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INVESTIGATING DECISION-MAKING IN BASKETBALL USING A WEB-BASED TEST

Yuwen Stella Ng[a], John Brian Peacock[a], Kay Chuan Tan[a]

[a] Department of Industrial and Systems Engineering, National University of Singapore, Singapore

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ABSTRACT

This study investigates the decisions made by participants for common basketball game scenarios. A total of 108 participants between 13 to 46 years old completed this test.

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KEYWORDS: *basketball, decision-making, computer, test*

INTRODUCTION

Decision making has been a popular research topic across many disciplines. There are two main theoretical perspectives in decision making research and both hold differing assumptions (1). Decision research first started from the mathematical perspective where theorists explain decision biases with statistical analysis. As such, researchers in this area believe that statistical modeling can help decision makers to select the optimal choices. This perspective is commonly known as the classical theory of decision making (2). However, it was later realized that the classical theory of decision making does not explain human decision making behaviour. Even in situations where decision makers were taught the classical theory of decision making, it was observed that they rarely apply the knowledge (1). Therefore, researchers began to investigate and understand human decision making from a psychological perspective, taking into account the context where a decision is made and the factors that affect decision making processes.

In all areas of their lives, every individual faces various decision making situations. Although most research in decision making focuses on applications with a greater impact, the "scientific study of decision making should have (and could have) applications to all areas of our society" (3). One of the possible applications could be in the area of decision making in sports games. In the world of sports, a wide range of cognitive processes associated with human judgment and decision making is involved and people start to make decisions in sports at a much younger age than in situations where there are more impactful outcomes. This makes the sports arena a potential laboratory that is appropriate for research in decision making. (4)

Therefore, in this paper, we attempt to study the decisions made by people of various ages and levels of experience in a sports scenario.

LITERATURE REVIEW

Decision making is most commonly defined as "the selection of one option from a set of two or more options" (5). Klein (3) discussed two main themes in decision research that was developed by Cohen and Doherty – a formal, mathematical paradigm and a rationalist paradigm. The formal, mathematical paradigm is the classical theory of decision making that considers the probability and value of outcome, while the rationalist paradigm attempts to describe human behaviour in judgment and decision making. The ergonomics perspective of decision making can be classified under the rationalist paradigm. In the field of ergonomics, decision making is seen as "a complex process… (that) involves seeking information relevant to the decision at hand, estimating probabilities of various outcomes, and attaching values to the anticipated outcomes". Thus, decision making "is at the heart of information processing" (6).

Despite being a good source of data for decision making research, there has been relatively little literature on the application of decision making research in sports (4). To date, researchers have studied decision making in various sports such as basketball, soccer, water polo and handball. In 2003, Tenenbaum studied the decision making processes of expert athletes and developed a model to match the stages of decision making with its corresponding cognitive skills (Figure 2.1 illustrates).

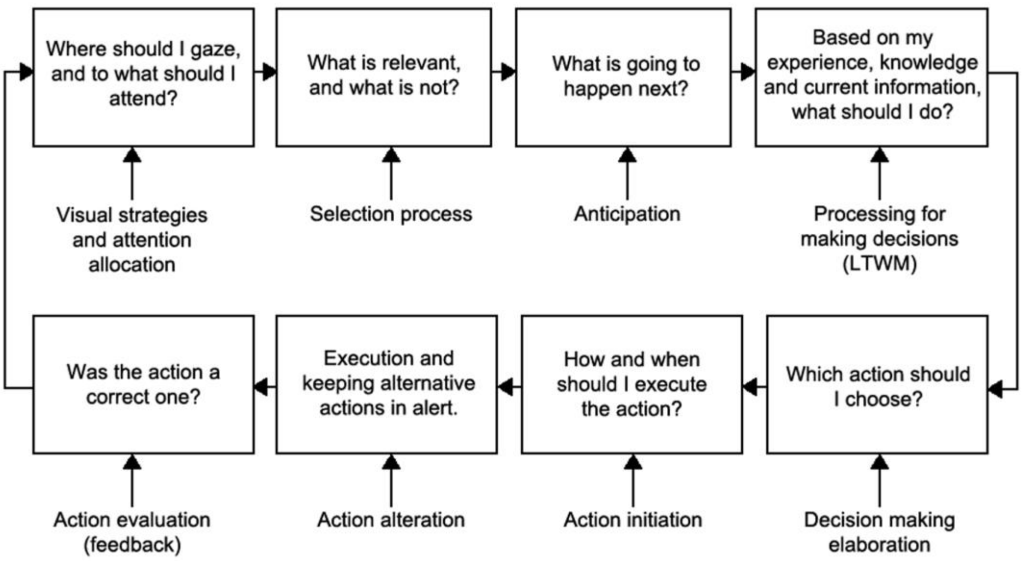

Figure 2.1 A model developed by Tenenbaum (2003, p195) that matches decision types with their respective cognitive components

Tenenbaum (7) explained that there are two types of visual strategies – target- and context-oriented. Novice athletes use more target-oriented strategies as they tend to focus on the target when making decisions. On the other hand, expert athletes use more context-oriented strategies as they tend to look at the "big picture" and consider more of the surrounding factors. As such, expert athletes are able to obtain more information about the situation in a shorter time. In addition, with more experience, expert athletes are more likely to encounter similar decision making situations before and thus, are better able to identify information that are more relevant and predict the next scenario more accurately. It was also noted that experts are able to quickly recognize situations that are similar to their prior experiences. They are also alert to changes in situation and are able to alter their actions even after they have decided.

METHODS

The objective of this study is to investigate how different people of various ages and experience levels make decisions in sports scenarios. In this experiment, it was hypothesized that expert athletes will be more consistent in their decisions than that of the novice athletes, and expert athletes will take less time to decide than novice athletes

.Experimental instrument

For this experiment, the domain of basketball was chosen. The decision making test used was adapted from that developed by McMorris and Graydon (8). In this test, participants are presented with static images of sports scenarios. For each of these scenarios, the participants are required to imagine that they are the player with the ball and decide on their choice of action (hold, pass, dribble or shoot) in the presented situation.

A 3-Dimensional (3D) modeling software, Google SketchUp, was used to develop the static images of 40 basketball scenarios. These 40 scenarios were then presented separately to three expert coaches, each with more than ten years of experience in coaching basketball. The coaches were asked to judge if the scenarios are commonly seen in a game of basketball (i.e., scenario occurs at least once in each quarter of a basketball game) and to choose the action where they think is the best action for each scenario (hold, pass, dribble or shoot). As the scenarios were modeled, there were no references to any players in particular. Coaches can only judge and choose their best action base on the scenario.

Out of the 40 scenarios, 28 were found to be common (judged by all three coaches to be common scenarios). For these 28 scenarios, all the coaches agreed on the same best action for 13 of them. Twenty-three scenarios were used eventually – 3 common scenarios which coaches agreed were used as practice scenarios, 10 common scenarios which coaches agreed were used in the test, and 10 common scenarios which coaches disagreed were also used in the test. The scenarios which the coaches agreed on were considered easy scenarios, while the scenarios which the coaches disagreed were considered difficult scenarios. The test consists of 25 scenarios – 10 scenarios which the coaches agreed on, 10 which the coaches disagreed on, and 5 randomly selected from the 20 scenarios and repeated.

In addition, the coaches were also asked to suggest the possible position played by the player with the ball in each of the scenarios. Thus, we are able to categorize the scenarios if they are more commonly observed for players who play in specific positions (forward, center, guard). If all three coaches suggested different positions for a scenario, that scenario will be categorized as "general".

Procedure

The test was placed on a website (http://enterprise.ise.nus.edu.sg/~stella_ng/bball-dmt/login.php). Participants were able to take the test at any location as long as there is internet access. All test takers were presented with the same scenarios but the scenarios may be ordered differently. There were six different orders of presentation for the scenarios. When the test taker starts the test, he or she would be randomly shown one of the presentation orders. The decision and the time taken to decide for each scenario was recorded and analyzed in this experiment.

Subjects

This online test was made known to primary and secondary schools, junior colleges and various basketball clubs in Singapore via e-mail. The test was available from October 2011 to March 2012 for participants to take the test. Participants did not receive any monetary compensation for the experiment. A total of 108 participants between 13 to 46 years of age, with a mean of 21.5 years, a standard deviation of 8.4 years, took the decision making test voluntarily.

These participants had between 0 to 31 years of experience in basketball (mean = 8.1 years, standard deviation = 7.6 years). The participants were divided into two levels of expertise – novice (5 or less years of experience in basketball), and experienced (more than 5 years of experience in basketball). Thus, 48 of the participants were novices, and the remaining 60 were experienced.

In addition, information on the participants' usual playing position in basketball was collected also. Excluding the participants with no experience in basketball, 8 participants did not have a usual playing position, 22 participants played the center position, 34 participants played the forward position, and 36 participants played the guard position (23 of which are point guards).

RESULTS AND ANALYSIS

Consistency in choice of action

With 108 participants for this experiment, a total of 540 scenarios were repeated and 144 of these repeated scenarios had inconsistent responses. Figure 4.1 shows the frequency of each repeated scenario and the percentage of inconsistent responses for each scenario. Scenarios 1 to 10 are the easy scenarios, while scenarios 11 to 20 are the difficult scenarios. Scenarios 3, 5, and 6 were not repeated. Using the one-factor analysis of variance (ANOVA), the percentage of inconsistent responses for easy scenarios is found to be significantly less than that of the difficult scenarios at an alpha value of 0.05 (F = 6.64, P-value = 0.02).

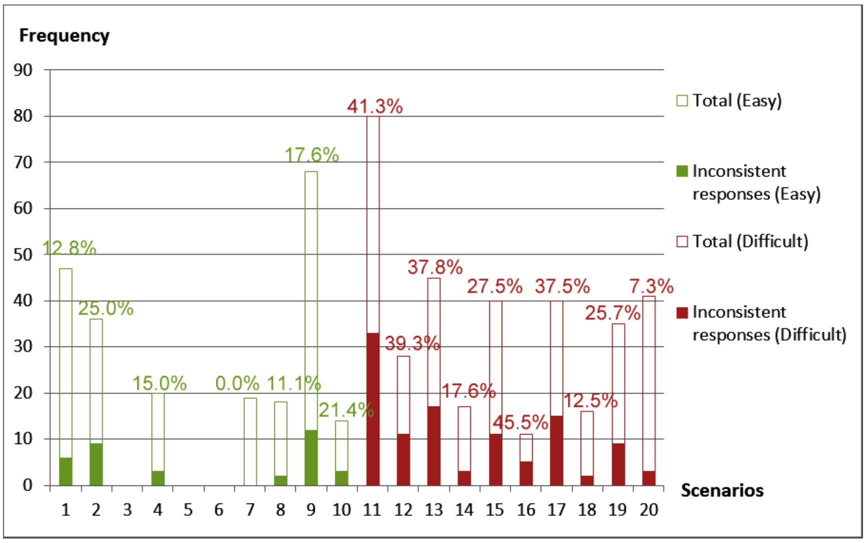

Figure 4.1 Percentage of inconsistent responses for each scenario

Tables 4.1a and 4.1b show the number of inconsistent responses made by each group of participants. Although experienced players made less inconsistent responses than novice players, a one-factor ANOVA showed no significant differences between age groups or experience levels. Therefore, the inconsistencies in responses are more affected by the difficulty of the scenarios rather than age or experience.

Table 4.1a Number of inconsistent responses grouped by age

Age group (years old)	< 16	16 - 20	21 - 25	26 - 30	31 – 35	> 35
Easy scenarios	16	5	5	8	0	1
Difficult scenarios	38	21	21	12	6	11
All scenarios	54	26	26	20	6	12
Number of inconsistent responses per participant	1.35	1.13	1.625	1.43	1.00	1.33

Table 4.1b Number of inconsistent responses grouped by experience

Experience level	Novice	Experienced
Easy scenarios	18	17
Difficult scenarios	54	55
All scenarios	72	72
Number of inconsistent responses per participant	1.50	1.20

Time taken to decide

The time taken to decide was also analyzed by grouping the participants by their years of experience. The fastest time taken by experienced and novice players for each scenario were used to calculate the average fastest timing per scenario.

$$\textit{Average fastest timing per scenario} = \frac{\sum_{i=1}^{20} fastest\_time\_taken\_for\_scenario\_i}{20}$$

Table 4.2a shows the average for the experienced and novice players, as well as the *p*-value obtained using a one-factor ANOVA. Experienced players are found to be significantly faster than novice players at an alpha value of 0.05.

Table 4.2a Average fastest timing per scenario grouped by experience

Experience level	Novice	Experienced	p-value	Test significance
Easy scenarios	2.40 seconds	1.91 seconds	0.013	Significant
Difficult scenarios	2.55 seconds	2.05 seconds	0.015	Significant
All scenarios	2.48 seconds	1.98 seconds	< 0.001	Significant

In addition, participants were grouped according to the usual positions that they play in a game of basketball and the time they took to decide for the position-specific scenarios were compared with the scenarios for other positions. The average fastest timing was also used in this comparison. In the easy scenarios, players actually took more time to decide for the position that they are experienced in (Figure 4.2a illustrates).

In the difficult scenarios, the centers and guards took more time to decide for their position-specific scenarios, while the forwards and controllers took less time to decide (Figure 4.2b illustrates). Contrary to our hypothesis, participants did not make quicker decisions for scenarios that are similar to their playing positions.

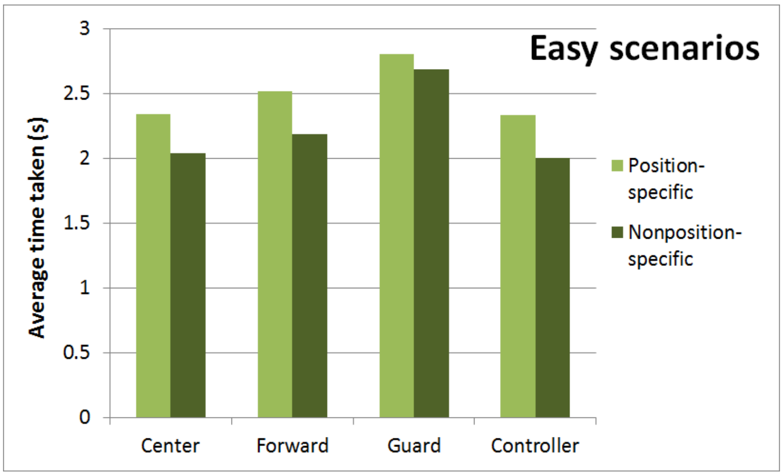

Figure 4.2a Average fastest timing for easy scenarios

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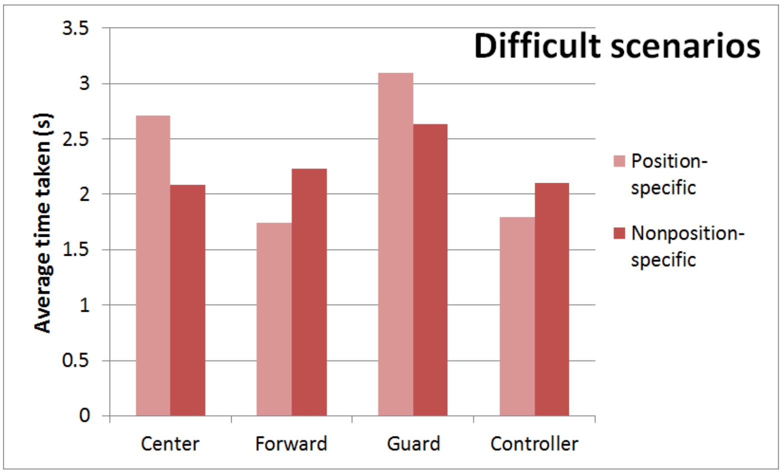

Figure 4.2b Average fastest timing for difficult scenarios

DISCUSSION

In this experiment, we attempted to investigate part of this decision making process – from the visual input, to the selection of cues to attend to in order to anticipate what is likely to happen next, followed by tapping on one's prior knowledge and choosing which action to take. By presenting static images of common basketball scenarios, participants were required to attend to the scenarios presented and choose the action that they are likely to take in a similar scenario. Experienced basketball players were found to take less time to decide than novice players for all scenarios. However, no experience-related effect was observed for scenarios with specific playing position. Also, when comparing the inconsistent responses for repeated scenarios, we found that the inconsistencies are more affected by the difficulty in scenario rather than by age or experience.

In this analysis, the average fastest time taken was used instead of the commonly used average time taken to decide. Unlike most experiments which are conducted in a controlled setting, this experiment was placed on a website where participants were allowed to take the test at any time and location to their convenience. As such, there may be variation in the data collected due to differences in computer processing speed or internet connection. Participants could have also been affected by external factors such as disease, distraction, and motivation.

The use of top records in analysis of human performance is not new (10-16). Tanaka and Seals (15) used running and swimming record timings to assess physiological function capacity (PFC). They noticed that PFC "decreased only modestly until age 60–70 years but declined exponentially thereafter, while Sehl and Yates (17) observed a linear decline in most organ systems of healthy people between the ages 30 – 70 years old. Therefore, we decided to select the fastest timing for each scenario and derive the mean across all scenarios instead.

Human decision making is often illustrated as a sequential process (7, 18, 19). As the decision maker becomes more experienced in making decisions, he or she will then be able to reduce the time taken for each stage of the process and make decisions very quickly. In 1989, Gary Klein (cited from Ross, Klein (20)) described the recognition-primed model to explain how experienced decision makers are able to make decisions in a very short time as they are able to quickly recognize situations that they have experienced before and generate possible courses of action. Instead of having to go through the decision making process stage by stage, experienced decision makers are able to combine and process several stages at once. As such, they are able to greatly reduce the time needed to make decisions. In sports scenarios, experienced players should be able to make decisions for common scenarios very quickly, without conscious effort. Novice players, on the other hand, require more time to comprehend the situation that is still relatively new to them before deciding on their course of action.

The results from our experiment also showed that experienced basketball players did take less time to decide than novice players. However, we did not obtain the same results for position-related expertise. This may be due to the limited sample size as well as the unequal number of data points for each position. Also, as the number of data points within each group is small, we are unable to further categorize the participants by their years of experience in that playing position. There may be more experienced players in one particular position and more novices in another position. Nonetheless, with the small sample size, it was still surprising to note that experienced players actually took longer time to decide for the easy scenarios of their position. Yet, more data will be needed to investigate this observation as the difference is found to be insignificant.

Besides taking less time to decide, experienced decision makers are also expected to be more consistent when deciding on their course of action. As explained by Klein, Calderwood (5), experienced decision makers use their prior experience of similar scenarios as a ‘template’ to assist them in generating possible courses of action. In this experiment, we attempted to investigate the consistency in selected actions by repeating some of the scenarios. Therefore, with repeated scenarios, we expect the experienced basketball players to use the same ‘template’, which results in the same choice of action. From Table 4.1b, it was shown that experienced basketball players did have less inconsistent responses than those of the novice basketball players on average. However, this difference was found to be insignificant.

This experiment is a pilot study to investigate the differences in experts versus novices when making decisions in a sports scenario and it was found that there are indeed differences in the time taken to decide and consistency in selected choice of action. Figures 2.1 and 2.2 show that the decision making process comprises of various cognitive components such as visual strategies, attention allocation, selection process (selecting which cues are relevant), and anticipation (how the situation develops). However, it is unclear exactly how and how much each of these components integrate and contribute to the decision making process.

From the research findings described in this paper, it can be seen that individual cognitive component affects decision making and differences have been observed between various expertise levels. Yet, it is still unknown how the components interact and facilitate the decision making process together, especially when variations in the athletes’ emotional and motivational states are considered. Many tools and methods have been developed to measure and improve various aspects of human cognitive performance (21). For example, situation awareness – the ability of a person to perceive and understand information surrounding his situation – is a critical component of the decision making process (22) and the situation awareness global assessment technique (SAGAT) has been developed to study it. In addition, the Hick-Hyman Law can also be used to study reaction times. Therefore, we can move on from this experiment to investigate the various cognitive components of the decision making process.

CONCLUSION

In summary, by using this test battery adapted from the soccer decision making test developed by McMorris and Graydon (8), it was found that there is indeed a difference in decision making at different experience levels. However, due to a limited sample size, we are unable to study the effects of expertise on decision making within each age group. More work should be done to investigate differences between experts and novices in each age group and investigate the different components of the decision making process.

Moreover, future research can also investigate the components of decision making separately. This can be done by developing a computerized test that incorporates different tools and methods to measure participants' short-term spatial memory, situation awareness, domain knowledge, and learning ability. Participants' decision making performance in an actual game can then be observed by collecting their game statistics as well as getting spectator judgments. Therefore, by linking the results of the computerized test with the actual game performance, we can attempt to derive how much each component contributes to a player's decision making performance in an actual game.

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