Shared Understanding and Coordination in Team Sports

Contribution of Viewpoints Changes and Shared Information Displays for Team Situation Awareness Training

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Abstract: The paper aims at examining the interest of viewpoints changes and shared information displays for promoting shared understanding and decision-making coordination in team sports. The role of technological device such as virtual reality and video-cued training are examined. The paper starts with a description of major features in shared understanding elicited in sport psychology, and then focuses on review and choices concerning the use of virtual reality (VR). Finally, an exploratory study in soccer is presented, supported the idea that, using two properties of VR (viewpoint changing, and displaying player's judgments), an innovative 2-D video-cued training should enhance shared understanding between four defensive players. First results suggest that such technological device could enhance sharing processes and modify sharedness (i.e. shared knowledge structure).

1 INTRODUCTION

Over the past three decades research in sport psychology has focused on the "winning factors" such as decision-making in order to develop training effectiveness. Some of these studies have been conducted in real-world setting, that is one of the Naturalistic Decision Making (NDM) paradigm's objectives. Recognition-Primed Decision and Situation Awareness, applied to military or aeronautics research, are well-known model of decision-making in complex and dynamic environments (Endsley, 1995; Klein, 2008). Most sports situations can be characterized as dynamic and uncertain. Athletes have to perform in complex environments, wherein they have to assess situations, cope with time pressure and emotions, so that they used to make optimal adjustments or intuitive decision (e.g., Bossard et al., 2011; Kermarrec and Bossard, 2014).

The growth of interest in team games suggest that the premises of NDM are now stimulating research and application that cover a set of cognitive processes such as Team Situation Awareness (TSA), Shared Understanding (SU), and thus decision-making coordination in team games. Whereas the study of TSA and SU has received a good deal of attention as performance factors, relatively little is known about team training (see Salas, Nichols, and Driskell, 2007 and Salas et al., 2008 for recent meta-analyses), particularly in a team games setting. In work context, previous studies on TSA lead researchers to make recommendations for employing effective team-based practices in various applied settings (aeronautic, medical care, military operations). Programs for enhancing TSA have been developed, implemented and evaluated. Some of them promote simulation for training. Virtual Environment (VE) technology aims at giving the user the sense of being "in" the environment. VE should have the potential to improve simulation-based training for many settings, especially when SU is not "given", but dynamic and emergent from each partner's course of action. One of the main innovations for acquiring common knowledge should be 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 principles of Naturalistic Decision Making paradigm (Klein, 2008), derived from the ergonomic psychology, and which allows the study and the growth of SU and TSA in dynamic situation. The purposes of this contribution are to examine

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current research on the role of TSA and SU in teams' performance and discuss potential application of using technological devices to enhance training in team games. The paper is organized in three sections: (a) a description of major features in TSA conducting in principles for coordination training, (b) choices about technological devices such as Virtual Reality in a sports setting, and (c) a presentation of an exploratory qualitative study on the contribution of a 2-D video-cued training in soccer.

2 SHARED UNDERSTANDING AND COORDINATION IN TEAM GAMES

2.1 Team Performances and Shared Understanding

Eccles and Tenenbaum (2004, 2007) argued that team performance requires a high degree of coordination and that coordination arises from shared understanding. Thus, research on team performances has shown the interest of two sources of shared understanding: shared knowledge and shared context.

2.1.1 Shared Mental Models and Sharedness

Most studies on team performance have focused on shared knowledge. They tried to elicit "what is shared" and described Shared Mental Models, i.e. a stabilized structure of knowledge, ready to be used before the team members have to make decision and to coordinate themselves (Reimer, Park and Hinsz, 2006).

Two types of shared knowledge have been identified: (a) knowledge about the task to be accomplished; (b) knowledge about the organisation of the teamwork (Cannon-Bowers and Bowers, 2006; Lim and Klein, 2006; Mathieu et al., 2000). Shared Mental Models (SMM) have been extensively studied in various domains. Researchers used experimental studies and quantitative measures of sharedness. They have demonstrated the role of SMM in team performance.

2.1.2 Team Situation Awareness and Sharing

However, in dynamic (i.e. complex and indeterminate) situations like most team games interactions, shared understanding cannot be reduced to shared knowledge constructed before the course of action. Team members probably have to share perceptions, judgements, expectations for the on-going situation (Poizat, Bourbousson, Saury and Sève, 2009). Considering that what is shared is "contextual" (Salembier and Zouinar, 2004), researchers have developed conceptual and methodological frameworks for describing and assessing the dynamic of shared understanding. For example, with the Team Situation Awareness framework, the notion of situation awareness (Endsley, 1995) was extended to study coordination in teams.

Endsley (1995) defined Situation Awareness as the perception of the elements in the context, the understanding of their meaning, and the projection of their role in the near future. In a team games setting, the players should take in account these elements over the course of their interactions and probably share some of them to be coordinated. Over the past few years, Team Situation Awareness (TSA) has emerged as a major concept in research dedicated to study coordination among members of the same team (e.g., Cooke et al., 2007; Cooke, Stout, and Salas, 2001; Fiore and Salas, 2006). TSA cannot be reduced to the sum of each individual's awareness, but either cannot be elicited without taking in account each individual point of view.

Cooke and Gorman (2006) indicated that the processes leading to share understanding might be more important than the outcome of shared knowledge. To describe these processes, the notion of sharing may be sometimes preferable to the notion of sharedness (Bourbousson et al., 2011). Sharing refers to when and how cognitive contents are shared. To study sharing in teams, using TSA framework, both of quantitative and qualitative methods were employed during the activity of a team operating in its naturalistic environment. TSA was assessed with a particular focus on the forms of sharing that appeared during real-time activity and on the sharing processes.

2.2 Team Situation Awareness Performance in a Team Sports Setting

2.2.1 Team Sports, Sharedness and Sharing

Despite several researchers have called for empirical studies in a team sports setting (Eccles and Tenenbaum 2004, 2007; Fiore and Salas, 2006), the investigation of SU and TSA in team sports has been neglected. Few studies were conducted in a naturalistic setting.

Bourbousson et al. (2011) studied the sharedness of knowledge within a basketball team (nine players) and how it changes during an official match. The results elicited types of change in shared knowledge and the heterogeneous and dynamic nature of sharedness within the team.

One of our recent studies in Handball (Dekeukelaere et al., 2013) was conducted on the TSA perspective. Behavioural data from six elite players during nine selected offensive phases were recorded and supplemented by verbal data collected during self-confrontation interviews after the game. Data were analysed in five stages: (1) generate offensive phases chronologies, (2) encode and examine players' situation awareness during each phase, (3) identify shared content, (4) analyse processes of sharing, (5) analyse forms of sharing. First, the results showed that the athletes alternated between two main modes of shared understanding. In some cases, a pre-established plan was followed-up, based on "sharedness" (e.g. the routines or tactics that were reinforced during training). Most of the time, these shared content have to be adjusted at the end of the course of action. In other cases, performances needed a real-time adaptation to the context of action. "Context sharing" during the course of action were based on various forms of sharing and on many sharing processes. Although the similarity mode is usually reported to be most efficient for teams, in this study, the complementarity mode is efficient when team members have to coordinate themselves based on pre-established sharedness (when the attackers took time to prepare the offensive sequence). When the coordination seemed to be context-dependant (during counter-attacks), the similarity of local sharing (only between two or three players) was efficient.

Focusing on sharing as a process, Bourbousson et al. (2010) investigated the cognitive coordination modes between teammates showed that shared understanding was constructed essentially from chains of local coordination. The results suggested that local sharing seemed to be sufficient to ensure coordinated collective activity.

In few studies (Dekeukelaere and Kermarrec, 2013; Poizat et al., 2009), the analysis and comparison of the team members' activity in situations revealed processes that regulated sharing such as inquiry or surveying, verifying or monitoring, displaying, masking or resisting.

These studies elicited the alternative role of sharedness (as a "product") and sharing (as a "process") in team performances.

2.2.2 Team Training Strategies: Implications for Training in a Team Sports Setting

The underlying assumption is that teams can be led to perform better and more effectively when the team members participate in a training intervention. Several recent reviews have delineated two orientations for team training strategies (Salas, Nichols, and Driskell, 2007; Salas et al., 2008): task work *vs* team work.

In the SMM perspective, team training strategies are based on "task work" in order to develop specific competencies for each teammate and acquire common knowledge about "what and who" organizing the task. Thus, shared understanding in a team games setting should be based on the similarities and the complementarity of the knowledge the players acquired over the course of years of competition and over training (i.e. sharedness as a product of experiences). In a sports setting, most of training strategies have been used to increase knowledge sharedness; they consisted essentially in pre-briefing, post-briefing and cross training (Cannon-Bowers and Bowers 2006).

Therefore, considering that shared understanding is rarely completely pre-established before team performance, recent studies suggested that training methods have to develop further in the direction of team adaptiveness (Bourbousson et al. 2011; Dekeukelaere et al., 2013, 2014). Considering that team performances are based on the dynamic of TSA, team-training strategies should target "team work". Teamwork may include inter-individual processes such as mutual performance monitoring, mutual surveying, or intention displaying. Team coordination and adaptation training should be based on context sharing (i.e. sharing as a process).

In accordance with this second type of team-training strategies (i.e. strategies based on teamwork), we made the assumption that technological devices such as Virtual Reality (VR) simulations could be salient for shared understanding and coordination training.

3 VR AND TRAINING IN A SPORTS SETTING

New technologies became 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 and Tisseau, 2009a). In this perspective, virtual reality is a scientific and technical field which exploits computing and behavioural interfaces to simulate a virtual world. In this world, behaviour of entities are implemented in 3D real-time interaction among themselves and with one or several users in immersion. In the context of high performance sport, especially team games, the protagonists are often subjected to many pressures (e.g, time-pressure) that have a strong influence on their co-adaptation in the game, so that simulation and VR should be a great perspective for innovative training.

3.1 Four Types of Simulators

Several types of simulations have emerged and have thus been used in various studies involving physical activity and sports. In this context, four types of simulators could be distinguished: simulators for studying or practicing a technical gesture, for studying physiological responses to physical activity, for analysing strategies in sports situations, and for immersing the user in sport environments (for a review see Bossard et al., 2009b; Pasco, 2013).

First, physical simulators have been designed for studying technical movements and for motor skill training. The aim was to create a more believable environment with regards to senses, mainly relating to sight, balance, touch and sound. The physical interaction between the user and the machine is an essential part of believability. For exemple, Bideau et al. (2003) suggest immersing handball goalkeepers by confronting them with virtual players.

Secondly, in recent years, VR technology has been viewed as an opportunity to study and improve physiological responses to exercise in a safe, controlled, and motivational environment. Heart rate, ventilation rate, and sweating, are important physiological indicators for the impact of exercise/physical activity on the human body. Standards based on these indicators, especially on heart rate, are used as platforms on which the effect of physical activity is evaluated for adults and children alike. For example, Chuang, et al. (2003) examined the influence of VR technology on physiological responses of the cardiovascular systems during incremental exercise testing.

Thirdly, the advantage of virtual reality simulations is that it is possible to conduct risk-free experiments and to be able to analyse the consequences of choices made by the players in different situations. In order to generate a believable environment, this tool uses image processing and synthesis. For example, Ziane (2004) suggests that basketball coaches could be trained to analyse their team's actions.

Fourth, when the aim is to immerse the human user within a believable virtual environment, simulators attempt to produce virtual agents with a certain degree of autonomy. Video games can therefore provide very effective simulations. The TeamVision system from Konami, for example, is an adaptive artificially intelligent system for Pro Evolution Soccer 2008. The creators of the game FIFA 2008 referred to a system evaluating up to thirty action options at any given time as an opportunity map. In the current state of affairs, the achieved behaviours are realistic, as they are due to the relative autonomy of the virtual players. The choices are made by each agent independently of a metamodel.

3.2 Simulation and Context Sharing

Combining the two last types of simulation listed above, virtual environment could be designed in order to make it a participatory simulator allowing reproducing collaborative and dynamic situations. Those situations would led the users to make decisions and to coordinate their decisions to be more efficient. For example, the CoPeFoot simulator is a soccer simulator, in which 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). A VR system, such as the CopeFoot, can be helpful in order to facilitate shared understanding. Players will become immerged in this environment by controlling an avatar. They collaborate with other players (via their avatars) in creating attack scenarios and use them repeatedly to find out those most effective. During the process, they experienced decision-making and co-constructed effective tactics. Because they shared the same virtual soccer field and attempted to solve same tactical problems, players could develop a dynamical sharing of the situation. In the next sections, two properties of VR simulation will presented in relationship with our objective, the training of sharing and dynamic coordination in team.

3.2.1 Sharing and Viewpoints Changes

In sport sciences, number of studies has looked into the relationship between the viewpoint adopted by expert players and cognitive processes. Some of these simulations used virtual reality technology (Cardin et al., 2013) or combined video sequences and VR properties (Petit and Ripoll, 2008). Cardin et al. (2013) argued that changes of viewpoint could lead players to simulate other players' judgment. They experimented an immersive and an external viewpoint in the CoPeFoot simulator (see figures 1 and 2).

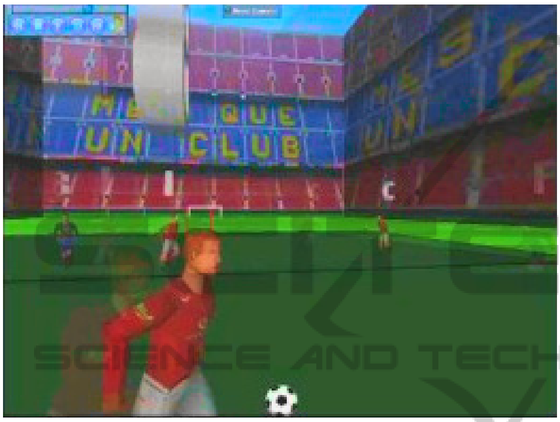

Figure 1: Immersive Viewpoint.

Figure 2: External Viewpoint.

Considering this property of VR, we hypothesized that if a soccer player "could take place in his teammates' dynamic environment", he should assess the situation from a new subjective point of view, and reinforce or adjust his first judgment. This usual property in VR environments should be useful for sharing and shared understanding.

3.2.2 Sharing Context and Displaying Team Members' Focus

Considering the interest of VR simulation for coordination training, the CoPeFoot simulator was extended to ExpeCoPeFoot, designed in order to display the information the users take in account when interacting with the environment (Bossard et al., 2011). The first stage consisted in playing a game. Then, using a replay stage, each participant in the simulation can select on the screen the information he focused on when he made his own choice. For instance on figure 3, a player standing in the right corner was in possession of the ball. He could see three players and particularly paid attention in two of them because many informations were displayed. He indicated their color (e.g. one of his teammenbers in red on the right side), their speed and their direction. In this way, each team member could share with others the meaningful contextual elements of his own situation awareness.

Figure 3: Displaying Meaningful Information in Context.

Future development could promote the sharing of the whole judgement in the situation, and the decisions each player made. Therefore, VR technology needs long-time design processes, so that we considered that 2-D or 3-D video, mixed with augmented reality (i.e., viewpoints changes and sharing information displays) should be a useful training tool in a team sports setting.

4 PROMOTING SHARING IN A TEAM SPORTS SETTING: AN EXPLORATORY STUDY

In previous studies (De Keukelaere et al., 2013a, 2013b, 2014) TSA was studied and defined as the articulation of each player judgment during a course of action. Promoting SU through instruction and traditional training method can be difficult. Before engaging in a dynamic setting, it is difficult for players to know exactly what they will have to do and what decision they will have to make. The role of each player (the tactic content of sharedness) may not be entirely determined before the game, so that players should be trained in adjusting their judgments to others, and in being receptive to others' point of view. In this perspective, the training of sharing in the on-going course of action is a challenge for trainers, researchers and for new technology designers.

4.1 An Innovative Video-Cued Training

One possibility to train sharing process is to provide players information about their teammates judgment. A technological device can help this process by providing viewpoints changes and shared information displayed in either a 2-D or a 3-D environment. As players recall their experience in relation to other teammates judgments, they can see, feel, and, hopefully, assess the situation as a collaborative situation. During training session, viewpoints changes modified spatiotemporal configurations and stimulated the teammates' perception of environment. In conclusion of an empirical study in a handball setting, Dekeukelaere et al. (2013) suggested that sharing information displays could be designed using video and video-cued recall interviews. After the interviews, each player's successive judgments could be labelled on a video just above the players' positions (see figure 4). Such a sharing information display should be used for collective debriefing session training and should give the players the habit to pay attention in teammates' situation awareness or in opponents' judgments.

Figure 4: Example of a Sharing Information Display in Handball.

4.2 Promoting sharing between Defensive Soccer Players

Such a technological device was used with four young male football players from an elite football school. Their mean age was 12.5 years (*SD* = 1.2 years). They had played on this team for several months. The team used zone defense. It is a tactic that is used in invasion sports where the players are made to guard a specific area of the field: all of them have their own zone to guard. During one month, training, previous matches, and feedbacks between players and coaches had developed sharedness about this tactic. Indeed, in zone defense, if a defender is under pressure or in a critical situation his teammates must assist him; because of this, zone defense requires extensive interactions between the defensive players. Thus, context sharing and sharing processes are supposed to help them to coordinate their decision-making and their actions.

Technological device was used for two weeks during regular training sessions. Ten 2-D video-cued training sequences were designed combining changes of viewpoints (attackers viewpoints, defenders viewpoints) and sharing context displays (judgment verbalized by the central defender, or the right or left back defenders, or the attacker in possession of the ball). Each sequence was 15 seconds long and was ended by a question: what decision should you make? The ten sequences were alternatively organized into individual or collective presentation. During collective presentation, the four players could debate, explain their option or show which information was salient for them.

These collective presentations were videotaped, and the participants' verbalizations during these collective sessions were used as verbal data for analysis. Complementary, observational data of the training process as the subjects progressed through the two weeks were also collected.

Qualitative analysis of the data indicated that such a team training could contribute to change coordination mechanisms. First, verbal report showed that the participants trust in the capabilities of the system for training. Observational data showed that when the team played defensive stages, participants paid more attention into each other: more communications between defenders were observed; forms of sharing became less hierarchical or more symmetric. Verbal data collected during the collective training sessions showed that shared knowledge structure has been modified: roles are more precisely identified, and operations for each of them are more explicit.

5 CONCLUSIONS

These results suggested that viewpoints changes and shared information displays should be considered as resources for coaches: they could help them to stimulate complex phenomenon such as sharing and shared understanding in a team games setting. Technological devices could be designed for training coordination in teams, decision-making of players, coaches or referees. Effectively using VR technology to promote shared understanding is still more of an assumption than a reality. VR technology needs long-time design processes, so that we considered that 2-D or 3-D video, mixed with VR properties (viewpoint changes and sharing information displays) should be a useful training tool in team games settings.

It seems that the TSA can be used as an effective theoretical framework to guide the future design, development, implementation, and evaluate the impact of technological-based training on team performances.

REFERENCES

Bideau, B., Kulpa, R., Ménardais, S., Fradet, L., Multon, F., Delamarche, P. and Arnaldi, B., 2003. Real Handball Goalkeeper vs. Virtual Handball Thrower. *Presence: Teleoperators and Virtual Environments*, 12(4), 411-421.

Bossard, C., Kermarrec, G., Bénard, R., De Loor, P. and Tisseau, J., 2009a. An exploratory evaluation of virtual football player's believability, *In proceedings of 11th Virtual Reality International Conference – VRIC'09* (pp.171-172), Laval, France.

Bossard, C., Kermarrec, G., Bénard, R., De Loor, P., and Tisseau, J., 2009b. Virtual Reality for Research and Training in Sport: an Illustration with CoPeFoot (Chap. 16), In C.H. Chang (Ed), *Handbook of Sports Psychology* (pp. 391-402), New York: Nova Science Publishers, Inc. ISBN: 978-1-60741-256-4.

Bossard, C., Kermarrec, G., De Keukelaere, C., Pasco, D., and Tisseau, J., 2011. Analyser l'activité décisionnelle de joueurs de football en situation d'entraînement pour développer un modèle de joueur virtuel [Analyze soccer players decision making during training to develop a virtual soccer player model]. *eJRIEPS*, *23*, 124–151.

Bourbousson, J., Poizat, G., Saury, J., Sève, C. (2010). Team coordination in basketball: description of the cognitive connections between teammates. *Journal of Applied Sport Psychology, 22,* 150-166.

Bourbousson, J., Poizat, G., Saury, J., Sève, C., 2011. Description of dynamic shared knowledge: an exploratory study during a competitive sports interaction. *Ergonomics, 54,* 120-138.

Cannon-Bowers, J. A., and Bowers, C., 2006. Applying work team results to sports teams: Opportunities and cautions. *International Journal of Sport and Exercise Psychology, 4*, 363-369.

Cardin, Y., Bossard, C., Buche, C., and Kermarrec, G., 2013. Inves- tigate naturalistic decision making of football players in virtual environment: Influence of viewpoints in recognition. In *Proceedings of the 11th International Conference on Naturalistic Decision Making* (pp. 109-117). Marseille, France: Arpege.

Chuang, T. W., Chen, C. H., Chang, H. A., Lee, H. C., Chou, C. L., Doong, J. L., 2003. Virtual reality serves as a support technology in cardiopulmonary exercise testing. *Presence*, *12*, 326–331. doi: 10.1162/ 105474603765879567

Cooke, N. J., Stout, R., and Salas, E., 2001. A knowledge elicitation approach to the measurement of team situation awareness. *New trends in cooperative activities: Understanding system dynamics in complex environments,* 114–139.

Cooke, N. J., Gorman, J. C., and Winner, J., 2007. Team cognition. In F. Durso, R. Nickerson, S. Dumais, S. Lewandowsky and T. Perfect (Eds.), *Handbook of applied cognition* (pp. 239-268). Wiley (2nd Edition).

Cooke, N. J., and Gorman, J. C., 2006. Assessment of team cognition. In P. Karwowski (Ed.), *International encyclopedia of ergonomics and human factors* (pp. 270-275). London: Taylor and Francis Ltd.

De Keukelaere, C., Kermarrec, G., Bossard, C., and De Loor P., 2014. Évolution et partage du sentiment de performance collective au cours d'un match de handball. *@ctivités, 11 (1),* 47-64.

De Keukelaere, C., Kermarrec, G., Bossard, C., G., Pasco, D., and Loor, P., 2013. Formes, contenus et évolution du partage au sein d'une équipe sportive de haut-niveau. *Le Travail Humain, 76*. 227-255.

De Keukelaere, C. and Kermarrec*, G.,* 2013. L'évolution du partage et artefacts technologiques en théâtre d'improvisation. *Education Permanente, 194,* 91-101.

Eccles, D. W., and Tenenbaum, G., 2004. Why an expert team is more than a team of experts: A social-cognitive conceptualization of team coordination and communication in sport. *Journal of Sport and Exercise Psychology, 26*, 542-560.

Eccles, D. W., and Tenenbaum, G., 2007. A social cognitive perspective on team functioning in sport. In G. Tenenbaum and R. C. Eklund (Eds.), *Handbook of sport psychology* (pp. 264-283). New York: Wiley.

Endsley, M.R., 1995. Toward a theory of situation awareness in dynamic systems. Human Factors. *The Journal of the Human Factors and Ergonomics Society, 37*, 32–64.

Fiore, S. M. and Salas, E., 2006. Team cognition and expert teams: Developing insights from cross-disciplinary analysis of exceptional teams. *International Journal of Sport and Exercise Psychology*, 4(4), 369–375.

Kermarrec, G., and Bossard, C., 2014. Defensive Soccer Players Decision-Making: a Naturalistic Study. *Journal of Cognitive Engineering and Decision Making,* 8(2), 187 - 199. DOI: 10.1177/ 1555343414527968.

Klein, G., 2008. Naturalistic Decision Making. *Human Factors, 50*(3), 456-460.

Lim, B. C., and Klein, K. J., 2006. Team mental models and team performance: A field study of the effects of team mental model similarity and accuracy. *Journal of Organizational Behavior, 27,* 403–418.

Mathieu, J. E., Heffner, T. S., Goodwin, G. F., Salas, E., and Cannon-Bowers, J. A., 2000. The influence of shared mental models on team process and performance. *Journal of Applied Psychology, 85*, 273-283.

Pasco, D., 2013. The Potential of Using Virtual Reality Technology in Physical Activity Settings, *Quest, 65 (4),* 429-441. DOI: 10.1080/00336297.2013.795906

Petit, J-P. and Ripoll, H., 2008. Scene perception and decision-making in sport simulation: A masked priming investigation. *International Journal of Sport Psychology*, 39(1), 1-19.

Poizat, G., Bourbousson, J., Saury, J., and Sève, C., 2009. Analysis of contextual information sharing during table tennis matches: An empirical study on coordination in sports. *International Journal of Sport and Exercise Psychology. 7,* 465-487.

Reimer, T., Park, E. S., and Hinsz, V. B., 2006. Shared and coordinated cognition in competitive and dynamic task environments: an information-processing perspective for team sports. *International Journal of Sport and Exercise Psychology, 4*, 376-400.

Salas, E., Nichols, D. R., and Driskell, J. E., 2007. Testing three team training strategies in intact teams: A meta-analysis. *Small Group Research, 38*, 471–488.

Salas, E., Diaz Granados, D., Klein, C., Burke, S., Stagl, K., Goodwin, G. and Halpin, S.M., 2008. Does team training improve team performance? A meta-analysis. *Human Factors,* 50, 903-933. DOI:10.1518/ 001872008X37500

Salembier, P. et Zouinar, M., 2004. Intelligibilité mutuelle et contexte partagé : Inspirations conceptuelles et réductions technologiques. *@ctivités,* 1(2): 64–85.

Sève, C., Bourbousson, J., Poizat, G., and Saury, J., 2009. Cognition et performance collectives en sport. *Intellectica, 52,* 1-25.

Ziane, R., 2004. *Contribution à la formation des entraineurs sportifs, caractérisation et représentation des actions de jeu : l'exemple du basket-ball.* [A Contribution to Training Sports Coaches, and to Characterising and Representing Actions from Sports: The Example of Basketball. (Doctoral Thesis)] Thèse de doctorat, ENS Cachan.