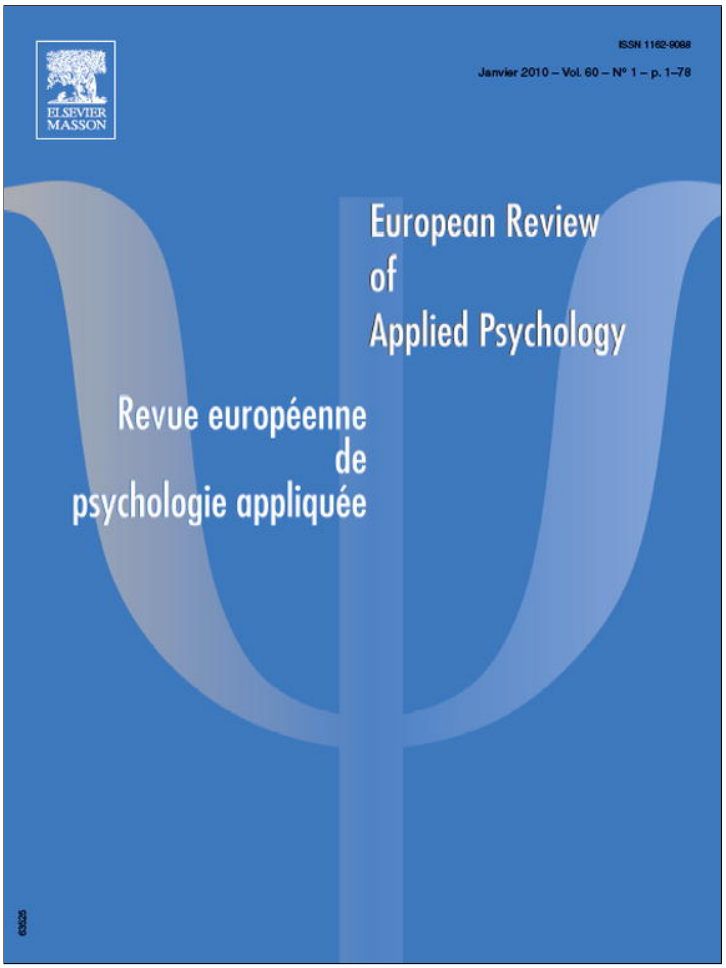
Decision-making in basketball and handball games: A developmental perspective

Eric Fruchart, Patricia Paques Rulence, Etienne Mullet



Disponible en ligne sur ScienceDirect www.sciencedirect.com

Elsevier Masson France EM|consulte www.em-consulte.com

Revue européenne de psychologie appliquée

Revue européenne de psychologie appliquée 60 (2010) 27–34

Original article

Decision-making in basketball and handball games: A developmental perspective

La prise de décision au basketball et au handball : une perspective développementale

E. Fruchart [c], P. Pâques [b], E. Mullet [a,*]

[a] *Institute of Advanced Studies (EPHE), France*
[b] *Cote d'Opale University, Boulogne, France*
[c] *Faculté des sports et de l'éducation physique, université d'Artois, 62800 Liévin, France*

Received 4 October 2007; received in revised form 16 October 2009; accepted 22 October 2009

Abstract

The study examined the way in which novice basketball or handball players used different informational cues (current score, time left to play, numerical status of the team) for deciding a quick restart of play during a basketball or a handball game. The study also compared their responses with the responses from a senior experts group. The more experienced the novices, (a) the more they gave importance to the numerical status and the current score for judging the appropriateness of the strategy, and (b) the more the effect of time moderated the effect of current score on the appropriateness judgments. These developmental trends were shown to be faster in basketball than in handball. Learning the conditions under which a quick restart of play is appropriate or not appeared as more difficult in the case of handball than in the case of basketball.

Keywords: Basketball; Handball; Development; Information integration

Résumé

On a étudié la manière dont des joueurs novices au basketball et au handball intègrent divers éléments d'information (score actuel, temps de jeu restant, statut numérique des équipes) au moment de décider d'une remise en jeu rapide durant un match. On a également comparé leurs réponses et celles de joueurs experts. Plus les novices ont d'expérience, et plus (a) ils donnent d'importance au statut numérique des équipes et au score actuel pour juger du caractère approprié de la stratégie de remise en jeu, (b) le facteur temps modère l'effet du score actuel lors du jugement. La tendance développementale s'est avérée plus forte s'agissant du basketball que du handball. Apprendre les conditions sous lesquelles une remise en jeu rapide est appropriées semble nettement plus facile au handball qu'au basketball.

Mots clés : Basketball ; Handball ; Développement ; Intégration de l'information

In the domain of sport and exercise (collective as well as individual), expertise has largely been explained by superiority in perceptual and cognitive processes related to specific-knowledge bases (or decision schemata, Araújo et al., 2005; Helsen and Starkes, 1999; Lerda et al., 1996; McPherson, 2000; Starkes et al., 1994; Starkes et al., 2001). These knowledge bases are "specifically concerned with the processes which intervene between the intake of the information and the behavioral response, that is to say between the input and the output. . . The processes concern the underlying logic of the system, which corresponds to the software" (Ripoll, 1991, p. 187, quoted in Bar-Eli and Raab, 2006). Despite the importance that has been attributed to these knowledge bases for explaining why experts perform better than novices, and why experienced players perform better than beginners, how these knowledge bases are structured, the way in which they develop among novices, and how they are used to make decisions has received only little attention (Bar-Eli and Raab, 2006; Thomas and Thomas, 1994).

* Corresponding author.
E-mail address: etienne.mullet@wanadoo.fr (E. Mullet).

1162-9088/$ – see front matter © 2009 Elsevier Masson SAS. All rights reserved.
doi:10.1016/j.erap.2009.10.003

During a game, players must quickly process many kinds of information (Bennis and Pachur, 2006; Darnis et al., 2005): the current score, the team organization, the opponent's position, the time constraint, and many other cues. The way players decide "what to do" (Rink et al., 1996) is necessarily a function of the information that is available at a given time and depends on their level of expertise. One possible factor responsible for sport performance might be the degree of organization and integration of this expertise in more or less efficient decision-making schemata (or action rules), as suggested by Lerda et al. (1996). As most decisions are taken under time pressure, the quality of these decision schemata plays an important role because appropriate schemata (or action rules, Darnis et al., 2005) allow players to efficiently plan and program the movement before executing it with speed and precision.

What is the structure of these decision schemata? How is information used for deciding which strategy should be implemented? Which cues are considered determinant? Which rule is used to combine these cues into a judgment? These questions have been examined by Pâques et al. (2005) in the case of soccer, basketball, and handball, using a methodological approach that was devised by Anderson (2008), and already used in sport decision-making by Vergeer and Hogg (1999), and also Dru et al. (2004). Pâques et al. (2005) presented their participants with hypothetical vignettes in which one player had to decide whether a quick restart of play during the final phase of a match was appropriate. Quick restart is a strategy often enacted when the opposite team has just scored a goal. It consists of deciding to put the ball back into play as quickly as possible in the hope of preempting a defensive action from the opposite team; that is, acting before the defense has been able to re-organize. This strategy involves risks. The major risk is the possibility of losing the ball when increased speed of play tends to reduce the precision of passes between partners. It is a tactical decision for which tangible rules exist.

In Pâques et al. (2005), the vignettes were composed according to an orthogonal design, with importance of the game (friendly or championship), numerical status of the team (superiority, equality, or inferiority), current score (win, tie, lose), and time left to play (very little time or little time), as the four factors. Participants were instructed to consider each vignette and to judge the appropriateness level of a quick restart of play, knowing that the opposing team has just scored. In the case of basketball, the main findings were that:

(a) current score and time left to play were the most important factors for deciding a quick restart of play strategy;
(b) numerical status of the team and importance of the game were secondary factors;
(c) time left to play was a strong moderator of the effect of score;
(d) time left to play was a strong moderator of the effect of numerical status of the team.

In the case of handball, the main findings were similar, but not identical, to the ones observed in the case of basketball. The main message conveyed by Pâques et al.'s (2005) study was that knowledge bases may be structurally complex, involving interactions between factors.

How do these decision schemata (or action rules) develop among novices? This question has been examined by Rulence-Pâques et al. (2005) in the case of a game of soccer. They presented novices (12–14, 15–16, and 17–18 year-olds) with the same material that was used in Pâques et al. (2005), and they also included in their study a group of seniors as a standard. They showed that the knowledge bases at work among the three groups of novices and among the seniors were structured in a different way. Among seniors, a quick restart of play strategy was judged very appropriate when at least one out of four sets of conditions were fulfilled:

(a) losing in a championship game and very little time left to play;
(b) losing in a championship game and little time left to play but with the condition of numerical superiority;
(c) losing in a friendly game but with the conditions of very little time left to play and actual numerical superiority;
(d) tie in a championship game and very little time left to play with the condition of numerical superiority.

By contrast, among 12–14 year-olds, the sets of conditions were more restricted. A quick restart of play strategy was judged very appropriate in only two cases:

(a) losing in a championship game and very little time was left to play;
(b) tie in a championship game and very little time left to play with the condition of numerical superiority.

Among the two intermediate groups the knowledge bases were structured in a way that was more and more similar to those of the senior players.

The present study was similar in design to the Rulence-Pâques et al.'s (2005) study. The only difference was the chosen settings: basketball and handball instead of soccer. We were interested in examining:

(a) the extent to which the developmental trend, from 12-14 year-olds to 17-18 year-olds that was observed in Rulence-Pâques et al. (2005) in a soccer setting was also discernable in other settings;
(b) the extent to which differences in developmental trends between basketball and handball can be discerned. In the present study, as in Rulence-Pâques et al.'s (2005) study, the rule used by the seniors in both sports was taken as the gold standard for judging whether the trend possibly observed among the novices was or was not in the correct direction.

The choice of basketball and of handball was guided by:

(a) the fact that the four factors (time left to play, current score, team numerical status, and importance of the game) that were shown to play a role in decision-making (regarding the quick restart of play) in a soccer game could also be

considered as playing a role in basketball and handball games, which made direct comparisons possible (Pâques et al., 2005);

(b) the fact that basketball, handball, and soccer were clearly different sports in terms of playing area (e.g., large area in the case of soccer, small area in the case of basketball and handball), in terms of rules (e.g., the ball is carried by hand in two cases and moved by foot in the other case), in terms of risk taking (e.g., simply losing the ball in basketball is often synonymous to increasing the opposite team score), and in terms of scores (e.g., the scores observed in basketball games and in handball games at the end of the match are considerably higher than the scores observed in soccer games), and finally;

(c) the fact that these sports are popular in Europe; as a result, it was easy to gather a wide population of novice and experienced players.

The choice of basketball and handball was also guided by the fact that the quick restart of play strategy has not the same status in handball as compared with basketball. In handball, this strategy is relatively new. It was only introduced in 1997 in order to make the handball games more attractive. It was only slowly that expert players, first, and then educators discovered that this strategy may be a powerful one. However, this strategy is still not systematically taught everywhere, and many young players may not have been fully exposed to it during training.

The hypotheses were based on the findings in Pâques et al. (2005) and Rulence-Pâques et al. (2005). Among seniors, current score, time left to play and team composition have been shown to be important factors for deciding a quick restart of play strategy. As a result, the first hypothesis was that there should be an increasing use of these three cues with age (from 12–14 year-olds through the 15–16 year-olds and up to the 17–18 year-olds). This increase should be reflected in significant Age × Score, Age × Time, and Age × Team interactions.

Among seniors, time has been shown to be a strong moderator of the effect of team composition and of the effect of current score. As a result, the second hypothesis was that there should be an increasing strength of these two moderating effects with age (from 12–14 year-olds through the 15–16 year-olds and up to the 17–18 year-olds). This increase should be reflected in significant Age × Time × Team, and Age × Time × Score interactions.

Finally, as handball players are, during training, possibly less exposed to the quick restart of play strategy than basketball players are, differences in developmental trends may be expected. As a result, the third hypothesis was that the differences between the 15–16 years old and 17–18 years old participants on the one hand and the seniors on the other hand, should be less among basketball players than among handball players. These differences in trends should be reflected in significant interactions involving both Sport and Level of Expertise (from young novice to senior, e.g., Sport × Expertise × Time × Score).

1. Method

The methodological framework of the study was the Functional Theory of Cognition (Anderson, 2008). This framework was chosen because it allows a precise measurement of the weights of the factors (e.g., Ligneau and Mullet, 2005), an easy detection of the interactions between factors (e.g., Esterle et al., 2008), and an easy detection of developmental trends in terms of changes in weights and changes in strength of interactions (e.g., Rulence-Pâques and Mullet, 1998). A similar framework has already been used in sport decision-making by Vergeer and Hogg (1999) who analyzed coaches' decisions about an injured athlete's participation in competition as a function of several situational factors (injury severity, the gymnast's age, ability level and importance of the competition) they systematically varied in an orthogonal design.

In addition, this methodology has been shown to give results that are extremely close to the ones that are observed in real settings. Fruchart et al. (2007) showed that between the mean ratings obtained using scenarios constructed according to this methodology and the actual probabilities of quick restart of play in similar conditions, which were computed through the analysis of 500 videos of championship meetings, the correlation was higher than 0.98; that is, the pattern of results was extremely similar.

1.1. Participants

The participants are 240 volunteers living in the North of France. They were all male members of junior basketball teams ($N = 120$) or handball teams ($N = 160$). Their age varied from 12 to 18 years. They formed three age groups: 12–14 year-olds (80 participants, mean age = 12.8), 15–16 year-olds (80 participants, mean age = 16.0), 17–18 year-olds (80 participants, mean age = 18.2). All participants played basketball or handball from the age of 12. They played at a regional level.

The group of seniors was composed of 80 participants (mean age = 24.1). All the senior participants played at a national level; that is, they were undisputedly all experts in their field. They were approached by one of the authors (who was a senior player as well).

1.2. Material

The material was exactly the same as the one used in Rulence-Pâques et al. (2005). It consisted of 36 cards showing a short story of about four lines and a response scale. Each story contained four critical items of information in the following order:

(a) the relative importance of the game (friendly match versus competitive match);
(b) the current numerical status of the team (numerical inferiority, equality versus numerical superiority);
(c) the current score (loss, tie versus win);
(d) the time left to play (little time versus very little time).

All possible combinations of these types of information yielded $2 \times 3 \times 3 \times 2 = 36$ stories. One typical story was as follows: "Your team is playing a championship match. At present, your team's score is one goal higher than the other team's and your team has one player more than the opposing team. The ball has left the field of play. Very little time remains to play. Are you going to decide to adopt a quick restart of play strategy?".

Beneath each story was a 19-cm response scale with "Completely Sure I am not going to adopt a quick restart of play strategy" indicated at the left and "Completely sure I am going to adopt a quick restart of play strategy" indicated at the right.

1.3. Procedure

The participants were interviewed in 2003. The basketball players (juniors and seniors) were presented with the vignettes labelled for the basketball game, and the handball players were presented with the vignettes labelled for the handball game. Participants responded individually, generally during sport training or in sport club meetings.

According to the methodology in Functional Theory of Cognition (Anderson, 2008), the test was administered in two phases. In the first/familiarization phase participants, the participants were explained their role in the study and asked to read a certain number of stories (in which during a match, a player must decide whether a quick restart of play strategy has to be adopted or not). The task was to identify with this player and express an opinion about the appropriateness of this type of strategy in each case. It was explained that:

(a) if they were not at all ready to adopt a quick restart strategy they should mark the far left side of the scale;
(b) if they were completely ready to adopt a quick restart strategy they should mark the far right side of the scale;
(c) if they were undecided they should mark the center of the scale.

In this initial/familiarization phase, each participant was presented with the 36 stories. Each story was read aloud by the participant. Subsequently, participants provided the required ratings and were given an opportunity to compare their responses and make changes if necessary. During the second/experimental phase, the 36 stories were re-submitted to participants in a different order. Participants provided their ratings at their own pace but were not allowed to compare responses or to go back and make changes as in the familiarization phase. The scenarios were randomized across participants.

2. Results

All participants' ratings (juniors and seniors) from the second phase were converted to a numerical value expressing the distance (measured with a ruler) between the point on the response scale, and the left anchor which served as the point of origin. These numerical values were then subjected to graphical and statistical analyses.

A first ANOVA with a Sport × Age × Importance × Team × Score × Time, $2 \times 3 \times 2 \times 3 \times 3 \times 2$ design was conducted on the raw data from the junior participants. Owing to the great number of comparisons, the significance threshold was set at $p = 0.001$.

A quick restart of play strategy was considered more appropriate in the case of basketball ($M = 11.76$) than in the case of handball ($M = 10.39$), $F(1.234) = 35.48$, $p < 0.001$, $\eta_p^2 = .13$. A quick restart of play strategy was considered more appropriate among the younger participants ($M = 12.23$) than among the older participants ($M = 10.33$), $F(2.234) = 25.84$, $p < 0.001$, $\eta_p^2 = .18$. The Sport × Age interaction was, however, significant, $F(2.234) = 11.69$, $p < 0.001$, $\eta_p^2 = .09$. Among the younger participants, there was practically no difference as a function of sport (12.13 versus 12.33). Among the other participants, the difference was larger (11.57 versus 9.43) and significant, $p < 0.001$.

A quick restart of play strategy was considered more appropriate in the case of a championship match ($M = 11.47$) than in the case of a friendly match ($M = 10.69$), $F(1.234) = 38.20$, $p < 0.001$, $\eta_p^2 = .14$. A quick restart of play strategy was considered more appropriate when the team was numerically superior ($M = 11.68$) than when the team was numerically inferior ($M = 10.32$), $F(2.468) = 45.95$, $p < 0.001$, $\eta_p^2 = .16$. The Age × Team interaction was, however, significant, $F(6.468) = 8.01$, $p < 0.001$, $\eta_p^2 = .06$. Among the younger participants, there was practically no difference as a function of the composition of the team (12.10 versus 12.34). Among the other participants, the difference was larger (9.42 versus 11.35) and significant, $p < 0.001$.

A quick restart of play strategy was considered more appropriate when the team was losing ($M = 13.11$) than when the team was winning ($M = 7.76$), $F(2.468) = 485.05$, $p < 0.001$, $\eta_p^2 = .67$. The Sport × Score interaction was, however, significant, $F(2.468) = 16.52$, $p < 0.001$, $\eta_p^2 = .07$. Among the basketball players, the difference as a function of score was more than six points (13.97 versus 7.85). Among the handball players, it was less than five points (12.26 versus 7.68). The Age × Score interaction was also significant, $F(2.468) = 6.94$, $p < 0.01$, $\eta_p^2 = .05$. Among the younger participants, the difference as a function of the score was about four points. Among the other participants, the difference was higher than six points. The Sport × Age × Score interaction was significant, $F(4.468) = 7.94$, $p < 0.001$, $\eta_p^2 = .06$. The Age × Score interaction was stronger among the handball players than among the basketball players.

A quick restart of play strategy was considered more appropriate in the case of very little time to play ($M = 12.31$) than in the case of little time to play ($M = 9.85$), $F(1.234) = 178.75$, $p < 0.001$, $\eta_p^2 = .43$. The Sport × Time interaction was significant, $F(1.234) = 8.56$, $p < .001$, $\eta_p^2 = .04$. Among the basketball players, the difference as a function of time to play was three points (13.26 versus 10.26). Among the handball players, it was less than two points (11.36 versus 9.43).

The effect of current score on the appropriateness of a quick restart of play was stronger in the case of championship match

(13.65 versus 7.84) than in the case of a friendly match (12.58 versus 7.70), $F(2.468) = 13.35$, $p < 0.001$, $\eta_p^2 = .05$. The effect of team composition on the appropriateness of a quick restart of play was stronger (10.71 versus 8.98) when little time was left to play than when very little time was left to play (12.65 versus 11.65), $F(2.468) = 9.10$, $p < 0.001$, $\eta_p^2 = .04$.

The effect of current score on the appropriateness of a quick restart of play was stronger when very little time was left to play (15.34 versus 10.89) than when little time was left to play (7.06 versus 8.47), $F(2.468) = 299.73$, $p < 0.001$, $\eta_p^2 = .56$. The Sport × Score × Time interaction was significant, $F(2.468) = 16.42$, $p < 0.001$, $\eta_p^2 = .07$. The Score × Time interaction was stronger in the case of basketball than in the case of handball. The Age × Score × Time interaction was also significant, $F(4.468) = 9.16$, $p < 0.001$, $\eta_p^2 = .07$. The Score × Time interaction was stronger among the seniors than among the younger participants.

A second ANOVA with a Sport × Expertise × Importance × Team × Score × Time, $2 \times 3 \times 2 \times 3 \times 3 \times 2$ design was conducted on the raw data from the junior and from the senior participants; that is, the group of seniors was included in the second analysis. Only the results that were not redundant with the ones found in the first ANOVA are mentioned. These new results are essentially interactions involving the Expertise factor.

A quick restart of play strategy was considered more appropriate among the novices ($M = 12.23$) than among the seniors ($M = 10.27$), $F(3.312) = 24.94$, $p < 0.001$, $\eta_p^2 = .19$. The Sport × Expertise interaction was, however, significant, $F(3.312) = 9.49$, $p < 0.001$, $\eta_p^2 = .08$. Among the younger participants, there was practically no difference as a function of sport (12.13 versus 12.33). Among the other participants and among the seniors, the difference was larger (11.43 versus 9.40) and significant, $p < 0.001$.

The Expertise × Team interaction was significant, $F(6.624) = 7.94$, $p < 0.001$, $\eta_p^2 = .07$. Among the younger participants, there was practically no difference as a function of the composition of the team (12.10 versus 12.34). Among the other participants and among the seniors, the difference

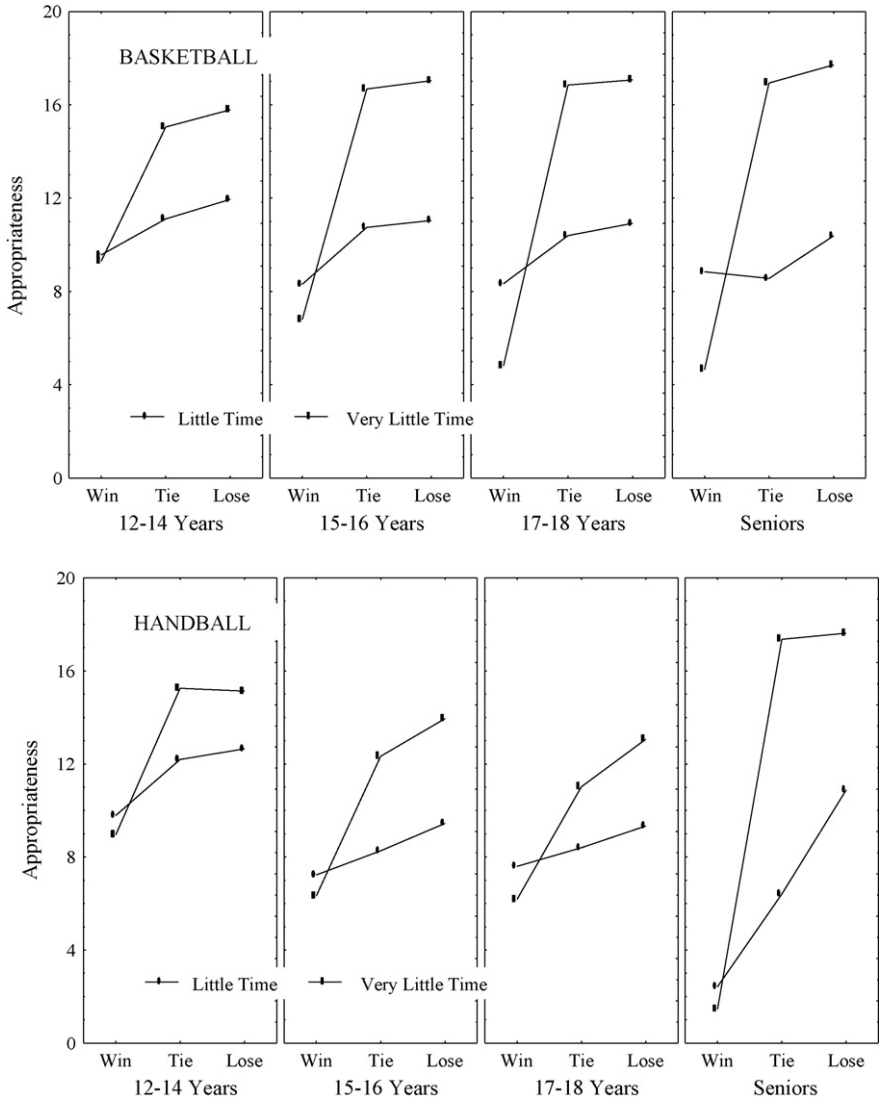


Fig. 1. Relationships between appropriateness judgments, current score and time left to play observed in each of the four groups of participants for basketball (top panels) and handball (bottom panels).

was larger (9.33 versus 11.31) and significant, $p < 0.001$. The Sport × Expertise × Team interaction was also significant, $F(6.624) = 6.01$, $p < 0.001$, $\eta_p^2 = .05$. The Expertise × Team interaction that has just been described was stronger in the case of handball than in the case of basketball.

The Expertise × Score interaction was significant, $F(6.624) = 32.90$, $p < 0.001$, $\eta_p^2 = .24$. Among the younger participants, the difference as a function of score was about four points (13.88 versus 9.40). Among the seniors, it was about 10 points (14.15 versus 4.34). Among the two other groups, it was intermediate (12.74 versus 6.94). The Sport × Expertise × Score interaction was also significant, $F(6.624) = 24.88$, $p < 0.001$, $\eta_p^2 = .19$. The Expertise × Score interaction was stronger in the case of handball than in the case of basketball.

The Expertise × Time interaction was significant, $F(3.312) = 17.26$, $p < 0.001$, $\eta_p^2 = .14$. Among the seniors, the difference as a function of time to play was about five points (12.62 versus 7.92). Among the novices, it was about two points (12.31 versus 9.85). The Sport × Expertise × Time interaction was also significant, $F(3.312) = 6.14$, $p < 0.001$, $\eta_p^2 = .06$. The Expertise × Time interaction was stronger in the case of handball than in the case of basketball.

The Expertise × Team × Time interaction was significant, $F(6.624) = 11.34$, $p < 0.001$, $\eta_p^2 = .10$. Among the seniors, the Team × Time interaction was very strong, $p < 0.001$. Among the younger participants, it was not significant. Among the other groups, it was intermediate.

The Expertise × Score × Time interaction was significant, $F(6.624) = 31.43$, $p < 0.001$, $\eta_p^2 = .23$. The Score × Time interaction was stronger among the seniors than among the younger participants. Finally, the Sport × Expertise × Score × Time interaction was significant, $F(6.624) = 5.21$, $p < 0.001$, $\eta_p^2 = .05$. This complex interaction is depicted in Fig. 1. In the case of basketball, the pattern of results observed among the 15–16 and 17–18 year-olds is already very similar to the one observed among the seniors. By contrast, in the case of handball, the pattern of results observed among the 15–16 and 17–18 year-olds is still very similar to those observed among the younger participants.

3. Discussion

The study compared the way in which novice players (different levels) on the one hand, and experienced players (seniors) on the other hand use different informational cues for deciding a quick restart of play during a basketball or a handball match. The first hypothesis was that among experts, there should be an increasing use of the three cues that have been shown to be important factors for deciding a quick restart of play: current score, time left to play and team composition. As expected, the Age × Team and Age × Score interactions were significant, and their shapes were compatible with the hypothesis. These cues were given more importance for judging the appropriateness of a quick restart strategy among older participants than among younger participants. This finding was consistent with the Rulence-Pâques et al. (2005) results. It is also consistent with the Darnis et al. (2005) results showing that cognitive development positively influences handball performance among juniors. The Age × Time interaction was not significant but the trend was in the expected direction.

The second hypothesis was that there should be an age-related increase in the strength of two moderating effects that have been shown to be present in experts' judgments. Time left to play has been shown to be a strong moderator of the effect of team composition on appropriateness judgments and time left to play has also been shown to be a strong moderator of the effect of current score on appropriateness judgments. As expected, the Age × Time × Score interaction was significant, and its shape was compatible with our hypothesis. The more experienced the participants, the more the effect of time moderated the effect of current score on the appropriateness judgments. This finding was also consistent with the Rulence-Pâques et al. (2005) results. The Age × Time × Team interaction was, however, not significant, but the effects were in the expected direction; that is, the more experienced the participants, the more the effect of time moderated the effect of composition of the team on the appropriateness judgments.

The third hypothesis was that the differences between the 15–16 year-olds and 17–18 year-olds on the one hand and the seniors on the other hand, should be less among basketball players than among handball players. As expected, several interactions involving Age × Sport were observed: Sport × Expertise × Team, Sport × Expertise × Score, Sport × Expertise × Time, and Sport × Expertise × Time × Score. In other words, the developmental trend observed regarding the use of the three important cues – composition of the team, current score and time left to play, and their interactions were different from one sport to the other. In fact, this developmental trend was faster in basketball than in handball, which was expected owing to the fact that the quick restart of play strategy has only recently been introduced in handball, and senior players, and now educators, have discovered that it may be a powerful tool. The findings regarding basketball were consistent with the results Rulence-Pâques et al. (2005) observed for soccer. However, the findings regarding handball are clearly different. Learning the conditions under which a quick restart of play is appropriate or not is possibly more difficult in the case of handball than in the case of basketball and soccer.

Looking at the results in another, if-then way (McPherson and Kernodle, 2003), it can be observed that, among seniors, and regarding basketball, a quick restart of play strategy is viewed as appropriate (rating > 16) when:

(a) the game is an important one, the score is tied (or worse), and there is very little time left to play, irrespective of the numerical status;
(b) the game is a friendly meeting, the score is tied, the two teams are (at least) numerically equal, and there is very little time left to play;
(c) and finally, the game is a friendly meeting, the team is losing, the team is numerically superior, and there is very little time left to play.

By contrast, among the youngest novices, a quick restart of play strategy is viewed as appropriate only when:

(a) the team is losing, there is very little time left to play, and the team is (at least) numerically equivalent, irrespective of the importance of the game;
(b) the game is important, the score is tied, the team is numerically superior, and there is very little time left to play;
(c) and finally, the game is important, the score is tied (or worse), the team is (at least) numerically equivalent, and there is very little time left to play.

In other words, among the seniors, the strategy was viewed as appropriate in 11 cases (out of the 36 shown). Among the youngest novices, it was viewed as appropriate in only six cases (five out of these 11).

Regarding handball, and among seniors, a quick restart of play strategy was viewed as appropriate (rating > 16) when the score is tied (or worse), and there is very little time left to play, irrespective of the numerical status of the team and of the importance of the game. Among the youngest novices, a quick restart of play strategy was viewed as appropriate (rating > 16) when:

(a) the game is important, the team is losing, the team is numerically equal, and there is very little time left to play;
(b) and the game is important, the score is tied, the team is numerically superior, and there is very little time left to play.

In other words, among the seniors, the strategy was viewed as appropriate in 12 cases. Among the youngest novices, it was viewed as appropriate in only four cases.

Future studies should examine the extent to which one of the reasons why the set of conditions is systematically broader among seniors than young juniors (Rulence-Pâques et al., 2005) may reside in the fact that seniors tend to consider the quick restart of play strategy as not very risky because they are confident in their own abilities, whereas young people less often agree with this strategy because they know that they are not very likely to pull it off. In other words, the appropriateness of a strategy should, in future studies, be assessed by also taking into account the players' physical (and mental) conditions: Strategies that are appropriate for seniors are possibly not appropriate for novices.

The decision rules that are suggested above are simple ones, and their structure is fully compatible with what is commonly called decision heuristics (Bennis and Pachur, 2006). The simplest of these rules has two components. It just supposes that if the score is tied (or worse) and there is very little time left to play, then a quick restart of play is appropriate. No complex computation is needed. The more complex of these rules has four components. It supposes that if the score is tied (or worse), the team is (at least) numerically equivalent, there is very little time left to play and the game is important, then a quick restart of play is appropriate. Even in this more complex case, cognitive processing is not very costly; the decision can be immediate. In each of the four cases described before, the set of rules form a specific knowledge base (Lerda et al., 1996). It can be noted that the knowledge basis on which seniors rely are, as expected, more extended than the ones on which juniors rely.

3.1. Implications

The results of this research may have implications for physical educators. Knowing what knowledge bases are available, to each individual player in particular and to young players in general, should be helpful to sports coaches for elaborating adapted training situations aimed at improving players' skills. Learning settings based on the ones devised by Bonin-Scaon et al. (2002) and Lafratta (2007) in health psychology or Liégeois et al. (2003) in educational psychology may prove useful in sport psychology. In these learning settings, the same scenarios as the ones used in the present study may be employed. After each judgment, the participant would be informed about the "correct" response. Bonin-Scaon et al. (2002) and Liégeois et al. (2003) have shown that after a reduced number of trials, the pattern of response of the participants typically came closer to the experts' one. Examining the extent to which this type of learning setting is transposable to a sport situation, and the extent to which such type of training may prove useful for young players (that is, may transfer into real games) should be interesting topics for future studies.

This type of learning setting is also amenable to dyads of learners instead of individual learners. After each judgment, each participant in the dyad could be informed about the other's response, and a discussion centered on the appropriateness of each response could be engaged between learners. Darnis-Paraboschi et al. (2005) have shown that these interactions may be fruitful in terms of progress in sport performance.

References

Anderson, N.H., 2008. Unified social cognition. Psychology Press, New York.
Araújo, D., Davids, K., Serpa, S., 2005. An ecological approach to expertise effects in decision-making in a simulated sailing regatta. Psychology of Sport and Exercise 6, 671–682.
Bar-Eli, M., Raab, M., 2006. Judgment and decision making in sport and exercise: Rediscovery and new visions. Psychology of Sport and Exercise 7, 519–524.
Bennis, W.M., Pachur, T., 2006. Fast and frugal heuristics in sports. Psychology of Sport and Exercise 7, 611–629.
Bonin-Scaon, S., Lafon, P., Chasseigne, G., Mullet, E., Sorum, P.C., 2002. Learning the relationship between smoking, drinking alcohol, and the risk of esophagal cancer. Health Education Research 17, 415–424.
Darnis, F., Lafont, L., Menaut, A., 2005. Dyadic interactions and operative level for handball strategies construction by 11–12 years old participants. European Review of Applied Psychology 55, 255–265.
Darnis-Paraboschi, F., Lafont, L., Menaut, A., 2005. Influence of dyadic interactions on tactical choices in a collective ball game. European Journal of Psychology of Education 20, 171–184.
Dru, V., Pâques, P., Mullet, E., 2004. The performance schemata in dyadic athletic competition. American Journal of Psychology 117, 479–496.
Fruchart, E., Rulence-Pâques, P., Mullet, E., 2007. Ecological validity test of laboratory studies on information integration. Teorie e Modelli [Special Issue on Functional Measurement] 12, 281–288.

Esterle, M., Muñoz Sastre, M.T., Mullet, E., 2008. Judging the acceptability of sexual intercourse among persons with learning disabilities: French lay people's viewpoint. Sexuality & Disability 26, 219–228.

Helsen, W.F., Starkes, J.L., 1999. Multidimensional approach to skilled perception and performance in sport. Applied Cognitive Psychology 13, 1–27.

Lafratta, A., 2007. Ecological validity test of laboratory studies on information integration. Teorie e Modelli [Special Issue on Functional Measurement] 12, 53–62.

Lerda, R., Garzunkel, R., Therme, P., 1996. Analogic transfer: A strategy for adapting to spatial constraints: The case of a duel in soccer. International Journal of Sport Psychology 27, 133–145.

Liégeois, L., Chasseigne, G., Papin, S., Mullet, E., 2003. Improving high school students' understanding of potential difference in simple electric circuits. International Journal of Science Education 25, 1129–1145.

Ligneau, C., Mullet, E., 2005. Perspective-taking in adults and elderly people. Journal of Experimental Psychology: Applied 11, 53–60.

McPherson, S.L., 2000. Expert-novice differences in planning strategies during collegiate singles tennis competition. Journal of Sport and Exercise Psychology 22, 39–62.

McPherson, S.L., Kernodle, M.W., 2003. Tactics, the neglected attribute of expertise: Problem representations and performance skills in tennis. In: Starkes, J.L., Ericsson, K.A. (Eds.), Expert performance in sports: Advances in research on sport expertise. Human Kinetics, Champaign, IL, pp. 137–168.

Pâques, P., Fruchart, E., Dru, V., Mullet, E., 2005. Cognitive algebra in sport decision-making. Theory and Decision 58, 387–406.

Rink, J.-E., French, K.E., Tjeerdsma, B.-L., Bonnie, J., 1996. Foundations for the learning and instruction of sport and games. Journal of Teaching in Physical Education 15, 399–417.

Ripoll, H. (Ed.). (1991). Information processing and decision making in sport. *International Journal of Sport Psychology* (Special Issue).

Rulence-Pâques, P., Fruchart, E., Dru, V., Mullet, E., 2005. Decision-making in soccer game: A developmental perspective. European Review of Applied Psychology 55, 131–136.

Rulence-Pâques, P., Mullet, E., 1998. Perception of surface and inference of surface: The case of the rectangle. Journal of Experimental Child Psychology 69, 1–27.

Starkes, J.L., Allard, F., Lindley, S., O'Reilly, K., 1994. Abilities and skill in basketball. International Journal of Sport Psychology 25, 249–265.

Starkes, J.L., Helsen, W., Jack, R., 2001. Expert performance in sport and dance. In: Singer, R.N., Hausenblas, H.A., Janelle, C.M. (Eds.), Handbook of sport psychology. Wiley, New York, pp. 174–204.

Thomas, K.T., Thomas, J.R., 1994. Developing expertise in sport: The relation of knowledge and performance. International Journal of Sport Psychology 25, 295–312.

Vergeer, I., Hogg, J.-M., 1999. Coaches' decision policies about the participation of injured athletes in competition. Sport Psychologist 13, 42–56.