Investigate Naturalistic Decision-Making of Football Players in Virtual Environment: Influence of Viewpoints in Recognition

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ABSTRACT

Introduction: The study of underlying processes of decision-making in dynamic situation, whether in work or in sport, is essential to the development of training tools. Virtual simulations are both key tools to study these processes and training. **Method**: Our work consisted in analysing the players' naturalistic decision-making in the virtual simulator CoPeFoot and the influence that changes of viewpoint can have on it. Behavioural data were recorded from six players in two different views (immersive and external), supplemented by verbal data collected during self-confrontation interviews. **Results:** A content analysis of the data revealed that in situations with strict time constraints, the players, to make decision, used twenty four schemata which facilitated the recognition of game situations. **Discussion:** These results points to the dynamic aspect of decision-making activity in the simulator and the consistency with the findings of studies in natural situations and the homogeneity for immersive and external views.

KEYWORDS

Decision making; dynamic situation; viewpoint; virtual reality; football.

INTRODUCTION

New technologies have always been an essential asset for researchers in sport science and have recently led them to question the value of simulation for research and training in high-level sport (Bossard, Kermarrec, Bénard, De Loor & Tisseau, 2009a). In this perspective, the virtual reality is now a scientific and technical field which exploits computing and behavioural interfaces to simulate a virtual world behaviour of entities in 3D real-time interaction among themselves and with one or several users in immersion. One of the main innovations allowed is in the development of participatory simulations that highlight the coupling between a user and the computer system. This coupling between individual and environment is also one of the theoretical principle of Naturalistic Decision Making paradigm (Klein, 2008), derived from the ergonomic psychology, and which allows the study of intuitive decision making in dynamic situation, i.e. in a unpredictable environment and where the agents are under strong time pressure. The naturalistic or intuitive decision making is defined generally as a complex cognitive process for the selection of an action or series of actions. In the context of high performance sport, especially team sports, the protagonists are often subjected to many pressures, including time that have a strong influence on their behaviour in the game. Quality of decisions is thus seen as the ability of an athlete to act at any moment of the game quickly and efficiently.

To understand this phenomenon, many studies have been developed in recent years (for a review see Bossard & Kermarrec, 2011) highlighting two different and complementary epistemological perspectives : cognitive and naturalists approaches. However, the cognitive approach, both the oldest and most predominantly adopted by the researchers does not take into account the actual context of the activity. This lack of consideration for the environment and the resulting discrepancy between what is experienced in an experimental situation and what is actually "really" lived in a natural situation has led some researchers to understand the context in which the actors are immersed during their activity. Thus the naturalistic approach, whose main characteristic is to study the complexity of human activity in the individual-environment coupling, appears to be best suited to the dynamic situations that concern us in this case.

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NATURALISTIC DECISION MAKING

The NDM approach has set the aim to improve support systems for decision-making in the military field but also in the nuclear industry and the field of civil aviation. It examines how experts, working alone or in groups in uncertain dynamic environments, identify and evaluate situations, make decisions and perform actions whose consequences are meaningful to them and their environment (Lipshitz, Klein, Orasanu & Salas, 2001). In this context, a dynamic situation is characterized by evolution, uncertainty and time pressure (Hoc, 2001) that imposes on a group of agents that interact to achieve a identified common goal (Gutwin & Greenberg, 2004). Sport situations being also dynamic situations *par excellence*, the parallel with social, professional or training situations that meets these criteria is no longer needed (Fiore & Salas, 2006). Indeed, in a team, the roles are often progressive and the majority of game situations requires the player to make decisions under time pressure.
Within the NDM approach, the Recognition-Primed Decision (RPD) model developed by Klein (1997, 2008) is particularly suited to analyse the player-situation coupling and intuitive decision-making processes.

Recognition-Primed Decision model

Klein and Brezovic (1986) refute the idea that individuals, confronted with dynamic situations, base their choice on a rational calculation or an exhaustive utility analysis (game theory and formal theory of decision). More specifically, the evaluation of the situation in course of action is based on the recognition of significant spatio-temporal configurations from their own experience. In a dynamic situation, the recognition process is based on the mobilization of a "cognitive package" that combines four types of secondary by-products: expectancies, cues, actions from experience and goals (Ross, Schafer & Klein, 2006). The "glance" of the expert in course of action, is an implicit matching between relevant cues perceived and functional structures available in memory.
Additionally, the RPD model proposed by Klein (1997, 2008) distinguishes three recognition processes used by experts faced with a dynamic situation. The "Simple match" that can be considered as a reactive process whereby the expert recognizes a situation already encountered and directly associates an adequate course of action. The second one, "Diagnose the situation" which is a process of diagnosis by comparing relevant cues from the situation encountered with several similar previously experienced situations to choose among known answers and implement an appropriate course of action. And finally, the third one "Evaluate a course of action" when the expert develops a new solution in the course of action and evaluates by a process of mental simulation in order to imagine how his actions could be integrated into the current situation.
However, the RPD model is subject to several criticisms especially with certain limits on unusual and complex events or by not explaining clearly how the "cognitive package" activated by a subject update over the situational dynamics. Thus, Ward, Williams and Ericsson (2012) showed by three experiments realised in the field of soccer that about prediction about the other players the best performances were supported by a situation model-type mechanism as proposed by long-term working memory theory rather than RPD model for example.
Despite of this, the RPD model has been validated in the field of sport in experimental conditions in handball (Johnson & Raab, 2003) and in real conditions of training or of competitive settings respectively in football, ice hockey and volleyball (Bossard, Kermarrec, De Keukelaere, Pasco & Tisseau, 2011; Bossard, De Keukelaere, Cormier, Pasco & Kermarrec, 2010; Macquet, 2009).
Thus, Macquet (2009) used RPD model to analyse the expert players' decision-making in a real volleyball game. The results show that experts in a volleyball competitive situation invest primarily the first modality of the RPD model ("simple match") to make decisions. Bossard et al. (2010, 2011) in the context of football and ice hockey, have subsequently confirmed that the time pressure exerted on the players in counter-attack situation forced them to mobilize primarily this first process. Additionally, these recent investigations under natural conditions showed that the constitutive categories of "cognitive package" of expert football or hockey players covered the four initial by-products RPD model and could be supplemented by a fifth called "knowledge".
To recognize a situation as typical and respond to it quickly, experts would have structures to maintain meaningful and effective action potentials. This hypothesis refers to the idea that people store and organize information from past experiences in abstract forms, i.e. schemata.

The schema theory

The concept of schema has been proposed in cognitive psychology ergonomic to study jointly the role of cognitive structures involved in an adaptive process and the role of contexts that affect their implementation (Anderson, Matessa, & Lebiere, 1997). Studies on naturalistic decision making suggest that the experience of the practitioner is an important factor (Klein, 1997), particularly in determining the decision-making schemata that an expert use in a situation. Researchers generally conclude that real-world decision-making is strongly schema-driven (Lipshitz & Shaul, 1997). They are reused to make quick decisions in new, similar or identical situations (Rumelhart, 1980). Schemata allow experts to interpret a situation as a whole and thus to make decisions by categorizing it efficiently as a whole pattern (Federico, 1995).
In the recent application of RPD model in sport (Macquet, 2009), the results clearly illustrate the assessment of the situation. The volleyball experts players mobilized a decision process that relied on both the evaluation of the situation and the choice of action.

The schema theory applied by Bossard et al. (2010, 2011) in recent studies on the naturalistic decision-making, respectively of expert football and hockey players during fast-breaks, highlights the role and adaptation of these background structures. The authors show the activation and permanent adaptation of schemata depending on the context. To choose the right action to perform, the main prerequisite is then the matching between the contextual invariants from the situation and the background invariants which enable to act: schemata. Additionally, when members of a group (or sports team) share experiences, they build similar schemata, which leads them to respond similarly in prototypical situations within the reference field (Piergorsch, Watkins, Piegorsch, Reininger, Corwin & Valois, 2006). Thus, schemata are reference structures, characteristics of an area of expertise.

APPLICATION OF THE VIRTUAL SIMULATIONS

In the trend of new technologies, the field of virtual reality can enable an individual to immerse himself in a completely virtual world. As part of these participatory simulations, are taken into account not only the influence that the environment has on the individual (simple simulation) but also the influence that the individual has on the virtual environment. And it is precisely this mutual influence individual-environment that is at the heart of the naturalistic approach. This is called the “co-evolution principle” which can then be connected to the notion of implicit learning (Bossard, Kermarrec, Bénard, De Loor & Tisseau, 2009b).
Several simulations have emerged and have thus been used in various studies involving physical activity and sports. In this context, three types of simulators have been created: for studying or practicing a technical gesture, for analysing strategies in sports situations and for immersing the user in sport environments. The main inconvenience in all these sports simulations lies in the fact that all of them, whatever their type, fail to really involve the three criteria which are autonomy, scalability and interaction. This is the question which was at the basis of the CoPeFoot simulator design in order to make it a participatory simulator allowing to reproduce credibly the decision-making in collaborative and dynamic situations (football counter-attacks) and combining the three indicators listed above (Bossard et al., 2009a). It is on this football simulator, whose the design model of virtual agents is the result of an analytical work on the activities of real football players during a practice (Bossard et al., 2011), that our study rested.

CHANGES OF SCENE PERSPECTIVE AND DECISION-MAKING

A number of studies have looked into the relationship in the field of sport between the viewpoint adopted by expert players and decision-making (Petit & Ripoll, 2008; Williams, Ward, Ward & Smeeton, 2008; Farrow, 2007). The majority of them was to ask participants about the decisions they would take by watching some pictures or films showing different game situations under standardized conditions. Thus, Petit and Ripoll (2008) for example, made a study based on the presentation of two video sequences in external and immersive views for two football players groups (experts and novices). The players had to make the choice to pass the ball or not to answer to the game situations and the results showed faster decisions for the experts and overall faster and more relevant decisions in immersive view than in external view. In the contrary, Farrow (2007) found water-polo players had superior decision-making accuracy with an aerial perspective relative to the player-view perspective. He explained that by the wider view of essential spatial information provided by the aerial view.
Beyond these constrasting results, this kind of study shows a large gap between what is perceived, experienced in an experimental situation and what is perceived, lived in a natural situation thus obscuring the real context (or natural) of the decision and the individual-environment coupling upon which the NDM approach rests. In this direction, the contribution of new technologies has enabled researchers to improve ecological conditions of experimental methods to get closer to natural situations. This is particularly the case of a virtual reality simulator as CoPeFoot which is a very interesting tool to conduct a qualitative study on the decision-making of football players based on the viewpoint they adopt on the game situation.
For this study, our work is based on three presuppositions: 1) decision-making is a recognition process which results of the association of the background elements and relevant cues identified in the context, 2) decision-making in dynamic situation can be described, explained and commented in continuous way by the actor exposed to the records of his own activity, 3) each experienced situation reflects the activation of a "schema", used as a benchmark to perceive and decide in course of action.
The purpose of this study is to highlight in the virtual simulator: a) the diversity of significant elements taken into account by the football players to decide quickly b) the types of recognition processes used under high time pressure c) the homogeneity of schemata activated by a group of experienced players, and d) the influence of viewpoint on football players decision-making in a virtual environment.

METHOD

Participants and procedure

The study was conducted in collaboration with six volunteers specialized in football, students from the University of Sport and Physical Education of Brest and playing all at regional level. They have been solicited for their experience and knowledge in this sport. The average age of the players during the experiment was 21 years old and their average experience of practice was 13.8 years.

The six players were separated randomly into two teams which competed in a football match on the virtual simulator CoPeFoot. It is also important to note that players from the same team were together in the same room making it possible for verbal dialogue between them. The situation then set up on the virtual simulator consisted of a typical football training: a game of three versus three on a small field (30x40m) with a goal on both sides (1.50 m).

The experiment was conducted in four phases. First, the players participated in a phase of training session that lasted about 20 minutes during which players were able to familiarize themselves with the software commands. Then, the study strictly speaking consisted of three phases of 5 minutes during which the players competed on the network with different viewpoints. The first sequence was played in immersive view (view called "first person") during which participants adopted the viewpoint of the avatar they led (Image 1). The second sequence took place in external view, then all subjects with the same raised viewpoint allowing them to see the field as a whole (Image 2). Finally, during the third sequence, each player freely adopted one of these two viewpoints to play.

Image 1. Immersive view

Image 2. External view

Data collection

During the experiment, two types of data were collected. First, observational data corresponding to the virtual recording by the simulator of all the game sequences between the six players, allowing to replay at will all the actions carried out during the match.

Then, verbalization data collected during individual self-confrontation interviews (Theureau, 2010) conducted during about one hour at the end or the day following the experience on CoPeFoot. During these interviews, conducted by the same person, the investigator and the player watched together virtual recordings of the three game sequences following the own viewpoint of the player. This confrontation with virtual records of his activity aims to promote the recall of elements actually mobilized by the player during the game sequences studied. The researcher attempts to place the player in a posture and a mental state favourable for the explanation of his decisions through reminders on the sensations, perceptions, focalisations, concerns, emotions and thoughts that accompany each decision. During these interviews, the subject was then asked to describe and comment on his activity. The reminders focused on the actions that were significant (and therefore described and explained by the players) in the game sequences and on the events for which the researcher wanted to obtain additional information. Sharing a common sports culture between the researcher and the players has facilitated the understanding of the comments of the protagonists and has avoided the reminders leading to an explanatory style. This kind of interview is based on a true moral contract of cooperation between the players and the researcher.

Data analysis

Finally, the analysis of the data was carried out in five steps. At first, the data transcription that is to prepare them by linking the behaviours observed in the game recordings with the data obtained during self-confrontation interviews. The second step was to select and identify meaningful units, that is to say observed behaviours and passages or sentences pronounced by the player who gave information on his decisions during phases of play. To encode the meaningful units selected, the system of categories defined by the RPD model (Klein, 1997; 2008) and recently completed by Bossard et al. (2010, 2011) was used to classify the elements of players speech in five categories: plausible goals, expectancies, course of action, knowledge mobilized and relevant cues collected. Then, the task was to cut the stream of player activity to identify and distinguish the successive situations experienced by (and with the point of view of) each player. The fourth step was to make clusters of situations experienced in the same way by the same individual or several of them. Finally, this analysis ended by a validation process to ensure the validity of the data and which consisted of a "triangulation" process between two researchers familiar with the object of the study.

RESULTS

Coding and identification of meaningful units

The work of identifying and coding meaningful units (MU), corresponding to the game sequences, enabled us to count 1606 MU. According to the RPD model and its components, data analysis by theoretical categorization shows that these units are divided into the five theoretical categories expected: goal, action, relevant cue, expectation and knowledge. All these results are collected in Table 1.

Table 1. Distribution of Meaningful Units

Meaningful Units	Immersive view	External view	Total
Goals	161	109	270
Knowledge	71	46	117
Relevant cues	332	191	523
Actions	372	215	587
Expectations	71	38	109
Total	1007	599	1606

Identification of experienced situations and categorization of patterns

The cutting of each player's activity progress, taking into account the indications on the form and the meaning of the speech, we identified 424 experienced situations for all players interviewed during the study. Through a process of empirical categorization, these situations have been gathered together in 24 "schemata" that can be classified into three distinct groups: 6 in "Offensive phases with the ball" (the subject was in possession of the ball), 6 in "Offensive phases without the ball "(a team-mate was in possession of the ball) and finally 12 in " Defensive phases "(the opposing team had possession of the ball). Some schemata may be regarded as typical of expertise in football because they are activated by several players in various situations. Table 2 shows the number of typical schemata used in each type of game phase by all players with the two viewpoints adopted.

Table 2. Distribution of typical schemata classified into types of game phases

Types of game phase	Immersive view	External view	Total
Offensive phases with the ball	48	29	77
Offensive phases without the ball	86	48	134
Defensive phases	124	80	204
Total	258	157	415

Analysis of experienced situations and RPD model

The analysis of experienced situations, referring to the RPD model (Klein, 1997; 2008) showed that participants mobilized three levels of recognition process to decide in dynamic situation. Among the 424 experienced situations identified, 415 could be classified into one of the three modalities. Table 3 summarizes the distribution of recognition processes per viewpoint adopted. Table 4 summarizes the number of recognition processes per type of game phase.

Table 3. Distribution of recognition processes

Recognition processes	Immersive view	External view	Total
Mod 1 : Simple match	166	97	263
Mod 2 : Diagnose the situation	49	29	78
Mod 3 : Evaluate a course of action	43	31	74
Total	258	157	415

Table 4. Distribution of recognition processes per type of game phase

Types of game phase	Immersive view			External view			Total / Mod			Total
	Mod 1	Mod 2	Mod 3	Mod 1	Mod 2	Mod 3	Mod 1	Mod 2	Mod 3	
Offensive phase with the ball	38	9	1	23	5	1	61	14	2	77
Offensive phase without the ball	48	13	25	21	14	13	69	27	38	134
Defensive phase	80	27	17	53	10	17	133	37	34	204

DESCRIPTION AND DISCUSSION OF RESULTS

Elements taken into account by the players to decide in action in CoPeFoot

The coding of the players' decision-making according to five by-products (expectations, goals, knowledge, actions and relevant cues) enables us to note that all these elements are involved in the decision-making of each individual. This study enables also to go into the content of these elements in depth. Goals correspond to the intentions of the player in action. Knowledge expressed by the players refers to their own activity, the strengths and weaknesses of the partners and opponents, the characteristics of the simulator (how to steal the ball into the opponent's feet, running speed with or without the ball) or general principle of the football game. Expectations mainly correspond to assumptions made by the players on the evolution of the current situation, verified or not later. The actions performed by the actors refer to their own movements but also those of the opponents and partners. Finally, the relevant cues detected from the context by players mainly concern the placement and movement of the partners and opponents. Thus, these results enable to establish the elements considered significant by subjects to decide during the simulation CoPeFoot.

In light of our results, we observe some similarities with the content of the categories proposed by other qualitative studies to describe decision-making in team sports (Bossard et al., 2010; Lenzen, Theunissen & Cloes, 2009; Macquet, 2009). Although the interpretation of the number of occurrences of the elements involved in the decision-making must be conducted carefully in a qualitative study, we observe a large proportion of data for the categories "perception" or "relevant cues" in these qualitative studies that are conducted either under natural conditions or in a virtual simulator. Expert players in team sports do not report all information collected by them to make a decision but they only call critical or significant signs in the situation (Kevin: "Player B is along the line, normally it's easier for a double team block at that moment"). These results support the idea that in dynamic situation, experts (athletes or not) devote more time to recognize the situation than compare various options for making a decision (Johnson & Raab, 2003; Klein, 2008). That seems to be the case in simulation too.

The results relating to the contents of the elements mobilized in and for action are in the continuity of those obtained in previous studies. They allow to enrich the establishment of decision-making model because they capture the characteristics of expertise in dynamic situation whether in natural or virtual environment.

Relationships between elements mobilized in action and the constraints imposed by CoPeFoot

In a general way, the results in Table 3 show that the decisions adopted by the players on the simulator primarily involve a process of “simple match” (263 of 415 cases, i.e. 63.37%) rather than processes of “diagnose the situation” (78 cases, 18.8%) or “evaluate the course of action” (74 cases, 17.83%). During game sequences, players have worked primarily on a reactive mode meaning that each decision was an implicit reaction to some signs (mainly the positioning and the movements of partners and opponents) perceived as significant in the same situation. This holistic assessment of the course of action (Lipshitz et al., 2001) is consistent with the results of studies conducted under natural conditions of work (Klein & Brezovic, 1986) or sports (Macquet, 2009).

The results in Table 4 highlight more specifically the relationship within the CoPeFoot simulator between the type of game phases played and the processes mobilized by the players. Thus, in offensive phase with ball, players have overwhelmingly used the “simple match” level (61 cases of 77, i.e. 79.22%). This is explained by the fact that being with the ball contributes to feel a strong time pressure from the opponents (who want to steal the ball quickly) but also from the team-mates and the experienced situation itself. Indeed, some situations may require to fast-forward, toward the target areas to take advantage of clear spaces and take opponents by surprise. Under this strong time pressure, the recognition process is thus more related to "course of actions" and "relevant cues" than the mobilization of general knowledge about the game or other players and assumptions on the game situation.

We can also notice that the process of assessment of the situation by mental simulation has been used very few times during the offensive phases with the ball (2 of 77 cases, 2.60%), and much more in defensive phases (34 of 204 cases, 16.67%) and especially in offensive phases without the ball (38 of 134 cases, 28.36%). This is explained by the fact that not being with the ball, the players do not feel as much time pressure and therefore consider that they have more time to make their decision. The verbalization of a greater amount of knowledge and above all expectations by the players during these phases "without ball" can also be explained by the uncertainty of the situations experienced during these game sequences that does not always favour a simple and quick recognition process. Indeed, when the ball is with another player (opponent or partner), the feeling of control over the result of the current action seems much lower than with the ball and therefore contributes, for players, to evaluate its possible evolution by mental simulation because less relevant cues are then recognized.

Time pressure, or more precisely the perceived urgency of the situation by the player, as well as the uncertainty concerning the evolution of the situation seems to be the main factors influencing the process of recognition in the CoPeFoot simulator. These results tend to confirm those noticed in previous qualitative studies (Bossard et al., 2010, 2011; Macquet, 2009) conducted in natural situation.

Learning, individual dynamic faced with the simulation

The particularity of this study of not being conducted in a natural situation highlights an important aspect of this experience which is the learning faced with the CoPeFoot simulator. Indeed during the study, the protagonists didn’t have more than 20 minutes of grip on the simulator, which does not exclude the fact that they continued this "learning" phase during the three steps of the experiment that followed.

Thus, our results show that among the five categories of elements identified, the "knowledge" expressed by the players is the only category steadily increasing over the three stages of the experiment (5.15% for the first step, 7.68% for the second and 8.24% for the third). This evolution can be explained by several aspects including especially the learning of the simulator features (e.g. Julien: "as the defenders were faster than the player who had the ball ..."). Indeed, while no acquired knowledge about the virtual simulator features was issued during the first step conducted in immersive view, there were 7 during both phases of the experiment that followed (external view and view chosen by each player). This increase of using knowledge by players for their decision-making within the simulation can therefore be explained in part by the learning of the football simulator features. The players having, by practice, an amount of knowledge more important would be likely to use it most frequently to make decisions, influencing in this way the recognition process of the experienced situation. The verbalization of a greater amount of knowledge by the participants in these situations can be interpreted as the players' commitment to a process of seeking solutions among those available and acquired during the previous actions. The players beginning to know more typical situations then used their experience to decide quickly.

These results on the recognition process and meaningful units, even few in number, show us an important component to consider in order to interpret objectively the possible influence of the viewpoint adopted within the simulation on the players' decision-making.

Influence of viewpoint adopted on the decision-making

First of all, Table 1 shows a perfect homogeneity between the two viewpoints adopted for each of the five types of by-products identified during the interviews (chi-square test of homogeneity giving a p-value=0.977). Then, contrary to what might be expected, the external view, presenting yet more cues owing to a wider field of vision, does not cause a greater share of significant cues quoted by players to make their decisions. However, this confirms that whatever the viewpoint adopted, experienced players recognize situations quickly through the collection of only a few elements. These relevant cues picked up from external view then may not be the same as those identified in immersive view in the same type of action.

Then Table 2, displaying the distribution of types of typical schemata recorded shows once again a certain homogeneity observed between the two viewpoints (but not significant, p-value=0.813). A slight difference can just be notified about the proportion of typical schemata of “offensive phases without ball” which is lower in external view (30.57% to 33.33% for immersive view). And conversely, for the typical schemata of “defensive phases”, of which the proportion is greater for the external view than for the immersive view (50.96% to 48.06%). This slight difference could be explained by the fact that the external view allowed the players to raise more cues on the opposing team (positions and movements of the three opponents) then facilitating perhaps the activation of some typical schemata when they were in defence.

Finally, as previously with the typical schemata, concerning the recognition processes of typical situations during this experience, their proportion remains overall constant, but not significant (p-value=0.74), from one step to the next (Table 3). It just can still be noted once again, a slight difference about the recognition process “simple match” which is somewhat lower in external view than in immersive view (61.78% to 64.34%). The results confirm those obtained by Petit and Ripoll (2008). Indeed, for immersive view, experienced players seem to activate more frequently a recognition process “simple match” allowing a faster decision. This difference can also be directly connected to what has been previously analysed for the highest proportion of typical schemata of “defensive phases” recognized in external view.

However, if these results are relatively consistent between the two viewpoints, Table 4, detailing the recognition processes of game phases, shows a big difference. Indeed, the proportion of recognition processes during "offensive phases without the ball" seems to be much more variable from one view to another. Concerning this game phases, the players have much more used the diagnostic process in external view to recognize typical situations (29.2% to 15.11%) and in return, less recognition processes “simple match” (43.8% to 55.81%). This highlights the fact that in immersive view, when team-mate has the ball, the player would be more likely to quickly recognize a typical situation by a simple analysis of relevant cues. In external view, in the same situation, that player would be more likely to scan the various possibilities to make his decision. This can be explained by the greater number of elements that can be picked up by the player who, detecting more cues and having probably more possibilities, would tend to use the diagnosis process of the experienced situation.

Other work opportunities could complete these first results by another analysis more based on the concept of team cognition enabling to highlight the collective aspect involved in the two viewpoints available in CoPeFoot. In this way, the coordination models governing the collaborative activity within each team as well as the dynamic of contents shared by teammates could have been put forward (Bourbousson, Poizat, Saury & Sève, 2012). Nevertheless, despite of this lack, the sight difference between the viewpoints adopted, linked with our other results shared by other studies in natural situations (Bossard et al., 2011; Lenzen et al., 2009; Macquet, 2009) presents an interesting perspective concerning decision training on the CoPeFoot simulator. Thus, the two viewpoints could be interesting: the external view to train players to identify several alternatives by allowing them to have hindsight about the game situations and the immersive view for the training of the quick and simple recognition of game situations in order to decide quickly. A combination of both would be also possible with an experience in immersive view, then an analysing in external view and finally a return to the immersive view.

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