Expertise development in sport: contributions under cognitive psychology perspective

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ABSTRACT

Iglesias D, García-González L, García-Calvo T, León B, Del Villar F. Expertise development in sport: contributions under cognitive psychology perspective. *J. Hum. Sport Exerc.* Vol. 5, No. 3, pp. 462-475, 2010. The aim of this paper has been that of revising and updating research about expertise development in sport under the cognitive psychology approach. At first, the structure of sport action in open contexts is analysed, differentiating cognitive and execution components. Secondly, having as a reference frame Anderson's cognitive theory, it is possible to remark the importance of the process of building knowledge as a forerunner variable of ability. Finally, the most relevant and consistent findings about the role of knowledge, technical ability and experience are exposed, as well as their inter-relation effect. Departing from the current state of this matter, the necessity to propose new studies deepening about this area of investigation is suggested, especially about the characterization of practice quality that may contribute to the development of sport ability. **Key words:** EXPERTISE, COGNITION, SPORT.

INTRODUCTION

The level of skill, ability, expertise or performance of human beings when doing sport tasks increase significantly as well as the subject acquires experience and accumulates practice (Ericsson, 2003; Côté, Baker, & Abernethy, 2003; Hodges, Starkes, & MacMahon, 2006). Therefore, one of the biggest worries of researchers is finding how these changes are produced, how a subject evolves from novice to expert, and how we can provoke this evolution effectively dealing with systematic training (Côté, Baker, & Abernethy, 2007; Starkes & Ericsson, 2003; Williams & Hodges, 2004).

Difficulties in expertise development in sport could be explained by means of the Thomas and Thomas analysis (1994), who remark two differentiating factors related to other performance areas. These researchers point out that the development of skills related to movement mean, in a first place, a processing system characterised by a high time pressure activities. This fact is mostly obvious in collective or in high strategy sports, where players have to take fast decisions about their action. Secondly, "knowing when" and "how" doesn't mean taking into account a task in a satisfactory way. Tasks such as chess or solving a mathematical problem are highly correlated to knowing how to solve it and solving it in a practical way. However, in sport, knowing how to solve a playing situation doesn't mean performing it during real game. In other words, a player may have high levels of specific knowledge, but he may also not have any expertise on execution skills (Thomas & Thomas, 1994).

Knapp (1963) stated that ability in team sports is determined by technique and by decision making, being technique the ability to perform the motor component of an action, and being decision making the knowledge needed to choose the right technique according to the particular situation where the playing action is developed. Following this line, it is possible to divide the performance during game play, differentiating cognitive and skill components (Iglesias, Moreno, Santos-Rosa, Cervelló, & del Villar, 2005). Cognitive components include knowledge and decision making, while the skill component is related to motor execution. Consequently, the quality in decision making in a game situation is as important as the motor skill execution, being both key elements to get sport performance (Thomas & Thomas, 1994; Blomqvist, Luhtanen, & Laakso, 2001).

PARADIGM OF KNOWLEDGE. A COGNITIVE APPROACH

At the beginning, the paradigm of knowledge was introduced into the study of human cognitive processes (Anderson, 1982; Chi & Rees, 1983) and later, it was adapted to measure expertise in sport (French & Thomas, 1987; McPherson & Thomas, 1989). Under the cognitive psychology approach, it is considered that decision making is done by means of knowledge structures stored into memory. This approach tries to describe in depth the knowledge structures that lie underlying expert performance (Iglesias, Ramos, Fuentes, Sanz, & del Villar, 2003).

It is suggested that expert players have a more elaborated and sophisticated knowledge than novice players. Experts not only know what to do in a wide variety of situation, but they also know how and when to apply this knowledge and they are able to reproduce it in the appropriate situations (Singer & Janelle, 1999). To support this question some researches analysing differences between experts and novices have been developed about cognitive aspects. Results show that experts differ from novices on the quantity and on the type of knowledge they get, as well as in the way this information is used in decision making (Williams, Davids, & Williams, 1999).

Thomas, French and Humphries (1986) defined sport expertise as a complex system of knowledge productions about the current situation and about past events, combined with the players' ability to develop the required technical skill. Anderson (1987) proposed two types of knowledge: declarative and procedural. Declarative knowledge is the number of adjectives and characteristics we use to refer to an object, event or idea. It is the concept we have about something. It is identified as "knowing", "knowing what". Procedural knowledge is defined as the knowledge about how to act and how to do things ("knowing how"). It is a description about how to do something. Procedural knowledge includes the appropriate selection within the game context (McPherson & French, 1991). Even though it is important to remark that the definition of procedural knowledge is complex because when dealing with motor expertise, as Thomas and Thomas (1994) indicate, the knowledge of "how" can be referred, either to the response selection or to its execution, that is, "doing it". On this way, Thomas and Thomas (1994) establishes a subdivision of procedural knowledge, differentiating response selection procedures and motor procedures. Chi (1978) adds another type of knowledge: strategic knowledge. This refers to the knowledge about rules and general forms of performing (Thomas & Thomas, 1994).

Several authors suggested that a base of declarative knowledge is necessary to develop more complex structures of procedural knowledge (Anderson, 1976, 1982; Chi & Rees, 1983). Following this line, French and Thomas (1987) remark that you must develop a base of declarative knowledge of a sport, before being able to develop good skills in decision making in a suitable way.

This way, as a product of experience, subjects may closely relate both types of knowledge, developing their motor competence (Ruiz, 1995). An appropriate decision making in different game situations is as important as the execution of the motor skills required to perform the decided actions. Those subjects that show a minimum declarative knowledge of their sport, show a low quality in their decisions in real game situations (French & Thomas, 1987). It is possible that a lot of these mistakes observed in young players of different sports, may be the result of a lack of knowledge about what to do in every game situation, that is, the lack of procedural knowledge (French & Thomas, 1987; Thomas & Thomas, 1994).

Given the connection between procedural knowledge and decision making in sport, Thomas and Thomas (1994) point out that the development of this type of knowledge is important and interesting, and it has a great improvement capacity potential. But, how can procedural knowledge be developed? How do age and expertise increase influence on procedural knowledge? Specific studies suggest two approaches (French & McPherson, 1999). Firstly: a determined quantity of declarative knowledge goes before knowledge within a specific area (Anderson, 1982; Chi, 1981; Chi & Rees, 1983), as for example, sport. Declarative knowledge is represented by a number of conditions related to different action options and later related to concrete actions (McPherson & Thomas, 1989). Secondly: having into account that the development of procedural knowledge needs a wide amount of time and practice, there aren't at this moment any direct instrument that let us measure the influence of the factors related to the development of this type of knowledge. Perhaps, the development of procedural knowledge may follow these lines (Thomas & Thomas, 1994): direct instruction (cognitive) about "what" and "how", deductions during the game and observation, trial and error during the game.

Cross-curricular studies have proved that expert players differ from novices in declarative, procedural, conditional and strategic knowledge (Abernethy et al., 1993; Glaser & Chi, 1988; McPherson, 1994). Experts have a wider interrelation among the different types of knowledge, structured into a more hierarchical way and, consequently, an easier access to it (Glaser & Chi, 1988; Sternberg & Horvath, 1995). Experts are faster, better, and they have a more automatic cognitive processing. They are able to

give more appropriate and creative solutions to the problems in a game (Sternberg & Horvath, 1995). Experts have a more abstract representation of game problems, they use different production systems to solve them, and they pay attention to the deep characteristics of the problem. On the other hand, novices respond according to the surface characteristics of that problem (Abernethy et al., 1993; Sternberg & Horvath, 1995).

A novice placer gets into an expert when he develops in a deeper way his specific procedures (French & Thomas, 1987; McPherson, 1999a, 1999b, 2000; McPherson & Kernodle, 2003, 2007; McPherson & Thomas, 1989). Players evolve from prosecuting general objectives (i.e.: fast shoot to the basket) to the planning of more specific objectives (i.e.: feinting to get the ball in a comfortable position and shooting without any opposition). McPherson and Thomas (1989) suggest that novice players make a general approach to the problem because they are still developing their declarative knowledge and skills. Expert tennis players of this study showed in the verbal protocols that, in all cases and when compared with novices: a higher level in concepts, more conditions, more actions, greater flexibility in decision making, faster decision making and greater interconnection of concepts.

Anderson's theory

There are several theories trying to explain how a high level of knowledge is acquired by experts and how they use it in sport. One of the most popular is the Active Control of Thought model (ACT) developed by Anderson (1982, 1983, 1987). From now on some outlines of this theory are going to be developed, departing from the Williams et al. compiling (1999).

Anderson (1983) suggests that human cognition is based upon a series of condition-action connections named productions. These productions are responsible of doing suitable actions under specific conditions. A production is what McPherson and Thomas (1989) named as propositions or conditional statements of the type "IF…, THEN…" between the specific conditions of the context and the execution of the suitable action in that situation.

A production system is composed out of three different types of memory: declarative, procedural and working. Declarative memory is the information about "what to do", while procedural memory has the knowledge about "how to do" something. On this way, the importance of declarative and procedural knowledge is pointed out in sport performance. Working memory has updated information about the accessible systems. This is information, as well as that recovered by the long term declarative memory and that eventual information are stored up by coding processes and production actions.
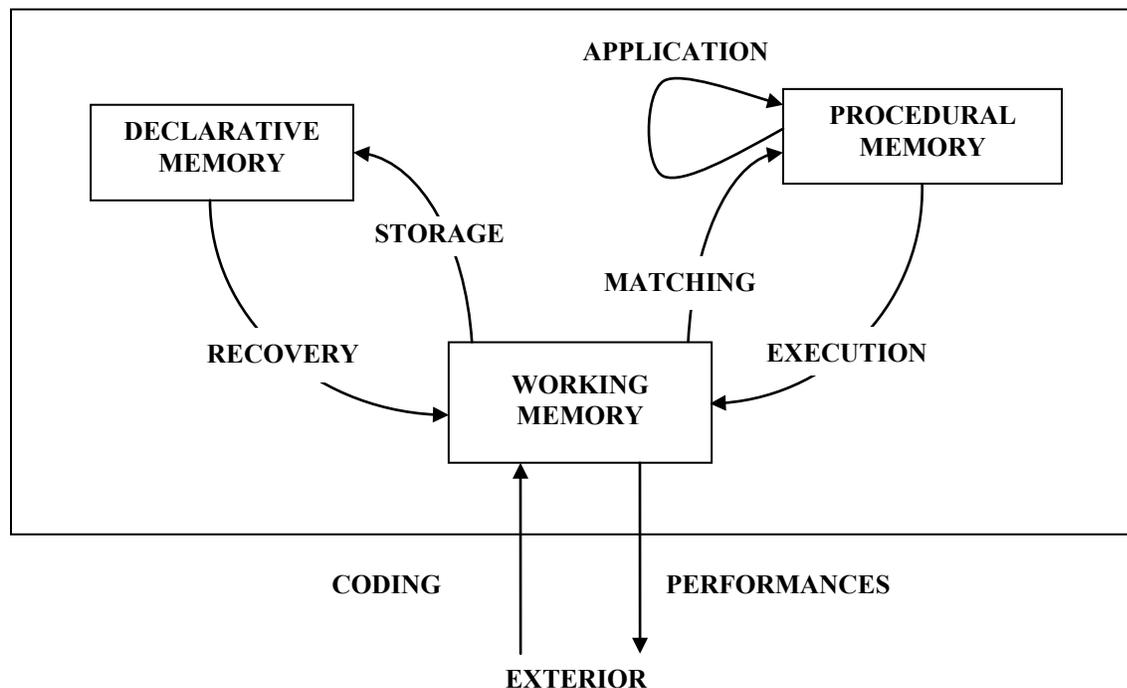
Figure 1. *Model of the ACT system of production, represented departing from its main components and interrelation processes (Anderson, 1983)*

In Anderson's theory, represented in Figure 1, we can identify several processes. As indicated at the bottom of figure 1, the subject has two ways to connect with the outer world. Coding processes let him to put sensory information about the environment into the working memory, while acting processes change these commands, by means of the working memory, into behaviours or actions. On the same way, the working memory is linked to the declarative memory by means of recovering and storing processes. Storing processes are used to create new and permanent registers or files with contents belonging to the working memory and to increase the reinforcement of the already stored registers into the declarative memory. Recovering processes recover information from the declarative memory. Matching processes, represented on the right side of the figure, inform to the production memory about the conditions presented on the working memory. Execution processes transfer the appropriate procedure required as a response to the declarative memory. All this production process by matching and executing is called application. According to Anderson, this process of application shows that the new procedures are learnt by the result of the already existent productions. The result of the performed action as a response informs the executor about if it was suitable or not. In this sense, the executor "learns by doing".

An important aspect of this theory is that expertise is developed by means of control transition, by means of declarative knowledge, towards procedural knowledge control. Anderson (1983) remarks that, initially, all knowledge is coded in a declarative way. You can have access to these declarative codifications, step by step, by a process of limited capacity and under a conscious control (for example, by means of verbal propositions). Consequently, the actions performance requires the working memory to keep the components tasks and their interrelations. By means of practice, the production system develops the replacement of the interpretation of the application process by behaviour procedures in a direct way,

unconsciously. The production system represents procedures of specific tasks in the long term memory, which is activated without needing knowledge about the processes to recover in the working memory. This means a decrease in the number of the production rules required to complete the task.

Declarative knowledge is transferred to procedural knowledge by means of processes of storing knowledge. This is a gradual process where some errors in procedural information happen, which will be corrected with practice. Knowledge compilation has two subprocesses of composition and development of procedures (proceduralisation). The composition process is the combination of sequences of production in unique procedures, which are also stored. This accelerates the process of knowledge compilation, creating new operators that have the sequences of steps used in a particular problem. The process of procedures development deletes data about production conditions that require the matching from the long term memory by means of the working memory. That is, it builds versions of productions that don't need declarative information that has to be recovered from the working memory. The declarative knowledge required is built under a production rule. This supposes a significant advantage for experts, because it implies an increase of the available capacity in the working memory for other functions related to activity (Allard & Burnett, 1985).

Once a production set is created, this is accurated by means of generalisation, discrimination and reinforcement subprocesses. The generalisation subprocess is the development of more flexible productions that may be applied in different situations. Discrimination processes limit the use of a production only in those situations that were previously successful. Reinforcement processes refer to the improvement of the production rule by means of repeating the application, which means that the application time decreases. This process lets the better rules to be reinforced and the worse to be weakened. Finally, the selection of a production rule in a situation is determined by the competition among the different production rules. These rules compete for the activation of the necessary elements for matching. The result of this competition will be strong production, selected among other weaker productions. The successful development of these production systems shows us the important role of "proceduralisation" in expert performance. For this reason, from a practical point of view, the study of the most efficient means to develop these production systems in sport is highly relevant.

Anderson (1983) suggests that the new productions are learnt from the study of the result of the already existent production. By doing a task the acquisition and keeping of declarative knowledge is promoted. It is important to remark that in the ACT theory, the actions refer to the cognitive actions more than to the motor actions. Consequently, "the performance of a task" is only related to the component of response selection. Furthermore, the strict application of the ACT theory to the study of expertise in sport will be incomplete because "the performance of a task" in sport may refer to both the selection of a movement or the execution of a movement (Abernethy et al., 1993; McPherson, 1994).

Finding the relationship between "knowing" and "doing" is a controversial matter among researchers of expertise development in sport. Parker (1989) studied how to determine if the improvement of declarative knowledge of experts is in fact a component of skill or the product of experience and of task exposure. For this study, groups of hockey players, trainers and spectators were required to classify pictures of game phases into conceptual categories (i.e.: counterattacks, defensive strategies, tactical resources, etc). The achieved results showed that spectators were less skilful to identify the predominant game in each pictures, being differences among groups in the pictures categorisation. Expert players and trainers were able to use their current knowledge, developed through game, to interpret what they were watching in those pictures, while novel subjects who saw a great amount of hockey games with a limited game experience , made their

choices only by means of the basic information shown in the pictures. The conclusion is that declarative knowledge is an element of skill more than a result of the time devoted to a particular domain. That is, "knowing" helps "doing".

Allard and Starkes (1991) suggest that if "knowing" and "doing" are related, this connection should also be produced on the other way round. That is "doing" should also help "knowing". Williams and Davids (1995) analysed the importance of the "doing-knowing" connection within the declarative knowledge in football. In that study expert players and physically handicapped spectators participated. They did specific tests on football about remembering, recognition and anticipation. Expert players had an average of six hundred and fifty competition games and they had watched at least fifty, while expert spectators had watched an average of six hundred games and they had never played football. The hypothesis was that expert football players should show a higher knowledge because "doing" helps "knowing". Expert football players showed a better remembering, recognising and anticipation than the group of physical handicapped. The main difference between both groups was that the physical handicapped had only acquired experience by being spectators, while the football players got their experience by means of execution. In other words, the subjects were compared according to their football experience, but achieved in a different way. These findings suggest that "knowing" and "doing" are related, but not only "knowing" influences "doing". "Doing" also helps "knowing".

However, Allard and Starkes (1991) suggest that "knowing" and "doing" aren't directly related by means of the "IF…, THEN..." statements. They point out that "knowing" and "doing" may be influenced in an independent way. Experts not only have a wide declarative and procedural knowledge, they also have better connections between this stored knowledge. These authors suggest that "it is the flexibility of the connection, more than the establishment of stable connections, what is vital for a successful motor performance" (Allard & Starkes, 1991).

CONTRIBUTION OF KNOWLEDGE, TECHNICAL SKILL AND EXPERIENCE

Skill and performance in game are frequently used as synonyms. However, when it is necessary to do research it is possible to remark the division of the term "performance in game" into cognitive components and technical or skills components. Knowledge and decision making are included as cognitive components, while motor execution or the capacity to do sport skills (i.e.: bouncing, passing or shooting) is similar to the word skill (Thomas & Thomas, 1994). The hypothesis is that expertise is additive and game performance may be divided into an easy mathematical operation in which the addition of knowledge and skill equals expertise. However, it is probable that expertise could be something else than a group of components (Thomas & Thomas, 1994).

But, how do age, expertise about development of knowledge and experience influence sport? Experience is usually lineal to age (but not necessarily), and in an analogous way practice, performance and competition. Both knowledge and skill increase as a result of an increase of practice and competition. The idea is that experience is something else than knowledge acquisition and skill acquired by practice. In fact, experience should be the interaction of knowledge, skill and psychological variables. Those subjects that begin in sport practice have a reduced level of game knowledge, and usually a low level of skill. The development of technical skills is slowly developed by means of a great amount of practice. Usually, knowledge is improved in a faster way than skill (French & Thomas, 1987), and both increase with experience since childhood to adolescence.

Execution of technical skills

Technical skills have both a qualitative and quantitative evaluation. The processes of qualitative evaluation try to evaluate the way in which a skill execution is performed. Quantitative evaluation deals with measuring the final result (i.e.: time, distance). There are two important aspects that have to be taken into account when using skill tests. We are referring to the instrument's validity (Abernethy et al., 1993; Johnson & Nelson, 1986; Thomas & Nelson, 1990) and to its suitability to the age of the studied groups.

French and Thomas (1987) measured bouncing and shooting at the beginning and at the end of a basketball season in young players with two different levels of performance, and they made initial comparisons. Expert players were significantly better in shots than the less expert players, despite of their age. Some young players showed higher levels of skill than others older than them. In the case of bouncing, experts had higher marks than novices, but not in a significant way. The fact that the best players have higher levels of skill is not a surprising finding, but the fact that older players (aged eleven and twelve) don't have higher levels of skill than the youngest (aged eight, nine and ten) is remarkable. Basketball players played in the same league and the teams had both experts and novices, all of them belonging to the same age rank. Individual differences and expertise may explain this variability.

There were similar results in a study about baseball players (Nevett, French, Spurgeon, Rink, & Graham, 1993). Age and performance level were significant variables for shooting distance and accuracy.

Another surprising fact found in the French and Thomas (1987) study was that shooting and bouncing skills didn't improve along the season in the case of the younger players. In this case practice didn't bring about an improvement on these variables. Tinberg (1993) studied basketball with players in their fourth and seventh year, remarking the content in their training sessions. Seventh grade players made an average of fifteen shoots per session, independently of their skill level. On the other hand, it could be observed that the best players in fourth grade made an average of thirteen shots per training session, while the worst players made an average of ten shots. If we compare these results with the average results in shot of professional players (about three hundred a day, without including real game), we can face one of the causes that creates performance differences in both experts and novices. But we cannot state that practice by itself could grant skill development (Thomas & Thomas, 1994).

Knowledge and decision making

As pointed before, knowledge is usually categorised into declarative, procedural and strategic (Chi, 1981; French & Thomas, 1987; McPherson & Thomas, 1989; Thomas, Thomas, & Gallagher, 1993). The link between a situation and an action is called procedure, being able to differentiate between motor procedure (movement execution) and response selection (the movement to execute in a given situation) (Thomas & Thomas, 1994).

Response selection is more important in open or high strategy sports, in which an interaction attack-defense appears and in those sports where there is a high demand of constant changes. Knowledge is acquired as a result of instruction and practice. Within a range of cognitive working, knowledge must be perceived as equally reachable by all subjects.

McPherson (1994) proposed that in the process of expertise development, the subject's knowledge may develop a number of transformations:

  – Action plans based on different goal levels, without a hierarchical goal structure, are substituted by conditions and actions that act as decision rules.
  – Weak or inappropriate conditions and actions turn into tactical, refined and associated conditions and actions.
  – Global approximations to sport situations, with a minimum processing of relevant elements in the task, are replaced by more tactical approximations with relevant information (both of past and present events)
  – The processing of environmental events or surface characteristics is replaced by the processing of information in depth, with more tactical levels.
  – The monitoring and planning processes are replaced by specialized controls and higher planning processes (mostly based on conditions)
  – Limited actions without specialized processing are replaced by tactical actions including specialized processes, with the aim of remarking or modifying actions.

Decision making may be evaluated by its accuracy level and speed. Accuracy, understood as the appropiateness-unapropriateness of doing an action in a precise moment, and understood as knowledge, may depend on instruction and practice. Additionally, speed should increase with expertise, but practice doesn't grant a fast decision making (Thomas & Thomas, 1994). Speed in decision making is basic in some sports. There is a traditional belief which says that decisions (response selection) are based on concepts (declarative knowledge) and the more concepts a subject has, the more elaborated procedures (procedural knowledge) will be able to develop. This lets him have an accurate decision making. Although this hypothesis about declarative knowledge is the basis of procedural knowledge has been questioned (Allard, Deakin, Parker, & Rodgers, 1993). In open or high strategy sports, players have to learn individual skill techniques as well as different combinations of skills. This learning process of technical skills is probably similar to the low strategy sports. However, in high strategy sports, players have also to learn to change the roles given by the attack-defence interaction. Consequently, response selection and decision making must be learnt in high strategy sports (Thomas & Thomas, 1994). For young players, knowledge is probably the most relevant factor in game (Abernethy et al., 1993). Knowing what to do is a basic element in young players (French & Thomas, 1987). The problem is how to be able to teach procedures in a short time (Thomas & Thomas, 1994).

KNOWLEDGE DEVELOPMENT, TECHNICAL SKILL AND PERFORMANCE IN GAME

The fact that the older and more experienced subjects in sport get a greater game performance has been suggested by a big number of researches. But, the way these changes happen and their nature might be a more complex problem (Thomas et al., 2001). French and Thomas (1987) and McPherson and Thomas (1989) showed that knowledge in basketball and tennis (declarative and procedural), skills and performance for young experts (aged between eight and eleven) were not only better than novices of the same age but even better than older novices (aged eleven to thirteen).

Later researches, as the one done by French, Spurgeon and Nevett (1995) found out that the execution of technical skills in baseball during the game discriminated among different expertise levels. French, Nevett, Spurgeon, Graham, Rink and McPherson (1996), y Nevett and French (1997) related the practice level in a specific task with response selection in baseball competition. Young expert players showed a higher level of representation in game situations than novices of the same age, but a lower level than older players and "High School" players. French et al. (1996) also pointed that young players had less practice opportunities

during the game (i.e.: they played in the further spaces in the game field) and less game time than older players. Experience and maturity were taken as possible explanations of these findings.

McPherson (1999a) examined technical skills in tennis and problem representation during individual competitions with experts and novices aged ten and twelve, and with adults. The players' competition level, apart from their age, influenced in the task's performance. Despite of age, experts were able to make forceful shots during competition and to supervise successfully their actions to develop solutions or to modify. Behavioural data showed that experts made similar percentages in sophisticated response selection. However, data from interviews show that adults' responses were more sophisticated than those of the younger experts. Young experts have less tactical plans of action, they use less strategic supports and they have less support on context evaluation. Expert adults use their cognitive flexibility in their approaches to game situations. Adult players differ from young players, without taking into account their expertise level, because they use more regulatory strategies (output supervision) than the young players. This is why it is possible that adults use more general approximations to solve game problems. Despite of age, novices didn't use "IF…,THEN…" statements to execute technical skills in games, suggesting that these subjects were beginning to learn basic concepts of tennis competition, before focusing on skill learning (Thomas, Gallagher, & Thomas, 2001).

LINKS AMONG KNOWLEDGE, TECHNICAL SKILL AND GAME PERFORMANCE

French and Thomas (1987), and McPherson and Thomas (1989) found out significant links among knowledge and skill as a component and game performance as another component. In both cases the canonical correlation was 0.70. In the case of the basketball study, knowledge and skills (shooting and bouncing) were significantly related to game performance (decision making and execution). In the case of tennis, there were also found significant links between knowledge and skill, and game performance (decision making and execution). Consequently, it is possible to say that links between knowledge, skill and game performance have been consistent in the studies about these two sports with subjects aged from eight to thirteen. French and Thomas (1987) studied young basketball players (experts and novices) during a season, measuring knowledge, skill and game performance at the beginning and at the end of the season. Only basketball knowledge improved along the season; skill didn't improve. The only measure of game performance that improved along the season was decision making. At the end of the season, knowledge and decision making were the only variables that correlated in a significant way. As a consequence, cognitive components of performance (knowledge about basketball and decision making during the game) seem to improve before skill components (bouncing, shooting and executing). French and Thomas (1987) suggest that these results may be caused by the emphasis of trainers when developing cognitive aspects, taking apart skill aspects.

Young players participating in the French and Thomas (1987) studies and McPherson and Thomas (1989) were interviewed to value their procedural knowledge on basketball or tennis. Verbalisations of interviews were coded according to a specific criterion of analysis. Results suggested that experts had a greater and more complex knowledge, more organised than novices in basketball or tennis. The idea that procedural knowledge is more developed in experts is based on the greater and more varied use of "IF…,THEN…" statements in both sports, and the lack of its use on the part of the novices. McPherson and Thomas (1989) have given empiric support to this idea that says that experts develop "IF…, THEN…" productions. This study stated that the expertise level is the really important thing in the link between "the selection of an action" and "the execution of that action". Young experts disagreed between their skill to select an action and its execution when compared with novices. This happened because young experts made a more

complex action selection which is more difficult to execute. Older experts didn't disagree so much between the selected actions and their execution when compared with young experts, proving that the level of expertise increases with practice and experience. So, we could think that the successful incorporation of the part dealing with "execution" within the simple statements "IF…, THEN…" is the real distinctive of expertise. That is, a higher expertise level is originated from a great number of agreements between "conditions / action selection" and "execution" (Thomas et al., 2001).

The role of experience, understood as a specific practice, has been examined in experts as well as in expertise development. Practice itself doesn't grant expertise. For example, dancers who had a similar experience and practice showed remarkably different expertise levels (Starkes, Deakin, Lindley, & Crisp, 1987). The proposed hypothesis is that quality practice is a factor that may facilitate expertise development (Ericsson & Charness, 1994; Helsen, Starkes, & Hodges, 1998). Although ten thousand hours of practice may be the breaking point in practice quantity to become an expert (Ericsson, 1996), describing the crucial components of quality is even more complex (Thomas et al., 2001), being that a question that has to be solved by research (Baker & Davids, 2007).

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