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Assessing the Effectiveness of Antecedent and Consequent Interventions to Enhance Sports Performance

Merritt Schenk
University of South Florida, schenk@mail.usf.edu

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by

Merritt Schenk

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Department of Child and Family Studies
College of Behavioral and Community Sciences
University of South Florida

Major Professor: Raymond Miltenberger, Ph.D, BCBA-D
Kwang-Sun Blair, Ph.D., BCBA-D
Kimberly Crosland, Ph.D., BCBA-D
Mallory Quinn, Ph.D., BCBA

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TABLE OF CONTENTS

LIST OF FIGURES

ABSTRACT

Sports research in behavior analysis is becoming increasingly popular. As the proliferation of research continues, multiple interventions have been shown to help enhance sports-related performance. However, different intervention components are rarely if ever used alone, which has created a limitation with the current body of research. To begin to address this limitation, this study had three experiments to evaluate some different components of video recording procedures and behavioral skills training (BST) to facilitate performance enhancement. Experiment 1 separated video modeling and video feedback to see which component best improved pitching form in Little League baseball players. Experiment 2 evaluated video self-evaluation and video feedback to evaluate which component best improved swing form of recreational golfers. Experiment 3 separated the different antecedent and consequence components of BST (instruction and feedback) to see which component best improved safe-tackling form in Pop-Warner football players. Results showed that consequent interventions were more effective than antecedent interventions. We discuss the importance of the results to current literature, and how they might guide future research.

CHAPTER 1:

INTRODUCTION

Applied behavior analysis (ABA) research on sports-related performance enhancement involves using a behavioral measure to assess an aspect of sports performance and using a single-subject or group research design to evaluate the effect of a behavioral intervention for the targeted performance. Although sports-performance research has become more common in ABA, there is still a relatively small body of research on the topic. Yet, the research shows much promise in establishing differing behavior analytic techniques to enhance sports-performance.

In addition to producing useful knowledge regarding effective interventions, sports-related behavior analytic research is a perfect conduit for fueling the ever-growing field of behavior analysis. A recent poll found that three quarters of all Americans will play an organized sport during their lifetime, and about 25% of those people will continue to play sports throughout their lives (Sports and Health in America, 2015). Furthermore, Americans spent $100 billion on sports in a 1-year span (2016-2017), highlighting the importance that people place on sports in culture (Kutz, 2017).

Research on behavior analysis and sports performance began when Rushall and Pettinger (1969) assessed the utility of reinforcement for increasing the work output of young swimmers during practice. They demonstrated that differing forms of reinforcement were more effective than no reinforcement at producing behavior change. Since this initial study, there have been roughly 20 different behavioral interventions used in sports-related performance research

(Schenk & Miltenberger, 2019), and these interventions have been applied to over 20 different sports (of around 64 total sports). The most common interventions used are reinforcement procedures, video-based procedures, goal-setting procedures, instruction procedures, descriptive-feedback procedures, and skills-teaching procedures. These procedures can be divided into four groups: antecedent interventions, consequence interventions, feedback interventions, and skills training interventions, and each group has multiple different types of interventions that have been shown to produce performance improvements. The following sections provide information on interventions, experimental designs, and participant demographics from experiments that were behavior analytic in nature and targeted athletic performance enhancement.

Intervention Groups

Antecedent interventions. These interventions involve introducing an intervention before behavior occurs in order to improve the target athletic behavior. Antecedent interventions used in sports include prompting, modeling, instruction, and goal setting. For example, Ziegler (1987) provided verbal instruction to teach intermediate tennis players to engage in proper self-talk techniques. As a result, participants' forehand and backhand return performance was enhanced. Mellalieu, Hanton, and O'Brien (2006) implemented a goal setting procedure to increase engagement in five performance behaviors of Rugby players. In this instance, no additional incentives were provided for reaching their goals, although goal setting is often implemented in conjunction with some form of reinforcement for goal attainment. Shapiro and Shapiro (1985) used expert modeling to enhance the performance of high school track sprinters. Using this procedure in conjunction with others, the runners' correct movements increased and incorrect movements decreased, resulting in an improvement in time it took to finish a race. Boyer, Miltenberger, Batsche, and Fogel (2009) used video modeling in conjunction with video

feedback to enhance three gymnastics moves with young gymnasts. The students watched a video of an expert performing the movement and then watched their own performance on video to compare to the expert. In one other example, Fitterling and Ayllon (1983) used physical prompting along with other procedures to increase the ability of young ballet dancers to maintain correct posture while performing four dance exercises.

Consequence interventions. These interventions involve introducing a reinforcement or punishment procedure after behavior occurs in order to improve the target behavior. For example, Heward (1978) provided monetary reinforcement to professional baseball players contingent on successful at bats. At the end of each week, the three players with the highest efficiency average (a metric of successful hitting) were given monetary reinforcement, resulting in efficiency averages increasing for most of the participants. Quinn, Miltenberger, and Fogel (2015) used TAGteach to enhance the performance of competitive dancers. Each time a student engaged in correct performance of a step in a dance move, the dance teacher provided auditory feedback with a click, and incorrect responding resulted in no sound. Reitman, Hupp, O'Callaghan, Gully, and Northup (2001) used a reinforcement procedure and demonstrated that it was more effective than medication at increasing attentive behavior and decreasing disruptive behavior for students playing kickball. In yet another example, O'Brien and Simek (1983) used a backward chaining procedure with mastery criteria to improve shot accuracy of golfers. Once each golfer mastered the easiest and closest shot and contacted the reinforcement of the ball dropping into the hole, the shot difficulty and distance was increased until the golfers reached all mastery criteria.

Feedback interventions. These interventions involve providing information about some aspect of the behavior after behavior occurs in order to improve the target behavior. The

provision of feedback may serve a number of functions such as reinforcement for desired behavior, punishment of undesired behavior, instructions or prompts to evoke a correct behavior, or a motivating operation to evoke a correct behavior or abate an undesired behavior. For example, Schonwetter, Miltenberger, and Oliver (2014) used verbal feedback along with self-monitoring to increase the number of laps swam during practice by competitive swimmers. They demonstrated that descriptive verbal feedback helped enhance performance when other interventions might not produce substantial effects. Kelley and Miltenberger (2016) used video feedback to enhance horseback riding skills by recording the target behavior and immediately showing the rider the video while describing the correct aspects of the performance and providing further instruction for incorrect aspects of the performance. Rushall and Smith (1979) used self-monitoring in conjunction with instruction to enhance a swimming coach's verbal reinforcement repertoire, presumptively leading to the performance enhancement of the swimmers. Ward, Smith, and Sharp (1997) used public posting to improve route running of collegiate level football players. They showed that player route running was honed as a result of publicly posting performance feedback after each practice. Wack, Crosland, and Miltenberger (2014) used graphical feedback in conjunction with other intervention components to increase the distance that five college-age females ran. In some studies public posting included graphs of subject performance (e.g., Quinn, Miltenberger, Abreu, & Narozanick, 2017).

Skills-training interventions. These interventions involve procedures for teaching an athletic skill directly or a skill different from the target behavior that results in an improvement in the target behavior. For example, Landin and Herbert (1999) demonstrated that a self-talk procedure helped female collegiate tennis players improve their use of strategic advantages, such as hitting the ball behind their opponent. Templin and Vernacchia (1995) used a self-imagery

intervention in conjunction with relaxation training to increase the field goal percentage of five male collegiate basketball players. Kearns and Crossman (1992) used relaxation training in conjunction with self-imagery to increase the percentage of foul shots made by male collegiate basketball players. Hazen, Johnstone, Martine, and Skrikameswaran (1990) used behavioral rehearsal in conjunction with multiple other treatment components to improve competitive swimmers' ability to correctly engage in direction transitions between lengths swam. Christina, Baressi, and Sheffner (1990) used simulated practice to demonstrate that a male collegiate football linebacker increased his directional response accuracy to the opposition during actual play by training response accuracy to a video highlight using a joystick to indicate which movement he would make given the movements of the offense. Furthermore, Scott, Scott, and Howe (1998) used simulated practice to help tennis players identify direction of their opponents serve more quickly by verbally responding to a video recording of an individual's serve.

Also, acceptance and commitment therapy (ACT), behavioral skills training (BST), habit reversal, and discrimination training interventions were implemented in one study each. For example, Little and Simpson (2000) used ACT to decrease the number of negative thoughts that five collegiate softball players had, in turn, facilitating performance enhancement. Tai and Miltenberger (2017) evaluated BST for teaching safe tackling skills to young football players by using a task analysis and providing instructions for all the steps in a safe tackle and then modeling safe tackling. They then had the participants practice tackling and provided feedback, pointing out which steps were done correctly and which steps needed to be improved. Allen (1998) demonstrated that a habit reversal intervention helped an adolescent tennis player decrease his angry outbursts to increase his overall performance. Osborne, Rudrud, and Zezoney (1990) used discrimination training by placing specific marks on baseballs that were thrown as

curveballs and then fading the size of the lines to help collegiate baseball players discriminate between the spin of curveballs and other types of pitches.

Experimental Designs

In order to demonstrate the effects of each intervention, an acceptable experimental design has to be used. The most common experimental design used in the literature has been a multiple baseline across subjects. For example, Kladopoulos and McComas (2001) demonstrated that a behavioral intervention increased the number of foul shots made when it was sequentially introduced across three collegiate basketball players. A multiple baseline across behaviors is the second most common design. For example, Fogel, Weil, and Burris (2010) showed that four out of five behaviors related to a golf swing were enhanced by sequentially implementing a TAG teach procedure for each behavior, and that these behaviors generalized to other golf clubs. Allen (1998) used a multiple baseline across settings to demonstrate that the behavioral intervention helped enhance a tennis players overall performance by decreasing inappropriate outbursts, first in the practice setting and then in different tournament settings.

Several studies have used an ABAB reversal design. For example, Hume and Crossman (1992) showed that contingent music for on-task behavior increased the amount of productivity by competitive swimmers each time it was implemented. It is important to note that an ABAB design is only appropriate for evaluating interventions that focus on performance enhancement rather than skill acquisition. Five studies have used a multi-element design. For example, Wolko, Hrycaiko, and Martin (1993) demonstrated that one intervention was more effective at increasing the productivity of gymnasts compared to another intervention and a baseline by having the subject experience all conditions during each week and counterbalancing their implementation over the course of the study. Four studies have used a changing criterion design.

For example, Scott et al. (1998) decreased the amount of time it took competitive tennis players to identify their opponent's serve. This was done by sequentially decreasing the maximum required latency that the subject was allowed to engage in the correct response. Also, two studies have used a multiple-probe design. For example, Shapiro and Shapiro (1985) demonstrated high-school athletes could improve three separate track related behaviors by sequentially introducing intervention across behaviors after an improvement occurred with the previous behavior.

Six studies have used modified ABAB designs in which multiple conditions were evaluated. For example, Baudry, Leroy, and Chollet (2006) demonstrated that the behavioral intervention (B) enhanced the performance of gymnasts above baseline (A) and more substantially than traditional coaching (C) or specific instructions using an ABCBCBCBC design. However, 20 different studies have used designs that did not clearly demonstrate within-subject experimental control. Such studies include AB case studies (Maryam, Yaghoob, Darush, & Mojtaba, 2009), group designs with statistical analysis (e.g., Rikli & Smith, 1980), ABA reversal designs (e.g., Polaha, Allen, & Studley, 2004), and one study that began assessment with the treatment phase (Christina et al., 1990).

Participant Characteristics

Although several studies in the literature do not describe the age or sex of the participants, a total of 1,370 individuals have participated in the identified sports-related behavioral research, of which 438 were children under the age of 18 and 920 were adults (the ages of 12 participants were reported ambiguously). Participant ages have ranged from 4 to 61. Although all studies focus on performance enhancement of athletes, some studies intervened on the coach's behavior to facilitate performance enhancement. For example, Stokes and Luiselli

(2010) demonstrated that altering the number of coach interactions with their players increased the likelihood that a high school football player engaged in proper tackling technique. Of all experiments, 18% improved coach behavior and 93% improved competitor behavior. Percentages are greater than 100 because some experiments focused both on coaching improvement and competitor performance enhancement. Skill levels studied in the current literature include recreational participation (e.g., Rikli & Smith, 1980), competitive club sport or studio (e.g., Quinn et al., 2015), collegiate (e.g., Silva III, 1982), high school (e.g., Stokes, Luiselli, & Reed, 2010), and international (e.g., Scott, Scott, & Goldwater, 1997).

Numerous studies have assessed sports-related performance but were not behavior analytic in nature. For example, studies involving hypnosis are not included, as research has demonstrated that hypnosis interventions do not function to promote behavior change compared to control measures (e.g., Sanders & Simmons, 1983) and involve processes seemingly incongruent with behavioral principles. Also, some studies discuss the utility of interventions as opposed to implementing them (e.g., Crews & Boutcher, 1986; Lacy & Goldston, 1990; Smith, Smoll, & Christenson, 1996; Virués-Ortega & Martin, 2010). Such studies are useful for expanding the application of behavior analysis, or establishing useful measurement techniques and behaviors of interest, but they are not the focus of this study.

Other studies measured and discussed sports performance in the context of providing further applications of behavioral science, but did not expand into performance enhancement. For example, different quantitative analytic approaches have been used to demonstrate the application of behavioral science to sports environments. Vollmer and Bourret (2000), Romanowich, Bourret, and Vollmer (2007), and Alferink, Critchfield, Hitt and Higgins (2009) demonstrated that the matching law (i.e., relative rates of behavior are equal to relative rates of

reinforcement) could be used to accurately describe basketball players' shot selection, and Seniuk, Williams, Reed, and Wright (2015) extended these findings to describe shot selection of professional hockey players. Furthermore, Roane, Kelley, Trosclair, and Hauer (2004) used behavioral momentum theory (i.e., resistance to change given rates of behavior and reinforcement obtained) to describe patterns of behavior in women's college basketball. Although this line of research provides an exciting extension of behavior analysis, it does not evaluate interventions. Rather, it provides descriptions of behavior analytic principles applied to sports (for an in depth review of quantitative analytic techniques as they are applied to sports see Reed, 2011). Future research could assess the utility of using quantitative models to facilitate performance enhancement and inform interventions.

There are also a few limitations with the current literature on ABA and sports-related performance enhancement. First, there are several terms that have been used non-operationally throughout the literature. For example, the term "behavioral coaching" has been used to describe a number of different coaching techniques when a behavioral intervention was added, and it is often compared to standard coaching techniques that do not include a behavioral intervention. Most often, behavioral coaching is similar to BST in that it includes instruction, modeling, rehearsal, and feedback. However, these four components have not always been present in a behavioral coaching intervention and other components have sometimes been added. Seniuk, Witts, Williams, and Ghezzi (2013) provide a full history of the term "behavioral coaching" and provide an alternative definition to operationalize the term as a behavior analytic technique.

Second, as with many fields, the literature on the application of behavior analysis to sports appears to suffer from the "file-drawer" problem, in that very few articles report partially negative results regarding the intervention. For example, Lerner, Ostrow, Yura, and Etzel (1996)

found that only goal setting produced improvements in basketball free-throw shooting for most subjects instead of the package intervention of goal setting and self-imagery. In fact, the additional procedure of self-imagery reportedly diminished behavioral improvement. Osborne, Rudrud, and Zezoney (1990) introduced cues as discriminative stimuli to signal types of pitches thrown, and they reported an increase in hitting curveballs. However, this did not appear to generalize to unmarked balls, and players actually hit unmarked balls worse overall during the experiment compared to baseline. Moreover, hitting only increased when larger cues were used, and behavior returned to approximately baseline levels when the cues were made smaller. One reason the abundance of positive results could be a problem is that some studies reported small but significant findings (e.g., Aiken, Fairbrother, & Post, 2012 found their result statistically significant with $p = 0.04$, but graphical analyses showed little to no difference). Although statistics can emphasize important differences between data sets, statistically significant results are not the same as substantial and socially significant results. A possible explanation for the mostly positive results could be the abundance of multi-component interventions. Thus, using multiple procedures could hedge the bet, so to speak, that interventions would be a success. That being said, the focus of the research has been the subject's behavioral improvement, so it is not surprising to see successful multi-component interventions.

Third, there is a lack of clarity in the effects of individual intervention components because interventions have generally been part of a package. Although these *package interventions* result in some loss of experimental control (regarding certainty of which component affects behavior) there are several likely reasons that they have been used: (a) they produce favorable effects; (b) it is difficult to separate certain components in a sports setting without making the intervention seem peculiar to an athlete, which could, in turn, be detrimental

to the intervention process; and (c) the focus of the research is more on performance enhancement in general, as opposed to an analysis of which components best facilitate performance enhancement. Although the last reason seems counterintuitive because identifying the components that best facilitate performance enhancement would allow for the most efficient interventions to be used, when working with athletes, time is of the essence for the subjects. Therefore, a desire to improve the science is eclipsed by the participant's need to improve performance.

Although the current literature has generally shown that behavioral interventions have been successful at facilitating sports-related performance enhancement, the current limitations need to be addressed. Some studies (e.g., Rikli & Smith, 1980; Smith & Ward, 2006) have assessed the efficacy of intervention components regarding behavior change, but few others have clearly demonstrated a specific intervention as the important component facilitating behavior change. Because the different procedures are often used in various combinations in order to produce beneficial effects on behavior, there remain questions as to whether certain interventions are effective for different sports and different age groups, or effective at all. Although the use of multi-component interventions is likely considered good practice when helping to improve an individual's behavior, it has left a gap in the literature regarding the utility and efficiency of each procedure.

For example, video technology, such as video modeling (VM), has been used extensively as an intervention component in sports, and interventions using VM are generally shown to be effective interventions. However, there is little research demonstrating that VM alone (without the use of additional concurrent intervention components) can change behavior. Maryam, Yaghoob, Darush, and Mojtaba (2009) used VM to improve the performance of track and field

athletes, but they also provided specific instruction as a component of the intervention, and it is possible that the instruction was more effective than the VM component. This confound could be easily controlled with a sufficient experimental design that separates necessary instructions from a coach and video modeling from an experimenter. Addressing this overall limitation in the literature gets to the purpose of this dissertation.

VM and video feedback (VF) are two common interventions to improve sports performance. These interventions are quite different, however, as VM is an antecedent procedure introduced before the behavior occurs, and VF is a consequence procedure provided after the behavior has occurred. Some studies have used one of these procedures separately (e.g., BenitzSantiago & Miltenberger, 2016; Kelley & Miltenberger, 2016; Maryam et al., 2009; Partington, Cushion, Cope, & Harvey, 2015; Rikli & Smith, 1980; VanWieringen, Emmen, Bootsma, Hoogesteger, & Whiting, 1989), and some studies have used these procedures in combination (e.g., Baudry, Leroy, & Chollet, 2006; Boyer, Miltenberger, Batsche, & Fogel, 2009; Hazen, Johnstone, Martin, & Skrikameswaran, 1990). However, no studies have compared the use of VM and VF separately to demonstrate their effectiveness relative to one another. VM and VF as different interventions are likely more effective for different types of behaviors across sports and different performance levels. For example, VM might be useless to teach a young baseball player proper pitching technique, but VF would be effective to teach the same individual proper technique. Yet, VM might be effective for a behavior with few bodily movements that can be completed at a slow and steady pace such as weightlifting, but it might be ineffective for a complex behavior involving multiple body parts that move at a rapid pace such as certain dance moves or a golf swing. For these reasons, evaluating the utility of VM and VF separately would be an important addition to the literature.

Video self-evaluation (VSE) is another intervention used in the literature that allows participants to evaluate their own performance while they view a video of themselves performing a certain skill. For example, Downs, Miltenberger, Biedronski, and Witherspoon (2015) used VSE to help young adults improve their yoga poses by having them view a video recording of them getting into and holding certain poses. It is important to evaluate VSE compared to VF because VSE eliminates the verbal feedback component that is delivered by an expert during a VF procedure. Therefore, VSE is a procedure that helps to assess if video technology can be used in isolation from other intervention components and in the absence of an experimenter.

Behavioral skills training (BST) is another behavioral intervention that has been shown to produce acquisition of important behavior. However, similar to VM and VF, BST consists of multiple intervention components that are potentially effective alone. BST refers to the systematic use of instructions, modeling, rehearsal, and feedback, and has resulted in improvements across a number of different behaviors (e.g., Gross, Miltenberger, Knudson, Bosch, & Breitwieser, 2007; Iwata et al., 2000; Johnson et al., 2005; Miles & Wilder, 2009). BST has also been used to successfully improve sports performance. For example, Shapiro and Shapiro (1985) used "behavioral coaching" that resembled BST to increase the speed at which track athletes completed 100 m and 200 m races. Also, Tai and Miltenberger (2017) used BST to teach proper tackling technique to young football players. However, each individual component of BST has been reported experimentally, professionally, or anecdotally to produce improvements related to sports performance. For example, O'Brien and Simek (1983) used modeling and instruction to increase shot accuracy and decrease the number of strokes needed to complete a round of golf for amateur athletes. Komaki and Barnett (1977) used instruction and feedback with a reinforcement component to improve the play execution of young football

players; Kladopoulos and McComas (2001) used a similar procedure to increase collegiate basketball players' foul shot form and accuracy. Ziegler (1987) simply used verbal instruction and a self-talk procedure to teach recreational tennis players to improve their forehand and backhand returns. Furthermore, coaches often do not provide immediate feedback to players, but the player's play still improves. Also, athletes such as golfers will spend hours on the practice range without any instruction or feedback, but will begin to notice improved results solely due to rehearsal. Because of these examples, it is important to evaluate the use of the antecedent components of modeling and instruction versus the consequence component of feedback following rehearsal when using BST in different sports settings.

To evaluate the effectiveness and efficiency of intervention components often evaluated as part of package interventions in the literature, this study will evaluate the antecedent and consequent intervention components of three common packages, VM and VF, VSE and VF, and BST. Experiment 1 will address the limitations that currently exist with understanding VM and VF by evaluating the contributions of each intervention component. Experiment 2 will evaluate the efficacy of VSE versus VF by assessing if participant's swing form will improve using video feedback without supervised assistance (VSE) or with VF. Likewise, experiments 3 will address the limitations that currently exist with understanding BST regarding performance enhancement by evaluating the antecedent components of instruction and modeling and the consequence components of feedback separately. As a result, this study will provide empirical evidence as to which components of video recording and BST are most useful or necessary for enhancing sports performance.

CHAPTER 2:

EXPERIMENT 1

The purpose of experiment 1 was to evaluate the separate effects of video modeling and video feedback for the improvement in pitching skills of young baseball players.

CHAPTER 3:

METHOD

Subjects

Three typically developing and functioning novice pitchers participated in the study. Participant 1 (P1) was 10 years old, P2 was 9 years old, and P3 was 8 years old. Participants were recruited from a community Little League program. The team coaches referred players who could benefit from additional behavioral techniques and who met the following criteria: (a) be identified by the coach not to have mastered the target pitching skills, (b) have experience as a pitcher on their baseball team, (c) have little to no previous exposure to behavior analytic training techniques, and (d) state interest in being trained to improve their pitching skills. Prior to conducting the study, the researcher provided a brief explanation of the study to coaches and parents and reviewed consent forms with those who participated. No participants had to be excluded during this study, but one was dropped due to participation issues, and his data were not reported. The parent or guardian of each child provided informed consent, and each child's assent was also obtained.

Setting and Materials

The setting was a local little league baseball park. The park had multiple fields of different sizes on which sessions were conducted. However, the measurements used for the distance from home plate to the pitcher's mound were consistent with Little League *minor a* and *minor b* rules (46 ft from the front of the mound to the back of home plate). The strike zone used to determine accurate pitches was the width of the plate and the height from the knee to the

armpit and called by the player's coach, or denoted by a strike zone indicator placed at home plate.

The materials included were a 47-s video of a professional baseball player, Zach Grienke, throwing a pitch from the wind-up that can be alternated from normal speed to slow motion. Zach Grienke was used as a model because he is a professional baseball player with multiple years of experience including several individual awards at the Major League level. Also, he is widely considered by baseball experts to demonstrate some of the best form for a pitcher. The video was recorded from Youtube.com. An iPad was used to record the participants performing the skill and the Hudl Technique electronic application was used to compare, replay, and focus on certain aspects of the performances. Features of the software include dual display screens to compare two videos, slow motion replay, freeze frame capabilities, and timer display. An Apple MacBook Air with dual screens was used to view and analyze each video recording. A 15-item task analysis was used to assess the correct execution of each pitch (see Appendix A). Materials also included standard baseball equipment - baseballs, baseball gloves (mitt), and cleats.

Response Measurement and Interobserver Agreement

The behavior being measured was pitching form - the movements of the pitcher while he prepares and throws the ball to the catcher. A secondary measurement was taken on how often each pitcher threw a strike. As there was not a validated task analysis for pitching form in the current ABA literature, the correct form to be taught was identified and agreed on by the experimenter and the player's head coach to increase the social validity of the target behavior. Correct pitching form consisted of four main phases: the set up, the wind up, the release, and the follow through. Additionally, the experimenter ensured that all aspects of correct form agreed on were present in the video model used. The experimenter reviewed every pitch using the task

analysis to assess correct form. Four independent researchers (three undergraduate students and one master's student) also assessed 49% of pitches thrown for P1, 36% of pitches for P2, and 11% for P3, accounting for 29% of total pitches thrown across participants. IOA was calculated by taking agreements between the experimenter and the independent observers on task analysis steps and dividing that by the total number of steps. This number was then multiplied by 100 to provide a percentage.

Social Validity

Social validity was assessed with each participant at the conclusion of the study. This was done using a seven-question survey with the first six questions being answered on a 7-point Likert scale (see Appendix D). Furthermore, the head coaches were shown videos of a baseline session and the final intervention session for each participant in random order. The coach, blind to the condition for each video, was asked to rank each pitch on a 15-point scale (as the TA had 15 steps) from very bad to very good. Social validity assessed treatment acceptability by the participants and assessed outcome by the coach.

Design and Procedure

A multiple baseline across participants design with an ABC sequence was used to evaluate the relative contributions of video modeling and video feedback to improving pitching performance for each participant. The experimental conditions included baseline, VM, and VF. For participants whose pitching performance did not reach 90% during VM or data were indicating a trend counter to the desired direction, VF was introduced. Once an improvement was seen with the previous participant who was in the VF condition, then VF was introduced for the next participant as is common with a multiple-baseline design. Once a player consistently

completed an average of 90% of steps correctly for at least three consecutive sessions, then the intervention was stopped, and a follow-up phase was conducted after a minimum of 2 weeks.

Baseline. Baseline data were collected during normal practice routines. The researcher asked participants to throw their best pitch as they normally would. Each participant did this 10 times. The head coach caught each pitch and determined whether it was a ball or a strike, but he did not comment on the participant's pitching form or provide feedback to the player on balls and strikes. Participant performance was video recorded and scored based on accurate performance for each step on the task analysis. Coaches were instructed not to change how they would normally coach, as typical practice includes the coaches providing instruction, modeling, rehearsal, and feedback.

Video modeling. During this phase, the researcher had each participant view the expert-video model performing the desired pitching skills before the participant completed his pitching trials for the session. No additional vocal instructions were provided to participants during their watching of the video model; however, the participants were instructed to pay attention to how the model pitches and asked to attempt to pitch the ball just like the expert. During this phase, the participants were shown the video at normal speed. Then the researcher showed the video in slow motion to better demonstrate each of the steps of the task analysis being performed correctly by the model. The participant watched the video and then attempted to imitate the movement three times. The participant then threw three pitches for assessment. After completing their pitching trials for that session the session was over. VM sessions lasted approximately 15 min. This phase continued until progress stopped. We then moved into the VF phase.

Video feedback. During this phase, the researcher had the participant throw a pitch and recorded the participant's throw. Immediately following the throw, the researcher showed the recording to the participant while starting and stopping the video to provide the participant feedback. The researcher provided praise for each correct component of the task analysis and provided further instruction for each step of the task analysis that was not correct. Therefore, this phase also had a verbal feedback component concurrently with the VF. This was done for three consecutive pitches. Afterwards, the participant completed his three assessment trials for the session without feedback. This phase continued until the participant consistently completed around 90% of the steps correctly.

Follow up. The follow up phase was conducted exactly how the baseline phase was conducted. At a minimum of 2 weeks after completing the intervention, the participant was asked to throw three pitches. The participants were not provided with any VM or VF during these sessions.

CHAPTER 4:

RESULTS

All results across participants are demonstrated in Figure 1. As can be seen, VM increased the percentage correct for one participant, but VF increased performance further for all participants. The mean percentage correct for P1 was 67.5% of steps in baseline, 76.1% correct in VM, and 94.7% in VF (note; the last nine trials were used to calculate the mean in intervention phases). The mean percentage correct for P2 was 65.4% of steps in baseline, 67.7% in VM, and 89.4% in VF. The mean percentage correct for P3 was 65% of steps in baseline, 67.7% in VM, and 94% in VF.

P1 had 49% of his trials independently assessed. IOA for P1 was 81% (range 60-93%). P2 had 36% of his trials independently assessed. IOA for P2 was 91% (range 80-100%). P3 had 11% of his trials independently assessed. IOA for P3 was 83% (range 80-93%). Total IOA across all participants was at 84%. Procedural fidelity, as assessed by coaches in 27% of sessions, was 100%. A questionnaire was provided to all players to assess the social validity of the study. Seven questions were asked using a Likert scale from 1 to 7. When asked if they thought the study was useful for improving overall pitching form, the average answer was a 6.7. When asked if they thought VM was useful at improving their form, the average answer was a 6. When asked if they thought VF was useful, the average answer was a 6.7. When asked if they enjoyed participating in the study the average answer was a 7. When asked if they would recommend others participate in similar studies, the average answer was a 7. When asked if they

thought they were a better baseball player as a result of their participation, the average answer was a 6.7. Lastly, all three of the participants identified VF as the more beneficial intervention.

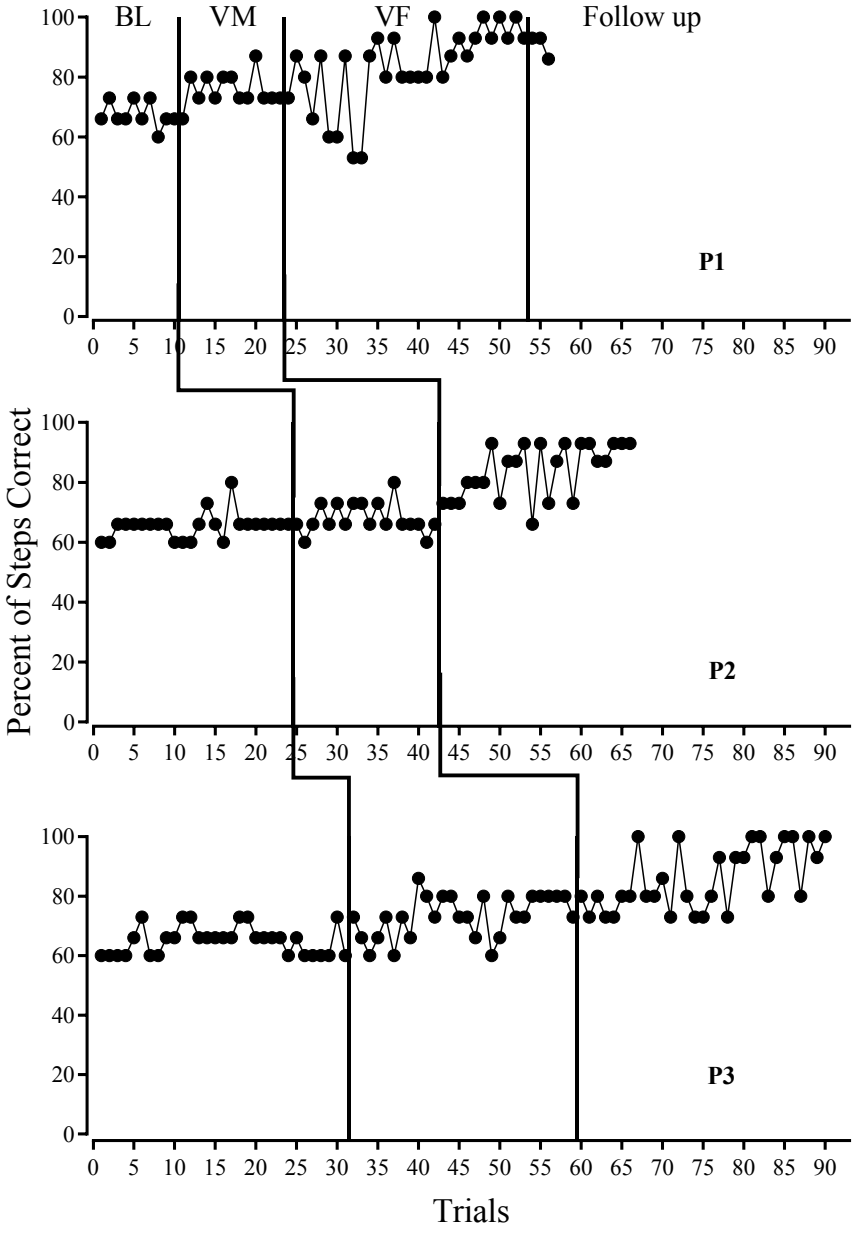

Figure 1. Shows the percentage correct of steps in the task analysis of a baseball pitch across baseline, video modeling (VM), and video feedback (VF) phases.

As a secondary measure, strikes and balls were assessed for each pitch. P1 threw 0% of his pitches for strikes during baseline, 46% for strikes during VM, 17% for strikes during VF, and 66% for strikes during follow up. P2 threw 4% of his pitches for strikes during baseline, 22% for strikes during VM, and 17% for strikes during VF. P3 threw 13% of his pitches for strikes during baseline, 21% for strikes during VM, and 19% for strikes during VF.

A baseball coach from the Little League park assessed before and after pitch form for each participant. He scored overall pitch form using a Likert scale from 1 to 15. The videos were presented in a random order so not to affect his judgment. P1's score improved from 4 to 6. P2's score improved from 1 to 3. P3's score improved from 2 to 6. It must be noted that the coach strictly focused on the feet of the pitcher, and the experimenter only asked the coach to rate the pitch on a 1 to 15 scale with no other instructions provided.

CHAPTER 5:

DISCUSSION

We assessed the utility of VM and VF as efficient interventions for teaching pitching form to Little League baseball players. Overall, we found that VM can be an effective intervention to help kids learn how to improve some aspects of their form. However, no participant reached the mastery criterion during the VM phase. On the other hand, all participants reached the mastery criterion in the VF phase. This suggests that VM, although effective to some degree, is inferior to VF.

That said, VM is at a disadvantage because it is an intervention component that stands alone, whereas VF must also involve a verbal feedback component. To make VM perfectly analogous to VF, one might assume that instruction should be included with VM. Thus, there would be two antecedent components during the VM phase and two consequence components during the VF phase. However, VM and VF are often used together, which is why we chose this research question over another.

Because we always started with VM, one could argue that the child was older (i.e., more physically able) when he started VF. However, this does not seem likely. In Florida, there are two baseball seasons every year for Little League players, and two participants completed the study within three seasons, while the other (P3) completed the study in one season. Based on the data for all participants, the progression of learning does not appear to be based on age or growth, but as a result of the intervention. Of course, one could argue that there is an interaction

effect because VM always came before VF, but we would hypothesize that if starting with VF, one would never need VM.

Over the course of the study, only P1 threw a substantially higher percentage of strikes during intervention phases compared to baseline. However, when looking at the total number of strikes thrown, it was 0 out of 10 pitches in baseline, 6 out of 13 pitches in VM, and 5 out of 30 during VF. Although this is an increase in number, it likely would not be of great importance in a game, as throwing 17% of pitches for strikes would not be considered effective pitching. However, in follow up, P1 threw 2 out of 3 pitches for strikes, and his form mostly maintained as can be seen in figure 1. This would suggest that the pitchers performance became better as a result of prolonged practice with correct form.

Overall we found that all participants started the study with high baseline scores, as all participants already had the ability to pitch, albeit poorly. Although the scores were not substantially greater, there was an improvement. VM was partially effective for all participants in that all participants improved their performance on average during the VM phase, but none of them reached mastery criterion during this phase. VF, therefore, was the most effective and efficient intervention when teaching baseball pitching performance, as all participants were able to reach the mastery criterion during the VF phase.

CHAPTER 6:

EXPERIMENT 2

The purpose of experiment 2 was to evaluate the separate effects of video self-evaluation and video feedback for the improvement in golf swing form of recreational golfers.

CHAPTER 7:

METHOD

Subjects

Five typically developing and functioning amateur recreational golfers participated in this study. Participant 1 (P1) was 24, P2 was 22, P3 was 28, P4 was 22, and P5 was 23. Each participant reported his average 18-hole score at the beginning of the study. P1's score was 110, P2's was 105, P3's was 120, P4's was 95, and P5's was 90. Participants were recruited from a local golf course affiliated with the university. A flyer was placed at the golf-course clubhouse for potential participants to contact the experimenter. All applicants who were physically able to play golf and were able to effectively communicate were allowed to participate, until the number of golfers needed was met. No participants were excluded during the course of this study. Prior to conducting the study, the researcher provided a brief explanation of the study and reviewed consent forms with each participant. All participants signed an informed consent form before participating.

Setting and Materials

The setting was a local golf course affiliated with the university. The golf course had a public driving range on which all of the sessions took place. The driving range had synthetic turf off of which golf balls could be hit, but all participants were required to hit off of the grass unless hitting off the synthetic turf was enforced by the golf course due to weather-related reasons. The range was large enough to allow approximately 15 golfers to practice at the same time.

The materials included were an Apple iPad with a 7.9 in. screen. The iPad was used to record the participants performing the skill and the Hudl Technique computer application was used to compare, replay, and focus on certain aspects of the performances. Features of the software include dual display screens, drawing on the screen to assess angles, slow motion replay, freeze frame capabilities, and timer display. An Apple MacBook Air with dual screens was used to view and analyze each video recorded. A 21-item task analysis was used to assess the correct execution of each swing (see Appendix B). This task analysis was approved by a golf pro from the Tampa area. Materials also included standard golf equipment such as golf clubs, a golf glove, and golf shoes.

Response Measurement and Interobserver Agreement

The behavior being measured was overall swing form - the movement of the golfer as he or she brings the club back, hits the ball, and swings through the ball. A secondary measurement was taken on the vertical and horizontal accuracy of each ball. There is not currently a task analysis in the literature on proper swing form. Although Fogel et al. (2010) used task analyses to assess proper swing form; it breaks down the swing into several phases (including approach to the ball), which was further than was the purpose of this study. However, there is a cornucopia of advice in popular literature (e.g., Golf Magazine) regarding proper swing form for every club in every situation. Therefore, the task analysis was based on advice from experts in popular sources that describe and discuss proper swing form. This task analysis was then approved by a golf professional. Correct swing form consisted of three main phases: the backswing, the downswing, and the follow through. The experimenter reviewed every swing using the task analysis to assess correct form. A percentage of steps on the task analysis performed correctly was calculated for every golf swing, and was the primary measure of success. For purposes of

interobserver agreement, three independent researchers (two master's students and one undergraduate student) assessed 24% of P1's swings, 53% of P2's swings, 32% of P3's swings, 23% of P4's swings, and 28% of P5's swings. This accounted for 33% of all swings. To calculate IOA, the number of agreements of steps in the task analysis between the observers was calculated and divided by the total number of steps. This number was then multiplied by 100 to provide a percentage.

Social Validity

Social validity was assessed with each participant at the conclusion of the study. This was done using a seven-question survey with the first six questions being answered on a 7-point Likert scale (see Appendix E). Furthermore, a professional golfer was shown videos of a baseline session and the final intervention session for each participant in random order and was blind to the condition of each video. The golfer was asked to rank each swing on a 21-point scale (as the TA had 21 steps) from very bad to very good. Social validity assessed treatment acceptability by the participants and assessed outcome by the professional.

Design and Procedure

A multiple baseline across participants design with an ABC sequence was used to evaluate the relative contributions of VSE and VF to improving golf swing performance for each participant. The experimental conditions included baseline, VSE, and VF. VF was introduced in accordance with the multiple-baseline design for participants whose swinging performance did not reach 90% following VSE or data exhibited a trend counter to the desired direction. Once a player was consistently performing above the 90% mark for at least three consecutive sessions, then the intervention was stopped, and a follow-up phase was conducted after a minimum of 2 weeks.

Baseline. Baseline data were collected during standard business hours at the participant's convenience. The researcher asked participants to stretch out and hit 15 balls to ensure consistency. Each participant then took three swings that were recorded as the baseline data. The experimenter recorded each swing and verbally stated the flight path of the ball on the recording. Participant performance was scored based on accurate performance of each step on the task analysis. The experimenter provided no instruction and no feedback other than information related to questions the participants had regarding what he could and could not do for the purposes of the study.

Video self-evaluation. Pre-session warm up for the VSE phase was identical to the baseline phase. After the participant had hit his 15 balls, the researcher had each participant hit one ball and immediately review his swing on the iPad. While reviewing his swing he used the task analysis to assess if he did or did not engage in each step correctly. This process was completed a total of three times for each VSE session. No additional vocal instructions were provided to participants while he watched himself on video; however, the participants were asked to think about what they did not do and attempt to do it on the next swing. During this phase, the participants watched the video at normal speed, and they were allowed to start and stop the video to review each of the steps of the task analysis they performed correctly. Following the VSE component, the participant completed three swings that were used for assessment. After completing three swings the session was over. VSE sessions lasted approximately 40 min. This phase continued until progress stopped, the participant was consistently completing 90% or more of the steps correctly, or correct performance was trending downward.

Video feedback. Pre-session warm up for the VF phase was identical to the baseline and VM phases. After the participant hit 15 balls, the researcher had the participant take a swing and recorded the participant's swing. Immediately following the swing, the researcher showed the recording to the participant while starting and stopping the video to provide the participant feedback about the steps of the task analysis he did correctly or incorrectly. The researcher provided praise for each correct component of the task analysis and provided further instruction for each step of the task analysis that was not correct. Therefore, this phase necessarily had a verbal feedback component concurrently with the VF. This process was repeated three times. Following VF, the participant completed three swings without feedback that were used for assessment. After completing three swings the session was over. VF sessions lasted approximately 45 min. This phase continued until the participant was consistently completing at least 90% of the steps correctly.

Follow up. The follow up phase was conducted exactly how the baseline phase was conducted. After a minimum of 2 weeks of not being in the intervention, each participant was asked to come to the driving range, warm up, and take three swings. The participants were not provided any VSE or VF during these sessions.

CHAPTER 8:

RESULTS

All results across participants are depicted in Figure 2. As can be seen, VSE increased the percentage correct for some participants, but VF increased performance further for all participants. The mean percentage correct for P1 was 63.3% of steps in baseline, 69.3% correct in VSE, and 95% in VF (note; the last nine trials were used to calculate the mean in intervention phases). The mean percentage correct for P2 was 71% of steps in baseline, 90% correct in VSE, and 96.1% in VF. The mean percentage correct for P3 was 66.7% of steps in baseline, 82.7% correct in VSE, and 90% of steps in VF. The mean percentage correct for P4 was 71.4% of steps in baseline, 76% correct in VSE, and 90% in VF. The mean percentage correct for P5 was 86% of steps in baseline, 88% correct in VSE, and 97.8% in VF.

IOA was calculated for 33% of total trials conducted. IOA was 92% (range 86-95%) for P1, 92% (range 81-95%) for P2, 91% (range 71-95%) for P3, 95% (range 95-95%) for P4, and 98% (range 86-100%) for P5. Total IOA across all participants was 94%. Procedural fidelity, as assessed by independent researchers either present or via video for 28% of sessions, was 100%. A questionnaire was provided to all players to assess the social validity of the study. Seven questions were asked using a Likert scale from 1 to 7. When asked if they thought the study was useful for improving overall swing form, the average answer was a 6.4. When asked if they thought VSE was useful at improving their form, the average answer was a 6. When asked if they thought they could accurately assess their swing via VSE, the average answer was a 5.6. When asked if they thought VF was useful, the average answer was a 7. When asked if they

enjoyed participating in the study the average answer was a 7 (one participant answered with a 10). When asked if they would recommend others participate in similar studies, the average answer was a 6.6. When asked if they thought they were a better golfer as a result of their participation, the average answer was a 6.4. Lastly, four of the five participants stated that they thought VF was more useful than VSE. The only participant that stated VSE was more useful was participant 4, whose follow-up data reverted to near baseline levels (see Figure 2).

As a secondary measure, contact and straightness of shot was assessed for each swing. A "good ball" was scored when both good contact and a straight shot occurred. All baseline sessions were used for this measure, and the last nine swings of each phase were used (unless they did not engage in nine trials during any phase). P1 made good contact 37% of the time in baseline, 50% of the time in VSE, and 56% of the time in VF. P1 hit a straight shot 52% of the time in baseline, 50% of the time on VSE, and 66% of the time in VF. P1 hit a good ball 22% of the time in baseline, 17% of the time in VSE, and 22% of the time in VF. During follow up, P1 hit a good ball 33% of the time.

P2 made good contact 17% of the time in baseline, 11% of the time in VSE, and 78% of the time in VF. P2 hit a straight shot 66% of the time in baseline, 56% of the time in VSE, and 66% of the time in VF. P2 hit a good ball 0% of the time in baseline, 11% of the time in VSE, and 56% of the time in VF. During follow up, P2 hit a good ball 50% of the time.

P3 made good contact 11% of the time in baseline, 44% of the time in VSE, and 44% of the time in VF. P2 hit a straight shot 44% of the time in baseline, 33% of the time in VSE, and 78% of the time in VF. P3 hit a good ball 0% of the time in baseline, 11% of the time in VSE, and 22% of the times in VF. During follow up, P3 hit a good ball 33% of the time.

P4 made good contact 66% of the time in baseline, 33% of the time in VSE, and 11% of the times in VF. P4 hit a straight shot 33% of the time in baseline, 44% of the time in VSE, and 44% of the time in VF. P4 hit a good ball 17% of the time in baseline, 11% of the time in VSE, and 0% of the time in VF. During follow up, P4 hit a good ball 33% of the time.

P5 made good contact 37% of the time in baseline, 50% of the time in VSE, and 56% of the time in VF. P5 hit a straight shot 52% of the time in baseline, 50% of the time in VSE, and 66% of the time in VF. P5 hit a good ball 22% of the time in baseline, 17% of the time in VSE, and 22% of the time in VF. During follow up, P5 hit a good ball 66% of the time.

A professional golfer assessed before and after swing form for each participant. He scored overall swing form using a Likert scale from 1 to 21. The videos were presented in a random order so not to affect his judgment. P1's score improved from 4 to 12. P2's score decreased from 9 to 4. P3's score improved from 2 to 5. P4's score improved from 4 to 5. P5's score improved from 13 to 15.

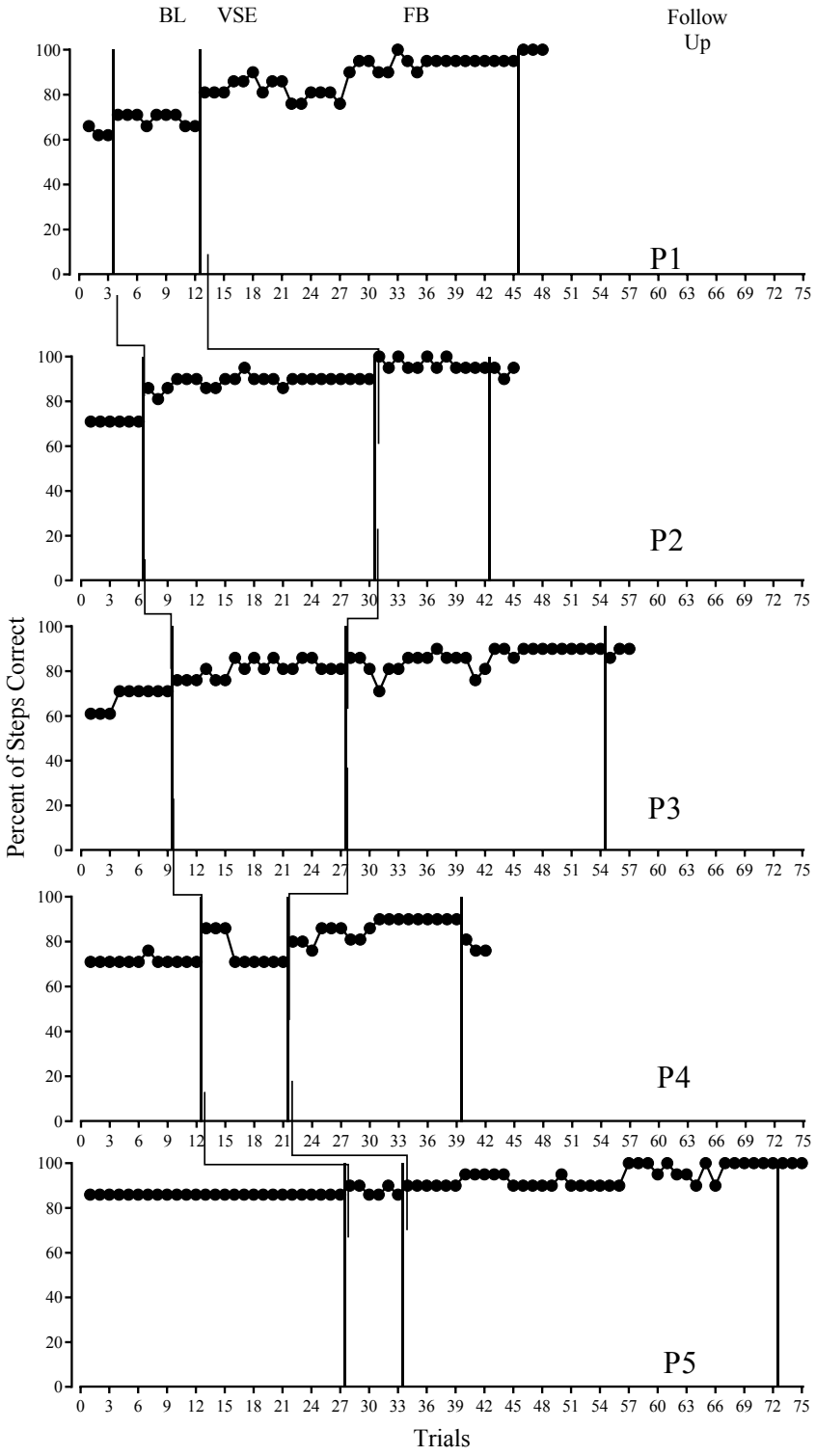

Figure 2. Shows the percentage correct of steps in the task analysis of a golf swing across baseline, video self-evaluation (VSE), and video feedback (VF) phases.

CHAPTER 9:

DISCUSSION

We evaluated whether VSE or VF was more effective for improving golf swing form. Overall we found that VSE was useful to help some participants improve their swing, only slightly useful for other participants, and not useful for one participant. On the other hand, all participants met termination criteria when using VF, and three of the participants engaged in 100% of the steps correctly during the VF intervention. Although VSE was useful for some participants, VF appears to be a necessary intervention when helping to maximally improve a golf swing.

One interesting point was how much two of the participants improved during VSE, when others only improved minimally, if at all. One hypothesis is that the two participants who improved during VSE might have had experience using VSE in different settings. For example, P3 used to be a professional baseball player and had spent many hours evaluating his baseball swing via VSE. Thus, the ability of evaluating his baseball swing might have generalized to evaluating his golf swing.

As was noted, P4 was the only participant who stated that he thought VSE was more useful than VF, although his data are clearly suggestive that VF was much more effective. Anecdotally, P4 did not enjoy being told to change certain aspects of his swing as he stated it decreased the distance he was able to hit the ball. In golf, distance is not very important if one cannot hit the ball straight. However, P4 seemed to care more about distance over straightness of shot. This can be seen in the secondary measure, as he hit the ball straighter 11% more often

during the intervention phases compared to baseline and follow up, but he had less consistent good contact during intervention; this would decrease distance, as good contact and swing speed is what generates farther distances. This decrease in good contact during intervention is usually not seen when looking at the last trials of each phase. However, it is not unexpected, as any time athletes change their mechanics (swing form), overall performance is adversely effected for a short time.

Each golfer's swing form improved over the course of the study. Additionally, each golfer's ability to strike the ball correctly improved over the course of the study. Anecdotally, P3 did not get a ball off of the ground during his warm-up swings during baseline, and only got one ball off of the ground during his baseline assessments. However, by the end of the study, the participant was regularly stroking good balls. Furthermore, as a validation measure, a professional golfer empirically identified each golfer besides P2 as improving over the course of the intervention. The golf pro made several comments explaining his rating system. He noted that a score from 18 to 21 would indicate a professional golfer, and he also mentioned that he adjusted the ratings based on his perceived athletic prowess of each participant. Although the golf pro was instructed to only look at overall swing mechanics, he stated that he also evaluated contact and different parts of the swing plane that were not evaluated with the task analysis.

Overall we found that all participants started with high baselines, as each participant knew how to swing a golf club to some extent. Although VSE can be useful at improving golf swing form, VF helped all participants improve their swing form. Therefore, VF was the more proficient intervention, as all participants reached mastery criteria or surpassed mastery criteria in the VF phase. Furthermore, a golfer's overall game can be improved with the help of these

interventions as is shown via the secondary measures. A professional golfer validated the task analysis and intervention effects, and all participants reported enjoying participating in the study.

CHAPTER 10:

EXPERIMENT 3: BST COMPONENTS WITH FOOTBALL TACKLING SKILLS

The purpose of experiment 3 was to evaluate the separate effects of antecedent instructions and modeling and consequence feedback for the improvement in football tackling form of young children.

CHAPTER 11:

METHOD

Subjects

Three typical developing and functioning football players participated in the study. Participant 1 (P1) was 9 years old, P2 was 9 years old, and P3 was 8 years old. Each player played on both offense and defense. Participants were recruited from a community Pop Warner affiliated program. Pop Warner refers to a nonprofit organization that provides different opportunities such as American Football to children ages 5 to 16 in the United States. Pop Warner football is basically the same as all American football, but there is a mandatory play rule that ensures coaches play every player on the team during a game. For this study, the team coaches referred players who might benefit from additional behavioral techniques and who met the following criteria: (a) were identified by the coach not to have mastered the target tackling skills, (b) had practice or in-game football tackling experience, (c) had little to no previous exposure to behavioral skills training, and (d) were interested in being trained to improve their safe-tackling form. One participant was dropped during this study because he engaged in maladaptive behavior while at school. As a result, the participant's mother would not let him finish the study. Prior to conducting the study, the researcher provided a brief explanation of the study to coaches and parents and reviewed consent forms with those who wished to participate. The parent or guardian of each participant provided informed consent, and each participant's assent was obtained.

Setting and Materials

The setting was a local Pop Warner practice field. The playing field was of approximately standard Pop Warner measurements (80 yds. in length and 70 yds. in width, with an additional 8 yds. for each end zone). Overall, the park was much larger, and multiple local teams shared a number of fields. However, actual tackling drills during which the experimental sessions were conducted occurred in a coned-off area approximately 10 yds. in length and width.

All participants were required to wear standard football equipment for every practice and experimental session (i.e., helmet, pads, cleats, and mouth piece). A foam prop about 4 ft. tall and 1 ft. wide was used as a faux football player allowing participants to practice proper tackling technique during training sessions. An iPad was be used to record all sessions for assessment purposes.

Response Measurement and Interobserver Agreement

The behavior being measured was tackling form (i.e., the movements of the defensive player as he approaches and makes contact with the offensive player to bring the offensive player to the ground). Stokes et al. (2010) previously created a task analysis that was demonstrated to measure safe-tackling technique, and it was based on recommendations from the American Football Coaches Association and USA Football. Using an empirically established task analysis (see Appendix F) increases the social validity of the experiment. One trial consisted of a player with the ball running toward the participant and the participant tackling the player with the ball. Correct tackling form consisted of ten steps in two main phases: the ready position, and the tackling position. A video recording was taken of all tackle trials. Additionally, all measurement procedures described by Tai and Miltenberger (2017) were conducted similarly in this study, in

that steps completed correctly and incorrectly were scored and turned into a percentage of steps competed correctly.

Independent researchers (two undergraduate students) assessed 30% of all tackles for each participant and reviewed them using the task analysis to assess correct form. To calculate IOA, the number of agreements between the observers on task analysis steps was divided by the number of task analysis steps.

In the latter half of the study, the task analysis steps were modified to include nine versus 10 steps. The change occurred at session 23 for P1, session 18 for P2 and session 20 for P3. The modification occurred because the coaches no longer wanted the subjects to take the player with the ball to the ground in each tackle (task analysis step 10) to help avoid injury. Therefore, after the change, percentages were based on nine steps rather than 10 steps.

Social Validity

Social validity was assessed with each participant at the conclusion of the study. This was done using a seven-question survey with the first six questions being answered on a 7-point Likert scale (see Appendix F). Socially validity assessed treatment acceptability by the participants.

Design and Procedure

A multiple baseline design across participants with an ABC sequence was used to evaluate the relative contributions of antecedent instructions and modeling versus consequent feedback to improving tackling performance for each participant. The experimental conditions included baseline, instruction and modeling, and rehearsal and feedback. For participants whose tackling performance did reach 90% following instruction and modeling or data were exhibiting a trend counter to the desired direction, then rehearsal and feedback was introduced in

accordance with a multiple-baseline design. Once a player was consistently performing above the 90% mark for at least three consecutive sessions, then the intervention was stopped and a follow-up phase was conducted after a minimum of 2 weeks of no intervention.

Baseline. Baseline data were collected during normal practice routines. During practice, participants competed in tackling drills in which two players stood about 3 m apart, and one player held a football. The other player then attempted to tackle the ball carrier as the ball carrier ran toward and attempts to avoid the tackler. The form used to tackle the ball carrier was video recorded and scored using the task analysis to assess the number of steps correctly completed. The goal was to have each participant do this three times in each assessment session, but the number varied depending on time restrictions due to evening practices. The experimenter did not provide any specific instruction or feedback during this phase. However, coaches were instructed to not change how they normally coached, and typical practice included the coaches providing some instruction and some feedback.

Instruction and modeling. During this phase, the researcher modeled the correct tackling form with a foam dummy and provided specific instruction regarding tackling that covered all steps in the task analysis. Afterwards, the participants were given an opportunity to demonstrate their tackling ability using a foam dummy. This process was completed three times. No additional verbal instruction or feedback were provided during tackling exercises, but the participants were asked to do as the researcher showed and instructed. After modeling and instruction was completed, each participant attempted around three tackles for assessment and the session was over. All assessment tackles were video recorded. These sessions lasted approximately 20 min. This phase continued until progress stopped, the participant was

consistently completing 90% or more of the steps correctly, or correct performance was trending downward.

Rehearsal and feedback. During this phase, the researcher had the participant attempt a tackle using the foam dummy. The researcher then provided immediate feedback consisting of praise for each steps of the task analysis the participant did correctly and further instruction for each step of the task analysis the participant did incorrectly. This process was completed three times. No additional vocal instruction or modeling was provided during these tackling exercises, but the participants were asked to attempt to correct what they did incorrectly after each feedback trial. Once the three feedback trials were completed, each participant attempted around three tackles for assessment and the session was over. These sessions lasted approximately 20 min. This phase continued until the participant consistently completed at least 90% of the steps correctly.

Follow up. The follow-up phase was conducted exactly how the baseline phase was conducted. After a minimum of 2 weeks of not being in the intervention, the participant was asked to make three tackles during practice drills. The participants were be provided any instruction, modeling, or feedback during these sessions.

CHAPTER 12:

RESULTS

All results across participants are demonstrated in Figure 3. As can be seen, instructions and modeling increased performance for one of three participants and rehearsal and feedback increased performance for all three. Participant 1 (P1) completed an average of 30% of steps correct during baseline, 38.3% of steps correct during the antecedent phase, and 94.2% during the consequence phase (note; the last six to nine trials were used to calculate the mean in intervention phases). P2 completed an average of 27% of steps correctly during baseline, 67.5% of steps correct during the antecedent phase, and 94.7% during the consequence phase. P3 completed an average of 22% of steps correctly during baseline, 31.6% of steps correct during the antecedent phase, and 64.8% during the consequence phase.

IOA was calculated for 33% of total trials. IOA was 85% (range 70-100%) for P1, 89% (range 80-100%) for P2, and 86% (range 66-100%) for P3. Total IOA across all participants was 86.2%. Procedural fidelity, as assessed by coaches in 36% of sessions, was 100%. A questionnaire was provided to all players to assess the social validity of the study. Seven questions were asked using a Likert scale from 1 to 7. When asked if they thought the study was useful for improving overall tackling form, the average answer was a 6.3. When asked if they thought instruction and modeling was useful at improving their form, the average answer was a 6.3. When asked if they thought direct feedback was useful, the average answer was a 7. When asked if they enjoyed participating in the study the average answer was a 6.3. When asked if they would recommend others participate in similar studies, the average answer was a 7. When

asked if they thought they were a better football player as a result of their participation, the average answer was a 6. Lastly, one subject identified instruction and modeling as the more beneficial intervention, with the other two identifying direct feedback.

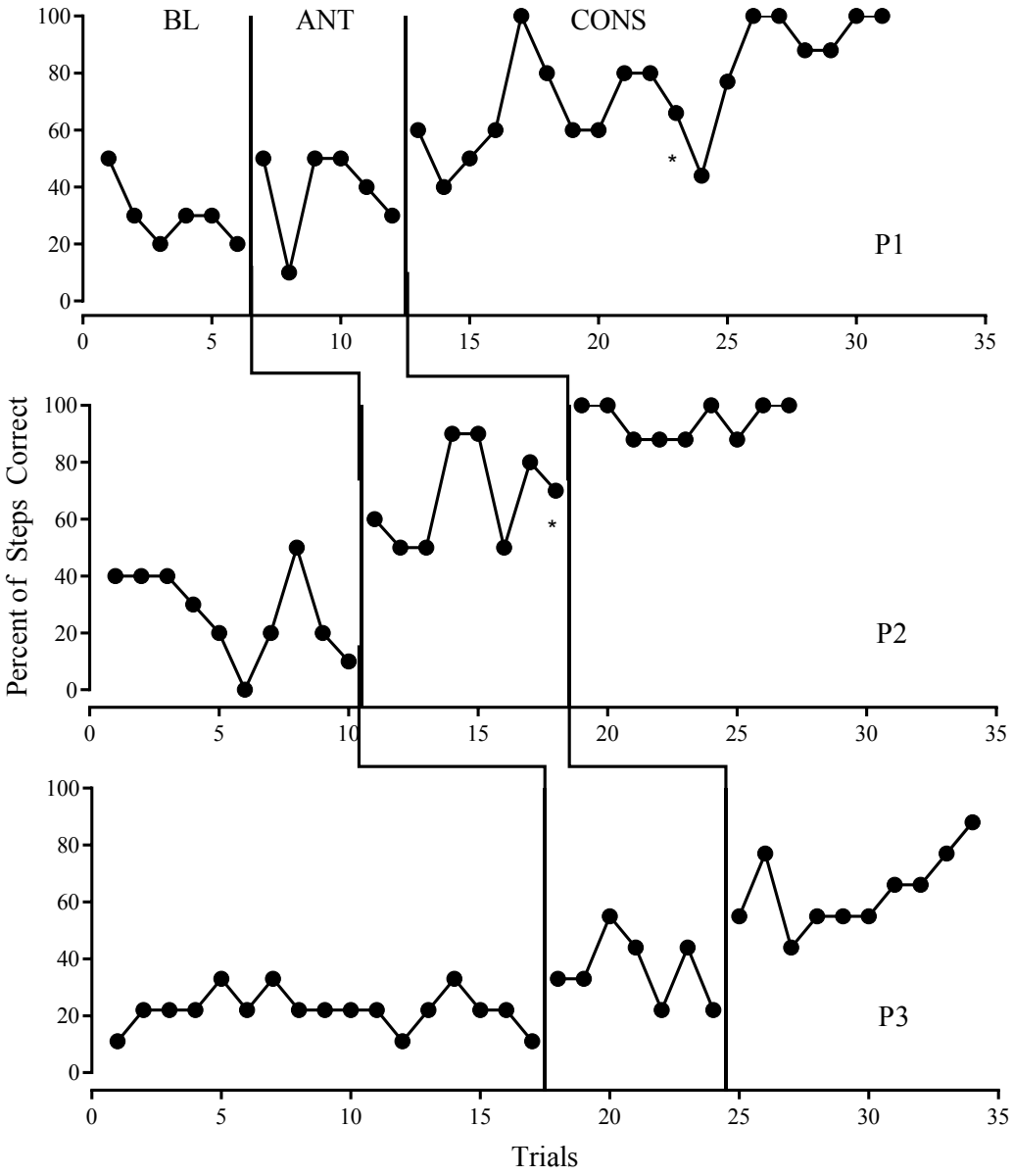

Figure 3. Shows the percentage correct of steps in the task analysis of a football tackle across baseline, instruction (INST), and feedback (FB) phases. The * indicates a change in the task analysis.

CHAPTER 13:

DISCUSSION

We evaluated whether antecedent or consequence components of a BST procedure were more effective for improving tackling form. Overall we found that instruction and modeling were useful to help participants improve their tackling. However, the rehearsal and feedback components of BST appear to result in the greatest improvement in form. Therefore, feedback following behavior seems to be more effective regarding enhancing performance.

An interesting finding was the tendency for participants' performance to peak and then regress over the course of the antecedent phase of the intervention. One potential explanation for this is that instruction and modeling helps improve behavior as the kids are young and have little experience playing tackle football when wearing pads. Therefore, behavior improves at first, but it begins to regress because of a lack of consequences (i.e., feedback). Thus, as seen in figure 3, performance is substantially enhanced once feedback is provided.

One potential limitation of this study was time restraints and the number of trials completed during each session. After some practices, parents and coaches needed to leave. As a result, they cancelled the session after as few as one trial. Furthermore, some sessions had 6 trials during the session. These extra trials were done for a number of reasons. For example, P3 engaged in 6 trials during his first session because the coach asked if it was okay if he made "a few more tackles." Also, P2 engaged in nine trials during his last session in order to conclude the study due to experimenter deadlines. Although these variations in trials might potentially improve performance due to practice effects, or worsen performance due to fatigue effects, it is

unlikely that this was a problem. If either of the effects occurred, the effects would be apparent in the data. Yet, no trends or level changes appear evident as a result of differing session lengths.

Each player's tackling form improved over the course of the study. All participants were able to improve tackling form with a maximum of 34 trials and a minimum of 27, but P1 needed 19 consequence trials, while P2 and P3 needed a maximum of 10 trials to demonstrate a performance. Anecdotally, this is likely because of expressed interest in research sessions. This is supported in that P1 answered with a five out of seven on the social validity survey regarding how much he enjoyed participating in the study.

Overall we found that all participants started with intermediate to low baselines, as each participant was relatively new to tackling when wearing pads. Although instruction and modeling are useful at improving tackling form, it does not seem to maintain behavior without consequences. Therefore, feedback following behavior was the more effective intervention, as all participants reached mastery criteria in the consequences phase. Because of problems related to potential injuries in full-contact sports such as football, future considerations should be made regarding how to further increase the safety of all players and all research procedures. However, all participants reported enjoying participating in the study, and no participants were seriously injured while participating in this study.

CHAPTER 14:

GENERAL DISCUSSION

We evaluated the effectiveness of different common interventions to enhance performance in sports. Overall, we found that antecedent-based interventions were less effective compared to consequence-based interventions. Additionally, we found that more experimenter involvement usually produced better improvement. Although performance improved for all participants, related outcome measures did not always improve. For example, when teaching proper pitching form to kids, their form substantially improved over the course of the intervention. However, the number of strikes thrown did not improve for two of the three participants. That said, when teaching proper swing form to golfers, their ability to make good contact with the ball and hit the ball straight did improve along with their form.

One potential explanation as to why antecedent interventions seem less effective compared to consequence interventions is that we are working at enhancing performance and improving a skill that is already in their behavioral repertoire, as opposed to skill acquisition. For example, if someone were to be learning a new skill, he or she would likely need ample instruction and modeling in order for him or her to begin attempting the behavior. Without instruction, he or she would likely not be able to identify the correct behavior. However, once he or she can identify the correct behavior, then different consequences can shape and maintain that behavior. Alternatively, consequent approaches may be more effective than antecedent approaches, even for skill acquisition, because an instructional component is involved in each of the consequent procedures. In video feedback, in addition to praise for correct steps, there is

further instruction for improvement in the next rehearsal. In the rehearsal and feedback component of BST, likewise, feedback consists of praise for correct performance and instruction for improvement in the next rehearsal. Therefore, both forms of feedback have inherent instructional components. Auditory feedback is the one feedback procedure that does not have an instructional component, but it usually is used in conjunction with instructions and or modeling (e.g., Quinn et al., 2015).

It is perhaps intuitive that more experimenter involvement usually produces greater enhancement of performance. Although people can effectively provide their own prompts and consequences, having another individual to provide additional feedback or consequences is often more effective (Van Houten, 1984). For example, Skinner, Shapiero, Turco, Cole, and Brown (1992) demonstrated that both self-feedback and peer feedback were effective procedures to improve school children's multiplication performance. That said, some people seem to be better than others at identifying the correct or incorrect aspects of their behavior. These people might need less feedback from others compared to those who are not as keen at identifying correct and incorrect aspets of their own performance. However, an argument stating some individuals need not experience contingencies mediated by others is not being made here; more research is needed to evaluate this phenomenon.

Over the course of these studies several difficulties occurred. First, some parents and coaches appeared hesitant to allow participation during sessions for various reasons. One participant was dropped from study 1 due to his parents stopping communication with the experimenter. His parents became upset with the specific Little League ballpark due to playing time, and they went to play baseball with another team. Although their home environment remained consistent, they refused to work with anyone related to the original park. Second,

some coaches did not fully understand single-subject methodology and wanted the experimenter to work with all athletes on the team. After single-subject research designs were further explained, they became more hesitant to allow sessions during practices. This occurred despite meetings and informed consent being delivered as required by the IRB.

Third, there is a necessary time sensitivity regarding the coaches, parents, and young athletes. Because both football and baseball practice are held in the evening for kids during weekdays, parents would often state that the participants did not have time that evening due to their nightly routine and subsequent school day. Additionally, there were multiple occasions in which sessions were cut short (to as few as 1 trial) because the coach deemed practice more important than research. Although this did not seem to affect the results of any study, it did increase the amount of time needed to complete the studies. Fourth, because all studies were conducted with sports that are played outside, nearly 30% of sessions were cancelled due to inclement weather. Thus, adding parent and coach hesitance, time constraints of practice and families, and weather, each study lasted between 1 to 2 years.

One interesting experience in the football study was the occurrence of participants engaging in behavior not coherent with the TA because an alternative behavior would result in different reinforcement (i.e., they engaged in horseplay). As a result, several data points do not depict relevant behavior because sometimes the participants would engage in horseplay instead attempting to engage in the proper behavior. As a result, of these difficulties, both the football and baseball studies were prolonged.

One important aspect of research involving performance enhancement in sports is that no reinforcers other than praise were offered for participation. This is likely because participation in sports produces reinforcement for most individuals when a skill is completed correctly. For

example, the golfer contacts reinforcement by seeing the golf ball fly high through the air and travel a far distance. The baseball player contacts reinforcement when the ball is thrown at a high speed in the correct spot. The football player contacts reinforcement every time he or she makes a tackle and stops the ball carrier. As a result, perhaps no other reinforcement need be provided to an athlete invested in their sport. Of course, a coach or experimenter is still important as young athletes need to learn all the steps in their specific skills before they can be expected to execute them correctly and contact reinforcement. Furthermore, once they have learned skills, they often do not identify their incorrect behavior, or their deficits in performance, and thus need feedback from a coach to correct errors and maintain consistent performance. But it is important to note that the inherent motivation for most athletes to improve or perform well can help take some of the burden off the experimenter trying to recruit participants.

Another important consideration is differences across individuals. Although many of the data paths across the studies look similar, they are slightly different for each participant. For example, in study 2, P5 had an extremely high baseline - correctly completing 18 of the 21 steps consistently. Yet, the intervention still helped this participant correctly complete 100% of the steps consistently: although some participants do not begin at the same level, a participant can still benefit from the intervention. Also, some participants learned very quickly, while others seemed to need more sessions than others. For example, in study 2, P2 needed four fewer sessions in total compared to P3, even though P3 began VF before P2. Thus, it is important to recognize differences among athletes when conducting sports related research, as some have more or less to learn than others, and others will improve their skills more or less quickly.

One limitation in the current studies is the possibility of sequence effects. In each study, the more efficient antecedent intervention preceded the consequence intervention. Although the

consequence intervention did not include the antecedent intervention components, the fact that the antecedent intervention always preceded the consequent interventions could have influenced the effectiveness of the consequence intervention. In future studies, one way to avoid this possible confound of sequence effects would be to compare antecedent and consequent interventions with two skills from the same sport (e.g., two similar dance movements) in an alternating treatment design.

Another limitation of this study is that the experimenter conducted all sessions. This has the potential of resulting in poor generalizability, as different people provide instruction and feedback differently; two people could potentially say the same thing to a participant and have completely different effects. Thus, different experimenters might affect behavior differently. It seems important for an experimenter to establish rapport with participants to enhance the likelihood of feedback functioning as a reinforcer and promoting increases in performance. Rapport can be established by engaging in positive interactions with the participants to establish oneself as a conditioned reinforcer and by establishing one's credibility as an expert (or at least accomplished or proficient) in the particular sport. Another limitation is the possibility of inaccurate feedback. This is especially true when conducting BST sessions. For example, in study 3, the experimenter would watch a tackle and provide immediate feedback on the tackle by following the task analysis. However, this must involve some degree of recall as there is no recording viewed during BST training sessions. In studies 2 and 3, VF was used, which potentially functioned as a prompt to help the experimenter provide more accurate feedback. Therefore, future research could look into the accuracy of feedback and ways to improve it.

Overall we found that some interventions are more effective than others when attempting to enhance sports-related performance, and several considerations should be made when

conducting similar research. Because of this, it does not seem to be efficient for the experimenter or the athlete to use complicated multicomponent interventions when a single intervention should be effective. Furthermore, the specific skill should be considered when choosing the intervention. If the skill is not in an individual's repertoire, then some instruction and modeling should benefit the athlete. However, if an individual already engages in the skill to a fairly high degree, then some simple feedback techniques to help the athlete learn what he or she is doing correctly or incorrectly should be advised. Also, before starting a sports-related research project one must consider all of the potential difficulties that might be encountered during the study. By considering these aspects of sports-performance-enhancement research, applying ABA principles to sports-related behaviors will continue to become more popular and more effective.

REFERENCES

Aiken, C. A., Fairbrother, J. T., & Post, P. G. (2012). The effects of self-controlled video feedback on the learning of the basketball set shot. *Frontiers in Psychology, 3*, 338-345. doi: 10.3389/fpsyg.2012.00338

Alferink, L. A., Critchfield, T. S., Hitt, J. L., & Higgins, W. J. (2009). Generality of the matching law as a descriptor of shot selection in basketball. *Journal of Applied Behavior Analysis, 42*, 595–608. doi: 10.1901/jaba.2009.42-595

Allen, K. D. (1998). The use of an enhanced simplified habit-reversal procedure to reduce disruptive outbursts during athletic performance. *Journal of Applied Behavior Analysis, 31*, 489–492. doi: 10.1901/jaba.1998.31-489

Baudry, L., Leroy, D., & Chollet, D. (2006). The effect of combined self-and expert-modelling on the performance of the double leg circle on the pommel horse. *Journal of Sports Sciences, 24*, 1055-1063. doi: 10.1080/02640410500432243

BenitezSantiago, A., & Miltenberger, R. G. (2016). Using video feedback to improve martial arts performance. *Behavioral Interventions, 31*, 12-27. doi: 10.1002/bin.1424

Boyer, E., Miltenberger, R. G., Batsche, C., & Fogel, V. (2009). Video modeling by experts with video feedback to enhance gymnastics skills. *Journal of Applied Behavior Analysis, 42*, 855-860. DOI: 10.1901/jaba.2009.42-855

Christina, R. W., Barresi, J. V., & Shaffner, P. (1990). The development of response selection accuracy in a football linebacker using video training. *The Sport Psychologist, 4*, 11-17. doi: 10.1123/tsp.4.1.11

Crews, D. J., & Boutcher, S. H. (1986). An exploratory observational behavior analysis of professional golfers during competition. *Journal of Sport Behavior, 9*, 51-58.

Downs, H. E., Miltenberger, R., Biedronski, J., & Witherspoon, L. (2015). The effects of video self-evaluation on skill acquisition with yoga postures. *Journal of Applied Behavior Analysis, 48*, 930-935. doi: 10.1002/jaba.248

Fitterling, J. M., & Ayllon, T. (1983). Behavioral coaching in classical ballet enhancing skill development. *Behavior Modification, 7*, 345-368. doi: 10.1177/01454455830073004

Fogel, V. A., Weil, T. M., & Burris, H. (2010). Evaluating the efficacy of tagteach as a training strategy for teaching a golf swing. *Journal of Behavior Health and Medicine, 1,* 25-41. doi: 10.1037/h0100539

Gross, A., Miltenberger, R., Knudson, P., Bosch, A., Breitwieser, C. B. (2007). Preliminary evaluation of a parent training program to prevent gun play. *Journal of Applied Behavior Analysis, 40*, 691–695. doi: 10.1901/jaba.2007.691-695

Hazen, A., Johnstone, C., Martin, G. L., & Skrikameswaran, S. (1990). A videotaping feedback package for improving skills of youth competitive swimmers. *The Sport Psychologist, 4*, 213–227. doi: 10.1123/tsp.4.3.213

Heward, W. L. (1978). Operant conditioning of a .300 hitter?: The effects of reinforcement on the offensive efficiency of a barnstorming baseball team. *Behavior Modification, 2*, 25-40. doi: 10.1177/014544557821002

Hume, K. M., & Crossman, J. (1992). Musical reinforcement of practice behaviors among competitive swimmers. *Journal of Applied Behavior Analysis, 25*, 665-670. doi: 10.1901/jaba.1992.25-665

Iwata B. A, Wallace M. D, Kahng S, Lindberg J. S, Roscoe E. M, Conners J, et al. (2000). Skill acquisition in the implementation of functional analysis methodology. *Journal of Applied Behavior Analysis, 33*, 181–194. doi: 10.1901/jaba.2000.33-181

Johnson B. M, Miltenberger R. G, Egemo-Helm K, Jostad C. M, Flessner C, Gatheridge B. (2005). Evaluation of behavioral skills training for teaching abduction-prevention skills to young children. *Journal of Applied Behavior Analysis, 38*, 67–78. doi: 10.1901/jaba.2005.26-04

Kearns, D. W., & Crossman, J. (1992). Effects of a cognitive intervention package on the free-throw performance of varsity basketball players during practice and competition. *Perceptual and Motor Skills, 75*, 1243-1253. doi: 10.2466/pms.1992.75.3f.1243

Kelley, H., & Miltenberger, R. G. (2016). Using video feedback to improve horseback riding skills. *Journal of Applied Behavior Analysis. 49*, 138-147. doi: 10.1002/jaba.272

Kladopoulos, C. N., & McComas, J. J. (2001). The effects of form training on foul-shooting performance in members of a women's college basketball team. *Journal of Applied Behavior Analysis, 34*, 329–332. doi: 10.1123/tsp.12.3.271

Komaki, J., & Barnett, F. T. (1977). A behavioral approach to coaching football: Improving the play execution of the offensive backfield on a youth football team. *Journal of Applied Behavior Analysis, 10*, 657-664. doi: 10.1901/jaba.1977.10-657

Kutz, S. (2017). $100 billion – That's how much Americans spent on sports in the last 12 months. *MarketWatch.* Retrieved from https://www.marketwatch.com/story/heres-how-much-americans-spend-on-sports-in-one-chart-2017-09-11

Lacy, A. C., & Goldston, P. D. (1990). Behavior analysis of male and female coaches in high school girls' basketball. *Journal of Sport Behavior, 13*, 29-39. doi: 10.1123/tsp.13.1.29

Landin, D., & Hebert, E. P. (1999). The influence of self-talk on the performance of skilled female tennis players. *Journal of Applied Sport Psychology, 11*, 263-282. doi: 10.1080/10413209908404204

Lerner, B. S., Ostrow, A. C., Yura, M. T., & Etzel, E. F. (1996). The effects of goal-setting and imagery training programs on the free-throw performance of female collegiate basketball players. *The Sport Psychologist, 10,* 382-397. doi: 10.1123/tsp.10.4.382

Little, L. M., & Simpson, T. L. (2000). An acceptance-based performance enhancement intervention for collegiate athletes. In M. J. Dougher (Ed.), *Clinical behavior analysis.* (pp. 231-244). Reno, NV, US: Context Press.

Maryam, C., Yaghoob, M., Darush, N., & Mojtaba, I. (2009). The comparison of effect of video-modeling and verbal instruction on the performance in throwing the discus and hammer. *Procedia Social and Behavioral Sciences, 1*, 2782-2785. doi: 10.1016/j.sbspro.2009.01.493

Mellalieu, S. D., Hanton, S., & O'Brien, M. (2006). The effects of goal setting on rugby performance. *Journal of Applied Behavior Analysis, 39*, 257-261. doi: 10.1901/jaba.2006.36-05

Miles, N. I., & Wilder, D. A. (2009). The effects of behavioral skills training on caregiver implementation of guided compliance. *Journal of Applied Behavior Analysis*, *42*(2), 405-410. doi: 10.1901/jaba.2009.42-405

NPR, Robert Wood Johnson Foundation, Harvard T. H. Chan School of Public Health. (2015). *Sports and health in America* [Data file]. Retrieved from https://media.npr.org/documents/2015/june/sportsandhealthpoll.pdf

O'Brien, R. M., & Simek, T. C. (1983). A comparison of behavioral and traditional methods for teaching golf. In G. L. Martin & D. Hrycaiko (eds.). *Behavior Modification and Coaching; Principles, Procedures, and Research* (pp. 175-186). Springfield, IL: Charles C. Thomas.

Osborne, K., Rudrud, E., & Zezoney, F. (1990). Improved curveball hitting through the enhancement of visual cues. *Journal of Applied Behavior Analysis, 23*, 371–377. doi: 10.1901/jaba.1990.23-371

Partington, M., Cushion, C. J., Cope, E., & Harvey, S. (2015). The impact of video feedback on professional youth football coaches' reflection and practice behaviour: A longitudinal investigation of behaviour change. *Reflective Practice, 16*, 700-716. doi:10.1080/14623943.2015.1071707

Polaha, J., Allen, K., & Studley, B. (2004). Self-Monitoring as an Intervention to Decrease Swimmers' Stroke Counts. *Behavior Modification, 28*, 261-275. doi: 10.1177/0145445503259280

Quinn, M., Miltenberger, R., Abreu, A., & Narozanick, T. (2017). An intervention featuring public posting and graphical feedback to enhance the performance of competitive dancers. *Behavior Analysis in Practice, 10*, 1-11. doi: 10.1007/s40617-016-0164-6

Quinn, M. J., Miltenberger, R. G., & Fogel, V. A. (2015). Using TAGteach to improve the proficiency of dance movements. *Journal of Applied Behavior Analysis, 48*, 11-24. doi: 10.1002/jaba.191

Reed, D. D. (2011). Quantitative analysis of sports. In J. K. Luiselli, D. D. Reed (Eds.), *Behavioral sport psychology: Evidence-based approaches to performance enhancement*. (pp. 43-59). New York, NY, US: Springer Science + Business Media.

Reitman, D., Hupp, S. D. A., O'Callaghan, P. M., Gulley, V., & Northup, J. (2001). The influence of a token economy and methylphenidate on attentive and disruptive behavior during sports with ADHD-diagnosed children. *Behavior Modification, 25*, 305-323. doi: 10.1177/0145445501252007

Rikli, R., & Smith, G. (1980). Videotape feedback effects on tennis serving form. *Perceptual and Motor Skills, 50*, 895-901. doi: 10.2466/pms.1980.50.3.895

Roane, H. S., Kelley, M. E., Trosclair, N. M., & Hauer, L. S. (2004). Behavioral momentum in sports: A partial replication with women's basketball. *Journal of Applied Behavior Analysis, 37*, 385-390. doi:10.1901/jaba.2004.37-385

Romanowich, P., Bourret, J., & Vollmer, T. R. (2007). Further analysis of the matching law to describe two- and three-point shot selection by professional basketball players. *Journal of Applied Behavior Analysis, 40*, 311–315. doi: 10.1901/jaba.2007.119-05

Rushall, B. S., & Pettinger, J. (1969). An evaluation of the effects of various reinforcers used as motivators in swimming. *Research Quarterly, 40*, 540–545.

Rushall, B. S., & Smith, K. C. (1979). The modification of the quality and quantity of behavior categories in a swimming coach. *Journal of Sport Psychology, 1*, 138-150. doi: 10.1123/jsp.1.2.138

Sanders, G. S., & Simmons, W. L. (1983). Use of hypnosis to enhance eyewitness accuracy: Does it work?. *Journal of Applied Psychology*, *68*, 70-77. doi: 10.1037/0021-9010.68.1.70

Schenk, M. S., & Miltenberger, (2018). A review of behavioral interventions across sports. *To be Submitted to the Journal of Applied Behavior Analysis*.

Schonwetter, S., Miltenberger, R., & Oliver, J. (2014). An evaluation of self-monitoring to improve swimming performance. *Behavioral Interventions, 29,* 213-224. doi: 10.1002/bin.1387

Scott, D., & Scott, L. M., & Goldwater, B. (1997). A performance improvement program for an international-level track and field athlete. *Journal of Applied Behavior Analysis, 30*, 573–575. doi: 10.1901/jaba.1997.30-573

Scott, D., Scott, L. M., & Howe, B. L. (1998). Training anticipation for intermediate tennis players. *Behavior Modification, 22*, 243-261. doi: 10.1177/01454455980223002

Seniuk, H. A., Williams, W. L., Reed, D. D., & Wright, J. W. (2015). An examination of matching with multiple response alternatives in professional hockey. *Behavior Analysis: Research and Practice, 15*, 152-160. doi:10.1037/bar0000019

Seniuk, H. A., Witts, B. N., Williams, W. L., & Ghezzi, P. M. (2013). On Terms: Behavioral coaching. *The Behavior Analyst, 36*, 167-172. doi: 10.1007/BF03392301

Shapiro, E. S., & Shapiro, S. (1985). Behavioral coaching in the development of skills in track. *Behavior Modification, 9*, 211-224. doi: 10.1177/01454455850092005

Silva III, J. M. (1982). Competitive sport environments: Performance enhancement through cognitive intervention. *Behavior Modification, 6*, 443–463. doi: 10.1177/01454455820064001

Skinner, C. H., Shapiro, E. S., Turco, T. L., Cole, C. L., & Brown, D. K. (1992). A comparison of self-and peer-delivered immediate corrective feedback on multiplication performance. *Journal of School Psychology*, *30*, 101-116. doi: 10.1016/0022-4405(92)90024-y

Smith, R. E., Smoll, F. L., & Christensen, D. S. (1996). Behavioral assessment and intervention in youth sports. *Behavior Modification, 20*, 3–44. doi: 10.1177/01454455960201001

Smith, S. L., & Ward, P. (2006). Behavioral interventions to improve performance in collegiate football. *Journal of Applied Behavior Analysis, 39*, 385-391. doi: 10.1901/jaba.2006.5-06

Stokes, J. V., & Luiselli, J. K. (2010). Functional analysis and behavioral coaching intervention to improve tackling skills of a high school football athlete. *Journal of Clinical Sport Psychology, 4*, 150–157. doi: 10.1123/jcsp.4.2.150

Stokes, J. V., Luiselli, J. K., & Reed, D. D. (2010). A behavioral intervention for teaching tackling skills to high school football athletes. *Journal of Applied Behavior Analysis, 43*, 509–512. doi: 10.1901/jaba.2010.43-509

Tai, S. & Miltenberger, R. (2017). Evaluating behavioral skills training to teach safe tackling skills to youth football players. *Journal of Applied Behavior Analysis, 50,* 849-855. doi: 10.1002/jaba.412

Templin, D. P., & Vernacchia, R. (1995). The effect of highlight music videotapes upon the game performance of intercollegiate basketball players. *The Sport Psychologist, 9,* 41-41. doi: 10.1123/tsp.9.1.41

Van Houten, R. (1984). Setting up performance feedback systems in the classroom. In W. L. Heward, T. E. Heron, J. Trap-Porter, & D.S. Hill (Eds.), *Focus upon applied behavior analysis in education* (pp. 114-125). Columbus, OH: Charles Merrill.

Van Wieringen, P. C. W., Emmen, H. H., Bootsma, R. J., Hoogesteger, M., & Whiting, H. T. A. (1989). The effects of video-feedback on the learning of tennis service by intermediate players. *Journal of Sports Sciences, 7*, 153-162. doi: 10.1080/02640418908729833

Virués-Ortega, J., & Martin, G. L. (2010). Guidelines for sport psychologists to evaluate their

interventions in clinical cases using single-subject designs. *Journal of Behavioral Health and Medicine, 3*, 158–171. doi: 10/1037/h0100549

Vollmer, T. R., & Bourret, J. (2000). An application of the matching law to evaluate the allocation of two- and three-point shots by college basketball players. *Journal of Applied Behavior Analysis, 33,* 137-150. doi: 10.1901/jaba.2000.33-137

Wack, S. R., Crosland, K. A., & Miltenberger, R. G. (2014). Using a goal-setting and feedback procedure to increase running distance. *Journal of Applied Behavior Analysis, 47*, 181–185. doi: 10.1002/jaba.108

Ward, P., Smith, S., & Sharp, T. (1997). The effects of accountability on task accomplishment in collegiate football. *Journal of Teaching in Physical Education, 17,* 40–51. doi: 10.1123/jtpe.17.1.40

Wolko, K. L., Hrycaiko, D. W., & Martin, C. L. (1993). A comparison of two self-management packages to standard coaching for improving practice performance of gymnasts. *Behavior Modification, 17*, 209-223. doi: 10.1177/01454455930172007

Ziegler, S. G. (1987). Effects of stimulus cueing on the acquisition of groundstrokes by beginning tennis players. *Journal of Applied Behavior Analysis, 20*, 405–411. doi: 10/1901/jaba.1987.20-405

APPENDICES

Appendix 1

SKILL	STEPS FOR PITCHING FROM THE WINDUP	STEP DONE CORRECTLY	
		YES	NO
SET UP	Feet shoulder width apart, perpendicular to home plate		
	Turn head and look towards home plate for at least 2 seconds		
	Hold the ball in the glove belly to chest high		
WIND UP	Lift leg closest to home plate to at least waist high, knee bent at least 45 degrees		
	Keep pitching hand in glove centered over the leg still on the ground		
	Bend the knee of the leg still on the ground		
RELEASE	Remove ball and pitching arm from glove, extending away from home plate (elbow extends past 90 degrees)		
	Lunge forward extending leg in the air towards home plate, keeping shoulders closed		
	Begin rotating hips slightly before front foot touches the ground, keeping shoulders closed		
	Front foot lands on ground with toes pointed towards home plate		
	Pitching arm moves towards home plate as front foot is landing on the ground		
	Transfer weight from back leg to front leg		
	Once the pitching arm is moving forward, begin to open up shoulders		
	Extend arm towards home plate and release baseball		
FOLLOW THROUGH	Back leg swing around and does not pass between home plate and the other foot		
Percent Correct			

Appendix 2

SKILL	STEPS FOR LONG-IRON SWING	STEP DONE CORRECTLY	
		YES	NO
SET UP	Feet are shoulder width apart		
	Ball is within 2 inches of the middle of your stance		
	Head is not moving and looking down at the ball		
BACKSWING	Begin rotation keeping arms and hips turning together		
	Keep front arm straight (between 170 and 180 degrees)		
	Keep back arm and elbow tucked close to your body so that your triceps do not leave your ribcage		
	Begin to hinge in order to help move the club shaft		
	Keep both feet (sole and heel) planted on the ground		
	Keep back leg planted with no sway during backswing		
	At top of swing, have shaft nearly parallel with your shoulders (past 45 degrees with the shaft and the ground)		
DOWNSWING	Begin downswing with arms and hips rotating together		
	Lead arm remains straight through downswing		
	Head has remained still throughout swing so far (did not move more than 1 inch)		
	Begin weight shift from back foot to your front foot		
	No substantial outside to in or inside to out swing path occurs		

	Contact is made with the ball		
FOLLOW THROUGH	Club did not slow down until after impact		
	Front foot remains flat as knee straightens out (front foot does not slide more than 45 degrees towards target)		
	Back foot comes to rest on toes and it points toward target		
	Weight is almost solely on the front leg (looks as if at least 85% of weight is on front foot)		
	The Club follows through with the shaft coming to rest outside of your head		
Percent Correct			

Appendix 3

SKILL	STEPS FOR CORRECT TACKLING	STEP DONE CORRECTLY	
		YES	NO
Feet	Feet shoulder width apart, weight on toes		
Squeeze	Squeeze shoulder blades – chest out and head up		
Bend	Knees bent to 90 degrees		
Hands	Hands open with thumbs pointed up		
Hunt	Run towards the opponent		
Buzz Feet	Buzz feet to prepare for contact with opponent		
Hit	Lead in with shoulder with head off to the side of the opponent and wrap arms around the body		
Shoot	Shoot hips upwards towards the opponents sternum		
Grab Cloth	Grab the back of the players jersey		
Drive to Ground	Straighten legs to lift opponent and drive to the ground		
Percent Correct			

Appendix 4

Social Validity Questionnaire - Baseball Video Modeling and Feedback

1 is "Definitely Not" **7** is "Most Definitely"

Did you think this study was useful at improving your overall pitching form?

1 2 3 4 5 6 7

Do you think the video-modeling portion of the study was useful at improving your pitching form?

1 2 3 4 5 6 7

Do you think the video feedback portion of the study was useful at improving your pitching form?

1 2 3 4 5 6 7

Did you enjoy participating in this study?

1 2 3 4 5 6 7

Would you recommend other individuals participate in similar pitching sessions?

1 2 3 4 5 6 7

Do you think this study made you a better baseball player overall?

1 2 3 4 5 6 7

Which portion of the study do you think is the most beneficial?

Video Modeling (VM) or **Video Feedback (VF)**

Appendix 5

Social Validity Questionnaire - Golf Video Self-Evaluation and Feedback

1 is "Definitely Not" **7** is "Most Definitely"

Did you find this study useful at improving your overall swing form?

1 2 3 4 5 6 7

Do you think the self-evaluation portion of the study was useful at improving your swing form?

1 2 3 4 5 6 7

Do you think you could accurately assess your swing form during the self-evaluation portion of the study?

1 2 3 4 5 6 7

Do you think the video feedback portion of the study was useful at improving your swing form?

1 2 3 4 5 6 7

Did you enjoy participating in this study?

1 2 3 4 5 6 7

Would you recommend other individuals participate in similar golf sessions?

1 2 3 4 5 6 7

Do you think this study made you a better golfer overall?

1 2 3 4 5 6 7

Which portion of the study do you think is the most beneficial?

Video Self-Evaluation (VSE) or **Video Feedback (VF)**

Appendix 6

Social Validity Questionnaire - Football BST Components

1 is "Definitely Not" **7** is "Most Definitely"

Did you think this study was useful at improving your overall tackling form?

1 2 3 4 5 6 7

Do you think the modeling and instruction portion of the study was useful at improving your tackling form?

1 2 3 4 5 6 7

Do you think the direct feedback portion of the study was useful at improving your tackling form?

1 2 3 4 5 6 7

Did you enjoy participating in this study?

1 2 3 4 5 6 7

Would you recommend other individuals participate in similar tackling sessions?

1 2 3 4 5 6 7

Do you think this study made you a better football player overall?

1 2 3 4 5 6 7

Which portion of the study do you think is the most beneficial?

Instruction and Modeling or **Direct Feedback**