

Article

Factors Used to Make Appropriate Decisions in Youth Categories in Volleyball

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Abstract: The study aim was to examine the associations between the category of play and the factors athletes use to make appropriate decisions. We observed 6567 game actions performed by 144 athletes. All game actions involved appropriate decisions. The study variables were factors on which appropriate decision-making is based (for five game actions in volleyball: serve, reception, setting, attack, block) and game category (Under-14, Under-16, Under-19). Our analysis—using contingency tables, the Chi-square test, and Cramer’s V—revealed a significant association between the two variables across the five actions. In the U-14 category, and sometimes in the U-16 category, it was more frequent than the expected random frequency that appropriate decisions were of low tactical complexity, focused on the performance of the skill, with an attentional focus on close elements, of low risk, and with actions of reduced difficulty and precision. For the U-19 category, it was more frequent than the expected random frequency that decisions were of greater tactical complexity, with an attentional focus on the opposing team, considering more relevant stimuli, with greater risk, and with greater time pressure. There is, therefore, a need for coaches to understand the decision-making skills of athletes from early on, as this will allow them to develop tasks and apply cognitive strategies that are adapted to the level of the athlete and that can ultimately improve decision-making further.

Keywords: teaching–learning process; physical activity; sport; cognitive processes

1. Introduction

The pursuit of efficiency or success in the teaching–learning process is a primary objective in sport. Sports performance is defined as the outcome of a motor action that allows the athlete to express their physical and mental potential [1]. In this way, performance in sport is determined by the interaction of different factors: physiological, technical, cognitive (decision-making and knowledge), and emotional [2]. These factors do not act in isolation but are considered appropriate to be used in multidisciplinary analyses of the different factors that determine sporting expertise [3].

The impact of sports practice on cognitive development is considered to be of fundamental importance in recent trends in sports coaching. Behavioral approaches where isolated technical training is decontextualized (leading to a difficulty in applying training to real-game situations [4]), and which involve a limited training of decision-making skills [5], creativity, and reflection [6], have given way to approaches focused on constructivism and the impact of the understanding of the game. In these approaches, contextualization, practical understanding [7], and the development of cognitive, emotional, and motor skills are given high importance [8].

Athletes often need to be aware of several stimuli in a short period of time and participate in situations where there are many possible response options [9]. In such situations, making appropriate decisions is essential to achieving success or performance [10]. Team sports are complex and require athletes to make decisions in highly dynamic environments in which random and often unpredictable situations occur [11].

From a cognitive perspective, and specifically one based on the paradigm of knowledge and information processing (the Adaptive Control of Thought-Rational Theory—ACT-R, Anderson et al. [12]), it is understood that mental representations between the perception of the stimulus and the selection of the response influence athletes' performances [13,14]. As such, athletes' working memory is a fundamental aspect of decision-making [15]. This working memory is involved in tasks that require attentional and conscious processing [16].

Indeed, various studies have obtained a significant correlation between knowledge and decision-making in sport [17], as well as between knowledge and game performance [18].

Multiple studies based on the expert–novice paradigm have shown that expert athletes possess knowledge that is more organized, sophisticated, and structured than novice players [19,20]. This allows expert athletes to identify and process the most relevant information and thus to conduct faster and more effective decision-making [21].

Athletes' understanding (the representation of problems and strategy planning) of game situations has been analyzed using verbal protocols, notably that of McPherson and Thomas [14]. Specifically, as an indication of explicit knowledge, athletes have been able to verbalize their understanding of the factors they consider when making decisions during a game [22]. In addition to this type of knowledge, athletes also learn via an implicit, unintentional, and automatic process of observing the structural relationship between subject and environment [23]. According to Raab and Johnson [23], "decision-making can be understood as a continuous process that moves from being intuitive and implicit under conditions of high complexity or high temporal pressure, to more deliberate or explicit in less complex situations" (p. 119). Similarly, according to Dreyfus and Dreyfus [24], decision-making is an explicit and conscious process for young athletes, and intuitive when it comes to expert players.

Decision-making is of importance in sports such as volleyball where athletes and teams interact, compete, and cooperate during the development of each game [25]. Volleyball players, who typically have a short time to make decisions [26], must scan and process information from the environment and integrate this with their existing knowledge from past experiences to generate adequate responses [27].

During the decision-making process, athletes have to perceive environmental stimuli by focusing their attention on those most relevant to be processed, and this allows a response to be chosen [28]. In this process, the athletes should perceive and interpret the environmental information regarding their situation in the game, their playmates, and the opponents, while simultaneously performing appropriate actions [29].

Observation has been used frequently to evaluate decision-making in athletes because it allows for a description and analysis of the dynamics that occur in real-game situations [30]. Among observational instruments, those created by French and Thomas [13] for basketball, Nielsen and McPherson [17] for tennis, or Blomqvist et al. [31] and García-López et al. [32] for football are noteworthy. These instruments each analyze the cognitive components of performance obtained by the execution of motor skills. These instruments differentiate between appropriate and inappropriate decision-making, with specific items for different sports dependent on their characteristics. The Game Performance Assessment Instrument (GPAI), produced by Oslin et al. [33] to assess the performance of game behaviors, differentiates between seven factors (with ball: decisions made, skill execution; without ball: adjust, base, support, cover, guard/mark). This measure has been one of the most widely used in educational and sports research in youth categories (for a review see [34,35]).

Using the instruments described above, studies analyzing athletes' decision-making have mostly focused on the frequency of appropriate and inappropriate decisions to assess or evaluate the success of a developed teaching–learning process [36], or the relationship between decision-making and other

variables such as technical execution [37], the performance of game actions [38], the function or role of players [39], the result of the set [40], or motivational variables [41].

Usually, the specific factors that athletes use when making decisions in different game actions have not been considered in studies. An exception to this is the study by Moreno et al. [41], with the same sample of the present study, which tried to characterize the defense action in terms of game, cognitive, and situational variables. The authors of the aforementioned study, at the cognitive level, analyzed what decision-making (appropriate or inappropriate) was like in won and lost sets, and the factors on which appropriate decision-making was most frequently based. We consider that observing and performing a concrete analysis of these factors is relevant and necessary as such information can be widely used to guide the teaching–learning process of cognitive skills in the different stages of sports training.

Accordingly, the aim of the present study was to assess the association between the category of play and the factors athletes use to make appropriate decisions.

2. Materials and Methods

2.1. Design

The present study uses an observational methodology and corresponds, according to Anguera et al. [42], to a nomothetic, punctual, and multidimensional design (considering aspects athletes use to make appropriate decisions on five different game actions).

2.2. Participants

The study sample comprised 6567 game actions with appropriate decision-making. This corresponds to the observation of 144 players from the four highest-ranked teams in the Spanish Boys' Volleyball championships, held in 2018: 53 players Under-14 (U14), 49 players Under-16 (U16) and 42 players Under-19 (U19).

The game actions observed included: 1531 serve, 1668 reception, 549 setting, 1074 attack, and 1745 block.

We conducted a systematic observation of four matches for each of the four highest-ranked teams in the U14, U16, and U19 championships. This involved the Final Phases of these championships.

2.3. Variables and Instruments

The variables considered in the study were (1) the factors used by players to make appropriate decisions across five game actions and (2) the category of play.

The factors used by players for appropriate decision-making are the elements or issues that allow a decision to be considered appropriate. These are measured via multiple items of validated observation instruments.

To measure the factors used by players to make appropriate decisions, we used the Game Performance Assessment Instrument, University of Massachusetts (GPAI) [33]. This measure captures seven dimensions, although only decision-making was assessed in the present study. It differentiates between appropriate decision-making (when the action satisfies one of the established items) and inappropriate decision-making (when the action does not satisfy any of the established items). This study only considered appropriate decision-making. The instruments used to evaluate decision-making in the different game actions have been validated and/or used in previous investigations: serve [43], reception [44], setting [45], attack [43], and block [46].

First, the items of each instrument were ranked according to their decisional difficulty by expert judges [47] from previous studies [48]. Specifically, the measures were sent to a group of 13 expert judges [49] who: (a) were Graduates in Physical Activity and Sport Sciences or Graduates in Primary Education with a specialization in Physical Education, (b) had achieved the highest level of volleyball coaching (Level III Coaches), and (c) had a minimum of 5 years of experience in volleyball training.

These experts were asked to sort the instrument items from least to most difficult, where 1 represents the easiest item in terms of decision-making, and 4 (or 3) represents the hardest item in terms of decision-making. To clarify the selection criteria, the experts were asked to provide a qualitative justification of the item orders. The criteria considered were as follows: stimulus to be attended to, distance to the attentional focus, time pressure, tactical complexity, risk assumed, action difficulty and required precision, and performance of skill.

For a decision to be considered appropriate for each of the game actions, the experts considered the ranked items from the instruments shown in Tables 1–5.

Table 1. Game Performance Assessment Instrument (GPAI) instrument for the serve action [43].

| GPAI SERVE ACTION | |
|-------------------|--|
| 1 | The player sends the ball to players who are weak at serve-reception. |
| 2 | The player sends the ball to attacking players, making it difficult for them to attack. |
| 3 | The player sends the ball to the setter or to areas where it is difficult to perform the different set options. |
| 4 | The player sends the ball to areas of interference between players, near court lines, or areas involving displacement and contact movement by the players. |

Table 2. GPAI instrument for the reception action [44].

| GPAI RECEPTION ACTION | |
|-----------------------|--|
| 1 | The receiver does not contact the ball when it goes off the court. |
| 2 | The receiver adjusts their movement adequately to reach the place and position needed to intercept the ball. |
| 3 | Receiver increases the rate of passes to serves with ease of reception, to favor rapid attacks. |
| 4 | The receiver adequately resolves situations in which the ball is directed to an interference zone between receivers. |

Table 3. GPAI instrument for the setting action [45].

| GPAI SETTING ACTION | |
|---------------------|---|
| 1 | The set is accurate, and the attack is made against a single block. |
| 2 | The set is accurate, and the attack is made without a block. |

Table 4. GPAI instrument for the attack action [43].

| GPAI ATTACK ACTION | |
|--------------------|---|
| 1 | Attack directed to an open area of the opposite half. |
| 2 | Attack directed toward an area that is uncovered or poorly covered by the blocking players. |
| 3 | Attack on the block with the aim of achieving block-out. |

Table 5. GPAI instrument for the block action [46].

| GPAI BLOCK ACTION | |
|-------------------|---|
| 1 | The player does not jump to block in unnecessary situations (when hitting the ball from the ground to one hand, clear pre-cues of a feint jump, finger pass, forearm pass). |
| 2 | The blocker is correctly situated relative to the attacker and adjusts the blocking tempo to that of the attack. |
| 3 | The player removes their hands before the intention of block-out. |

The category of play was defined as the level at which the athletes competed based on their age. It differed between categories Under-14, Under-16, and Under-19.

2.4. Procedure

Observation was conducted after data collection. To ensure the reliability of the recorded data, an observer (a Graduate in Physical Activity and Sport Sciences, National Volleyball Coach Level III, and with five years of experience as a volleyball coach) received training sessions, using over 10% of the sample, following the proposals of Losada and Manolov [50]. For the analysis of the factors on which appropriate decision-making is based (for all five game actions), intra-observer Cohen Kappa values were above 0.81 [51]. To ensure the temporary reliability of the measure, the analysis was conducted on two occasions separated by ten days. Cohen's Kappa values for these analyses were above 0.81.

2.5. Data Analysis

We conducted an inferential analysis using SPSS (IBM SPSS, Armonk, NY, USA) to test the association between the game category and the factors on which appropriate player decision-making is based (for each of the five game actions). This analysis is presented with contingency tables, the Chi-Square test, and Cramer's V values. For all analyses, the level of significance was set at $p < 0.05$.

3. Results

There was an association between the game category and the factors that athletes used to make appropriate decisions in the serve ($\chi^2 = 33.541$; Cramer's V = 0.105; $p < 0.001$), contributing positively: the Under-14 category with factors 1 and 2; and the Under-16 category with factor 4 (Table 6).

Table 6. Contingency table of factors used to make appropriate decisions for the serve.

| | | | Factors Used to Make Appropriate Decisions for the Serve | | | | |
|---------------|--------------------|--------------------|--|------|--------|--------|-------|
| | | | 1 | 2 | 3 | 4 | TOTAL |
| Game category | Under-14 | Count | 50 | 26 | 3 | 442 | 521 |
| | | Expected frequency | 37.4 | 15.7 | 5.4 | 462.5 | 521.0 |
| | | Adjusted residuals | 2.6 | 3.3 | -1.3 | -3.5 | |
| | Under-16 | Count | 15 | 5 | 4 | 437 | 461 |
| | | Expected frequency | 33.1 | 13.9 | 4.8 | 409.2 | 461.0 |
| | | Adjusted residuals | -3.9 | -2.9 | -0.4 | 4.9 | |
| | Under-19 | Count | 45 | 15 | 9 | 480 | 549 |
| | | Expected frequency | 39.4 | 16.5 | 5.7 | 487.3 | 549.0 |
| | | Adjusted residuals | 1.1 | -0.5 | 1.7 | -1.2 | |
| TOTAL | Count | 110 | 46 | 16 | 1359 | 1531 | |
| | Expected frequency | 110.0 | 46.0 | 16.0 | 1359.0 | 1531.0 | |

1 cell (8.3%) has an expected frequency < 5. Minimum expected frequency: 4.82.

There was an association between the game category and the factors that athletes used to make appropriate decisions in the reception ($\chi^2 = 57.849$; Cramer's V = 0.132; $p < 0.001$), contributing positively: the Under-14 category with factor 2; the Under-16 category with factor 3; and the Under-19 category with factor 4 (Table 7).

There was an association between the game category and the factors that athletes used to make appropriate decisions in the setting ($\chi^2 = 9.126$; Cramer's V = 0.129; $p = 0.010$), contributing positively: the Under-14 category with factor 1; and the Under-19 category with factor 2 (Table 8).

Table 7. Contingency table of factors used to make appropriate decisions for the reception.

| | | | Factors Used to Make Appropriate Decisions for the Reception | | | | |
|---------------|--------------------|--------------------|--|-------|-------|--------|-------|
| | | | 1 | 2 | 3 | 4 | TOTAL |
| Game category | Under-14 | Count | 36 | 287 | 3 | 87 | 413 |
| | | Expected frequency | 35.7 | 251.6 | 28.2 | 97.6 | 413.0 |
| | | Adjusted residuals | 0.1 | 4.1 | -5.7 | -1.4 | |
| | Under-16 | Count | 36 | 309 | 49 | 89 | 483 |
| | | Expected frequency | 41.7 | 294.2 | 33.0 | 114.1 | 483.0 |
| | | Adjusted residuals | -1.1 | 1.6 | 3.4 | -3.2 | |
| | Under-19 | Count | 72 | 420 | 62 | 218 | 772 |
| | | Expected frequency | 66.6 | 470.2 | 52.8 | 182.4 | 772.0 |
| | | Adjusted residuals | 0.9 | -5.1 | 1.8 | 4.1 | |
| TOTAL | Count | 144 | 1016 | 114 | 394 | 1668 | |
| | Expected frequency | 144.0 | 1016.0 | 114.0 | 394.0 | 1668.0 | |

0 cell (0.0%) has an expected frequency < 5. Minimum expected frequency: 28.23.

Table 8. Contingency table of factors used to make appropriate decisions for the setting.

| | | | Factors Used to Make Appropriate Decisions for the Setting | | |
|---------------|--------------------|--------------------|--|-------|-------|
| | | | 1 | 2 | TOTAL |
| Game category | Under-14 | Count | 123 | 9 | 132 |
| | | Expected frequency | 113.5 | 18.5 | 132.0 |
| | | Adjusted residuals | 2.7 | -2.7 | |
| | Under-16 | Count | 102 | 15 | 117 |
| | | Expected frequency | 100.6 | 16.4 | 117.0 |
| | | Adjusted residuals | 0.4 | -0.4 | |
| | Under-19 | Count | 247 | 53 | 300 |
| | | Expected frequency | 257.9 | 42.1 | 300.0 |
| | | Adjusted residuals | -2.7 | 2.7 | |
| TOTAL | Count | 472 | 77 | 549 | |
| | Expected frequency | 472.0 | 77.0 | 549.0 | |

0 cell (0.0%) has an expected frequency < 5. Minimum expected frequency: 16.41.

There was an association between the game category and the factors that athletes used to make appropriate decisions in the attack ($\chi^2 = 26.839$; Cramer's $V = 0.112$; $p < 0.001$), contributing positively: the Under-14 category with factor 1; and the Under-19 category with factor 2 (Table 9).

Table 9. Contingency table of factors used to make appropriate decisions for the attack.

| | | | Factors Used to Make Appropriate Decisions for the Attack | | | |
|---------------|--------------------|--------------------|---|-------|--------|-------|
| | | | 1 | 2 | 3 | TOTAL |
| Game category | Under-14 | Count | 203 | 34 | 27 | 264 |
| | | Expected frequency | 175.3 | 46.5 | 42.3 | 264.0 |
| | | Adjusted residuals | 4.2 | -2.3 | -3.0 | |
| | Under-16 | Count | 260 | 58 | 70 | 388 |
| | | Expected frequency | 257.6 | 68.3 | 62.1 | 388.0 |
| | | Adjusted residuals | 0.3 | -1.7 | 1.4 | |
| | Under-19 | Count | 250 | 97 | 75 | 422 |
| | | Expected frequency | 280.2 | 74.3 | 67.6 | 422.0 |
| | | Adjusted residuals | -4.0 | 3.7 | 1.3 | |
| TOTAL | Count | 713 | 189 | 172 | 1074 | |
| | Expected frequency | 713.0 | 189.0 | 172.0 | 1074.0 | |

0 cell (0.0%) has an expected frequency < 5. Minimum expected frequency: 42.28.

There was an association between the game category and the factors that athletes used to make appropriate decisions in the block ($\chi^2 = 66.160$; Cramer's $V = 0.195$; $p < 0.001$), contributing positively: the Under-14 category with factor 1; and the Under-19 category with factor 2 (Table 10). No appropriate decision-making was observed in this action based on the appearance set out in factor 3.

Table 10. Contingency table of factors used to make appropriate decisions for the block.

| | | | Factors Used to Make Appropriate Decisions for the Block | | |
|---------------|--------------------|--------------------|--|--------|-------|
| | | | 1 | 2 | TOTAL |
| Game category | Under-14 | Count | 95 | 352 | 447 |
| | | Expected frequency | 49.4 | 397.6 | 447.0 |
| | | Adjusted residuals | 8.0 | −8.0 | |
| | Under-16 | Count | 51 | 503 | 554 |
| | | Expected frequency | 61.3 | 492.7 | 554.0 |
| | | Adjusted residuals | −1.7 | 1.7 | |
| | Under-19 | Count | 47 | 697 | 744 |
| | | Expected frequency | 82.3 | 661.7 | 744.0 |
| | | Adjusted residuals | −5.4 | 5.4 | |
| TOTAL | Count | 193 | 1552 | 1745 | |
| | Expected frequency | 193.0 | 1552.0 | 1745.0 | |

0 cell (0.0%) has an expected frequency < 5. Minimum expected frequency: 49.44.

4. Discussion

The aim of the study was to analyze the associations between the game category and the factors that players use to make appropriate decisions.

The results showed a significant association between the category of play and the factors that volleyball players use to make appropriate decisions for the serve, reception, setting, attack, and blocking game actions.

These results show an advancement in decision-making difficulty, with decisions based on more basic factors in Under-14 and Under-16, and more complex and advanced factors in Under-19. Specifically, it was more frequent than the expected random frequency that decision-making in Under-14 and Under-16 was dependent on factors relating to the performance of the skill (U-14 reception), attentional focus on the elements close to the player (U-16 reception), low tactical complexity, taking little risk, and requiring little effort and precision (U-14 block, attack, setting, serve). However, it was also more frequent than the expected random frequency that in Under-19 appropriate decisions were dependent on factors of greater tactical complexity (reception), focusing the attentional focus on the opposing team (block), taking care of the most relevant stimuli (setting), involving actions with greater temporal pressure (block; attack), and assuming a greater risk (attack).

These results are consistent with the results of prior studies that studied different volleyball game actions using the expert–novice paradigm. When asked about the factors used to make decisions during games, expert players generate more advanced and sophisticated analyses than novices ([45] in setting). Moreover, experts refer more often to opponent factors ([52], in attack; [20], in serve; [45], in setting). In contrast, novices refer to factors of low tactical quality such as their position on the court or location of the ball [53], or focus on issues related to the performance of the skill [45].

The distinct volleyball game actions considered in this study have, according to Ureña and González [54], a different decision-making level. As such, the serve is considered the action with the lowest demand, as it requires attending to few stimuli and allowing ample time to decide (1–8 s); reception, setting, and attack actions are considered of medium difficulty because the player has tenths of a second to decide, and there are several elements to attend to; and blocking is considered the most difficult action due to the great temporal pressure it involves, and the combinative capacity of the attack, which can cause an error while reading it.

According to Macquet [55], expert volleyball players, when acting in situations with high time pressure, base their decisions on a process of recognizing typical situations where they consider issues such as expectations, key elements, acceptable goals, and typically performed actions. In volleyball, players experience a quick game pace [56] where tempo is an important factor [57]. For example, in the block, where the window to make decisions is short, perceptual mechanisms are crucial for determining successful decision-making [58]. Thus, for this action, achieving a higher percentage of hits relates to the better use of visual pre-cues and the ability to extract relevant information from the

environment [59]. This use of visual pre-cues is different depending on the level of play. In younger categories, players typically have a central fixation on specific stimuli, whereas in older categories, players develop a peripheral awareness, which provides relevant information that can be processed more quickly and which allows them to attend to a greater number of stimuli in situations of high time pressure [60].

The present study provides specific information that is highly relevant for the process of developing decision-making in youth athletes. This information will make it possible to understand the factors that athletes consider in their decisions, and will help to guide decision-making progressively toward other aspects of major tactical complexity that should be considered. For example, to develop decision-making in attack situations, coaches can move from (a) 2vs2 non-blocking tasks in large courts, where free spaces are generated that attackers must explore, to (b) tasks with a variable quality block that must be perceived and exploited by attackers, to (c) tasks that provide an optimal well-formed block and well-defended game area to cause attackers to search for alternative solutions to solve the situation (e.g., block-out).

The main strength of this study is that it is focused on elucidating the specific factors that volleyball players use to make appropriate decisions in different game actions. It implies a contribution to research, and can help to guide the teaching–learning process of decision-making in youth volleyball players. As one of the limitations of the study, it should be taken into account that, due to the characteristics of collaboration–opposition sports, the performance of the athlete in the game situation is conditioned by the opposing team, influencing the action result.

5. Conclusions

In current literature, little attention has been given to observing and analyzing the specific factors that athletes use to make appropriate decisions. This study sought to address this issue.

We identified significant associations between the category of play and the factors that athletes consider to make appropriate decisions. In the U-14 category, and sometimes in the U-16 category, it was more frequent than the expected random frequency that appropriate decisions were of low tactical complexity, focused on the performance of the skill, with an attentional focus on close elements, of low risk, and with actions of reduced difficulty and precision. For the U-19 category, it was more frequent than the expected random frequency that appropriate decisions were of greater tactical complexity, with an attentional focus on the opposing team, considering more relevant stimuli, with greater risk, and with greater time pressure.

This evolution of the decision-making skill as athletes progress through different categories emphasizes the need for coaches to understand the decision-making skills of athletes from early on, thus allowing them to adapt the teaching–learning process to the characteristics and needs of individual athletes. Therefore, it is necessary to use techniques for improving decision-making in young athletes that acknowledge the factors athletes use to make appropriate decisions.

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