MECHANISMS UNDERLYING THE ACTIVATION OF KNOWLEDGE BASIS IN IDENTIFICATION OF BASKETBALL PLAY CONFIGURATIONS BY EXPERTS AND NON-EXPERTS PLAYERS

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Introduction

Analysis of sportsmen's performance in recall or problem-solving task simulated in laboratory shows that expert are generally better in recalling material when information is correctly structured, that is to say coherent related to the logic of the sport (see Williams et al. 1998 for a review on these experiments). However, we know little about the psychological processes subtending these performances and it is the aim of this presentation to identify the nature of these operations. Rather to study a classical recall task we have used a task of judgement of similarity more appropriated to reproduce some characteristics of the situations found in actual play. Indeed, we hypothesis that in play, when facing a visual play configuration, the player has to activate his or he knowledge base, and then to compare the present situation to the ones stored in long term memory, and finally to chose the more appropriate response to the present situation. The tasks of judgement of similarity used in our experiments share some particularity with this description. The player has to store in his or her working memory a first play configuration and following its disappearance to compare it to another play configuration in order to judge if it is similar or different to the previous one. Another interest of using a task of judgement of similarity is that this task has been widely studied and we have a coherent view of psychological processing subtending this operation (Goldstone, 1998). The originality of the study lies in the fact that we have compared the players' performances in the experiments to the simulation of a mathematical model specially developed for this research by Courrieu et al. (2000). The model is of algebraic type, and it can be interpreted as a neuron-like model given that its basic operations reduce to computing sums of products (i.e. algebraic polynomials), and simple vectorial operations. It comprises three stages: a *perceptual encoding* stage, whose input is the set of coordinates of players and ball in a low level space generated by image processing, and whose output is a real vector called *"access code"*. Access codes are assumed to vanish rapidly after the source stimulus disappeared. An access code allows for accessing a second stage, called *knowledge system*, whose output vector, called *"post-access code"*, is the projection of the access code in a vectorial space of *features*, and then represents what was recognized from the target stimulus. It is assumed that post-access codes vanish much more slowly than access codes, and that the space of post-access codes is the space on which expert functions are learned. The third stage is a *decision* stage that can compare two post-access codes and provides a same/different judgement in a probabilistic way. One can note that the first stages are not task dependent, while the third stage is the only one that is specifically devoted to comparison tasks. It is assumed that the first two stages correspond to automatic parallel activation subsystems, while the third stage is under control of central processes. Finally, it is assumed that the only basic difference between experts and novices is the content of their respective knowledge systems.

Methods and Procedure

Two experiments of judgement of similarity have been carried out. The first experiment was used to test the model. Subjects had to compare at each trial (150 trials) a basketball play configuration (called source) presented 4 sec. on a computer monitor to a second (called target), similar or different to the source (1, 2 or 3 differences between the two), and following the source after a mask of 2s. The second experiment was used to test the nature (semantico-propositional vs. perceptual) of the visual encoding of the configuration. In this experiment, the task was very similar to the first one except that the target was, (1) similar or presenting only two differences with the source, and (2) aligned as the source or rotated 90° clockwise or counterclockwise. Our rationale was the following. A strict mapping of the two configurations being impossible when target rotates, then a mental rotation is necessary before the mapping process intervenes. Only a semantico-propositional rotation is possible (because logical rules are invariant by rotation) while a perceptual rotation is not possible. If experts use a semantico-propositional encoding then the decrement effects of rotation would have been less important than in non-experts.
In the two experiments subjects had to push on two different keys of the computer keyboard to deliver their response (similar or different). Two groups of expert basketball players and non-experts participated to the experiments (24 and 22 subjects in the first and second experiment respectively).

Results

Experiment 1

Simulation

The correlation between the predictions of the model and the observed responses times was $r = 0.985$ (Table 1).

Table 1. Predicted (Pred.) and Observed (Obs.) Mean Response Times (ms) in Experts and Novices in Experiment 1

Differences	Novices Non-Struct. Pred.	Novices Non-Struct. Obs.	Novices Structured Pred.	Novices Structured Obs.	Experts Non-struct. Pred.	Experts Non-struct. Obs.	Experts Structured Pred.	Experts Structured Obs.
0	1636	1634	1625	1615	1250	1230	1300	1335
1	1614	1635	1595	1598	1242	1186	1250	1245
2	1571	1519	1552	1580	1217	1238	1203	1219
3	1544	1602	1533	1487	1176	1201	1182	1166

Analysis of performance

An effect for Expertise on Accuracy, $F(1, 22) = 6.05$, $p<.05$, and on Time to Respond, $F(1,22) = 15.8$, $p < .01$, (experts were more accurate and faster than non-experts), an effect for Structure, $F(1,22) = 16.5$, $p < .001$, and Difference, $F(3, 66) = 85.3$, $p < .0001$ were obtained. A significant Structure by Expertise interaction was also found ,$F(1, 22) = 8.37$, $p < .01$.

Experiment 2

Simulation

The correlation between the predictions of the model and the observed responses times was $r = 0.99$ (Table 2).

Table 2. Predicted (Pred.) and observed (Obs.) Mean Response Times (ms) for Structured and Non-Structured Configurations in Experts and Novices in Experiment 2

	Novices Non-Struct. Pred.	Novices Non-Struct. Obs.	Novices Structured Pred.	Novices Structured Obs.	Experts Non-Struct. Pred.	Experts Non-Struct. Obs.	Experts Structured Pred.	Experts Structured Obs.
No Rot. Similar	1898	1870	1901	1914	1578	1547	1604	1539
No Rot. Different	1877	1839	1875	1927	1526	1594	1475	1503
Rot. Similar	2558	2593	2558	2621	2078	2077	2109	2232
Rot. Different	2552	2417	2549	2586	2059	2024	2036	1948

Analysis of performance

An effect for Expertise on Accuracy, $F(1.20) = 23.38$, $p < .0001$, and an effect for Structure, $F(1.20) = 15.36$, $p < .001$, Difference, $F(1,20) = 98.57$, $p < .0001$, and Rotation, $F(1,20) = 100.15$, $p < .0001$, were obtained. No effect of expertise for time-to-answer and no Expertise by Rotation interaction (Figure 1).

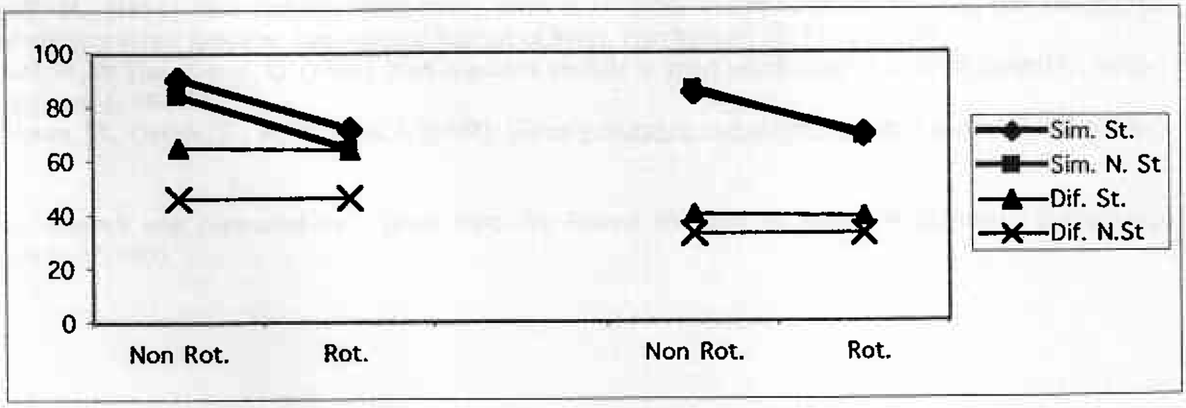

Figure 1. Percentage of correct responses for experts (left) and non-experts (right)

Discussion and Conclusions

The extreme high correlation between simulated and empirical results (superior to 0.98) indicate that it is possible to refer to some components of the model to discuss psychological operations involved in man. Let recall that in our model: (1) the initial coding of game configurations involves a simple vectorial representation and not a hierarchical and structured propositional representation, (2) the comparison does not proceed from a local-to-global but rather from a global-to-global manner and does not pass over the term-to-term alignment of source and target elements. This signifies that the encoding of the configuration is rather perceptual than semantico-propositional, automatic and parallel. This is confirmed by results from the second experiment in which we found no Expertise by Rotation interaction. This signifies that experts do not use a semantico-propositional mode of encoding (because this one is invariant by rotation) and use, like non-experts, a perceptual mode of encoding. However, the Expertise X Structure interaction found in the second experiment shows that experts are always "sensitive" to the structures in spite of the rotation. This could signify that the structures stored in knowledge base constraint, with a bottom up type of functioning, the visual input. Another conclusion can be drawn from this result. The fact than experts use a global-to-global mode of processing can be put in relation with the use of the chunking strategy described in experts in every task of visual inspection in order to memorize, to identify, or to decide on an action. This mode of functioning could explain the adoption of the inter-event visual strategy used by experts in decision-making (see Ripoll, 1991). This could be considered as a general mode of processing, well adapted to sport situations, and used to analyze visual displays under extreme time pressure conditions.

What is the role of knowledge base in experts? Our model ignores all propositional coding, and all game rules or existing tactical schemes. Does this imply that players do not use propositional coding in this type of task? We can consider that a discrete propositional representation intervenes at the level of a posteriori analysis or for the intersubjective communication whereas a perceptual continuous representation intervenes when task processing involves ecological strong temporal constraints. Then, two remarks can be made. First, it is possible that in extreme time constraint conditions such as in real game, players would use rather a fast, automatic, and parallel perceptual mode of encoding than a long time consuming, sequential and exhaustive semantico-propositional mode of computational processing. Second, the point of view of the researcher, when he or she describes, from the observed behavior, the logical rules used by players (such as in an expert system in artificial intelligence), or the point of view of the player itself when he or she describes after his or her action his or her behavior, is not the point of view of the actor involved in action. It is probable, and this is the main conclusion of our work, that as firmly evoked by Ripoll and Tenenbaum (1996), the relation between cognition and action is in real situation more automatic, of a low (bottom up) level of processing, and less resource consuming that classically claimed in sport psychology.

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