ANALYSIS OF THE RELATIONSHIP BETWEEN THE AMOUNT OF TRAINING AND COGNITIVE EXPERTISE. A STUDY OF YOUNG VOLLEYBALL PLAYERS

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ABSTRACT

The main goal of this research was to analyze the relationship between the amount of practice accumulated in training and the level of cognitive expertise achieved by volleyball players who are still in training. Another goal was to determine the number of training hours per week needed to improve knowledge significantly. The study’s sample was composed of 520 volleyball players between the ages of 12 and 16 years. The independent variable was the amount of training, defined as the number of weekly hours that the volleyball player devoted to training. The dependent variable was cognitive expertise, measured by declarative knowledge and procedural knowledge. A univariate analysis of variance was done to examine the relationship between the number of weekly hours and the declarative and procedural knowledge reached by volleyball players in the athletic formation training stages. Statistical significance was set at \( p < 0.05 \). There were significant differences in knowledge according to the number of weekly training hours \( (p < 0.001) \). These results confirm that there is a relationship between the quantity of practice and the development of cognitive expertise. It is recommended that young players dedicate at least 4 hours weekly to training to achieve a significant improvement in cognitive expertise.

KEY WORDS weekly training hours, cognitive paradigm, declarative knowledge, procedural knowledge

INTRODUCTION
Expert performance in sports has been studied based on various paradigms that explain how an individual acquires high levels of expertise. In this sense, the study of sport expertise through the Theory of Deliberate Practice provides relevant information about the processes that take place in an athlete to achieve athletic excellence \( (10,13,18) \). This theory falls within an “environmental” approach, where the underlying idea is that expert performance is influenced by acquired mechanisms and is not the result of genetic inheritance \( (14) \).

The initial studies by Ericsson et al. \( (13) \) established a linear relationship between the amount of practice and sports performance. Today, there is a strong association between the number of weekly training hours and the achievements attained by deliberate practice \( (10,12) \). Thus, athletes who accumulate more deliberate practice hours per week show a higher level of sport expertise \( (5,9) \). With regard to the concept of deliberate practice, there are many factors that interact with each other. That is why it is important to determine how much practice is needed to reach high levels of sport expertise. Within sport expertise, and in collaboration-opposition sports such as volleyball, cognitive factors play an important role \( (36) \), and they are determined by knowledge (declarative and procedural knowledge) and decision making, which are both indicators of cognitive expertise.

From the cognitive paradigm, research has been carried out that associates the amount of practice with knowledge and decision making in sport. Based on these studies, it was established that those athletes who accumulated more training hours in structured activities showed a greater development of knowledge (declarative and procedural knowledge) and greater precision in decision making \( (7) \). Knowledge also influences processes such as attention, visual behavior, anticipation, response selection, and execution. Likewise, the response selection and the execution refine the intermediate processes (anticipation, recognition, visual...
behavior, and attention) and the athlete’s knowledge (23). Applied research in different sports, such as volleyball, tennis, basketball, and baseball, has studied the relationship between cognitive and performance variables. It has established that the knowledge (declarative and procedural knowledge) stored in one’s memory determines the quality of one’s decision making, and this, in turn, influences the increase in sports performance in competition (3,15,31,35).

Different research studies attribute the level of sport expertise to the number of weekly training hours, to the number of games played, to the accumulated experience in games, or to the different types of practice sessions carried out (6,36). Regarding these variables, the trainer should focus their attention on the number of weekly training hours and on the experience accumulated by the athletes in competition because these are the main variables that predict the cognitive expertise in sport (11,19,27,28,34,40).

The main aim of this research was to analyze the relationship between the amount of practice, measured by the number of weekly training hours, and the level of cognitive expertise, measured by declarative and procedural knowledge reached by volleyball players in the athletic formation training stages. Another aim was to determine how many weekly training hours are needed to significantly improve knowledge. The hypotheses of this study are (a) volleyball players in training, who accumulate a greater amount of training practice, will demonstrate higher levels of declarative and procedural knowledge than those players who get less practice, and (b) a minimum number of weekly training hours will be required for the individual to reach a significantly higher level of cognitive expertise.

**METHODS**

**Experimental Approach to the Problem**

A cross-sectional descriptive correlation study was carried out to analyze the relationship between the amount of practice and cognitive expertise.

**Subjects**

The study sample was comprised of 520 individuals between the ages of 12 and 16 years who participated in the Spanish Volleyball Championship in 2010. The protocol was fully approved by the Research Ethics Committee of the University of Extremadura (Spain). All players and their parents or guardians were fully informed about the study, and they signed a consent form.

**Procedures**

The independent variable was the amount of training, defined as the number of weekly hours that a volleyball player devotes to training/practice. Three levels were established: from 1 to 3 hours, from 4 to 6 hours, and 7 hours or more.

The dependent variable was cognitive expertise, measured by declarative and procedural knowledge. Declarative knowledge is defined as the set of attributes and characteristics of an object, event, or idea (2). It is identified with “knowing,” “knowing what,” and “knowing what to say.” It is the information that can be remembered exactly as it was memorized (26,37). In volleyball, knowledge of the dimensions of the court, the position of the players, and the
Characteristics of the ball are declarative knowledge data. Procedural knowledge refers to the knowledge of how to do something. It is defined as a motor procedure (execution of the motor action) and as a response selection procedure (which movement has to be performed in a certain situation) (1). It is identified with “knowing how.” In volleyball, procedural knowledge is represented by action procedures, such as being in a certain area to defend an attack by the opposing team or deciding to serve the ball toward a certain area of the opponent’s court that has less coverage.

The dependent variable was measured by 2 questionnaires, one on declarative knowledge (33) and the other on procedural knowledge (32). Both instruments were prepared and validated based on an adaptation of the original questionnaires by McGee and Farrow (25) to volleyball. The declarative knowledge questionnaire (33) is composed of 24 questions. It is divided into 5 blocks: technique, terminology, rules, general knowledge, and strategy. The procedural knowledge questionnaire (32) is composed of 25 questions. This instrument includes topics related to the tactical behavior of the athlete in different game situations in volleyball: serve, reception, placement, attack, and defense. The measurement of the dependent variables was calculated by the frequency of correct answers achieved by each individual in both questionnaires.

Data collection was done at the team’s lodging site for the competition. The questionnaires were completed by the athletes after a practice session during the 2010 Spanish Volleyball Championship. The 2 questionnaires were presented together in 1 single document, and the procedural knowledge questionnaire was completed first because it required a greater cognitive effort.

Statistical Analyses

Data normality was determined. Three measures (skewness, kurtosis, and the Kolmogorov-Smirnov test with the Lilliefors correction) indicated that the sample distribution was normal. Consequently, the use of parametric statistics was proposed. A descriptive analysis was performed and an inferential analysis by means of a univariate analysis of variance (ANOVA) to examine the relationship between the amount of training (number of weekly training hours) and cognitive expertise (declarative and procedural knowledge) of volleyball players in formative training stages. A Bonferroni post hoc test was carried out to determine the number of hours needed to achieve a significant improvement in cognitive expertise. A 95% confidence interval was calculated, and statistical significance was α < 0.05.

The effect size was also calculated by means of the partial eta-squared (ηp²) to assess the extent of the differences found because this eliminates the influence of the sample size. The statistical analyses were performed with the use of the statistical software package SPSS Version 18.0 (SPSS Inc., Chicago, IL, USA).

RESULTS

Descriptive Analysis

As the number of weekly training hours increase, the declarative and procedural knowledge also increase (Table 1).

Inferential Analysis

A univariate ANOVA was performed to analyze declarative knowledge. The results showed that there are significant differences in declarative knowledge depending on the number of weekly training hours (F2,517 = 12.247; p < 0.001; ηp² = 0.045).

Table 2 shows multiple comparisons for declarative knowledge. Significant differences were found between athletes who trained from 1 to 3 hours per week compared with those who trained from 4 to 6 hours per week and those who trained 7 or more hours per week. No significant differences were found between the athletes who trained from 4 to 6 hours per week and those who trained 7 or more hours per week.

A univariate ANOVA was performed to analyze procedural knowledge. The results showed significant differences in procedural knowledge depending on the number of weekly training hours (F2,517 = 10.827; p < 0.001; ηp² = 0.040).

Table 3 shows multiple comparisons for procedural knowledge. Significant differences were found between athletes who trained from 1 to 3 hours per week and those who trained from 4 to 6 hours or 7 or more hours per week. No significant differences were found between athletes who trained from 4 to 6 hours per week and those who trained 7 or more hours per week.


**DISCUSSION**

The main aim of this research was to analyze the relationship between the amount of practice, measured by the number of weekly training hours, and the level of cognitive expertise, measured by the declarative and procedural knowledge reached by volleyball players in formative training stages. Another aim was also to determine how many weekly training hours are needed to significantly improve knowledge.

The first hypothesis proposed that volleyball players in formative training stages who accumulated more practice in training would show higher levels of declarative and procedural knowledge than those players who accumulated less practice. The results have shown that the participants in this study displayed a progressive increase of both declarative and procedural knowledge the more hours they devoted to volleyball training each week. Consequently, these results confirm the existing relationship between the amount of practice and cognitive expertise.

Our results coincide with previous research studies that have associated the amount of practice with cognitive expertise, determining that the more training hours, the greater development of declarative and procedural knowledge and greater precision in decision making (4,7,38). Thus, based on the data that were obtained, the variable referring to the amount of practice, measured by the number of weekly hours a player devoted to training, behaves as a relevant variable for developing knowledge in volleyball (5,16,20,39).

The second hypothesis of this study indicated that a minimum number of weekly training hours would be necessary for the individual to reach a significantly higher level of cognitive expertise. In this study, the results have shown that at least 4 hours of weekly training are necessary for there to be a significant improvement in cognitive expertise in volleyball players in formative training stages.

Similar results were found by Leite et al. (21). In that study, the amount of practice in the different training stages until reaching specialization was studied. The results showed that players from different sports (roller hockey, volleyball, soccer, and basketball) who reached elite competition devoted at least 5 hours to training each week. Another similar study that was carried out with basketball players (22) indicated that the athletes dedicated at least 5 weekly hours to training during the specialization training stage (aged 15–18 years). Thus, it seems reasonable to suggest that coaches of athletes in formative training stages must devote at least 4 hours a week to sport training, so that their athletes can get closer to the cognitive profile of expert players. This expert profile is characterized by a higher level of declarative and procedural knowledge (8,17,24,29,30). This higher level of knowledge allows athletes to make more tactically appropriate decisions during the competition because they have access to more sophisticated knowledge and they use more specific strategies that allow them to decide and to execute better (28,30).

Finally, more research aimed at analyzing whether the amount of practice is a determining factor in the development of the athlete’s knowledge is necessary. Furthermore, it would be important to combine the study of the amount of practice with the characteristics that determine the quality of practice within the training sessions or with competition experience.

**PRACTICAL APPLICATIONS**

The quantity of weekly practice is a variable that the coach should take into consideration in the planning of sport training. Coaches of athletes in formative training stages should progressively increase their players’ number of weekly training hours, with the intent of reaching a basic level of cognitive expertise that would allow optimal performance in their age group.

The results demonstrate that it is necessary to dedicate a minimum of 4 hours per week to training to achieve a significant improvement in the cognitive expertise that favors adequate decision making by the athlete in competition.

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