SOPHIE ISABELLE WOORONS
An Analysis of Expert and Novice Tennis Instructors' Perceptual Capacities
(Under the Direction of PAUL G. SCHEMPP)

The purpose of this study was to examine the differences between expert and novice tennis instructors' perceptual capacities. Specifically, this study investigated how expert tennis instructors' analytical perceptions differ from novices'. Four experts and four novices participated in the study. Both a video analysis and a recall test served as data collection methods for the study. For the video analysis, the participants were asked to describe what they observed while watching a ten minute long instructional video. The recall test consisted of a series of ten tennis related slides. Both experts and novices were asked to recall as much as possible from the slides.

The most striking differences between expert and novice tennis instructors' perceptual capacities were found in (a) their critical analysis (of both motor skill and instruction), and (b) relevance to tennis and tennis instruction. Secondary findings determined a distinct difference in experts and novices' use of inferences, interpretations, evaluations, use of meaningful patterns, understanding of a present situation, and anticipation of future events. The difference between experts' and novices' perception was minimized, however, when an unfamiliar situation was presented to the participants. This finding confirmed the domain specificity of experts' superior perceptual capacities.

INDEX WORDS: Experts, Novices, Expert Teachers, Sport Instruction, Tennis Instruction, Perceptions, Observations, Critical Analysis, Pattern Recognition

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by

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DEDICATION

This work is dedicated to Rene Bavay, who, thanks to his courage gave me a chance to exist, the opportunity to succeed and the strength to stand up through adversity. You have inspired me many times and I owe it to you to achieve any accomplishment that is within my reach, for thanks to you, I was given a chance.

Love,

Sophie.

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CHAPTER 1

INTRODUCTION

Olympians pushing the limits of human performance, medical doctors discovering ways of fighting diseases and increasing life expectancy, teachers' finding new solutions for each child to receive the best education possible; experts in every discipline make a difference in people's daily life. Tan (1997) defined expert performance as "consistently superior performance on a specified set of representative tasks in a specific field of human activity," (p. 30). Experts are the ones who consistently reach a higher level of efficiency in their domain.

Researchers from a wide range of disciplines have focused their attention on expertise, particularly the characteristics that make an individual exceptional in their specialty. Research on expertise has its roots in cognitive psychology. Studies in cognitive psychology provided critical information on the nature of expertise notably in chess (Chase & Simon, 1973; De Groot, 1965) physics, (Coleman & Shore, 1991; Discenna, 1998) mathematics, (Bennet & Sebrechts 1996; Niemi, 1997; Schoenfeld & Herrman, 1982; Staszewski, 1988) social science, (Coughlin, 1994) medicine, (Christie, 1996; Schmidt & Norman, 1990) computer programming, (Anderson, Pirolli, & Farrell, 1988), and music (Standley & Madsen 1991).

The study of expertise in teaching also aroused interest. This trend has led to the emergence of a distinct body of knowledge. (Livingston & Borko, 1989; O'Connor & Fish, 1998; Schempp, Manross, Tan & Fincher, 1998). A series of articles following the

seminal work of David Berliner (1986), identified the characteristics of expert teachers (Borko & Livingston 1989; Lavely, Berger, Bullock, Follman, Kromrey & Sawilowsky, 1986; Tan,1997). Tan (1997) noted that experts possess qualities and attributions that account for their outstanding performances. He believed that experts possess (a) an extensive knowledge base and domain specificity, (b) a hierarchical organization of knowledge, (c) acute perceptual capacities, (d) superior problem representation and problem solving, (e) automaticity of behavior, (f) a superior long- and short-term memory, and (g) self-monitoring skills.

Tan believed that understanding the characteristics of experts would be useful to teachers and coaches striving to improve their practice. Further, researchers have proposed steps for the development of expertise in teaching and coaching (Berliner, 1988; Bell, 1997; DeMarco, & McCullick 1997). Identifying the different stages of the development of expertise promised to guide teachers' progression toward a higher level of expertise.

Compared to the literature on expertise and teaching expertise, studies pertaining to expertise in teaching sport were fairly sparse. Yet, the interest in expertise in physical education and sport pedagogy was flourishing, indicating a growing trend in this field. Recent studies on expert golf instructors (Baker, Schempp & Clark, 1998), physical education teachers (DeMarco, 1998), a dance instructor (You, 1999), and major league batting coaches (Fincher, 1996) were examples of this growing interest.

Among the experts' characteristics consistently found in the literature, experts' perceptual ability had been overlooked and remained an understudied characteristic of expert teachers. Tan (1997) defined experts' acute perceptual capacities as follows:

> Experts see details or information that other people either miss or dismiss. They recognize patterns during their performance that allow them to draw on their sizable knowledge store. This process of pattern recognition involves the identification of critical cues (e.g., words, sounds, movements) as the event or performance unfolds… Experts can quickly extract meaningful chunks of information from often confusing and complex activity… Through observation, experts quickly perceive large clusters of information. Then, drawing from their knowledge stores, they are able to predict the next series of events or can plan an appropriate course of action… The ability to differentiate critical cues in the environment permits them to anticipate likely situations, and to generate contingency plans based on those possibilities. (p. 31-32)

Expert teachers were able to make appropriate self-monitoring decisions due to their perception of student understanding. Chen and Ivegno (2000) confirmed that "in interactive teaching decisions, expert teachers tended to make situational decisions appropriately based on children's responses to learning tasks and adjusted their lesson plans if necessary" (p. 359).

Specific to teaching physical education and sport, Dodds (1994) defined perceptual capacities or observational skills as the capacity to diagnose correct and incorrect movement execution. Pinheiro and Simon (1992) defined perceptual capacities or diagnostic ability as

> The ability to recognize variations from a schema in visually represented examples of a motor skill. To make a diagnosis is to compare the problematic

technique profile with a standard profile in long-term memory, drawn from all the information available as a result of experience and learning (p. 292).

Expert-novice differences in perceptual abilities have consistently been found in the literature (Anderson-Nickel, 1997; Graham, French, & Woods, 1993). Those differences have also been underlined among motor skill experts, physical educators, sport instructors and coaches (Abernethy, Woods, & Parks 1999; Dodds, 1994; Pinheiro & Simon, 1992). Abernethy et al. (1999) reported that experts in motor skills "appear to be reliably discriminated from novices by their ability to quickly and accurately recognize patterns from within their domain of expertise and their ability to anticipate their opponents actions on the basis of limited preview information" (p. 313). Dodds (1994) reported that expert sport or physical education teachers were extremely accurate in their movement diagnoses. In coaching, Pinheiro and Simon (1992) found that expert track and field coaches acquired more cues, made more interpretations and diagnostics decisions, were more accurate, and missed fewer important errors when working with individual performers than did novices.

Identifying expert sport instructors' perceptual capacities is paramount for teachers and coaches to evaluate their students and their own teaching effectiveness. Anderson-Nickel (1997) showed that more experienced teachers were able to predict students' errors, diagnose potential problems and prescribe solutions. The evaluation of students is crucial for teachers to be able to provide accurate feedback and offer refined solutions to instructional problems. Livingston and Borko (1989) believed that acute perceptual abilities also helped instructors plan and teach more effectively. Carter and others (1988) concluded that observational skills were crucial for optimum instruction.

Graham et al. (1993) considered that due to their observational skills, experts were better able to verify student understanding.

Manross and Templeton (1997) focused on physical education teachers and believed that due to their observational skills, expert physical education teachers were able to predict future events and take corrective action if necessary. This idea that experts' perceptual abilities allow them to make inferences about what they see was well supported in the literature (Berliner, 1986; Pinheiro & Simon, 1992; Standley and Madsen, 1991). Consequently, perceptual ability appeared to be an important skill to consider for the development of expertise.

Pinheiro and Simon (1992) believed that the ability to diagnose motor skills was one of the most important competencies of a teacher of physical education and sport. The authors considered perceptual ability to be:

> an essential ingredient of expert coaching and the teaching of coaching, training in cue recognition should form a substantial part of the instructional regimen… Novices must learn to notice at the time of performance precisely how actual performance has departed from the norm (Pinheiro & Simon, 1992, p. 299).

Cushing, Sabers, and Berliner (1992) recognized the importance of expert-novice teachers' studies for teacher training, certification and career ladder plans. Chen and Rovegno (2000) offered a series of suggestions for preservice teachers following their study of expert and novice teachers' constructivist-oriented teaching practices. As for the players, Abernethy et al. (1999) advised that "a fruitful approach would be to train, using sport-specific protocols, those perceptual skills (such as pattern recognition and anticipation) known to reliably discriminate between experts and novices and known,

therefore, to be linked to skill in the sport of interest," (p. 314). Dodds (1994) reinforced the importance of studying observational skills. She considered observational skills to be paramount for expert teachers of movement: "observational (or movement analysis) skills are essential to physical education expertise because a high-priority teaching goal should be improving students' movement skills…. One critical characteristic of expert physical educators is their ability to analyze motor skills qualitatively better than novices could." (Dodds, 1994, p. 157).

The literature portraying tennis instruction is scattered and only few studies relate to expertise in teaching tennis (Lubbers, 1998). Additional research was needed to develop the body of knowledge in sport instruction expertise, notably in tennis. The speed of execution of the athletes' strokes and the importance for the instructor to diagnose potential mistakes led me to believe that perceptual capacities were paramount for expertise in tennis instruction. The determination of a profile of excellence can serve as the basis for the development of expertise. Students will, consequently, have the opportunity to benefit from better instruction. No prior study had directly attempted to examine expert tennis instructors' perceptual capacities, so the present study was a beneficial addition to the body of knowledge in expertise in teaching sport.

The results of the present study may benefit teacher educators and program administrators who are directly responsible for developing and certifying the corps of professional instructors. A thoughtful and thorough study of experts should provide a professional association with the knowledge necessary to design potent certification and teacher development programs. Instructors and teacher educators of other sports should also benefit from this study of expertise in teaching and enhance their own programs and

instruction. The research on expert sport instructors should allow sport teachers to gauge their own practice and provide them with insights for improvement. Berliner (1988) found that "although the expert teacher may not be the ideal mentor, experts can be very good models," (p. 62). In spite of a growing body of knowledge in sport instruction, the need remained for studies of expert instructors in many sports. Abernethy et al. (1999) considered "perceptual skills such as pattern recognition and anticipation to play a key role in expert performance" (p. 313). The present study offered to analyze expert and novice tennis instructors' perceptual capacities.

Definition of terms

Novices were first year professional tennis instructors. They were employed in a tennis club and teach tennis a minimum of 15 hours a week. They had not completed the United States Professional Tennis Registry certification program. Experts were considered the elite in tennis instruction. They consistently performed at a higher level than the rest of the instructors. For this study the criteria of selection of experts had been adapted from Berliner (1986). Experts had a minimum of 10 years of experience, they were certified instructors, had received formal recognition at a regional or national level, and had established consistent record of student performance at the regional or national levels.

Purpose of the study

The purpose of the study was to examine the differences between expert and novice tennis instructors' perceptual capacities. Specifically, this study investigated how expert tennis instructors' analytical perceptions differ from novices'. The study aimed at answering the following questions relating to expert and novice tennis instructors:

1. How do experts' perceptual capacities differ from novices' in matters of selection, detail and relevance to tennis instruction?

2. What are the differences between experts' and novices' inferences, interpretations and evaluations of what they perceive?

3. How do experts and novices differ in their perceptions of meaningful patterns, their understanding of a present situation and their anticipation of future events in tennis motor skill and instruction?

4. What are the differences between experts' and novices' critical analysis and diagnosis of both a motor skill and an instructional situation?

CHAPTER 2

REVIEW OF RELATED LITERATURE

This study examined the differences between expert and novice tennis instructors' perceptual capacities. Specifically, the purpose was to determine how their analytical perceptions differ. The purpose of this chapter was to provide a thorough literature review pertaining to expertise and experts' perceptions with, to begin with, a definition of each concept (i.e., expertise, expertise in teaching). Studies in teaching expertise and expertise in teaching sport found their roots in cognitive psychology. Consequently, works in cognitive psychology pertaining to the study of expertise were reviewed. The chapter then listed common characteristics among experts as identified in the literature. Specifically for this study, the last section of this chapter focused exclusively on experts' perceptions.

Definition of expertise and expertise in teaching

Expertise

Hanninen (1988) referred to expertise as "the possession of a large body of knowledge and procedural skills" (p. 139). For Siedentop and Eldar (1989) expertise corresponded to the following interpretation:

> Expertise is primarily a matter of fine stimulus control. Experts are said to 'see things' that nonexperts don't see… Experts clearly respond more quickly (they have shorter latencies), which Bloom (1986) calls automaticity… Experts clearly have larger response repertoires… Experts clearly are under control of more

complex elements of the stimulus field than are novices… and Experts are plan independent (p. 258-259).

Holyoak (1991) underlined commonalities among experts. This list of characteristics furthered the understanding of what defines expertise:

1. Experts perform complex tasks in their domain much more accurately than do novices.
2. Experts solve problems with greater ease.
3. Expertise is based on automatic evocation of actions by conditions.
4. Experts have superior memory for information related to their domains.
5. Experts are better at perceiving patterns among task-related cues.
6. Expert problem solvers search forward from given information rather than backward from goals.
7. One's degree of expertise increases steadily with practice.
8. Learning requires specific goals and feedback.
9. Expertise is highly domain specific.
10. Teaching expert rules results in expertise.
11. Performances of experts can be predicted accurately from knowledge of the rules they claim to use (Holyoak, p. 303).

Teaching expertise

As for expert teachers, O'Sullivan & Doutis (1994), believed that "expert teachers are virtuosos: professionals who are experts in the content, knowledgeable of their learners and context, sensitive, and socially responsible educators," (p. 179). Dodds

(1994) defined teaching expertise as a global construct that refers to the ease with which teachers perform their work to maximize student learning:

> Expert teachers (only a few reach this pinnacle) teach intuitively, having an overall sense of the situation such that they can respond fluidly without deliberating. They work unconsciously until there is a specific problem on which to focus their analytical skills. They operate a cut above all other teachers, just as expert musicians and sports performers do. (p. 156)

In summary, experts are eminent in their domain. Tan (1997) explained that experts possess qualities and attributions that account for their outstanding performances. He defined experts as the ones who, in their domain, can consistently achieve a superior performance on a specified set of representative tasks.

Studies in cognitive psychology

Cognitive psychology at the origin of research on teaching expertise

Work in cognitive psychology provided the background for research in teaching expertise. Cognitive psychology primarily analyzed decision making and thinking processes. Studies in cognitive psychology revealed precious information regarding experts' understanding processes, learning processes, and knowledge representation. Poon and Rodgers (2000) confirmed that:

> Expertise paradigms have stemmed, by and large, from the theoretical and methodological framework of cognitive psychology. The pattern-recognition paradigm has been used in chess studies (e.g., Chase & Simon 1973) to highlight the expert advantage with familiar and domain-specific structured information. (p.135).

Research in cognitive psychology: findings relating to memory and knowledge

Chase and Simon (1973) offered to examine the structure of short-term memory among chess players. They studied 3 chess players of different levels from novice to master. They concluded that stronger players encoded the information in larger perceptual structures they called chunks. Those differences may be explained by a hierarchical organization of the chunks related to chess skill. Glaser (1987) demonstrated the connection between cognitive psychology and knowledge structure. He found that "investigations of problem solving in knowledge-rich domains show strong interactions between structures of knowledge and cognitive processes" (Glaser, 1987, p. 82). Chi (1981), in her article on knowledge development and memory performance, explained that cognitive development is largely the increment of content knowledge, both declarative and procedural. Her study went beyond past viewpoints that considered the acquisition, production and mediation of strategies as main components of cognitive development. McPherson (2000) attested that:

> How declarative knowledge (facts or concepts) and procedural knowledge (plans, rules, or patterns) develop in knowledge representations and how this knowledge guides the solution processes have also been modeled extensively by other cognitive scientists interested in the nature of expertise. (p. 40)

Cognitive psychology and memory performance: the Ericsson and Polson study

Another study relating to memory performance was Ericsson and Polson's (1988) cognitive analysis of exceptional memory for restaurant orders. Ericsson and Polson did a case study of a headwaiter called JC. They first created a model of JC's memory skills from his thinking aloud. Second, they compared JC to novice waiters. Lastly, their model

of JC's memory skills was tested empirically and examined for generalizability. Findings were that JC's exceptional memory skill was the result of extensive practice. JC's skills matched the Chase and Ericsson (1981) model of skilled memory. This model assumed that "subjects are able to extend their limited short-term memory by using long-term memory with rapid and accurate encoding and retrieval in such a way that the performance characteristics resemble the use of short-term memory by untrained subjects" (Ericsson & Polson, 1988, p. 41). There were five characteristics of skilled memory. First, subjects encoded the present information using existing semantic knowledge and patterns. They divided the information into units or chunks. The number of chunks was limited, due to the capacity of attention, to four or five symbols. Second, the knowledge was rapidly accessible through recognition of retrieval cues associated with the coded information. Third, the encoded information was stored in long-term memory, which was easily accessible even long after initial storage. Fourth, if motivated, subjects could improve, through practice, their speed of encoding. The fifth characteristic of skilled memory was that the acquired memory skill was specific to the stimulus domain used during practice. The theory was supported by empirical studies by Chase and Ericsson (1981, 1982).

Cognitive psychology: theory and models

Abernethy (1994) found that numerous studies in cognitive psychology offered theories and models that were appropriate for the study of sport. He explained that "theories and models of expertise in cognitive tasks in particular are now readily available (e.g., Anderson, 1982; Chi, Glaser, & Farr, 1988; Gilhooly & Green, 1989) and are being increasingly applied to the study of sport (e.g., French & Thomas, 1987;

Garland & Barry, 1990; Vickers, 1988)" (Abernethy, 1994, p 241). In 1966, De Groot introduced the pattern recognition paradigm, and in 1982, Anderson introduced the knowledge-base paradigm. Abernethy, Burgess-Limerick and Parks (1994) acknowledged the effective use of those two paradigms to demonstrate respectively the superior declarative and procedural knowledge of motor experts and the linkage of this knowledge acquisition to performance improvement. Declarative knowledge according to Chi "may be viewed as lexical knowledge or the knowledge of facts" (Chi, 1981, p. 222). Procedural knowledge, on the other hand, "can be characterized as knowledge of rules" (Chi, 1981, p. 222).

Another popular model was the expert-novice paradigm. The expert-novice paradigm was widely used both in cognitive psychology and in pedagogy (Stephich , 1991; Lavely and others, 1986; Leinhart, 1983). Stephich summed up findings in cognitive psychology and "identified differences between experts and novices in three closely interrelated areas: 1. The amount of information stored in memory; 2. The organization of that information; and 3. The methods used to apply that information" (Stephich, 1991, p.14). Lavely, Berger, Bullock, Follman, Kromrey and Sawilowsky (1986) offered a review of empirical literature to explain expert teacher behavior, by analogy, from the cognitive psychology expertise literature. They quoted, from the cognitive psychology literature, the seminal studies from de Groot (1965) and Chase & Simon (1973) in chess, as well as Coleman and Shore (1991) in physics. The paper showed empirical examples which contrasted experts to novices in chess, medicine and physics, bridge, computer programming, counseling, designing, computer software, circuit drawings, mathematics, music, social science, and writing. The authors found

"substantial overlaps between the characteristics of experts vs. novices in cognitive psychology and expert vs. novices in pedagogy" (Lavely et al., 1986, p. 8).

Cognitive psychology and teacher cognition

Leinhart (1983) compared expert teachers to novice teachers and referred to cognitive psychology to determine cognitive skills in teaching. Similarly, Leinhart and Greeno (1986) showed that teaching was a complex cognitive skill similar to others described by cognitive psychology. Frederiksen (1984) realized the implication of cognitive psychology in the understanding of teachers' mental processes:

> Over the last 25 years or so, cognitive scientists have attempted to describe the psychological processes that occur while one reads, plays chess, solves puzzles, or attempts to solve mathematical problems. The result is an information-processing theory of cognition that is seen by some as highly relevant to teaching, as evidenced by the number of edited volumes that deal with the application of cognitive science to instruction. (p. 364)

Livingston and Borko (1989) reinforced this idea and characterized teaching as a complex cognitive skill that was determined in part by the nature of a teachers' knowledge system. Livingston and Borko described expert-novice differences in cognitive structure. They found that "recent research on expert-novice distinctions in teaching suggests that characteristics of expertise in other complex cognitive domains apply to teaching as well. For example, expert teachers notice different aspects of classrooms than do novices, are more selective in their use of information during planning and interactive teaching, and make greater use of instructional and management routines" (Livingston & Borko, 1989, p. 36). Hastie and Vlaisavljevic (1999) reinforced

that for researchers in teaching, the Holy Grail has been the identification of factors that differentiated expert from novice teachers.

Cognitive psychology, summary

In summary, cognitive psychologists provided the background for research on teaching expertise. The previous studies demonstrated that experts encode information in larger perceptual structures they call chunks. Their knowledge, acquired through extensive practice, is organized hierarchically. Experts' knowledge structures are great assets for problem solving and cognitive processes. Their skilled memory requires the use of patterns. Cue perception stimulates the pattern recognition process. The previous studies showed consequent overlaps between the characteristics of experts vs. novices in cognitive psychology and in pedagogy. The expert-novice paradigm is one of the popular models used for research on expertise, notably expertise in pedagogy. The chapter then turned to experts' characteristics and their influence on experts' perceptual capacities.

Experts' characteristics

The study’s theoretical framework: Tan (1997)

Common qualities to experts have consistently been found in the literature. Tan (1997) explained that understanding experts' characteristics and qualities were not sufficient to make one an expert for experts are unique and their thoughts and actions may appear unusual, even idiosyncratic, at times. Nevertheless researchers have been interested in finding consistencies among experts. Tan offered a list of common characteristics found among experts of multiple disciplines. According to Tan, experts possess an extensive knowledge base. Experts make a significant investment in learning all they can about their field. Their knowledge is organized hierarchically. They have

acute perceptual capacities. Experts work forward from known facts to the unknown. Experts show automaticity of behavior. Their automaticity of behavior is the result of years of practice. Experts have extensive memory in their domain. Their knowledge organization together with their automaticity of behavior allows them to focus and remember more of current events. Experts use self-monitoring skills. Specifically, experts are more aware of their errors, they accurately predict which problem will be most difficult. They understand why they fail to comprehend certain elements of the problem. Experts are aware of appropriateness of their solutions; they are able to identify their shortcomings and realize the cause of their failure.

Experts' characteristics across domains

Glaser (1987) listed a series of what he called generalization and speculations on the characteristics of expertise. He found that experts seem to experience:

> A continuous development of competence… expertise seems to be domain specific… the knowledge of experts is highly procedural and goal oriented… the fast-access recognition and representational capability of experts facilitate problem perception in a way that leads to the reduction of the role of memory search and general processing… experts have developed skilled self-regulatory processes… the precision of expert performance results from specialized schemata… the development of expertise is influenced by task demands constrained by environmental requirements. (Glaser, 1987, p. 90-91)

Lavely et al. (1986) found that experts: (p. 90-91)

> Possess more information, both facts and patterns, especially in long-term memory; conceptualize more abstractly; operate semantically rather than

> episodically; construct more complex schema; operate more quickly, both on perception and recall; demonstrate more automatization of routines and control processes; respond with abstract solution procedures rather than respond determined by the entities in the problem statement; think more flexibly; manifest marked chunking, with larger chunks; manifest clear superiority, about 50% more, in achieving criterion, with structured meaningful material. (p. 2)

Berliner (1994) listed 11 expert characteristics:

1. Expertise is specific to a domain, developed over hundreds and thousands of hours, and it continues to develop.
2. Development of expertise is not linear. Non-monotonicities and plateaus occur indicating shifts in understanding and stabilization of automaticity.
3. Expert knowledge is structured better for use in performances than is novice knowledge.
4. Experts represent problems in qualitatively different ways than do novices. Their representations are deeper and richer.
5. Experts recognize meaningful patterns faster than novices.
6. Experts are more flexible, are more opportunistic planners, and can change representations faster when it is appropriate to do so. Novices are more rigid in their conceptions.
7. Experts impose meaning on ambiguous stimuli. They are much more "top down processors." Novices are misled by ambiguity and are more likely to be "bottom up" processors.

8. Experts may start to solve a problem slower than a novice, but overall they are faster problem solvers.
9. Experts are usually more constrained by the task requirements and the social constraints of the situation than are novices.
10. Experts develop automaticity to their behavior to allow conscious processing of ongoing information.
11. Experts develop self-regulatory processes as they engage in their activities (p.163).

Expert athletes' characteristics

Abernethy, Burgess-Limerick and Parks (1999) identified experts' characteristics in motor skills. Motor experts are known to "(a) be faster and more accurate in recognizing patterns; (b) have superior knowledge of both factual and procedural matters; (c) possess knowledge organized in a deeper, more structured form; (d) have superior knowledge of situational probabilities; (e) be better able to plan their own actions in advance; (f) be superior in anticipating the actions of an opponent; (g) be superior perceivers of essential kinematic information; (h) perform in a less effortful, more automatic fashion; (i) produce movement patterns of greater consistency and adaptability; and (j) possess superior self-monitoring skills." (Abernethy et al. 1999, p.186-187). Abernethy indicated that many of those characteristics were consistent with those identified in the cognitive domain. McPherson (2000) explained that "cognitive strategies such as planning, anticipating, focusing, and self-monitoring during competition have been considered important characteristics of elite sport performers by sport psychologists" (p. 39).

Expert teachers' characteristics

Berliner (1986) used the expert-novice paradigm to show features common to expert teachers. For Berliner, experts make inferences of objects and events they perceive. Experts categorize problems to be solved at some kind of higher level than novices do. Experts use higher order systems of categorization to analyze the problem they face. Experts have extraordinarily fast and accurate pattern-recognition capabilities. Experts are opportunistic planners. They also show self-regulatory or meta-cognitive capabilities. Berliner cited skills in planning and using time sensibly as examples of meta-cognitive skills displayed by experts. Their sense of anticipation is also exemplary. Experts are student-oriented. And lastly, they establish routines to facilitate instruction.

Later, Berliner (1988) showed that expert teachers were more likely to discern what is important from what is not in a classroom environment. Berliner provided empirical evidence of expert characteristics--

> Experts, on the other hand, did not demonstrate any confusion or difficulty in making sense of their classroom observations when presented with the videotapes. The experts responded effortlessly and fluidly. They not only made more comments about what was happening, but their comments were more detailed and descriptive than those of the other two groups. The experts appeared comfortable both describing what they observed and interpreting those events on the basis of their experience in classroom instruction and management, (Berliner, 1988, p.46).

Berliner perceived greater uniformity among the interpretations of experts. Experts have the ability to distinguish the typical from the atypical occurrence, paying closer attention to the atypical. Experts evaluate teaching performances, and seem to

combine interpretation with evaluation of the events and behaviors they viewed. Focus on student behavior differentiates experts' from novices' interpretation of classroom events. Further, experts make better assumptions concerning classroom events and student behavior. Berliner explained this phenomenon through experts' experience for experience leads to recognition of similarities. Experts make better use of routines and perform with fluidity. And lastly, experts show more responsibility in their profession.

Pieron (1994) considered teacher enthusiasm to be an important characteristic of effective teachers. Care and compassion, according to De Marco and Hughes (2001), "are no less important than effectiveness and expertise in the promotion of high quality physical education (p. A-62).

Holt et al. (2001) identified characteristics that define "master instructors":

> In terms of personalities, master instructors frequently displayed: sensitivity, they showed an interest in participants away from the organized sport environment and displayed humor, calmness, and seemed to enjoy what they were doing. Many of the teaching practices related to the maintenance of discipline including: setting high standards' making everyone feel part of the group, regardless of ability, and, as a result, rarely having to "get angry" or maintain discipline (A-66).

Housner and Griffey (1985) found that effective teachers "(a) are businesslike and tasks oriented, (b) plan to prevent problems during instruction by anticipating how transitions between activities would be accomplished, and (c) focus feedback on student performance rather than behavior" (p.202).

Chen and Rovegno (2000) noted that findings in research on teaching expertise revealed difference between expert and novice teachers' content knowledge, students'

characteristics, use of routines, decision making and interpretation of classroom events. They found that:

> First, the expert teachers facilitated students' self-responsibility and self-regulation by engaging them in problem solving activities and thinking processes and guiding students in critical thinking about movement quality and elaborating on their limited movement responses. Second, the expert teachers helped students make connections between what they had learned and what they were learning by activating the students' prior knowledge and emerging relevance. Third, the expert teachers facilitated students' social cooperation by establishing and reinforcing the rules for group work and guiding students in discussing and sharing ideas with one another in productive ways (p.369).

Characteristics of expert coaches and sport instructors

Bloom (1997) studied expert team sport coaches during both practice and competition and focused on experts' common characteristics, their knowledge and strategies. He found that the expert coaches were extremely motivated individuals. They also were very efficient organizers. For example, the coaches would share an outline of the objectives of the team so both the coaches and players would effectively comply with the mission of the team.

De Marco and McCullick (1997) identified several characteristics of expert coaches. They found that expert coaches possess extensive, specialized knowledge. They have an unremitting and enduring commitment to their sport. They are committed to gaining expertise. Expert coaches organize knowledge hierarchically. They compare an

idealized performance standard with the present performance of their athletes, and lastly, expert coaches plan and strategize more appropriately and efficiently.

Perceptual capacities, although linked to other characteristics, remain understudied

Finally, the understanding of experts' common characteristics provided useful information for teachers to improve their practice and strive for better performance. The literature considered superior perceptual capacities to be an important characteristic of expertise (Abernethy, Wood, & Park, 1999; Dodds, 1994; Tan, 1997). Nevertheless, experts' perceptions have been understudied. Further studies regarding experts' perceptions were therefore necessary.

Experts' perceptual capacities are linked to other characteristics found in the literature. Extensive knowledge (Johnson, Severance & Feltovich, 1979), knowledge organization (Chase & Simon, 1973), superior memory (Ericsson & Charness, 1994), and automaticity of behavior (Dodds, 1994) are factors that influence experts' perceptions. The literature pertaining to each of these factors was therefore reviewed in relation to experts' perceptions. Ultimately, the body of knowledge referring to experts' perceptions is reviewed through studies on experts' perceptions, expert teachers' perceptions, and expert sport instructors' perceptions.

Experts' knowledge

Experts' knowledge across domains

Vickers (1986) showed that expert-novice differences in knowledge representation had been demonstrated by a number of studies in fields such as "chess (Chase & Simon, 1973), mathematics and physics (Chi, Feltovich, & Glaser, 1981), computer programming (McKeithen, Reitman, Rueter & Hirtle 1981), medical diagnosis

(Johnson, Severance, & Feltovich, 1979), and teaching (Leinhardt & Smith, 1985)" (p. 260). Also, experts have more detailed and richer knowledge bases than do novices. Scardamalia (1994) added that this extensive knowledge and skill allows experts to accomplish, with ease, tasks that nonexperts can do, if at all, only with difficulty.

Knowledge types

Shulman (1987) differentiated seven types of knowledge-- pedagogical content knowledge, content knowledge, knowledge of learners, knowledge of educational content, curricular knowledge, general pedagogical knowledge, and knowledge of educational purposes. Schulman declared that pedagogical content knowledge is the most appropriate for understanding expertise. Lavely et al. (1986) showed that the teacher perception could be derived from four different knowledge categories: "knowledge about pupils in general, general knowledge about particular pupils, specific knowledge about pupils and knowledge related to diagnostic remediation routines" (p. 4).

Knowledge acquired through years of experience

Chi, Glaser and Farr (1988) noted that research has examined expert's domain-specific knowledge, and found that the knowledge-rich tasks exhibited by experts require hundreds and thousands of hours of learning and experience. Dodds (1994) added that experts' knowledge evolved over the years for experts were able to learn from their experiences. She showed that experts were extremely motivated learners who have learned more than others from their past experiences. Schempp, Templeton and Clark (1998) found that experts showed:

> the ability to acquire, retain, recall, and recognize significantly more knowledge about their subject than virtually anyone. The excellence of experts is crafted in

> their extensive knowledge and skills amassed over years of practice. Experts make significant investments in learning all they can about their field. Experts enjoy talking almost endlessly about their subject, gather others' views on pertinent topics, and have extensive libraries devoted to their subject…. Expert performances are not only dependent on how much experts know, but also how they employ a strategy that is best suited to their state of knowledge. Experts are both highly knowledgeable in a particular field and eminently skilled in the application of that knowledge. (p. 2)

Knowledge in expertise in sports instruction

Studies relating to expertise in teaching and coaching physical education and sports also considered extensive knowledge to be characteristic of experts. Housner and French (1994) acknowledged that:

> research indicates that the nature of expertise in teaching physical education is best characterized by its multidimensionality. Expertise in teaching is contingent on the acquisition and application of a complex amalgamation of knowledge and beliefs…. Also included in teacher's knowledge base are beliefs about effective teaching, goals of sport and physical education programs, and social, political, and moral issues. (p. 241)

In their article on expert coaches, De Marco and McCullick (1997) noted experts' thirst for new knowledge. Experts were more attentive to what they could learn from other successful coaches. They read more about their subject, hence they had impressive libraries and journal collections. They knew where to find new sources of knowledge (i.e. videotapes, clinics, and seminars).

St. Pierre, Spencer and Woorons (2000) studied expert tennis instructors' sources of knowledge. Teaching experience and interaction with other teachers were established as primary sources of knowledge. Students, playing experience, workshops, certification programs and formal education were secondary sources. Those results were consistent with Schempp, Templeton and Clark's (1998) findings on expert golf instructors.

Schempp, Templeton and Clark (1998) studied experts' knowledge sources. They found expert golf instructors' sources of knowledge to be-- other teachers, their own teaching experience, books, students, workshops, certification programs, playing experience, journals and magazines, films and videos, formal education, and popular media. The authors concluded that the knowledge sources were people oriented since other teachers and students were the primary sources for knowledge. Comparatively, Fincher and Schempp (1994) agreed that physical education teachers considered teaching experience to be a prime source of knowledge. But how do experts organize their extensive knowledge?

Experts' knowledge organization

Knowledge organization: a rich structure

Chi, Glaser and Farr (1988) mentioned that the learning and thinking of experts were processes that required a rich structure of domain specific knowledge. Glaser (1987) defined knowledge structure as the organization of the content of knowledge. He believed that "complete knowledge of a domain, if not organized, cannot constitute expertise" (p. 83). Interest in understanding knowledge structure have attracted diverse fields. Indeed, Glaser (1987) mentioned artificial intelligence-- "in the area of artificial intelligence, the

problem of understanding intelligence has become increasingly focused on large structure of domain specific knowledge that is characteristic of experts" (p. 84).

Expert athletes' knowledge organization

Poon and Rodgers (2000) found direct implications of knowledge organization in the segmentation of new routines of novice and advanced dancers. Indeed, not only did advanced dancers organize their routines in fewer but larger segments of movements than novices but "advanced dancers segmented the routines in a dance-specific manner, demonstrating more domain-specific knowledge" (Poon & Rodgers, 2000, p. 140).

Knowledge organization for better problem solving

Another benefit of knowledge organization is that it generates better problem solving abilities. This problem solving ability should be an enhancing factor for experts' analytical perceptions, specifically their problem diagnoses. Problem diagnosis is one of the factors involved in expert perceptions. Chi, Glaser and Farr (1988) confirmed that "investigations into knowledge-rich domains show strong interactions between structures of knowledge and processes of reasoning and problem solving" (p. xxi). Charness (1981) found that "chess skills depends on a large knowledge base that consists primarily of a store of patterns or chunks that are associated with plans or plausible moves. Plausible moves are evaluated through a search procedure that was described initially by de Groot (1965) as progressive deepening," (p. 467).

Consequently, Anderson (1977) reflected on the implications of the concept of schema for education and proposed that "one of the important benefits of schooling may be to equip the student with knowledge, often not directly reproducible in sentences,

which provides him or her with a framework or context for interpreting new experience" (p. 416).

Knowledge structure and perceptual capacities

Chase and Simon (1973) demonstrated the connection between knowledge structures and perceptual capacities. They found that chess masters encoded information about a position in chunks. Two different types of chunks are identified with empirical evidence that the chunks are about the same size in perception tasks and in memory tasks. Yet in chess, the difference is in the ability to perceive quickly, (speed of chunks used for perception tasks) and recall extensive amounts of information, (size of chunks used in memory tasks). The authors concluded that stronger players encode the positions into larger perceptual chunks and that there are more chunks in recall for the stronger players. A hypothesis is drawn on the hierarchical organization of the chunks related to chess skill. Stepich (1991) reinforced this idea and found that:

> Experts organize information in terms of 'large scale functional units', (Larkin, 1979) or schemata (Rumelhart, 1980) that connect related information and allow the expert to make accurate inferences and predictions. These large-scale functional units facilitate problem solving in two ways: 1. They allow the expert to select the conceptual principal that is most relevant to a particular problem, which quickly narrows the definitions of the problem and the search for a solution; and 2. They allow the expert to execute logically related steps as a unit, which speeds the execution of the response (p. 15).

Expert-novice differences in knowledge organization

Experts and novices differ in their ability to organize their knowledge. Chi, Glaser and Farr (1988) noted the difference between experts and novices' knowledge and interpreted "these differences as primarily reflecting the experts' possession of an organized body of conceptual and procedural knowledge that can be readily accessed and used with superior monitoring and self-regulation skills," (p. xxi). Graham, French and Woods (1993) provided empirical evidence of experts' greater stores of appropriate knowledge as well as their more efficient knowledge organization. Lavely et al. (1986) found that experts construct more complex schema than do novices.

Knowledge organization in teaching expertise

Expert-novice teachers' knowledge organization

Ethell and McMeniman (2000) noted that the literature predominantly differentiates experts and novices with regard to their cognition and knowledge organization. They found that "in comparison to novices, expert teachers have a larger knowledge base from which to draw; they organize their knowledge more efficiently in complex interconnected schemas and utilize it more effectively" (Ethell & McMeniman, 2000, p. 88). Livingston and Borko (1989) considered teaching as a complex cognitive skill and one of the major components of this statement is that expert teachers possess an abstract knowledge structure also called schema-- "the cognitive schemata of experts typically are more elaborate, more complex, more interconnected, and more easily accessible than those of novices," (p. 37).

Leinhardt and Greeno (1986) hypothesized that teacher's agenda, including the lesson plan, activity structures and routines are part of the schemata in the teacher's

general knowledge base. Borko and Livingston (1989) added that "the quick and efficient planning reported by the expert teachers would be a result of having well-developed and easily accessible schemata for teaching," (p. 482). They provided empirical evidence showing that experts' are quicker and more efficient than novices in their planning because they "are able to combine information from existing schemata to fit the particulars of a given lesson…Experts' knowledge systems are structured to provide a framework for determining what information is relevant to their planning and interactive decisions and what information can be ignored" (Borko and Livingston, 1989, p. 490-491). The authors concluded saying that novices' cognitive schematas were less sophisticated and interconnected than experts'. Borko and Livingston considered knowledge organization to be a central characteristic of expert teachers. They found teaching to be a complex cognitive skill that required the use of schema. They defined schema and a script reciprocally as "an abstract knowledge structure that summarizes information about many particular cases and the relationships among them … and a knowledge structure that summarizes information about familiar, everyday experiences" (Borko & Livingston, 1989, p. 475).

Sabers, Cushing and Berliner (1991) reinforced the idea that "many differences in the thinking and actions of novice and expert teachers can be accounted for by assuming that novices' cognitive schemata are less elaborate, less interconnected, and less accessible than that of the experts, and that the novices' pedagogical reasoning skills are less well-developed," (p. 85).

Knowledge organization and perceptions during interactive teaching

Experts' knowledge systems help them differentiate the important from the unimportant both in their planning and during their interactive decisions. Peterson and Comeaux (1987) wrote about teachers' schemata and the implications for classroom events. They confirmed that knowledge organization is an important factor in experts' perceptual capacities. They provided empirical evidence for the knowledge organization of experienced teachers: "Cognitive psychologists have argued that schemata affect perception, understanding, remembering, learning and problem solving. Our results indicate that experienced high school social studies teachers have more cognitively complex schemata for classroom events than do beginning social studies teachers" (Peterson, & Comeaux, 1987, p. 329).

Expert teachers' knowledge organization influences perceptions

Knowledge organization enhances teachers' perception of events during interactive teaching, helps their decision-making, their ability to solve problems and their understanding of students. Clark & Peterson, (1986) showed that schemata affect perception. Pinheiro and Simon underlined that "at the core of the theory, and its application to skill diagnosis, is the concept of schema," (Pinheiro, & Simon, 1992, p. 290).

Housner and Griffey (1985) found that the knowledge structure of experienced teachers (including expert teachers) allows them access to multiple strategies to manage students. For expert teachers, the knowledge is organized related to class management, subject matter, curriculum, and pedagogical principles. Dodds (1994) stressed that

cognitive mapping and other research techniques indicate that experts have more sophisticated knowledge structures.

Knowledge organization also influences the perception of critical cues. Standley and Madsen, (1991) acknowledged that experts make inferences from what they observe in the classroom. Their knowledge organization allows them to be more efficient in their analysis of the presented situation. The authors showed experts' ability to perceive, interpret cues and make correct inferences on events going on in the classroom. Housner and French (1994) added that "pedagogical researchers have uncovered some general properties regarding the knowledge structures (interconnected, sophisticated, rich, coherent, organized) and cognitive processing abilities (e.g., identification and recognition of relevant cues, adaptability, automaticity) of expert teachers…" (p. 242). French and Housner (1994) acknowledged the richer and better instantiated cognitive representations of expert teachers about notably students and instructional strategies.

Clark and Peterson (1986) noted that "schema" was the word used in cognitive psychology literature to refer to the way knowledge is stored in memory. They suggested that expert teachers' knowledge structure may be better developed for classroom learning and teaching than novices'. The authors found that differences in knowledge organization could explain the difference in teachers' perception of classroom events:

> Differences between experienced and novice teachers in another kind of schema--knowledge underlying their awareness of what happens in classrooms-- may lead experienced and novice teachers to focus on different types of student cues in their interactive decision making… cognitive psychologists have argued that

schemata affect perception, understanding, remembering, learning, and problem solving. (Clark & Peterson, 1986, p. 280)

Knowledge organization: expertise in sports instruction

In physical education, O'Sullivan and Doutis (1994) explained that researchers used "various techniques such as the ordered tree technique, pathfinder analysis, and semantic maps to measure teachers' and teacher educators' cognitive schemata"(p. 178). Berliner (1986) explained that experts are extremely fast and efficient in their recollection of information through pattern recognition: "these recognition skills appear to act like schema instantiations. The recognition of patterns reduces the cognitive processing load for a person" (p. 11). Knowledge organized hierarchically makes it easier for the expert to recall information. Experts' extensive memory could be explained by the organization of their knowledge.

Experts' memory skills

Memory linked to knowledge structure

Ericsson and Polson (1988) studied the exceptional memory of JC, a restaurant waiter. They mentioned that experts, within their field of expertise, have demonstrated superior memory skills. It is possible to do so by organizing the knowledge into chunks. Using long-term memory can also extend short-term memory. They found, through the post-session recall, that JC used long-term memory and that his memory skills improved with practice. The authors acknowledged that JC has acquired his extensive memory skills through years of practice.

In a study of young dancers, Starkes and others (1987) proved that expert dancers recalled more than did novices. Also, choreographic structure had an influence on

experts' memory: "the fact that both expert and novice dancers performed unstructured sequences poorly indicates the influence of choreographic structure on their knowledge base of ballet," (Starkes et al., 1987, p. 229). These findings were comparable to the findings by de Groot, (1965), who proved that expert chess players' memory was significantly superior to novices when the chess boards presented were actual game situations as opposed to randomly set. Similarly, Chase and Simon (1973) recognized the connection between expert chess players' memory skills and their organization of knowledge in chunks. Chase and Simon reinforced that when chess players were presented real games situation chessboards, there was strong evidence of experts' superior memory of pieces placement over novices'. Yet, there was no significance difference between expert and novices' memories when the pieces were placed randomly on the chessboard.

Memory linked to experience

In an interview with Brandt (1986), David Berliner mentioned that expert chess players had enormous memory for chessboards, and that this memory was the fruit of years of experience. Ericsson and Charness (1994) showed that experts defy the limits of human memory. In other words, experts can acquire knowledge and skills beyond the limits of working memory capacity and sequential processing. Experts' perceptions are influenced by experts' memory. In fact, in Ericsson and Charness's study, experts demonstrated immediate memory of perceived situations even after a brief exposure of only a few seconds. It seemed like memory was a function of playing skills. The authors found that experts "acquire skill in memory to meet specific demands of encoding and

accessibility in specific activities in a given domain" (Ericsson & Charness, 1994, p. 736).

Memory in teaching expertise

In teaching expertise as well, the organization of knowledge provides experts with superior memory skills. Dodds (1994) noted that knowledge was represented and organized by internal schemata in long-term memory. From that point on, short-term memory allows access to the richer and more detailed material stored in long-term memory- "What they [experts] have learned is more easily remembered and more effectively connected to other knowledge. Experts can retrieve knowledge appropriately and transfer it more easily to unfamiliar situations" (Dodds, 1994, p. 155).

Poon and Rodgers (2000) contrasted the mental space used by novice and expert dancers: "The mental space it took for a novice to encode 'do a turn, stand up really tall' may simply be a 'chaine' to an advanced dancer" (p. 140). Patel and Groen (1994) also stressed experts' superior memory skills (process of enhanced recall) and forward reasoning. Housner and Griffey (1985) showed that "experienced teachers were better able to anticipate possible situations that could arise when teaching and had a larger number of contingencies stored in memory to handle these situations"(p. 52). Stepich (1991) acknowledged the difference between experts and novices in the amount of information stored in memory.

Tan (1997) considered skilled memory as a characteristic of experts: "experts can recall a great deal of information about their subject, both short and long-term… Their ability to exceed the limitations of short-term memory is because of the automaticity in many of their behaviors. Having rehearsed routines, their short-term memory is free to

store more information" (p. 32). Consequently, one of the explanations for experts' superior memory skills, notably short-term memory skills, is their automaticity of behavior.

Use of routines and automaticity of behavior

Overlearning to develop automaticity

Another characteristic common to experts across different fields is their automaticity of behavior. Bloom (1986) identified the development of automatic, reflexive, and repetitive behaviors as one of the distinguishing characteristics of an expert performer: "the mastery of any skill… depends on the ability to perform it unconsciously with speed and accuracy while consciously carrying on other brain functions" (p. 70). He provided empirical evidence for this phenomenon using experts in six different fields. Experience and commitment were key factors in the development of automaticity and Bloom's participants had an average of 16 years of experience. Bloom found that "overlearning" was a necessity for the development of automaticity. He listed a series of function of automaticity notably economy of effort, rapidity, and increase in accuracy, and other conscious brain functions may occur simultaneously with the automatic functions, so automatic functions can simultaneously serve higher functions.

For Tan (1997), experts appear to perform automatic rehearsed patterns with fluidity, elegance and ease. Experts' visible ease is due to extensive hours of practice that led to automatic and unconscious responses to activities. He considered automaticity of behavior as one of experts' characteristics: "with the attainment of a high degree of skill, both mental and physical, comes both automaticity and unconscious behavior" (Tan, 1997, p. 32).

Berliner (1991) revealed the importance of practice to develop automaticity in teachers' becoming experts. He found that "experts often develop automaticity for the repetitive operations that are needed to accomplish their goals" (Berliner, 1991, p. 169). Automaticity allows experts to free memory space and therefore store more information in short-term memory and be more receptive to situations.

Automaticity: rapidity and ease

Sharpe and Hawkins (1992) reinforced the notion of rapidity. They found that automaticity explains the absence of expert confusion, as well as their ability to perform a task at a high speed and the coherence of their action. Siedentop and Eldar (1989) confirmed that the ease with which experts perform is related to their automaticity of behavior. They found that experts' shorter latencies and rapidity of execution come from their automaticity of behavior. This idea is reinforced by Stepich (1991) who found that "increasingly expertise is associated with performance that is increasingly rapid, accurate, effortless, and automatic" (p. 13).

Automaticity and use of routines to enhance analytical perceptions

Automaticity of behavior and use of routines influences experts' ability to solve problems and their analytical perceptions. Berliner (1986) defined those routines as "shared, scripted, virtually automated pieces of action. Routines often allow students and teachers to devote their attention to other, perhaps more important matters inherent to the lesson" (p. 5). He added that automaticity of behavior also means that experts could perform their tasks with less effort.

Routines in teaching expertise

Berliner (1988) showed that the use of classroom routines was a function of experience. Borko and Livingston (1989) mentioned that expert teachers make greater use of routines. Fink and Siedentop (1989) showed that effective teachers demonstrated the use of routines to set their expectations of students from the very first day of school. Glaser (1987) found that "routine experts are outstanding in terms of speed, accuracy, and automaticity of performance" (p. 92). Griffey and Housner (1991) realized that young teachers do not have the automaticity of behavior that expert teachers have acquired with practice and experience. Brandt (1986) noted that experts' advantage in using routines is that automatic behaviors free them to focus on other things. Consequently, experts' use of routines influences experts' perceptual capacities. Lavely et al. (1986) showed that expert pedagogues, just like experts in cognitive psychology, demonstrate automatization of central processes.

One of the elements of perceptual capacities is the ability to solve problems rapidly and accurately. McCullick, Cumings and Schempp (1999) reviewed the literature and demonstrated that routines influence problem solving capacities. They found that expert teachers "establish routines, procedures, rules, and strategies to usher learning and solve problems with maximum efficiency and minimal error (Carter, Sabers, Cushing, Pinnegar & Berliner, 1987, Leinhardt & Greeno, 1986, Livingston & Borko, 1989, Peterson and Comeaux, 1987)" (p. 16).

Leinhardt and Greeno (1986) explained that "the use of routines reduces the cognitive processing for teachers and provides them with the intellectual and temporal room needed to handle the dynamic portions of the lesson" (p. 94). Dodds (1994) added

that experts perform smoothly, effortlessly, appropriately, and in context until an unusual event occurs on which to focus their analytical skills. She believed that "expert teachers teach intuitively, having an overall sense of the situation such that they can respond fluidly without deliberating... Experts 'just know'… They work unconsciously until there is a specific problem on which to focus their analytical skills… " (Dodds, 1994, p. 160).

Automaticity in expertise in teaching sport

Experience is a major factor in automatization. Baker, Schempp, and Clark (1998) found that the repetition of behavioral patterns and exposure to the same environment over years led experts to acquire subconscious automatic routines. Expert teachers have developed automatic behaviors, routines and rituals which partly explain the superior teaching performances and therefore superior student learning. Baker et al. (1998) showed that expert golf instructors used routines and automatic behaviors that have a profound impact on student learning.

Expert tennis instructors have demonstrated the use of routines as well. "Similarities between a majority of the instructors were noted in the a- lesson opening, b- verbal instruction, c- non-verbal instruction, d- positioning, e- pacing f- drill organization and g- lesson closure" (Woorons, 2001, p. 15).

The same automaticity of behavior is true of expert coaches. De Marco and McCullick (1997) noted that expert coaches exhibit automaticity of behavior. Their effort is minimized by the use of routines and unconscious behavior which makes their coaching more efficient and fluid. Luppani and Stillwell (2000) studied successful collegiate women's basketball coaches and found that effective coaches' routines included

similarities in establishing long-term team goals, short-term team goals, and individual goals with goal congruency as a major factor of success and student empowerment.

In summary, experts' characteristics influence their perceptions

Consequently, experts' extensive knowledge, their knowledge organization, their superior memory skills and their automaticity of behavior influence their perceptual capacities. In what way are experts' perceptual capacities different from non-experts?

Experts' perceptual capacities

Perceptual capacities and experts from a variety of fields

Researchers from a wide variety of fields have demonstrated their interest in the study of experts' perceptual capacities (i.e.: medicine (Christie, 1996), art (Kay, 1992), and mathematics, (Schoenfeld & Herman, 1982)). In her study of artists' perceptions, Kay (1992), found a significant difference in experts and novices' perception-- experts' perception being more selective. She called it 'selective encoding of perceptual information'. Studies in the medical field also focused on experts' perceptual capacities.

Christie (1996) studied expertise in nurses' clinical judgments and found that judgment quality depended on accuracy, consistency, latency, confidence, calibration and knowledge accessibility. Kramer (1996) found that expertise in clinical nursing educators was characterized by intuitive links between the ability to read situations and ways of responding. In mathematics, Schoenfeld and Herrmann, (1982) found that novices only perceive problems on the surface, and concluded that criteria for problem perception increases as a function of knowledge.

Glaser (1985) studied the nature of expertise. One of the generalizations he made of experts in different fields is that they develop the ability to perceive large meaningful

patterns. Later, Glaser (1987) showed that experts have superior observation skills, an ability they have developed which allows them to rapidly perceive large meaningful patterns.

Experts' pattern recognition

Tan (1997) defined experts' pattern recognition capabilities as follows:

> They recognize patterns during their performance that allow them to draw on their sizable knowledge store. This process of pattern recognition involves the identification of critical cues (e.g., words, sounds, movements) as the event or performance unfolds. These cues are then matched to the expert's knowledge base (Cooke, 1992). Pattern recognition processes are important for comprehending and categorizing the things they see, hear, and feel. Experts can quickly extract meaningful chunks of information from often confusing and complex activity. (p. 31)

Berliner (1986) added that "experts have extraordinarily fast and accurate pattern-recognition capabilities… Sense is instantaneously made of a field, such as a chess board," (p.11). Later, Berliner (1994) mentioned that experts recognize meaningful patterns faster than novices do: " experts have fast and accurate pattern recognition capabilities. Novices cannot always make sense of what they experience" (p.177).

Perceptual capacities: expertise in motor skill

In motor-skill expertise, Magill (1998) focused "on the learning of critical cues in the environment that 'regulate', or constrain, the specific movement characteristics required to successfully perform an open motor skill," (p.109). The author suggested practice situations that encourages the acquisition of knowledge about environmental

regulatory information critical for motor skill performance. Poon and Rodgers (2000) allude to auditory perceptions. They found that all the participating advanced dancers "were not only able to selectively attend to many different and significant musical stimuli, but they were also able to combine and encode them in such a way to ease the retention process" (Poon & Rodgers, 2000, p.140).

Abernethy, Wood and Parks (1999) showed that top level athletes in fast ball sports have superior perceptual attributes in their discipline. These athletes are able to recognize patterns with speed, precision and accuracy and to anticipate opponents' action, they take the example of "racquet sport players pick up information from the motion of the opponent's arm in addition to the racquet cues used by novices" (Abernethy, Wood, & Parks, 1999, p. 313). Their study focused on whether or not these perceptual skills are trainable. They provide empirical evidence that indeed, practice can improve anticipatory skills-- "the evidence from this study simply reveals that perceptual training, using a combination of video simulations and knowledge augmentation approaches, enhances anticipatory skill as assessed using video-based procedures" (Abernethy, Wood, & Parks, 1999, p. 313).

Singer and others (1998) did a study on expert tennis player's visual search patterns while performing returns of serves and determined "the relationship between visual search, selective patterns of attention, and the influence of these processes on decision-making strategies," (Singer et al. 1998, p.290). In expertise in soccer, Williams and Davids, (1998), reported that:

> contemporary research examining skill-based differences in visual search strategy in sport has highlighted important discriminating characteristics between experts

> and novices… differences are assumed to be indicative of the expert's more refined perceptual strategy. Experts have a more extensive task specific knowledge base, which can be used to interpret events encountered in circumstances similar to those previously experienced… These knowledge structures direct the performer's search strategy towards more pertinent areas of the display based on situational probabilities (i.e. expectations) and the more effective processing of contextual information. (p. 111)

Radlo et al. (2001) studied intermediate-level and advance-level baseball batters' pitch recognition. They concluded that due to greater limitations in attentional capacity intermediate batters are less efficient in their perceptual decision-making processes. The authors recognized that "recent studies in baseball and other sports requiring similar perceptual decision-making demands have supported the idea that when players use advanced cues extracted from their sporting environment, faster decision-making occurs (Bahill & LaRitz, 1984, Bard & Fleury, 1981, Hyllegard, 1991, McPherson & French, 1991, Ropoll, 1988, Singer et al., 1998, Williams & Davids, 1998)" (Radlo et al., p. 22).

Expert tennis players, for example, focus on the opponent's arm and racquet to better read a serve while novice tennis players mainly focus on the ball:

> using visual search equipment, Goulet, Bard, and Fleury (1989) observed that expert tennis players made numerous fixations on the arm and racquet to determine the outcome of the tennis serve, whereas novices focused primarily on the tennis ball. Furthermore, in a study of baseball batters, Shank and Haywood (1987) showed that high-level players looked primarily to the area of the release point to predict pitch location. Beginners varied their fixations between the

> pitcher's head and the release point. Going further, Hyllegard (1991) demonstrated that batters used visual information provided but the seams of a pitched baseball when determining what type of pitch was thrown (Radlo, 2001, p. 23).

Expert tennis players' acute perceptions reflect in their ability to strategize. McPherson (2000) compared expert to novice tennis players and found that: "Dramatic differences were noted in overall total concepts (i.e., goal, condition, action regulatory, and do concepts), as experts generated three times more planning concepts during competition than novices" (p. 49) McPherson's findings suggested that:

> Collectively, experts' current thoughts during competition suggest both current event profiles and action plan profiles are used to develop and plan their response selections. These profiles enhanced the tactical decisions during competition by maintaining pertinent information relevant to the current competitive event…Experts utilize sport-specific strategies between points (a) to monitor pertinent current and future events, (b) to monitor the applicability of procedures (and make modifications if necessary), (c) to encode and retrieve current and past events for diagnosing and updating their condition profiles, and (d) to plan actions based on elaborate and sophisticated action plan and current event profiles. In contrast, novices…(a) made few plans to monitor pertinent events or monitored irrelevant events, (b) did not monitor the applicability of procedures, (c) lacked specialized encoding and retrieval strategies, (d) did not update conditions or actions, and (e) lacked planning strategies…Most important, players' solution

> processes and sport-specific strategies emerged from their problem representations accessed during competition. (McPherson, 2000, p.56).

Experts in motor skill demonstrated the ability to focus their attention on the cues that were most relevant to the situation. Radlo (2001) explained that:

> sport researchers believe one of the reasons high level athletes can attend to and process the most relevant information within a highly dynamical sport situations is that they have the ability to allocate a sufficient amount of attention to the most pertinent information and have enough "attentional reserve" to allocate to secondary perceptual information or for early response preparation processes (Abernethy, 1993). Beginners, on the other hand, need to allocate most if not all their attentional resources to the task at hand. For instance, Castiello and Umilta (1992) observed that expert volleyball players developed a quicker reorientation of attention to visual targets as opposed to inexperienced players. They attributed this enhance attentional flexibility to the expert volleyball players' extensive practice in their sport, whereby quickly disengaging, moving, and engaging attention from one position to another is important. (p.23).

McFarland (1975) acknowledged the beauty of top level athletes' performances and how much one benefits from observational skills. He realized that with guidance, the spectator could appreciate and learn more from the athletes:

> A superb athlete in action is a joy to watch. To see him playing with sureness and competence delights more ordinary, clumsy mortals. And as we see the tennis star or the outfielder in game after game making the right moves, performing incredible and beautifully executed feats, we sooner or later come to wonder how

> he does it… [the skill] fortunately can be isolated and looked at carefully and even learned. Thus, on television we grow accustomed to moments in a football game replayed in slow motion. The announcer may urge us to notice particularly how the player steps to the left at just the right instant, how he turns and signals for the ball the second he finds himself in the clear. We who missed those movements in the hurry of the first time through look now and marvel. And after becoming aware of the various movements, we understand and appreciate the demands of the game all the better and admire all the more the people who play it well. (p.1)

Perceptual capacities and teaching expertise

In education, Rahilly and Saroyan (1997) studied university professors and compared their perception of critical incidents in classroom teaching at different levels of expertise. Anderson-Nickel (1997) studied elementary music teachers and found that experts and novices differed in their evaluation of a classroom and that experts were more selective in their use of information regarding the classroom environment. Experts were able to simultaneously control the classroom, as well as gather and process new information. Carter et al. (1988) showed that experienced teachers, as opposed to beginning teachers, were able to perceive and make sense of a multitude of classroom stimuli. They noted that effective teachers "make use of finely tuned observational skills and perceptual abilities in their teaching," (Carter, et al. 1988, p.25). While novices may pay attention to the color of a student's hair, experts focused more on information of instructional significance. Chen and Rovegno (2000) noted that "expert teachers also

exhibited a greater ability to attend and respond to multidimensional and simultaneous class activities than did novice teachers" (p.359).

Schempp (1993) noted that experts quickly perceive large, meaningful environmental cues, and were able to anticipate what was going to happen next and plan accordingly. Expert teachers were able to differentiate the important from the unimportant in the teaching environment. He noted that "effective managers are quick to spot potential behavior problems. They don't give a behavior problem time to fester and grow" (Schempp, 1993, p. 11). Silverman (1991) considered the ability to anticipate events as one of the effective teachers' characteristics.

Klauke (1988) completed a case study of an expert teacher and found that the teacher was alert and responsive to every activity in the classroom. Manross and Templeton (1997) believed that "experts are acutely aware of what is happening and why. Because of their well-tuned awareness, experts detect slight but significant shifts in the learning environment, which foretell events to come" (p. 31). Tan (1997) noted that experts had superior perceptual abilities and were able to notice things that other people would miss. Experts' knowledge organization facilitated their pattern recognition. Experts quickly recognized cues pertinent to their understanding of a situation or a phenomenon-- "Experts can quickly extract meaningful chunks of information from often confusing and complex activity… Expert teachers extract meaningful cues from the instructional context… The ability to differentiate critical cues in the environment permits them to anticipate likely situations," (Tan, 1997, p. 32). Tan added that the difference between experienced and novice teachers' knowledge structures might explain the difference in their focus on environment cues. He provided empirical evidence

showing that "these groups of teachers vary considerably in their perceptual patterns of environment cues. The most notable of these differences involved the organization and complexity of their conceptual maps in: (a) the number of perception cues and their relations, (b) the conceptual levels of interrelated cues," (Tan, 1996, p. 167). Expert teachers have complex knowledge structures and superior cognitive schemata.

Dodds (1994) underlined that the knowledge structure and schemata allowed experts to retrieve information for movement diagnosis and provided them with acute perception skills. She suggested that experts differentiate important visual details. They perceive, monitor, and understand classroom events in far richer ways than do novices.

Graham, French and Woods (1993) showed that novices only interpreted the surface of classroom events. Hanninen (1988) found that novices tend "to perceive the learning environment as being limited to what is possible only in the classroom. In contrast, the expert encourages and supports opportunities which put the learner in contact with real professionals in the community" (p. 142). Kennedy, (1987), in her article on professional education and the development of expertise, presented four definitions for expertise, including expertise as critical analysis.

Berliner, (1988) studied novices, advanced beginners and expert teachers. He showed empirical evidence of differences in their classroom perception and ability to differentiate the important from the unimportant. Kulinna, et al. (2001) enumerated what was considered troublesome student behaviors. These behaviors were categorized as mild, moderate, and severe. They found that many of the students behaviors that were troublesome for classroom teachers were also present in physical education classes: “additional research is needed in this area to gain a better understanding of (a) teachers'

perceptions of the student behaviors taking place in classes, (b) how teachers deal with student misbehavior, and (c) to develop strategies to reduce behavioral problems, thus enabling teachers to focus on helping students learn." (Kulinna, et al. p. A-70).

Manross and Templeton (1997) considered that "when activities are going well, experts merely monitor the class and observe the natural course of events that carry the class to the desired outcome. The expert teacher's ability to perceive and discriminate the important from the unimportant has the beneficial effect of making the teacher's job look easy; for they are unencumbered by the trivial and focus their full attention on the significant matter at hand" (p. 31).

Carter et al, (1988) showed that expert teachers' attention was aroused by atypical classroom events:

> The notion of 'typicality' seemed to affect the way experts processed visual information. Once experts assessed a situation as 'typical', the need to process further what was seen in the slides was reduced… If something in the slides appeared to be unusual, however, experts appeared to spend their mental energies attempting to make sense of anomalies. (p. 28)

Cushing, Sabers & Berliner (1992) did a comparable study and agreed that experts tended to pay more attention to atypical events. They showed the teachers three screens and asked them to monitor all three screens at the same time. The authors found that "experts were better able to monitor all three screens and to respond to the audio cue… [and that] only the experts provided an instructional interpretation of what was observed," (Cushing, Sabers & Berliner, 1992, p. 110). The authors found that perception abilities differed with the level of expertise. Expert teachers provided more instruction

related interpretations of the classroom events for they focused on events that were relevant to instructional matters.

Conle, (1999) focused on teaching and evaluated the importance of interpretation in the perception and evaluation of teaching events. Carter et al. (1988) were struck by expert teachers' ability to connect what they saw on a series of slides with their own classroom experiences. They concluded that this ability allowed expert teachers to draw from their extensive knowledge and to react to events for optimum classroom effectiveness.

Webb and others (1997) studied the interpretation of student comprehension from nonverbal behavior and found that expert teachers showed a greater ability to "discern comprehension based on the knowledge they possess and the extent to which they process information from the classroom to make their judgments" (p. 96). Manross and Templeton (1997) mentioned that experts' perceptual abilities allow them to make instructional adjustments. Livingston and Borko (1989) noted that expert teachers extracted meaningful cues from the instructional context that allowed them to understand events in ways that helped them plan and teach more efficiently.

Perceptions in expertise in sports instruction

In physical education and sport instruction, Nelson (1988), found that expert physical education teachers responded in greater length and detail than did the novices. They were able to notice more information from the situation presented and interpret more meaning from what they observed. Graham, French and Woods (1993) studied differences and similarities of observational skills at different levels of teaching expertise. They considered observation and interpretation of events during instruction as an

important dimension of effective teachers. The authors found that expert teachers made interpretations of classroom events, and that those interpretations were more organized and focused on lesson occurrences that influenced students' motor-skill performance. Their empirical study of experts and PETE students showed that "experts tended to interpret what they saw in a considerably fuller and richer fashion than experienced PETE students. Experts appeared to 'see more' and 'in greater depth' than did PETE students" (Graham, French & Woods, 1993, p. 56). They concluded that there were four major differences in observations as a function of expertise-- frequency of observations, functions of observations, distribution of observations within categories, and qualitative content of observations.

French and Housner (1994) noted that observational skills regarding the nature of both teaching and skill analytic abilities underlying motor skill instruction form an important advantage for the expert teacher in sport and physical education. Dodds (1994) added that "one critical characteristic of expert physical educators is their ability to analyze motor skills qualitatively better than novices could. Expert teachers of motor skills are qualitatively different from novices in their ability to detect errors and appropriate aspects of skill performance….Experts differ from novices in diagnosing movement skills" (p. 157). She found that observational skills are essential to physical education expertise because one of the major goals is to improve students' motor skills. Extensive practice and experience are critical to developing the automaticity aspect of expertise in observational skills.

Kollias et al. (2001) offered solutions for physical education teachers to improve their analysis of the standing vertical jump. They wondered if Principal Components

Analysis could help identify individual differences in vertical jump performance. The authors explained that even though the standard vertical jump is one of the most common tests, the numerous variables involved created confusion and inconsistencies. Kollias et al. concluded that Principal Component Analysis:

> can be a useful method for assessing jumping performance, because it can eliminate the large number of highly interrelated variables to a fewer number of independent factors that would better reflect the characteristics of the jump. It permits a quantitative evaluation of each athlete's performance while combining useful information from some of the most critical mechanical variables that have been proposed as potential predictors of jumping performance in the literature (p. 67).

McKethan and Kernodle (2001) studied the effectiveness of a distance learning program for improving preservice teachers' error detection in the overhand throw. They found that preservice teachers would benefit most from this program if they combined both the video capture and the text. Konukman et al. (2001) considered the use of technology for the benefit of instructional programs. They studied "the effects of multimedia tennis computer-assisted instruction on tennis forehand, backhand knowledge, and psychomotor skills in a collegiate tennis basic instruction course" (Konukman et al., A-69). They used video tapes and skill technique charts to qualitatively analyze students' performance.

As for expert coaches, De Marco and McCullick (1997) wrote that "expert coaches are highly perceptive and are superior problem solvers. They are uniquely capable of accurately perceiving stimuli in game situations. They dissembled meaningful

and pertinent information from less important information and then generate superior responses" (p. 38). Young (1998) analyzed expert downhill ski instructors and found that for coaches to be able to analyze a sport performance qualitatively, they need an internal image of the desired skill against which to make comparisons. Pinheiro & Simon (1992) found that expert track and field coaches acquired more cues, made more interpretations and diagnostic decisions, were more accurate, and missed fewer important errors when working with individual performers than did novices. The authors proposed a model to develop diagnostic competence. They wondered how the best coaches were able to pick out the errors of skill to be corrected. They found that teachers and coaches need "to provide students with the opportunity to assimilate knowledge and with practical experience in using that knowledge in clinical diagnosing situations" (Pinheiro & Simon, 1992, p. 298).

Summary of the literature on perceptual capacities

In summary, experts' perceptions were more selective and experts' distinguished the important from the unimportant (Berliner, 1988; Kay, 1992; Schempp, 1992; Tan, 1997). Experts recognized critical cues in the environment (Magill, 1998). Expert teachers focused on events that were relevant to instructional matters (Cushing, Sabers, & Berliner, 1992). Expert teachers perceived more information and interpreted more meaning out of a situation. The interpretations were organized and focused on students' performance (Graham, French & Woods, 1993; Nelson, 1988). Experts in their perceptions were more accurate, consistent, and confident (Christie, 1996). Experts' selective patterns of attention influenced their decision-making strategies (Singer et al. 1998, Manross, & Templeton, 1997). Problem perception increased as a function of

knowledge. Experts were superior problem solvers. Experts generated superior responses. Novices on the contrary only perceived problems on the surface (De Marco, & McCullick, (1997); Graham, French, & Woods, 1993; Schoenfeld & Herrmann, 1982; Young, 1998). Novices could not always make sense of what they experienced (Berliner, 1994). Experts rapidly perceived large meaningful patterns (Berliner, 1986; Glaser, 1985; and Glaser, 1987). They had extraordinarily fast, precise and accurate pattern-recognition capabilities (Abernethy, Woods, & Parks, 1999; Berliner, 1986). This allowed experts to instantly make sense of the situation and anticipate future events (Klauke, 1988; Schempp, 1983, Silverman, 1991). Experts' knowledge was used to interpret events, compare the present situation to former experiences, and process contextual information to maximize effectiveness (Livingston, & Borko, 1989; Williams & Davids, 1998). In teaching expertise, experts' perceptual abilities allowed them to self-monitor their teaching (Webb et al. 1997). In their domain, experts evaluated what they saw and were able to perceive and make sense of a multitude of stimuli (Anderson-Nickel, 1997; Carter, 1988). Experts perceived, monitored and understood events in a far richer way than did novices (Dodds, 1994). Experts offered a critical analysis of the present situation (Kennedy, 1987). In expertise in teaching sport, experts analyzed motor skills qualitatively better than novices did. Experts' knowledge structures allowed them to retrieve information for movement diagnosis, notably error detection and appropriateness of skill performance (Dodds, 1994; Pinheiro & Simon, 1992). Graham, French and Woods (1993) found four major differences in observations as a function of expertise: difference in frequency, functions, organization, and the qualitative content of observations.

Conclusion to the review of literature: purpose of the study

The purpose of the study was to understand how expert tennis instructors' analytical perceptions differ from novices'. The present study should provide insightful information regarding expert tennis instructors' selection of information and therefore potentially reinforce Tan's theory (Tan, 1997) which suggested that experts' perceptions are more selective than novices'. Magill (1998) showed that experts recognize critical cues in the environment. The present study should provide additional evidence of experts' recognition of critical cues in the environment. The study aimed at discovering if expert teachers do indeed focus more on instructional matters than novices do, as suggested by Cushing, Sabers and Berliner (1992). The present study focused on questions relating to expert tennis instructors' depth of perception, evaluation, pattern recognition, critical analysis, diagnosis and anticipation of future events. In such, the study should be a substantial contribution to the body of knowledge relating to teaching expertise and experts' perceptual capacities.

CHAPTER 3

METHODS AND PROCEDURES

The present study contrasted expert and novice tennis instructors' perceptual capacities. Specifically, this study investigated how expert tennis instructors' analytical perceptions differ from novices'. This chapter enumerated the methods that were designed to answer the research questions. The questions were the following:

1. How do experts' perceptual capacities differ from novices' in matters of selection, detail and relevance to tennis instruction?

2. What are the differences between experts' and novices' inferences, interpretations and evaluations of what they perceive?

3. How do experts and novices differ in their perceptions of meaningful patterns, their understanding of a present situation and their anticipation of future events in tennis motor skill and instruction?

4. What are the differences between experts' and novices' critical analysis and diagnosis of both a motor skill and an instructional situation?

This chapter included study design, participants, pilot study, procedures for data collection, and data analyses.

Study design

Four expert tennis instructors and four novice tennis instructors participated in the study. Studies using the expert-novice paradigm involving eight participants are fairly common in the literature (Lubbers, 1998; Nelson, 1988; Young, 1998). Recently, Ethell

and McMeniman (2000) considered that "One way to reconcile the dilemma of the theory-practice nexus is to examine and make explicit the typically tacit understanding of both beginning and expert teachers" (p. 88). Experts' characteristics have also been derived using expert-novice comparisons (Abernethy, Wood, & Parks 1999; Hardiman Dufresne & Mestre, 1989; Sharpe & Hawkins, 1992). Recently Chen and Rovegno (2000) used the expert-novice paradigm to examine expert and novice teachers' constructivist-oriented teaching practices.

The present study was qualitative in nature. Two data collection methods were used to answer the question: How do expert tennis instructors' analytical perceptions differ from novices'? Both a video analysis and a recall test served as data collection methods for the study. The video analysis method was used by Graham, French and Woods, (1993) to compare the ability to observe and interpret teaching physical education at different stages of expertise. This session provided information relating to "cue acquisition, cue interpretation, and diagnostic decisions" (Pinheiro & Simon, 1992, p. 289). The recall test method was used by Carter et al. (1988) to examine differences in expert and novice teachers' perception and processing of visual classroom information.

Participants

For increased validity in the study, Butch Staples agreed to participate as a peer debriefer. Butch Staples is Director of Special Projects with the Van Der Meer Tennis University and is responsible for the Tennis University Courses, which include the basic and general teaching course, the munchkin tennis course and the coaching course. Butch earned three degrees, two of them in Physical Education and Sport Science (Bachelor’s of Physical Education from McMaster University, Canada, and Master of Science in

Physical Education from Springfield College, Massachusetts). He was Chairman of Tennis Canada Coaching and Development Instructors' Committee. He has both the theoretical and practical background to be a prominent asset to this study.

There were two groups of participants in this study. The first group was comprised of four first-year tennis instructors. The novices were recruited with the help of the United States Professional Tennis Registry (USPTR). These instructors are certified and employed as tennis instructors for a minimum of twenty hours a week. The four novices were referred to as novice one through four to preserve their anonymity. They were interviewed during a Van Der Meer Tennis University in Hilton Head, South Carolina. The Van Der Meer Tennis University staff together with the researcher selected them out of a group of 15 novices because they corresponded exactly to the criteria raised by the study. Novice one had started teaching a few months prior in Virginia. Novice two was a first year tennis instructor in South Carolina. Novice three had been teaching in Florida for less than a year and novice four was a first year tennis instructor in a club in Maryland.

Butch Staples considered these novices to be well chosen for the study because by travelling to Van Der Meer's for their professional development they had demonstrated time and financial commitment towards improving their teaching. In addition, Butch Staples determined that a number of the tennis teachers the USPTR considered experts had gone through the process of the Tennis University years before. So for Butch Staples, there is a commonality between the two groups with a notable difference in terms of years of experience.

The second group was constituted of four expert tennis instructors. Criteria for selecting expert teachers were difficult to establish since, as opposed to motor experts or experts in specific fields like chess, expert pedagogues' competence is not easily measurable. Berliner (1986) suggested years of experience and regional or national recognition as an example of criteria. In this study, the experts were selected according to the following criteria:

1. A minimum of 10 years of teaching experience in tennis.

2. Professional certification. (level: Tennis Professional with either the USPTR or USPTA: United States Professional Tennis Association)

3. Have received formal recognition for the quality of their instruction form the tennis community in the form of teacher of the year award, (e.g. state, regional, or national).

4. Have established consistent record of success by students at the local, regional, and national levels.

The four experts for this study were Chuck Kriese, Jody Hyden, Andy Johnston and Jeff Wallace. As a means of verifying the trustworthiness of their expert status, no pseudonyms have been used for the experts. Their real names were used with their permission. All four experts were certified professionals through either the USPTR or the USPTA. Chuck Kriese had been the Clemson University Men's tennis coach since 1975. He was named the National Coach of the Year by the ITCA (Intercollegiate Tennis Coaches Association) in 1981 and the USPTA in 1981 and 1986. He had published four books on the game: Total Tennis Training, Winning Tennis, Youth Tennis and Coaching Tennis. He was a speaker at the 2001 USPTR international symposium. Coach Kriese

was widely recognized as one of the top educators and motivators in his profession. Jody Hyden had over 15 years of experience as a tennis teacher and almost 30 years as a player. He was the former Duke University Women's tennis coach. He had brought his team to the top three in the country. He had coached nine National Champions and 22 All-American collegiate players. He had a master's degree in Guidance and Counseling k-12. He was the Athletic Director at the Charleston Day School. His duties included managing 14 athletics coaches and 7 tennis teams. Andy Johnston was the former Clemson University Women's tennis coach. He had over 20 years of tennis teaching / coaching experience. He was five times ACC coach of the year. His most renowned student was Gigi Fernandez, Gold Medalist in doubles in Barcelona, 1992. Jeff Wallace had over 15 years of tennis teaching / coaching experience. He was coaching the University of Georgia Women's Tennis team and won the National Championships with his team in 2000.

Procedures

The researcher contacted first year tennis instructors. Data collection was scheduled at a convenient time for the participants and took place at the United States Professional Tennis Registry's head quarters in Hilton Head, South Carolina. The researcher also contacted expert tennis instructors selected according to the criteria listed above. After agreeing to participate, the experts scheduled for an appointment with the researcher. The researcher met individually with the experts in a location convenient to them.

During this meeting with either experts or novices, the researcher greeted the instructors, gave further explanations regarding the project, and answered any questions regarding the project. The informed consent form was then distributed to the instructors.

Data collection followed with participation in the video analysis and the recall test. The Inform consent form was approved April 17th, 2000 by the University of Georgia Office of the Vice President for Research. A copy is attached in Appendix A.

Video Analysis

A videotape of the first 10 minutes of a tennis lesson was shown to the participants. The person teaching on the video was chosen because he is a competent teacher. He was asked to teach a group lesson to state ranked juniors. The researcher overviewed the procedures of the study with each participant. They read the following typed protocol adapted from Graham, French and Woods (1993) which stated:

'For the next 10 minutes, you will be watching a video-tape of tennis instruction. The purpose is to have you describe what you observe happening during this lesson.

You should find it helpful to take notes while you observe the tape. After viewing the tape you will be given another 20 minutes to write down your perceptions and evaluation of the lesson. Please try to provide as full a description as possible of what you observe.'

At the end of the first ten minutes the tape was turned off and the participants were asked to write their full individual accounts. The participants were given 20 minutes to complete their descriptions.

Recall Test

The expert and novice instructors participated in individual sessions of memory recall test during which they viewed a series of slides (Appendix B) depicting a variety of tennis players performing fundamental tennis strokes (e.g., forehand, backhand, volleys, serves) as well as tennis instruction related activities. The instructors viewed each slide

for five seconds. After the slide is removed, the instructors were asked to recall as much as possible from the slide. The participants had as much time as desired in between slides to provide as much information as they can. The instructors would then move on to the next slide. The comments were audio taped, the tapes later transcribed and analyzed.

Table 1. Data Collection Schedule

Analytic Technique	Estimated Time to Complete
Orientation meeting and inform consent form	10 minutes
Video Analysis	35 minutes
Recall test	15 minutes
Total for each participant	1 hour

Pilot study

A pilot study tested the time demand, efficiency and reliability of each instrument. The pilot study was performed with both expert and novice tennis instructors and for each of the instrument (video analysis as well as recall test). The novices met individually with the researcher. The experts were assembled in a salon at the Crown Plaza Hotel in Hilton Head, at the Head Quarters of the United States Professional Tennis Registry during the week of the USPTR international tennis symposium. For both the experts and the novices, the Informed Consent form was distributed and signed by both parties, the researcher and the participants. The instructors were introduced to the procedures of the study. The researcher distributed the written protocol for the video analysis and some pencils. They took notes while watching the 10-minute video. After the video was over, they completed their notes. This took approximately 20 minutes.

For the second data collection instrument, each instructor met with the researcher individually. The procedure for the recall test was explained and the teachers watched the series of slides. They watched each slide for 5 seconds. After each slide, the participants were given as much time as needed to tell the researcher everything they could recall

about the slide. This session was audio-taped. Once the recall test had begun, the researcher limited verbal communication with the participant to "recall anything you can about the slide". The instructors were then thanked for their participation in the pilot study.

Data analysis

Data collected from the different sources were analyzed to answer the research questions. Data analysis was qualitative in nature. For the video analysis, the completed written accounts served as written transcripts. The recall test audiotapes were transcribed and the transcripts were analyzed qualitatively. The researcher looked for recurring themes and categories using the "basic" or generic qualitative study technique recommended by Merriam (1998). The data analysis process of the video analysis written accounts and the transcripts from the recall tests also involved the development of a meta-matrix (Graham, French & Woods, 1993). This meta-matrix displayed information extracted from both data sources relating to participant's perceptual capacities. The matrix was divided into two for each participating group, (i.e. novices and experts).

The use of the constant comparative method (Glaser & Strauss, 1967) provided answers to each of the questions. In order to answer the first question, the researcher compared from the matrix, the focus of experts' perceptions as opposed to novices, the amount of detail, and the relevance to tennis instruction. Pertaining to the second question, the researcher isolated, on the matrix, instances where the participants might make inferences, interpretations and evaluations of what they perceive. Matrix reports relating to the participants' pattern recognition, and references to future events guided the answer to question three. The researcher underlined, on the matrix, every instance of

critical analysis and diagnosis mentioned by the participants and then compared both groups to answer question four.

CHAPTER 4

FINDINGS

The purpose of the study was to examine the differences between expert and novice tennis instructors' perceptual capacities. Specifically, this study strived to determine how expert tennis instructors' analytical perceptions differ from novices'. The findings are presented as they pertain to the four research questions.

Question one: issues of selection, detail and relevance to tennis instruction

There was a distinct difference between the participating experts and novices' perceptions in matters of selection and relevance to tennis instruction. Contrary to assumptions, however, novices went as much into detail relating to their observations as the experts did. Let's first inquire about experts' and novices' differences in their selection, then amount of detail and finally, the relevance of what they observed to instruction.

Selection: experts focus on technique and instruction

Both novices and experts were concerned with issues of safety. "I don't know how much they go into safety and if there's any stretching or warm-up then stretch" (Novice one). "It's a good safety technique there" (Novice two). "The instructor is pretty careful out there about his students getting hurt, which is good." (Novice three). Experts also made safety a priority: "He needs to be really careful with the kids at the baseline to make sure that the kids behind stay further behind them rather than very close where they could get hit by the racquet. Another safety feature." (Andy Johnston) "Two hoppers in the

picture, one on the side and one in the back but neither one in the way, which is good" (Jody Hyden). "The pro is way too close on the way back and there are way too many balls all over the court- it's a very dangerous situation" (Jeff Wallace)

Novices' perceptions: selection

In general though, novices' perceptions lacked selection. They commented on a variety of topics from technique to age, tennis wear and sometimes weather conditions. On the same slide, (slide number four) one of the novices observed:

> It was a young lady. Had one of her legs up - I couldn't make out whether it was the right or the left up -- towards the back. She had on a blue hat. She was holding the racquet in both hands. Looked like she was charging toward the net. She had a smile on her face. She had a blue cap on. I think it was a girl because she had long hair streaming down the back of her neck. That's it. (Novice two)

One of the novices was interested in racquet brands: "She had a Prince Michael Chang Titanium...She had a black Prince racquet with blue strings…he had a yellow black racquet." (Novice four). An interpretation could be that this person had just started teaching full time in a club and his duties include racquet sales and stringing. None of the experts mentioned racquet brands. Another novice paid specific attention to the court surface: "It's on a clay court…On a hard court." (Novice three). The reason behind it was he had severe knee problems and his personal preference was to play on clay courts.

Experts' perceptions: selection

Experts' perceptions were much more selective. They focused primarily on either technique or instruction. Here are instances were the emphasis is on instruction. The tennis teacher "has to stop and start over a lot. He should have had all that stuff ready

before he ever started. So far, I would say it's very disorganized. He's going too fast for this level." (Jody Hyden). "The good thing about the drill is he's got them working forward toward the net - that's good" (Chuck Kriese).

As far as technique, here are Jeff Wallace's perceptions on slide number four:

> That's somebody hitting a backhand groundstroke. Their elbows are very high in on the body. It don't like that position too much. She's actually stepping across. So, with her feet she's having to reach to the ball but with her hand she's very jammed. So I think her footwork and elbows and hands should be a lot different. That was about it. (Jeff Wallace) His comments on this slide were exclusively focused on technique.

In brief, in matters of selection, both experts and novices were aware of safety issues. Experts focused mostly on technique and instructional situations. Novices were much less selective in their commentaries. However, in some instances, selection for the novices seemed to be connected to personal history.

Detail: accounts were similarly detailed but qualitatively different.

Pertaining to the amount of detail in experts' and novices' data, surprisingly, novices gave as detailed a description as did the experts. The amount of information was similar. Nonetheless, the focus of the description differed greatly.

Novices' perceptions: detail

Here are the commentaries of slide number 10, from one participant of each group. Novice one explained:

> Okay, the guy's going for a backhand. Looked like Clemson University -- a big tiger paw back there. I'm not sure, I'm not a fan so I won't make any statement

> regarding that but it looked like the guy was going for a low backhand volley. He had a white uniform on, a hat. It was probably Clemson is what it looked like to me -- like a university setting or a -- I thought I saw a car, buildings may have looked like they were in a school setting. It looked like several courts. It was a -- the tennis courts were -- courts were lower than the surrounding buildings -- not submerged -- not like an atrium, but like a sunken living room or something like that. That's it. (Novice one).

This is a very detailed description of what Novice one perceived with comments relating not only to the player's technique but also his tennis wear, the setting and the environment.

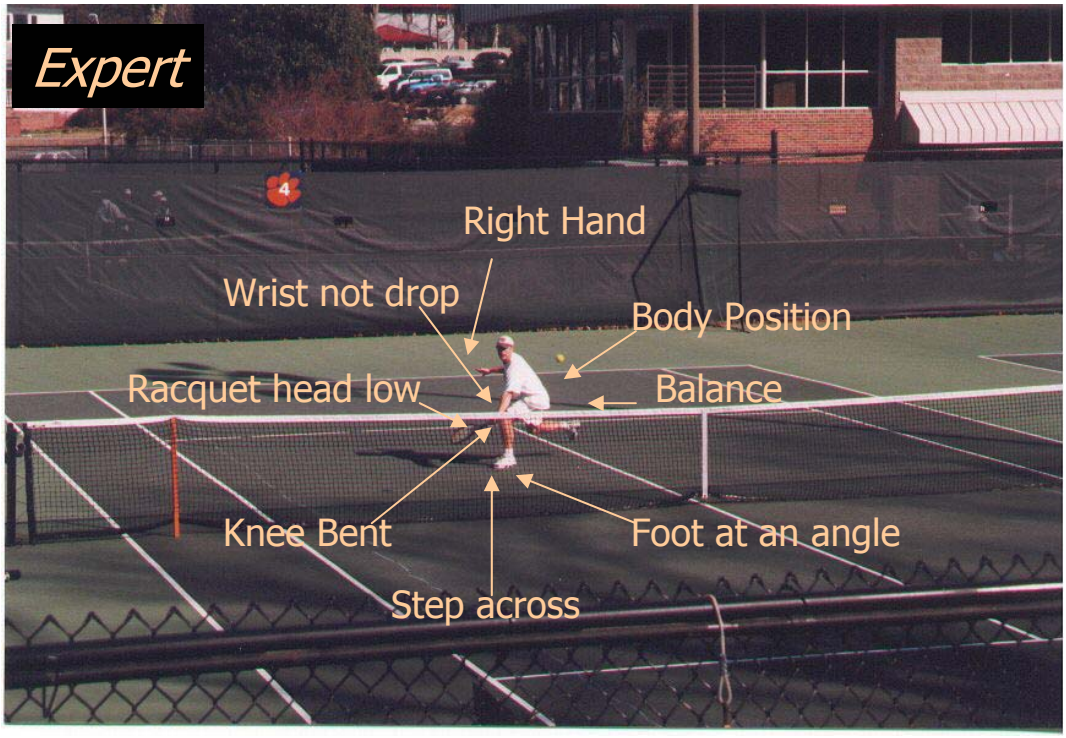
Experts' perceptions: detail

On the other hand, Andy Johnston's comments on the same slide focused solely on technique:

> This is a great tennis shot, a great instructional shot. It looks like the person coming into the net was in textbook positioning, nice step across, looks like he hit a low volley. He had his racquet head down. He didn't really break down or let his wrist drop - beautiful shooting his right hand back that extra power being left handed. Looked like he had good body position, and good power off the ball, good balance - really getting a good knee bend and that foot looks like it's closed off at an angle. Textbook picture. (Andy Johnston).

It appears that quantitatively there was as much detail in the novices' data as in the experts'. Yet, the contrast in the content demonstrated that experts' perceptions focused extensively on information that was relevant to tennis instruction. In other words,


Novice
Car
Courts lower than buildings
Buildings
Clemson Tiger Paw
Hat
Several Courts
Backhand
White Uniform
Low Backhand Volley
University setting


Expert
Right Hand
Wrist not drop
Body Position
Racquet head low
Balance
Knee Bent
Foot at an angle
Step across

pertaining solely to motor skill or instructional information, experts' accounts were more detailed than novices'.

Relevance: experts solely focused on relevant information

Butch Staples was intrigued by the amount of irrelevant comments in the novices' data. "Is that consistent? Are there lots more irrelevant comments made by the novices vs. the expert teachers?"

Novices' perceptions: relevance

Indeed, novices noticed a variety of things on the video and the slides that did not have any relevance to tennis instruction:

> The guy had blue shorts on, a white hat, a white shirt; he had on a watch with a bright band… a little bit of foliage back there. I think she had a white blouse on. She had reddish-blond hair, I think brown eyes…Two cars in the background, I don't remember if I said he had dark glasses on… The device you drag the court with was on the court… (Novice one)

"He was wearing blue Reebok shorts…It was a sunny day… She had her tongue hanging out…"(Novice four). "There was a balcony on the left… There's a couple of cars there behind the windscreens" (Novice three).

On slide five, all four novices noticed that the man was wearing sunglasses. None of the experts mentioned it. "He had shades on" (Novice four). "The guy has sun glasses on" (Novice three). "It was a middle aged man with sun-glasses" (Novice two). "dark glasses… I don't remember if I said he had dark glasses on" (Novice one). Butch Staples wondered how the participants interpreted the recall test protocol. He thought the novices did exactly what the protocol asked them to do: "He looked at the slide, remarked all

kinds of things on the slide (laugh)."(Butch Staples) Indeed, novices' data included information regarding some tennis motor skill and instruction related comments but also observations on a variety of topics like the environment, the weather, or players' clothes.

On average, the novices would make approximately three technical comments per slide, considerably less than the experts.

> It was a middle-aged man with sun glasses. He had on a white shirt, blue pants. He was doing a two-handed backhand. There were cars in the back on the other side of the fence. He had the racquet over his left shoulder - his right leg was bent he had both hands on the racquet. Had shorts on. That's all (Novice two).

Experts' perceptions: relevance

Jeff Wallace's comments on the same slide read:

> Basically, I see someone with a forehand groundstroke just inside the baseline. He's made contact, he's in his finish - he's got good follow through - he's got the racquet wrapped around. A pretty good ball. His left hand is on the racquet. A lot of people like to follow through up front just to be extended out right up in front but I like a little more racquet speed on shots - and following through a little more than that (Jeff Wallace).

Most if not all of the experts' perceptions were relevant to tennis instruction. Butch Staples noticed commonalities in the experts' data as far as their selection, relevance to tennis instruction and critical analysis: "Look at all the tennis related feedback, in terms of the body position, feet, grip, impact too soon, legs, grip, head position." (Butch Staples)

Experts would mention age only if it had relevance to instruction. Chuck Kriese explained: "He should have been going left foot forward into the court. He's an old guy so he's not going to get much leverage with his legs, so that makes it hard." (Chuck Kriese) Experts would also mention tennis wear if it was not appropriate for the surface: "She had on running shoes"(Chuck Kriese).

When asked why he didn't mention anything regarding the background (i.e.: cars, foliage) or the student's hair color and clothes, Jody Hyden explained:

> I don't think that's relevant nor has any bearing on their technique or stroke mechanics or anything to do with tennis, coaching or observing. I don't think that makes any different at all. Because I feel like as somebody critiquing the game of tennis the things to observe are mechanics, positioning, strategy, teaching technique. Now if the tennis pro had been dressed poorly, I would have mentioned it or if the players had improper equipment for the surfacing, that would be relevant (Jody Hyden).

Butch Staples noticed both a qualitative and quantitative difference between the experts and novices tennis related feedback.

> These data here show half a dozen technical related comments. Rather than leaving room for bias and interpretation, if there are six or seven points in the experts' data and only one or two points are tennis related in the novices' data and you find that to be consistent, it takes away from the personal bias (Butch Staples).

The comparison between expert and novice data revealed a dramatic difference in the amount of irrelevant comments made by both groups. Experts' data cumulated only 4

irrelevant comments: “Do you want environment things like windscreens and backgrounds? There was a windscreen missing right behind him.” (Jeff Wallace).

In contrast, a total of 94 irrelevant comments appeared in the novices’ data: “She had on blue shorts, tennis shoes, pink shirt… There were flowers/trees behind the fence.”(Novice 2).

Summary analysis of question one: selection, detail, relevance

As an answer to question one, in matters of selection, experts’ perceptions pertained mostly to technique and instruction whereas novices had a wider range of observations from technique to weather conditions and tennis wear. There was as much detail in the two sets of data but the information was qualitatively different. Experts' accounts relating to motor skill or instruction were more detailed than novices'. Most if not all the comments emerging from the experts' data was relevant to tennis instruction. The novices, on the other hand, studiously complying with the protocols, described everything they could perceive regardless of its relevance to tennis instruction.

Pertaining to question two: differences in inferences, interpretations and evaluations

Inferences on motor skill, athleticism and instruction

Novices’ perceptions: inferences

Instances of inferences were quasi absent from novices' data. The only few examples were as follow:

> There were singles sticks up which is unusual, probably a competition and the guy, whoever is hitting that backhand volley just looks gorgeous…It leads me to believe it's a high level of tennis being played here. If it wasn't Clemson it was probably a college match or something going on (Novice three).

"Looks like it was a Clemson tiger court cause I saw an orange 4 so I think they are a university team" (Novice four). Novices one and two did not make any inferences.

Experts' perceptions: inferences

In contrast, experts made inferences on athleticism, motor skill, as well as power and timing: "You can tell from the muscle tones of the kids that they're not very athletic" (Chuck Kriese). "It looks as though she's got a semi-western forehand grip and has looped forehand, probably rather large loop forehand, on what I could see of the preparation" (Jody Hyden). The footwork seemed to be an important clue for experts' inferences: "She was loading on the right foot- looks like she stepped out on the right foot first" (Chuck Kriese). "She's probably leaning way too much forward and therefore her back foot came off the ground" (Jody Hyden). Experts also made inferences on timing and power, for these could not be determined from a still picture.

> I think she probably hit the ball a little bit early in an open stance with the way the footwork looked right there…beautiful shooting his right hand back that extra power being left handed. Looked like he had good body position, and good power on the ball (Andy Johnston).

In some cases experts would make a number of inferences from just one still shot:

> He flips the follow through up over his shoulder which means he probably hits a top spin but he probably hits pretty well short of the court. It looks like the length of the stroke wasn't very good… He was inside the baseline which means he just hit a short ball (Jody Hyden).

In other cases, inferences pertained to drill and instruction: "Whether the pro was hitting a mid-court drill or a low-ball drill, obviously he was hitting the ball to

them and then the two on his side were reacting to their ball and probably playing the point out from there and re-setting after that" (Jody Hyden).

Interpretations: expert's interpretations were more relevant to tennis and instruction

Both novices and experts made interpretations on what they perceived. As opposed to novices, experts interpreted events solely relating to tennis or instruction.

Novices' perceptions: interpretations

Novices' interpretations incorporated a variety of topics, from hairdos to facial expression: "It looks like it's staged for the picture there…it's just a little too perfect. There's not a hair mussed. I don't think he actually hit the ball. It's just my suspicion" (Novice 3) "They're burning plenty of calories out there -- whether it's because they're on film, it's hard to say" (Novice 3). "He had confidence on his face like he'd hit a winner" (Novice 1)

Experts' perceptions: interpretations

Experts' interpretations, on the other hand, were more tennis and instruction related. Experts made interpretations relating to motor skill: "The one on the right looked to have a better serve and motion and the one on the left looked to be a slightly lower level player just by looking at her and her back swing…I would probably say it was a back-in-play ball or an offensive volley" (Jody Hyden). "But I really couldn't tell if she was stepping in stepping forward or to the side depending on where the court is. If she was stepping to the side I would say her weight was to the side and not forward" (Andy Johnston). Interpretations were sometimes linked to drills and instruction: "Maybe they're working on pinch drills - maybe they've got the two volleyers hitting down at them and making them react" (Chuck Kriese). "It looked like a low ball drill for the net people"

(Jody Hyden). "It didn't seem like there was that much instructor / pupil communication. He was saying things but I don't know if they really understood the things they were being told" (Jeff Wallace). "He uses some positive reinforcement so he seems to be a pretty positive guy" (Jody Hyden). Some interpretations referred to students' interest: "Kids get bored with technique and want to go to another teacher. They just want to hit the ball" (Chuck Kriese).

Evaluation: experts substantiated each of their evaluations with a specific explanation

Both experts and novices' perceptions demonstrated the use of evaluation. However, experts not only made evaluations but they would constantly substantiate their observations with precise information. The experts' data would evolve from evaluation to critical analysis. Experts' and novices' critical analysis was the focus of question four.

Novices' evaluations

Novices' evaluations were mostly descriptive and not analytical: "He had pretty form on it. He is stepping across…He seems to have a lot of energy that's really good" (Novice four) "The student hit a good volley and the instructor explained that it was good" (Novice 2). "He also seems to be hard in the punishments he gives out" (Novice 3). "The guy, whoever is hitting a back-hand volley just looks gorgeous -- pretty form on that" (Novice 3).

One of the novices (Novice one) was an experienced teacher but a novice tennis teacher. His evaluations pertaining to instruction were significantly more astute than the other novices'. This first example illustrates his evaluation of the drill according to students' behavior: "I don't see any boredom -- I see plenty of attention. There's enough movement so they don't have time to be bored. They had to concentrate on where they're

supposed to be. It's a good drill…I don't see anything negative" (Novice one). When it came to technique, Novice one was not as specific in his evaluations: "Looked like pretty good service poses as far as the toss was concerned" (Novice one)

Experts' evaluations

Here are a series of examples illustrating experts' evaluations relating to instruction. Each statement was reinforced by a specific explanation: "So overall so far, I would say that he's feeding the ball pretty well; he's vocal and verbal which is good; he does know their name and that's good…He is good with kids. The kids seem to like him. He has a good personality for teaching" (Jody Hyden). "It's good that the instructor is instructing them while they are picking balls about a firm wrist and keeping the swing shorter" (Andy Johnston). "The kids are having a good time and he's teaching them -- they're hitting a lot of balls and he's got an organized drill going but like most teachers, technical skills aren't taught" (Chuck Kriese). Experts evaluated the children as well: "So the eye hand coordination is good and athletic ability average… That little kid has good hands there. The kids are staying into it pretty good" (Chuck Kriese). Technical evaluation was very specific: "Still too much racquet movement, too much swinging, too much loose wrists, instead of keeping a short compact swing with the volley" (Andy Johnston). "He had a good backhand grip pronated" (Chuck Kriese).

As opposed to novices, experts would evaluate an action using (a) why this instance deserved positive or negative evaluation, and (b) substantiate their observations with suggestions for improvement. The evaluation would evolve into critical analysis as discussed in response to question four. One of the novices was an experienced teacher but novice tennis instructor. His evaluations of tennis mechanics were comparable to the

other novices yet he stood out in his evaluations of the instructor. This finding suggested that teaching experience influences the ability to evaluate a teacher regardless of the subject matter.

Summary analysis of question two: inferences, interpretations and evaluations

In summary, experts and novices were drastically different in their use of inferences, interpretations and evaluations. Inferences were quasi absent from novices' data. Experts on the other hand were able to make inferences on a multitude of topics, from athleticism, to motor skill, power, timing, but also drill organization and instruction. Both experts and novices made some interpretation of what they perceived, yet as opposed to novices', experts' interpretations essentially portrayed to tennis and tennis instruction. Evaluation was widespread in both sets of data. As opposed to novices, experts' evaluations focused solely on tennis and instruction. Further, experts evaluations would evolve into critical analysis and diagnosis as will be discussed in answer to question four.

Pertaining to question three: patterns, understanding of a situation and anticipation

Patterns: experts' cognition followed a similar pattern

Novices' perceptions: patterns

Novices' data were full of random thoughts and no noticeable, meaningful pattern. Novices were less predictable in their response. As mentioned in response to question one, the novices were less selective and even though their accounts were detailed, they were not always relevant to instruction. The comments would ricochet from technical observations to tennis wear, environmental remarks or instructional interventions in miscellaneous order.

> Two girls [gender] One looked like they had a dark dress on, the other a blue dress on white skirts [tennis wear]. They were going through their toss [technical observation] like maybe the older girl might have been instructing the other girl [hypothesis]. Looked like a clay court [surface]. The device you drag the court with was on the court [court maintenance device]. Looked like pretty good service poses as far as the toss was concerned [evaluation of the technique]. It looked like that was what the instructor was emphasizing -- the toss -- [instruction] and they were getting ready to hit the ball [observation, anticipation of future event]" (Novice 1).
>
> It was one person on the court. They were in front of the T. [court positioning]. The court was labeled number four. [description environment] The man -- it appeared to be a man-- had on white shorts, white shirt, white hat, and white tennis shoes. [tennis wear] It looked like he was going down for a volley - I did not see a ball. It looked like he had the racquet in his left hand but he was bent down like he was digging out a volley. [tennis related observation] (Novice 2).

Experts' perceptions: patterns

It was anticipated that experts' perceptions would follow specific technical patterns like those endorsed by the USPTR certification program with first the grip, then the stance, preparation, footwork, point of contact and follow through. Contrary to assumptions, the data did not reveal any such patterns. However, there was a distinct pattern in experts' cognition.

Expert tennis instructors displayed a similar pattern in their thought processes and critical analysis. They would first mention what was most striking to them and then derive the rest of their analysis from that first observation.

For example, on slide one, experts first noticed the player's footwork, weight transfer, and wrist pronation: "He's moving into the court…he's pronated as has hit the ball, and he's looking up at the ball, and he's beginning to follow through as he's going to the net as he serves and volleys" (Jody Hyden)

> He had good weight transfer - weight was coming forward - he had good pronation with the racquet head. I liked the way he curled his left arm to his stomach to get extra power - I didn't like his footwork though - he was crossing over and it was sort of a stepping across more than a thrust with his footwork (Andy Johnston).
>
> Not too bad. He opened his body too soon. The guy had a cross-over step on his serve. He had a good grip. Pronated well when he served - the cross over step made him open up too soon and he should have been going left forward into the court…(Chuck Kriese).

On slide two, a more chronological approach prevailed with emphasis on preparation, shoulder turn, grip and footwork:

"Good preparation… Good grip, good turn…She was loading on the right foot, looks like she stepped out on the right foot first. She had a semi-western grip - good shoulder turn." (Chuck Kriese). "Wide forehand groundstroke-they're starting to bring the racquet back - has a little bit of a weak back swing because the racquet is back kind of high with a continental grip- shoulders turned hard" (Jeff Wallace).

> She's getting ready to hit a forehand, her shoulders are turned. Left hand is out in front as if she's spotting the ball, hips are turned, she's moving to the ball. Half way in preparation, she's dropping her shoulders… semi-western forehand grip… running to the ball (Jody Hyden).

There was a distinct pattern in experts' cognition. Indeed, experts would (a) start from an atypical event, (b) build their technical or instructional analysis from this particular event, (c) validate their point with specific technical or instructional explanations, and (d) conclude with suggestions for improvement as well as occasionally infer on future events. Through this process, experts utilized and demonstrated their extensive knowledge.

Situation: experts made instant sense of a situation

Just as novices and experts differed in their thought organization and use of meaningful patterns, the two groups showed disparities in their ability to make instant sense of a situation.

Novices' perceptions: understanding of a situation

Novices' had a limited understanding of the presented instructional situations. They were often unable to describe with any precision what the drills entailed. Sometimes the drill would not make any sense: "I'm not sure if they are supposed to stay at the service line or if they are allowed to move in" (Novice 4). "I'd have to study the drill I don't understand… I don't understand this drill" (Novice one). "I don't know what the numbers mean, one, two, three, four, five but all five of them are doing sit-ups, I'm not sure why." (Novice two)

Significantly, in some instances, novices did not recall how many students were involved in the drill. After watching the five children taking a group lesson for more than ten minutes, Novice three commented: "the kids weren't perfectly matched, I don't think, in ability levels but there were six of them out there (I think)." (Novice three).

Experts' perceptions: understanding of a situation

In contrast, experts made instant sense of what they perceived. Their ability to recognize drill patterns greatly influenced their understanding of the instructional situation. Experts would look at the number of students, their division on each side of the court, then focus on the students' court position (i.e. at the net, baseline, singles line, doubles teams…) and finally notice the teacher location and activities (feeding or not). This routine helped experts understand the drill pattern and therefore make sense of the situation.

> The instructor here has five students…He's got three at the service line on one side and two on the service line on the other side of the net… He's alternating feeding both lines… After they hit the volley, they're to come up, split step, hit the volley, split step and then get back in the opposite line (Andy Johnston).

Anticipation of future events: absent from novices' data

Novices' perceptions: anticipation of future events

None of the novices' data revealed instances of anticipation of future events. Their difficulty in making sense of the present situation did not give them the opportunity to evolve beyond the present and into the future. The following slide illustrated two mixed doubles players, one serving and one up at the net. Here is what Novice two perceived:

> Looked like two Afro Americans, one at the net and one at the baseline. The one at the net was facing the other side of the court. The one at the baseline was in a configuration. I don't know what they were doing. I don't even know if they had a tennis racquet in their hand. I couldn't see. That's all (Novice two).

Experts' perceptions: anticipation of future events

Experts' understanding of drill patterns, as well as technical analysis and past experience, were factors influencing their ability to anticipate events to come. Drill patterns provided answers regarding what event was coming next. "The pro was in the back in the center initiating with the other two players on the other side and … then the two on his side were reacting to their ball and probably playing the point out from there and re-setting after that" (Jody Hyden).

Anticipations of future events were sometimes linked to observations or technical analysis: "The lady at the net is not very ready. She's got a western grip. She's going to get smacked in the head with a ball" (Chuck Kriese). From a still picture, Chuck Kriese analyzed the present situation, explained the dynamics of the movement and drew conclusions on events to come.

While observing the video, experts provided some suggestions for improvement. Andy Johnston suggested instructional feedback while students were doing sit-ups. Almost instantly, the instructor made some comments on the students' level of intensity and on how they should close in on their volleys. This was an example of experts' ability to anticipate instructional situations: "They've missed five volleys so he has the players doing twenty sit-ups. This would be a good opportunity for the instructor to do some

teaching and give some corrections as the students are doing sit-ups…He just started giving a little instruction while they're doing sit ups" (Andy Johnston).

Past experience also influenced experts' ability to anticipate future events. In this case, Chuck Kriese justified his judgment with facts based on knowledge and past experience:

> Contrary to the guy that served the first one, this guy is jumping in with his right foot first. He keeps his shoulder squared longer and he doesn't spin out. When you do a cross-over step, you hit the ball into the net, you pull the ball down, you open up too soon. You have to stay sideways until the point of contact and then you'll land on the foot so it's up and come forward. 100% of the pros now go front foot first into the court so they stay sideways. Old people have to do a cross-over step like we used to in the 50's because they're not strong enough - so you can hit a flatter slicer (Chuck Kriese).

Butch Staples agreed that when an expert "sees something in terms of an action or a movement even before it happens, they can anticipate what's going to occur because they've seen it so many times." Experts associated a present situation with past experiences and therefore had a better understanding of the present situation. They had the knowledge to compare the present situation to a norm and therefore had a better sense of anticipation of what's going to happen next:

> Backhand ground stroke. She was very off balance [observation] cause she was only on one foot [justification] and was on the weight off her right foot which would be correct [comparison to a standard] but probably leaning way too much forward and therefore [consequence of leaning too much] her back foot came off

> the ground so her body was moving a lot forward or to the side which is more than should be [comparison to ideal] and if she would [suggestion] keep her back foot down and not take such large steps to the ball - it would probably help her to take smaller steps - and be on balance more and to keep her back foot down as she hits through the stroke (Jody Hyden).

Experts' ability to contrast information with a norm granted them a greater ability to anticipate future events.

Summary analysis of question three: patterns, understanding and anticipation

In summary, novices did not demonstrate the use of meaningful patterns and anticipation of future events. Their accounts lacked structure and their limited understanding of the present situation did not allow them to make comments on future events. Experts' data, on the contrary, revealed some commonalities with regards to use of patterns, understanding of a situation and anticipation of future events. Experts' cognition followed a specific pattern. Experts made instant sense of a situation, due to their ability to recognize drill patterns. By contrasting the present situation to a standard and relying on past experience and personal knowledge, experts were able to anticipate events to come.

Pertaining to question four: critical analysis and diagnosis of motor skills and instruction

Butch Staples inquired about the video analysis and recall test protocols and asked if there was a difference in the interpretation of the word "describe" among the participants. He found that experts in the study did much more than just describe what was going on. He found experts' data to be interpretive, full of judgment and critical

analysis. "It's not just a description of what they see as much as it is an analysis" (Butch Staples).

On the other hand, he found novices' data to be descriptive and to lack judgment even if there were some personal comments here and there. When asked if he could tell the difference between expert and novice data, he answered "Oh absolutely, it jumps out at you." Butch Staples added: "The way the protocols read, you ask them to observe and not necessarily to analyze. But all of them, you say, all the experts pretty well did some type of critical analysis? This indicates the difference between experts and novices. So that's a finding then." (Butch Staples). Indeed, experts offered specific critical analysis of both motor skill and instructional situations:

Motor skill: considerably more critical analysis and diagnosis in experts' data

What does critical analysis of a motor skill involve? Knudson (2000) explained that critical analysis requires a plan for diagnosis. For Knudson, accurate qualitative analysis also requires appropriate diagnosis of movement. He defines diagnosis as "the determination of the underlying causes of the strengths and weaknesses identified in evaluation" (Knudson, 2000, p. 21)

Novices' perceptions: motor skill

Novices' perceptions of a motor skill were mostly descriptive and lacked critical analysis. Novices noticed some technical mistakes but rarely analyzed it or offered any suggestions for improvement: "He's hitting a serve. A little pronation. It's a sunny day out there. He's a right handed guy in his mid-fifties. The guy was wearing a hat" (Novice three). In the next excerpt, the novice made a judgment on the quality of the volley but did not justify his opinion with any argumentation or critical analysis: "It's a volley drill

and it seems to be a lost art -- the volley. Some of them can do it and others not so good. That one is really good. The two top players are volleying now -- seems all right" (Novice three). In addition, they often mentioned the same error repetitively. "Swing too much on the volley. He's still swinging a little too much…He's still swinging too much… their volleys, they were kind of swinging" (Novice four). Two explanations might be (a) the mistake captivated their attention and they were unable to detect other technical mistakes, (2) their knowledge was too limited for them to be able to perceive other technical mistakes.

Novices' diagnoses of technical errors were scarce and intertwined among a multitude of irrelevant comments: "It's a lady who's getting ready to hit a forehand. She just got a high racquet back. Looks like she's keenly focusing on the ball -- seems to have a bit of a perm -- seems intense out there. Again, weather appears to be a nice day" (Novice three). The novice described that the racquet was high but did not make any critical analysis regarding the consequences of that racquet being high. He did not mention if that was good or bad. He simply described what he saw.

Experts' perceptions: motor skill

Experts went into details in their diagnosis and critical analysis of a motor skill. Focusing on the same slide as above, Jody Hyden explained:

> She's getting ready to hit a forehand; her shoulders are turned. Left hand is out in front as if she's spotting the ball, hips are turned she's moving to the ball. Half way in her preparation, she's dropping her shoulders. She's getting ready to hit a ground stroke from the baseline. It looks as though she's got a semi-western forehand grip and has a looped forehand, probably rather large loop forehand, on

> what I could see of the preparation. She's looking at the ball, running to the forehand side (Jody Hyden).

His account reflected superior critical analysis and diagnosis of a motor skill. He not only noticed her large preparation but also her shoulder turn, the position of her non-dominant hand and why she had her left hand in front. He noticed her hip rotation, her movement, her timing, her shoulders, her grip, and her concentration on the ball.

Experts' diagnosis of a motor skill was not limited to error perception but included suggestions for improvement as well. "They're starting to bring the racquet back… I prefer to track the ball at the tip of the racquet versus getting the racquet back too early then stroke at the ball all at once - holding and then stroking at the ball controlling racquet speed" (Jeff Wallace). "Could have got a little lower on his legs - could have stepped into the ball a little more - a little bit wider base with his footwork" (Andy Johnston). Experts seemed to consider critique and suggestions for improvement as their priority.

In his diagnosis and critical analysis of a motor skill, Jody Hyden started from an observation, justified his observation, compared the technique with a standard technique, then showed the causes and consequences of the technical error, and concluded with suggestions for improvements.

> Backhand ground stroke. She was very off balance cause she was only on one foot and was on the weight off her right foot which would be correct but probably leaning way too much forward and therefore her back foot came off the ground so her body was moving a lot forward or to the side which is more than should be and if she would keep her back foot down and not take such large steps to the ball

- it would probably help her to take smaller steps - and be on balance more and to keep her back foot down as she hits through the stroke (Jody Hyden).

Sometimes the experts would even disregard a potential error and justify the use of an unorthodox technique: "It's tough for a kid to put a high floater away without swinging. He said no swing. It's almost impossible… If the ball sits, you have to generate some pace" (Jody Hyden)

A series of "critical features" emerged from the data. "Critical features are the most invariant technique points of a movement: they determine whether a movement is effective, efficient, and safe" (Knudson, 2000, p.20). Table 1 and Table 2 (Appendix C) contrasts the experts and novices' technical references.

Experts focused their attention on a multitude of critical features notably arm, back swing and preparation, back and body position, point of contact, balance and weight transfer, elbow, eyes, footwork, grip, hand, head, legs, movement, positioning on the court and towards the ball, racquet, timing, and wrist. Experts were able to perceive significantly more technical elements. The four novices' data combined did not include as many critical features as one single expert transcripts. For example Andy Johnston examined 30 different critical features (hand, wrists, body position, head, legs, grip, etc…) while the four novices combined examined at total of 19. Experts' technical comments added up to 578 words, while the novices had less than half as much with a total of 251 words.

Further, there was a lot of consistency among experts' critical analysis and diagnosis of motor skill: "He opened his body too soon. The guy had a cross-over step… pronated well when he served - the cross over step made him open up too soon and he

should have been going left foot forward into the court" (Chuck Kriese). "It looked like he might be a little open… he had both feet very close" (Jeff Wallace) "He's pronated… he's moving into the court" (Jody Hyden). "He had good pronation… he was crossing over and it was sort of a stepping across more than a thrust with his footwork". (Andy Johnston).

On slide three, what caught the experts' attention was that the volleyer was not stepping with the right foot. The experts made this technical abnormality their priority and then derived the rest of their analysis accordingly. On slide four, experts focused on the lack of balance. Again, the experts organized their train of thought starting from the loss of balance, brought out possible causes for it, the consequences of the loss of balance, what would happen if the balance was good and suggestions for improvement. For slide five experts evaluated the follow through. On slide six the emphasis was on the elbow, on slide seven there were some comments on the server but mostly on the volleyer who wasn't in a proper ready position.

Instruction: similar findings emerged in experts' data relating to instruction

Novices' perceptions: instruction

The findings were similar with regards to the critical analysis and diagnosis of an instructional situation. The novices made some evaluations of the instructor, they described the instructional situation but in most cases, had limited analysis and diagnosis: "He didn't shake hands and look them all in the eye at all -- but maybe that's not important with younger kids" (Novice three). In some cases, the novices would respond with critical statements but yet not develop their train of thoughts: "He's making sure they do it right. Positive reinforcement. Spontaneous decision making. It helps cause they

know exactly where to stand…" (Novice four). No examples nor explanations were provided on why positive reinforcement and spontaneous decision making could be relevant or have any weigh in the critical analysis of the instruction. "I think that' s right. I don't know if I would do that same approach, harder than it's supposed to be. Now they're trying the five balls again" (Novice four). The reader is left with a personal interpretation of why "that same approach" would or would not be appropriate.

Novices' data lacked structure. Points were made randomly without the thought organization demonstrated by the experts. However, Novice one, who was a first year tennis instructor but had teaching experience was able to, in one instance, critique instruction and also provide some suggestions:

> I wouldn't have gone through all those drills without giving feedback on how the volleys should be done -- I would have stopped and given them demonstrations -- let them see how it should be done. To me that was a long drill without some correction without getting an error to bring out, emphasizing that this is not the way to do it. It's like reinforcing the wrong way -- don't let them hit too many times the wrong way -- you don't want that to sink into the psyche. To me, the only way to learn the game is the feel of it -- you've got to know what's right and once you feel what's right that's where the repetition comes in. If you know it's right, and it feels right, and you keep hitting it and reinforce that right feeling is the only way to progress. It's true that you can progress in just playing but to me it's a much slower process." (Novice one).

Consequently, it appeared that a critical analysis and diagnosis of instructional situations was linked to general teaching experience. However, even though Novice one

provided this specific argumentation, this instance was the only one in the entire data set. The rest of the novice data were less structured and more descriptive.

Experts' perceptions: instruction

In contrast, experts were constantly making critical analysis and diagnosis of instructional situation:

> First off, he should know their names before they start. He should tell them what they're going to do before he tells them to get over there. No technique at all. He should demonstrate the drill before you start it with himself and maybe one more kid on each side. That would have helped them at the start. He had to stop and start over a lot. He should have had all that stuff ready before he even started. So far, I would say it's very disorganized. He's going too fast for this level-- he should probably slow his feed down a little. Also, technique is thrown out the window because… (Jody Hyden)

Thus, Jody Hyden jumped directly into critical analysis without a word of introduction nor any type of description. His analysis was chronological. The entire first page of his video analysis account was dedicated to critique and diagnosis of instruction. There was no room for description. No time was spent on any comments that would be irrelevant to tennis or tennis instruction.

Andy Johnston began with a description of the drill and then his comments developed into technical and instructional analysis: "The instructor here has five students. He's giving instructions about what the drill will be…He's got three at the service line on one side and two on the service line of the other side of the net…The purpose of his lesson is for the students to cut toward the ball and to cut the volleys at a diagonal

angle…They're not working on placing the volleys anywhere -- they're pretty much hitting them anywhere. He'd do a better job by having them place the volleys and have a target on the other side of the net" (Andy Johnston).

Similarly to motor skills, there were consistencies regarding experts' critical analysis of instruction: "He'd do a better job by having them place the volleys and have a target on the other side of the net" (Andy Johnston). "They've got one ball in play now and this is the fifth ball, sixth ball -- still no ball [consistency]" (Jody Hyden) "Where are they suppose to hit the ball… I also feel like there's been no discussion about where they should be hitting these volleys… But I really feel again, at this level… they need to be thinking about consistency versus thinking about passing whose at the net" (Jeff Wallace). "I'd like to see the children have to keep a rally going 3-4-5 balls" (Chuck Kriese)

There was some consistency among novices' data as well for they all offered a complete description including sun glasses, clothes, or even cars. However, the novices' data scarcely involved critique or diagnosis. "He had a yellow black racquet, he had shades on, he was hitting a two handed back hand, he had really nice form on it, he followed through with his racquet up by his ear. Very nice looking backhand follow through." (Novice four) "This is a picture of a fellow who just completed a follow-through… It looks like it's staged for the picture there. There's a couple of cars there…The guy has sun glasses on" (Novice three). "It was a middle aged man with sun-glasses. He had on a white shirt, blue pants. He was doing a two-handed back-hand. There were cars in the back on the other side of the fence" (Novice two). "Blue pants,

white shirt, dark glasses. He just hit a two-handed forehand, it looked like to me. Two cars in the background. I don't remember if I said he had dark glasses on" (Novice 1).

Domain specificity of experts' superior critical analysis and diagnosis:

One of the slides (slide nine) represented a physical education instructor, at the beginning of a tennis class of approximately 30 college students. The instructor did not have a racquet in his hand and the students were all standing behind the baseline. This slide was chosen because it was related to tennis and tennis instruction yet it was out of a traditional context and assumed to be peculiar to the expert eye. Slide nine was presumed to offer answers to the domain specificity of experts' superior perceptual capacities.

Indeed, experts and novices data were quasi interchangeable when it came to slide nine. Experts had trouble making sense of the situation. Their critical analysis of the situation was scarce. They were more descriptive than analytical. Their thoughts were not as structured and lacked selection. They did not make any inferences or any comments on events to come: "He's doing a clinic- maybe a warm up. People are there. Half of them are finding shade. They're going to do a few exercises. Didn't pick up anything else" (Chuck Kriese).

In spite of their confusion, experts showed some commonality in their perceptions of this slide nine. The data reflects experts' interpretations as opposed to affirmations through the use of "maybe, I'm not sure, probably, looks like, possibly, something". "Looks like the instructor here is talking to the class either starting to get them warmed up stretching them or just about ready to start an instructional piece" (Andy Johnston). "This looks like an instructor talking to a large group of people getting ready to do something… He's getting the group ready to watch something. Lot of people up front

right there. They look cold" (Jeff Wallace). "Wow, a lot of people per court. One guy doing something-- Probably too many people for that one court if that's what they were getting ready do because there's much more than a four or five to one ratio there" (Jody Hyden).

No one on the picture was performing a motor skill so there was no critical analysis of a motor skill. Yet, in spite of the peculiar situation, the experts were able to offer some suggestions to improve instruction. "I'd like to see the class closer to him unless he's walking to them to get closer" (Andy Johnston). "Two or three baskets on the baseline -- incorrect place for those baskets to be. Probably too many people for that one court if that's what they were getting ready do because there's much more than a four or five to one ratio there" (Jody Hyden). "Just a very start of the group and he needs to get them going because they're not focused right now" (Chuck Kriese).

Experts all tried to associate the situation with their prior knowledge. Three out of the four experts suggested a serving drill because of the location of the baskets, the positioning of the students on the court (baseline) and the number of students on one side: "serve - so they are possibly discussing serving" (Jeff Wallace). "It looks like they maybe doing a serving drill or something with the baskets back there" (Andy Johnston). "I'm not sure if they were stretching or telling them to back up for a serving drill" (Jody Hyden).

Summary analysis of question four: critical analysis and diagnosis

In summary, experts' data were invariably more analytical. While novices just described technical or instructional problems in elementary terms, experts would define the problem, find causes to the problem, and offer solutions to resolve the problem. In several cases experts were able to anticipate events to come. Experts referred to twice as

many technical, critical features as did the novices. In addition, because of their internal image of a standard technique, experts were attentive to abnormal or idiosyncratic occurrences. Indeed, experts triggered their analysis from a striking or abnormal event. Novices' critical analysis and diagnosis of a motor skill were scarce. Furthermore, novices' technical remarks were mostly descriptive and scattered among comments that had no relevance to tennis or tennis instruction. Similarly, with respect to instruction, while novices were mostly descriptive and occasionally evaluative, experts would constantly critique instruction and propose a variety of suggestions for improvement. However, experts' superior critical analysis and diagnosis were specific to their domain of expertise.

Summary of the findings

In summary, in response to question one, experts' perceptions were very selective with a specific focus on technique and on information that was relevant to tennis and instruction. Novices on the other hand commented on a variety of topics regardless of their relevance to tennis and instruction. Because of the wide range of observations mentioned, novices' data were as detailed as experts. However, when pertaining to relevant information, experts' perceptions were unquestionably more detailed.

Pertaining to question two, novices rarely made use of inferences. Experts, on the other hand, made inferences on the players' athleticism, motor skills, technique as well as on drills and instruction. Both novices and experts made interpretations of what they perceived. However, experts made interpretations on perceptions that were solely relevant to tennis and instruction. Both novices and experts evaluated the presented

information. Experts stood out for they substantiated each evaluation with a precise explanation.

As for question three, while no distinct patterns appeared in novices' perception, experts used the same pattern in their thoughts organization. Indeed, experts' cognition was triggered by an unusual event from which they derived their analysis. Novices' confusion contrasted with experts' ability to make instant sense of a situation. Experts were able to both recognize drill patterns and compare the presented situation with past experience. This ability allowed experts to anticipate future events while novices focused solely on the present situation.

The answer to question four demonstrated that while novices were mostly descriptive and lacked judgment, experts' data were full of critical analysis and diagnosis of both motor skills and instruction. In motor skills, experts began with an observation, justified their statement, compared the technique with a standard drawn from past experience, demonstrated the causes and consequences of the technical mistake and offered suggestions for improvement. Experts perceived considerably more critical features than novices did (a ratio of 578 to 251 emerged from the data). There was a lot of consistency among experts' diagnosis of motor skill. The findings were similar when dealing with instruction. There were many similarities among experts' critical analysis and diagnosis of instructional situations. While novices' perceptions were mostly descriptive, experts critiqued instruction with a lot of precision and offered solutions for improvement.

Finally, it appeared that the most decisive differences between novice and expert tennis instructors were a) in matters of relevance to tennis instruction and b) in their

critical analysis of both a motor skill and an instructional situation. However, experts' superior perceptual capacities were domain specific since when compelled to observe a non-familiar situation, experts' perceptions were not as acute.

While reading some of the data, Butch Staples found that even though the experts' data were more critical and judgmental and the novices' more descriptive, he could follow along what experts were watching at the same time. Yet in some instances, Butch Staples couldn't tell if the expert and novice he was comparing were actually watching the same videotape. Their responses were so different with experts involved in a critical analysis of information that was relevant to tennis and instruction, and novices duly following the protocol and describing everything they could perceive: "Now is this the same tape? These people are watching the same tape? It's unbelievable. Are you sure? (laugh)." (Butch Staples)

CHAPTER 5

DISCUSSION

This study examined the differences between expert and novice tennis instructors' perceptual capacities. Specifically, the questions raised issues of (a) selection, detail and relevance to tennis instruction; (b) use of inferences, interpretations and evaluations; (c) meaningful patterns, understanding of a present situation and anticipation of future events; and (d) critical analysis and diagnosis of both a motor skill or an instructional situation. This chapter includes a discussion of the present findings to the body of literature, beneficiaries of the study and practical applications.

Question one: findings referring to selection, detail and relevance

Selection: findings and literature found experts' perceptions to be more selective.

The present findings revealed that experts' perceptions were more selective. Indeed, experts chose to focus mostly on technique and instruction whereas novices had a wider range of observations from technique to weather conditions and tennis wear. These findings were consistent with Kay's (1992) study of artists' perceptions. Kay found a significant difference in experts and novices' perception-- experts' perception being more selective. The present study confirmed Livingston and Borko's (1989) suggestion that expert teachers are more selective in their use of information during interactive teaching. Similarly, it reinforced Anderson-Nickel's (1997) study of elementary music teachers which found that experts were more selective in their use of information regarding the classroom environment.

Detail: findings consistent with the literature

There was as much detail in the experts' data as there was in the novices', but the information was qualitatively different. Pertaining to motor skill or instructional information, experts gave considerably more details than did novices. These findings were consistent with McPherson (2000) who concluded that in athletics, "although experts and novices generated similar amounts of reactive statements during competition, their statements were dramatically different in terms of content" (McPherson, 2000, p. 57). In addition, Berliner (1988) argued that experts "not only made more comments about what was happening, but their comments were more detailed and descriptive than those of the other two groups" (Berliner, 1988, p.46). Because experts focused on relevant information, they were able to see more. Tan (1997) also believed that experts have superior perceptual abilities and are able to notice things that other people would miss. For Tan, experts' knowledge structures might explain the difference in their focus on environment cues.

Experts' ability to see more details may be partly explained by their automaticity of behavior. Novices wasted some of their attention on their own teaching skills. Novice one mentioned having to focus on feeding the ball. This lack of automaticity is a source of distraction from important information. This observation is a supposition however since this study did not examine automaticity of behavior. Berliner (1994) explained that experts' automaticity allows conscious processing of ongoing information. Likewise, Leinhardt and Greeno (1986) showed that automaticity of behavior and the use of routines reduce teachers' cognitive processing and "provide them with the intellectual and temporal room needed to handle the dynamic portions of the lesson" (p. 94).

Relevance to instruction: consistent finding: experts' focus on relevant information

While novices commented on everything they could see regardless of their relevance, experts' comments were invariably relevant to tennis or tennis instruction. These findings are similar to Carter's (1988) who found that if experts focused most of their attention on information of instructional significance, novices may pay attention to the color of a student's hair. This argument reinforced findings from a study by Cushing, Sabers and Berliner (1992) who found that perception abilities differ with level of expertise. They found that expert teachers provided more instruction related interpretations of the classroom events for they focused on events that were relevant to instructional matters.

Summary of discussion relating to question one

In matters of selection, detail and relevance to instruction, the present results reinforced findings from the body of literature on expertise. Expert tennis instructors' perceptions were more selective for they focused more on technique and instruction than did novices. Novice tennis instructors' accounts were as detailed as experts yet qualitatively different. However, relating to motor skill or instruction, expert tennis instructors gave considerably more detail than novices did. Also, as opposed to novices, expert tennis instructors focused all of their attention on information relevant to instruction.

Question two: differences in inferences, interpretations and evaluations

Inferences: new evidence of experts' use of inferences

Experts' and novices' data were significantly different in their use of inferences, interpretations and evaluations. While novices scarcely used any inferences, experts made

inferences on both motor skill, drill organization and instructional situations. These findings are similar to the study by Berliner's (1986) which showed that experts make inferences from objects and events they observe. Similarly, Standley and Madsen (1991) also acknowledged experts' use of inferences. They maintained that experts' knowledge organization allows them to better analyze an instructional situation and make correct inferences on classroom events. Berliner (1988) suggested that experts' experience gave them the ability to recognize similarities; therefore experts make better assumptions relating to classroom events and student behavior.

Interpretations vary with expertise

The present study showed that both experts and novices interpreted what they observed. However, as opposed to novices, experts interpreted information that pertained solely to tennis and tennis instruction. The body of literature also argued that interpretations vary with expertise. Chen and Rovegno (2000) noted that findings in research on teaching expertise revealed differences between expert and novice teachers' content knowledge and interpretation of classroom events. Graham et al. (1993) agreed that expert physical education teachers made interpretations that were more organized and more focused on factors effecting students' motor-skill performance. Experts were able to interpret a situation in a far more precise and richer way than novices. Experts' acute perceptions allowed them to see more and in greater depth than the PETE students. Further, Berliner (1988) explained that thanks to experience in classroom instruction and management, expert teachers appeared comfortable describing their observations and interpreting classroom events.

Evaluations combined with interpretation

The present study showed that both experts and novices made evaluations but while novices' evaluations stayed superficial, experts' evaluations would evolve into critical analysis and diagnosis. Likewise, Anderson-Nickel's (1997) found that expert and novice elementary music teachers differed in their evaluation of a classroom. Berliner (1988) explained that expert teacher educators evaluated teaching performances and seemed to combine interpretation with evaluation of the events and behaviors they viewed.

Summary of discussion relating to question two

In summary, the present findings on expert tennis instructors' inferences, interpretations and evaluations coincide with the body of literature on expertise. Indeed, expert tennis instructors made more inferences than novices. Specifically, experts' inferences pertained to technique, drill patterns and instruction. Tennis instructors' interpretations also varied with expertise for expert tennis instructors' interpretations solely pertained to tennis and tennis instruction. Expert tennis instructors' evaluations were supported with precise explanations and critical analysis. These findings with reference to experts' perceptions and specifically their use of inferences, interpretations and evaluations provide evidence to support Tan's theory that experts have acute perceptual capacities.

Question three: patterns, understanding of a situation and anticipation of future events

Patterns: findings support De Groot's pattern recognition paradigm

Expert tennis instructors recognized drill patterns with speed and accuracy. This finding supports De Groot's pattern recognition paradigm (1966) which suggested that

experts had the ability to recognize patterns in a domain specific situation. Further, expert tennis instructors' recognition of drill patterns with speed and accuracy reinforced Berliner's (1986) argument that experts have extraordinarily fast and accurate pattern-recognition capabilities. The present findings strengthen Tan's (1997) theory. Tan believed that experts' knowledge organization allowed them to recognize patterns in the environment that is presented to them, hence their better recognition of cues pertinent to their comprehension of a phenomenon.

There was a recurring pattern in expert tennis instructors' thought processes and critical analysis. Indeed, expert tennis instructors would begin their analysis with an observation, and then offer a precise justification of why this observation was accurate through a precise critique of the technique. Experts would follow up with suggestions for improvement and occasionally make inferences on events to come. This process ascertained expert tennis instructors' extensive technical knowledge.

Understanding: instant sense of a situation and comparison to past experience

Expert tennis instructors' made instant sense of the tennis related situations presented to them. Not only did they rapidly recognize drill patterns but they were able to juxtapose the presented situation with a standard. In addition, their selective perceptions together with their ability to discern the important from the non-important, facilitated their understanding of a situation. Novice tennis instructors, on the other hand, sometimes expressed confusion and did not make instant sense of the presented situations. Novices' confusion did not enable them to make reliable assumptions on eventual events to come. Further, novices did not exhibit the use of patterns whereas experts followed the same logic in the organization of their thought processes.

These findings supported Carter et al. (1988) who demonstrated experts' ability to connect what they perceived on a series of slides to their own classroom experiences. They found that experts could draw from their extensive knowledge and react to events for optimum classroom effectiveness. Carter et al. (1988) contrasted experienced teachers to beginning teachers with regard to their perceptions and ability to make sense of a multitude of classroom stimuli. They noted that effective teachers "make use of finely tuned observational skills and perceptual abilities in their teaching," (Carter, et al. 1988, p.25). According to Livingston and Borko (1989), expert teachers extract critical cues which help them make instant sense of the instructional situation.

The ability to respond to a multitude of stimuli was also detected by Chen and Rovegno (2000) who found that "expert teachers exhibited a greater ability to attend and respond to multidimensional and simultaneous class activities than did novice teachers" (p.359). Further, the present study confirms Berliner's (1988) findings that expert teachers' are able to make instant sense of an instructional situation. Berliner theorized that expert teachers differentiate the important from the unimportant in the teaching environment.

Anticipate future events: exemplary sense of anticipation

Using meaningful patterns and the ability to compare the present situation to a norm allowed expert tennis instructors to not only make better sense of what they observed but also to anticipate events to come. Expert tennis instructors' technical knowledge allowed them to anticipate the outcome of the shot. Further, relating to both motor skill and instruction, experts were able to predict events to come when they would (a) define the problem and the consequences of the problem, or (b) offer solutions to fix

the problem and consequences of the implementation of these solutions. In addition, anticipation was possible thanks to experts' experience and their ability to compare the present instructional situation with past experiences.

These findings were congruent with Berliner (1986) who wrote and noted that experts' sense of anticipation was exemplary. McPherson (2000) found that expert tennis players "utilize sport-specific strategies between points to monitor pertinent current and future events" (p. 56). In teaching expertise, Schempp (1993) also noted that due to an expert's ability to perceive critical cues, they were able to anticipate better and therefore plan accordingly. For Tan (1997), "experts can quickly extract meaningful chunks of information from often confusing and complex activity… The ability to differentiate critical cues in the environment permits them to anticipate likely situations" (p. 32).

Summary of discussion relating to question three

In summary, expert tennis instructors' use of meaningful patterns, understanding of a situation and anticipation of future events reinforced theories and former research on expertise (Berliner, 1986; Berliner, 1988; Carter et al. 1988; Chen & Rovegno, 2000; Schempp, 1993; Silverman, 1991; Tan 1997). Expert tennis instructors rapidly recognized drill patterns, connected the present with past experiences, and compared the situation with a norm. Experts were able to anticipate shot outcomes as well as instructional events. Novices, on the other hand, were often confused, were not able to recognize meaningful patterns and did not demonstrate the ability to anticipate future events.

Question four: critical analysis and diagnosis of motor skill and instructional situations

Expert tennis instructors' accounts were full of judgment and critical analysis of both a motor skill and the instructional situation.

Motor skill critical analysis and diagnosis: a manifestation of extensive knowledge?

Expert tennis instructors' perceptions were more analytical and demonstrated more analysis of motor skills than novices'. These findings were consistent with the literature (Dodds, 1994; French & Housner, 1994; Pinheiro & Simon, 1992).

Indeed, French and Housner (1994) believed that observational skills pertaining to sport performance gave experts in sport and physical education an important edge over novices. In addition, Dodds (1994) showed that expert sport instructors analyze a movement qualitatively better than novices do: "Expert teachers of motor skills are qualitatively different from novices in their ability to detect errors and appropriate aspects of skill performance…Experts differ from novices in diagnosing movement skills" (p. 157). She believed that experts' knowledge organization facilitated movement diagnosis and provided them with acute perceptual capacities.

Similarly, in coaching expertise research, Pinheiro and Simon (1992) found that experts perceived more critical cues, and were more accurate in their diagnosis decisions than novices were. They found that experts missed fewer important errors than novices. For Siedentop and Eldar (1989), experts see things that others don't see. Black and Wright (2000) argued that "indexes of error detection mechanism improve with practice" (p. 331).

Expert tennis instructors defined a technical or instructional problem, offered a precise argumentation of the nature of the problem, compared the problem to a standard

and offered solutions for improvement. This method reinforces Berliner's (1988) belief that experts' thought processes were most often triggered by an atypical event or observation and that, consequently, experts pay closer attention to the atypical in the teaching environment.

Expert tennis instructors' problem representation and analysis was far more complex than novices'. These findings echoed Berliner (1994) who believed that experts "represent problems in qualitatively different ways than do novices. Their representations are deeper and richer" (p. 163). Moreover, expert tennis instructors' problem solving approach demonstrated that they search forward from given information rather than backward from goals. This problem solving capability strengthened Holyoak's (1991) theory that experts are forward problem solvers. Forward reasoning suggests reasoning from the given facts rather than from a hypothesis.

In their diagnosis and analysis of a motor skill, experts focused on specific aspects of the motion also called "critical features". Not only did experts perceive significantly more technical elements than novices, but experts went into great depth in analyzing technique, compared it to a standard and offer suggestions for improvement. Abernethy, Wood and Parks (1999) showed that in fast ball sports, high level athletes have superior perceptual skills and are able to extract crucial information from the opponents' body position.

Expert tennis instructors compared the action shots presented on the slides to the techniques they had acquired through the years. Similarly, Young (1998) studied expert downhill ski instructors and discovered that coaches need an internal image of the skill in order to compare it to the actual performance. In coaching, De Marco and McCullick

(1997) realized that expert coaches could mentally visualize an idealized performance standard and compared that standard to the performance of their athlete.

Expert tennis instructors' extensive knowledge was reflected through this ability to perceive more technical points, compared the technique to a standard and analyzed the technique in greater depth. Several authors have acknowledged experts' extensive knowledge (Carter et al. 1988; Housner & French, 1994; Tan, 1997). McPherson (2000) studied experts in motor skills and argued that athletes' cognition during competition is linked to their knowledge base or problem representation. Consequently, athletes' performance is strongly dependent on their current and past knowledge and on the application of this knowledge during competition. In tennis, "both response selection skills (e.g. reading and opponent, planning a shot) and response execution skills (e.g., knowing how to hit a slice serve, hitting a topspin serve during competition) involve aspects of knowing what to do and doing it" (McPherson, 2000, p.40).

One reason experts have such an extensive knowledge may be their determination and commitment to learning: "True professionals are continuous students of human movement who integrate a wide variety of sources of knowledge" (Knudson, 2000, p. 20). Occasionally, expert tennis instructors would justify the use of an unorthodox method. This reinforces Tan's (1997) comments that experts are idiosyncratic at times. He explained that experts are unique and their thoughts and actions may appear unusual.

Instruction: critical analysis and diagnosis triggered from unusual events

Similar findings emerged in matters associated with the instructional situation. Expert tennis instructors analyzed instruction with great precision. They perceived more instruction-related information. The expert tennis instructors focused on important and

relevant information. Indeed, in response to question one which involved selection and relevance, the present study showed that expert tennis instructors disregarded non-relevant information and focused solely on motor skill and instruction. Further, expert' analyses were triggered by an atypical event such as a technical error or an instructional anomaly. These findings were consistent with the literature. Researchers have demonstrated that experts have the ability to focus on important events and that their attention was aroused by atypical events (Berliner, 1988; Carter et al, 1988; Cushing, Sabers & Berliner 1992; Manross & Templeton, 1997). Berliner (1988) theorized that expert teachers have superior perceptual capacities. He believed that expert teachers have superior classroom perceptions and differentiation between the important and the non-important.

Further, the present study demonstrated that while novices' accounts were mostly descriptive, experts' critiqued instruction, substantiated their observations with precise justification and, when necessary, offered solutions for improvement. Similarly, Graham, French and Woods (1993) noted that novice teachers only perceived the surface of classroom events. For Schoenfeld and Herrmann (1982), novices only superficially recognized problems therefore criteria for problem perception increased as a function of knowledge.

Along the same line, Dodds (1994) believed that expert teachers have the ability to select important visual details. Their perception of classroom events was much richer than novices'. The author explained that experts "work unconsciously until there is a specific problem on which to focus their analytical skills" (Dodds, 1994, p. 160). Likewise, in coaching, De Marco and McCullick (1997) explained that "expert coaches

are highly perceptive and are superior problem solvers. They are uniquely capable of accurately perceiving stimuli in game situations. They dissembled meaningful and pertinent information from less important information and then generate superior responses" (p. 38)

Expert tennis instructors' transcripts proved more consistent than novices'. For example, the four experts critiqued the instructor for his lack of technical feedback. These findings are similar to Berliner's (1988) who perceived greater uniformity among the interpretations of experts. Knudson (2000) believed that using multiple observations and specific critical features increase reliability in qualitative analysis. However, the number of repetitions decreased with expertise: "the analyst's own perceptual abilities will also affect the number of movements that need to be observed"(Knudson, 2000, p. 22).

Expert tennis instructors' superior critical analysis and diagnosis could be explained by their knowledge and knowledge organization. Several studies considered extensive knowledge and knowledge organization as influential factors in experts' critical analysis and diagnosis (Glaser, 1987; Schempp, Templeton and Clark (1998); Stepich, 1991). Similarly, in motor skill expertise, Clark & Peterson (1986) noted that knowledge organization influenced perceptions. For Pinheiro and Simon (1992) "at the core of the theory, and its application to skill diagnosis, is the concept of schema" (p. 290). Peterson and Comeaux (1987) considered knowledge organization to be an important factor in experts' perceptual capacities including their problem solving abilities. Glaser (1987) explained that experts' knowledge organization and fast-access recognition facilitated problem perception.

In the present study, expert tennis instructors were very knowledgeable. Their extensive knowledge was reflected in their ability to critique a motor skill or instructional situation with detail, precision and accuracy. Furthermore, expert tennis instructors were able to offer solutions to each problem encountered. Experts would also clearly justify the appropriateness of their solutions.

The study demonstrated the domain specificity of expert tennis instructors' superior perceptual capacity. These findings support DeGroot's (1965) theory about domain specificity. Indeed, when viewing a non-traditional situation (slide 9), experts' accounts were more descriptive and less analytical. Experts' and novices' data were quasi interchangeable when analyzing slide 9. Experts were less assertive in their comments, and their analyses less structured.

Summary of discussion relating to question four

In short, expert tennis instructors' accounts were very analytical. Experts were very specific in their technical analysis and instruction critique. They were able to differentiate the important from the non-important in both a motor skill and an instructional situation. Indeed, expert tennis instructors solely focused on relevant information. In addition, they demonstrated consistency in their critical analysis triggered by similar critical cues. Expert tennis instructors would perceive a problem, analyze the problem, and offer solutions for improvement. Novices' accounts, on the other hand, were mostly descriptive and lack the depth of judgment experts showed. These findings were consistent with the literature on expertise. Researchers have demonstrated experts' superior critical analysis and ability to perceive important information (Berliner, 1988; French & Housner, 1994; Pinheiro & Simon, 1992).

Beneficiaries of the study and suggestions for practical application

When asked how this study could benefit Van Der Meer tennis teacher education program, Butch Staples explained:

> It's all a question of trying to short cut the process of learning. If there's a way we can become expert tennis teachers without having to spend numerous years assimilating information, trial and error, etc., if we can determine the characteristics of expert tennis instructors and actually focus on those characteristics sooner in our career, then I'm sure some of these novice teachers will be able to, in much less time, become "expert teachers". I think a lot of it has to do with the information we assimilate early in our career, information that can assist us to move faster in our quest of successful teaching.

During their training, student teachers are introduced to a number of basic technical errors. For the error detection test, one of the teacher educators performs a series of tennis strokes. Each stroke is repeated 3 times with a specific technical mistake the student teachers are expected to detect. Butch Staples specifically expressed his concerns regarding novices' poor performance during the error detection test:

> We could do an awful lot of help improving novices' error detection test. Remember we had three errors on the serve, three on the forehand, three on the backhand? It's absolutely atrocious how poor our novice tennis teachers do and that is an extremely easy part. I could take the 20 expert tennis teachers [that participated in the pilot study] and have them see a max of three not even six repetitions and they would get them all, all the time. Our novices on the other hand, numerous times, can't even pick up the obvious and technically, if they

> don't see that, then their ability to make relevant technical comments is way down. The comparison between experts' and novices' data confirms this drastic lack of technical analysis from the novices as opposed to the depth of technical diagnosis demonstrated by the experts. This area needs to be a priority in the minds of the teacher educators.

Butch Staples confirmed the value of the study for tennis instructor development: "I'll tell you, there's tremendous practical application of this study for Van Der Meer Tennis."

Novices could benefit from the study if indeed some of the notions were integrated in the Van Der Meer teacher education program. The teacher training program should "spend more time assisting novice instructors with perceiving and assimilating technical information because a tennis teacher or coach can't be that effective if they are unable to observe and diagnose a motor skill" (Butch Staples).

Further, the study helped define the critical features in a tennis motor skill as mentioned above in the answer to question four. By focusing more on those features, the novices may improve their selection and therefore their technical perceptions of a motor skill. As recommended by Knudson (2000), defining the critical features will increase the consistency of the qualitative analysis of a movement. Critical features need to be adapted to different ages and developmental levels. The more specific the critical features the more efficient they will become:

> The use of vague definitions of critical features may lead to observer bias and inconsistent evaluation… most critical features will need to be defined as clearly as possible… There are two approaches to evaluating critical features using visual

> observation of the motion of the body. One is to define discrete boundaries of acceptable performance, while the other involves a more holistic judgment of the quality of the critical feature on a continuous scale specific to the analyst. (Knudson, 2000, p. 22).

Knudson (2000) suggested that defining the "critical features" would help novices understand and more accurately perceive the fundamentals of the motion: observation may be more accurate if teachers "get an overall impression of critical features before attempting to analyze discrete body positions that are difficult to perceive in fast movements…It is important that physical educators be aware of the critical features of various movements and develop a preferred strategy for observing them." (Knudson, 2000, p. 21).

In brief, tennis teacher education programs may benefit from this study. Other beneficiaries may be the novices as well as experienced tennis instructors who want to develop as better teachers and advance through the stages of expertise development. Tennis students may enjoy better instruction. Motor skill instructors, coaches, and teachers in general may benefit from the study.

Recommendations: prioritize the development of perceptions

The expert tennis instructors' study should help teacher educators realize that there is a need for an emphasis on observational skills during teacher preparation as well as in continuing education. Improvement, however, may be associated with tennis instructors' personal recognition for the need to better their perceptual capacities.

Ameliorate selection and relevance to tennis and instruction: observation checklist

The findings, in response to question one, revealed that experts' perceptions were more selective and more focused on relevant information. It was very surprising to note how little novice teachers perceived during data collection. Students might even be less perceptive. Therefore, while demonstrating a motor skill, teachers need to be very specific and precisely relate to their students the technical point they are trying to illustrate (i.e. racquet preparation, shoulder turn, footwork, weight transfer, etc…). Otherwise, just like the novice instructors in the study, the students might focus on irrelevant details and miss whole or part of the demonstration.

A suggestion could be for teacher educators to provide an observation checklist of technical principles or guidelines the instructors could follow while developing their perceptual capacities. The instructors would therefore have specific features to focus on. This should reduce the amount of irrelevant information in novices' statements. For example, the LPGA (Ladies Professional Golf Association) published an "observation checklist of full swing principals" (Appendix D). The checklist incorporated 13 principals: (a) hold, (b) aim/alignment, (c) set up, (d) connection, (e) swing plane (shaft), (f) width of arc, (g) levers, (h) length of arc, (i) position, (j) swing center, (k) timing, (l) release, and (m) dynamic balance.

Perceptions more detailed due to improved knowledge

The study demonstrated that experts' accounts were more detailed when pertaining to tennis and instruction. For novices to be able to comment more on relevant information, a suggestion would be to strive to increase their knowledge of the motor skill technique. To do so, St. Pierre, Spencer and Woorons (2000) found that (a) practical

teaching experience, and interaction with other teachers; and (b) students, playing experience, and participation in workshops were principal sources of knowledge for teachers.

Improve evaluations through justifications

Novice tennis instructors made some evaluation but they did not substantiate their evaluation with any justification. In my opinion, justifying their evaluation is critical. Indeed, I believe that students not only need an evaluation of their motor skill, they also need to understand the reason why, together with suggestions for improvement. During their training, it might be important to request from tennis instructors the "why" of their evaluation (i.e.: Evaluation: this is a great shot; Why: nice step across, racquet head down, beautiful shooting his right hand back for extra power). In addition, it appears to me that the evaluation of a motor skill should be adapted to the student's abilities, talent and ambition. Lack of knowledge may be a reason why novice teachers were not able to substantiate their evaluations with proper explanations. Instructors' evaluation may improve as a factor of their knowledge.

Better understanding of an instructional situation due to basic drill patterns

Experts' ability to make instant sense of a situation was enhanced by their quick recognition of drill patterns. Teacher educators could therefore provide novices with basic drill patterns in order to help them make better sense of the instructional situation.

Cognition patterns triggered by idiosyncrasies: emphasis on error detection training

Since experts' cognition was triggered by irregularities in the motor skill, teacher educators should provide novices with a series of technical errors to look for while observing a motor skill. As suggested by Butch Staples, there should be emphasis on

error detection training (i.e. error detection test mentioned above). Cognition also includes critical analysis and diagnosis, to be examined below.

Motor skill: error detection training, instructional technology and standard technique

Experts' critical analysis and diagnosis of motor skill involved not only a commentary on the quality of the motor skill but also a justification, comparison to a standard technique, causes and consequences of the technique used and suggestions for improvement. Consequently, proper training in error detection is critical. The use of instructional technology, including the study of motor skills on video using the slow motion feature, may be a great asset in improving instructors' movement analysis. In addition, in order to improve tennis instructors' critical analysis and diagnosis skills, my suggestion would be to give tennis instructors a standard technique or fundamentals as a means for comparison. Instructors may also use professional athletes as well as world class juniors as a standard for comparison.

Instruction: learn from the experts!

Novice tennis instructors' were mostly descriptive in their perceptions relating to instruction. Experts, on the other hand, offered critical analysis and diagnosis of the instructional situation. My first suggestion would be for novices to participate in internships with experienced instructors. This practice is common in higher education teacher preparation programs (i.e. University of Georgia physical education pre-service teachers training requirements).

Another suggestion would be for teacher educators to provide apprentices with a video analysis of an instructional situation. During the pilot study, 20 expert instructors were video taped teaching a group lesson to four intermediate level players. Butch

Staples argued that "one of the great value of those tapes would be for novices to actually watch them… It would be a tremendous assignment to a tennis teacher." He added that with guidance novices would benefit tremendously from observing and studying the tapes. They would get a better appreciation of what expert tennis instructors do during their actual teaching.

Conclusion

The purpose of the study was to examine the differences between expert and novice tennis instructors' perceptual capacities. Specifically, this study investigated how expert tennis instructors' analytical perceptions differ from novices'.

In conclusion, the study determined that expert tennis instructors' perceptions were considerably more selective than novices. Indeed, experts mostly focused on information that was relevant to tennis and tennis instruction. Novices' accounts were as detailed as experts' although qualitatively different. However, when pertaining to motor skill or tennis instruction, experts went into more details and with greater precision than did novices. Expert tennis instructors made more inferences, interpretations and evaluations than novices did. Experts' inferences, interpretations and evaluations solely pertained to tennis and tennis instruction. Evaluations evolved into specific critical analysis. As opposed to novices who often expressed confusion, expert tennis instructors in the study were able to rapidly recognize drill patterns and would make instant sense of an instructional situation. In some cases, experts' knowledge and experience allowed them to anticipate events to come. Pertaining to critical analysis and diagnosis of a motor skill or instructional situation, while novices were mostly descriptive, experts were very analytical and critical of what they observed. Experts displayed the same patterns in their

cognition. Experts had the ability to recognize important cues. Unusual instructional events or motor skill would trigger their analysis. They would compare the instruction or motor skill to an internal image or standard, justify their critique, and offer suggestions for improvement. In some instances, experts would explain what was to be anticipated if the problem remained or how their suggestion would influence the outcome.

The present study reinforces Tan's (1997) theory for it provided empirical evidence that expert tennis instructors have acute perceptual capacities. The findings support the notion that experts' perceptions are (a) more selective since experts focus on important cues (Berliner, 1988; Kay, 1992; Schempp, 1992; Tan, 1997); (b) expert teachers perceive more information and make better sense of a situation and respond to a multitude of stimuli (Anderson-Nickel 1997; Carter, 1988; Graham, French & Woods, 1993; Nelson, 1988); (c) expert teachers focus on events that are relevant to instructional matters (Cushing, Sabers, & Berliner, 1992); (d) experts make instant sense of a situation and anticipate future events (Klauke, 1988; Schempp, 1983, Silverman, 1991); (e) experts' perceptions are more consistent and more accurate (Christie, 1996); (f) experts' perceptions are analytical as opposed to simply descriptive (Kennedy, 1987); and (g) while novices only perceive problems on the surface, experts excel at perceiving, analyzing and solving problems (De Marco, & McCullick, 1997; Graham, French, & Woods, 1993; Schoenfeld & Herrmann, 1982; Young, 1998). In addition, it appears that experts' knowledge may allow them to interpret events, compare them to past experiences and process the information to maximize effectiveness as suggested by Livingston and Borko (1989), and Williams and Davids (1998). Also, it seems like in expertise in teaching sport, experts' knowledge organization may allow them to retrieve information

for movement diagnosis. As a result, experts analyze motor skills qualitatively better than novices as mentioned by Dodds (1994) and Pinheiro and Simon (1992).

Finally, researchers consider superior perceptual capacities to be an important characteristic of expertise (Abernethy, Wood, & Park, 1999; Dodds, 1994; Tan, 1997). The literature noted that factors influencing experts' perceptions included experts' extensive knowledge base (Johnson, Severance & Feltovich, 1979), knowledge organization (Chase & Simon, 1973), superior memory (Ericsson & Charness, 1994), and automaticity of behavior (Dodds, 1994). Similarly, in the present study, it appeared that perceptual capacities may be closely linked to some of the qualities Tan (1997) theoretically attributed to experts, which were extensive knowledge base, knowledge organization, domain specificity, superior problem solving, automaticity of behavior and extensive memory. However, further studies are necessary to provide empirical evidence of the connection between perceptual capacities and other experts' characteristics.

Knudson (2000) believed that:

> There is a great need for research documenting…the accuracy of different approaches to evaluation…The accuracy and consistency of qualitative analysis of human movement is vital to maximizing improvement in the performance of students in physical education. Such analysis is possible only if several characteristics are present. The analyst must be guided by a comprehensive vision of qualitative analysis that goes beyond the traditional method of error detection and correction. Accurate qualitative analysis must be based on an understanding of observable movement, continual preparation, critical-feature research, a plan for diagnosis, and an appropriate observational strategy. Although different

> analysts tend to offer somewhat contradictory analyses, the consistency of ratings by individual analysts is often enough to achieve the goal of student improvement. Such consistency can be attained through the use of multiple observations, well-defined critical features for observation, and a simple method for evaluation critical features that is intuitively meaningful to the analyst (p. 22).

Beneficiaries of the study include, tennis teacher education programs, novice to expert tennis teachers, motor skill instructors and teachers in general, as well as their students. How can one most benefit from "an analysis of expert and novice tennis instructors' perceptual capacities"? Here are several recommendations for practical application: (a) the development of acute perceptual capacities should be prioritized; (b) observation checklist may help focus on relevant information and also ameliorate motor skill diagnosis; (c) acute perceptual capacities maybe linked to knowledge, consequently the quest for better knowledge may result in improved perceptions; (d) pre-service teachers should be encouraged to substantiate each of their evaluations; (e) instructors should be familiar with basic drill patterns; (f) error detection training is paramount; (g) pre-service teachers should be provided with a standard technique as a means for comparison; (h) instructional technology like the use of video analysis for both motor skill and instruction may be a great asset to improve instructors' perceptual capacities; and lastly, (i) learn from the experts, both expert instructors and expert athletes.

Finally, the study of expert tennis instruction was fascinating. It was a wonderful learning experience, not only through the research process, but also through listening to the participants' expertise. As Dodds (1994) noted, motor skill diagnosis is one of the primary concerns for sports' instructors. Motor skill diagnosis seems to be crucial not

only as a corrective tool, but also to instruct an appropriate motion right from the start while teaching beginners. Additionally, the ability to recognize proper instruction seems essential, especially for professionals who are responsible for hiring tennis instructors, training and managing tennis instructors, together with the monitoring and evaluation of their own teaching.

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APPENDIX A:

INFORMED CONSENT FORM

I agree to participate in the research entitled EXPERTISE IN TENNIS INSTRUCTION, which is being conducted by Sophie Woorons, Sport Instruction Research laboratory, Department of Physical Education and Sport Studies, 300 River Rd., University of Georgia, Athens, GA. 30633, Tel. (706) 542-4210. I understand that this participation is entirely voluntary; I can withdraw my consent at any time without penalty and have the results of the participation, the extent that it can be identified as mine, returned to me, removed from the experimental records, or destroyed. The following points have been explained to me:

1) The reason for the research is to analyze the nature of expertise in teaching sport skills specifically expert-novice differences in their analytical perceptions. The benefits that I may expect from it are: first, sharing the research results, and second, having some insight into my own teaching of sports skills.

2) The procedures are as follows:
I will view a video tape of tennis instruction and write down what I perceived during this video projection. Second, I will view slides during a short term memory / recall task.

3) The discomforts or stresses that may be faced during this research are: None

4) Participation entails the following risks: None

5) The result of this participation will be not be confidential or anonymous. There will be no harmful use of the data collected in this study. Audio tapes will be used by the investigator. They will be permanently stored in the Sport Instruction Laboratory.

6) The investigator will answer any further questions about the research, either now or during the course of the project.

PLEASE SIGN BOTH COPIES OF THIS FORM. KEEP ONE AND RETURN THE OTHER TO THE INVESTIGATOR.

Date: Date:

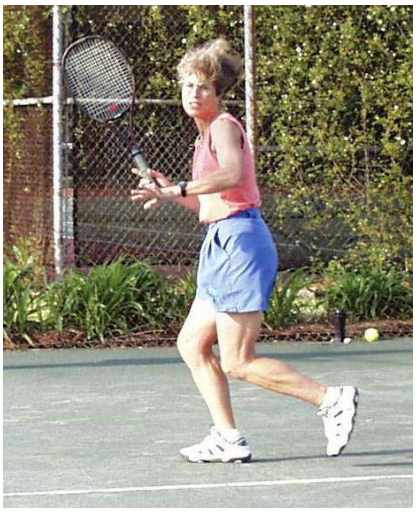
_____ _____

Signature of Investigator Signature of Participant

Research at the University of Georgia that involves human participants is overseen by the Institutional Review Board. Questions or problems regarding your rights as a participant should be addressed to Julia D. Alexander, M.A., Institutional Review Board, Office of the Vice President for Research, University of Georgia, 606A Boyd Graduate Studies Research Center, Athens, Georgia 30602-7411; Telephone (706) 542-6514; E-Mail Address: IRB@uga.edu.

APPENDIX B:

RECALL TEST SLIDES



APPENDIX C:

CRITICAL FEATURES TABLE

These tables show, in alphabetical order, the technical references extracted from both sets of data. Table one includes the technical comments made by the four experts. In contrast, the noticeably smaller table two illustrates the technical comments made by novices.

Technical comments made by the four experts

Aim, play short, depth
Arm, extension, non-dominant arm curled in stomach, tossing arm, racquet arm
Back swing, backswing incorrect. Backswing palm, weak back swing
Back, nice arch in back, didn't break down, bent over, back straight not bent, bend their back and don't have a horizontal plan over vertical access.
Balance, balanced, off balance
Ball Ball centered on racquet
Body position, shoulder turn, hips are turned, dropping shoulders, open body, good turn, very athletic woman, facing the net, he doesn't spin out, have to stay sideways, little opened,shoulders turned hard, stretching wide
Contact, in front, contact is at eye level out in front, have to stay sideways until point of contact, had made contact.
Elbow up, elbow low, elbow dropped, elbow high
Eyes- concentration, intensity, looking up, eye level out in front, looking off and not really looking out to the court
Follow Through, good follow through
Footwork- crossing over, thrust, short steps, open stance, close stance, step across, stepping in, step to the ball, move their feet, foot at an angle, stepping in with the wrong foot, on one foot, back foot came off the ground, large steps, small steps, back foot down,should left foot forward, loading on the right foot.stepped out on the right foot first, stance square, closed stance, both feet on the line, both feet very close
Form, looked good, good technique
General attitude, intense, energy
Grip, semi-western forehand grip, good back hand grip, good back hand grip for serve, continental grip instead of such a severe eastern backhand grip.
Hand, which is the dominant hand, non-dominant hand back for power, left hand out in front spotting the ball, non-dominant hand on racquet, two handed forehand. Two handed backhand, serve backswing palm up instead of down
Head, face and chin are up, head straight forward instead of up, he didn't freeze his head, head is up, head needs to be down.
Hit through the stroke
Legs, Knee bend, lower his legs, used legs, getting low, straight up and down, low volley, wide base, jumping, he's an old guy so he's not going to get much leverage with his legs, leverage, down low, good leg strength, should be bending
Length of stroke
Level with ball
Movement, forward, moving to the ball, moving to the left side, diagonal towards net, moving

into the court, moving forward or to the side, moving together (doubles), hitting the ball on the run
Positioning on the court, on the baseline, inside baseline, serving from ad court, no man's land, not quite closed in, too close
Positioning towards the ball, all that would take place if positioning was correct
Preparation, looped forehand, good preparation
Quality in comparison to a set standard, perfect, classical
Racquet, racquet head position, racquet not dropped too far behind back, racquet out, racquet below the ball, racquet low for back swing, racquet leaning towards her, racquet back inside, racquet head below wrist, controlling racquet speed, racquet wrapped up around, racquet speed
Ready position, racquet was left instead of center
Sources of power
Spin
Swing
Timing, early, beginning to follow through, half way in preparation, hand should still be on the racquet, too soon, shoulder square longer, have to stay sideways until point of contact, has already hit the ball, he has followed through, just made contact, racquet back too early. Holding and then stroking at the ball.
Weight transfer, weight off her right foot, leaning, into the court
Wrist- pronation, wrists should be up

Technical comments made by the four novices

Arm, arm to the side, reaching up, left hand extended up in the air
Ball, ball in air, toss in air, ball way up in the air
Body, little stiff
Elbow up
Eyes, determined look on her face, looking to the side not forward so not focusing on the ball, keenly focusing on the ball, intense, confidence on his face
Follow through
Footwork, front foot up, not stepping in, back foot up, stepping across, didn't step out, stepped with left leg
Form, nice form, pretty form, looks gorgeous, pretty form on that.
Hand, hand is up, two handed, one handed, dominant hand, his left hand had come across his body, left hand kind of up across her body,left hand in the air
Leg, one leg up, leg bent
Moving to her right, moving to her left, charging the net, going down for a volley
Point of contact, coming through the stroke
Position on the court, in ad court, at the net, in deuce court, one at the net, one at the baseline, about 5 or 6 yards from the fence, right up on the net
Power, hitting as hard as she can
Racquet, racquet back, high racquet back, racquet pointing up, racquet over his left shoulder, racquet behind their heads
Ready position
Timing, about to hit a forehand, on his way to hit a serve, about to hit, had hit the ball, just returned the ball, ready to hit the ball, ready to serve
Toss, ball toss, good toss
Wrist pronation

APPENDIX D:

OBSERVATION CHECKLIST
FULL SWING PRINCIPLES
Clark et al. (1999)

Pre-Swing Principles

Anatomical Arm/Hand - inwardly rotated
- neutral
- outwardly rotated

Desired Ball Flight - push/draw
- straight shot
- pull /fade

1- Hold

Target Hand - less than 2 knuckles
- 2 knuckles
- more than 2 knuckles

Rear Hand - match
- no match

Pressure - less than appropriate
- appropriate
- more than appropriate

Precision - precise positioning each
- not consistently precise

2. Aim / Alignment

Clubface - open
- square
- closed

Shoulders - open
- square
- closed

Hips - open
- square
- closed

Feet - open
- square
- closed

3. Set up

Posture - Less thatn 45 degrees
- 45 degrees
- more than 45 degrees

Weight distribution - target
- even
- rear

- heals
- even
- toes

Ball position - forward
- center
- back

Stance - Wider than shoulder
- even with shoulders
- Narrower than shoulders

Torso Tilt - target side
-center
- rear side

IN SWING PRINCIPLES

4. Connection
At takeway - disconnected away
- connected
- disconnected inside

After impact - disconnected inside
- connected
- disconnected away

5. Swing Plane (Shaft)
Backswing - above target line
- on target line
- below target line

Forward Swing - above target line
- on target line
- below target line

6. Width of Arc
Backswing - extended
- collapsed

Forward Swing - extended
- collapsed

7. Levers - one
- two
- three

8. Length of Arc - short of parallel
- parallel
- beyond parallel

9. Position - matched with address hold position
- not matched with address hold position

10. Swing Center
Top of backswing - forward of ball
- even with ball
- back of ball

At finish - forward of ball
- even with ball
- back of ball

11. Timing
- upper body begins forward swing
- upper & lower body move together
- lower body begins forward swing

12. Release - late
- timed
- early

13. Dynamic Balance
- falling forward
- balanced
- falling back

impact!