Cognitive Control in the Activity of a Handball Coach

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ABSTRACT

Introduction: This paper focuses on the dynamic adjustment of the cognitive control mode used by a coach during handball matches. Two main dimensions characterize cognitive control modes: one is the level of abstraction (symbolic/subsymbolic) and the other the origin (internal-anticipative, external-reactive) of the data used for control. **Method:** Verbal communications between a coach and his team were recorded during four matches and coded using the MacSHAPA software. **Results and discussion:** Analysis shows that the coach adjusts his cognitive control according to the team performance. He favors a more abstract level of control as well as more internal data when the score is no longer in the team's favor. An identical analysis will be carried out with other professional coaches. The goal of such studies is to identify the cognitive control modes that are the most satisfying according to the main features of a match.

KEYWORDS

Practical applications; Cognitive field research; Team and organizational factors in complex cognitive work; Cognitive control; Coaching activity; Sport.

INTRODUCTION

The coaching activity is dynamic and chaotic (Bowes & Jones, 2006) and generated by on-going events. This is particularly true for team sport competitive situations, which are dynamic and complex environments (Fiore & Salas, 2006) and make up a specific subclass inside the generic class of dynamic situations.

This paper focuses on coaching activities for handball teams. It describes the first results obtained in a study that aimed at modeling the activity of a handball coach during the defensive part of a handball match.

Handball is a team sport in which two teams of seven players each (six outfield players and a goalkeeper on each team) pass a ball to throw it into the goal of the other team. A standard match consists of two periods of 30 minutes, and the team that scores the most goals wins. Substitutes may enter the court, at any time and repeatedly. Team handball, like other team sports, is an invasion game, but it is also a collision contact sport, as is ice hockey, where contact is necessary and integral to playing (Silva, 1983). In this type of game, the main objective of defensive players is to stop offensive players from reaching the goal. In order to do so, defensive players are organized in different systems to attempt to push opponents away from the score area and to be numerous between the ball and the goal.

This paper is divided into four main parts. The main cognitive and cooperative features of the activity of a coach are pointed out in a first section. The method used to analyze this activity is then explained. For this paper, the activity of one coach was analyzed on the basis of four different matches. Results are presented in a third part and discussed in a fourth and last section.

THEORETICAL FRAMEWORK

The activity of handball coaching has three main features: it happens in a highly dynamic situation, it applies to a team, and it has to take opponents' behaviors and intentions into account. This activity may be described in keeping with the theoretical framework designed by Hoc and Amalberti (1995), Hoc (2001), Hoc and Amalberti (2007).

Hoc and Amalberti (1995) proposed a cognitive architecture of Dynamic Situation Management (DSM) to account for individual cognitive activities (cf. Fig. 1). Largely inspired by Rasmussen's (1986) step ladder model of diagnosis and decision-making, this architecture distinguishes three feedback loops in terms of the abstraction level and temporal span of the decision.

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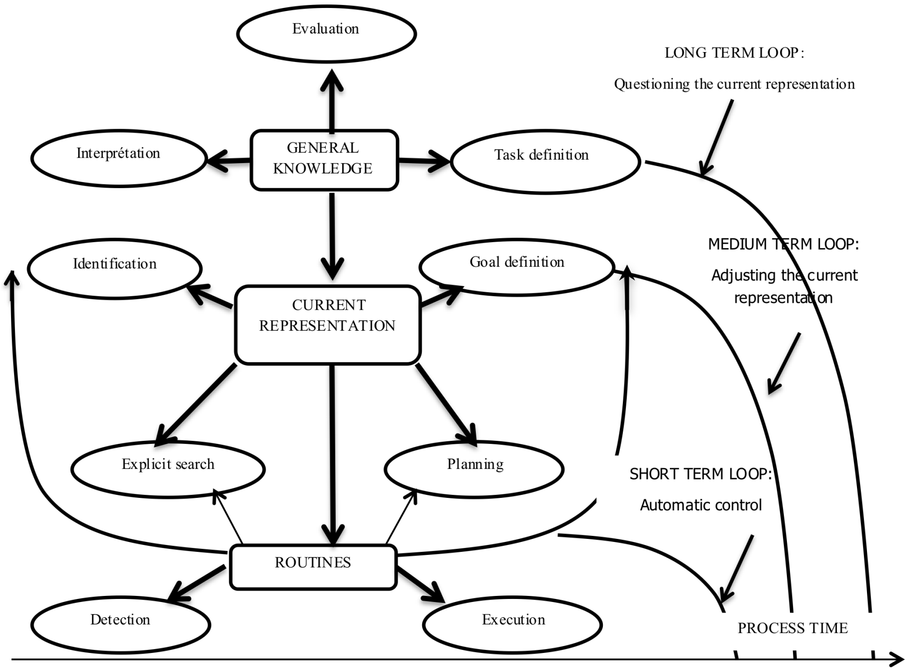

Figure 1. Dynamic Situation Management model (Hoc & Amalberti, 1995)

This model may be extended to team cooperation. Hoc (2001) thus proposed to analyze cooperation at three different levels:
Action level. At this level, cooperative activities consist in locally creating, detecting, anticipating, and resolving interference. Interference creation can be positive when it consists in mutual control or cross-checking. In this case, one agent can inform another of his or her disagreement or can give advice.
Planning level. At this level, a Common Frame of Reference (COFOR) is explicitly generated and maintained as a common representation of the situation. The situation includes the environment (currently referred to as Situation Awareness — SA) as well as the agents' activities. COFOR also includes common goals, common plans, and function allocation.
Metacooperation level. Just as the Planning level activity can facilitate the Action level activity, the Metacooperation level activity facilitates the Planning level activity. It includes high-level knowledge that is useful to other levels, such as mental models of the other agents and of oneself.
These models show that a specific system may be controled at different abstraction and temporal levels. In a more recent paper, Hoc and Amaberti (2007) distinguished the level of abstraction (symbolic/subsymbolic) and the origin (internal-anticipative, external-reactive) of the data used for control. Metacognition is considered as a means to distribute cognitive control within these dimensions in order to ensure mastery of the situation.
The consideration for the data origin remains the notion of "supervision span". This notion concerns information as well as action. From an informative point of view, the operator can have access to the process variables through a more or less limited window that can be defined in temporal, causal, or spatial terms, or at times, isomorphic terms. A restricted information span can result in difficulty to anticipate and to make decisions at the right time (Hoc, 2006).
In this paper, we propose to examine the mode of cognitive control used by a handball coach, that is, to identify its adjustments according to the situational features. Cognitive control will be analysed in terms of the abstraction level as well as in terms of the data used.

METHOD

Participant and Procedure

This paper focuses on the activity of one coach, observed during four matches of the top male professional French championship (coded M1, M2, M3, M4). He is 38 years old, has 4 years of experience as a professional coach and was selected 23 times in the French national team.
Three kinds of data were collected: (i) the main situational features (main events of each match); (ii) the coach's verbal communication with defensive players; (iii) self-confrontation interviews.

Each match was video-recorded from the first to the final whistle of the game. Verbal communication between the coach and the players was collected using the digital voice recorder connected to the microphone. Self-confrontation interviews with the coach were conducted during the week following the match.

Data Collection

The audiotapes from matches and self-confrontations were transcribed.
For the self-confrontation interviews, we used video recordings in natural settings and interview techniques of stimulated recall (Lyle, 2003).

Data Analysis

All data (situational features, coach communication, and self-confrontation data) were synchronised.
Verbal protocols (coach communication) were encoded using a general cognitive method introduced by Amalberti and Hoc (1998). It consists of inferring elementary cognitive activities from the overt behavior, the context, a general cognitive architecture, and knowledge of the application domain. Each verbal protocol was decomposed into elementary units. These units were coded using a predicate–arguments format, with the MacSHAPA software. MacSHAPA is a software tool built to help human factors investigators to carry out protocol analysis. It allows them to develop sophisticated coding schemes – relying on predicate calculus - and to use statistical routines to analyze the data once fully encoded (Sanderson et al., 1994).
The predicates were classified into several classes, according to the coding scheme defined by Hoc (2001) (see Table 1). Each predicate has several arguments, and each argument has several sub-arguments. For example, the argument "structure" has three sub-arguments: density (defenders' density), depth (movements towards opposite players), and defensive system (defensive team organization).

Table 1. Extracts of verbal protocols

Predicate	Main argument	Examples
CR-ITF (creation of an interference with a player's behavior [Action level])	Structure	*Don't remain flattened! Get out on the players!*
	Involvement	*Run! Come back!*
	Technique	*If you go back, you must fall with him.*
PLA-ACT-PLAN (plan maintenance or elaboration [Planning level])	Structure	*Change defense system, align, 0-6..*
	Involvement	*The first half-time, you forget it. Now you must impose yourself, physically, with your team.*
	Technique	*Don't hesitate to pull his arms.*
PLA-ENV (maintenance or elaboration of a shared situation awareness [Planning level])	Information	*He does not score as many goals as you think.*
	Comprehension	*Actually, we are in trouble only on Morgan's duels. Everything else is OK.*
	Anticipation	*Careful, they will play "Szeged" (name of combination).*
PLA-ACT-REPFCT (maintenance or setting of role allocation [Planning level])		*Cedric, you will change with Morgan.*
META (activities of metacooperation eliciting the different structures of knowledge used by the operators (general knowledge, task-related knowledge, knowledge about partners, etc.)		None
OTHER		

The verbal data were coded by both authors. The overall Kappa revealed a satisfying rate of agreement among the two coders ($k = .71$; $z = 25.94$, $p < .0001$). All the conditional coefficients were also high and significant.

Hypothesis

According to the Hoc and Amalberti model, we expect that the coach will adjust his cognitive control to the situational features. The relevant features of a handball match are the current phase (offensive or defensive), the score (in favor of the team or not), and the current period (first or second half-time). Cognitive control adjustments may concern the level of abstraction and the data used by the coach. Predicates refer to three different levels of abstraction (action, planning, and metacooperation levels). Arguments refer to different kinds of data evoked by the coach.
This general hypothesis will be proved using chi2 tests and the "transition" function of the MacSHAPA software, which enables the calculation of the frequencies and probabilities of transitions between predicates.

RESULTS

Results will be presented separately for the two half-times of matches and for the break period.

During Half-times

Predicate analysis

Predicates belonging to the metacognition level are almost non-existent. During the two half-times of each match, two predicates are predominant (cf. Fig. 2): CR-ITF (coach interference with players' actions) and PLA-ACT-PLAN (maintenance or generation of plans).

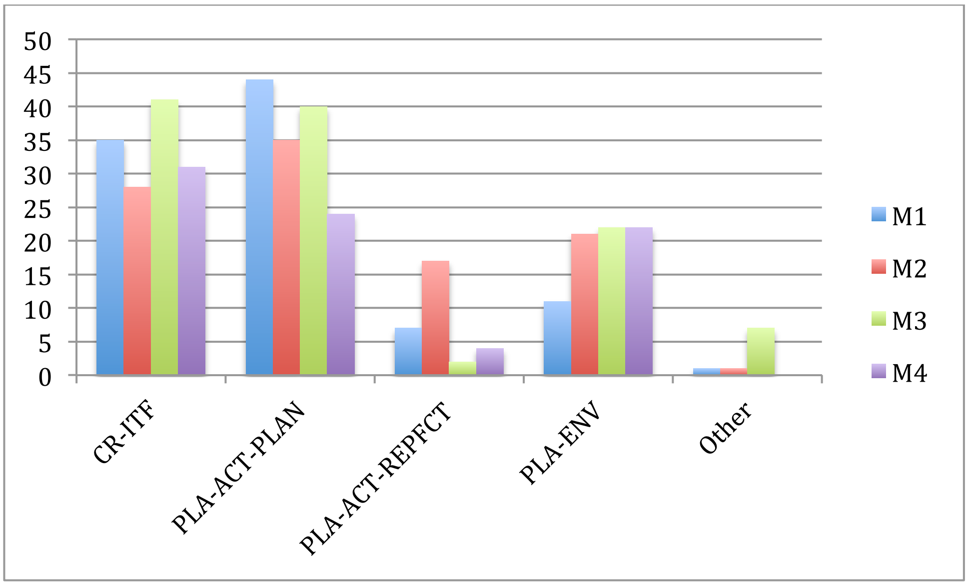

Figure 2. Breakdown of units into predicate categories during the two half-times

There are no significant relationships between their occurrence and the match period (first or second half-times). There is a significant link between the occurrence of the PLA-ACT-PLAN and the performance in only one match (M4). In this match, this predicate is more frequent when the team's score becomes unfavorable, $\chi 2$ (1, 81) =4.5, $p < .05$.

Above all, there are strong significant relationships – in all matches – between the occurrence of these predicates and the match phase (attack or defense). PLA-ACT-PLAN is far more frequent during offensive phases than during defensive phases ($p < 0.0005$ for three matches and less than 0.003 for the fourth one), whereas CR-ITF is far more frequent during defensive phases ($p < 0.0005$ for three matches and $p< 0.001$ for the fourth one).

The "transition" function of the MacSHAPA software confirms the importance of these two predicates. The probability that they initiate a sequence of several predicates is higher than 0.6. The probability for them to be present at the first, second or third place of a sequence is higher than 0.8. In contrast, the predicate PLA-ENV (related to situation awareness) appears to initiate the sequences with a probability lower than 0.3 and even, for some matches, lower than 0.2 (M1, second half-time of M2, first half-time of M3).

Argument analysis

Argument occurrence of the CR-ITF and PLA-ACT-PLAN predicates varies significantly according to the match period, in three of the four matches. In two matches (M1, M4), the plan deals mainly with structure in one half-time and mainly with players' involvement in the other. In two matches (M2, M4), the same may be said concerning interference.

In M2, there is a also a link between the "structure" argument and the score ($p < .05$). "Structure" is absent when the performance is balanced, and it becomes the main argument when the team's score is unfavorable. In this match, as in M1, there is also an obvious link between the score and one sub-argument of "structure": the defensive system becomes the predominant (and even the only) sub-argument as soon as the team's score is unfavorable.

As far as the situation awareness is concerned (PLA-ENV), one may notice differences depending on the match. They are related to predicate frequency (it is almost absent in the second half-time of M2 as well as in the first half-time of M1), to the object addressed (either own team or the opposite team), and to the data nature (information, comprehension, or anticipation). In most matches or half-times of matches, they deal mainly with the opposite team (M3, M4, first half-time of M2). They are mainly of "anticipation" type in the M4 two half-times as well as in the M2 and M3 first half-times.

During Breaks

Predicate analysis

During the break periods, three predicates are represented (Cf. Fig. 3): PLA-ACT-PLAN, PLA-ENV and PLA-ACT-REPFCT. In three matches (M2, M3 and M4), PLA-ACT-PLAN and PLA-ENV are the two predominant categories.

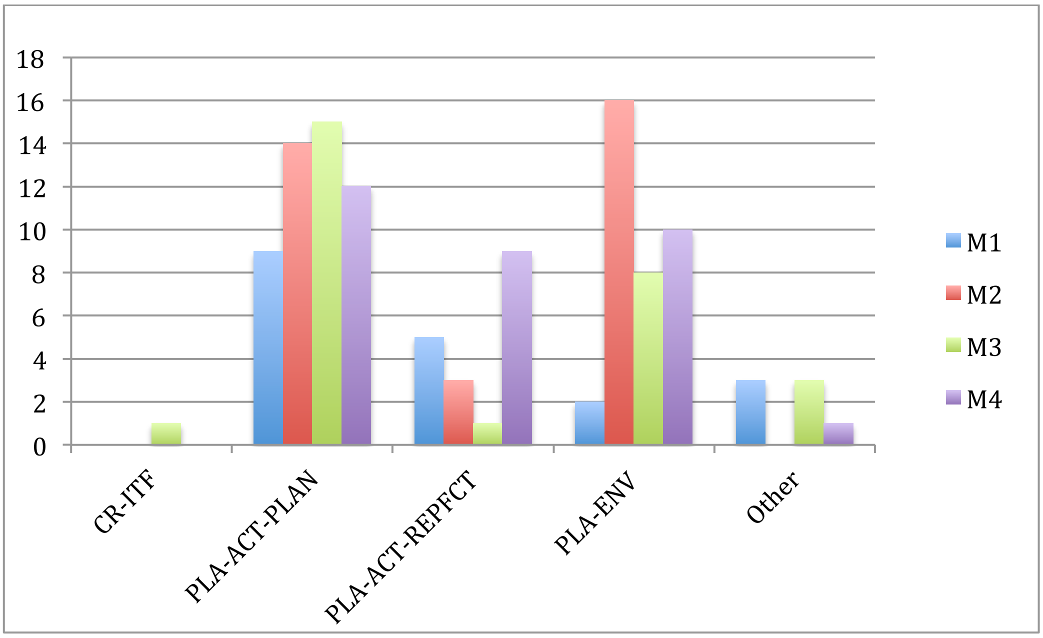

Figure 3 - Breakdown of units into predicates categories during the break

The probability – for a sequence – to begin with the predicate PLA-ACT-PLAN ranges between 0.4 and 0.55. The probability, for this predicate, to appear at the first, the second or the third place is higher than 0.9 for three matches (over 0.7 for M4). The probability, for the predicate PLA-ENV, to appear at the first or the second place of a sequence changes depending on the match: from a low value of 0.25 (M1) to medium and high value (0.5 for M3, 0.57 for M2 and 0.76 for M4).

Argument analysis

Arguments of the PLA-ACT-PLAN also vary depending on the match. They are mainly related to the team structure (depth) for M3, divided between the "structure" and "energy" categories for M4 and mainly related to energy for M1 and M2.

For M3 and M4, the arguments of PLA-ENV deal mainly with the opposite team, whereas they deal mainly with own team in M2.

DISCUSSION AND CONCLUSION

These results show two main adjustments in the cognitive control mode of the coach.

The coach alternates between two abstraction levels, depending on the match phase. During the offensive phase, both central defensive players are replaced by offensive players. The coach therefore takes advantage of each offensive phase to plan future actions for the central defensive players. In the same manner, the break period is mainly used to maintain or elaborate plans.

The cognitive control mode is adjusted according to the team performance.

In one match (M4), the level of abstraction rose (from action to planning) when the score was unfavorable. In this match, the score worsened in the second half-time; in the same time, the data used by the coach changed: the plan no longer concerned the players' involvement but only the team's structure. This kind of data is more "internal", since it relies on a mental representation of what a satisfying structure is. It also implies a more extensive information span (in causal and spatial terms) than data related to players' involvement.

Changes in the data used, according to the performance, are noticeable in two other matches. Structure becomes the main planning object in M1 when the score is unfavorable for the team. In this match, as well as in M2, it is – more precisely – the team's defensive system that is evoked by the coach.

The adjustment of the cognitive control mode may also depend on the opposite teams. In two matches (M3 and – to a lesser extent- M4), planning deals more with team structure than in the other matches. These two matches have several common features. In both cases, the opposite team was ranked lower than the coach's team. A victory was, therefore, possible. Furthermore, the stakes were high, since a victory would have ensured the team's presence in first division for the next season. The effect of the opposite team on the activity of the coach has been shown in a previous study (Debanne & Fontayne, 2012).

The consideration for the environment also varies depending on the match. The opposite team's features are taken into account mainly in M3 and M4 and are almost ignored in M1. These results may be explained in the light of the match stakes. Additionally, French teams (involved in M3 and M4) are better known to the coach than foreign ones (the opposite team is a foreign one in M1). This knowledge makes the situation awareness elaboration easier.

From a theoretical point of view, this study tends to show that the cognitive control mode migrates towards more abstraction and more complex data when the coach faces difficulties and/or high stakes. These results need to be confirmed by the analysis of data that have been recorded with two other coaches in eleven other matches.

These further studies should also enable the identification of the cognitive control modes that are the most satisfying according to the match main features.

From a practical point of view, these findings are expected to have an impact on coach training and, more generally, on the training of supervisors in dynamic and competitive situations. Following this study, we may suggest that coaches (a) should acquire, before each match, specific knowledge concerning the opposite team and opponent players, and (b) should learn to use routine procedures concerning the management of the defensive phase. They should make it a habit to make a systematic assessment of the defensive phase and plan future actions during the offensive phase.

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