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Original empirical article

GAME SITUATION INFORMATION IN VIDEO-BASED PERCEPTUAL DECISION MAKING: THE INFLUENCE OF CRITICALITY OF DECISIONS

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Abstract. *This study examined the effects of game situation information, manipulated in terms of time and score, on decisions made in a video-based perceptual test in basketball. The participants were undergraduate university students (n=159) who viewed 21 offensive basketball plays, under two test conditions (low decision criticality; high decision criticality). To manipulate the conditions, prior to each clip, the participants were presented with a description of the remaining time and score differential. High decision criticality situations were characterised by a remaining time of 60 seconds or less and score differentials of 2 points or less. Low decision criticality situations were characterised by remaining time of 5 minutes or more and score differentials of 5 points or more. The participants indicated their decision (pass, shoot, dribble) after the visual display had been occluded for each clip. The results indicated that decision profiles differed under the low and high decision criticality conditions. More pass decisions were made under high decision criticality situations and more shoot decisions under low decision criticality situations. These variations differed according to the type of main sport played but not for the basketball competition level. It was concluded that game situation information does influence decision making and should be considered in video-based testing and training.*

Key words: *Decision making, perceptual-cognitive, context, game situation, criticality.*

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INTRODUCTION

The appropriate utilisation of perceptual-cognitive skills such as visual search, pattern recognition, estimation of situational probabilities, and anticipation to make effective decisions is an important activity in high levels sports (Williams, Davids, & Williams, 1999). Because of its importance to skilled performance, research focusing on anticipation and perceptual decision making in sport has increased rapidly and many of the studies on perceptual-cognitive tasks in sport have found that experts perform better than non-experts (see Mann, Williams, Ward & Janelle, 2007 for a review). It is important to recognise, however, that decision making is unlikely to be an uncontextualised process, influenced only by the position of team mates and opponents, but is likely to be influenced by game factors including the game score and remaining time in the game. In the dynamic environment of team sports a player must process, often simultaneously, many performance variables including the opponent's position, team organisation, remaining time as well as the current score (Rulence-Pâques, Fruchart, Dru & Mullet, 2005). Measuring perceptual-cognitive and decision making performance in sport, however, is challenging (Williams & Ericsson, 2005). As a consequence, laboratory-based video tasks have frequently been used, which may not be as realistic as in situ conditions (e.g., Mann et al., 2007; Shim, Chow, Carlton & Chae, 2005). Video-based tasks have often employed a temporal occlusion paradigm, where the video is paused at particular points momentarily before or after the action is completed (Williams, Davids & Williams, 1999) and the participants are asked to either to make a decision as to what they would do next, what the opponent would do next, or predict the result of the observed action, and the accuracy of their response is recorded.

Williams and Ericsson (2005) reported that many questions have yet to be answered in the design of representative task simulations attempting to capture perceptual-cognitive skills in sport. One question they raised is whether performance of these task simulations varies as a function of the amount of game situation information provided prior to the performance. During a game it is likely that decisions will be influenced by the changing game situation (Araujo, Davids, Bennett, Button & Chapman, 2004). These game situation factors in many sports include remaining time and the score differential. For example, a basketball player who is presented with a long open shot may choose a different course of action if the team is 10 points ahead with 10 minutes left in the game, as opposed to 1 point up with 5 seconds left in the game. That is, the affordances, or opportunities for action, may be perceived differently depending on the game situation information available (Fajen, Riley & Turvey, 2008). The perceived criticality of decisions may increase in the later stages of a game, especially when scores are close (Bar-Eli & Tractinsky, 2000).With this in mind it is surprising that the effects of time and the score on decision making have been relatively unexplored.

It is likely that video-based simulations of decision making in sport that do not provide game situation information do not include sufficient levels of complexity that would be incorporated in the decision making process. That is, studies have used linear models of analysis, whereas more representative designs that incorporate game situation variables may provide more information on how decisions are made (Hogarth & Karelaia, 2007). Two studies with umpires may provide a basis for understanding the potential effect of game situation information on players' decision making. MacMahon and Starkes (2008) reported that in a video-based test, baseball umpires changed their decision depending on the context, with balls being more likely to be called when there was a high strike or high ball/strike count and, conversely, strikes more likely to be called when there was a high ball count. However, in another study, MacMahon, Starkes, and Deakin (2007) found that there was no effect of providing basketball referees with

priming information, suggesting that the information contained in the video-clips was more important than any priming information. One study, in an interceptive sport, cricket, by McRobert, Williams, Ward, Eccles and Ericsson (2007) found that, although skilled batters were more accurate in anticipation than less skilled batters, both groups changed their visual search behaviour between primed and unprimed clips. While previous research using video-based tasks provides a knowledge base for differences between experts and non-experts, studies are required that explore the influence of time and score criticality on decision making. This may lead to a more realistic performance demand in these video-based tasks as well as a greater understanding of the influence of game situation information on decisions made in an open skill team sport.

The purpose of this study was to examine the effect of game situation information on decision making profiles (proportion of dribble, pass, shoot decisions) of the participants, under both high- and low-criticality game situations, in a video-based perceptual test of basketball. An additional aim was to determine whether these effects vary based on the participant's main type of sport and competition level. This is because those with more game situation knowledge may be more likely to modify their responses than those with less knowledge of the game, given the perceptual-cognitive task performance differences between experts and non-experts (see Mann et al., 2007 for a review). It was hypothesised that: (1) the decision profile made when presented with a low decision criticality game situation will be different from the one made when presented under a high decision criticality game situation – that is, the relative proportion of dribble, pass and shoot decisions will be different; (2) variations in decision making profiles for the two criticality conditions will interact with relevant experience factors including main type of sport and level of competition.

METHOD

Participants

The participants were 159 undergraduate university students (n=78 females, n=81 males) ranging in age between 18 and 47 (M=20.3, SD=2.9). The participants were asked to indicate the primary sport they participated in, with 121 of them primarily playing in team sports, 34 in individual sports, and 3 not participating in sport. Participants also indicated the highest level of basketball played, which consisted of 7 non players, 77 social/recreational players, 30 local, and 45 state league or national/international players.

Measures

The decision making test footage was recorded from two men's games in the South East Australian Basketball League and one game in the BigV men's Championship division. The footage was captured in widescreen with a Canon digital video camcorder (PAL MV850i) from a fixed and elevated (3m) position away (5m) from the half court line and contained offensive patterns of play from all six teams. The sequences were occluded 0.05–0.30 seconds prior to the ball handler commencing their movement with all three possible decision options (pass, dribble, shoot) available (Spittle, Kremer & Hamilton, 2010). The sequences were then shown to three accredited basketball coaches (1 × level 3 and 2 × level 2 Basketball Australia accredited coaches), who ranked pass, shoot, or dribble, in order from best option to worst option, for each clip. All three coaches had to agree on the best option, with two agreeing on the worst option, for the

clip to be included. All rankings made by the coaches on the clips were made without any specific game situation information. This criteria were used to select 21 appropriate clips which consisted of 7 clips where pass was the best option, 7 where dribble was the best option, and 7 clips where shoot was the best option when no game situation information was provided. This was used to determine an expected number of responses in each category for statistical analysis. The final test contained 21 clips with 5 practice clips, with an 8 second presentation of game situation information prior to the clip and a 6 second response period after each clip. In testing, the clips were projected using a Sony 3LCD (XGA VPL-Cx30) digital projector onto a screen that was 1.8m high and 1.45m wide. The participants were seated 5m from the screen. The participants indicated their decision (i.e., dribble, pass or shoot decision) on a response sheet.

The clips were presented to participants under two test conditions: a low decision criticality situation and a high decision criticality situation. Two blocks of the 21 clips were used during testing. For the first block each clip was presented under either the low- or high-decision criticality situation and the same clip was then presented under the converse condition during the second block. Separate randomised sequences were used for each block. The decision criticality situation of the game was indicated prior to each clip via a still screen that provided a description and a "scoreboard" displaying the remaining time and the game score. The game situation information was manipulated according to time and score. For the high decision criticality situations, remaining time consisted of 4 alternative time lengths (60, 30, 20, and 10 seconds). For low decision criticality situations, remaining time consisted of 4 alternative time lengths (5, 10, 15, and 20 minutes). For high decision criticality situations, the score consisted of 5 differentials (2 points ahead, 1 point ahead, score level, 1 point behind, and 2 points behind). For low decision criticality situations, he tscore consisted of 4 differentials (10 points ahead, 5 points ahead, 5 points behind, and 10 points behind). Thus, the high decision criticality situations all involved combinations of remaining time of 60 seconds or less and score differences of 2 points or less and low decision criticality situations all involving combinations of remaining time of 5 minutes or more and score differences of 5 points or more. An example screen description from a high decision criticality situation was "In this clip, there are 10 seconds remaining in the game and scores are level".

Procedure

The participants were briefed on the general purpose of the study and the test procedures. The participants were asked to decide which of the three options they would have executed if they were the player with the ball at the time of occlusion. It was emphasised to the participants that they were not trying to guess what the ball handler on the screen was about to do but what the best option was for them if they were the player in possession of the ball in that situation. All testing was completed in a single session with a duration of approximately 30 minutes. Ethics approval for the study was provided by a University Human Research Ethics Committee and all of the participants provided informed consent prior to testing.

Design and Data analysis

This experimental study incorporated a mixed design that included one repeated measures factor (game situation: low decision criticality, high decision criticality) and two be-

tween groups factors: highest level of basketball competition and main type of sport. Decision profiles were derived from the number of pass, shoot, and dribble responses indicated for the two game situation conditions. The number of dribble, pass and shoot decision responses were aggregated for each block of 21 trials for each of the two criticality conditions and the mean number of each decision type was computed. We used a 2 × 3 within-within ANOVA to assess whether decision profiles varied for the two criticality conditions. Since overall scores for the two conditions were invariant (i.e., always totalled 21), we were specifically interested in the effect of the criticality of game situation (*Criticality*) × decision type (*Decision*). We then used separate 2 × 3 × 2 within-within-between mixed ANOVAs to separately assess the decision profiles for the low- and high-criticality conditions (i.e., the *Criticality* × *Decision* effect) according to type of sport (*Type*: individual vs. team) and competition level (*Level*: none-social vs. domestic-international). To facilitate interpretation we plotted mean scores and 95% confidence intervals and included a reference profile with a value of 7 which represented an equivalent number of nominations for each decision. We used the partial eta squared (ηp^2) statistic to indicate the strength of the effects. All testing was performed using SPSS V17.0 and significance was accepted as $p < .05$.

RESULTS

The mean number of dribble, pass, and shoot decisions for the two criticality conditions are shown in Figure 1. There was a significant main effect for *Decision* ($F(2,316) = 103.42$, $p < .001$, $\eta p^2 = .40$) and a significant *Decision* × *Criticality* interaction ($F(2,316) = 28.69$, $p < .001$, $\eta p^2 = .15$); overall participants indicated fewer dribble decisions relative to pass or shoot for both criticality conditions, but a cross over effect was also observed for pass and shoot so that under the low criticality condition more shoot decisions were nominated and under the high criticality condition more pass decisions were nominated (Figure 1).

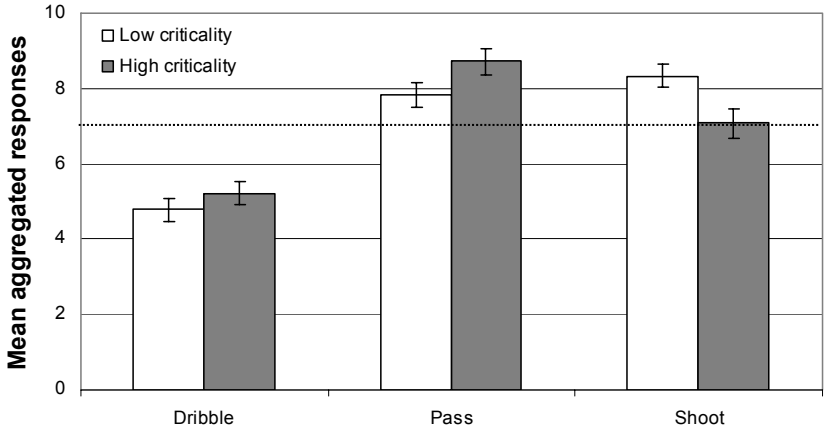

Fig. 1. Mean (± 95% CI) Aggregated Dribble, Pass and Shoot Decisions for Low-Criticality and High-Criticality Game Situations (Reference Line Indicates Expected Number of Responses).

To determine whether the variations in decision profiles across the criticality conditions were moderated by type of sport or basketball competition level, we computed the mean number of dribble, pass and shoot decisions for the two criticality conditions separately. These results are shown in Figure 2a-b.

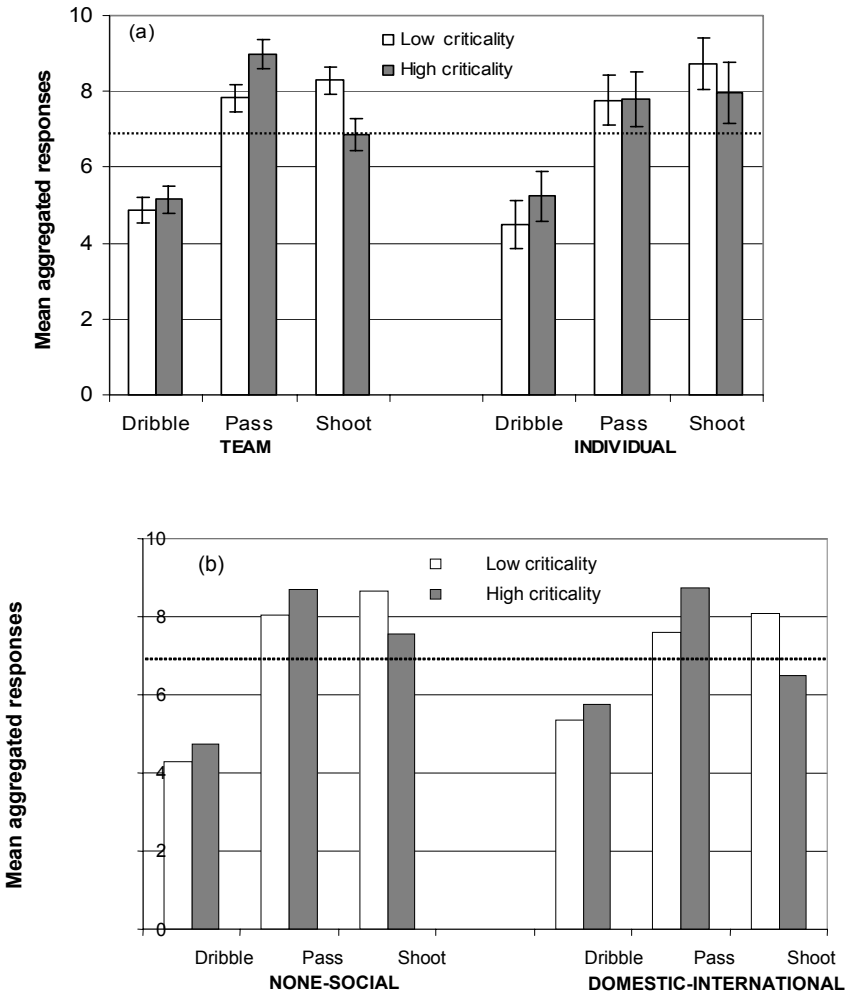

Fig. 2 a-b. Mean (± 95% CI) Aggregated Dribble, Pass and Shoot Decisions for Low-Criticality and High-Criticality Game Situations (Reference Line Indicates Expected Number of Responses) with Type of Sport (a), Basketball Experience (b), and Competition Level (c) Factors.

For type of sport, there was a significant main effect for *Decision* ($F(2,306) = 72.14$, $p < .001$, $\eta p^2 = .32$), and the participants indicated fewer dribble decisions relative to pass or shoot. However, there was some evidence indicating that this overall profile varied for the two sport type subgroups. Although the *Decision* × *Type* effect was not significant ($F(2,306)$

= 2.87, $p = .06$, $\eta p^2 = .02$), the *Decision × Criticality* interaction was significant ($F(2,306) = 13.36$, $p < .001$, $\eta p^2 = .08$). Under the low criticality condition participants nominated more shoot decisions and under the high criticality condition they nominated more pass decisions (see Figure 2a). These effects, however, need to be interpreted in light of the significant three-way effect for *Decision × Criticality × Type* ($F(2,306) = 3.54$, $p < .05$, $\eta p^2 = .02$). This result indicated that for the low criticality condition the team sport subgroup equally nominated more pass and shoot decisions than dribble decisions; however, under the high criticality condition this subgroup indicated more pass decisions than shoot decisions. In contrast, the individual sport subgroup equally nominated more pass and shoot decisions than dribble decisions under both the low and high criticality conditions (Figure 2a).

The results of the competition level analysis failed to show any three-way effects, indicating that the decision profiles across the low and high criticality conditions were not moderated by competition level. There was a significant main effect for *Decision* ($F(2,314) = 104.66$, $p < .001$, $\eta p^2 = .40$) and a significant *Decision × Level* interaction ($F(2,314) = 7.77$, $p < .05$, $\eta p^2 = .05$); overall,the participants indicated fewer dribble decisions relative to pass or shoot. However, this overall profile varied for the two competition level subgroups. The *Decision × Criticality* interaction was significant ($F(2,314) = 29.32$, $p < .001$, $\eta p^2 = .16$), under the low criticality condition participants nominated more shoot decisions and under the high criticality condition they nominated more pass decisions. The three-way effect for *Decision × Criticality × Level* ($F(2,314) = 1.37$, $p > .05$, $\eta p^2 = .01$) was not significant (Figure 2b).

DISCUSSION

This study investigated the effect of game situation information on decision making profiles during a video-based perceptual basketball test. The results indicated that decision profiles did vary according to game situation and that these variations were moderated by type of main sport but not for the highest level of basketball competition. The finding that the decisions made were different under the two game situations highlights that contextual game related information is important to decision making. The participants appeared to take into account the game situation information provided when making a decision, even when they were viewing exactly the same clips. This finding is consistent with evidence from previous studies with baseball umpires (MacMahon & Starkes, 2008) and cricketers (McRobert et al., 2007) which have suggested the influence of priming on perceptual-cognitive performance in video-based tests. This study builds on these findings by determining that the combination of game score and time are important game situation factors in the decision making process in video-based tests.

Possession criticality can change in relation to the game situation (e.g., Bar-Eli & Tractinsky, 2000) and it appears that participants in a decision making paradigm recognise this and this influences their decision making. If the decisions made in task-simulations of perceptual-cognitive performances are influenced, it is important to consider how to incorporate game situation related information into these tasks. Future research should also investigate whether perceptual-cognitive processes such as visual search (e.g., Ripoll, 1991) and anticipation are also influenced. Although there are now a few studies that have explored the influence of other contextual factors related to decision-making, such as fatigue (Pijpers, Raoul, Oudejans & Bakker, 2007), anxiety and stress (McNeil,

Spittle & Mesagno, in press; Vickers & Williams, 2007), and confidence (Jackson, Warren & Abernethy, 2006) these could be explored further (Williams & Ericsson, 2005). Other contextual factors that could influence decision making include an individual's perceptions of their strengths and weaknesses and established team game plans. For example, in basketball a good 3-point shooter is more likely to consider a 3-point shot as a valid option in a video-based perceptual task than a poor shooter from the field. That is, in line with Gibson's (1977, 1979) theory of affordances, the opportunities for action available in a situation may vary because they are dependent on individual capabilities (Fajen et al, 2008).

Interestingly, the decision making profiles differed under low criticality and high criticality, with more pass decisions under high criticality and more shoot decisions under low criticality. This reinforces that the game situation information was taken into account in the decisions made. Perhaps participants made more pass decisions in high criticality decision situations in order to maintain possession of the ball for the team and minimise risk, rather than take on responsibility for shooting. In low criticality decision situations, participants may have felt more security in taking a shot for themselves, minimising the need to pass. This appears to be similar to the findings of MacMahon and Starkes (2008) with baseball umpires and suggests that players or umpires attempt to minimise risk or avoid being the decisive factor in a critical situation. Future research could explore how the decision making process is influenced by decision criticality in relation to risk and risk-avoidance. For example, this could be explored in line with regulatory focus theory and whether players adopt a promotion or prevention focus (e.g., Plessner, Unkelbach, Memmert, Baltes & Kolb, 2009).

Changes in the decision making profiles across the low and high criticality conditions may be moderated by previous sporting experience. The decision profiles across the low and high criticality conditions varied for those involved in team sports but did not for those engaged in individual type sports. Thus, participants with team-based experience under the high criticality condition appeared to be influenced by the game situation, while participants with individual-based sporting experience were not influenced. Significantly, however, decision profiles across the two criticality game situations did not alter for basketball competition levels, suggesting that both higher level and lower level participants incorporated the game-related information into their decisions.

The findings need to be interpreted with a number of issues in mind. First, the number of trials for the two conditions (i.e., 21), while similar to other video-based occlusion studies (e.g., Starkes & Lindley, 1994; Williams et al., 1994; Williams, Ward & Chapman, 2003), was low for any strong conclusions to be made about the effect of the game situation on decision making profiles. Second, the sample comprised a range of experiences and competitive levels and player position was not taken into account in the analysis. Third, the study aimed at exploring differences in decision making profiles, so the accuracy of the decisions was not assessed.

Based on the present findings, it was concluded that the game situation information influenced decision making profiles in a video-based decision making task. This supports the contention that contextual information is important in decision making in sport and should be incorporated into the design of task-simulations of perceptual-cognitive performance in sport. Paradigms that do not incorporate game situation factors are unlikely to provide sufficient information to accurately simulate decision making demands and the affordances available in the actual sport (Fajen et al, 2008; Williams & Ericsson, 2005).

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PODACI IZ IGRE U PROCESU DONOŠENJA PERCEPTUALNIH ODLUKA NA OSNOVU VIDEO ZAPISA: UTICAJ KRITIČNE PRIRODE ODLUKA

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Ovaj rad tiče se uticaja podataka iz same igre, koji se prikazuju uz pomoć preostalog vremena igre i rezultata, na donošenje odluka u okviru perceptualnog testa baziranog na video snimku košarkaške utakmice. Učesnici su bili student osnovnih studija (n=159) koji su gledali ukupno 21 ofanzivnu strategiju u košarci, pod uticajem dva uslova (odluka nije bila visoko kritične prirode; odluka je bila visoko kritične prirode). Da bi se uslovi menjali, pre gledanja svakog video zapisa, učesnicima su ponuđeni podaci o preostalom vremenu i razlici u broju bodova. Situacije u kojima je odluka imala visoko kritičnu vrednost bile su one u kojima je do kraja igre ostalo još 60 sekundi ili manje, a razlika u poenima bila je 2 ili manje. Situacije u kojima odluka nije imala visoko kritičnu vrednosti bile su one u kojima je bilo još minimum 5 minuta igre i razlike u broju bodova bila je 5 ili više. Učesnici su svoje odluke (o dodavanju, šutiranju na koš ili driblingu) davali nakon gledanja video zapisa. Rezultati su pokazali da se profili donetih odluka razlikuju pod uticajem situacija u kojima su odluke bile ili nisu bile kritične. Veći broj odluka o dodavanju donošene su u okviru situacija gde je kritična priroda odluke bila visoka a veći broj odluka o šutiranju na koš u okviru situacija gde kritična priroda odluke nije bila visoka. Ove varijacije zavisile su od tipa sporta ali ne od nivoa na kome je igrana košarkaška utakmica. Zaključeno je da podaci iz igre utiču na process donošenja odluka i da bi ih trebalo uzeti u obzir i u slučaju testiranja uz pomoć video zapisa i u toku samog treniranja.

Ključne reči: *donošenje odluka; perceptualno-kognitivno; kontekst; uslovi igre; kritična priroda*