The Effect of Two Types of Video Tape Instructions on the Resequencing Performance of Female Tennis Players at Different Skill Levels

by

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ABSTRACT

The purpose of this study was to examine the effects of two types of videotape instructions on the resequencing performance of female tennis players at the novice, low, medium, and elite skill levels. Resequencing performance on the tennis serve and forehand drive was examined. Three different treatment conditions were administered: a control group was required to simply resequence the twelve still photographs of the tennis serve, another group were presented a videotape replay of the tennis serve played at regular speed, then three times in slow motion and then a final showing at regular speed, and a third group viewed a videotape replay augmented by skill cues. A posttest was administered. Similar procedures were carried out for the forehand drive. The results indicated that the resequencing performance was related to expertise in tennis. The slow motion and slow motion replay with augmented information treatments improved the resequencing performance of all the players on the tennis serve but not on the forehand drive.

RESUMÉ

L'objet de la présente étude était le suivant: examiner l'incidence de deux types d'instructions vidéo sur les résultats obtenus par des joueuses de tennis (niveaux novice, débutant, intermédiaire et expert) chargées de remettre en ordre des photographies représentant un service et un coup droit. Les circonstances de test et les groupes étaient au nombre de trois. Un premier groupe témoin devait simplement reclasser douze images d'un service. Un second groupe regardait une bande vidéo montrant le geste à cinq reprises: d'abord à la vitesse normale, puis trois fois au ralenti et enfin de nouveau à la vitesse normale (premier type). Le troisième groupe regardait une bande vidéo enrichie de brèves légendes (deuxième type). L'épreuve de reclassement avait lieu par la suite. On suivait la même méthode pour le coup droit. D'après les résultats, l'aptitude à reclasser relevait de la connaissance du tennis. Par ailleurs, les ralentis et les ralentis avec légendes permettaient à toutes les joueuses d'améliorer leurs résultats pour le service, mais non pour le coup droit.

CHAPTER I

INTRODUCTION

The sport of tennis has enjoyed immense popularity since its origins during the Middle Ages, and its popularity continues to grow (Schickel, 1975). The public's fascination with tennis has led coaches and researchers toward more in-depth studies of how tennis skills may be acquired and enhanced in an effort to facilitate skill acquisition in tennis players at all levels.

Throughout the modern era, tennis has seen an impressive increase in player participation (Schickel, 1975). This tremendous increase in participation has given rise to a variety of teaching methodologies (Van Der Meer, 1974, 1975, 1976, 1982, 1984; Murphy, 1976; Kenfield, 1964) aimed at improving technical and strategic tennis play. The development of a National Tennis Rating Program (see Appendix A) has also been a significant factor in the teaching of tennis to players at all levels.

Although the focus of modern tennis has been on the physical improvement of tennis skills (Van Der Meer, 1974, 1975, 1976, 1982, 1984; Murphy, 1976; Kenfield, 1964; Braden, 1977), recent research has given new insights about how tennis teachers, physical educators, and coaches might help learners acquire tennis skills and the conceptual knowledge base that underlies the effective playing of tennis.

Thomas, French and Humphries (1986) suggest that recent research on the nature of domain specific knowledge provides important insight on how specific sport skills are learned. They observe that the shift from task-oriented to process-oriented studies in skill learning has raised two issues in research in this field. The first being whether one can transfer the results of laboratory studies on the processes governing skilled action to ecologically-valid sports situations. The second being that there is very little information from which to examine knowledge base development and its effects on the acquisition of expertise within a given sport. They contend that previous research in non-sport environments may have implications for the development of sport skills. The authors suggest that the structure and organization of a person's knowledge base in sport environments may be similar to the knowledge network in cognitive sport domains.

Wall et al (1985, 1986, 1988) presented a knowledge-based approach to skill acquisition by distinguishing between two major categories of knowledge about action; namely, structural capacity and acquired knowledge. They suggest that acquired knowledge may be broken down into five major knowledge types which interact during motor learning and performance; namely, procedural, declarative, affective and metacognitive knowledge as well as metacognitive skills. Of importance to the present study is the importance of the interface between procedural knowledge and metacognitive skill (Wall, 1985, 1986, 1988) in the development of the image of the act. The image of the act is an important aspect of skill execution that develops with practice and expertise (Whiting, 1980).

Bandura recognized the importance of developing a cognitive representation of a skill-to-be-learned. He contends that developing the idea of a movement through symbolic coding and cognitive rehearsal is a key feature of observational learning in the skill acquisition process (Bandura, 1971). The cognitive representation of a skill-to-be-learned is similar to Whiting's concept of the image of the act. Furthermore, Bandura (1971, 1984) suggests that observational learning, and through it, skill acquisition, may be enhanced when the skill-to-be-learned or modelled focuses learner's attention on key cues or features in that skill. A person's knowledge base will clearly affect such skill acquisition processes.

Recently, Vickers (1986) developed a task to evaluate expert-novice differences in the performer's understanding of the spatial and temporal organization of movement sequences. Vickers' resequencing task requires that an individual reorder a randomly distributed set of still photographs into a correct action sequence. Vickers showed that expert gymnasts resequenced photos of gymnastic sequences faster and more accurately than intermediate gymnasts, and both expert and intermediates resequenced the material significantly faster and better than novice gymnasts. Vickers suggested that these results could be attributed to differences in the quality of the knowledge structures developed by the gymnasts at the three skill levels. This was one of the first studies to show the effects of expertise in a given sort on resequencing skill. Both Downey (1988) and Stafford (1988) showed such differences in resequencing skill in dance and gymnastics.

The use of videotape playback has been suggested as a means of directing a learner's attention toward critical cues in skills-to-be-learned (Rothstein, 1980; Dwyer, 1978; Magill, 1980). However, these studies have been primarily concerned with the effects of knowledge of results through videotape replay. Little research is available regarding the use of videotape playback as a means of fostering the development of appropriate cognitive representations of skilled action.

The present study uses the resequencing task as a means of measuring the development of cognitive representations or images of the act in tennis players of varying expertise. Furthermore, it investigates the value of videotape replay and videotape with augmented information on the development of appropriate cognitive representations of skilled action as measured by the resequencing of photos of two tennis actions.

Hypotheses

The following section presents specific hypotheses regarding skill level, pre-treatment resequencing performance scores, and the differential effects of the three treatment programs, slow motion with augmented information (SMI), slow motion (SM), and a control treatment. A brief rationale for the expected results is provided for each skill level.

1. Elite Skill Group

It is expected that the elite players will have better resequencing performance scores than all other groups and the three treatments will have minimal effect on their posttest performance.

The elite players will have high resequencing performance scores because of their extensive procedural and declarative knowledge bases which allow them to attend to the most critical features within an action sequence. These critical features provide means by which they may sequentially organize the skill-to-be-resequenced. The SM and SMI treatments will have minimal effect because the elite players already possess a clear image of the action and do not require further cues to help them organize the sequence. Hence, there will be a ceiling effect on their performance that will prevent a significant increase in their resequencing scores.

2. <u>Medium Skill Group</u>

It is expected that the pretest resequencing performance scores obtained by the medium skill group will be better than those obtained by the low skill and absolute novice groups.

The medium skill group will have better resequencing performance scores than the low skill and absolute novice groups as they have consolidated relatively clear images of the act for the skill-to-be-resequenced. Their procedural and declarative knowledge bases have not been developed to the same degree as the elite skill players; thus, their resequencing performance scores will be poorer than those of the elite players.

2.1 At this skill level, it is expected that the SMI will have significantly higher posttest scores than the SM group and the control group. In like manner, the SM group should obtain better resequencing performance scores than the control group.

3. <u>Low Skill Group</u>

It is expected that the pretest resequencing performance scores will be poorer than those obtained by the elite skill group and the medium skill group but better than those obtained by the absolute novice groups.

The low skill group will have better resequencing performance scores than the absolute novice group as they have begun to develop an image of the skills-to-be-resequenced. Although the members of this group have not acquired the procedural and declarative knowledge bases of the elite and medium skilled players, they do possess more fully developed procedural and declarative knowledge bases than those of the absolute novice group.

3.1 It is expected that the SMI will have significantly better posttest scores than the SM group and the control group. Similarly, the SM group should obtain better resequencing performance scores than the control group. The slow motion with augmented information treatment program should have a beneficial effect on both the medium and low skill groups due to the fact that the slow motion replay will allow for a verbally-cued visual rehearsal through the use of key skill cues that help organize both the visual observation process and the memorization of the skills-to-be-resequenced.

The slow motion treatment condition will also positively affect the post-treatment resequencing performance of the players in the medium and low skill groups. However, the absence of verbal cues to guide the visual rehearsal process and provide organizational cues for the memorization of the skill-to-be-resequenced will result in poorer post-treatment scores than those obtained by subjects of the medium and low skill groups who receive the SMI treatment program.

4. <u>Absolute Novice (never have played)</u>

It is expected that the absolute novice subjects will have poor resequencing performance scores and the three treatments will have minimal effect on their posttest performance.

The absolute novice players will have poorer resequencing performance scores as they have yet to develop the procedural and declarative knowledge bases of the higher skill groups. As a result, they cannot attend to the critical features of an action sequence, thus they are unable to sequentially organize the skill-to-be-resequenced. The treatments will have minimal effect as the absolute novice players have an absence of any image of the action. These players require further cues and experience to help them develop broader knowledge bases which will help them to organize the skill-to-be-resequenced.

1.3 Delimitations

The delimitations of this study are:

1. A total sample of 58 club level tennis players from the Gray Rocks Inn Tennis School served as subjects for the study. Elite, intermediate, low skill and absolute novice subjects, as defined in the definitions section, were used in the study.

2. Female tennis players were used as subjects for the study on the assumption that gender may have some effect on the treatment being investigated.

3. Only subjects between the ages of 17 to 27 years were used.

4. The tennis strokes used in the study were the serve and the forehand drive.

5. Time constraints and the availability of subjects did not allow for an interim period following the post-test session. Hence, only one post-test was used to assess the retention of the skill-to-be-learned.

1.4 Definitions

1. TENNIS SERVE	A tennis stroke which begins a point. A player tosses the ball overhead and uses an action similar to overhand throwing to strike the ball.
2. FOREHAND DRIVE	A tennis stroke played on the right side of the body by a right-handed player. The ball will have bounced once on the court before the stroke is executed.
3. SEQUENCE	A tennis action sequence is defined as a skill being executed from an accepted starting point, through a body movement and ball contact phase, and finishing with a recovery of the body to a balanced position.
4. ABSOLUTE NOVICE	Defined as a person who has never played tennis.
5. LOW SKILL	Defined as a person who has been evaluated within the range of 1.0-2.5 as listed on the National Tennis Rating Program Scale.

6. MEDIUM SKILL Defined as a person who has been evaluated within the range of 3.0-4.0 as listed on the National Tennis Rating Program Scale.

7. ELITE SKILL Defined as a person who has been evaluated as 5.0 and above as listed on the National Tennis Rating Program Scale.

8. COGNITIVE REPRESENTATION SCORE

The total score obtained on the resequencing of twelve still photographs of either the tennis serve or the forehand drive.

9. AUGMENTED INFORMATION

Six written cues presented at key times within a videotaped tennis sequence designed to focus the attention of the subject on critical learning characteristics within that action sequence.

10. RESEQUENCING TASK

A task to measure the extent to which a subject can place a series of photographs depicting a given action sequence into correct sequence from a random display of such photographs.

CHAPTER II

REVIEW OF THE LITERATURE

Although psychologists have been concerned with the problems of observational learning for a number of years, knowledge about observational learning in motor skill acquisition is still not much understood (Adams, 1987). This fact seems somewhat unsettling inasmuch as observational learning is so widely used in the teaching and learning of motor skills. During the past decade, researchers have begun to focus on a number of important aspects of observational learning. The research literature on this important skill acquisition process reflects a number of different theoretical perspectives. A review of some of these follows.

2.1 Bandura's Social Learning Theory of Modeling

Bandura (1971) proposed a model of observational learning which is divided into two phases: the response acquisition phase and the performance reproduction phase. These phases were further subdivided into subprocesses. In order to symbolically acquire a response, attention had to be paid by the learner to critical features of the modeled act and then the new information about the act had to be retained in memory. Then, in order to elicit a response, the visual or verbal symbolic representations had to be converted into appropriate actions; furthermore, the conditions which motivated the observer to reproduce the modeled response had to be appropriate. Thus, observational learning depends on attentional, memorial, motor reproduction and motivational processes.

Bandura (1984) states that people cannot learn much by observation unless attention and accurate perception of important features of modeled behavior are in place. He contends that the learner's attentional processes are the determining factors related to what one observes and what is extracted from those observations.

Bandura (1984) further recognizes a number of attentional determinants such as the kinds of people with whom one regularly associates, the attention that some individuals command within any social group, the form that the modeling behavior takes, and the degree of salience and complexity of the modeled behavior. Also, the observer's capacity to process information governs the benefits which will be derived from observed experiences. For the purposes of this study, the form that the modeling takes, the familiarity of the subjects with the skill-to-be-modeled, and the saliency of the cues within the action sequence are of prime importance.

Observational learning will not be as effective if individuals have difficulty remembering the modeled behavior (Bandura, 1984). In order for individuals to gain from observing a model's behavior after the model is no longer visually present, response patterns must be symbolically stored in memory. Two systems are primarily responsible for retention in observational learning: imaginal and verbal. Bandura suggests that most of the cognitive processes that require observational learning are verbal rather than visual, as these symbolic codes have a greater information carrying capacity in an easily stored form. Thus, for Bandura, the use of verbal labels is an important aspect in the retention of modeled behavior.

Rehearsal also serves as an important aid in the retention of the modeled behavior. Individuals who mentally or physically rehearse are less likely to forget modeled response patterns than if they do not. The greatest amount of observational learning will take place by symbolically coding and then overtly practising a modeled behavior (Bandura, 1984).

According to Bandura (1984) the third component process of modeling is converting symbolic representations into appropriate actions. Responses are first selected and organized at the cognitive level. Behaviors are then initiated, monitored and refined on the basis of information feedback. The availability of component skills will determine the amount of observational learning that will be exhibited. Learners who possess the important skills to reproduce the coded action will reproduce new actions quite easily, but if some of the response components are lacking, motor reproduction will be faulty.

Individuals are more likely to adopt a modeled behavior if they value the outcomes that may result in such behavior than if the results are unrewarding. Even though an observer has attended to the relevant activities of the modeled behavior, adequately coded modeled events for cognitive representation, retained what was learned, and has the physical capabilities to perform, there is no guarantee that the modeled act will be reproduced if the observer has no incentive to do so. Hence, the skill-to-be-learned must be relevant to the learner.

Bandura (1984) develops his theoretical framework further by suggesting that a number of subfunctions evolve with motivation and experience. Thus, skill in observational learning is greatly influenced by prior development. Bandura also states that observational learning is facilitated by improvements in component processes such as, acquiring and improving skills in selective observation, memory encoding, coordinating sensorimotor and ideomotor systems, and by the ability to foresee probable consequences of matching a model's behavior. Bandura also suggests that observational learning may be hindered by deficiencies in these component processes, and both improvements and deficiencies in these processes may be related in part to age or experience related factors.

2.2 A Knowledge-Based Approach to Motor Skill Acquisition

Bandura's (1971, 1984) theory assumes that when attending, the observer knows what to look for, how much to look at, and how to avoid being distracted. Optimal observational learning requires that an observer have a knowledge base of what to look for within a given display (Barrett, 1979). Thus, observation can be facilitated by having a predetermined and systematic approach (Arend & Higgins, 1976).

Recently, Wall (1985) and his colleagues developed a theoretical framework which emphasizes a knowledge-based approach to skill acquisition. A knowledge-based approach to skill acquisition contends that knowledge about action can be differentiated into two major categories: structural capacity and acquired knowledge. Structural capacity refers to the anatomical and physiological potential that humans inherit and that is modified by experience. Acquired knowledge refers to the knowledge gained through experience which increases with development. Furthermore, Wall and his colleagues propose that acquired knowledge can be divided into three major types: procedural, declarative and affective. In addition, metacognitive knowledge and higher level metacognitive skills can be differentiated (Wall et al, 1985; Wall, 1986).

Procedural knowledge refers to the storage of action schemas that underlie the execution of skilled movement. Action schemas are viewed as packets of knowledge that store information in a generalized manner (Norman & Shallice, 1980). As such, they facilitate the storage and flexible use of large amounts of information. Procedural knowledge, stored in schema form, underlies all aspects of an action sequence including stimulus identification, perception, decision-making and response selection and execution, and the evaluation of intrinsic and extrinsic feedback (Norman & Shallice, 1988; Howarth & Abernethy, 1984).

The developmental level of a person's procedural knowledge about action can be viewed in terms of the amount or number of automatized skills one has available to meet the demands of a given situation. An individual with an extensive repertoire of well-learned skills will be able to more efficiently handle a broader range of tasks than would an individual with a smaller skill repertoire. Recent expert-novice studies in basketball (French, Thomas, 1987), gymnastics (Vickers, 1986; Stafford, 1988) and badminton (Abernethy & Russell, 1987) demonstrate the domain specific nature of procedural knowledge and emphasize the importance of physical skills in the development of sport expertise. Individuals develop extensive procedural knowledge bases within various domain specific areas. A person who has been intensively involved in tennis acquires many automatized skills in comparison to an individual that has practised golf rather than tennis for extended periods of time and who has automatized acquired skills within that specific domain.

Declarative knowledge about action refers to factual information stored in long-term memory that can influence the development and execution of physical skills and the strategic skillfulness with which one plays a given sport. Declarative knowledge encompasses the morphological, biomechanical and environmental constraints involved in the execution of actions (Wall et al, 1985). As children develop, they begin to appreciate the personal and environmental factors that limit performance and the learning of motor skills. As procedural and declarative knowledge bases increase, they acquire symbolic codes and verbal labels that help them learn and control physical performance. Within the game of tennis, players automatize skills needed to hit the ball through extensive practise and play, but they also increase their knowledge of the strategies, rules and etiquette of the game.

An early expert-novice study by Chiesi, Spilich and Voss (1979) demonstrates the importance of domain specific knowledge in the acquisition and retention of declarative knowledge. The authors show that subjects who scored high in baseball knowledge were better able to read and retain written passages on baseball than those without such domain specific knowledge. The authors argue that the subjects with knowledge of baseball used such information to develop a context from which to organize the new baseball information that they were reading. Thus, their knowledge of the game allowed them to place key actions into perspective much more readily than those with less skill in baseball.

Expert-novice studies in the skill acquisition literature indicate that experts have richer conceptual knowledge bases than do novices. Specifically, it has been shown that experts demonstrate superior recall of game-structured information (Allard, Graham & Paarsalu), 1980), use appropriate cues to predict the flight path of sport objects (Starkes, 1987; Jones & Miles, 1978; Buckolz, Papavesis & Fairs, 1988) and use a variety of cues to make effective decisions during a game (Bard & Fleury, 1976; Buckolz, Papavesis & Fairs, 1988).

In a more recent study, French and Thomas (1987), show that young experts in basketball possess broader knowledge in both the procedural and declarative domains. Most importantly, the authors showed that greater sport-specific knowledge had a significant relationship with decision making processes. The authors cautiously conclude that "there is reason to speculate that acquisition of domain related knowledge is responsible in part for the facilitation of performance on certain tasks" (French & Thomas, 1987, p.29).

Affective knowledge about action refers to an individual's subjective feelings in various action situations (Wall et al, 1985). Such feelings are associated with successful and unsuccessful experiences in physical activity settings. Positive experiences in action situations elicit feelings of confidence and competency. Individuals who are competent in a variety of action situations are more likely to experience a larger number of success experiences than would those individuals who are less skilled; thus, positively affecting their skill acquisition process. Conversely, those individuals who experience failure in action situations often develop negative feelings about themselves. This negativity may adversely affect the skill acquisition process (Keogh & Griffin, 1984). Recent studies in the affective domain show that sport confidence is relatively sport specific; quite simply, players in a particular sport feel more confident when they can play that sport relatively well (Feltz, 1989).

Newell and Barclay (1982) refer to metacognition as being broadly defined as "a person's knowledge about his own or other's psychological, social and physical behavior and abilities" (p.187). According to Newell and Barclay (1982) this type of knowledge is acquired through purposeful and intentional interaction with one's environment. Wall et al (1985) refer to metacognitive knowledge about action as being consciously aware of what an individual can or can not do in a variety of action situations. They refer to metacognitive knowledge as "knowing about knowing how to move" (p.11). The development of metacognitive knowledge relies on an individual developing an understanding of how various cognitive processes may be used to handle a variety of tasks. For example, if a person is skilled at tennis serving, he must know the amount of force and spin required by the task in order to determine an appropriate action to be able to serve the tennis ball at a specific target. Newell and Barclay (1982) suggest that this form of sensitivity is not only knowledge, but an individual's awareness of the means-end nature of action. Wall et al (1985) refer to metacognitive knowledge as a higher level form of declarative knowledge reflecting the quantity and quality of information stored in memory within a given domain. As an individual's metacognitive knowledge develops, he or she shows greater appreciation of the multitude of variables affecting skill acquisition and performance.

As mentioned earlier, French and Thomas (1987) examined the relationship of sport-specific knowledge and the development of children's skills in basketball. Their findings suggest that a major component of performance that differentiated child-expert and novice players is the ability for child-experts to make better decisions about basketball situations than child novices. In their second experiment, the authors found that a change in a child's performance across the whole basketball season was related to an increased cognitive ability to make appropriate decisions during game situations, and procedural skill in catching the ball. These findings suggest that the development of the sport knowledge base plays an important role in learning as well as skilled performance.

Metacognitive skill is related to the learning and control of physical skills (Wall, 1986). It represents higher level executive processes necessary for the optimal control of skilled action. Planning, monitoring and an ability to evaluate outcomes are all included under the term, metacognitive skills. Newell and

Barclay (1982) refer to metacognitive skill as a person's knowledge of the factors affecting skilled performance. Three related elements are included: person, task and strategy variables. Thus, effective metacognitive control would allow a learner to analyze task demands, select appropriate strategies useful for solving specific tasks, control the operations of these strategies and evaluate successes and failures of selected strategies through feedback mechanisms.

The knowledge based approach (Wall et al, 1985) suggests a strong link between metacognitive skill and motor skill acquisition. French and Thomas (1987) contend that not only does knowledge play an important role in the development of cognitive processes necessary for skilled performance in sport, but it also facilitates the effective use of proceduralized skills developed in that sport. Such findings reinforce the importance of developing both metacognitive knowledge and metacognitive skill in young learners.

2.3 Recent Expert-Novice Studies

The knowledge base theory of skill acquisition assumes that the acquisition of domain specific knowledge in a given activity is a critical feature in the development of an adequate cognitive representation of a skill. Therefore, it is important to examine the effect of differences in the knowledge bases of experts and novices on resequencing performance. The expert-novice paradigm has been widely used to assess knowledge base differences. As indicated earlier, numerous studies show the differences between experts and novices in domain specific knowledge as well as other related factors in the learning process.

In a study of visual search patterns of gymnastic judges, Bard et al (1980) found differences between number and location of eye fixations between expert and novice gymnastic judges. Expert judges make 27% fewer eye fixations than novice judges; furthermore, novice judges detect only half of the gymnasts' errors that are seen by expert judges. Of importance for this study is the implication that experts know what to look for in a performance and systematically control their visual search based on their more extensive knowledge base.

In a similar study, Petrakis (1986) examined the visual observation patterns of novice and expert tennis teachers when viewing a serve and a forehand drive. Petrakis found that experts' scan patterns were more compact than those of novice tennis teachers. Again, it was demonstrated that experts' organization of observation of a model is much more systematic than that of a novice, with specific observation objectives in mind. In other words, experts have the domain specific knowledge of what to look for and the metacognitive skill of how to observe when viewing a modeled demonstration.

Buckolz (1988) showed that advanced tennis players predicted types of passing shots more accurately than intermediate tennis players. In some instances, the difference in accuracy was attributed to the fact that intermediate players were unaware of what the telegraphic cues were, while in other situations the intermediate players were not even aware of the presence of such telegraphic cues. Both instances demonstrate the effect of a more extensive domain specific tennis knowledge base.

In a study which assessed the relative importance of attributes primarily determined by the efficiency of the central nervous system versus cognitive attributes, Starkes (1987) developed a profile of elite field hockey players in contrast to moderate and novice level players. The elite players did not appear to differ from other skill levels on attributes determined by the efficiency of the central nervous system. However, elite players were superior in all of the knowledge base related areas. As expected, elite players had superior recall of game-structured information and were able to make more accurate decisions during the course of game play.

The above expert-novice studies support the importance of domain-specific procedural and declarative knowledge in a variety of sports and indicate that higher-level metacognitive skill is also important in explaining differences in sport expertise.

2.4 The Resequencing Task

The resequencing task was introduced by Vickers (1986) as an indirect means to measure the recall of a movement sequence. She argued that the resequencing task could be used to assess the performer's understanding and retention of the spatial and temporal organization of movement sequences. The resequencing task requires subjects to resequence or re-order a randomly distributed set of still photographs of a given movement sequence. Vickers (1986) chose female gymnasts as subjects. Elite and intermediate ranked gymnasts from the same gymnastic club and novice gymnasts who were members of an elite soccer club were the subjects in her study.

Six corresponding still photographs were prepared for each of six different gymnastic sequences. The sequences were low to medium in task difficulty with both elite and intermediate subjects able to perform all or most of the stunts. Novice subjects were unable to perform any of the sequences.

As was predicted, the elite gymnasts were able to resequence the photograph sequences faster and more accurately than both the intermediate and novice groups. Both elite and intermediate groups were significantly better than the novice group.

Vickers suggests that a cognitive or information processing explanation would attribute the differences between groups to internal factors. These factors might include different schemas or knowledge structures, and internal processing differences such as top-down versus bottom-up systems.

Stafford (1988) used the resequencing task to examine expert-novice differences between grades four, five and six female students in physical education classes on simple and advanced tumbling sequences. As expected, she found that the more skilled students in the physical education classes were better in the resequencing of gymnastics sequences that their less-skilled peers. Her results provide further support for the notion that expert-novice or domain specific knowledge plays a critical role in the processes underlying the resequencing task. Stafford (1988) suggests that individuals with higher levels of skill are able to more accurately resequence photos of an action sequence because of a greater domain specific knowledge base related to the particular action sequence. Conversely, less skilled individuals will not resequence photos of an action sequence as well because of an insufficient knowledge base in that particular activity.

2.5 Videotape Replay and Instruction

A method of demonstrating consistent performance of an action sequence to learners is through the use of videotape replay. Replay of demonstrations on film have been shown to be as effective as live demonstrations (Bandura, Ross & Ross, 1963). Martens et al (1973) point out that videotaped demonstrations may be viewed at the learner's convenience and the model demonstrator is not subject to the fatigue or errors a live model might be.

Appropriate attention directing devices, such as slow motion and instructional cuing may enhance observational learning (McGuire, 1961). When cuing directs the learner's attention toward specific items in videotaped tennis sequences that are important for successful skill performance, learning may be enhanced. McGuire (1961) points out that if all aspects of an action sequence are relevant to skill improvement, then it may be more beneficial not to use instructional cuing because directing the learner's attention toward specific items might augment the learning of those items at the expense of potentially important nonspecified items (McGuire, 1961). However, the research indicates that cuing is particularly useful in directing the learner's attention to items that are difficult to demonstrate visually (McGuire, 1961; Dwyer, 1978). Clearly, this is an issue that requires further research.

When a motor skill sequence is shown at a slower than normal rate, this may allow the learner's attention to focus upon details of the movement that would not normally be seen when played at normal speed (McGuire, 1961). This seems to be especially important in complex, fast-paced action such as those involved in tennis.

Dwyer (1978) refers to both written information and slow motion as forms of instructional cuing. Cuing as defined by Dwyer (1978) is the "process of focusing learner attention on individual stimuli within the model to make the essential learning characteristics distinct from other stimuli" (p.158).

Cuing, according to Dwyer (1978) may be classified into two basic strategies. The first consists of providing the learner with additional relevant stimuli to improve and make more complete their understanding of the information they are receiving. This may be accomplished with the use of written cues on videotape playback.

The second type of cuing provides no additional information for the learner. This strategy ensures that the intended stimuli is emphasized in such a way that it will be perceived from among other stimuli in the learner's total perceptual field. Slow motion video replay is a commonly used cuing strategy designed to reduce the total number of errors a learner makes when initially exposed to new information and to reduce the amount of time necessary to acquire new information.

A number of key issues emerge from the above review of the literature. In the initial section of the literature review, research by Bandura (1971, 1984) underscored the importance of using critical features to facilitate the learning of a modeled behavior. The value of verbal and visual cues to direct attention to such critical features was also underscored. He also stressed the importance of motivation in the modeling process and the value of using behaviors that are rewarding to the subject. Bandura (1984) also recognized the importance of prior experience within a given domain in the acquisition of new behaviors through observational modeling.

A knowledge-based approach to motor skill acquisition extended Bandura's research regarding the value of prior experience in modeling and re-sequencing processes. Wall and his colleagues (1985), along with other researchers (Vickers, 1986; Thomas and French, 1986; Stafford, 1988) note the importance of both procedural and declarative knowledge bases. They also recognize, as did Bandura (1984), the importance of the skill-to-be-modeled or resequenced in relation to its motivational value. The role of such metacognitive skills as attentional control and memory rehearsal strategies are also recognized.

Recent expert-novice studies support the significant role that domain-specific knowledge plays in the development of sport expertise. The effects of experience and systematic practice on the development of a person's knowledge base has been clearly documented.

In summation, the rationale for this study is based on the following considerations: the selection of ecologically valid tasks that will be valued by, and motivate subjects; the recognition of the role of developmental skill level of the subjects within a specific domain; the value of slow motion treatment programs to enhance visual modeling and resequencing processes, and the potential value of guiding observational modeling through the use of verbal cues.

The next chapter will discuss subjects, tasks, instrumentation, treatments, and procedures used to investigate the differential effects of slow motion videotapes with and without augmented cues on the resequencing performance of tennis players at four different skill levels.

CHAPTER III

METHODS AND PROCEDURES

3.1 Subjects

The subjects selected for this study were female tennis players involved in an instructional program at the Gray Rocks Inn Tennis School who volunteered to participate in the study. Four groups were formed based upon developmental skill level. Absolute novice (n=13), low skill (n=15), medium skill (n=15), and elite skill tennis players (n=15) were used. The developmental skill level of each subject was determined by certified tennis professionals from the Gray Rocks Inn Tennis School using the National Tennis Rating Program (see appendix A). The experimenter and two independent instructors rated the skill level of each player. Inter-observer agreement scores were 80%, showing that the subjects were classified quite accurately. All of the subjects were right-handed and had normal vision with eyeglasses if required. It was possible to use such a large group of female tennis players at varying levels because they were involved in a one week instructional tennis program. It should be mentioned that time constraints and the willingness of the subjects to participate in the study limited the extent of the experimental design. An interim period following the post-test treatment was simply not possible given these constraints.

3.2 Procedures

Treatment and testing of the subjects was divided into two parts. The initial phase consisted of measuring the performance of the subjects on the control task and the pretest experimental condition. During the second phase, the subjects were given one of the three experimental treatments followed by the posttest for that condition. Subjects were given the treatment and posttest for the tennis serve and then the forehand drive.

The subjects were tested in a quiet room at Auberge Gray Rocks Inn. Subjects were tested in pairs based on their skill level and treatment condition; they were tested in random order.

Subjects sat in a comfortable chair with a table in front of them that allowed them to arrange the photographs into their proper sequence. The photographs for each test were set out initially each time in a set random order. Subjects watched a 20-inch video monitor placed just in front of them for easy viewing. The content of videotape that the subjects viewed depended on the treatment condition to which they were assigned. The procedure for each phase of the experiment follows.

3.3 Experimental Conditions

3.3.1 Control Task

A control task was used to demonstrate that there were no differences among the groups due to intelligence, memory skill, and motivation. Subjects were shown a videotape replay at regular speed showing an action sequence in which a young man approached a table, drank a glass of juice, and then walked away from the table. The instructions used for this task are presented in Appendix B. After hearing the instructions, subjects were given an opportunity to ask questions related to the task. Subjects were then presented with eleven still photographs of the action sequence. The photographs of the action sequence were placed on a table in front of the subjects in a set random order. Subjects were then asked to reconstruct the action sequence with the photographs.

3.3.2 Pretest

The pretest condition for each of the two action sequences was the same for all subjects. The subject entered the room, sat comfortably at a table and viewed one playing of an action sequence showing a tennis serve played at regular speed. The instructions used for this task are presented in Appendix C. Subjects were then presented with twelve still photographs of the action sequence. The photographs of the tennis serve were placed on a table in front of the subjects in a set random order. Subjects were then asked to reconstruct the action sequence with the photographs. A forty-five second time limit was set for the resequencing task. Subjects were then given a three-minute rest and were pre-tested on the forehand drive in the exact same manner.

3.4 Treatment Conditions and Posttest

Three different treatment conditions were administered during the treatment phase of the study.

3.4.1 Control Treatment Condition

The control treatment condition consisted of the subjects viewing a videotape at regular speed of the tennis serve and then simply resequencing the twelve still photographs of that first action sequence, within a forty-five second time limit. The instructions for this task were presented with twelve still photographs of the action sequence. The photographs of the tennis serve were placed on a table in front of the subjects in a set random order. As in the pretest situation, subjects were asked to reconstruct the action sequence with the photographs. Subjects were then given a three-minute rest and were then tested on the forehand drive in exactly the same manner.

3.4.2 Slow Motion Treatment Condition

The second treatment condition consisted of the subjects in this group watching a videotape replay of the tennis serve in which the sequence to be learned was initially played at regular speed, then three times in slow motion, and then one last time at regular speed. The instructions for this task are found in Appendix D.

Subjects were then given a two-minute rest period in which they could relax in any way they wished. Subjects were then given the posttest in exactly the same way the pretest was administered. After a three-minute rest, the same procedure was then used for the second action sequence, the forehand drive.

3.4.3 Slow Motion with Augmented Information

The third treatment condition consisted of the subjects in this group watching a videotape replay of the tennis serve in which the sequence to be learned was initially played at regular speed, then three times in slow motion; and then one final showing at regular speed. Instructions for this task are found in Appendix E. During the slow motion playback phase, subjects were presented with relevant skill cue instructions. Six primary skill cues and two or three related subcues were highlighted in type written form on the videotape for each subject during the action sequence (see Appendices F and G). Again, subjects were given a two-minute rest period and then administered the posttest in the same manner as the pretest condition. The same procedure was then administered for the forehand drive.

3.5 Instrumentation

The instrumentation used in this study measured the resequencing task performance of the subjects (Vickers, 1985; Downey, 1988 and Stafford, 1988). Initially, all of the subjects were tested on a common control task which consisted of them resequencing an action sequence in which a young man approached a table, drank a glass of juice and then walked away from the table. The instructions for this task are presented in Appendix B. Two experimental tasks were also used. A videotape of an expert tennis player performing a tennis serve and hitting a forehand drive were made.

The video-copy processor model P60W manufactured by Mitsubishi was used to produce twelve still photographs of each of the above tennis skills. The tennis serve was used as it is a relatively closed skill which is commonly used in the game and the forehand drive was selected because it is one of the most common open skills used in tennis.

3.6 Scoring of Resequencing Performance

Scoring of the resequencing performance on all three tasks was completed as follows:

Twelve points were assigned to each of the twelve photographs in the action sequence; hence a correct placement of all twelve photographs could result in a score of 144 points. For every position that a photograph was placed out of sequence, one point was deducted for each place that it was away from its proper location in the correct sequence. Thus, if photograph 8 was resequenced in position 11, then photograph 8 would be given a score of 12 - 3 = 9 points. Each photograph in the sequence of 12 pictures was scored in this manner.

This scoring system was devised in order to take into consideration the degree of error involved in the placement of each photograph from its correct placement in the sequence. Designating an initial 12 points to each photograph ensured that only positive scores would be obtained. A committee of five experts with considerable experience in measurement and the use of resequencing techniques agreed that this scoring system appeared to be the most appropriate for use in this study. The next chapter reports on the results obtained in this study.

CHAPTER IV

RESULTS AND DISCUSSION

The results of this study will be presented in three separate sections. The first section deals with the resequencing scores obtained by the players on the control task whereas the second and third sections address the effects of the three experimental treatments on the players' resequencing of the tennis serve and the forehand drive.

4.1 Resequencing Performance Control Task

An analysis of variance was completed on the resequencing scores on the control task of the players in each of the four skill groups. As expected, there was no significant difference among the four groups; hence, it can be assumed that there were no significant differences in memory ability, general resequencing skill, or in motivation to complete such resequencing tasks. This is an important assumption on which to base subsequent phases of this study as memory, resequencing or motivational differences might have confounded the experimental findings of this study (Chase & Simon, 1973; Allard, 1980).

4.2 Resequencing Performance on the Tennis Serve

Table 1 presents the results of the analysis of variance completed on the scores obtained by each of the four skill groups when resequencing the tennis serve photos under three experimental conditions.

Table 1: Analysis of Variance of the Resequencing Scores for the Tennis Serve of Players in the Novice, Low, Medium, and Elite Skill Groups Before and After Three Experimental Conditions

Tests of Between Subjects Effects

Source of Variance	SS	DF	MS	F	SIG of F
Constant	2115868.57	1	2115868.6	13524.71	.000
Group	5938.34	3	1979.45	12.65	.000
TRT	576.90	2	288.45	1.84	.169
Group by TRT	1247.23	6	207.87	1.33	.263

Tests of Within-Subject Effects

Source of Variation	SS	DF	MS	F	SIG of F
Within Cells	1644.20	47	34.98		
Time	313.60	1	313.60	8.96	.004
Group by Time	161.41	3	53.80	1.54	.217
TRT by Time	382.87	2	191.43	5.47	.007
GRP by TRT by Time	118.95	6	19.83	57.00	.755

As expected, a significant difference was found for the skill factor, F (3,47) = 12.65, p<.000 indicating that the resequencing of the tennis photos was related to the tennis expertise of the players. Table 2 presents the cell means for the resequencing scores of the tennis serve by the players in the four skill groups and the results of the planned comparisons tests on them.

Table 2: Results of the Planned Comparisons Tests on Skill Group Main Effect on the Tennis Serve Resequencing Scores

	Mean	Novice	Low	Medium	Elite
Novice	123.18				
Low	132.30	2*			
Medium	139.90	3.67**	1.67*		
Elite	141.60	3.94**	1.97*	1.36	

* = .05; ** = .01; df = 47

As expected, the novice players had significantly lower resequencing scores than the other three skill groups. Furthermore, the medium and elite skill players were significantly better at resequencing the photos of the tennis serve than those in the novice and low skill groups; however, there was not a significant difference between the medium and elite players. These findings are congruent with those found by Vickers (1986) and Stafford (1988).

The treatment by time interaction on the resequencing of the tennis serve photos was also significant $F(2,47)=5.47$ $p \leq .007$. Figure 1 presents the mean resequencing scores for the tennis serve for the treatment by time interaction that was present across all skill levels. As the figure shows, and planned comparisons tests confirmed, it is clear that both the slow motion and the slow motion with augmented information experimental treatments had a significant effect on the resequencing performance of the subjects in all four skill groups. At the same time, it is clear that the control treatment did not have a beneficial effect on the resequencing scores of the players in the control group. Similar results to these are not available in the sport skill acquisition; however, they are clearly in keeping with the theoretical and applied information available on the value of slow motion replay in learning (Dwyer, 1978; McGuire, 1961; Rothstein, 1980) and the role of observational modeling through video in the development of cognitive representation (Bandura, 1971, 1973, 1984).

As presented earlier, a group by treatment by time interaction had been predicted on the basis of the information available before this study; however, the results indicate that players at all skill levels benefitted from video

presentations of the actions to be resequenced in slow motion and in slow

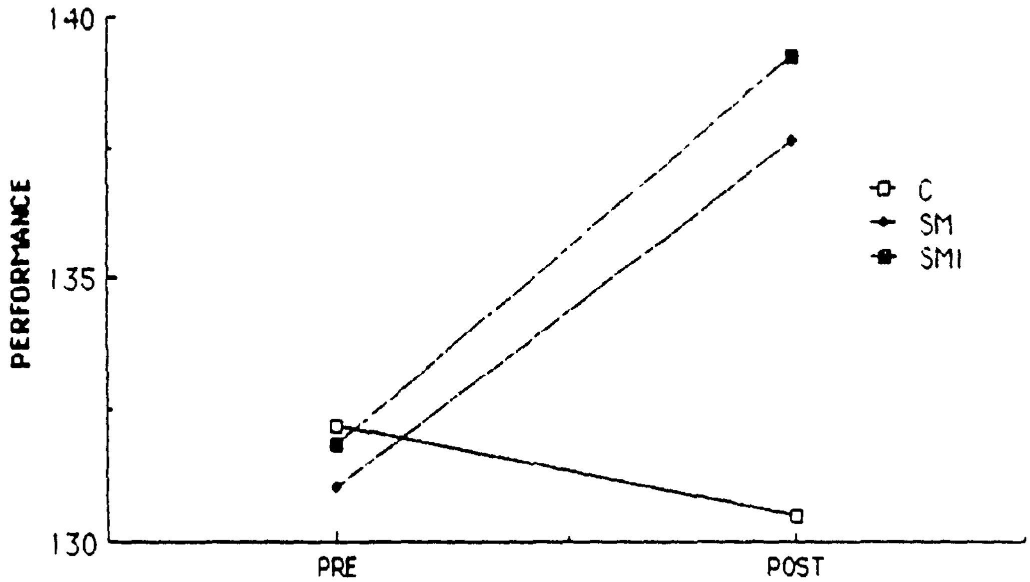

Figure 1 Mean Resequencing Scores for the Tennis Serve Treatment by Time Interaction

motion with augmented information as the predicted floor and ceiling effects did not occur at the elite and novice skill levels.

As noted earlier, the time constraints and the availability of subjects did not allow for follow-up testing of the subjects after a suitable interim period after the treatment conditions. However, the positive value of using slow motion and slow motion with augmented information videos for the development of the image of the act within an ecologically valid tennis lesson time frame is supported by these results. The subjects at all skill levels benefitted from reviewing the action sequences on slow motion video tape both with and without augmented information prior to the resequencing of the tennis serve. The beneficial effect of the slow motion video and the augmented slow motion video are in keeping with the theoretical ideas of Dwyer (1978) and McGuire (1961) on the value of providing learners with heightened information about key visual cues through the use of videotapes. A direct relationship between enhanced resequencing performance and improved physical execution of the tennis serve clearly cannot be inferred from these results. However, it would seem sensible to assume that the development of an appropriate image of the action sequence, or in Bandura's terms, a suitable cognitive representation of it, would be a positive step toward that end.

The fact that the augmented slow motion video did not improve the resequencing performance any better than the slow motion video alone must also be addressed. One of the first points that should be made is the fact that the augmented written cues might have actually detracted from the value of the slow motion videos for some of the players. Dwyer (1978) and McGuire (1961) point out that if all aspects of an action sequence are relevant to skill improvement it may not be more beneficial to direct the learner's attention toward specific items as it may augment the learning of some items at the expense of potentially important nonspecified ones. One of the novice players remarked, "I spent too much time reading and concentrating on the writing on the screen and thinking about it and not paying enough attention to the person". This was not an uncommon reaction in the less-experienced groups, that is, the novice and low skill groups; and it underscores the fact that the use of written cues along with the video presentation of the tennis serve may have required too much cognitive processing or focused the attention of the less-skilled players on aspects of the tennis serve that were not of importance to them. It should also be noted that a number of players in the expert group seemed to ignore the written cues as they judged them to be unimportant or redundant. Studies need to be completed on the type and quantity of cues that are used in relation to skill level in order to effectively assess the value of augmented information in video tape presentations of skills-to-be-learned.

Given the constraints of this study, it is impossible to provide specific causal reasons for these results; however, the above observations and those made in the general discussion may help in the design of future studies in this area.

4.3 Resequencing Performance on the Tennis Forehand Drive

Table 3 presents the results of the analysis of variance on the pre-post resequencing scores of the forehand drive by players at all four skill levels under the three experimental conditions. Only the skill group main effect was significant, $F(3,47)=15.26$, $p \leq .000$.

Table 4 presents the cell means for the players in the four skill groups and the results of the planned comparisons that were completed on them.

Again, as with the tennis serve, the resequencing scores on the forehand drive of the novice players were significantly lower than the scores obtained by the players in the other three skill groups. Furthermore, the elite players were significantly better at resequencing the forehand drive action sequence than the subjects in the other skill groups. The predicted treatment by time interaction and the group by treatment by time interaction were not significant.

Table 3: Analysis Variance of the Resequencing Scores for the Forehand Drive of Players in the Novice, Low, Medium, and Elite Skill Groups Before and After Three Experimental Treatments

Tests of Between-Subjects Effects

Source of Variation	SS	DF	MS	F	SIG of F
Within Cells	5249.37	47	111.69		
Constant	2049954.98	1	2049955.0	18354.16	.000
Group	5114.38	3	1704.79	15.26	.000
TRT	1094.08	2	547.04	4.09	.012
Group by TRT	1399.06	6	233.18	2.09	.072

Tests of Within-Subjects Effect

Source of Variation	SS	DF	MS	F	SIG of F
Within Cells	3183.17	47	67.73		
Time	1770.80	1	1770.80	26.15	.000
Group by Time	149.80	3	49.93	74.00	.535
TRT by Time	125.68	2	62.84	.39	.403
Group by TRT by Time	624.47	6	104.08	1.54	.187

Table 4: Results of the Planned Comparison Tests on the Skill Group Main Effect on the Forehand Drive Resequencing Scores

	Mean	Novice	Low	Medium	Elite
Novice	121.79				
Low	131.76	2.59**			
Medium	134.37	3.26**	.677		
Elite	140.30	4.80**	2.22*	1.54	

* = .05; ** = .01; df = 47

The fact that the slow motion video and the augmented slow motion video had a positive effect on the resequencing of the tennis serve and not the forehand drive will be addressed in the following general discussion.

4.4 General Discussion

4.4.1 The Tennis Serve vs the Forehand Drive: Resequencing Performance Considerations

An assessment of the task demands of the tennis serve indicates that it is a relatively consistent type of movement pattern as players must try to execute accurate, consistent, and powerful serves that land in the opponent's service box. The tennis service movement pattern has a very clear starting point and a very clear finishing point with quite distinct sub-movements that are readily identified as linking the beginning and ending of the action. In contrast, the forehand drive is a relatively inconsistent movement pattern inasmuch as it is used in an open, dynamic environment which requires that the action be executed from different areas of the court, under varying degrees of control, and at a variety of heights at which the ball is contacted. Thus, in contrast to the forehand, the tennis serve lends itself to encoding a relatively clear image of the action due to the standard position from which it is executed, its readily identifiable parts, and the unique way it is used to initiate a tennis playing sequence which allows one to observe it more systematically under less time stress. Therefore, it is argued that, the forehand drive is more difficult to encode due to its variability of execution.

In addition to the above observations, the tennis service motion has more concrete organizational anchor points than does the forehand drive. The anchor points of the forehand drive are much more diffuse than those of the serve and therefore it is argued that it is more difficult for an inexperienced player to develop a clear image of its action. Furthermore, under the treatment conditions in this study the anchor points of the serve were heightened by the slowing down of the action in the slow motion videos, thus reinforcing these distinct cues in the action sequence.

4.4.2 Tennis Expertise and Resequencing of Tennis Skills

One of the main findings of this study indicates that expertise in tennis is positively related to resequencing performance in both the tennis serve and the forehand drive. This finding is congruent with recent studies in gymnastics by Vickers (1986) and Stafford (1988) that demonstrated a positive relationship between expertise and resequencing performance. It should be stressed that such significant relationships are certainly not causal ones; however, they do speak to the need to explore why differences in sport expertise might positively affect the resequencing of photographs of an action sequence. The following ideas on this matter are based on a knowledge-based approach to sport expertise; clearly, further research will be needed to examine them in more detail. They are based on the assumption that the development of an image of the act, or cognitive representation, is an important consequence of improvement in physical skill and expertise in a given domain.

From a knowledge-based perspective, it can be argued that more highly skilled tennis players, like other experts, have developed broader declarative and procedural knowledge bases and a wider array of metacognitive skills that they can draw upon to aid in the resequencing process. More specifically, better resequencing performance may be due to a broader and more accurate procedural knowledge base on the part of highly skilled players. Given the fact that skilled tennis players have more automatized physical skills in their repertoire, they may be able to more readily access kinesthetic feelings associated with the correct execution of a particular action. Such kinesthetic feelings might be used to access and clarify an image of the action.

Even more importantly, highly skilled tennis players have better declarative knowledge bases about the context of the game and the environment within which a particular skill is executed. This declarative knowledge, if it is similar to that acquired by other experts, is more organized, coherent, and accessible than it is in lower skilled players (Wall, 1986; French & Thomas, 1989; Starkes, 1987). The highly skilled players may use their richer procedural and declarative knowledge bases to simplify a skill to-be-resequenced by attending to and verbally-coding key anchor points within an action sequence. Based on comments made by players in the elite skill group, it seems that the more skilled tennis players used such terms and phrases as: grip, stance, swing-back, backscratch, hip and shoulder rotation, extension to contact, follow-through, and balance to organize their image of the act of serving in tennis. Hence, their ability to resequence is enhanced by their ability to focus on what is important to remember in the sequence but also by their ability to code it effectively. Less skilled players inasmuch as their procedural and declarative knowledge base is much smaller, are less able to focus on the key cues, or anchor points, of a skill to be resequenced.

Based on observations made during this experiment, it should be noted that the less skilled players appeared more anxious while resequencing the photos which may have been due to the fact that they have smaller declarative and procedural knowledge bases and thus seem to have less confidence in their ability to resequence the actions. Further examinations of this possibility is clearly needed.

Finally, the metacognitive skills of the experienced players may also have had a major effect on the differences that have been found in resequencing performance. Many of the medium and elite players used an "anchor point" strategy that consisted of selecting key photographs out of the total sequence that were clearly key cues, or anchors, around which the rest of the photographs could be organized. This strategy was used by the majority of the more skilled players. In contrast, those with less skill looked at the photographs and often remarked that the pictures all looked the same. Furthermore, they did not seem to have a sufficient knowledge base of tennis to be able to generate a strategy that would enhance their resequencing of the photos. The importance of a sufficient knowledge base has been stressed in a number of recent expert-novice studies (French & Thomas, 1987; Vickers, 1986; Stafford, 1988; Abernethy & Russell, 1988); furthermore, the importance of such a knowledge base in problem solving and strategic planning has also been demonstrated in the cognitive domain (Glaser & Bassok, 1989).

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

The purpose of this study was to examine the effects of two types of videotape instructions on the resequencing performance of female tennis players at the novice, low, medium, and elite skill levels. Treatment and testing of the subjects was divided into two parts. During the first phase subjects were initially asked to resequence the culturally-normative action sequence of drinking a glass of juice.. They then were tested on the resequencing of the tennis serve and forehand drive action sequences. Three different treatment conditions were administered during the experimental phase of the study. Initially, the control group was required to simply resequence the twelve still photographs of the tennis serve as in the pretest situation. Another group was presented a videotape replay of the tennis serve played at regular speed, then three times in slow motion and then a final showing at regular speed. A third group viewed a videotape replay in the same sequence as the second group but augmented by written skill cues.

After a rest interval a posttest was administered to the three treatment groups in exactly the same manner as the pretest. Similar procedures were carried out for the forehand drive. The results indicated that the resequencing performance on both the tennis serve and the forehand drive was related to expertise in tennis; that is, the more skilled players achieved significantly better resequencing scores than the less-skilled players. Furthermore, the slow motion and slow motion replay with augmented information treatments significantly improved the resequencing performance of the players in the four skill groups on the tennis serve but not on the forehand drive.

5.2 Conclusions

In sum, within the limits of this study, the following conclusions can be made:

1. A person's level of expertise in tennis directly influences his or her ability to resequence a set of photos of action sequences that are commonly used in the game of tennis.

2. The use of a slow motion videotape treatment program differentially affected the resequencing of photos of the tennis serve and forehand drive action sequences. The slow motion video replay significantly improved the resequencing performance of the players at all skill levels; however, it did not affect the resequencing of the forehand drive. Task demand differences were used to account for this differential treatment effect.

3. In contrast to the expected results, the slow motion video replay treatment did not differentially affect the players at different skill levels.

4. Again, in contrast to expected results, the videotape replays with augmented written information on key cues did not enhance the resequencing performance of the players more than the slow motion treatment on its own. This result may have been due to an information overload or the inclusion of redundant cues in this aspect of the treatment.

5. Finally, in order to more fully understand the factors that influence the development and use of cognitive representations or images of the act, the resequencing process was examined from a knowledge-based perspective. Based on comments made by players during and after the experiment, the importance of increased declarative, and metacognitive knowledge and skills was emphasized.

5.3 Recommendations

1. The nature of cognitive representations, or image of the action, needs to be explored. The use of protocol analysis techniques with

players of different expertise might provide a better understanding of this important phenomenon.

2. A number of comments made by the players in this study reinforced some of the observations about learning that stem from a knowledge-based approach to skill acquisition. Further descriptive research needs to be completed on the nature of the image of the act, or cognitive representation of an action sequence The importance of all five types of knowledge about action to the development of the image of the act needs to be investigated.

3. As mentioned in the discussion of the results, the type and quality of any written cues that are provided must be related to the level of expertise of the players. Again, protocol analysis in conjunction with video taped action sequences would be valuable in determining this important aspect of an treatment program.

4. The relationship between the level of expertise and anxiety during the resequencing process needs to be examined. The time limit given to complete the task needs to be carefully determined as it could negatively effect the performance of the less-skilled players.

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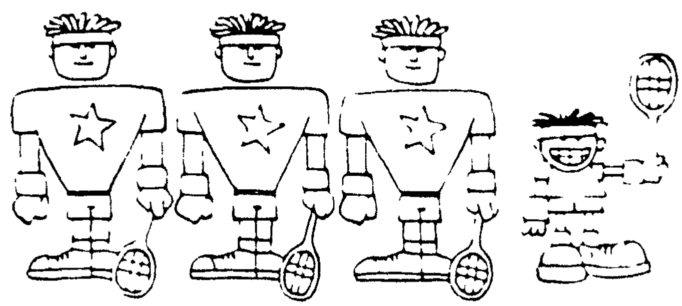
APPENDICES

TENNIS RATING PROGRAM

At last a system developed for rating players of all levels. For the first time it will be possible for a player to find a compatible opponent. HOW? It works on a scale of 1 to 7 depending on your experience and tennis ability. Very soon we hope that the old low intermediate or between low and high intermediate will disappear to make place for this new and accurate tennis rating program. Find out about it and be the first one to be rated on the scale.

SEE THE PRO S FOR MORE INFORMATION



THE NATIONAL TENNIS RATING PROGRAM: WHERE DO YOU STAND?

1.0 - This player is just starting to play tennis.

1.5 - This player has played a limited amount but is still working primarily on getting the ball over the net; has some knowledge of scoring but is not familiar with basic positions and procedures for singles and doubles play.

2.0 - This player may have had some lessons but needs on-court experience; has obvious stroke weaknesses but is beginning to feel comfortable with singles and doubles play.

2.5 - This player has more dependable strokes but is still unable to judge where the ball is going; has weak court coverage; is still working just to keep the ball in play with others of the same ability level.

3.0 - This player can place shots with moderate success; can sustain a rally of slow pace but is not comfortable with all strokes; lacks consistency in serving.

3.5 - This player still lacks stroke dependability, depth and variety but has improved ability to direct shots away from opponent; rarely double faults but does not usually force errors on the serve; hits forehand and backhand volleys with consistency if the ball is within reach.

4.0 - This player has dependable strokes on both forehand and backhand sides; has the ability to use a variety of shots including lobs, overheads, approach shots and volleys; can place the first serve and force some errors; is rarely out of position in a doubles game.

4.5 - This player has begun to master the use of power and spins; has sound footwork; can control depth of shots and is able to move opponent up and back; can hit first serves with above average power and accuracy and place the second serve; is able to rush net with some success on serve against players of similar ability.

5.0 - This player has good shot anticipation; is able to overcome some stroke deficiencies with outstanding shots or exceptional consistency; will approach net at opportune times and is often able to force an error or make a winning placement; can execute lobs, drop shots, half-volleys and overhead smashes with above average success; is able to vary the spin on the serve.

5.5 - This player is able to execute all strokes offensively and defensively; can hit first serves for winners and second serves to set up an offensive situation; maintains a winning level of play in social tennis and can reach at least the quarterfinals or semifinals of the highest level club or park championship.

6.0 - This player has mastered all of the above skills; is able to hit both slice and topspin serves; can vary strategies and styles of play in competitive situations; is capable of being ranked in a major city or USTA district.

6.5 - This player has developed power and/or consistency as a major weapon; has all of the above skills as well as the concentration necessary for successful tournament play; is capable of earning a USTA sectional ranking.

7.0 - This player is highly skilled in all of the above categories; is a polished tournament player who has traveled extensively for sanctioned competitions; has been ranked nationally by the U.S. Tennis Association.

APPENDIX "B"

Instructions for Common Control Task

- "I am going to show you a videotape of a person drinking a glass of juice."

- "The person will walk to a table, sit down, drink the glass of juice and then leave the table."

- "After you have watched this video I will place twelve still photographs of the action sequence in front of you. These pictures will be mixed up."

- "I will then give you forty-five seconds to resequence the photographs into their correct order which depicts the action sequence you saw on the video."

- "I will let you know when the time is up. Do you have any questions?"

APPENDIX "C"

Instructions for Pretest Condition

Tennis Serve and Forehand Drive

- "I am going to show you a videotape of the serve used in tennis."

- "After you have finished watching the video, I will place twelve still photographs in front of you which depict the same action sequence."

- "These photographs will be in a mixed order. You will have forty-five seconds to resequence the pictures into the order in which you think they belong."

- "When you hear the timer, the forty-five seconds is up and we will then go through the same procedure with a videotape and twelve photographs for the forehand drive."

- "Resequence the cards as well as you possible can. Do you have any questions?"

APPENDIX "D"

Instructions for Slow Motion Treatment Condition

Tennis Serve and Forehand Drive

- "I am going to show you a videotape of the serve used in tennis."

- "The videotape will show you the tennis serve at regular and slow motion speeds."

- "After you have finished watching the videotape, I will place twelve still photographs in front of you. These pictures represent the action sequence you saw on the videotape. The photographs will not be in their proper order."

- "You will have forty-five seconds to resequence these photographs into the order in which you think they belong."

- "When you hear the timer the forty-five seconds is up and we will then go through the same procedure for the forehand drive."

- "Resequence the cards as well as you possibly can. Do you have any questions?"

APPENDIX "E"

Instructions for Slow Motion with Augmented Information Treatment Condition

Tennis Serve and Forehand Drive

- "I am going to show you a videotape of the serve used in tennis."

- "The videotape will show you the tennis serve at regular and slow motion speeds."

- "Between some of the action sequences on the videotape, you will see written cues on the monitor which highlight some of the more important things to remember about the serve."

- "Once the videotape has finished, I will place twelve still photographs in front of you. These photos represent the action sequence you saw on the video."

- "These pictures will not be in the correct order. You will have forty-five seconds to resequence these photographs into the order in which you think they belong."

- "When you hear the time the forty-five seconds to resequence these photographs into the order in which you think they belong."

- "When you hear the time the forty-five seconds is up and we will go through the same procedure for the forehand drive."

APPENDIX "F"

Tennis Serve - Augmented Information

1. STANCE	. weight on back foot.
2. SWING BACK	. both arms move down and up together.
3. BALL TOSS	. ball "placed" high above the head.
4. BACKSCRATCH	. same position as if throwing overhand.
5. POINT OF CONTACT	. full extension of arm and racquet at impact.
6. FOLLOW-THROUGH	. racquet moves down and across body.

APPENDIX "G"

Forehand Drive - Augmented Information

1. STANCE	. feet about shoulder width; knees flexed.
2. SWING BACK	. shoulders turn to side as racquet goes back.
3. MOVEMENT	. small steps toward ball.
4. FORWARD SWING	. rotate hips and shoulders forward.
5. CONTACT	. racquet strings square to the ball at impact.
6. FOLLOW-THROUGH	. right hand in front of left eye.