THE EFFECTS OF A MENTAL TRAINING PROGRAM ON TENNIS PLAYERS’ SERVICE FORM AND CONSISTENCY

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The current study investigated whether combining a ten-week imagery training and video modeling intervention would improve the consistency and form of tennis serves, and to determine if differences in intervention effectiveness were based on skill level of the players. Sixty-one high school tennis players ($M_{age} = 15.44, SD = .98$) were separated into four groups; a control group and an experimental group which received the mental training program. Univariate analyses of covariance controlling for possible pre-test differences, gender, and years of tennis experience and a chi-squared analysis for responders to treatment showed no significant differences for the experimental group. Thus, the ten-week imagery training and video modeling intervention used in this study appeared to not influence tennis service form and consistency. There is a need for longitudinal studies of mental training techniques to determine whether these practices are effective for athletes of different sports and competitive levels.
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Figure 1. Image stills of data collection points (A- ready position, B- racket-arm movements toward the back, C- ball toss, D- racket-arm movements toward the front, E- contact point, F- follow through) for deviation scores of service motion.

Figure 2. Side-by-side comparison of service motions using Coach’s Eye application.
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Introduction

Imagery training in sport settings can be used to improve athletic performance by influencing psychosocial variables such as anxiety, self-confidence, and self-efficacy (Gould, Damarjian, & Greenleaf, 2002; Lukaszewski & Jarczewska-Gerc, 2012; Morris, Spittle, & Watt, 2005; Murphy, 2005; Ungerleider, 2005). For example, using imagery in practice situations may increase the efficiency and effectiveness of movements (Morris, Spittle, & Watt, 2005). Additionally, imagery can help athletes maintain their focus and persevere when physically and mentally fatigued (Murphy, 2005; Ungerleider, 2005). Imagery may also reduce the amount of physical practice time needed to improve sport performance (Lukaszewski & Jarczewska-Gerc, 2012). Hence, imagery training may not only improve movement response times and overall sport performance, it may also help athletes learn new skills and strategies for correcting their technical form more quickly. Unfortunately, limited research is available on enhancements, such as video modeling, to imagery training and the use of imagery with video modeling to improve consistency and form of the tennis serve. The following will provide information on (a) approaches to understanding how imagery works, (b) the use of video modeling to enhance imagery, and (c) adding imagery and video modeling to a regular practice schedule to improve service consistency and form.

Approaches to Understanding How Imagery Works

*Functional equivalence.* Researchers suggest that imagery training enhances performance through the principle of functional equivalence or because the same neurological processes underlie imagery that are involved during actual movement (Wright & Smith, 2009). In other
words, practicing with imagery, which implies the lack of physical movement, is
neurophysiologically similar to actually practicing the motor skill. This definition goes beyond
current neuroscientific evidence, but the concept is more easily shown in applied practice.
Imagery training engages all senses (sight, smell, taste, touch, and sound), including the
kinesthetic sense, to create a full mental image of the execution of a sport skill. Olssen and
Nyberg (2010) describe the necessary components—knowledge of task complexity, perspective,
and physical experience—for successful imagery through the functional equivalence theory.
Functional equivalence theory is an extension of other approaches such as the symbolic learning
theory.

*Symbolic learning theory.* Similar to the functional equivalence theory, symbolic learning
theory suggests that athletes create a “mental blueprint” of the movement patterns into symbolic
codes when learning a skill that are encoded in the nervous system. Sackett (1934) first identified
the symbolic learning theory and posited that “imagery provides the opportunity to rehearse the
sequence of movement and thus help the learner symbolically code these patterns in the central
nervous system” (Morris et al., 2005, p. 30). Unlike the functional equivalence theory, the
symbolic learning theory addresses the necessity of learning the skill completely before
practicing mentally. Imagery helps to further develop the cognitive representation of the skill
after the initial skill learning, and can be used in addition to physical practice to improve
technique, build strategies, and prepare for possible sport situations. Additionally, the symbolic
learning theory can support the use of enhancements to imagery that focus on skill acquisition
prior to imagery use. Imagery training appears to help athletes of varying levels to improve their
skills, but only if the skill is well understood physically (Gregg, Hall, & Nederhof, 2005).

Though the symbolic learning theory supports the usefulness of imagery training to improve
performance, athletes may differ on the extent to which they reap benefits from imagery training based on their competitive level.

Imagery and Competitive Levels

Although imagery training can be used by athletes at any competitive level (Hall, Rodgers, & Barr, 1990; Ryan & Simons, 1989), research also indicates that athletes at higher competitive levels are better at using imagery to improve performance (Gregg, Hall, & Nederhof, 2005). In addition to improved performance of a specific motor skill or strategy, imagery training can improve concentration and goal setting (Morris, Spittle, & Watt, 2005; Murphy, 2005; Ungerleider, 2005) and can also reduce anxiety (Gregg, Hall, McGowan, & Hall, 2011; Mamssis & Doganis, 2013; Mousavi & Meshkini, 2011; Weigert Coehlo et al., 2012). Imagery used by athletes of varying levels can be enhanced through feedback and modeling to provide additional improvements in performance.

Improving Performance through Video Modeling and Feedback

Video modeling can also be used to improve athlete performance of both skills and strategies and provides the opportunity to learn the motor skill that successful imagery requires. According to the social cognitive theory, modeling, also known as observational learning, is a powerful tool that a coach can use for athletes to learn a specific motor skill (Bandura, 1986). For modeling to work, athletes must have a clear representation of a motor skill before they can begin to practice the skill from memory (Carroll & Bandura, 1987). Video modeling is also supported by the symbolic learning theory, since the performer is creating a mental picture of the skill to be performed through observation. Also, similar to imagery training, athletes at higher competitive levels may see more benefits from modeling than athletes at lower competitive levels (Wesch, Law, & Hall, 2007). Video modeling allows athletes to view skilled performers
executing motor skills, and when athletes are provided with a clear picture of the motor skill to be learned, modeling can be used effectively to improve performance.

Using Video to Enhance Imagery Ability

Imagery and video modeling can be combined into a single mental training program to produce even more benefits to the motor skill production of the athletes (Boyer, Miltenberger, Batsche, & Fogel, 2009; Hardy & Callow, 1999). Based on a study by Hardy and Callow, external imagery, where the performer imagines watching him or herself perform the motor skill, produces greater improvements in tasks where form is important (1999). Therefore, providing participants with a visual representation of the correct form enhances imagery practice. In a study that provided video modeling to female gymnasts, asking participants to match the gymnast in the video led to achievement of a difficult skill in less time than the control group (Boyer et. al. 2009). Additionally, imagery combined with video modeling can improve the technical form of the motor skill. Modeling was found to be more effective than imagery, but both interventions produced improvements in the production of the squat lift in novice participants. (SooHoo, Takemoto, & McCullagh, 2004). Imagery training and video modeling can be seamlessly combined to produce increased improvements in technical form.

Imagery training and video modeling can be used in everyday coaching practices to improve performance (Gallwey, 1977; Ungerleider, 2005; Voight, 2005) during normal practice times throughout the athletes' competitive season (Janssen & Sheikh, 1994; Vealey & Greenleaf, 2001; Weinberg & Gould, 2003). These training techniques can be seamlessly integrated into normal practice procedures to help athletes learn skills more efficiently. Thus, athletes that employ imagery training and video modeling on a specific sport skill may be able to physically practice the skill less than athletes that do not employ mental training techniques during practice.
Imagery and video modeling are frequently used in tennis training, and because the serve is the only closed motor skill in tennis, these mental training methods are commonly applied (Atienza, Balaguer, & Garcia-Merita, 1998; Fery & Morizot, 2000; Guillot, Genevois, Desliens, Saieb, & Rogowski, 2012; Ungerleider, 2005; Weigert Coelho et. al., 2007). These studies deal with the production of the first serve only, and when video modeling is used, no feedback was given concerning how closely the athletes’ own production of the motor skills match those of the model.

Important Components of a Successful Tennis Serve

To date, few studies focus on the use of imagery and video modeling to improve both the consistency and technical form of the first and second tennis serves. There are numerous studies concerning the effectiveness of imagery training in sport related tasks, and there is strong evidence to suggest that the use of positive external imagery improves performance of sport skills (Atienza, Balaguer, & Garcia-Merita, 1998; Fery & Morizot, 2000). In research focusing on the effects of imagery training on the effectiveness of the tennis serve specifically, few of these studies differentiate between first and second tennis serves, and none isolate the second serve as a skill that could benefit from imagery training (See Appendix A for an extended review of literature).

In the current study, imagery training was combined with video analysis with feedback, in which the athletes in the experimental group received video modeling instruction initially, but then they were filmed performing the tennis serve in a mental training program. From this film, critiques at important technical points in the service motion (ready position/stance, grip, arm-racket movement toward the back, contact point, arm-racket movement toward the front, and follow through) were overlaid on the video and compared to the modeled serve. Critiques
focused on a single technical flaw and were phrased in a non-critical manner. For example, for a player with a low contact point, the critique would have been phrased “You will be more successful with a higher contact point.” Additionally, the video was marked using the Coach’s Eye application with an ideal contact point. From this video analysis, deviation scores were calculated between the participants’ serves and the model’s ideal serve. The athletes reviewed these videos to learn the differences between their own technical form and the ideal technical form to improve service form and consistency. Additionally, this study focused on both the first and second serves. Participants in the control group did not receive imagery training, video feedback, or verbal feedback throughout the intervention from the researcher; however, there were no restrictions on verbal feedback or instruction for the coaching staff.

The current study may add an improved feedback component to traditional video modeling to enhance an imagery mental training program. The purpose of this study was to determine whether combining an imagery training intervention with video analysis and feedback in addition to normal practice would improve the consistency and form of a tennis serve, and to see whether this intervention had differences in effectiveness based on the skill of the players. It was hypothesized that players who receive the imagery training intervention with video analysis and feedback would improve their successful service percentage and adherence to correct form compared to those that received no imagery training intervention or video analysis with feedback. A secondary purpose of this study was to determine whether further gains in service percentage and adherence to technical form were seen in athletes of a higher competitive level (varsity versus junior varsity). Thus, the secondary hypothesis was that varsity level athletes would experience more gains in first and second successful service percentage and form scores than junior varsity athletes.
Methods

Participants

Seventy-one high school tennis players participated in this study. No participant was excluded based on race or ethnicity, but subjects were required to complete all behavior and self-report testing dates. Additionally, those in the experimental group were required to complete all steps in the intervention. As a result, 10 participants were dropped from the study by not completing all necessary testing points. The final sample included 61 high school tennis players ranging from 14 to 17 years of age ($M = 15.44$, $SD = .98$). Subjects years of tennis experience ranged from .5 to 12 years ($M = 3.78$, $SD = 2.29$). All participants played tennis on their high school team. Participants in the experimental group ($n = 19$) were of similar tennis ability to participants in the control group ($n = 42$), though there were a larger number of participants in the control group. Participants were from two high schools in the southern United States, and experimental and control groups were defined by the schools’ fall tennis squads.

Measures

A demographic survey and mental imagery questionnaire was used to collect psychosocial data from the participants. Service form and consistency were assessed by an expert panel through filming and analysis of each participant’s serve.

*Demographic and tennis-related items.* Participants were asked to indicate their years of tennis experience, competitive level (varsity or junior varsity), age, and gender. This information was used to create the groups within the study.

*Sport Imagery Ability Questionnaire (SIAQ).* The SIAQ was used to measure participants’ ability to adequately image a sport skill (SIAQ; Williams & Cumming, 2011). The SIAQ is invariant across gender and can be used to assess athlete imagery ability across different
competitive levels. The SIAQ consists of 15 questions across five factors. These factors are skill, strategy, goal, affect, and mastery imagery ability. Items were posed as a statement (e.g., “The positive emotions I feel while doing my sport”) with the stem “I image”, and participants were asked to respond on the extent to which they could image the scenario. Responses are scored on a 7-point Likert scale (1 = very hard to image, 2 = hard to image, 3 = somewhat hard to image, 4 = neutral, 5 = somewhat easy to image, 6 = easy to image, 7 = very easy to image). Questionnaires were scored by averaging the sums of items on each subscale as well as an overall average of the sum of all items. Items subscale composite reliabilities range from .78 to .86, indicating acceptable reliability, and average variance extracted from factor analysis ranges between .55 and .67. The SIAQ has convergent validity with the MIQ, based on small to moderate significant bivariate correlations between the subscales of the SIAQ with those of the MIQ because the SIAQ assesses a different content on imagery than the MIQ (Williams & Cumming, 2011).

**Video recordings.** Service motions were captured using video recordings, and the camera was adjusted to film the participants’ first and second serves. Video segments of players’ serves were critiqued using the Coach’s Eye application, which allowed for isolated images within the video. Service motion was assessed at six points (ready position/stance, grip, arm-racket movement toward the back, contact point, arm-racket movement toward the front, and follow through), with data collected on the degree of technical correctness of each movement. The video was compared to a video recording of the production of the ideal service motion by a high-level player, and deviation scores were gathered from each collection point. Subjects in the intervention groups received feedback about one technical error at a time to reduce over-analysis by the players. Deviation scores were calculated by qualitative assessment of the players’ videos
by three members of an expert panel. All panel members had achieved at least an “Instructor” rating by the Professional Tennis Registry (PTR), and all expert panel members had youth coaching experience. Alpha values for the three raters ranged from .34 to .76, with pre-test alphas at the lower end of the range. Though the inter-rater variability was high, some differences are expected with subjective measurement. Also, although all raters were PTR certified, there were some individual differences in teaching styles of the three members of the expert panel. A correlation between raters indicated rater three as a possible outlier; however, alpha levels did not significantly increase without rater three scores. Therefore, all raters were included in generating form scores.

Scores were gathered at each isolated point in the service motion and for each motor, racket, or ball movement. The deviation scale was adapted from current publications on tennis form and Atienza, Balaguer, and Garcia-Merita (1998), which assessed the 6 service form points on a 7-point Likert scale ranging from grade 1 (very poor technique) to grade 7 (very high technique). Videos were compared to the video of the production of the ideal service motion used in the explanatory imagery and video modeling lesson prior to data collection.

Successful serve percentage. Successful service percentage was recorded as the number of serves that landed in the correct service box out of 10. Ten first and 10 second serves were assessed. Successful serve percentage was calculated at the pretest, mid-test, and posttest.

Procedures

IRB approval was obtained for the current study, and parents were given informed consent information and forms (see Appendix B) for participants under 18 years of age. Participants under 18 were also given assent forms and information.
The imagery training program and video modeling with feedback was conducted for 10 weeks. Vealey and Greenleaf (2002) suggest that mental training interventions should be congruent with the competitive season of the athletes to be optimally effective. Participants were separated into groups based on ability on the first day of practice. Both girls and boys competed for each team.

In Week 1, the SIAQ was also administered during practice. Then, a pre-test for service form and consistency was conducted. Each participant performed ten first and ten second serves, and successful serve percentage was recorded. Video critiques were done for one video recording of the first serve and one recording of the second serve to provide a service form baseline.

After the administration of the SIAQ and service tests, all participants received instruction on the service motion that was used as a representation of the correct service form. A video recording by a tennis player of similar age to the participants performing this service form was also shown during the lecture and was used to compare participant form to the ideal service motion for the first and second serves. An imagery script was included in the recording to illustrate the relaxation and sensory components of imagery. The experimental group received a pre-recorded imagery script for both first and second serves as well as a lesson about the use of imagery to improve service performance.

In Weeks 2 through 4 and 6 through 9, the experimental group received the imagery mental training program and video analysis feedback through the course of the team tennis fall season. The imagery training program consisted of weekly instruction and supervision of first and second serve mental imagery. To be in line with research on imagery training programs, imagery training and video recording sessions were conducted during regularly scheduled practice time (Suinn, 1997; Weinberg & Gould 2010). Due to the competitive level of the players
and the nature of the tennis skill, imagery practice of the entire service motion were introduced in Week 2 and continued through Week 9. Participants were instructed to externally image a successful first serve just before stepping up to the baseline of the tennis court to perform the actual serve. Each player performed 10 imaged first serves and 10 actual first serves. Then, the participants were instructed to use the same protocol with their second serve, resulting in 10 imaged and 10 actual second serves. Imagery training lasted approximately 10 minutes, which is consistent with optimal practice time (LeUnes & Nation, 2002; Nideffer, 1985; Sargent, 1997; Suinn, 1997). Participants in the experimental group were also instructed to listen to the imagery CD, keep an imagery journal, and were debriefed regularly to determine their use of imagery and their ability to imagine serves.

In Week 5, the SIAQ was administered a second time to determine mid-test imagery ability responses of both the experimental and control groups. Additionally, a serve mid-test of 10 first and 10 second serves was conducted, and successful serve percentage was recorded. Video analysis and feedback was done again for one first serve and one second serve to provide a representation of mid-test service form.

Video was recorded on one of the 10 actual first serves and one of the 10 actual second serves to obtain adequate film of service form. The film was critiqued and marked with the correction for one error in service motion using Coach’s Eye software. One of these critiqued videos was given to the participant to review until the next filming session. The control team were only video recorded for form and tested for service consistency; the coaches and players did not have access to the video footage and no feedback was given.

Participants were separated into small groups, 5 to 7 players per group, to complete the imagery training and video recording session for the week. A schedule of filming was provided
to the coaches and players to ensure that each participant completed the mental training program and filming. Order effects were controlled through randomization of group order, which was outlined on the schedule. Video of players serving was recorded once a week, and film was also used for the researcher to compare the participants’ service motion to the film of the correct service form. The training program lasted through the end of the fall team tennis season, which was approximately 10 weeks.

In Week 10, following the end of the team tennis season, the questionnaire was administered again to determine whether the mental training program impacted the participants’ ability to image and thoughts about mental training programs. A post-test was conducted consisting of 10 first and 10 second serves, and successful serve percentage was recorded. Video analysis and feedback was done for three first and three second serves and compiled to provide a final representation of service form.

Data analysis. To compare group differences, players were separated into 2 groups based on ability by the coaching staff at their respective high schools. These levels were varsity and junior varsity, and participants were divided further into varsity intervention, junior varsity intervention, varsity no intervention, and junior varsity no intervention based on their school. Group sizes were small in the experimental group compared to the control group due to the respective sizes of the teams. However, there were a comparable percentage of players at both varsity and junior varsity levels at each high school. There were marked ability differences between the varsity and junior varsity groups, but there were minimal differences within varsity groups or junior varsity groups based on gender.

The dependent variables included service consistency, movement deviations, and SIAQ subscale and overall totals from the model. The percentage of successful first and successful
second serves represented service consistency, and movement deviation scores were calculated using the scores from the deviation scale created by Atienza, Balaguer, and Garcia-Merita (1998). The independent variables were type of training (imagery and video modeling with physical practice versus physical practice) and competitive level (varsity or junior varsity). Initial analysis included examining the means, standard deviations, and internal consistency of study measures. Primary analysis included comparing means of dependent variables to determine baseline differences between experimental and control groups. The second wave of analysis included univariate analyses of covariance (ANCOVAs) controlling for possible pre-test differences, gender, and years of tennis experience for all dependent variables. Finally, a third wave of analysis examined individual responses to treatment by participants. The level of significance was set a \( p \leq .05 \). All analyses were performed using SPSS® version 20 software (SPSS, Inc., Chicago, IL).

Results

Means and standard deviations were reported for all dependent variables (see Table 1). To compare the mean difference of performance and self-report variables between pre- and posttest, independent-samples \( t \) test were performed for each variable. No significant differences were found, and many differences favored the control group.

An univariate analyses of variance was conducted on each of the performance variables and self-report variables to determine differences by group (see Table 2) and by level (see Table 3), controlling for differences between groups at baseline. No pretest variables were significant when comparing group differences; however, successful 1\(^{st}\) serves of 10 (\( p < .002 \)), successful 2\(^{nd}\) serves of 10 (\( p < .013 \)), SIAQ skill subscale (\( p < .020 \)), 1\(^{st}\) serve form ratings (\( p < .0001 \)), and 2\(^{nd}\) serve form ratings (\( p < .0001 \)) were significant by level.
Despite the lack of differences between groups at baseline, ANCOVAs for consistency performance variables, form performance variables, and self-report variables were conducted controlling for pre-test values, gender, and years of tennis experience (see Table 4). These variables were by subgroup (control varsity, control junior varsity, experimental varsity, experimental junior varsity). Though successful 1\textsuperscript{st} serves of 10 by subgroup ($p < .005$) was significant, the mean did not favor the experimental group.

Finally, to compare the responders to treatment by subgroup, a crosstabs analysis was conducted (see Table 5). Though the percentages of responders were marginally higher in the experimental groups for successful serves of 10 (58.3\% of experimental varsity participants vs. 52.4\% of control varsity participants) successful 2\textsuperscript{nd} serves of 10 (71.4\% of experimental junior varsity participants vs. 61.9\% of control junior varsity participants), 1\textsuperscript{st} serve form scores (85.7\% of experimental junior varsity participants vs. 81.0\% of control junior varsity participants and 75.0\% of experimental varsity participants vs. 71.4 \% of control varsity participants), and 2\textsuperscript{nd} serve form scores (100.0\% of experimental junior varsity participants vs. 71.4\% of control junior varsity participants and 83.3\% of experimental varsity participants vs. 81.0\% of control varsity participants), none of the chi-squared values were significant and the number of participants was too low for the differences to be significant.

**Discussion**

The purpose of the current study was to determine whether combining an imagery training intervention with video analysis and feedback in addition to normal practice would improve the consistency and form of a tennis serve, and to see whether this intervention had differences in effectiveness based on the skill of the players. The results of the study rejected these hypotheses, finding no relationship between the mental training program and imagery
ability or service consistency and form. Moreover, none of the data manipulations to control for population differences offered significant results. There were no significant differences between groups or levels found at baseline pretest, and no significant differences between groups or levels at posttest were found when controlling for pretest, gender, and years of tennis experience.

Strengths and Limitations

There were several possible reasons for the lack of improvement of the treatment group over the control group. A serious limitation in this study was the lack of randomization within groups and participants. The participants and groups were chosen based on availability and convenience rather than random selection and assignment of participants. This led to a small sample. To improve the current study, multiple levels of randomization should be used. First, multiple schools should have been recruited, and randomly selected schools would have been assigned to one of two groups. Second, these groups would have been randomly assigned experimental or control and the experimental group would receive the intervention. The control group would receive no mental training, and there would be no differences between ability.

For an even more controlled study, a third group would have been added to the study. After the experimental group had undergone the intervention, the second group would receive the same mental training program. The third group, the control group, would not receive the intervention at any point during the study. Thus, the first group of participants would hypothetically improve in performance due to the intervention in the first 10 weeks. The second group of participants would remain stagnant in their abilities during the first 10 weeks but would experience performance improvements upon the start of their intervention, and the third group of participants would not experience any gains in performance.
These results may also have been due to the ceiling effects for performance variables; participants were tested over 10 serves rather than 20, diminishing the room for improvement over the 10 week intervention. Additionally, raters only viewed one of the participants’ serves for pre-, mid-, and posttest. Because consistency performance variables was scored out of 10 and the form performance variable was scored on a 7-point Likert scale, determining the mean differences between groups may not have been a suitable method to determine whether the intervention was successful.

Additionally, some players may have overanalyzed their video feedback, resulting in broken movement on the serve. When a player is trying to correct a specific element of a tennis motor skill, it is common to experience some decrease in performance while the player relearns the correct sequence of movements. Some of the participants who received the intervention may have experienced this drop in performance because they were focusing on improving their error rather than simply hitting serves to complete the exercise. This focus on improvement may have actually decreased form score ratings. Lengthening the current study may have allowed for those broken movements to become more fluid, resulting in higher form scores.

Another issue with the current study was the differences in tennis abilities and experiences of the groups in the study. The control group consistently performed better than the experimental group on the performance variables in the study; however, the unequal starting points were not solved by controlling for the pretest performance variable values. The results of the univariate analyses indicate that the control group actually experienced more gains in performance for some variables than the experimental group. This could be due to several factors. Namely, the control group had no coaching limitations other than the use of mental training techniques during the course of their fall tennis season. So, the control group could have
experienced improvements in service consistency and form based on the volume and type of serve practice done through the school’s program. Second, there were many more participants in the control groups than the experimental groups, resulting in more statistical power due to the larger sample size. Finally, the groups were not sufficiently randomized. As stated previously, multiple levels of randomization would control for unequal starting points and unequal group abilities.

Another issue with this study was the timing of the intervention. High school tennis has both fall and spring seasons, but the intervention for the current study was completed during the fall season due to convenience. Because of this, the experimental group had a small number of participants and experienced some non-completion due to season overlap with other sports. These issues would have been alleviated by administering the intervention in the spring, but the experimental group would still have been smaller than the control group.

In addition to the limitations of the methodology, there may have been some issues with the intervention as a whole. There is limited support for the use of imagery and video imaged feedback together, and no previous research has used both of these mental training techniques together on high school athletes. Thus, the population could have been ill suited for this type of intervention, and the experimental group did not experience any gains in improvement because they were not able to understand or properly utilize the mental training techniques. The athletic maturity of the participants in the current study may not have matched the developmental requirements of the intervention. The apparent enthusiasm and interest in the intervention did not translate to positive results.

Another limitation with the intervention may have been the use of objective measures when subjective measures may have been more meaningful. A smaller number of participants
and a case study methodology were used in previous studies using similar mental training techniques, and perhaps a large group comparison with the expectation of finding substantial gains in performance was unrealistic (Atienza, Balaguer, & Garcia-Merita, 1998). Rather, a more in depth analysis of the ways in which a small number of participants employ imagery and videoed image feedback to make meaningful changes in imagery ability and service form and consistency over a long term would have been more useful than a 10-week intervention.

It may have been more useful to determine how many participants improved due to the intervention than by how much participants improved due to the ceiling effects of the instruments and procedures. No significant differences between percentages of responders to treatment between groups or levels were found; however, there were marginal improvements by the experimental group over the control group. In sport, even small improvements can have profound impacts on player performance and development. Performance of the tennis serve can transfer to many areas of a player’s game by acting as a barometer for performance throughout competition. Even minor consistency and form improvements can lead to major differences in competitive results. Thus, this intervention may be useful for coaches to improve the performance of the tennis serve 5-28% in a short amount of time.

Overall, this 10 week mental training program to improve the imagery ability and service form and consistency of high school tennis players’ first and second serves did not illustrate significant differences from the control group. Participants who used the mental training program did not experience any significant improvements in service form or consistency during practice assessment sessions, and their imagery abilities did not improve in comparison with the control group regardless of the players’ competitive levels. The lack of improvement from pretest to
posttest for the treatment group may have been a result of the flaws in the experimental design and procedures.

Implications and Conclusions

Although no significant differences existed as a result of the mental training program in this study, there were several positive aspects of this 10 week intervention. It was hypothesized that the intervention would help participants in the experimental group to improve their imagery ability and service form and consistency, but the use of imagery and videoed image feedback did not increase the values of the dependent variables. Issues with participant selection and methodology contributed to the poor results of the study. It should be mentioned, however, that an intervention of this duration and complexity is difficult to achieve by a single researcher, and attempting this real-world intervention, though unsuccessfully, should be appreciated. There is a need for less controlled application of mental training techniques to determine whether these practices can and should be used for athletes of different sports and competitive levels.

Because this was an applied study, there were many uncontrolled variables and unforeseen challenges. The two teams used in the study were chosen due to their comparable level of play as described by tennis professionals and coaches in the surrounding schools and city. Throughout the intervention, the control team was observed by the researcher to highlight differences in practice protocols between the two teams. No practice strategies were controlled by the researcher, as the control team did not use any mental training techniques that would conflict with the intervention; however, the coach of the control group led a lengthy serve warm-up on most practice days. While the focus was on quantity rather than quality, this uncontrolled practice may have led to improvements in service form and consistency for the control group.
While this negatively affected the results, this applied study had no intentions of diminishing the improvements of either group.

Another unforeseen challenge in this study was the depth of quality players in the two groups. The selection of participants and randomization of groups was a clear limitation in this study; nevertheless, the two teams had several players of comparable ability. There were fewer players in the experimental group, and when these players were separated by level, there were even fewer players in the junior varsity group. These small numbers certainly affected the results of the study, though the overall tennis abilities of the members of the experimental and control varsity groups were comparable. The ability level of the experimental junior varsity group was affected by the participants that were not able to complete the study; the two junior varsity groups were comparable in ability before the drop-out. Moreover, it should be stated that overall tennis ability is distinct from service proficiency, though successful servers typically fare better in matches. Despite the similarities in abilities between the groups, the differences in size and overall tennis ability may have contributed to the lack of significant differences between the groups after the intervention. These issues could have been avoided with a more controlled study but would have undermined the applied, real-life nature of the intervention.

The higher percentages of responders to treatment in the experimental groups shows that this intervention was able to improve service consistency and form by 5-28% in this 10-week time period. A nearly 30% increase in second service form by the experimental junior varsity group over the control junior varsity group has promising implications for the use of this intervention for player development. This intervention is efficient and, though no statistically significant results were found, likely useful for the moderate improvement of tennis serve consistency and form throughout a 10-week season. This study provides some promising results
for continued research on the use of mental training techniques, though some improvements could potentially show more statistically significant results.

There are several suggestions for improving the intervention, and a future study employing one or more of the previous changes could produce more useful results. This type of intervention, leaning heavily toward applied rather than experimental research, is useful for the field of sport psychology. Mental training techniques are only useful if they can be applied effectively and efficiently, and this study endeavored to employ a mental training program within the confines of a high school tennis season and its practice times. There will be differences between athletic teams at any level, and comparisons are never clear cut. This study attempted to compare two groups in spite of these expected differences, and while more teams may be needed to control inter-team variance, more mental training interventions should be used on high school athletes to expose younger athletes to applied sport psychology techniques.
Figure 1. Image stills of data collection points (A- ready position, B- racket-arm movements toward the back, C- ball toss, D- racket-arm movements toward the front, E- contact point, F- follow through) for deviation scores of service motion.
Figure 2. Side-by-side comparison of service motions using Coach’s Eye application.
Table 1

Means and Standard Deviations: All Variables

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
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</thead>
<tbody>
<tr>
<td>Pretest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1</td>
<td>5.00</td>
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</tr>
<tr>
<td>S2</td>
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<td>1.88</td>
</tr>
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<td>Midtest</td>
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<td></td>
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<tr>
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<td>Average</td>
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</tr>
<tr>
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</tr>
</tbody>
</table>

Note. S1 = 1st Serves in of 10; S2 = 2nd Serves in of 10; SIAQ = Sport, Imagery Ability Questionnaire; YTE = Years of Tennis Experience. Form = average rater form scores.
Table 2

*Pretest Means and Standard Deviation: Experimental vs. Control*

<table>
<thead>
<tr>
<th></th>
<th>Experimental</th>
<th>Control</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
</tr>
<tr>
<td>Pretest Serves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1</td>
<td>4.53 (2.07)</td>
<td>5.21 (1.79)</td>
</tr>
<tr>
<td>S2</td>
<td>6.11 (2.28)</td>
<td>6.83 (1.65)</td>
</tr>
<tr>
<td>Pretest SIAQ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strategy</td>
<td>4.77 (1.27)</td>
<td>4.43 (.975)</td>
</tr>
<tr>
<td>Goal</td>
<td>4.54 (1.11)</td>
<td>4.60 (1.28)</td>
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<tr>
<td>Affect</td>
<td>5.25 (1.04)</td>
<td>5.48 (1.02)</td>
</tr>
<tr>
<td>Mastery</td>
<td>4.84 (1.06)</td>
<td>5.10 (1.15)</td>
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<tr>
<td>Skill</td>
<td>5.04 (.942)</td>
<td>4.98 (.860)</td>
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<td>Average</td>
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<td>4.91 (.688)</td>
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</tr>
<tr>
<td>1st Serve</td>
<td>3.45 (.821)</td>
<td>3.43 (.559)</td>
</tr>
<tr>
<td>2nd Serve</td>
<td>3.46 (.714)</td>
<td>3.39 (.556)</td>
</tr>
</tbody>
</table>

*Note.* S1 = 1st Serves in of 10; S2 = 2nd Serves in of 10; SIAQ = Sport Imagery Ability Questionnaire. *p < .05. **p < .01

Table 3

*Pretest Means and Standard Deviations: Varsity vs. Junior Varsity*

<table>
<thead>
<tr>
<th></th>
<th>Varsity</th>
<th>Junior Varsity</th>
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<tr>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
</tr>
<tr>
<td>Pretest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1</td>
<td>2.67 (1.63)</td>
<td><strong>4.21</strong> (1.89)</td>
</tr>
<tr>
<td>S2</td>
<td><strong>7.15</strong> (1.58)</td>
<td>5.96 (2.03)</td>
</tr>
<tr>
<td>Pretest SIAQ</td>
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<td></td>
</tr>
<tr>
<td>Strategy</td>
<td>4.62 (1.15)</td>
<td>4.44 (.998)</td>
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<tr>
<td>Goal</td>
<td>4.69 (1.18)</td>
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<td>5.34 (1.03)</td>
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<tr>
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<td>5.12 (1.04)</td>
<td>4.89 (1.21)</td>
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<tr>
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</tr>
<tr>
<td>2nd Serve</td>
<td><strong>3.71</strong> (.601)</td>
<td>3.07 (.472)</td>
</tr>
</tbody>
</table>

*Note.* S1 = 1st Serves in of 10; S2 = 2nd Serves in of 10; SIAQ = Sport Imagery Ability Questionnaire; YTE = Years of Tennis Experience. *p < .05. **p < .01
### Table 4

**ANCOVAs**

<table>
<thead>
<tr>
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<th>Control</th>
<th></th>
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<tr>
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<td>JV (n = 7)</td>
<td>Varsity (n = 21)</td>
<td>JV (n = 21)</td>
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<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
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<td>6.33</td>
<td>2.10</td>
<td>3.57</td>
<td>2.44</td>
</tr>
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<td>1.17</td>
<td>5.29</td>
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</tr>
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<td>SIAQ</td>
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<tr>
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<td>.948</td>
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<td>1.17</td>
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<td>1.28</td>
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<td>Affect</td>
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<td>.889</td>
<td>5.67</td>
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<td>Mastery</td>
<td>4.89</td>
<td>1.14</td>
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<td>Skill</td>
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<td>.669</td>
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<td>Average</td>
<td>5.33</td>
<td>.696</td>
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<td>.588</td>
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<td>.613</td>
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<tr>
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<td>4.15</td>
<td>.639</td>
<td>3.33</td>
<td>.513</td>
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</tbody>
</table>

*Note.* SS1 = Successful Serves 1st Serve; SS2 = Successful Serves 2nd Serve; SIAQ = Sport Imagery Ability Questionnaire.  
* p < .05. ** p < .01

### Table 5

*Crosstabs Analysis: Percentage of Responders to Treatment*

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<tr>
<th></th>
<th>Varsity</th>
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<th>Junior Varsity</th>
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<th>Chi-square Value</th>
</tr>
</thead>
<tbody>
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<td></td>
<td>Exp %</td>
<td>Con %</td>
<td>Exp %</td>
<td>Con %</td>
<td></td>
</tr>
<tr>
<td>SS1</td>
<td>58.3</td>
<td>52.4</td>
<td>28.6</td>
<td>81.0</td>
<td>.262</td>
</tr>
<tr>
<td>SS2</td>
<td>25.0</td>
<td>47.6</td>
<td>71.4</td>
<td>61.9</td>
<td>.080</td>
</tr>
<tr>
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<td>75.0</td>
<td>71.4</td>
<td>85.7</td>
<td>81.0</td>
<td>.287</td>
</tr>
<tr>
<td>2nd Serve Form</td>
<td>83.3</td>
<td>81.0</td>
<td>100.0</td>
<td>71.4</td>
<td>.415</td>
</tr>
</tbody>
</table>

*Note.* Exp = Experimental Group; Con = Control Group; SS1 = Successful Serves 1st Serve; SS2 = Successful Serves 2nd Serve
APPENDIX A

REVIEW OF LITERATURE
Imagery Training and Video Modeling Effects on Service Form and Consistency

Tennis is an internationally popular sport that includes both closed and open motor skills. While most tennis skills must be practiced with a partner, backboard, or ball machine, the serve is the only shot that tennis athletes can practice without the aid of any person or device. The tennis serve is a closed motor skill, which implies that the performer initiates the action and can therefore control the entire movement. The tennis serve can be improved through several training techniques; however, many recreational and varsity level coaches or instructors do not employ mental training to the tennis serve. Interestingly, mental training programs for tennis are supported by popular training books (Gallwey, 1977) and empirical research (Atienza, Balaguer, & Garcia-Merita, 1998; Coehlo, De Campos, Da Silvia, Alves Okazaki, & Keller, 2007), and can be used in everyday coaching situations (Voight, 2005). There is sufficient evidence to support the use of mental training techniques such as imagery and video modeling to learn and enhance motor skills, specifically the production of the tennis serve. This review of literature outlines previous research in imagery training, video modeling, and imagery training combined with video modeling to improve performance on general motor skills or tennis serve production.

Imagery

Imagery training is a useful tool for athletes to improve performance in a variety of sport skills and situations (Hanrahan & Andersen, 2010; Lukaszewski & Jareczewska-Gerc, 2012; Morris, Spittle, & Watt, 2005; Murphy, 2005; Ungerleider 2005). Morris et. al. (2005) compiled many theoretical and applied definitions of imagery to produce an inclusive explanation for this mental training technique:

Imagery, in the context of sport, may be considered as the creation or re-creation of an experience generated from memorial information, involving quasi-sensorial, quasi-
perceptual, and quasi-affective characteristics, that is under the volitional control of the imager, and which may occur in the absence of the real stimulus antecedents normally associated with the actual experience. (p. 19)

This description implies that for imagery to be useful, one must employ sensory, perceptual, and affective components to the image, which means that imagery requires great specificity and attention to detail. According to several sport psychology books on imagery and mental training techniques in general, the content and use of imagery is completely controlled by the imager, which can have both positive and negative consequences (Hanrahan & Andersen, 2010; Morris et. al., 2005; Murphy, 2005; Ungerleider, 2005). Images that convey specific, successful execution of tasks or strategies help athletes to achieve optimal performance and build confidence (Morris et. al., 2005). Though imagery is the most widely used form of mental training by athletes, there is still much to learn about the mechanisms of and most successful implementation methods for imagery.

The use of imagery in practice situations can increase the effectiveness of the motor skill but also the persistence of task action, which implies that the ratio of practice time and quality of skill production is diminished when compared to physical practice alone (Lukaszewski & Jarczewska-Gerc, 2012). Lukaszewski and Jarczewska-Gerc (2012) also found that prior knowledge of the task is essential to effective imagery training; attempting to mentally practice a skill without physically learning or practicing the behavior does not improve performance or persistence. Also, it was found that in addition to increased performance and persistence of the motor skill, mental practice was also found to be more effective than simply imagining goal achievement. Thus, imagery training not only improves performance, it also allows for faster
adherence to correct technical form if the task is already well learned and can be more effective than other mental training techniques.

Several theories exist in sport psychology to describe the imagery. First, imagery training can enhance performance through the use of functional equivalence, which implies that "imagery enhances performance because the same neurophysiological processes underlie imagery and actual movement" (Wright & Smith, 2009, p. 18). This definition goes beyond current neuroscientific evidence, but the concept is more easily shown in applied practice. Before the production of physical movement, the brain forms a mental representation, which includes the plan for the movement and the anticipated results. Imagery training employs this mental plan, and the imager engages all senses, including the kinesthetic sense, to create a full mental image of the execution of a sport skill. Moreover, successful imagery requires knowledge of task complexity, perspective, and physical experience (Olssen & Nyberg, 2010). These characteristics of the image combine to create a neurophysiological representation, which according to the functional equivalence theory, is the same representation used in actual physical practice.

Second, symbolic learning theory can also explain the use of mental practice to improve performance of a motor or sport skill. Sackett (1934) stated that “imagery provides the opportunity to rehearse the sequence of movement and thus help the learner symbolically code these patterns in the central nervous system” (Morris et. al., 2005, pg. 30). Additionally, Vealey (1986) describes the symbolic learning theory as a mechanism through which athletes can create a cognitive “blueprint” of the motor skill and map the movements and cues. The functional equivalence theory and symbolic learning theory are similar in their explanations of imagery, in that the brain must create a representation of the motor skill to understand it. These theories can
be used in practical applications to utilize imagery training to improve performance and modify other psychosocial variables.

In a meta-analysis by Driskell, Copper, and Moran (1994), the effects of several moderators of imagery training on performance were evaluated. These moderators were type of task, retention interval, duration of practice, type of control, and experience level. It was found that imagery training was more effective for cognitive compared to physical tasks, and that imagery practice will be less effective if the interval between the image and the physical practice is long. Also, more experienced performers use mental practice more effectively than non-experienced performers, regardless of the type of task, and the longer mental practice is used, the larger the positive effect. Finally, mental practice has a greater significance when compared to a control group that did not receive imagery training (Driskell, Copper, & Moran, 1994). These results indicate the effectiveness of imagery training through different moderators; overall, using imagery in addition of physical practice is more effective than physical practice alone.

Imagery training can be used by athletes of all competitive levels (Hall, Rodgers, & Barr, 1990; Ryan & Simons, 1989). Ryan and Simons found that though those that typically use imagery had the greatest improvement, those that had not previously used imagery also had greater improvement in performance than those that do not use imagery. Therefore, prior use of imagery does not influence whether one can use imagery in the future. Some research also indicates that athletes at higher competitive levels are better at using imagery to improve performance, and that varsity level athletes have more structured imagery practices. Athletes at high competitive levels are also more likely to use imagery during practice, just before a competition, or outside of practice (Hall, Rodgers, & Barr, 1990). “When athletes increase their use of imagery, their imagery ability improves, and better imagers use imagery more effectively
in sport” (Gregg, Hall, & Nederhof, 2005, p. 94). While mental practice can be done by anyone, using imagery effectively takes time and practice. An imagery program should be supervised and participants should review their imagery use to ensure that imagery is being used correctly and effectively.

In addition to improved performance of a specific motor skill or strategy, imagery training can also reduce anxiety (Coehlo et. al., 2012; Mamssis & Doganis 2013; Mousavi & Meshkini, 2011) and improve concentration and goal setting (Morris, Spittle, & Watt 2005; Murphy, 2005; Ungerleider, 2005). In a study by Coehlo et. al., participants were given a relaxation, imagery, and behavioral modeling mental training intervention after normal practice times for nine weeks. Implementation of an imagery training program just before competition reduced anxiety and increased self-efficacy and self-confidence in elite level tennis players (Weigert-Coehlo et. al., 2012). Also, imagery use was shown to reduce pre-competitive anxiety in elite table tennis players (Mousavi, & Meshkini, 2011). In another multimodal mental training program, imagery practice was combined with goal setting, positive thinking and self-talk, concentration and routines, and arousal regulation techniques to produce enhanced general performance in tennis based on match results (Mamssis & Doganis, 2013).

Video Modeling

Likewise, video modeling can be used to improve athlete performance of both skills and strategies. According to the social cognitive theory, modeling, also known as observational learning, is one of the most powerful tools that a coach can employ for athletes to learn specific motor skills (Bandura, 1986). To be effective, modeling requires four sub-processes: attention, retention, production, and motivation. Attentional processes refer to characteristics of the observer and his or her ability to distinguish the distinct, complex elements of the motor skill and
their functional values. Retention processes make up the necessary cognitive skills required to code and rehearse the information, while motor reproduction processes combine the physical ability to complete the coded motor skill with the ability to obtain and understand feedback. Finally, motivational processes refer to the various sources of reinforcement (Bandura & Jeffery, 1973). Together these components of modeling produce the basis for learning a new skill.

According to a study by Carroll and Bandura (1987), observational learning is best achieved through visual guidance. For modeling to work, athletes must have and understand a clear representation of a motor skill before they can begin to practice the skill from memory. This is created through the repeated exposure of a particular skill to the subject through the use of a model. This model can be a video recording or the live performance of an expert. There are individual differences in the effectiveness of observational learning based on several moderators.

Similar to imagery training, athletes at higher competitive levels may see more benefits from modeling than athletes at lower competitive levels (Hardy & Callow, 1999; Wesch, Law, & Hall, 2007). In a study by Wesch, Law, and Hall (2007), the researchers aimed to determine whether various groups of athletes differ in their use of observational learning. Both individual and team sport athletes were asked to rate the extent of their use of three functions of imagery: skill acquisition, strategy production, and performance enhancement. The findings indicate athletes employ observational learning for more cognitive tasks than for motivational purposes. In other words, modeling is more useful to athletes to acquire or improve a particular sport skill than to increase motivation of learning or performance. It was found that male and female athletes used observational learning to about the same extent, but that varsity level athletes use the three functions of observational learning more than recreational athletes. Finally, there were differences based on sport type. Team sport athletes tended to use modeling to learn strategic
patterns, while individual sport athletes preferred to use observational learning while refining a specific skill (Wesch, Law, & Hall, 2007).

The type of feedback can also influence the effectiveness of observational learning through video modeling. In a study by Boyer, Miltenberger, Batsche, and Fogel (2009), four elite level gymnasts completed an observational learning training program with video feedback. After each gymnast performed the required skills, side-by-side frame-by-frame and real time videos of the participant and an expert performer were shown to the subject. The participant was then instructed to practice the skill two to three more times. Video modeling combined with video feedback improved skill performance more quickly than normal practice and coaching procedures alone. Moreover, this elevated performance was maintained after the video modeling and video feedback intervention ended. While there is currently little research concerning video feedback for skill production and performance, studies such as Boyer et. al. (2009) give support to the use of video feedback in observational learning training techniques.

Several theories support observational learning, and while there are distinct models for modeling alone, some overlap with imagery theories. Symbolic learning theory supports both observational learning and imagery. Symbolic learning theory suggests that the performer creates a “mental blueprint” of the movement patterns into symbolic codes that is encoded in the nervous system (Vealey & Greenleaf, 1998, pg. 243). While Bandura and Jeffery’s (1973) conceptualization of observational learning has four sub-processes, the outcome is simply a more detailed explanation of a symbolic representation. Symbolic learning theory and observational learning complement each other, and because symbolic learning theory is also an explanation for the use of imagery, there may be some support for the use of imagery and observational learning together to produce the greatest increases in skill learning.
Imagery with Video Modeling

Imagery and video modeling can be combined into a single mental training program to produce even more benefits to the motor skill production of the athletes (Boyer, Miltenberger, Batsche, & Fogel, 2009; Hardy & Callow, 1999). Based on a study by Hardy and Callow, external imagery, where the performer imagines watching him or herself perform the motor skill, produces greater improvements in tasks where form is important (1999). Therefore, providing a participant with a visual representation of the correct form enhances imagery practice. Additionally, imagery combined with video modeling can improve the technical form of the motor skill. Modeling was found to be more effective than imagery, but both interventions produced improvements in the production of the squat lift in novice participants. (SooHoo, Takemoto, & McCullagh, 2004). Thus, imagery training and video modeling can be seamlessly combined to produce increased improvements in technical form.

In their book *Imagery in Sport*, Morris, Spittle, and Watt (2005) devote a portion of their “Technical Aids to Imagery” chapter to the uses and applications of video modeling in imagery training. As stated previously, for imagery to be successful, the subject must have a clear representation of the motor skill to be learned or performed. Video modeling aids this process, as less skilled subjects can view an expert performing the skill, and skilled participants can watch video of themselves successfully executing the skill. Video modeling is best received by participants if the expert model is someone close to them in age and ability, and successful trials with video modeling, in which the subject improves his or her performance through matching the model, can increase confidence and self-efficacy. While the book’s chapter outlines several studies that support the use of imagery training with video modeling, there is less research on the
effectiveness of an applied model during regularly scheduled practice (Morris, Spittle, & Watt, 2005).

Additionally, several empirical studies provide support for the use of imagery and imagery plus video modeling in tennis. Guillot, Genevois, Desliens, Saieb, and Rogowski (2012) addressed the use of imagery training and the effectiveness of a placebo racket on the speed and accuracy of the tennis serve. Because participants were experienced tennis players, no modeling of the tennis serve was offered at any time during the intervention, and technical form was not a dependent variable. Subjects in the placebo racket group, in addition to receiving imagery training, were told that their replacement racket would help them to hit a faster, more accurate first serve. In another study, Coehlo, De Campos, Da Silva, Okazaki, & Keller (2007) addressed the use of imagery in tennis for both a closed skill (the serve) and an open skill (the serve return). Video modeling was confounded in the imagery group, as it was included in the imagery lesson but not identified as a separate training technique. It was found that imagery improved performance on the tennis serve but not the service return. Though video modeling to enhance imagery is often overlooked or confounded with imagery training, a few studies address the purposeful use of video modeling to enhance imagery of the tennis serve.

The use of video modeling in an imagery training program implies that adherence to the correct form is necessary for successful performance. In a pilot study of the effects of imagery and video modeling on the service accuracy and form of the tennis serve, young female tennis players were placed into either a video modeling, imagery and video modeling, or control group (Atienza, Balaguer, & Garcia-Merita, 1998). All groups completed regular physical practice. Though both experimental groups showed improvements in accuracy and form, the combination of video modeling and imagery training produced the greatest improvements in performance. In
another study of video modeling and imagery, Fery and Morizot (2000) introduced kinesthetic modeling and imagery to the performance of the tennis serve. Subjects had no tennis experience, and were taught service form through either visual or kinesthetic modeling and practiced the skill with either matched visual or kinesthetic imagery or no mental training in addition to physical practice. Kinesthetic was more effective than visual modeling, and matched imagery was more effective than no imagery training. These studies provide support for the video modeling and imagery; however, few studies exist on the effectiveness of imagery and video modeling for sport performance, and even less deal with the tennis serve.

Summary

Tennis is a complex sport with many open skills and only one closed motor skill - the serve. Imagery is a widely used mental training instrument and has been shown to be used to improve performance of specific motor skills. Because the tennis serve is a self-paced, performer initiated skill, imagery training can be beneficial to improving serve performance through increased accuracy and consistency. For imagery to be effective, athletes must develop a clear mental representation of the motor skill to be performed. Video modeling can provide a learning and skill enhancement tool for the acquisition and improvement of service form, and both imagery and video modeling can be theorized through the Symbolic Learning theory. It is important to understand the benefits of imagery and video modeling for skill acquisition to utilize applied mental training programs in tennis. Currently, there is a lack of applied research on the effectiveness of imagery combined with video modeling on the consistency and technical accuracy of the tennis serve.
APPENDIX B

INFORMED CONSENT FORMS
Title of Study: The Effect of Imagery Training and Video Analysis with Feedback on High School Tennis Players’ Service Form and Consistency

Student Investigator: Earlynn Lauer, University of North Texas (UNT) Department of Kinesiology, Recreation, and Health Promotion. Supervising Investigator: Dr. Scott Martin

Purpose of the Study: You are being asked to participate in a research study designed to determine whether combining a Movement Imagery intervention with video analysis with feedback in addition to normal practice will improve the consistency and form of a tennis serve, and to see whether this intervention has differences in effectiveness based on the skill of the players.

Study Procedures: You will be asked to participate in 10 sessions. In the first session, you will receive a questionnaire during practice. Then, a pre-test of service form and consistency will be conducted. Each participant will be filmed performing twenty first and twenty second serves, and successful serve percentages will be recorded. Critiques will be overlaid on these recordings at various points in the service motion to provide a service form baseline.

In the second through ninth sessions, you will receive imagery mental training and filming of your first and second serves during regularly scheduled practice. Sessions should take no more than 10 minutes. You will be instructed to review your imagery CD and keep a weekly imagery journal. Additionally, you will be debriefed by the research staff regularly to review your imagery ability and progress. Finally, critiqued image stills from the previous week’s video-taping will be handed out and reviewed in private.

In the final (tenth) session, the same questionnaire from week one will be administered again during practice. Then, a post-test identical to the protocol for the pre-test will be conducted to determine the effects of the imagery training program and video analysis with feedback on tennis serve form and consistency.

Foreseeable Risks: No foreseeable risks are involved in this study.

Benefits to the Subjects or Others: You will receive additional instruction on the tennis serve from an experienced tennis player and instructor. You will be taught valuable mental training techniques for the production of a more mechanically sound and consistent first and second serve. You will also be able to view your progress with video analysis and feedback. By participating in this study, you will add valuable knowledge to the academic and applied fields of sport psychology.

Compensation for Participants: None.
Procedures for Maintaining Confidentiality of Research Records: Participant surveys will be coded with numbers so that individual responses will remain anonymous. Surveys and electronic data will be stored in a locked office. The confidentiality of your individual information will be maintained in any publications or presentations regarding this study.

Questions about the Study: If you have any questions about the study, you may contact Earlynn Lauer at Emily.Lauer@unt.edu or Dr. Scott Martin at Scott.Martin@unt.edu.

Review for the Protection of Participants: This research study has been reviewed and approved by the UNT Institutional Review Board (IRB). The UNT IRB can be contacted at (940) 565-3940 with any questions regarding the rights of research subjects.

Research Participants’ Rights:

Your participation in the survey confirms that you have read all of the above and that you agree to all of the following:

- Earlynn Lauer has explained the study to you and you have had an opportunity to contact him/her with any questions about the study. You have been informed of the possible benefits and the potential risks of the study.
- You understand that you do not have to take part in this study, and your refusal to participate or your decision to withdraw will involve no penalty or loss of rights or benefits. The study personnel may choose to stop your participation at any time.
- Your decision whether to participate or to withdraw from the study will have no effect on your grade or standing in this course.
- You understand why the study is being conducted and how it will be performed.
- You understand your rights as a research participant and you voluntarily consent to participate in this study.
- You understand you may print a copy of this form for your records.

I, ____________________________________________, have read the description of the research project for which this consent pertains, and I hereby consent to participate in this study.

__________________________________________  ____________
Signature of participant (or guardian)    Date
Student Assent Form

You are being asked to be part of a research project being done by the University of North Texas Department of Kinesiology, Health Promotion, and Recreation.

This study involves your participation to determine whether combining an imagery program with video-taping with feedback in addition to normal practice will improve the consistency and form of a tennis serve, and to see whether this intervention has differences in effectiveness based on the skill of the players.

You will be asked to participate in 10 sessions that should take about 20 minutes twice a week. In the first session, you will receive a questionnaire during practice. Then, a pre-test of service form and consistency will be done. Each participant will be filmed performing ten first and ten second serves, and successful serve percentages will be recorded. Critiques will be overlaid on these recordings at various points in the service motion to provide a service form baseline.

In sessions two through four and six through nine, you will receive imagery practice and filming of your first and second serves during regularly scheduled practice. Sessions should take no more than 10 minutes. You will be instructed to review your imagery CD and keep a weekly imagery journal. Additionally, you will meet with the research staff to review your imagery ability and progress. Finally, your videos from the previous week’s video-taping will be handed out and reviewed in private.

In both the fifth and final (tenth) session, the same questionnaire from week one will be administered again during practice. Then, a post-test identical to the protocol for the pre-test will be conducted to determine the effects of the imagery program and video-taping with feedback on tennis serve form and consistency.

If you decide to be a part of this study, please remember you can stop participating any time you want to.

If you would like to be a part of this study, please sign your name below.

__________________________________________
Printed Name of Student

__________________________________________   ________________
Signature of Student     Date

__________________________________________   ________________
Signature of Student Investigator   Date
Before agreeing to participate in this research study, it is important that you read and understand the following explanation of the purpose, benefits and risks of the study and how it will be conducted.

Title of Study: The Effect of Coaching Techniques on High School Tennis Players’ Service Form and Consistency
Student Investigator: Earlynn Lauer, University of North Texas (UNT) Department of Kinesiology, Recreation, and Health Promotion. Supervising Investigator: Dr. Scott Martin

Purpose of the Study: You are being asked to participate in a research study designed to determine whether filming in addition to normal practice will improve the consistency and form of a tennis serve, and to see whether this intervention has differences in effectiveness based on the skill of the players.

Study Procedures: You will be asked to participate in 10 sessions. In the first session, you will receive a questionnaire during practice. Then, a pre-test of service form and consistency will be conducted. Each participant will be filmed performing ten first and ten second serves, and successful serve percentages will be recorded.

In the second through ninth sessions, you will receive weekly observation of your first and second serves during regularly scheduled practice. Sessions should take no more than 10 minutes.

In the final (tenth) session, the same questionnaire from week one will be administered again during practice. Then, a post-test identical to the protocol for the pre-test will be conducted to determine the effects of the coaching on tennis serve form and consistency.

Foreseeable Risks: No foreseeable risks are involved in this study.

Benefits to the Subjects or Others: During this intervention, you will be filmed performing first and second tennis serves. At the completion of this study, the researchers will provide you with critiqued video of your final filming. This can be used during the off-season to improve service form. By participating in this study, you will add valuable knowledge to the academic and applied fields of sport psychology.

Compensation for Participants: None.

Procedures for Maintaining Confidentiality of Research Records: Participant surveys will be coded with numbers so that individual responses will remain anonymous. Surveys and electronic data will be stored in a locked office. The confidentiality of your individual information will be maintained in any publications or presentations regarding this study.
Questions about the Study: If you have any questions about the study, you may contact Earlynn Lauer at Emily.Lauer@unt.edu or Dr. Scott Martin at Scott.Martin@unt.edu.

Review for the Protection of Participants: This research study has been reviewed and approved by the UNT Institutional Review Board (IRB). The UNT IRB can be contacted at (940) 565-3940 with any questions regarding the rights of research subjects.

Research Participants’ Rights:

Your participation in the survey confirms that you have read all of the above and that you agree to all of the following:

- **Earlynn Lauer** has explained the study to you and you have had an opportunity to contact him/her with any questions about the study. You have been informed of the possible benefits and the potential risks of the study.
- You understand that you do not have to take part in this study, and your refusal to participate or your decision to withdraw will involve no penalty or loss of rights or benefits. The study personnel may choose to stop your participation at any time.
- Your decision whether to participate or to withdraw from the study will have no effect on your grade or standing in this course.
- You understand why the study is being conducted and how it will be performed.
- You understand your rights as a research participant and you voluntarily consent to participate in this study.
- You understand you may print a copy of this form for your records.

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I, ____________________________________________, have read the description of the research project for which this consent pertains, and I hereby consent to participate in this study.

______________________________  ____________
Signature of participant (or guardian)    Date
Student Assent Form

You are being asked to be part of a research project being done by the University of North Texas Department of Kinesiology, Health Promotion, and Recreation.

You are being asked to participate in a research study designed to determine whether different types of coaching practices will affect the consistency and form of a tennis serve, and to see whether this intervention has differences in effectiveness based on the skill of the players.

You will be asked to participate in 10 sessions. In the first session, you will receive a questionnaire during practice. Then, a pre-test of service form and consistency will be conducted. Each participant will be filmed performing ten first and ten second serves, and successful serve percentages will be recorded.

In sessions two through four and six through nine, you will receive weekly observation of your first and second serves during regularly scheduled practice. Sessions should take no more than 10 minutes.

In the fifth and final (tenth) session, the same questionnaire from week one will be administered again during practice. Then, a post-test identical to the protocol for the pre-test will be conducted to determine the effects of the coaching on tennis serve form and consistency.

If you decide to be a part of this study, please remember you can stop participating any time you want to.

If you would like to be a part of this study, please sign your name below.

__________________________   ________________  
Printed Name of Student     Date

__________________________   ________________  
Signature of Student     Date

__________________________   ________________  
Signature of Student Investigator     Date
REFERENCES


Hardy, L., & Callow, N. (1999). Efficacy of external and internal visual imagery perspectives for the enhancement of performance on tasks in which form is important. *Journal of Sport & Exercise Psychology, 21*, 95-112.


