when receiving the ball (see figure below). The five different positions was defined as:

High position in space = when the player is positioned in the space near the opponent goal, indicated with red circle.

Mid position in space = when the player is positioned in the middle of the space, indicated with brown circle.

Low position in space =when the player is positioned in the space near his teams own goal, indicated with yellow circle.

In-between opponent section = when the player is positioned in-between either the attacking, midfield or defensive opponent section.

In-front of all opponent players = when the player is positioned in front of all the opponent players, meaning that all the opponent players are located between the analysed player and the opponent goal.

Figure explanation: Illustration of the players position in-between the opponent sections. The yellow circle indicates the player low in the space, the brown indicates the player in the middle of the space, and the red indicates the player high in space. The two final positions are not shown in the figure because these are self-explaining.

60 and 63. First action and last action.

Action with the ball (first/last) is operationally defined as the analysed player's actions with the ball. This is registered two times in each situation. Example: if the player receives the ball and then looses the ball to an opponent, the first action with the ball is receiving and the last action with the ball is receiving. If the player receives the ball and passes it forward, then the first action is receiving and the last action is passing. The purpose is to get a deeper analysis of the link between visual exploratory behaviour and action with the ball. Definitions of the different variable used is explained below:

Variables used for both first and last action:

Clearance = this is an action were the player clear the ball away, often in a panic situation in which the player is under pressure and is happy with an aimlessly kick upfield or out of play. This is often executed with the intention to prevent an immediate threat to the goal.

Finishing inside score box = when the player finishes with the intention to score inside the score box area, se variable 27 for score box definition.

Finishing outside score box = when the player finishes with the intention to score outside the score box area, se variable 27 for score box definition.

Direct pas/flick = when the player tries to pas or flick the ball to another teammate with the first touch of the ball.

Duel win = when the player is competing against an opponent to win the ball, both in air and on the ground, and the player wins the ball.

Let the ball pass by = when the player seemingly have control over the ball when it arrives, but chooses to jump over or let it pass with the intention that another teammate will receive it instead.

Receiving = when the player uses the technique required to control an incoming ball.

Passing = this is a technique used bye the player to transport the ball to another player. Different technique can be used inside of the foot, outside of the foot, heal etc.

Variables used only for final action:

Dribble = when the player moves the ball with control past one or more opponent players.

Running with the ball = when the player moves with the ball in control, in any direction without passing any opponent players.

61. Turn

Turn is operationally defined as whether the player executes a successful turn or not. If the player is backward orientated when the teammate passes the ball and are forward orientated in the first or second touch of the ball he has completed a successful turn. If the player tries to turn but looses possession of the ball as the result of the turn it is registered as not successful. If the player does not execute a turn it is registered as not used. This variable is a more objective measure of the turning variable used in Eldridge et al. (2013, p. 565).

62. Ball touches

Ball touches are operationally defined as the player's total amount of touches on the ball in each situation, counting starts with the first and ends with the last touch on the ball.

64. Hierarchical model

Hierarchical model is operationally defined as the analysed players intentions with the last action with the ball in relation to a six step hierarchical soccer model. Where the main goal, to score, indicates the highest level in the model. Score is registered when the player scores a goal or if he attempt to score. Pass/dribble into score box is when the player attempt to dribble or pass the ball into the score box. This area is developed by Tenga et al. (2009) (see variable 27) and underlined by Ruiz, Lisboa, Neilson, and Gregson (2015). Pass/dribble into assist area is when the player attempt to dribble or pass the ball into assist area (the final third area in the pitch area from Tenga et al., 2009. p16). Penetrating pass/dribble, forward pass/dribble and maintain possession was the registered when the players attempt to execute one of the actions.

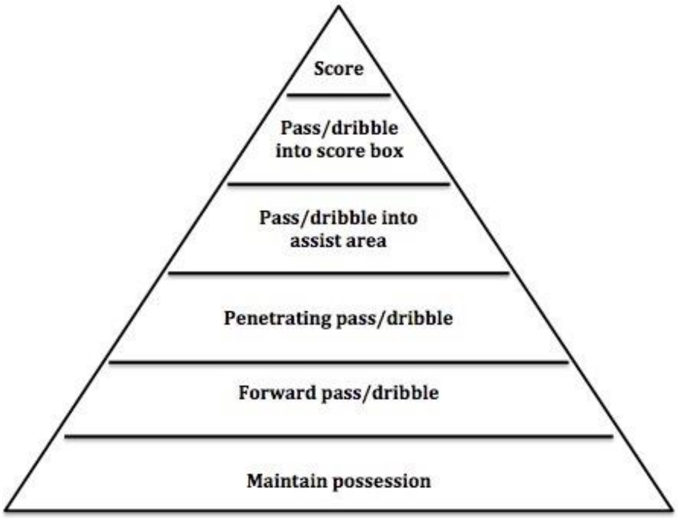


Figure explanation: Hierarchical football action model. The highest level of football action is to score and the lowest level is to maintain the possession.

65. Result of action

Result of action is operationally defined as the product of the players' action in each situation. In other words the outcome of the action, what the action leads to in the next situation. The player action can lead to:

Duel = a duel between one or more teammates and one or more opponents.

Finishing after duel = a situation where a teammate manages to finish after a duel against one or more opponent players. Typically a cross-in situation.

Finishing unpressed = a unpressed finishing by a teammate

Teammate Goal = a teammate scores in the next situation.

Free-kick = a free-kick either for or against his own team. Variable 67 registers whether it's a free-kick for or against the player.

Penetrating pass = passes towards the opponent goal past opponent player(s) while maintaining control over the ball.

Not penetrating pass = all completed passes that are not penetrating passes.

Corner = a corner either for his one team or the opponent team. Variable 67 registers whether it's a corner for or against the player.

Throw-in = a throw-in either for his own team or the opponent team. Variable 67 registers whether it's a throw-in for or against the player.

Retrieve the ball back = when the player lose the ball, but immediately manage to retrieve the ball back to him self or the team.
Goal = a direct goal. The player scores him self.
Lose the ball to opponent = when the player lose the ball to the opponent team, either by passing the ball to an opponent or lose the ball while dribbling the ball, or lose the ball while receiving it.
Offside = when the player passes the ball to a teammate in offside.
Penalty = when the player him self or the teammate that he passed the ball to is rewarded with a penalty kick by the referee, due to a infringement of the laws of the game inside the opponent 16meter area.
Goalkeeper kick = a goalkeeper kick by the opponent keeper.
Other = if the action leads to something else than the variables above.

66. Action direction

Action direction is operational defined as the main direction of the analysed players' action in each situation, where the direction is estimated by the player actions in relation to the opponent goal line:
Forward = registered when the players action (e.g. pass or dribble) is directed towards the opponent goal line.
Backwards = when the players action (e.g. pass or dribble) is directed away from the opponent goal line.
Sideways = when the players action (e.g. pass or dribble) is directed in the same distance from both the opponent goal line and his own goal line.

67. Possession status after action

Possession status after action is operationally defined as the result of the players' final action in terms of possession maintained in the team or possession lost to the opposition. This is only registered in the immediate situation after the players' last action. However, possession is not lost if an opponent player only touches the ball one time before the ball is regained, or the ball goes out of play, and the analysed players' team gets a throw-in, free-kick, penalty-kick or a corner, this is registered as possession maintained. If the player loses the ball out of play or passes the ball to an opponent player, it's registered as possession lost.

68. Pass direction

Pass direction is operational defined as the direction of the analysed players' pass in each situation, where the direction is estimated in relation to the attacking direction (opponent goal line).

Forward = registered when the players pass is directed towards the opponent goal line.

Backwards = when the players pass is directed towards his teams goal line.

Sideways = when the players pass is directed towards the sidelines without getting closer to his teams or the opponent teams goal line.

Not used = registered when players final action is not a pass.

69. Forward pass

Forward pass is operationally defined as the analysed players degree of forward pass completion, which is registered as forward pass complete, not complete or other. Forward pass complete is registered when the analysed player passes the ball forward in the attacking direction and a teammate receives the ball. Forward pass not completed is registered when the analysed player passes the ball forward but misses his teammate and the ball goes out of play, or an opponent player intercepts the pass. When the players' final action is not a forward pass it is registered as not used.

70. Penetrating pass

Penetrating pass is operational defined as the success rate of the analysed players' penetrating passes, registered as complete, not complete or not used:

Complete = registered when the player hits a teammate with the penetrating pass.

Not complete = registered when the player misses on a penetrating pass, where either an opponent intercept the ball or it goes out of play and the players team looses possession of the ball.

Not used = registered when players does not execute a penetrating pass.

71. Penetrating length

Penetrating length is operationally defined as the length of the players penetrating pass in terms of how many opponent players the ball passes in the attacking direction. If the ball passes one opponent player or one opponent section (e.g. midfield line) it is registered as a short penetrating pass. If the ball passes more than one opponent and/or several opponent sections (e.g. midfield and defensive line) it is registered as a long penetrating pass. If the final action is not a penetrating pass it is registered as not used.

72. Dribble/running with ball result

Dribble/running with ball result is operationally defined all the situations where the analysed player dribbles or run with the ball. This variable was inspired by the dribble penetration variable used in Tenga et al. (2009, p. 14), and is registered in seven categories:

1) Penetrating dribble success, is registered as all the situations where the player dribble past one or several opponent players in the attacking direction, regardless of the fact that his final action is to pass the ball to the opposition.

2) Penetrating dribble partial success, is registered as all the situations where the player dribble past one or several opponent players in the attacking direction, but when he attempt to dribble past one or several extra player(s) he looses the ball to the opposition.

3) Penetrating dribble not success, is registered as all the situations where the player attempts to dribble past one or several opponents in the attacking direction, but looses the ball to the opposition.

4) Not penetrating dribble success, is registered as all the situations where the player dribble past one or several opponent players backwards or sideways (not attacking direction), regardless of the fact that his final action is to pass the ball to the opposition.

5) Not penetrating dribble partial success, is registered as all the situations where the player dribble past one or several opponent players backwards or sideways (not attacking direction), but when he attempt to dribble past one or several extra player(s) he loses the ball to the opposition.

6) Not penetrating dribble not success, is registered as all the situations where the player attempt to dribble past one or several opponents backwards or sideways (not attacking direction), but looses the ball to the opposition.

7) Not used, is registered in the situations where the player doesn't dribble or run with the ball.

73. Dribble penetrating length

Dribble penetrating length is operationally defined as the length of the players penetrating dribble in terms of how many opponent players he passes in the attacking direction. If the he passes by one opponent player or one opponent section (e.g. midfield line) it is registered as a short penetrating dribble. If the ball passes by more than one opponent and/or several opponent sections (e.g. midfield and defensive line) it is registered as a long penetrating dribble. If the final action is not a penetrating dribble it is registered as not used.

75. Pass accuracy

Pass accuracy is operationally defined as whether the player completes or not completes the passes to another teammate. If the player passes the ball to another teammate who touches the ball once or more, it is registered as "pass completed". If the player passes the ball to an opponent player or out of play it is registered as "pass not completed". All other final actions made by the player are registered as not used. The purpose is to se if there is a correlation between a player's pass accuracy and VEB prior to receiving the ball.

76. Team possession types

Obtained from Tenga et al. (2009, p. 12):

1. Team possession type (four categories, two ordered)

Def. Degree of offensive directness by levels of utilization or creation of imbalance in the opponent's defence to achieve penetration (i.e. how quick penetration is attempted after ball winning). Penetration is achieved when a pass goes towards the opponent's goal past opponent player(s) while maintaining high degree of control over the ball. High degree of control over the ball means enough space and time that makes it easier to perform intended actions on the ball.

A. Counter attack ("direct play"): starts by winning the ball in play and progresses by either a) utilizing or attempting to utilize a degree of imbalance from start to the end, or b) creating or attempting to create a degree of imbalance from start to the end by using early (i.e. 1st or 2nd, evaluated qualitatively) penetrative pass or dribble. Utilizing degree of imbalance means seeking penetration in such a way that a defending team fails to regain high degree of balance from start to the end of team possession. Counter attacks progress relatively fast.

B. Set play: starts by a set play and finishes while players still are more in original set play grouping. In case team possession takes longer time and finishes while players' positions are no longer influenced by original set play grouping, a set play becomes elaborate attack with a set play-start. Set plays often take relatively short time.

C. Elaborate attack ("possession play"): starts by either winning the ball in play or a set play and progresses either a) without utilizing or attempting to utilize a degree of imbalance, or b) by creating or attempting to create a degree of imbalance by using late (3rd or later, evaluated qualitatively) penetrative pass or dribble. Not utilizing a degree of imbalance means seeking penetration in such a way that a defending team manages to regain high degree of balance before the end of team possession. Elaborate attacks often progress relatively slow.

D. Other: team possession that fails to be registered as counter attack or elaborate attack or set play. In addition, team possession that starts by winning the ball in play, but (i) finishes too fast to show a clear attempt to seek penetration or (ii) with no intention to seek penetration, for example during ball clearances, time-wasting tactics and fair play gesture or (iii) shows no entire action due to filming error.

75. Set play start

Obtained from Tenga et al. (2009, p. 12):

Set play start-type (four non-ordered categories)

Def. Quickness of starting set play team possession.

A. Delayed: delay start that allows a defending team to have enough time to establish a balanced defence.
B. Fast: fast start that denies a defending team enough time to establish a balanced defence.
C. Not applicable: team possession starts by winning the ball in play.
D. Other

75. Elaborate attack start

Obtained from Tenga et al. (2009, p. 12):
Elaborate attack start-type (four non-ordered categories)
Def. Type of starting elaborate attack team possession.
A. Counter attack-start: elaborate attack team possession starts by winning the ball in play.
B. Set play-start: elaborate attack team possession starts by a set play.
C. Not applicable: team possession registered as counter attack, set play, or other.
D. Other

79. Opponent balance

Opponent balance is operationally defined as the degree of numerical or positional balance in the opposing team when the analysed player receives the ball. The numerical balance is determined by counting the amount of opponents and teammates from the attacking players location and towards the opposing team goal line. The positional balance is determined by the location of the opposition in relation to the analysed players' location and his teammates location, in relation to the opponent control over the different attacking areas and spaces towards their own goal line. This variable is inspired by the defensive variables used in Tenga et al. (2009, p. 15).
A. High imbalanced: when the opposing team is both numerical unbalanced (out numbered) and positional unbalance.
B. Imbalanced: when the opposing team is either numerical unbalanced (out numbered) or positional unbalance.

C. Starting imbalance: when the opposing team is starting to get numerical unbalanced (out numbered) and/or position unbalanced, but at the moment the analysed player receives the ball they are technically in balance.

D. Balance: when the opposing team is equally many players on the right side of the ball and in positional balance.

E. High degree of balance: when the opposing team is over numbered and in positional balance.

G. Other: If the situation registered is none of the above variables, this is free-kick and penalty situations as two examples.

80. Pass number

Obtained from Tenga et al. (2009, p. 13):

Def. Series of passes between players of the attacking team.

A. Very low: 1 or 2 passes per team possession.

B. Low: 3 passes per team possession.

C. High: 4 passes per team possession.

D. Very high: 5 or more passes per team possession.

E. Not applicable: team possession without a pass.

F. Other

81. Playing tempo

Obtained from Tenga et al. (2009, p. 13):

Def. Number of touches per ball involvement including set play starting and ball winning at the beginning of team possession.

A. High: 1 or 2 touches.

B. More high: greater number of high than low tempo involvements.

C. Neutral tempo: equal number of low and high tempo involvements.

D. More low: greater number of low than high tempo involvements.

E. Low: 3 or more touches.

F. Other

82. VEB ball contact time interval

VEB Ball Contact Time Interval is operationally defined as the time interval between the last completed VEB and the first touch of the ball. “This time interval indicated the extent to which the players were able to collect information from the surroundings when the ball is on its way” (Jordet, 2005, p. 144).

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Appendix G:

Visual exploratory behaviour (VEB) timing variable overview

This appendix consists of the variables developed for and used in the analysis of the players' timing of each search. First a table overview of all variables is represented. Second, the definitions of all variables and subvariables are outlined. Some of the variables in this overview is identical to some of the variables in the situational variable overview but is registered in another way in this analysis and are therefore presented and explained also in this variable overview.

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Table overview of variables

Overview of all variables and their respective sub variables used in the analysis.

1	2	3	4	5	6
Player nr	**General playing position**	**Primary foot**	**Situation number**	**Player situation number**	**Situation type**
P1 P2 P3 P4 P5 P6 P7 P8	Attacking player Midfield player	Left Right Both	1 2 3 *	1 2 3 *	1) 10sec in team prior to receiving the ball 2) Turn over from opponent team 3) Wall pass with teammate 4) Set piece situation
7	**8**	**9**	**10**	**11**	**12**
Position when receiving from teammate	**Action direction**	**Forward pass**	**Possession status after action**	**Turn**	**Complete search**
Closer opponent goal Closer own goal Farther away from opponent goal Neutral	Forward Sideward Backward	Complete Not complete Not used	Maintained Lost Other	Successful Not successful Not used	Complete Not complete

13	14	15	16	17	18
Complete situation	**Total searches**	**Search number**	**Situation time interval (STI)**	**STI/5**	**STI phase**
Complete Not complete	1 2 3 *	1 2 3 *	01:00 seconds 01:02 seconds 01:02 seconds *	Situation time divided by five	1 2 3 4 5
19	**20**	**21**	**22**	**23**	**24**
Search initiated in STI	**Ball position time interval (BPT)**	**BPT/3**	**Search initiated in relation to BPT**	**Search initiated in BPT phase**	**Search duration**
01:00 seconds 01:02 seconds 01:02 seconds *	01:00 seconds 01:02 seconds 01:02 seconds *	Ball position time divided by three	01:00 seconds 01:02 seconds 01:02 seconds *	Phase 1 Phase 2 Phase 3 In teammate touch	01:00 seconds 01:02 seconds 01:02 seconds *
25	**26**	**27**	**28**	**29**	**30**
Ball position	**Pitch position, zones and corridors**	**Position in opponent section**	**Position in space**	**Ball angle**	**Search direction**
OLP TMFirstTouch TMLastTouch TMIBTouch TMP TMPP	FT-L FT-CL FT-CR FT-R M1-L M1-CL	In front of AL In-between AL and ML In-between ML and DL Behind DL In AL In ML	High position Mid position Low position In-between opponent section In-front of all opponent	Left Right Straight	Left Right Straight

APR APP SPS SPE IM	M1-CR M1-R M2-L M2-CL M2-CR M2-R FIT-L FIT-CL FIT-CR FIT-R SB-L SB-R	In DL	players		
31	**32**	**33**	**34**	**35**	**36**
Several search directions	**Visual exploratory behaviour (VEB) types**	**Opponent pressure**	**Body orientation**	**Body orientation receiving**	**Timing search**
Left and right Right and left Left and straight Right and straight Left and left Right and right Not used	Brief 180 degree Sequential Long	0m 0.5m 1m 2m *	Forward Sideward Backward	Forward Sideward Backward	OLP1 OLP2 OLP3 OPLastTouch TMFirstTouch TMLastTouch TMTouch TMIBTouch1 TMIBTouch2 TMIBTouc3 TMP1 TMP2

					TMP3 TMPP1 TMPP2 TMPP3 APR APP1 APP2 APP3 SPS1 SPS2 SPS3 SPE IM

37
Total search time
01:00 seconds 01:02 seconds 01:02 seconds *

Definition of variables

In this variable overview the variables used to analyse each search (VEB) performed by the players in the included situations is defined. First, the method used to register each initiated search is explained:

The Quick Time Player 7 made it possible to analyse the edited split-screen footage one frame at a time (50 frames per second), where one frame equals 0.02 seconds (two hundreds of a second). The player's initiation of each search was registered by analysing the shift of head direction (by head and/or body movements) away from the ball from one frame to the next frame, where the frame code of the frame indicating this change in head direction (away from the ball) was registered as search initiated. This is registration of search initiation is used in relation to several of the described variables below, and is essential in this analysis.

1. Player nr

The eight analysed UEFA Champions League players in the study have been randomly coded from P1 to P8. The purpose is to ensure the players immunity both in the analysis material and in the presentation of the results of the study.

2. General playing position

General playing position is operationally defined as the analysed players playing position. Either registered as midfielder or attacking (forward) player.

3. Primary foot

The primary foot variable registers if the player is left or right footed, if he uses both feet equally much it is registered as both.

4. Situation nr

Situation number is operationally defined as the number of each situation, starting at one with the first situation and continuing with a gradient of one to the last situation included for analysis (N = 249 situations).

5. Player situation number

Player situation number is operationally defined as the number of each situation for each player, starting at one for the first situation and continuing with a gradient of one for each situation included for analysis.

6. Situation type

This variable was first registered for each situation in the situational analysis, and is copied from that analysis and passed to each of the situations respective searches in this analysis. Situation type is operationally defined as the characteristics of the ball possession before the analysed player receives the ball. The time interval of these situation types was calculated by using frame codes conducted from the Quick Time Player 7 frame-by-frame analysis of the split-screen footage. There are four types of situations included in the analysis, which were registered for each initiated search.

1) **10 seconds in team** is operationally defined as the situations where the analysed players' team is in possession of the ball 10-seconds or more prior to receiving the ball. In these situations the analysis starts 10second prior to receiving, and variable 16 will therefore always be 10 seconds for these situations. The frame code when receiving was used as reference and the frame code ten seconds earlier was the start point of the situation.
2) **Turn over (opponent lost possession)** is operationally defined as the situations where the opponent team looses the ball in play to one of the analysed players teammates, and the analysed player receives the ball from a teammate inside the 10-second interval. The situation starts when the shift from one frame to the next indicates a space between the ball and the opponent's body when the next player touching the ball is a teammate. The situation ends when the shift from one frame to

the next indicates contact between the ball and the analysed players body. If the possession of the ball is maintained in the team for 10 seconds or more before the analysed player receives the ball, it is registered as situation one.

3) **Wall pass with teammate** is operationally defined as the situations where the analysed player plays the ball to a teammate and the possession of the ball is maintained in the team and the analysed player receives the ball back inside the 10 second interval. The situation starts when the shift from one frame to the next indicates a space between the ball and the analysed player's body when passing the ball to a teammate, and ends when the shift from one frame to the next indicates contact between the ball and the analysed players body. If the possession of the ball is maintained in the team for 10 seconds or more before the analysed player gets it back it is registered as situation one.
4) **Set piece** is operationally defined as all the situations where the analysed player receives the ball from one of his teammates set pieces (corner, throw-in, free-kick, goal kick etc.) within the 10 second time interval. The time interval in the set piece situations starts four seconds before the set piece is taken. When the shift from one frame to the next indicates that the teammate executes the set piece the frame code is noted and the frame code four seconds earlier is used as start point, which ends when the analysed player receives the ball. If the set piece is taken 10 seconds or more before the analysed player receives the ball, it is registered as situation one.

7. Position when receiving from teammate

This variable was first registered for each situation in the situational analysis, and is copied from that analysis and passed to each of the situations respective searches in this analysis. Position when receiving from teammate is operationally defined as the analysed player position in relation to the passing teammate. When the analysed player received the ball closer to the opponent goal in relation to the passing teammate it was registered as closer opponent goal. When the analysed player was closer to his teams own goal than the passing teammate it was registered as closer own goal. If the distance to the players own goal or opponent goal did not differ between the passing player and the analysed player it was registered as neutral. Finally, if the analysed player receives the ball farther away from the opponent goal but not closer to his teams on goal in relation to the passing teammate it is registered as “farther away from opponent goal”. This variable is based and developed from the included game situation definition by Jordet (2005, p. 146) and Jordet, Bloomfield, and Heijmerikx (2013, p. 2).

8. Action direction

This variable was first registered for each situation in the situational analysis, and is copied from that analysis and passed to each of the situations respective searches in this analysis. Action direction is operational defined as the main direction of the analysed players’ action in each situation, where the direction is estimated by the player actions in relation to the opponent goal line:

Forward = registered when the players action (e.g. pass or dribble) is directed towards the opponent goal line.

Backwards = when the players action (e.g. pass or dribble) is directed away from the opponent goal line.

Sideways = when the players action (e.g. pass or dribble) is directed in the same distance from both the opponent goal line and his own goal line.

9. Forward pass

This variable was first registered for each situation in the situational analysis, and is copied from that analysis and passed to each of the situations respective searches in this analysis. Forward pass is operationally defined as the analysed players degree of forward pass completion, which is registered as forward pass complete, not complete or other. Forward pass complete is registered when the analysed player passes the ball forward in the attacking direction and a teammate receives the ball. Forward pass not completed is registered when the analysed player passes the ball forward but misses his teammate and the ball goes out of play, or an opponent player intercepts the pass. When the players’ final action is not a forward pass it is registered as not used.

10. Possession status after action

This variable was first registered for each situation in the situational analysis, and is copied from that analysis and passed to each of the situations respective searches in this analysis. Possession status after action is operationally defined as the result of the players’ final action in terms of possession maintained in the team or possession lost to the opposition. This is only registered in the immediate situation after the players’ last action. However, possession is not lost if an opponent player only touches the ball one time before the ball is regained, or the ball goes out of play, and the analysed players’ team gets a throw-in, free-kick, penalty-kick or a corner, this is registered as possession maintained. If the player loses the ball out of play or passes the ball to an opponent player, it’s registered as possession lost.

11. Turn

This variable was first registered for each situation in the situational analysis, and is copied from that analysis and passed to each of the situations respective searches in this analysis. Turn is operationally defined as whether the player executes a successful turn or not. If the player is backward orientated when the teammate passes the ball and are forward orientated in the first or second touch of the ball he has completed a successful turn. If the player tries to turn but looses possession of the ball as the result of the turn it is registered as not successful. If the player does not execute a turn it is registered as not used. This variable is a more objective measure of the turning variable used in Eldridge, Pulling, and Robins (2013, p. 565).

12. Complete search

Complete search is operationally defined as whether the analysis of the search was without any missing registrations due to complete broadcast footage or not. The analysis is registered as complete if the whole search is analysed without any missing variables, as a result of complete broadcast footage throughout the situation. It’s registered as incomplete if one or more variables are missing from the analysis due to incomplete broadcast footage.

13. Complete situation

Complete situation is operationally defined as whether the analysis of the whole situation was without any missing registrations due to incomplete overview footage or not. The analysis is registered as complete if the whole situation and every single search is analysed without any missing variables, as a result of complete overview footage throughout the situation. It's registered as incomplete if one or more of the analysed searches are missing some of the variables due to incomplete overview footage.

14. Total searches

Total searches are operationally defined as a numeric registration of the total amount of visual exploratory behaviours (searches), executed by the analysed player within the situation time interval (see variable 16).

15. Search number

Search number is operationally defined as which search number in the given situation (variable 4) that is registered and analysed. If the player executes six searches in one situation, each of these searches are registered and analysed in a numerical order from 1 (first search) to 6 (last search).

16. Situation time interval (STI)

Situation time interval is the estimated total duration of each situation, which starts in according to the situation type (see variable three) and ends in the analysed players first touch of the ball. It's measured in seconds, tenths and 2 hundreds. The situation time is always 10 seconds in situation type one, for the other three situations the situation time varies (see variable 6 for situational description).

17. STI/5

STI/5 is operationally defined as the situation time interval divided by five, which is done to register in which phase of the time interval the players' initiates each search (see variable 18).

18. STI Phase

STI phase is operationally defined as the registration of which of the five phases (calculated in variable 17) the player initiates a search. Phase five is the first phase in each situation (when the situation starts) and phase one is the last phase (right before the analysed player receives the ball). As an example: if a situation time interval is 10 seconds the SIT/5 is 2.0 second, and if the player initiates a search one second after the time interval starts (nine seconds before receiving) it is registered as phase five. Phase overview in a 10 second time interval is therefore: Phase 5 = 10.0-8.0 seconds, Phase 4 = 7.99-6.00 seconds, Phase 3 = 5.99-4.00 seconds, Phase 2 = 3.99-2 seconds, Phase 1 = 1.99-0.0 seconds.

19. Search initiated in STI

Search initiated in STI is operationally defined as the exact moment the analysed player initiates the search (when the shift from one frame to the next indicates a change in head direction away from the ball) in relation to the situation time interval (variable 16). The total situation time is counted down from the moment the situations starts towards the moment the analysed player receives the ball (registered as 0.00 seconds). So the search is registered in a way that says something about how long before the player receives the ball each search is initiated. This variable is used together with variable 17 and 18 to register in which phase the players' initiates each search.

20 & 25. Ball position time interval & Ball position

Ball position time interval is operationally defined as the time the ball is located at different positions. The ball can be located five places in each of the situations defined in variable six. In addition, the ball can be located one extra place for situation two, three and four. This is further defined below:

Definition of the five general ball positions, which can bee registered in each of the situations defined in variable six:

1) **Teammates passes to each other (Teammate pass = TMP):** this time interval starts when the shift from one frame to the next indicates a space between the ball and the passing teammate's body and ends when the shift from one frame to the next indicates contact between the ball and the receiving teammate. The time interval between the start frame code and end frame code was calculated in Excel and registered as the ball position time interval.
2) **When teammate touches the ball:** this is registered when the analysed player initiates a search when a teammate is in touch of the ball, this ball position time interval is not measured in time, it is registered as 0.00 seconds.
3) **In-between teammates touches (Teammate in-between touches = TMIBT):** this time interval starts when the shift from one frame to the next indicates a space between the ball and the teammate's body and ends when the shift from one frame to the next indicates contact between the ball and the same teammate's body. In other words when the ball travels from one touch to the next touch when one teammate is in possession of the ball. The time interval between the start frame code and end frame code was calculated in Excel and registered as the ball position time interval.
4) **When teammate passes the ball to analysed player (Teammate pass player TMPP):** this time interval starts when the shift from one frame to the next indicates a space between the ball and the passing teammate's body and ends when the shift from one frame to the next indicates contact between the ball and the analysed players body. The time interval between the start frame code and end frame code was calculated in Excel and registered as the ball position time interval.
5) **When analysed player receives the ball (Analysed player receiving APR):** this was registered when the shift from one frame to the next indicates both the initiation of a search and contact between the ball and the analysed players body. In these situations no time interval was registered, it was set as 0.00 seconds.

Definitions of the specific ball positions for situation two, three and four:

1) **Turn over situations (Opponent lost possession OLP):** this time interval starts when the shift from one frame to the next indicates a space between the ball and the opponent's body and ends when the shift from one frame to the next indicates contact between the ball and a teammate's body. In other words it starts when the

opponent player looses possession of the ball and ends when a teammate of the analysed player touches the ball. The time interval between the start frame code and end frame code was calculated in Excel and registered as the ball position time interval.

2) **Wall pass with teammate (Analysed player pass = APP):** this time interval starts when the shift from one frame to the next indicates a space between the ball and the analysed players body and ends when the shift from one frame to the next indicates contact between the ball and the receiving teammate's body. In other words it starts when the analysed players passes the ball and ends when the receiving teammate touches the ball. The time interval between the start frame code and end frame code was calculated in Excel and registered as the ball position time interval.
3) **Set piece situation (SPS):** when the shift from one frame to the next indicates the execution of the set piece (the teammate's foot is in contact with the ball or the throw-in movement is started) the frame code is registered and the time interval starts four seconds prior to the execution of the set-piece, and ends when the set-piece is executed. In other words it starts four seconds prior to the execution of the set-piece. The time interval between the start frame code and end frame code was registered and calculated in Excel to make sure that the registered time interval was exactly four seconds. If the analysed player initiates a search in the moment the set-piece is executed it is registered as in set piece execution (SPE), and the ball position time interval was registered as 0.00 seconds.

21. BPT/3

BPT/3 is the ball position time interval estimated in variable 20 divided by three. The ball positions where no time interval was estimated (in teammate touch, in set-piece execution and in analysed players touch) is estimated as 0.00 in this variable.

22. Search initiated in relation to BPT

As mentioned in the start, the frame code when the player initiate the search was registered in excel. By using an algorithm in excel, the time difference between the initiated search frame code and the ball position time interval start frame code was calculated. In other words, the start frame code of the ball position was thought as 0.00

seconds and the initiation search frame code was used to measure how many hundreds of a second after the start of the ball position time interval the search was initiated. This was used together with variable 21 to register variable 23.

23. Search initiated in BPT phase

Search initiated in BPT phase is the sum of variable 20, 21, 22 and 25. This variable uses the calculated time in variable 22 (how many seconds after ball position start time the search is initiated) together with the time calculated in variable 21 to estimate in which of the phases of the ball position the player initiates his search. The ball position time interval is divided in three phases in variable 21, where phase 1 is the start of the ball position and phase 3 is at the end of the ball position. As an example, if the total ball position time interval (variable 20) is three seconds the BPT/3 equals one second, and if the player initiates the search 2.5 seconds after the ball position time interval started it is registered as phase 3 in that ball position. If the player initiates a search when the ball is in touch with a teammate (in play or in set-piece execution) it is registered as in touch.

24. Search duration

Search duration is operationally defined as the time interval estimated in two hundreds of a second from start to end of each search (VEB). The player's initiation of each search was registered by analysing the shift of head direction (by head and/or body movements) away from the ball from one frame to the next frame, where the frame code of the frame indicating this change in head direction (away from the ball) was registered as search initiated. When the shift from one frame to the next frame indicated that the head was redirected towards the ball the frame code was registered, and the time interval between the start frame and the end frame was calculated in excel and registered as the search duration in this variable.

26. Pitch position, zones and corridors.

Pitch position is operationally defined as the subdivisions of the football pitch, obtained from Tenga, Kanstad, Ronglan, and Bahr (2009, p. 12). The players position in these subdivisions where registered in each initiated search (see figure below). The definitions of the zones and corridors is obtained from Tenga et al. (2009, p. 12):

1. Pitch Zones (six categories, five ordered)
Def. Area across the playing field (see figure 1).

A. First third (FT): 1/3 of the playing field estimated from own goal line to middle third 1.

B. Middle third 1 (M1): first half of the middle third area estimated from end of the first third to midline.

C. Middle third 2 (M2): second half of the middle third area estimated from midline to final third.

D. Final third (FIT): 1/3 of the playing field estimated from end of the middle third 2 to opponent's goal line, excluding score box.

E. Score box: Area in front of the opponent's goal defined as an imaginary prolongation of the penalty area from 16 m to 30 m line estimated distance from opponent's goal line.

F. Other

2. Pitch corridors (five categories, four ordered)

Def. Area along the playing field (see figure 1).

A. Right (R): Area from imaginary line joining right sides of the penalty areas when facing the opponent's goal to right sideline.

B. Central right (CR): Area from imaginary midline along the field to imaginary line joining right sides of the penalty areas when facing the opponent's goal.

C. Central left (CL): Area from imaginary line joining left sides of the penalty areas when facing the opponent's goal to imaginary midline along the field.

D. Left (L): Area from left sideline to imaginary line joining left sides of the penalty areas when facing the opponent's goal.

E. Other

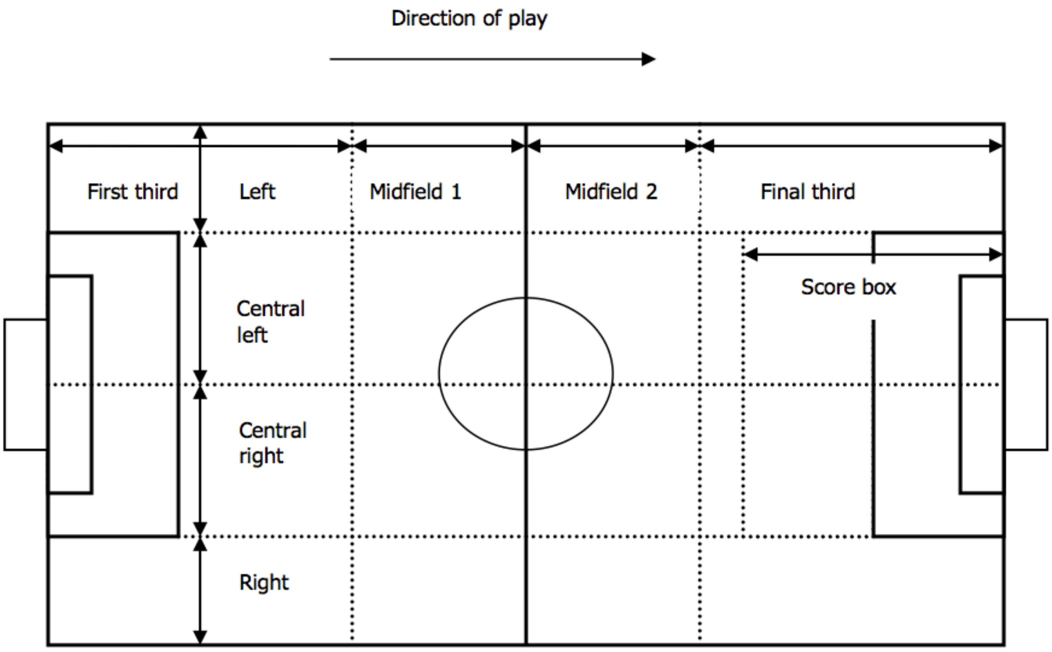

Figure explanation: Zones and corridors of the playing field. Zones included first third, midfield 1, midfield 2, final third and score box, while corridors included right, central right, central right, central left and left corridor. Note. Right side of figure is retrieved from Developing a New Method for Team Match Performance Analysis in Professional Soccer and Testing its Reliability, by A. Tenga, D. Kanstad, L.T. Rongland & R. Bahr 2009, International Journal of Performance Analysis in Sport, vol 9, s.16. Reprinted with permission from Albin Tenga, see Appendix E.

27. Position in opponent section

Position in opponent section is operationally defined as the participant's position in relation to the opponent teams line-up sections (see figure below). The player's position in between the opponent line-up was registered for each initiated search. This variable is an English refined version of the original ideas developed by Bergo, Johansen, Larsen, and Morisbak (2002, p. 125). The different positions in the opponent sections is defined as:

- **Behind DL** (defensive line) – space in-between the opponent defensive line and the opponent goal line.
- **In DL** (Space in defensive section) - in-between the players in the opponent defensive section.
- **In-between ML and DL** (midfield line and defensive line) - space in-between the opponent midfield and defensive section.

- **In ML** (Space in the midfield section) - in-between the players in the opponent midfield section.

- **In-between AL and ML** (attacking line and midfield line) - space in-between the opponent attacking and midfield section.

- **In AL** (Space in the attacking line) - in-between the players in the opponent attacking section.

- **In front of AL** (attacking line) - space in between the opponent attacking line and the participant's own goal line.

- **Corridor** – when the player is positioned in one of the four corridors wide in the field, between the sixteen-meter line and the sideline as illustrated on the figure below.

- **Centrally**- when the player is positioned in one of the four spaces centrally on the pitch, which are in-between the two sixteen-meter lines, as illustrated on the figure below.

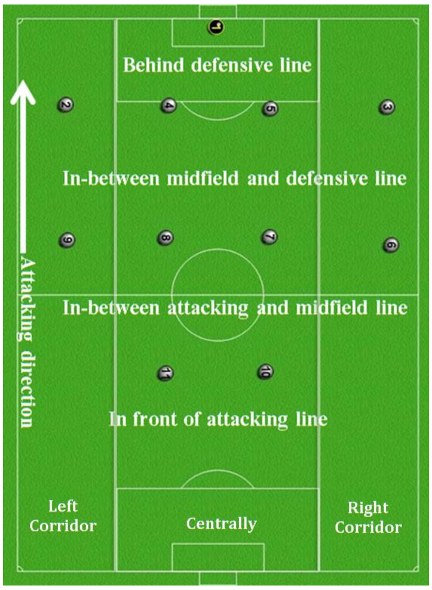

Figure explanation: Pitch illustration of the sections in-between, in front of and behind the opposition line-up. Exemplified with a 4-4-2 line-up.

28. Position in space

Position in space is operationally defined as the analysed players' position in the space in-between the opposition line-up (see figure below). This was registered for each initiated search. The five different positions was defined as:

High position in space = when the player is positioned in the space near the opponent goal, indicated with red circle.
Mid position in space = when the player is positioned in the middle of the space, indicated with brown circle.
Low position in space =when the player is positioned in the space near his teams own goal, indicated with yellow circle.
In-between opponent section = when the player is positioned in-between either the attacking, midfield or defensive opponent section.
In-front of all opponent players = when the player is positioned in front of all the opponent players, meaning that all the opponent players are located between the analysed player and the opponent goal.

Figure explanation: Illustration of the players position in-between the opponent sections. The yellow circle indicates the player low in the space, the brown indicates the player in the middle of the space, and the red indicates the player high in space. The two final positions are not shown in the figure because these are self-explaining.

29. Ball angel

Ball angel is operationally defined as the balls angel in relation to the analysed players frontal (anterior) side of the body when each search is initiated. This was estimating by drawing an imagined straight line from the ball to the analysed player when he initiated the search to see how the ball direction was in relation to the anterior side of the player's body. The angel was registered as left, right or straight.

30. Search direction

Search direction is operationally defined as the direction of each initiated search relative to the player's frontal (anterior) side of the body. This was registered as left, right or straight. Straight search direction was only registered when the analysed player searched right before receiving the ball by lifting his head straight ahead away from the ball.

31. Several search directions

Several search directions was only registered when the player executed a sequential exploratory behaviour (see definition in variable 32). When executing this search the player's head is directed towards several information sources by using several search directions before returning to the ball. This was registered as in which direction the analysed player directed the head away from the ball several times in one search before returning to the ball: Left and right, right and left, left and straight, right and straight, left an left, right and right. If the player did not execute a sequential search, the several search directions was registered as not used.

32. Visual exploratory behaviour (VEB) types

Visual exploratory behaviour was operationally defined as:

> A body and/or head movement in which the player's face is actively and temporarily directed away from the ball, seemingly with the intention of looking for teammates, opponents or other environmental objects or events, relevant to perform a subsequent action with the ball (Jordet et al., 2013, p. 2).

Visual exploratory behaviour (VEB) types are operationally defined as four different types of visual exploratory behaviour performed by the analysed player. Each initiated search was registered as one of the four types. The four exploratory activity types are operationally defined as:

> **1. Sequential** exploratory behaviour (a compounded continuous sequence of exploratory searches in which the player's face is clearly directed towards several distinct areas of the field, before the face is redirected towards the ball);
>
> **2. Long** exploratory behaviour (an exploratory search in which the player's face clearly is directed away from the ball for the duration of a second or more before it is redirected towards the ball); and
>
> **3. 180-Degree** exploratory behaviour (the player's face is clearly directed in the opposite direction of the ball viewed trough an axis from the ball straight trough the players body).
>
> **4. Brief** exploratory behaviour (regular exploratory search, not sequential, not long, and not 180 degree).

Type 1 to 4 is defined and used by Jordet (2004, pp. 128-129). Additionally, type 1 to 3 is defined and used by Jordet (2005, p. 144).

33. Opponent pressure

Opponent pressure was operationally defined as the distance between the analysed player and the closest opponent player, measured in meters (Jordet, 2004, p. 129). Opponent pressure was registered for each initiated search. Opponent pressure estimated as 0 meters means that there is body contact between the analysed player and the opponent player, and 0,5 meters means extremely close pressure with no body contact. From 0,5 meters and up, the pressure is estimated in whole meters (1m, 2m, 3m, and so on).

34. Body orientation

Body orientation is operationally defined as the direction of the frontal (anterior) side of the players' body (thoracic/chest and coxa/hip). If the frontal side is directed toward the opponent goal line, the player is forward orientated. When directed towards the sideline he is sideward orientated, and when directed towards his own goal line he is backward orientated. In doubtful situations the direction of the lower body (coxa/hip) was used as reference. The body orientation was registered for each initiated search.

35. Body orientation when receiving

This variable is conducted from the situational analysis, and the player's body when receiving the ball was copied from that analysis and passed to each of the analysed searches in this analysis.

36. Timing search

Timing search is operationally defined as the players timing of each initiated search in relation to the ball position. This variable is the end product of the registration of variable 6, 20, 21, 22, 23, 24 and 25. First variable 6 registers what kind of situation it is, then variable 20 and 25 registers in which ball position in that situation the search is initiated, then variable 21, 22 and 23 registers in which phase of the ball position the search is initiated. So the total picture of these earlier variables is registered in this variable. The different situation types and the different possible ball positions in which the analysed player may initiate his search is defined below:

Situation 1, 10 second in team prior to receiving

1) Search (VEB) initiated when teammate are in touch with the ball
    a. Search in teammate first touch = TMFirstTouch
    b. Search in teammate last touch = TMLastTouch
    c. Search when teammate is in touch with the ball (not first or last touch) = TMTouch
2) Search (VEB) initiated when the ball transfers between a teammates touches (TMIBT)
    a. Search right after a teammate has touched the ball (phase 1) = TMIBT1

    b. Search in middle of the balls travel between touches (phase 2) = TMIBT2
    c. Search right before teammate touches the ball again (phase 3) = TMIBT3
3) Search (VEB) initiated when the ball is passed between teammates = TMP (Teammate pass)
    a. Search right after teammate passes the ball (phase 1) = TMP1
    b. Search in the middle of the pass (phase 2) = TMP2
    c. Search right before another teammate receives the ball (phase 3) = TMP3
4) Search (VEB) initiated when the ball is passed from teammate to analysed player = TMPP (Teammate Pass Player)
    a. Search right after teammate passes the ball (phase 1) = TMPP1
    b. Search in the middle of the pass (phase 2) = TMPP2
    c. Search right before analysed player receives the ball (phase 3) = TMPP3
5) Search (VEB) initiated when the analysed player receives the ball = APR (Analysed player receiving)
6) Impossible to register this search due to incomplete match overview video footage = IM

Situation 2, Turn over (Opponent lost possession)

1) Search (VEB) initiated when opponent loses possession of the ball, and the player's team wins the ball in the next ball contact = OLP (Opponent Lost Possession)
    a. Search right after opponent player losses the ball (phase 1) = OLP1
    b. Search in the middle of ball traveling from opponent to teammate (phase 2) = OLP2
    c. Search right before teammate receives the ball (phase 3) = OLP3
2) Search (VEB) initiated when teammate are in touch with the ball
    a. Search in teammate first touch = TMFirstTouch
    b. Search in teammate last touch = TMLastTouch
    c. Search when teammate is in touch with the ball (not first or last touch) = TMTouch
3) Search (VEB) initiated when the ball transfers between a teammates touches (TMIBT)
    a. Search right after a teammate has touched the ball (phase 1) = TMIBT1
    b. Search in middle of the balls travel between touches (phase 2) = TMIBT2
    c. Search right before teammate touches the ball again (phase 3) = TMIBT3
4) Search (VEB) initiated when the ball is passed between teammates = TMP (Teammate pass)
    a. Search right after teammate passes the ball (phase 1) = TMP1
    b. Search in the middle of the pass (phase 2) = TMP2
    c. Search right before another teammate receives the ball (phase 3) = TMP3
5) Search (VEB) initiated when the ball is passed from teammate to analysed player = TMPP (Teammate Pass Player)
    a. Search right after teammate passes the ball (phase 1) = TMPP1
    b. Search in the middle of the pass (phase 2) = TMPP2

    c. Search right before analysed player receives the ball (phase 3) = TMPP3
6) Search (VEB) initiated when the analysed player receives the ball = APR (Analysed player receiving)
7) Impossible to register this search due to incomplete match overview video footage = IM

Situation 3, wall pass with teammate

1) Search (VEB) initiated when the ball transfers (is passed) from analysed player to another teammate = APP (Analysed Player Pass)
    a. Search right after analysed player passes the ball (phase 1) = APP1
    b. Search in middle of pass (phase 2) = APP2
    c. Search right before teammate receives the ball (phase 3) = APP3
2) Search (VEB) initiated when teammate are in touch with the ball
    a. Search in teammate first touch = TMFirstTouch
    b. Search in teammate last touch = TMLastTouch
    c. Search when teammate is in touch with the ball (not first or last touch) = TMTouch
3) Search (VEB) initiated when the ball transfers between a teammates touches (TMIBT)
    a. Search right after a teammate has touched the ball (phase 1) = TMIBT1
    b. Search in middle of the balls travel between touches (phase 2) = TMIBT2
    c. Search right before teammate touches the ball again (phase 3) = TMIBT3
4) Search (VEB) initiated when the ball is passed between teammates = TMP (Teammate pass)
    a. Search right after teammate passes the ball (phase 1) = TMP1
    b. Search in the middle of the pass (phase 2) = TMP2
    c. Search right before another teammate receives the ball (phase 3) = TMP3
5) Search (VEB) initiated when the ball is passed from teammate to analysed player = TMPP (Teammate Pass Player)
    a. Search right after teammate passes the ball (phase 1) = TMPP1
    b. Search in the middle of the pass (phase 2) = TMPP2
    c. Search right before analysed player receives the ball (phase 3) = TMPP3
6) Search (VEB) initiated when the analysed player receives the ball = APR
7) Impossible to register this search due to incomplete match overview video footage = IM

Situation 4, Set piece situation

2) Search (VEB) initiated in the four second period prior to the teammate's execution of the set piece = SPS (Set Piece Situation)
    a. Search earlier in the four second period (phase 1) = SPS1
    b. Search in middle of four second period (phase 2) = SPS2
    c. Search right before set-piece execution (phase 3) = SPS3
    d. Search in set piece execution = SPE

3) Search (VEB) initiated when teammate are in touch with the ball
    a. Search in teammate first touch = TMFirstTouch
    b. Search in teammate last touch = TMLastTouch
    c. Search when teammate is in touch with the ball (not first or last touch) = TMTouch
4) Search (VEB) initiated when the ball transfers between a teammates touches (TMIBT)
    a. Search right after a teammate has touched the ball (phase 1) = TMIBT1
    b. Search in middle of the balls travel between touches (phase 2) = TMIBT2
    c. Search right before teammate touches the ball again (phase 3) = TMIBT3
5) Search (VEB) initiated when the ball is passed between teammates = TMP (Teammate pass)
    a. Search right after teammate passes the ball (phase 1) = TMP1
    b. Search in the middle of the pass (phase 2) = TMP2
    c. Search right before another teammate receives the ball (phase 3) = TMP3
6) Search (VEB) initiated when the ball is passed from teammate to analysed player = TMPP (Teammate Pass Player)
    a. Search right after teammate passes the ball (phase 1) = TMPP1
    b. Search in the middle of the pass (phase 2) = TMPP2
    c. Search right before analysed player receives the ball (phase 3) = TMPP3
7) Search (VEB) initiated when the analysed player receives the ball = APR
8) Impossible to register this search due to incomplete match overview video footage = IM

37. Total search duration

Total search duration is operationally defined as the sum of search duration time (variable 24) of all searches performed in one situation.

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Appendix H

Excerpt of Excel frame calculation file

This appendix contains an excerpt of the Excel file used to recalculated the frame codes to seconds, tenths and two hundredth of a second. This file was developed for the visual exploratory behaviour timing analysis. By using algorithms we calculated the time interval for; each situation, the transfer phase of the ball, the search duration, the initiating of each search in relation to both the time interval and the transfer phase of the ball. See appendix G for variable definition and more elaborate definition of how this was done.

E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC
Search	Video st	Video st	Video st	Receiving			Search initiated			Search end			Situation start			Situation end								
1	2	0	11	2	10	11	2	2	6	2	2	45	2	0	41	2	2	13	120,22	130,22	122,12	122,90	120,82	122,26
2	2	0	11	2	10	11	2	3	44	2	4	5	2	3	3	2	4	4	120,22	130,22	123,88	124,10	123,06	124,08
3	2	0	11	2	10	11	2	5	40	2	7	0	2	5	9	2	7	5	120,22	130,22	125,80	127,00	125,18	127,10
4	2	0	11	2	10	11	2	8	3	2	8	21	2	7	7	2	9	3	120,22	130,22	128,06	128,42	127,14	129,06
5	2	0	11	2	10	11	2	9	14	2	9	32	2	9	4	2	10	10	120,22	130,22	129,28	129,64	129,08	130,20
1	4	1	40	4	5	18	4	2	2	4	2	21							241,80	245,36	242,04	242,42	0,00	0,00
1	5	45	46	5	55	46	5	49	0	5	49	40	5	48	19	5	50	5	345,92	355,92	349,00	349,80	348,38	350,10
2	5	45	46	5	55	46	5	50	36	5	51	12	5	50	9	5	51	30	345,92	355,92	350,72	351,24	350,18	351,60
3	5	45	46	5	55	46	5	53	20	5	53	38	5	53	7	5	53	49	345,92	355,92	353,40	353,76	353,14	353,98
1	7	0	1	7	10	1	7	2	33	7	3	6	7	1	48	7	2	49	420,02	430,02	422,66	423,12	421,96	422,98
2	7	0	1	7	10	1	7	4	46	7	5	14	7	4	12	7	6	7	420,02	430,02	424,92	425,28	424,24	426,14
3	7	0	1	7	10	1	7	5	26	7	5	46	7	4	12	7	6	7	420,02	430,02	425,52	425,92	424,24	426,14
4	7	0	1	7	10	1	7	6	18	7	6	40	7	6	14	7	7	10	420,02	430,02	426,36	426,80	426,28	427,20
5	7	0	1	7	10	1	7	7	38	7	8	34	7	7	14	7	8	42	420,02	430,02	427,76	428,68	427,28	428,84
6	7	0	1	7	10	1	7	9	14	7	9	32	7	8	46	7	10	0	420,02	430,02	429,28	429,64	428,92	430,00
7	7	0	1	7	10	1	7	9	44	7	10	5	7	8	46	7	10	0	420,02	430,02	429,88	430,10	428,92	430,00
1	10	57	29	11	7	29	10	59	34	11	1	27							657,58	667,58	659,68	661,54	0,00	0,00
2	10	57	29	11	7	29	11	2	44	11	4	4							657,58	667,58	662,88	664,08	0,00	0,00
1	12	28	25	12	38	25	12	30	22	12	31	8	12	30	8	12	31	23	748,50	758,50	750,44	751,16	750,16	751,46
2	12	28	25	12	38	25	12	31	10	12	31	32	12	30	8	12	31	23	748,50	758,50	751,20	751,64	750,16	751,46
3	12	28	25	12	38	25	12	32	26	12	32	40	12	32	21	12	33	20	748,50	758,50	752,52	752,80	752,42	753,40
4	12	28	25	12	38	25	12	35	17	12	35	44	12	34	20	12	36	5	748,50	758,50	755,34	755,88	754,40	756,10
5	12	28	25	12	38	25	12	37	26	12	37	47	12	37	18	12	38	23	748,50	758,50	757,52	757,94	757,36	758,46
1	16	2	7	16	13	26	16	2	40	16	3	18	16	2	8	16	3	36	962,14	973,52	962,80	963,36	962,16	963,72
2	16	2	7	16	13	26	16	3	28	16	3	39	16	2	8	16	3	36	962,14	973,52	963,56	963,78	962,16	963,72
3	16	2	7	16	13	26	16	6	24	16	7	2	16	6	16	16	6	41	962,14	973,52	966,48	967,04	966,32	966,82
4	16	2	7	16	13	26	16	11	38	16	12	4	16	11	34	16	12	7	962,14	973,52	971,76	972,08	971,68	972,14
5	16	2	7	16	13	26	16	12	26	16	12	39	16	12	8	16	13	24	962,14	973,52	972,52	972,78	972,16	973,48
1	17	54	21	18	4	21	18	0	13	18	1	4							1074,42	1084,42	1080,26	1081,08	0,00	0,00
2	17	54	21	18	4	21	18	2	8	18	2	35	18	2	7	18	2	25	1074,42	1084,42	1082,16	1082,70	1082,14	1082,50
3	17	54	21	18	4	21	18	3	36	18	3	43	18	3	28	18	4	20	1074,42	1084,42	1083,72	1083,86	1083,56	1084,40
1	18	5	32	18	14	13	18	5	46	18	6	20	18	5	32	18	7	8	1085,64	1094,26	1085,92	1086,40	1085,64	1087,16
2	18	5	32	18	14	13	18	8	12	18	8	40	18	7	42	18	8	49	1085,64	1094,26	1088,24	1088,80	1087,84	1088,98
3	18	5	32	18	14	13	18	9	18	18	9	47	18	9	16	18	9	35	1085,64	1094,26	1089,36	1089,94	1089,32	1089,70
4	18	5	32	18	14	13	18	10	42	18	11	18	18	9	36	18	11	18	1085,64	1094,26	1090,84	1091,36	1089,72	1091,36
1	18	21	34	18	31	34	18	25	20	18	25	47	18	25	0	18	25	41	1101,68	1111,68	1105,40	1105,94	1105,00	1105,82
1	22	21	3	22	25	18	22	21	36	22	22	6	22	21	3	22	22	15	1341,06	1345,36	1341,72	1342,12	1341,06	1342,30
2	22	21	3	22	25	18	22	23	14	22	23	28	22	23	8	22	25	17	1341,06	1345,36	1343,28	1343,56	1343,16	1345,34
3	22	21	3	22	25	18	22	23	47	22	24	12	22	23	8	22	25	17	1341,06	1345,36	1343,94	1344,24	1343,16	1345,34
4	22	21	3	22	25	18	22	24	22	22	24	34	22	23	8	22	25	17	1341,06	1345,36	1344,44	1344,68	1343,16	1345,34
1	24	17	33	24	27	33	24	19	42	24	20	14	24	18	36	24	20	15	1457,66	1467,66	1459,84	1460,28	1458,72	1460,30
2	24	17	33	24	27	33	24	22	26	24	23	5	24	21	33	24	23	33	1457,66	1467,66	1462,52	1463,10	1461,66	1463,66
3	24	17	33	24	27	33	24	24	14	24	25	46	24	23	36	24	26	20	1457,66	1467,66	1464,28	1465,92	1463,72	1466,40
1	25	33	40	25	43	40	25	36	10	25	36	35	25	35	19	25	37	9	1533,80	1543,80	1536,20	1536,70	1535,38	1537,18
2	25	33	40	25	43	40	25	37	38	25	38	10	25	37	12	25	38	48	1533,80	1543,80	1537,76	1538,20	1537,24	1538,96
3	25	33	40	25	43	40	25	40	2	25	41	4	25	39	1	25	41	13	1533,80	1543,80	1540,04	1541,08	1539,02	1541,26
4	25	33	40	25	43	40	25	41	36	25	42	24	25	41	19	25	41	47	1533,80	1543,80	1541,72	1542,48	1541,38	1541,94
5	25	33	40	25	43	40	25	43	34	25	43	40	25	42	46	25	43	39	1533,80	1543,80	1543,68	1543,80	1542,92	1543,78
1	29	5	9	29	15	9	29	7	10	29	7	32	29	6	32	29	8	22	1745,18	1755,18	1747,20	1747,64	1746,64	1748,44

Appendix I

Complementary results

1. Descriptive statistics

Descriptive statistics for each player in situations that meet Jordet's (2005b; 2013) inclusion criterion.

Player	Situations	Mean VEBF	SD	Pass completion	Forward pass completed	Maintain possession	Forward actions	Success forward action	Forward action success
P1	23	0.41	.24	100 %	100 %	95.7 %	56.5 %	56.5%	100%
P2	31	0.51	.33	80.8 %	75 %	67.7 %	67.7 %	45.2%	66.7%
P3	21	0.49	.23	84.2 %	90.9 %	76.2 %	71.4 %	57.1%	80%
P4	6	0.53	.15	100 %	100 %	100 %	83.3 %	83.3%	100%
P5	14	0.28	.21	83.3 %	60.0 %	71.4 %	50.0 %	21.4%	42.9%
P6	13	0.45	.23	100 %	100 %	100 %	23.1 %	23.1%	100%
P7	49	0.45	.27	77.3 %	66.7 %	75.5 %	59.2 %	38.8%	65.5%
P8	6	0.82	.21	100 %	100 %	100 %	83.3 %	83.3%	100%
Sum	163	0.46	.27	86.3%	80.8%	80.4%	60.1%	45.4%	75.5%

Notes: Mean VEBF = mean visual exploratory behaviour frequency: SD = Standard Deviation: Forward action = how many percentage of the player's actions that were in the attacking directing: Success forward action = percentage success of forward actions.

2. Visual exploratory behaviour and performance

2.1 Visual exploratory activity for different performance measurements

Mann-Whitney U test results when comparing VEBF between successful (complete) and not successful (not complete) actions in five different performance variables.

Earlier inclusion criteria (closer opponent goal situations)

Variable	Situations	VEBF Complete	SD Complete	VEBF not complete	SD not complete	*U*	*p.*
Possession	163	0.46	.28	0.51	.23	1550.5	.313
Pass	146	0.46	.28	0.46	.27	1244.5	.930
Forward pass	78	0.54	.30	0.45	.25	385.0	.267
Penetrating pass	56	0.56	.31	0.45	.25	244.0	.240
Forward action	98	0.52	.30	0.52	.26	871.5	.892

Notes: VEBF = Visual exploratory behaviour frequency: SD = Standard deviation: *U* = test statistics from Mann-Whitney test: *p.* = significance level from Mann-Whitney U test.

2.2 Visual exploratory activity and successful forward actions

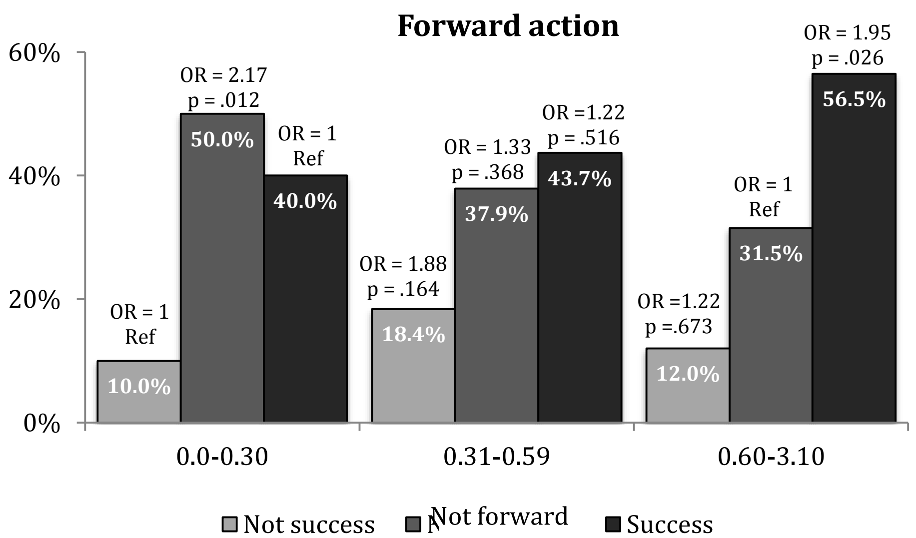


Figure 17: *Percentage of the players' forward action (not success, not forward and success), divided on three VEBF categories (little 0.00-0.30, some 0.31-0.59 and high 0.60-3.10). The low VEBF category is the reference category for forward action success and not success, while the high VEBF is the reference category for not forward actions.*

3. Visual exploratory behaviour and action direction

Action direction across player positions. When only investigating midfield players (n = 5 players/167 situations), we found a positive relationship between VEBF and action direction with the ball (H (2) = 8.44, p = .015). Players have significantly higher search frequency (p = .044, r = 0.20) when performing forward actions (n = 98 situations, M = .50 searches/second, SD = .33) then when performing backward actions (n = 45 situations, M = .42 searches/second, SD = .27). This relationship is not valid (H (2) = 3.35, p = .187) but the trend is in the same direction for forward players (n = 102 situations). When performing forward actions they have a higher VEBF (n = 64 situations, M = .50 searches/second, SD = .33) than when performing backward actions (n = 23 situations, M = .41 searches/second, SD = .38).

Player location. No significant differences in VEBF for different action directions were shown on players' own half of the pitch (n = 92 situations) (H (2) = 3.30, p = .193) or on the opponent half of the pitch (n = 177 situations) (H (2) = 4.32, p = .115). However, when performing Mann-Withney tests without adjusting the significance level we found that players have significantly higher (U = 1899.5, p = .037) visual exploratory frequency when performing forward actions (n = 105 situations, M = .50, SD = .33) compared to when performing backward actions (n = 46 situations, M = .42, SD = .27) on the opponent half of the pitch. This difference is not significant (U = 584.0, p = .143) on the players' own half of the pitch (n = 92 situations). But the trend is in the same positive direction, where players who act in the attacking direction have a higher VEBF (n = 57 situations, M = .58, SD = .34) than players acting backwards (n = 22 situations, M = .45, SD = .30).

4. Visual exploratory behaviour across pitch areas

A more correct illustration of Figure 8 in the thesis.

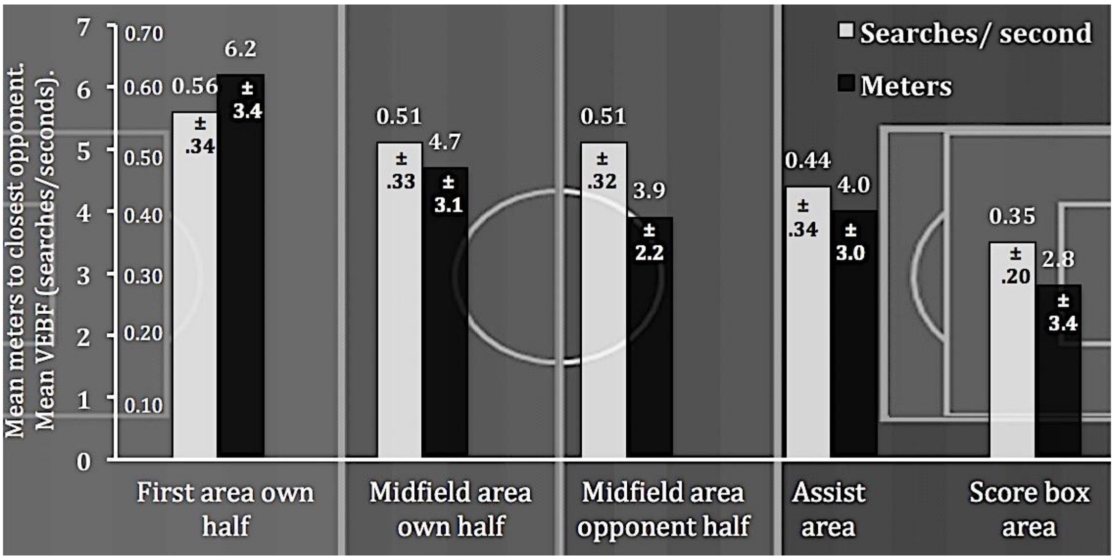


***Figure explanation**: Mean distance (meters) between the player and the nearest opponent when receiving the ball for each of the five pitch areas. Mean VEBF (searchers/second) for each pitch area (first area own half = 23 situations, midfield are own half = 74 situations, midfield area opponent half = 110 situations, assist area = 43 situations, score box area = 23 situations). The measures show how the VEBF drops and how the defensive pressure increases the closer the players get the opponent goal.*

5. Visual exploratory behaviour and defensive pressure

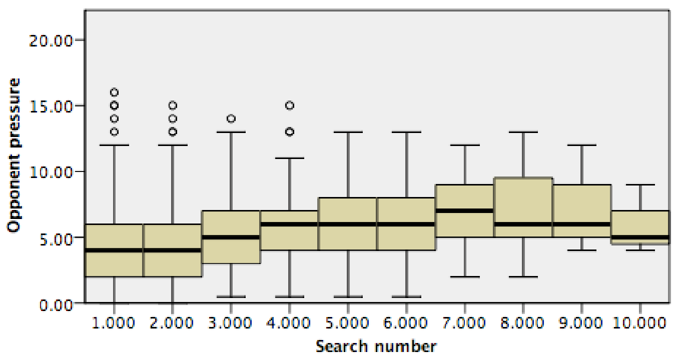
5.1 Pairwise comparisons of defensive pressure for each initiated search

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Opponent pressure is the same across categories of Search number.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Independent-Samples Kruskal-Wallis Test



Total N	783
Test Statistic	51.662
Degrees of Freedom	9
Asymptotic Sig. (2-sided test)	.000

1. The test statistic is adjusted for ties.

Each node shows the sample average rank of Search number.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
1.000-2.000	-16.456	23.094	-.713	.476	1.000
1.000-3.000	-60.452	24.683	-2.449	.014	.644
1.000-4.000	-110.813	27.647	-4.008	.000	.003
1.000-6.000	-111.763	36.981	-3.022	.003	.113
1.000-10.000	-133.485	130.852	-1.020	.308	1.000
1.000-5.000	-137.431	30.912	-4.446	.000	.000
1.000-7.000	-180.277	48.500	-3.717	.000	.009
1.000-8.000	-187.952	60.152	-3.125	.002	.080
1.000-9.000	-196.461	86.467	-2.272	.023	1.000
2.000-3.000	-43.996	25.651	-1.715	.086	1.000
2.000-4.000	-94.357	28.515	-3.309	.001	.042
2.000-6.000	-95.307	37.635	-2.532	.011	.510
2.000-10.000	-117.029	131.038	-.893	.372	1.000
2.000-5.000	-120.975	31.690	-3.817	.000	.006
2.000-7.000	-163.820	49.000	-3.343	.001	.037
2.000-8.000	-171.495	60.556	-2.832	.005	.208
2.000-9.000	-180.005	86.749	-2.075	.038	1.000
3.000-4.000	-50.361	29.816	-1.689	.091	1.000
3.000-6.000	-51.310	38.630	-1.328	.184	1.000
3.000-10.000	-73.033	131.328	-.556	.578	1.000
3.000-5.000	-76.979	32.866	-2.342	.019	.863
3.000-7.000	-119.824	49.769	-2.408	.016	.723
3.000-8.000	-127.499	61.180	-2.084	.037	1.000
3.000-9.000	-136.009	87.185	-1.560	.119	1.000
4.000-6.000	-.950	40.588	-.023	.981	1.000
4.000-10.000	-22.672	131.917	-.172	.864	1.000
4.000-5.000	-26.618	35.147	-.757	.449	1.000
4.000-7.000	-69.463	51.304	-1.354	.176	1.000
4.000-8.000	-77.138	62.434	-1.236	.217	1.000
4.000-9.000	-85.648	88.070	-.972	.331	1.000
6.000-10.000	-21.722	134.184	-.162	.871	1.000
6.000-5.000	25.668	42.879	.599	.549	1.000
6.000-7.000	-68.514	56.880	-1.205	.228	1.000
6.000-8.000	-76.189	67.092	-1.136	.256	1.000
6.000-9.000	-84.698	91.431	-.926	.354	1.000
10.000-5.000	3.946	132.640	.030	.976	1.000
10.000-7.000	46.792	137.804	.340	.734	1.000
10.000-8.000	54.467	142.324	.383	.702	1.000
10.000-9.000	62.976	155.288	.406	.685	1.000
5.000-7.000	-42.846	53.134	-.806	.420	1.000
5.000-8.000	-50.521	63.947	-.790	.430	1.000
5.000-9.000	-59.030	89.149	-.662	.508	1.000
7.000-8.000	-7.675	74.068	-.104	.917	1.000
7.000-9.000	-16.185	96.666	-.167	.867	1.000
8.000-9.000	-8.510	103.006	-.083	.934	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

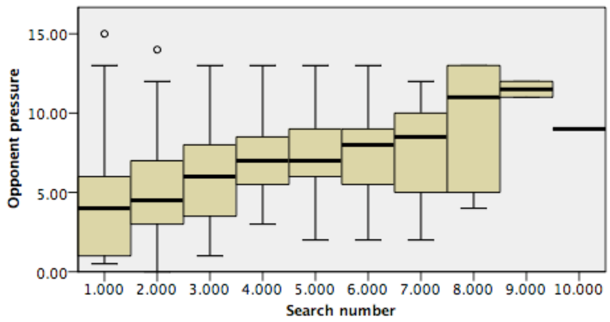
5.2 Pairwise comparisons of defensive pressure for each initiated search on players own half of the pitch

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Opponent pressure is the same across categories of Search number.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Independent-Samples Kruskal-Wallis Test



Total N	271
Test Statistic	42.190
Degrees of Freedom	9
Asymptotic Sig. (2-sided test)	.000

1. The test statistic is adjusted for ties.

Each node shows the sample average rank of Search number.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
1.000-2.000	-19.317	13.895	-1.390	.164	1.000
1.000-3.000	-37.005	14.132	-2.619	.009	.397
1.000-4.000	-58.428	15.796	-3.699	.000	.010
1.000-6.000	-71.656	22.058	-3.249	.001	.052
1.000-7.000	-76.227	29.019	-2.627	.009	.388
1.000-5.000	-78.442	18.580	-4.222	.000	.001
1.000-8.000	-95.889	36.045	-2.660	.008	.351
1.000-10.000	-118.789	78.583	-1.512	.131	1.000
1.000-9.000	-153.539	55.926	-2.745	.006	.272
2.000-3.000	-17.688	15.244	-1.160	.246	1.000
2.000-4.000	-39.111	16.798	-2.328	.020	.895
2.000-6.000	-52.339	22.786	-2.297	.022	.973
2.000-7.000	-56.910	29.576	-1.924	.054	1.000
2.000-5.000	-59.124	19.439	-3.042	.002	.106
2.000-8.000	-76.572	36.495	-2.098	.036	1.000
2.000-10.000	-99.472	78.791	-1.262	.207	1.000
2.000-9.000	-134.222	56.218	-2.388	.017	.763
3.000-4.000	-21.423	16.995	-1.261	.207	1.000
3.000-6.000	-34.651	22.931	-1.511	.131	1.000
3.000-7.000	-39.222	29.688	-1.321	.186	1.000
3.000-5.000	-41.436	19.609	-2.113	.035	1.000
3.000-8.000	-58.884	36.586	-1.609	.108	1.000
3.000-10.000	-81.784	78.833	-1.037	.300	1.000
3.000-9.000	-116.534	56.277	-2.071	.038	1.000
4.000-6.000	-13.228	23.993	-.551	.581	1.000
4.000-7.000	-17.799	30.516	-.583	.560	1.000
4.000-5.000	-20.013	20.840	-.960	.337	1.000
4.000-8.000	-37.461	37.260	-1.005	.315	1.000
4.000-10.000	-60.361	79.148	-.763	.446	1.000
4.000-9.000	-95.111	56.717	-1.677	.094	1.000
6.000-7.000	-4.571	34.179	-.134	.894	1.000
6.000-5.000	6.786	25.910	.262	.793	1.000
6.000-8.000	-24.233	40.316	-.601	.548	1.000
6.000-10.000	-47.133	80.632	-.585	.559	1.000
6.000-9.000	-81.883	58.770	-1.393	.164	1.000
7.000-5.000	2.215	32.045	.069	.945	1.000
7.000-8.000	-19.662	44.507	-.442	.659	1.000
7.000-10.000	-42.562	82.807	-.514	.607	1.000
7.000-9.000	-77.312	61.721	-1.253	.210	1.000
5.000-8.000	-17.448	38.523	-.453	.651	1.000
5.000-10.000	-40.348	79.750	-.506	.613	1.000
5.000-9.000	-75.098	57.555	-1.305	.192	1.000
8.000-10.000	-22.900	85.523	-.268	.789	1.000
8.000-9.000	-57.650	65.319	-.883	.377	1.000
10.000-9.000	34.750	95.617	.363	.716	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

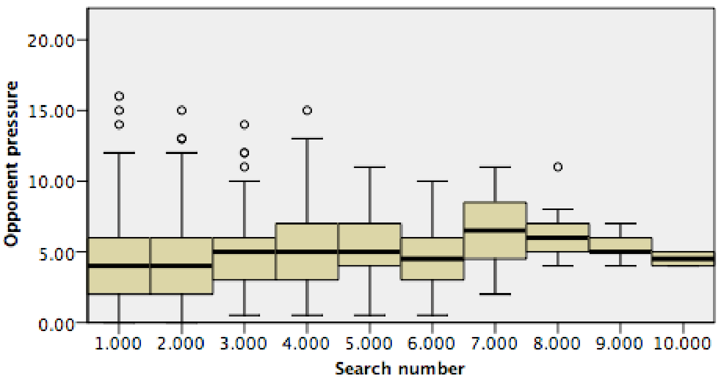
5.3 Pairwise comparisons of defensive pressure for each initiated search on opponents' half of the pitch

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Opponent pressure is the same across categories of Search number.	Independent-Samples Kruskal-Wallis Test	.014	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Independent-Samples Kruskal-Wallis Test



Total N	512
Test Statistic	20.652
Degrees of Freedom	9
Asymptotic Sig. (2-sided test)	.014

1. The test statistic is adjusted for ties.

Each node shows the sample average rank of Search number.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
2.000-1.000	2.197	18.507	.119	.905	1.000
2.000-3.000	-21.312	20.698	-1.030	.303	1.000
2.000-10.000	-23.479	104.800	-.224	.823	1.000
2.000-6.000	-43.429	30.004	-1.447	.148	1.000
2.000-4.000	-46.897	23.114	-2.029	.042	1.000
2.000-5.000	-61.208	25.103	-2.438	.015	.664
2.000-9.000	-82.779	67.091	-1.234	.217	1.000
2.000-8.000	-106.379	48.380	-2.199	.028	1.000
2.000-7.000	-110.042	39.120	-2.813	.005	.221
1.000-3.000	-19.115	20.268	-.943	.346	1.000
1.000-10.000	-21.282	104.716	-.203	.839	1.000
1.000-6.000	-41.232	29.709	-1.388	.165	1.000
1.000-4.000	-44.700	22.730	-1.967	.049	1.000
1.000-5.000	-59.011	24.750	-2.384	.017	.770
1.000-9.000	-80.582	66.960	-1.203	.229	1.000
1.000-8.000	-104.182	48.198	-2.162	.031	1.000
1.000-7.000	-107.844	38.895	-2.773	.006	.250
3.000-10.000	-2.167	105.125	-.021	.984	1.000
3.000-6.000	-22.117	31.121	-.711	.477	1.000
3.000-4.000	-25.585	24.547	-1.042	.297	1.000
3.000-5.000	-39.896	26.428	-1.510	.131	1.000
3.000-9.000	-61.467	67.598	-.909	.363	1.000
3.000-8.000	-85.067	49.081	-1.733	.083	1.000
3.000-7.000	-88.729	39.984	-2.219	.026	1.000
10.000-6.000	19.950	107.346	.186	.853	1.000
10.000-4.000	23.418	105.627	.222	.825	1.000
10.000-5.000	37.729	106.080	.356	.722	1.000
10.000-9.000	59.300	122.980	.482	.630	1.000
10.000-8.000	82.900	113.857	.728	.467	1.000
10.000-7.000	86.562	110.242	.785	.432	1.000
6.000-4.000	3.468	32.778	.106	.916	1.000
6.000-5.000	17.779	34.210	.520	.603	1.000
6.000-9.000	-39.350	71.002	-.554	.579	1.000
6.000-8.000	-62.950	53.673	-1.173	.241	1.000
6.000-7.000	-66.612	45.503	-1.464	.143	1.000
4.000-5.000	-14.311	28.360	-.505	.614	1.000
4.000-9.000	-35.882	68.377	-.525	.600	1.000
4.000-8.000	-59.482	50.147	-1.186	.236	1.000
4.000-7.000	-63.144	41.286	-1.529	.126	1.000
5.000-9.000	-21.571	69.074	-.312	.755	1.000
5.000-8.000	-45.171	51.095	-.884	.377	1.000
5.000-7.000	-48.833	42.432	-1.151	.250	1.000
9.000-8.000	23.600	80.509	.293	.769	1.000
9.000-7.000	27.262	75.309	.362	.717	1.000
8.000-7.000	3.663	59.253	.062	.951	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

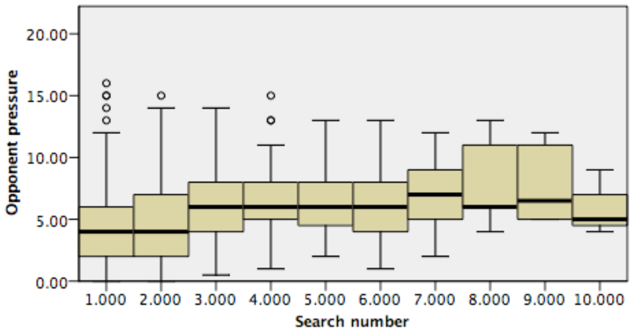
5.4 Pairwise comparisons of defensive pressure for each initiated search for midfield player

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Opponent pressure is the same across categories of Search number.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Independent-Samples Kruskal-Wallis Test



Total N	519
Test Statistic	42.557
Degrees of Freedom	9
Asymptotic Sig. (2-sided test)	.000

1. The test statistic is adjusted for ties.

Each node shows the sample average rank of Search number.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
1.000-2.000	-17.953	19.322	-.929	.353	1.000
1.000-3.000	-63.413	20.409	-3.107	.002	.085
1.000-6.000	-73.114	29.057	-2.516	.012	.534
1.000-10.000	-76.841	87.170	-.882	.378	1.000
1.000-4.000	-91.577	22.622	-4.048	.000	.002
1.000-5.000	-96.821	24.615	-3.933	.000	.004
1.000-7.000	-121.449	38.471	-3.157	.002	.072
1.000-8.000	-140.584	43.399	-3.239	.001	.054
1.000-9.000	-144.008	62.320	-2.311	.021	.938
2.000-3.000	-45.461	21.264	-2.138	.033	1.000
2.000-6.000	-55.161	29.664	-1.860	.063	1.000
2.000-10.000	-58.888	87.374	-.674	.500	1.000
2.000-4.000	-73.624	23.397	-3.147	.002	.074
2.000-5.000	-78.869	25.329	-3.114	.002	.083
2.000-7.000	-103.496	38.931	-2.658	.008	.353
2.000-8.000	-122.632	43.807	-2.799	.005	.230
2.000-9.000	-126.055	62.605	-2.013	.044	1.000
3.000-6.000	-9.701	30.383	-.319	.750	1.000
3.000-10.000	-13.428	87.621	-.153	.878	1.000
3.000-4.000	-28.164	24.302	-1.159	.246	1.000
3.000-5.000	-33.408	26.167	-1.277	.202	1.000
3.000-7.000	-58.036	39.482	-1.470	.142	1.000
3.000-8.000	-77.171	44.297	-1.742	.081	1.000
3.000-9.000	-80.594	62.949	-1.280	.200	1.000
6.000-10.000	-3.727	90.029	-.041	.967	1.000
6.000-4.000	18.463	31.912	.579	.563	1.000
6.000-5.000	23.708	33.354	.711	.477	1.000
6.000-7.000	-48.335	44.571	-1.084	.278	1.000
6.000-8.000	-67.471	48.888	-1.380	.168	1.000
6.000-9.000	-70.894	66.260	-1.070	.285	1.000
10.000-4.000	14.736	88.163	.167	.867	1.000
10.000-5.000	19.980	88.695	.225	.822	1.000
10.000-7.000	44.608	93.493	.477	.633	1.000
10.000-8.000	63.744	95.626	.667	.505	1.000
10.000-9.000	67.167	105.569	.636	.525	1.000
4.000-5.000	-5.244	27.928	-.188	.851	1.000
4.000-7.000	-29.872	40.670	-.734	.463	1.000
4.000-8.000	-49.008	45.360	-1.080	.280	1.000
4.000-9.000	-52.431	63.701	-.823	.410	1.000
5.000-7.000	-24.627	41.811	-.589	.556	1.000
5.000-8.000	-43.763	46.386	-.943	.345	1.000
5.000-9.000	-47.186	64.436	-.732	.464	1.000
7.000-8.000	-19.136	55.007	-.348	.728	1.000
7.000-9.000	-22.559	70.895	-.318	.750	1.000
8.000-9.000	-3.423	73.685	-.046	.963	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

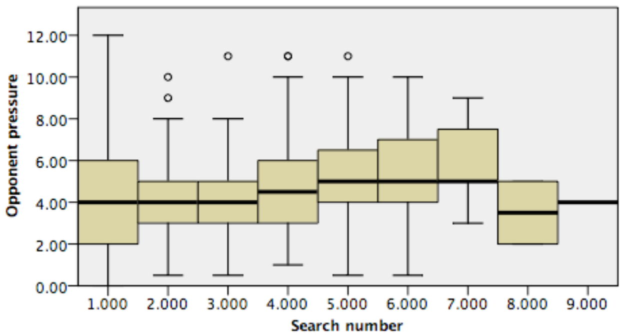
5.5 Kruskall Wallis H test result for defensive pressure in each search for forward players

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Opponent pressure is the same across categories of Search number.	Independent-Samples Kruskal-Wallis Test	.258	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Independent-Samples Kruskal-Wallis Test



Total N	264
Test Statistic	10.104
Degrees of Freedom	8
Asymptotic Sig. (2-sided test)	.258

1. The test statistic is adjusted for ties.
2. Multiple comparisons are not performed because the overall test does not show significant differences across samples.

5.6 Kruskal Wallis test results for defensive pressure for each search category throughout each situation

Kruskall Wallis test results of pairwise comparisons of mean distance to closest opponent player between the three search categories.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Opponent pressure, teammate passing is the same across categories of searchfrequencymod2.	Independent-Samples Kruskal-Wallis Test	.006	Reject the null hypothesis.
2	The distribution of Opponent pressure, receiving is the same across categories of searchfrequencymod2.	Independent-Samples Kruskal-Wallis Test	.001	Reject the null hypothesis.
3	The distribution of Opponent pressure second touch is the same across categories of searchfrequencymod2.	Independent-Samples Kruskal-Wallis Test	.033	Reject the null hypothesis.
4	The distribution of Opponent prressure, final action is the same across categories of searchfrequencymod2.	Independent-Samples Kruskal-Wallis Test	.092	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Teammate passing

Each node shows the sample average rank of searchfrequencymod2.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
1.000-2.000	-24.433	11.268	-2.168	.030	.090
1.000-3.000	-34.997	11.268	-3.106	.002	.006
2.000-3.000	-10.565	11.301	-.935	.350	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

First touch

Each node shows the sample average rank of searchfrequencymod2.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
1.000-2.000	-25.281	11.492	-2.200	.028	.083
1.000-3.000	-43.564	11.426	-3.813	.000	.000
2.000-3.000	-18.282	11.523	-1.587	.113	.338

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

Final touch (action)

Each node shows the sample average rank of searchfrequencymod2.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
2.000-1.000	4.047	9.806	.413	.680	1.000
2.000-3.000	-22.055	9.192	-2.399	.016	.049
1.000-3.000	-18.008	9.192	-1.959	.050	.150

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

Player position. Midfield players who explore much are put under significantly looser defensive pressure compered to when exploring little, throughout the situation; teammate passing (U = 990.5, p = .004), first touch (U = 1010.0, p = .002) and final touch (U = 60.5, p = .014). Forward players who explore much are put under significantly looser defensive pressure compered to when exploring little in the first touch of the ball (U = 395.0, p = .025). These results are not presented with an adjusted p value and most be viewed with caution.

Pitch position. When looking at situations on the player own half, players who explore much is significantly less pressed than players who explore little when the teammate passes the ball (U = 160.5, p = .004) and in the first touch of the ball (U = 181.5, p = .001). In situations on the opponent half, players who explore much is significantly less pressed than players who explore little in the first touch of the ball (U = 1509.5, p =

.039). These results are not presented with an adjusted p value and most be viewed with caution.

5.7 Degree of defensive pressure for each search category, when teammate passes and when receiving

When dividing the defensive pressure into categories; Tight 0-2meters, loose 3-5 meters, no pressure >5meters. The results show a positive relationship between VEBF and the degree of defensive pressure. Where players who explore more frequently are significantly more (OR = 2.44, p = .004) under no defensive pressure (55.3% of the situations) compared to when exploring less (31.4% of the situations) when the teammate passes the ball towards him. In addition, players who explore little are put under more tight defensive pressure (22.1% of the situations) compared to players who explore much (11.8% of the time) when the teammate passes the ball, but this was not significant different (OR = 2.19, p = .063). However, when analysing the defensive pressure when receiving the ball, the players' who explore little was put under significantly more (OR = 3.69, p < .001) tight defensive pressure (46.5% of the situations) compared to players' who explore much (18.8 % of the situations). In addition, players who explore much are put under significantly more (OR = 2.54, p = .009) no defensive pressure (36.5% of the situations) compared to players who explore less (15.1% of the situations) (see figure below).

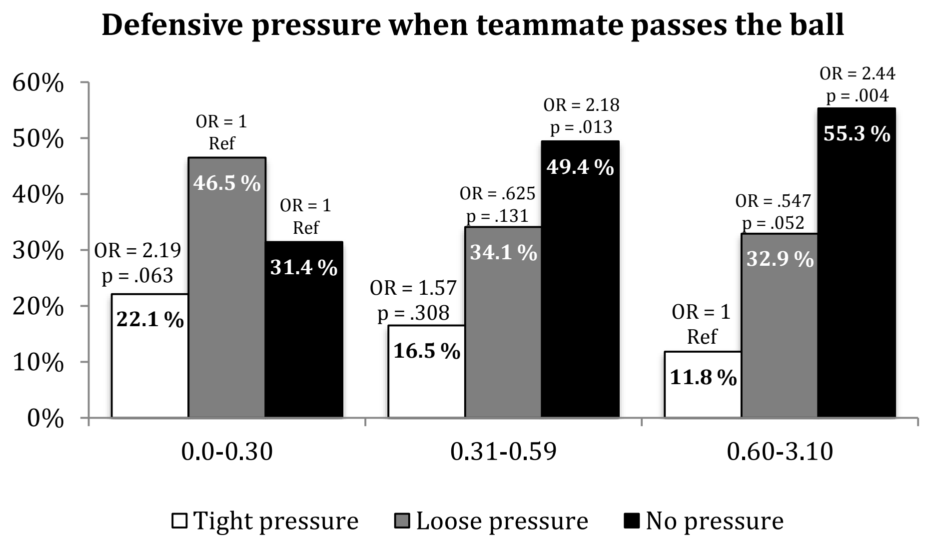


Figure explanation: Percentage tight (0-2meters), loose (3-5meters), and no pressure (>5meters) for each of the search categories when teammate passes the ball.

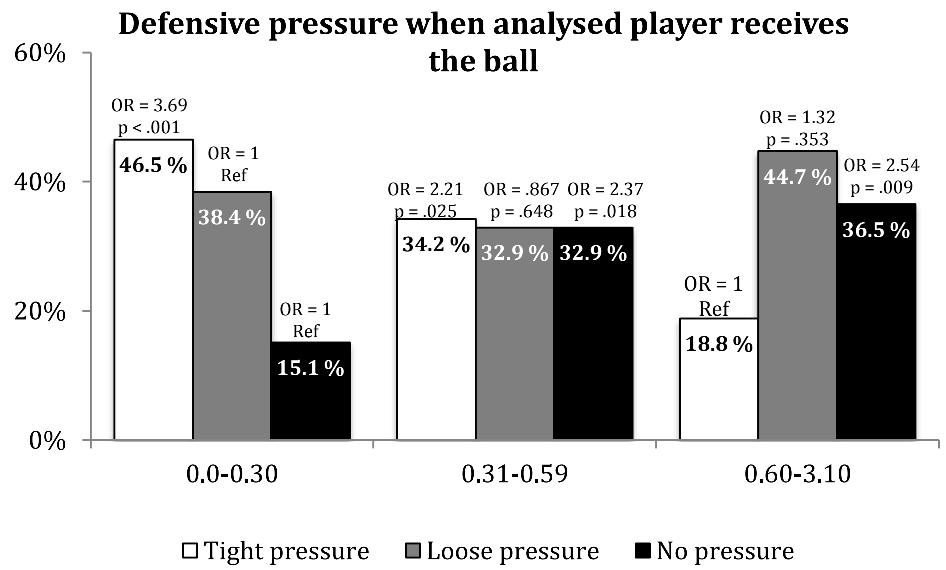


Figure explanation: Percentage tight (0-2meters), loose (3-5meters), and no pressure (>5meters) for each of the search categories when analysed player receives the ball.

6. Visual exploratory behaviour and body orientation

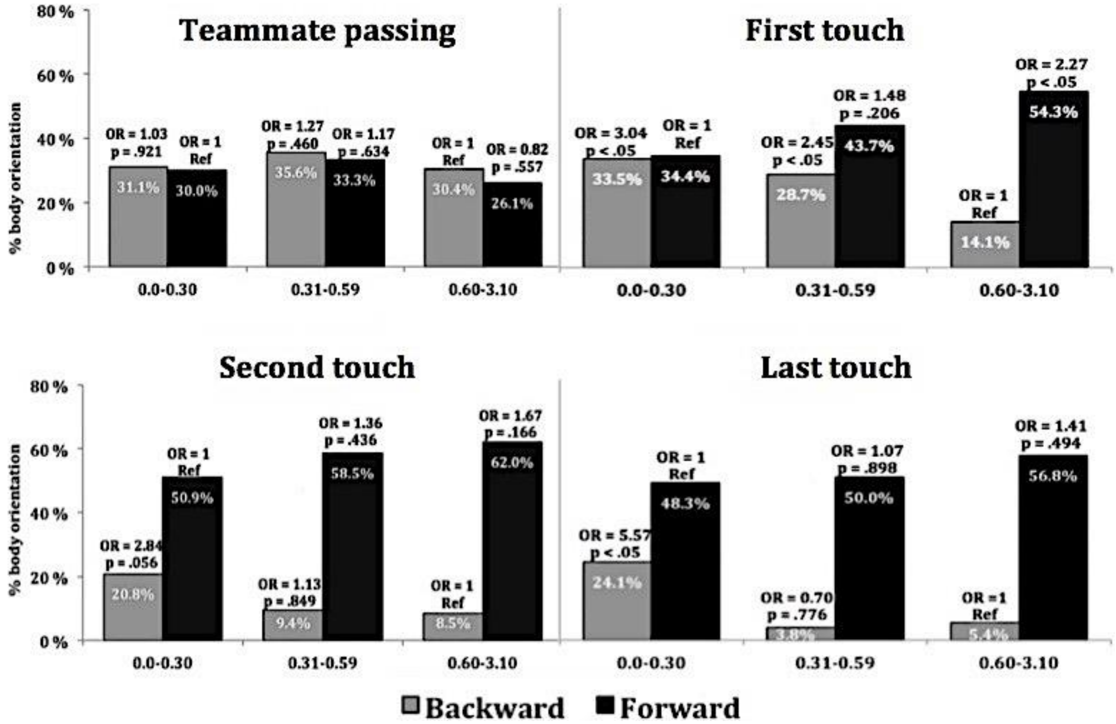


Figure *explanation:* Percentage backward and forward body orientation when the teammate passes the ball to the participant (n = 269 situations), in the first ball touch (n = 269 situations), in the second touch (n = 177 situations) and when executing the final ball touch (excluded situations with only one and two touch) (n = 92 situations). Note. All the body orientation registrations are divided on the three visual exploratory behaviour frequency categories; little 0.0-0.30, some 0.31-0.59 and high 0.60-3.10. The sideward body percentage for each variable is not included, which why the combination of backward and forward percentage does not equal 100%. The reference category for forward orientation is the low frequency category, and the high frequency category is the reference category for backward orientation when calculating OR.

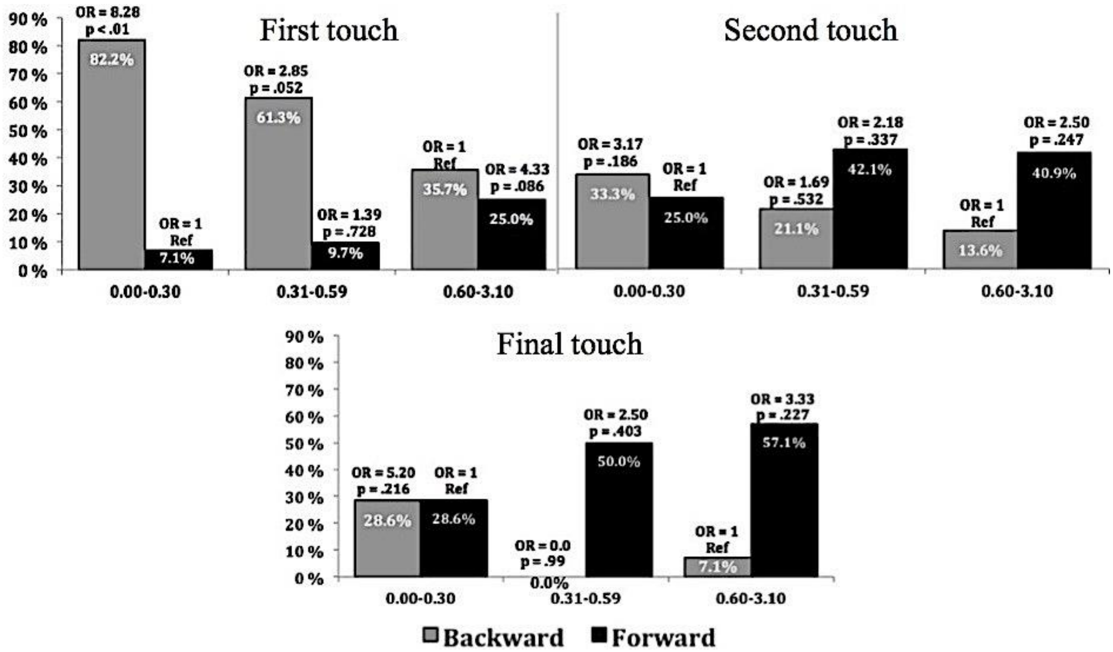
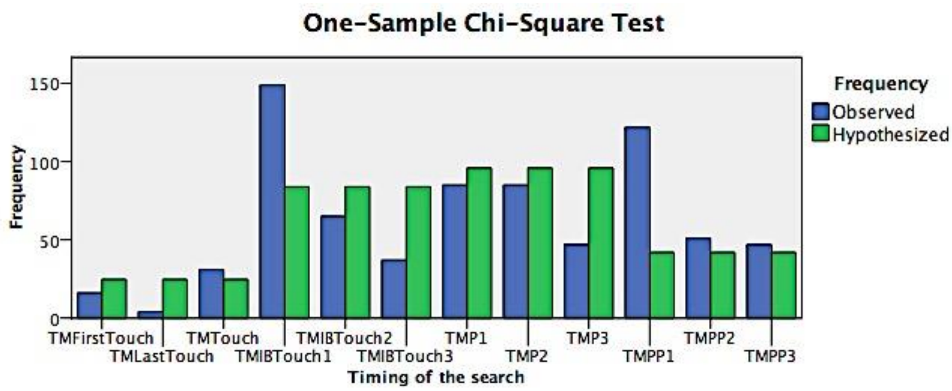


Figure explanation: *Percentage backward and forward (sideward is excluded) body orientation in situations where the players are backward orientated when the teammate passes the ball (n = 87 situations). Body orientation is registered in the first touch (n = 87 situations), second touch (n = 53 situations) and final touch of the ball (n = 29 situations). The reference category for forward orientation is the low frequency category, and the high frequency category is the reference category for backward orientation when calculating the p value and OR.*

7. Timing of search, chi square goodness of fit test results

Chi square goodness of fit test result of all searches. Illustrated by the same figure as in the thesis, for definition of the abbreviations in the figure below see Appendix G.

Hypothesis Test Summary				
	Null Hypothesis	Test	Sig.	Decision
1	The categories of Timing of the search occur with the specified probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
Asymptotic significances are displayed. The significance level is .05.				



Total N	739
Test Statistic	285.771
Degrees of Freedom	11
Asymptotic Sig. (2-sided test)	.000

1. There are 0 cells (0%) with expected values less than 5. The minimum expected value is 24.663.

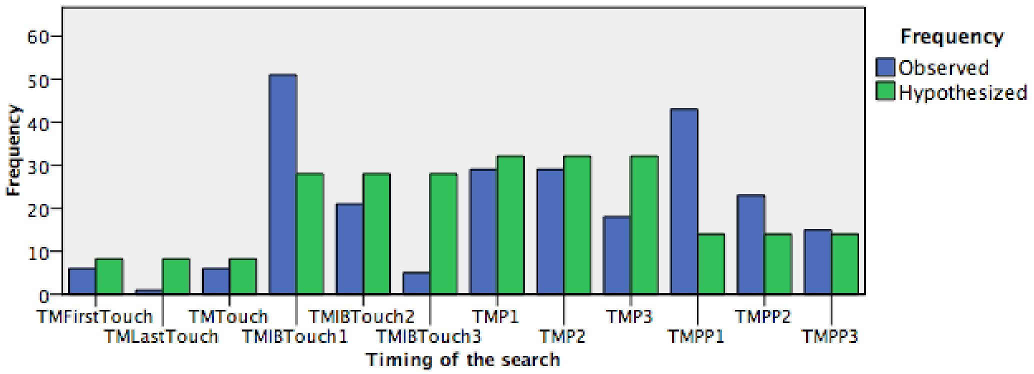
Forward players. Chi square goodness of fit test result of the distribution of all searches performed by forward players. Illustrated by the same figure as in the thesis, for definition of the abbreviations in the figure below see Appendix G.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The categories of Timing of the search occur with the specified probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

One-Sample Chi-Square Test

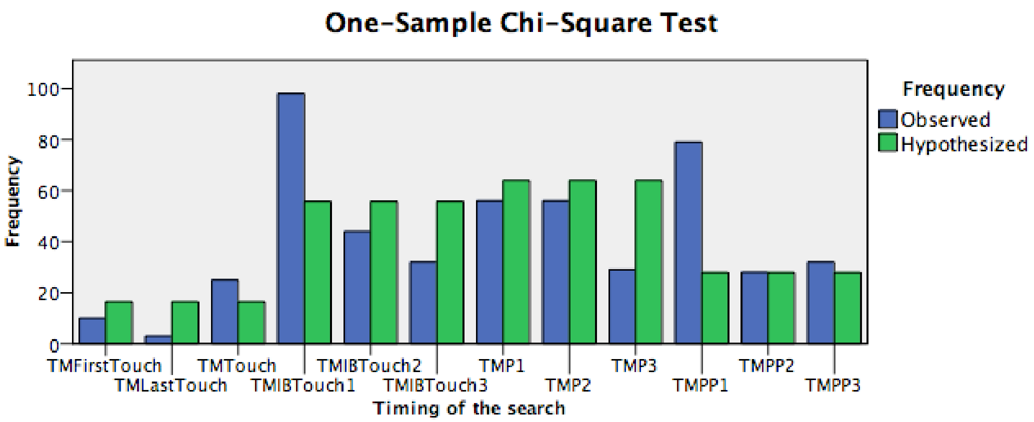


Total N	247
Test Statistic	119.860
Degrees of Freedom	11
Asymptotic Sig. (2-sided test)	.000

1. There are 0 cells (0%) with expected values less than 5. The minimum expected value is 8.232.

Midfield players. Chi square goodness of fit test result of the distribution of all searches performed by forward players. Illustrated by the same figure as in the thesis, for definition of the abbreviations in the figure below see Appendix G.

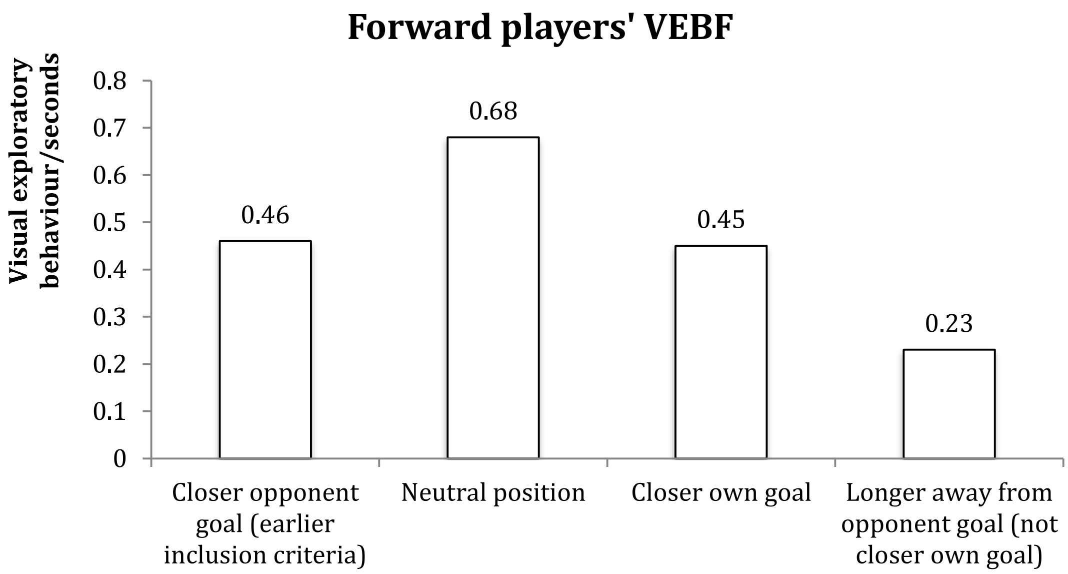
Hypothesis Test Summary				
	Null Hypothesis	Test	Sig.	Decision
1	The categories of Timing of the search occur with the specified probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
Asymptotic significances are displayed. The significance level is .05.				



Total N	492
Test Statistic	177.974
Degrees of Freedom	11
Asymptotic Sig. (2-sided test)	.000

8. Empirical evidence for the new inclusion criterion

8.1 VEBF for each receiving position divided on player position



Hypothesis Test Summary

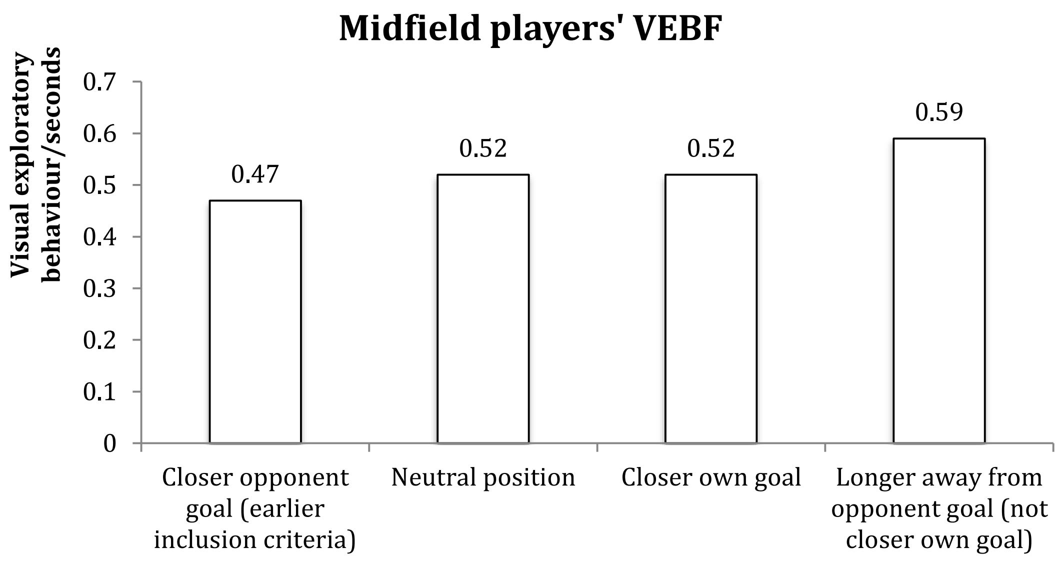
	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Search frequency modified is the same across categories of Pitch position in relation to passing teammate.	Independent-Samples Kruskal-Wallis Test	.058	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Pitch position in relation to passing teammate

Total N	102
Test Statistic	7.499
Degrees of Freedom	3
Asymptotic Sig. (2-sided test)	.058

1. The test statistic is adjusted for ties.
2. Multiple comparisons are not performed because the overall test does not show significant differences across samples.



Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Search frequency modified is the same across categories of Pitch position in relation to passing teammate.	Independent-Samples Kruskal-Wallis Test	.866	Retain the null hypothesis.

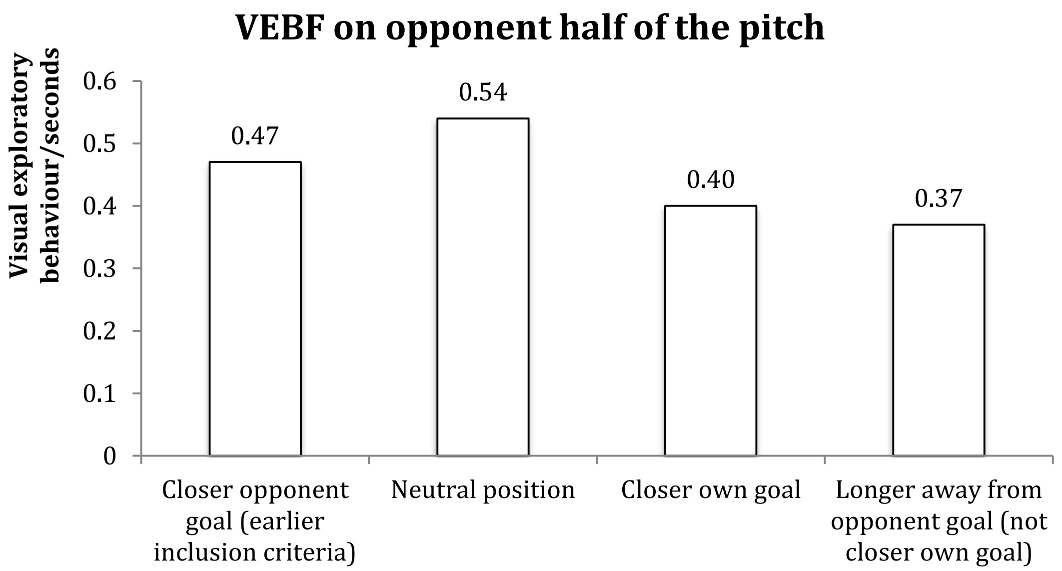
Asymptotic significances are displayed. The significance level is .05.

Pitch position in relation to passing teammate

Total N	167
Test Statistic	.730
Degrees of Freedom	3
Asymptotic Sig. (2-sided test)	.866

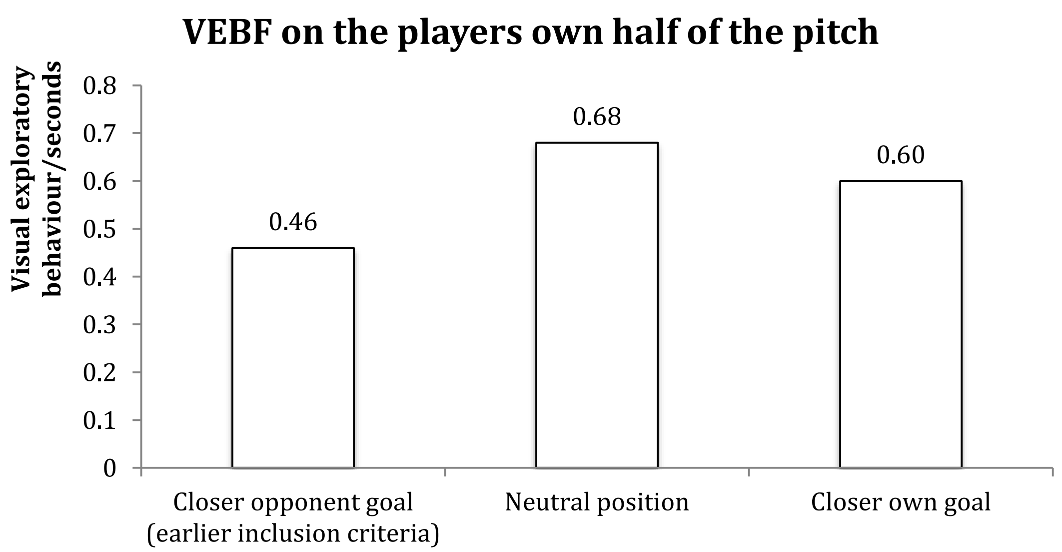
1. The test statistic is adjusted for ties.
2. Multiple comparisons are not performed because the overall test does not show significant differences across samples.

8.2 VEBF for each receiving position divided on player location (own half/opponent half)



Hypothesis Test Summary				
	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Search frequency modified is the same across categories of Pitch position in relation to passing teammate.	Independent-Samples Kruskal-Wallis Test	.262	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



	Hypothesis Test Summary			
	Null Hypothesis	**Test**	**Sig.**	**Decision**
1	The distribution of Search frequency modified is the same across categories of Pitch position in relation to passing teammate.	Independent-Samples Kruskal-Wallis Test	.137	Retain the null hypothesis.
Asymptotic significances are displayed. The significance level is .05.				

Pitch position in relation to passing teammate

Total N	92
Test Statistic	5.524
Degrees of Freedom	3
Asymptotic Sig. (2-sided test)	.137

1. The test statistic is adjusted for ties.
2. Multiple comparisons are not performed because the overall test does not show significant differences across samples.