Enhancing Intuitive and Coordinated Decision-Making in Soccer
From Research to the Field within the 4P Strategy

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Abstract: Since few years decision-making in team sports has been studied through a Naturalistic Decision-Making (NDM) approach and advances from research on team sports performance led to pedagogical principles and to tactical skills training strategies. Considering the need for coordinated and intuitive decision-making, implications from NDM framework are discussed according to literature on tactical skills training in team sports. For some years Small-Sided Games seems to be approved by a large majority of coach and researchers. Nevertheless, while the Teaching-Games-For-Understanding's (TGFU) pedagogical model focused on explicit learning, the Led-Constraints approach led to implicit learning. A significant proposition from our program of work is that there is a need for a wide range of decision-making processes in team sports, so that a tactical skills training strategy should be based on a blend of implicit and explicit learning. In this perspective, the 4P strategy (i.e., Positioning; Practicing; Picturing; Post-analysing) is a four-step-strategy designed by scientists and coaches in soccer. An empirical study has been conducted within technological artefacts embedded into the 4P strategy. Results showed that youth players benefited from technological aids because they highlight relevant configurations of play and help to share "pictures" during small-sided games. This exploratory study suggested that the whole 4P strategy was well suited for intuitive and coordinated decision-making enhancement.

1 INTRODUCTION

In recent times, decision-making in a sport setting began to be studied through a Naturalistic Decision-Making (NDM) approach (e.g., Macquet, 2009). The Naturalistic Decision-Making paradigm (Klein, 1998-2008) contributed to improve the understanding about how people make choices and coordinate themselves in military, nuclear power, aviation, human management, economic or sports settings. For that, NDM examines the ways in which experts in real-world contexts, alone or in a team, identify and assess situations, make decisions and coordinate their actions.

In team sports, players have to deal with complex, uncertain, dynamic environments; they have to be able to make decision based on their own actions and on the movements of other players. Thus, appropriate decisions are based on changes on relevant informational cues considering the dynamics of the teammates/opponents behaviours. In line with NDM advances, we made the assumption that these kinds of decisions rely on recognition and sharing of spatiotemporal configurations.

This communication is organized into four parts. First, we overview findings from our research on team performances from the NDM perspective. The results provide a rationale for considering the need for Coordinated and Intuitive Decision-Making in team sports, and have implications for designing decision-making training. Second, previous works on tactical skills training are discussed. While Teaching-Games-for-Understanding approach (TGfU) mainly focused on explicit learning, the Ecological Dynamic approach argued that team games training could benefit from practicing and implicit learning. We consider that both of these theoretical and practical perspectives provide precious rationales for implementing training programs based on Small-Sided Games (SSG) in soccer, and that they could be complemented thanks to the NDM advances in team sports. Third, these insights lead scientists and practitioners to design the

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4P strategy, the principles of which are presented and illustrated. Fourth, the 4P tactical skills training strategy has been experimented in four soccer schools using technological artefacts, and some empirical results are presented and briefly discussed.

2 THE NDM PERSPECTIVE FOR TACTICAL SKILLS ANALYSIS IN TEAM SPORTS

In NDM perspective, Recognition-Primed Decision (RPD) and Team Situation Awareness (TSA) are well-known models of expertise in complex and dynamic environments.

2.1 Tactical Skills and Intuitive Decision-making: Advances from the RPD Model

In the NDM approach, decision-making is seen as recognition of spatiotemporal configuration, and is called intuitive decision-making. Intuitive decision-making involves a fast and non-conscious process. The intuitive decision-making is an alternative to the rationalistic linear information-processing model. Rationalistic decision-making refers to a relatively slow and conscious process, so that it could not be effective in many sport situations.

Klein (1998-2008) has shown that experts in dynamic situations do not tend to make decisions based on rational deductions or exhaustive analyses of expectancies. Contrariwise, intuitive decision-making supposed that people confronted with uncertainty and time pressure are able to perceived relevant cues or salient features in the context, to recognize the configuration of a situation as familiar or typical, helping them to adjust their behaviour to the particular conditions of the environment. The Recognition-Primed Decision model suggests three levels of experiencing the situation: simple matching the situation is quickly perceived as familiar; diagnosis when the situation is perceived to be incongruous; simulation when an expert perceives the situation as typical and evaluates first or second option through mental simulation before implementing a course of action.

RPD models started to be applied also in sport settings over the last years (for a brief review, see Kermarrec and Bossard, 2014). Most of the studies used a video-based simulated methodology and a "first person approach" in a competitive setting. The results showed that experts in sport games recognize configuration of a play and made decisions based on previous experiences: a) they perceived the most salient informational cues of a situation and matched them together to recognized typical configurations of play; b) they tend to use a simple match mechanism and take the first option when they assessed the situations as familiar; c) when players did not assess the situation as familiar, two or three options were diagnosed; d) when players did not feel urgency, they took time to simulate the situation: especially defenders or goalkeeper anticipated opponents' options from an external "third person" viewpoint, or from an internal "first person" viewpoint. This process allows him or her to imagine how effective the option will be in the current situation.

Finally, empirical studies pointed out evidences for intuitive decision-making used by experts in team sports. In other words, according to NDM approach, tactical skills rely on recognition of configurations of play. In next section we examine teammates influences and the need to share the same configuration of play in order to make coordinated decision-making.

2.2 Tactical Skills and Coordinated Decision-making: Advances from the TSA Model

Several researchers argued that team performance requires a high degree of coordination (Salas and al., 2008; Eccles and Tenenbaum, 2004, 2007). Thus, NDM line of research on team performances has shown the interest of the TSA model to better understand such a complex phenomenon.

In dynamic (i.e. complex and indeterminate) situations like most team games interactions, coordination between teammates cannot be reduced to shared knowledge constructed before the course of action. Team members have to share perceptions, judgements, expectations during the on-going situation. Considering that what is shared could be "contextual", some researchers have developed conceptual and methodological frameworks for describing and assessing the dynamic of coordination. In this regard, the notion of situation awareness 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. SA is a "picture" of a situation to which it refers (Macquet and Stanton, 2014). 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. Both of quantitative and qualitative methods were employed and TSA was assessed with a particular focus on the shared contents, on the forms of sharing that appeared during real-time activity, and on the sharing processes.

One of our recent studies in Handball (De Keukelaere, and al., 2013) was conducted on the TSA perspective. Behavioural data from six elite players during offensive phases were recorded and supplemented by verbal data collected during video-cued recall interviews after the game. Content analysis was conducted. The results showed that the athletes alternated between two modes of coordination. In some cases, a pre-established plan was followed-up, based on shared content or "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 is based on a dynamic process of sharing a configuration of a play. Complementary, many sharing processes such as inquiry or surveying, verifying or monitoring, displaying, masking or resisting authorized members of team to adjust their own decision to ones' decision, or to influence ones' decision.

These studies elicited the alternative role of knowledge sharedness (as a "static product") and configuration of a play sharing (as a "dynamic process"). Considering that sharedness is rarely sufficient and completely pre-established before team performance, most of the recent studies pointed out that training methods have to develop further in the direction of team adaptation (Salas and al., 2007). Thus team-training strategies should target "team work" rather than "task work" (id.). Whereas task work consisted essentially in pre-briefing, post-briefing, team work emphases the role of practice and the need for sharing in the course of action. In this perspective tactical skills training in team sports could consist in involving the capabilities for players to recognize and share the same configurations of play during the on-going situation.

To conclude this brief report on advances from the NDM perspective, we suggest that tactical skills training strategies should consider both of individual and collective capabilities. Thus, in order to develop intuitive and coordinated decision-making, empirical findings lead us to focus on *configuration of play recognition and sharing*.

3 TACTICAL SKILLS TRAINING IN TEAM SPORTS: A BRIEF OVERVIEW

Most of the decision-making training programs could be placed along the implicit / explicit learning continuum (Raab, 2007). Number of these programs offers a large set of arguments for the interest of small-sided games (SSG) especially for tactical skills training in soccer. Thus, SSGs are plebiscited in both of the Teaching Games for Understanding framework and in the Constraints-Led Approach. SSG is not only a reduced game, but also we consider it as a combination of coaches' objective and task constraints: "space (e.g., the nature of the playing surface, playing area dimensions), time (e.g., time span of matches, time to attain a sub-objective of the match), players (e.g., number of players in each team, number of teams, roles of players), equipment (e.g., size and number of goals and balls), and intrapersonal and interpersonal coordination (e.g., limbs allowed to contact the ball or players allowed to pass the ball)". We also argue that SSG could be well-suited for configuration of play recognition and sharing, in line with the NDM perspectives.

3.1 TGFU and Explicit Learning

The Teaching Games for Understanding approach (TGFU) is one of the most validated approaches to tactical training. Key component of the TGFU approach are: a) practicing authentic reduced games; b) teaching in an explicit way. Based on the assumption that tactical knowledge should be developed before skills, TGFU was based on full playing games or on modified or reduced games. Coaches frequently stop the play and help players thanks to questions, debates, and verbalizations' artefacts, so that TGFU should promote explicit learning (Kirk and Mc Phail, 2002).

Thus, TGfU was extended in a constructivist perspective (Grehaigne, Godbut and Bouthier, 2001). First, SSG should be a reduced but an authentic game from the players' viewpoint. Second, teacher role is considered as essential in order to help (e.g. in analysing, debating) players in identifying configurations of play and appropriate responses (i.e. knowledge or rules that could be verbalized by the players). The explicit learning process implies constant interactions between the subject and the environment.

Nevertheless, the TGfU approach has some

limitations (Chow, et al., 2007), especially when researchers systematically examined the effectiveness of this pedagogical method, or considered that "tactical skills are not verbal skills" (Araujo et al., 2010).

3.2 Constraints-Led Approach and Implicit Learning

The use of small-sided games in soccer is viewed as an archetype of the constraints-led approach (CLA) of training (Davids and al., 2013). The manipulation of human and environmental constraints is supposed to shape players behaviours, in small-sided conditioned games (SSCG). At present, effects of SSCGs constraints on physiological and technical capabilities have been extensively investigated in the literature (id.). Recently, some authors demonstrated that SSCGs could enhance individual and collective tactical skills (Travassos and al., 2014). The ecological dynamics (ED) model underpinned the CLA and argued that decision-making behaviours emerge from the interactions of individuals with environmental constraints (Araujo, Davids and Hristovski, 2006).

In this perspective, SSCGs promote implicit learning (i.e. behaviours emergence within actions of individual players or also within interpersonal interactions between players). Previous idea has major implications for designing representative practice tasks in team sports (id.). Representative design is a concept initially proposed by Egon Brunswik (1956). It means that training tasks need to represent the competitive environment so that learners can learn credible action. In other words design of practice tasks need to represent opportunities to act, as the players would in competitive environment (Travassos and al., 2013).

Nevertheless, it is not clear how and why players modified their behaviour in SSCGs. Does behaviours' changes supported within a major tactical involvement, and changes in decision-making processes? Which constraint could provide effect on decision-making learning? How coaches could design SSGs aiming at involving rapid, spontaneous and accurate decision-making? Thus, there is a need for a better understanding of the effects of task's constraints on decision-making learning.

Despite links have been pointed between TGfU and LCA (Chow, et al., 2007), we pointed differences if considering the learning process. According to TGFU pedagogical aids in SSG are relevant for explicit learning, while according to CLA practicing SSG is supposed to enhance implicit learning. Both of these bodies of work suggest that SSG provide learners many occasions to adapt their actions and decisions through continuous on-going interactions with teammates and opponents and other task constraints. In line with NDM advances we can argue that the structure (task constraints) and organization (pedagogical artefacts) of SSG can to be designed in a whole tactical skills training strategy aiming at sustaining both of explicit and implicit learning.

Based on this assumption, the 4P strategy was designed for enhancing intuitive and coordinated decision-making in soccer.

4 ENHANCING INTUITIVE AND COORDINATED DECISION-MAKING: THE 4P STRATEGY

Despite many studies emphasise the interest of the NDM approach to better understand the mechanism underlying expertise in team sports, very few have inspired decision-making training tools in a sports setting (e.g. Mascarenhas and al., 2005). In team sports, experts should be able to immediately match the situation, and to quickly share the sense of the situation. That's why in team sport training, decision-making should be trained to be intuitive and coordinated. Small group of players should be trained to recognize and share configurations of play. It can be noted that earlier application of an intuitive decision-making approach have been developed based on the Ecological Rationality perspective (Raab, 2007). SMART (Situation Model of Anticipated Response consequences of Tactical Training) is a pedagogical model that promotes the use of implicit and explicit learning depending on the complexity of the situation.

According to Klein (1998) intuitive decision-making should be trained through four key ways: a) engaging in practice; b) compiling extensive experiences; c) obtaining accurate and quick feedbacks; d) reviewing prior experiences and learning from mistakes. Complementary, Hogarth (2001) has developed a learning approach to intuition. First, environments in which intuitions are trained need to be representative for the environments in which intuitions are supposed to be applied. Second, he highlighted the role of feedback that should be speedy, accurate and relevant. He pointed out that learners do not need explicit feedback, explanations, or conscious awareness of

the on-going learning situation. Hogarth's assumptions have been widely accepted in the field of intuition research (Kahneman and Klein, 2009) Theoretically, intuitive decision-making claims for implicit learning. Nevertheless, practically, it is difficult to separate implicit from explicit learning within learners' experiences in training program, and the role of explicit feedback in decision-making training is not clear. In naturalistic training environment, we argued that coaches should use a wide range of artefacts for decision-making training, including both of implicit and explicit feedbacks.

In line with this advances, sport scientists and professional coaches in soccer designed the 4P strategy. It's a four-step-strategy: a) Positioning; b) Practicing; c) Picturing; e) Post-analysing.

4.1 Positioning the Training Device: Prebriefing

Positioning the training device within a real performance context consists in introducing a tactical objective in line with team "story". In other words coaches should use prebriefing as a way toward sensemaking.

This principle is consistent with the heart of the TGFU approach (Kirk, 2002): a technical or tactical objective should be only introduced if the players can make sense about it, or can feel the need for it when they have performed a real game. From the NDM approach, this principle is lead on the sensemaking assumption. In team sport sensemaking is a continuous process of understanding the play. Sensemaking is a retrospective analysis of events and a projection to the future. The Frame Theory of sensemaking brought interesting implications for learning and training. A frame, call it schema, map, story or script, help us to recognize, connect or filter data in the environment. Empirical findings in soccer supported this assumption: Bossard and al. (2011) described the schemata experts in soccer used to reconstruct the dynamic of course of action.

Positioning the training device consists in facilitating the framing process of coupling within the game environment. Framing should be supported when an objective is positioned in the on-going story of a team (previous and future competition matches), positioned in specific sub-phases of team games (such as preparing the attempt to the goal, defending a zone, or passing the ball from the defenders to the forwards), and positioned in a space on the field.

4.2 Practicing SSPG

Practicing Small-Sided-Positioned Games is a consequence of previous step. The focus is made on designing representative small-sided games that could implicitly shape configurations of play required for competitive team games performance. This principle seems to be consistent with theoretical advances and empirical findings from the CLA. Therefore, it is based on some argument from the NDM line of research.

First, empirical studies showed that recognition mechanisms experts used depend on their position on the standard competitive pitch (e.g., Kermarrec & Bossard, 2014). We suggest that the location of the small-sided game within the standard pitch could enhance the representativeness of a game. In other words, sense making in the game and configuration recognition may depend on the on-field location within on the standard pitch. Thus position of the game and positions of the targets must be thought in accordance with the configuration of play the coach wants to be trained.

Second, because intuitive decision-making is based on a spatiotemporal recognition, our results pointed out that timing is relevant when experts identified a configuration of a play (id.); SSG could simulate specific sub-phases of team games such as preparing the attempt to the goal, defending a zone, or passing the ball from the defenders to the forwards. Especially each time a play is ended (e.g. the ball get out of the playing area), a game's starter should throw again the ball in the same area in order to lead to cumulative experiences.

Third recognition of a configuration in a game depends on previous experiences and on expertise in an assigned position on the pitch. Because previous research on decision-making in team sports demonstrated that spatiotemporal recognition is based on the players' point of view, the players' positions in the game should be related to their own position or task in their competitive team (De keukelaere et al., 2013; Le Menn & Kermarrec, 2015). In SSG each time the game starts again, the players should go back to their assigned positions in the game.

All of these points lead us to the idea that SSGs should be Small-Sided Positioned Games (SSPGs); SSPG and classical SSG are illustrated in figures 1 and 2.

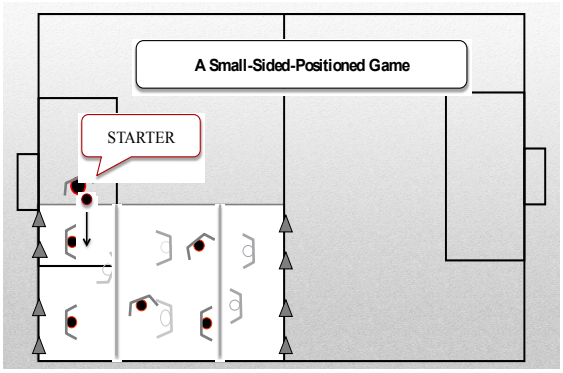

Figure 1: example of a SSPG aiming at passing the ball from the defenders to the forwards.

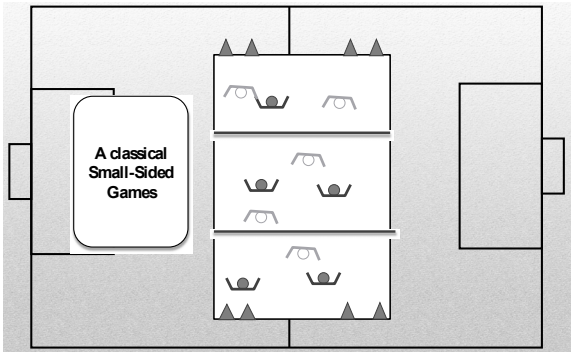

Figure 2: example of a classical SSG presenting the same structure than previous SSPG.

4.3 Picturing the Expected Configuration of Play

In order to highlight configuration of play, the coach can use the "Stop, Watch and Go" pedagogical artefact in SSPG (e.g. Kermarrec & Bossard, 2015): he stops the game shortly, orders the players to stay in place, stresses them to briefly watch their relations or positions, notes if the configuration is expected or not, and starts the play again. Because "picturing the configuration of play" is based on visual chunks more than on verbalizable information, this step of the 4P strategy should be classify more toward the pole of implicit learning than explicit learning. Of course in the field both types of learning are present (Raab, 2007).

This step is driven from NDM empirical findings. Studies based on RPD model highlighted the role of spatiotemporal configuration recognition in intuitive decision-making. These configurations are a blend of distances, visual cues, goals, and available motoric skills, more than explicit knowledge. The aim of this pedagogical step is also to help players, players and coach, to share, and to reinforce or to throw out the same pictures (Macquet and Stanton, 2014) when the team failed or succeed.

4.4 Post-analysing the Game

Post-analysing the game is not only a debriefing, aiming at evaluating and providing explicit feedbacks. It is also a time for putting pictures into words, and concepts, debating choices that players have made, associating configuration of play and knowledge or tactical principles, and sharing them between players and coaches. This principle seems to be consistent with theoretical advances and empirical findings from the TGFU approach: language productions, debate ideas about action, and explicit strategies are supposed to produce an impact on explicit learning (Grehaigne et al., 2001). Therefore, this fourth step of our 4P strategy is also based on some argument from the NDM line of research. Promoting verbal exchanges between players should improve their cognitive package for future decision-making. In work field, debriefing is a key point for improving individual decision-making (Klein, 2008) and for team coordination (Salas et al., 2007). In a sport setting, recent findings suggested that expert defenders (Kermarrec and Bossard, 2014) used knowledge to diagnose or simulate the situation, when the ball is far from them. Post-analysing the game is a key point for coaches in order to organize schemata within scripts or global frames, in order to classify specific configuration of play into a whole defensive or offensive strategy, in accordance with a game style or philosophy.

5 TECHNOLOGICAL ARTEFACTS WITHIN THE 4P STRATEGY: AN EXPLORATORY STUDY

The 4P strategy is based on both theoretical and empirical insights. A cooperative research program gathering together professional coaches and researchers from the Brittany Soccer League in France have been conducted in order to systematically assess this pedagogical strategy. It was expected that the 4P strategy was well suited for intuitive and coordinated decision-making training. Positioning/Practicing/Picturing/Post-analysing consist in four steps for a whole strategy and were supposed to favour recognition and sharing of configurations of play.

Moreover in the present research, technological

artefacts were introduced within the third step. Picturing consists in stopping the game for a very short time when a relevant configuration emerges from the on-going situation. It was hypothesized that technological device such as video-cued artefacts on digital tablet could help shared recognition of a configuration. The video of the game was recorded through digital camera, and immediately sent to the tablet thanks to Bluetooth system. Recent study demonstrated that it could a precious artefact for sharing process and content sharedness (Kermarrec, 2015).

The 4P strategy and video-cued artefacts were experimented in four soccer schools (U13) from the Brittany soccer League in France. Forty youth players (mean +/- SD; age=12,53 +/- 1.62) participated in this study, divided by 4 groups depending to their own soccer school. For each group the objective of training sequence was to be able to better transport the ball from the defenders to the attackers. Each group had 10 players who were divided into two teams of 5 players each by the coaches. Players and their parents were fully informed of aims and procedures of the study and signed a consent form. First, each group played a classical SSG (see fig. 2) at the beginning of the usual training session on a 30x50 m pitch with 10 minutes duration (pre-test). Then, the four groups practiced two periods of 15 minutes (training conditions), and a recovery period of 5 minutes between them. Each group had a specific condition. Three groups practiced a specific SSPG aiming at enhancing the advance of the ball from the defenders to the attackers within a team (see fig. 1 and 2). The area for both SSG was a 50 x 30 meter rectangle divided into 3 areas. The players are divided into two teams, which play 5 *vs* 5. Each team is allowed to score in any of their 2 goals. In the SSPG, the players are positioned within the inner zones depending on their tasks in the team (2 defenders, 2 midfielders, 1 forward). The game starts with the team positioned in the defense zone, when the starter passes the ball to one of the defender, whose goal is to advance the ball in the field and score in one of the two targets. If the opponents get the ball, they try to score a goal in any of their 2 goals.

The four training conditions were: C1, practicing the classical SSG; C2, practicing the SSPG, without any specific verbal instruction or demonstration; C3, practicing the SSPG and furnishing pedagogical aids through the 4P strategy; C4, practicing the SSPG and furnishing pedagogical aids though the 4P strategy included video-cued artefacts.

All the games were videotaped from a fixed and high position. Video-recorded images were transferred to a digital support for analyses. We tracked the ball position on the screen and measured the *Ball Advance* (i.e., the advance of the ball from the defenders to the attackers within each team's possession of the ball, in meters). Distances' measure method was inspired by the method using a single camera and combining manual video tracking and bi-dimensional reconstruction for sports performance analysis (Duarte et al., 2010). Virtual distances data (i.e., pixels) were transformed into world pitch distances. A calibration was built on the field's reference marks acting as control points. Researchers and coaches considered the *Ball Advance* as a good indicator for team coordination, in line with pedagogical content (i.e., being able to transport the ball from the defenders to the attackers). It was calculated for each group in the classical SSG (pre-test) and in each training condition. Effect sizes (partial eta squared) and ANOVA with post-hoc test (LSD) were performed using SSPS.

Table 1: *Ball Advance* within the field for each possession of a ball in a team (in meters).

Ball Advance		M	SD	F	p	Partial η^2
Pre-Test	G1	14,8	6,98	0,07	ns	0,04
	G2	15,4	6,48			
	G3	14,5	6,80			
	G4	15,4	5,35			
Training Conditions	C1	16,1	6,85	11,6	.00	1,67
	C2	12,6	7,85			
	C3	17,4	5,62			
	C4	20,8	6,02			

Table 1 presents *Ball Advance* mean (+/- SD) results per group (pre-test) and per training condition. During the pre-test, *Ball Advance* did not present statistical significant effect, so that the different groups' level of coordination could be considered as equivalent. The *Ball Advance* indicator revealed a high effect size value on the training conditions factor, so that we ran follow-up analyses. The ANOVA and post-hoc analyses revealed that *Ball Advance* in SSPG was longer in C4 than in C3 ($p< .05$), than in C2 ($p< .01$), and than in C1 ($p< .01$). Surprisingly, *Ball Advance* in SSPG without 4P strategy (C2) was shorter than in C1, in the classical SSG ($p<.05$).

6 CONCLUSIONS

The aim of this communication was to present some advances from NDM for tactical skills training in

team sports. It was expected that the 4P strategy and included video-cued artefacts could promote an intuitive and coordinated decision-making by highlighting configurations of play. First, our results suggested that coaches should carefully designed SSG, and ensure their representativeness. Because some SSPG presented high level of constraints (C2), youth players performed less than in a usual SSG (C1), if coaches did not took in account the need for making sense of the situation. Second, youth players' decisions and coordination were favoured in SSPG when the 4P strategy promoted positioning and picturing (C3 & C4). Furthermore, the results highlighted the interest of visual pedagogical aids. Video-cued artefacts embedded in the coaching process, seems to be useful for picturing the relevant configuration of play, and for sharing the same picture between teammates (C4).

Finally, we emphasized that both of the TGfU framework and the constraints-led approach should be complemented by NDM advances on intuitive and coordinated decision-making; they provide rationale for the implementation of a 4P strategy, which needs to be empirically examined in other various settings. Future research could also introduce new video-cued artefacts within the 4P strategy. At the first step, video from previous matches, or behavioural data analysis could be used for goal setting and positioning the training device. At the fourth step, debriefing could start with video footages: ideas debate is stimulated when ones can see his own behaviour or his teammates' performances, and sharing in promoted thanks to viewpoint changes (Kermarrec and Bossard, 2014).

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