Chapter 4

DECISION MAKING AND FATIGUE IN JUNIOR BASKETBALL PLAYERS

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Introduction

As a team ball sport, basketball can be described by the complexity of the interactions of players, where the intention of each team to have the ball to score is omnipresent. Due to these facts and to the dynamics of the game, it is not possible to predict in advance the decisions and the actions of each player (Araújo, Davids, Bennett, Button, & Chapman, 2004; Davids, Button, Araújo, Renshaw, & Hristovski, 2006). In order to have success the athlete has to deal with a high level of unpredictability and variability in the game. Therefore, the capacity to perform multiple correct decisions in a short time period is crucial. These assumptions put a high demand on the potential of adaptation to a reality of ever-changing game.

For a long time, the classic models of motor control and learning (e.g. Schmidt, 1975) proposed several arguments based on central regulatory structures to explain the decisional process. However, these models left much of the dynamics and complexity of the game to be explained.

In contrast, the ecological dynamics approach (Araújo, Davids, & Hristovski, 2006) conceives the tactical actions of the game in a close connection with the context, where the action and the information available have a mutual influence over the decision-making. Commonly the players in the game explore (intentionally) their context so they can
collect relevant information of the ball, colleagues and opponents, to accomplish the task. This tendency to perceive is adjacent to the emergence of other actions in a continuous cyclical relationship that allows a permanent adjustment of the tactical behaviour in the game.

Gibson (1979) defines the possibilities of action, as affordances because they afford an action for the individual, according his specific capacities to perform. Then, affordances can specify the individual's functional behaviour within a dynamical landscape. However, the establishment of an affinity (attunement) to contextual properties and surrounding energy patterns (invariants) is needed for effective perception. In this sense, action plays an important role in perception, so that the individual needs to move in order to perceive effectively.

Therefore, instead of a pre-programmed decision, this approach argues that the decisional process results mainly from the interaction between the individual and his surroundings. Consequently, the decision-making is considered as an emergent process that results from the interaction of several kinds of constraints (organismic, environmental, and task). From a constraints-led approach individuals perform channelled by the constraints that are posed on action, which includes performer's intentions, and not as a result of strict internal representations of the world and of pre-established actions (Araújo, et al, 2004).

According with Araújo (2003) the analysis of the morphological and functional features of the athletes on their intentional actions is primordial to a better understanding of the coordinative processes that support the performance in team sports. A relevant organismic constraint in sport is fatigue, defined as the reduction of performance on a task due to the need to continue working on that task (Reilly, 2003). In collective sports using balls, the influence of fatigue is frequently visible when deterioration in the production of work occurs near the end of the game (e.g. Bangsbo, Norregaard, & Thorsoe, 1991).

However, there have been some studies that suggest a more complex relation between fatigue and performance. An experiment con-
ducted in basketball reveals an improvement in the inter-limb coordination at the end of the match (Cortis, Tessitore, Lupo, & Capranica, 2008). In what relates to fatigue and cognition, recent findings show that fatigue specific to the task facilitates decision-making in skilled players (Royal, Farrow, Mujika, Halson, Pyne, & Abernethy, 2006).

These findings, complemented by the ones of Zanone, Monno and Temprado, (2001) signal a new perspective over the fatigue and cognition issue. Contrary to what would be expected by traditional theories, the deterioration of performance did not occur. Hence, action is not mechanical, or specific to certain anatomical structures, but it is functional in the relation between the individual and the environment to achieve a certain goal (Kugler & Turvey, 1987). The influence of fatigue on the self-organization of decision making towards a task goal is also not clear, particularly in tasks representative of the domain towards which researchers want to generalize their findings (e.g., training session).

In the literature in sport (e.g., McMorris & Graydon, 1996, 1997) static images, representative of typical situations of the game are displayed on a screen, while the athletes, simultaneously, accomplish a protocol on the cycle-ergometer. In addition to the lack of representativeness of the decision-making test, the process to induce fatigue has a modest correspondence to the specificity of the effort that takes place in the game. The way that individual participated in these experimental designs may have constrained the experiencing of a biological and psychological state correspondent to the one of the game, where performer’s skills may be realised.

From this standpoint, the notion of representative design (Araújo, Davids, & Passos, 2007) supports the conceptual model of this study, in what relates to the correspondence of the conditions of the experimental design to the features of the game. The clarification of the effects of fatigue on decision making on a task representative of the training session emerges as the main purpose of this investigation. Therefore, it clearly differs from a line of investigation coherent with
a cartesian dualism, that abruptly separates the physical dimension (body) from the cognitive one (mind).

**Methods**

Six male basketball players, aging between 16 and 17 years old, with six years of deliberate practice, participated in this study. They were studied in three training sessions of three consecutive microcycles, where in two determined moments of each session, played three-against-three games constrained by certain rules as the one on one defensive system and the prohibition of pick and roll. This reduced game is considered by the literature as a sub-system representative of the complex reality of the formal five-against-five game (Oliveira & Graça, 1995). However, the focus of the analysis was placed on the emergent 1-versus-1 situations.

Each session started with warm-up exercises that lasted for 15 minutes. Players were then evaluated over a six minute period about their perceived effort (scale CR10 from Borg, 2001), their anaerobic power following the Bosco, Luhtanen, and Komi (1983) protocol that includes the Squat-Jump test, Counter-Movement Jump test, and 15 seconds vertical jump test. Due to the specificities of the evaluation, only one athlete at a time could be assessed in the ergojump. Consequently, a low intensity basketball task was planned for the waiting period to prevent the recovery of effort.

The next seven minutes were spent on flexibility and joint mobility exercises. Then, there was the main part of the session with 15 minutes of exercises focused on fast break. After this, there were the three on three games, during nine minutes, where the decisional behaviour was recorded, as well as perceived effort and anaerobic power were tested (plus six minutes). Following an effort of replication of variability specific of the basketball game, a change in the composition of the teams was made for the third and the sixth minute (three on three games).
Then, the players played five on five games, first in half-court and then in court, for 15 minutes. Finally, there was a new moment for three-on-three and for the additional assessment, with the same recording and testing mentioned before (Figure 1).

![Figure 1. Description of the tasks performed in the training session.](image)

For the analysis of the decisional behaviour, a conceptual system of game analyses was created, focusing on the characteristics of a goal-directed dynamical system: stability and breaking of stability (e.g., dribble penetration to basket or three-point shot), exploration (e.g., number of dribbling and fake movements), and efficacy (e.g., shots attempted and shots made).

Beyond this, a decisional index was built to evaluate the changes in the quality of decisions taken in the situation of three-against-three, during the training session. Apart from the analysis of the literature in this specific domain, an experienced coach assisted in the preparation of this index that should contain the critical variables for a successful one-on-one situation in basketball. Consequently, the following variables were selected: shots made (SM), shots attempted
(SA), number of ball possessions (BP), number of faults suffered by the attacker (FS) and number of 1vs1 situations occurred (n1x1) in the three-against-three:

Decisional index = 7 (SM/SA) – 0.1 (BP/n1x1) + 0.2 (FS/n1x1)

The main purpose of the one-on-one game situation is to score a shot. If the ratio between the number of shots converted and the number of attempts conducted is large, then the players are performing in a more efficient way. Moreover, the number of ball possessions and the defensive fouls induced by the attacker offensive moves are also other important features relative to the decisional efficacy in the game, but not so important as the ratio mentioned before. Thus, the mathematical weights assigned to the different factors in the index express the relevancy that each one of them takes in a successful one-on-one situation.

Results

In this study 291 situations of one on one were recorded, 147 for the first moment and 144 in the second moment of the training session.

The analysis of the perceived exertion revealed a growth tendency along the moments of the session, from the level of moderate intensity (2.03 for 0.88), in first moment, to the strong intensity (5.17 for 0.79), third moment ($p \leq .001$).

In the Squat Jump test and in the 15 seconds test the medium values obtained in the three moments of training were relatively constant, while in Counter-Movement Jump a small decrease of the jump height was found (38cm to 36.6cm, $p = .284$).

In relation to the stability/instability category of the game analyses, the dribble penetration to basket for a lay-up was the solution most often performed by players (3.11 to 3.50). The second category – ex-
ploration – presented a similar number of dribbling, while variables as fake movements expressed small changes (1.95 to 1.11 \( p \leq .067 \)).

The effectiveness category exposed an increase of the average of points scored (6.34 to 7.94, \( p \leq .066 \)), while all the other variables did not present significant modifications.

An increase of the quality decision index was also observed comparing the first and last moment of training (.31 to .36, \( p = .387 \)). Besides that, the calculation of the effect size (.29) transmitted a moderate effect of the differences relative to the generality of the sample.

**Discussion**

The results suggested a facilitation of the decisional behaviour (efficacy) that expresses a capability to adapt to the increase of the time of exercise (fatigue) by the athletes; in spite of their perception of a significant increase in the intensity of effort. This progressive enhancement in the intensity of the training session was already expected as the literature in this specific domain argues this point of view. The results of the perception of effort test confirmed that the athletes were faced with a high load of training that required adaptation processes to maintain the performance in the session.

Additionally, as the tasks selected to evaluate the impact of fatigue in anaerobic power were specific of the basketball exertion, the athletes may have experienced similar constraints to those that they are used to. As a result, the medium values of the height obtained in the tests remained relatively constant, supporting the argument previously proposed. By this point, we suppose that the players, particularly in the attacking phase, may have been faced with a fatigue condition that induced adjustments in their action systems to achieve the goal.

Apart from the improvement in the ratio between shots attempted and shots made, the decisional index, composed by diverse variables close to the game, also expressed an increasing efficacy along the train-
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These results are coincident with a study conducted in water polo where, in different moments of the training session, was also observed an improvement in the decisional capacity of elite athletes (Royal et al., 2006).

The random variations observed in certain decisional categories may indicate that the improvement of the effectiveness happened from the modification of the coordination processes, which underline the self-organization properties of the individual’s functional systems for the accomplishing of the task. For example, the reduction of the shot fake actions allowed energy saving for other actions that contributed more to goal achievement.

Behind these unsystematic changes there is a tendency for exploratory behaviour that, pressured by a confluence of constraints, may lead to the emergence of stable coordinative patterns. In fact, the connexion between successful one-on-one situations and a certain number of dribbling and fake actions depends on the affordances (Gibson, 1979) that are perceived in the context. Although, this relevant contextual information has to be identified by the athlete in order to have success in their functional behaviour. Additionally, the evolving attunement to this prominent information in the game may have contributed to the better adjustment of the perception-action coupling, expressed in an increase of effectiveness of the actions taken part in the game.

Conclusions

From this study we can suggest that the time of practice influenced the decision-making process. As the training session progressed the individuals demonstrated a capacity to adapt to the evolving modifications in order to fulfil the task. Unlike the generality of research aligned with a mechanistic conception we would presume the performance of the athletes wasn’t affected by the fatigue. In addition, the effectiveness of their actions improved over the session.
Following an ecological dynamics approach the fatigue-performance issue takes on a different, and complex, nature. Instead of linear and causal properties, this rapport demonstrates a self-organization tendency. Here the individual’s entire systems (biological, psychological, physiological) rearrange in a functional mode to achieve a goal.

In this process several constraints, including fatigue, pressured the individual’s action system to organize itself according to a propensity for stabilization. Probably the different systems were able to manage the fewer resources available with parsimony, increasing their efficiency. Therefore, the energy saved may have been channelled to the areas most in need.

From a holistic conception, the athletes’ various systems operate in such a cooperative manner that the emerging coordination patterns induce more effective tactical actions. The development of a perceptual attunement to the salient contextual information may also have conducted to a higher performance. As the time passed, the refinement of the perception-action cycles reflected a more accurate use of the specific invariants and of the actions in the game. The understanding of the decision-making fatigue issue demands a primordial analysis over self organization of the individual’s systems, more than a focus over the mechanism that regulates this specific connection. Despite some of the existing research that contributes for the explanation of these processes, a large window of opportunity is available for a deepening of this topic.

References


