THE EFFECTS OF TAGteach™ ON THE EXECUTION OF RESISTANCE TRAINING MOVEMENTS

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ABSTRACT

Exercise programs that utilize resistance training, a specialized type of conditioning that provides stress (resistive loads) to the muscles, have appealed to athletes and recreational participants alike, due to its documented benefits for performance and overall health. Teaching the correct form for these skills is imperative for a safe and proficient execution of these movements. TAGteach™, a form of behavioral coaching, is a procedure that utilizes immediate acoustical feedback in the form of a clicker as a reinforcer for the desired behavior. TAGteach has been successfully used to teach novel or enhance existing athletic skills in many domains such as football, dance, yoga, pitching, golf and even surgical techniques (TAGteach International, 2012). The present study employed a multiple probe across behaviors design to evaluate the effectiveness of the TAGteach method to train three resistance training movements (deadlift, overhead press, and front squat) for adult novice participants. Results demonstrated an improvement in performance of each skill from baseline probes following training. Improved performance also generalized to heavier weight than those utilized during training. This generalization is a key to achieving progressive overload as a part of the typical practice in resistance training programs.

Keywords: TAGteach, resistance training, behavioral coaching, athletics

This thesis is dedicated to

my parents who taught me what I needed to know:

embrace realistic passion,

finish what you start,

use education as a springboard for discovery, and

embrace the roadblocks as fortuitous detours.

Without these guidelines, this thesis would not exist.

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CHAPTER 1

INTRODUCTION

Strength training, or more accurately, resistance training, is a specialized type of conditioning that provides stress (resistive loads) to the muscles with the goal of increasing strength, power, and endurance (Fleck & Kraemer, 2014). The external resistance can be in the form of bodyweight (such as pull-ups and push-ups), resistance bands, weight machines (such as Nautilus® or Precor®), or free weights (such as dumbbells, barbells and kettlebells; Fleck & Kraemer, 2014). Because free weights not only strengthen primary muscles but also engage and strengthen supporting muscles, they are considered the more efficient method of producing muscle growth and power (McCaw & Friday, 1994). Free weights are also preferable to machines because they allow participants to move in three dimensions which more closely mimic our activities of daily living; for example, lifting a heavy suitcase is the same movement and pattern as lifting a barbell from the floor (McBride, n.d.). Bending to pick up a weighted object or lifting a heavy box on to an upper shelf, the myriad of resistance exercises are all based on the seven primal patterns of human movement: squat, hinge, push, pull, lunge, rotation and loaded carry/walking (McDougall, 2018). Strengthening the muscles that support these foundational movements will provide a wide range of benefits to a wide range of participants (Mazur, Yetman, & Risser, 1993).

Resistance training with free weights appeals to a wide range of participants because of its many and varied benefits (Winett & Carpinelli, 2001). Primarily, resistance training can build muscle. During these sessions, tiny muscle fiber tears are

created (called "micro-tears"); the body then utilizes amino acid (proteins) to repair this microscopic damage and rebuilds the muscle bigger and stronger to adapt to the resistive stimuli, a process called hypertrophy (Brumitt & Cuddeford, 2015). Lifters who aim for bigger muscle gains must lift heavier weights, but this pursuit is not necessary in required to reap the multitude of advantages of resistance training. In addition to the general benefit of increasing strength and fitness, participants in this exercise program are attracted to its weight management advantages as it increases metabolism and leads to fat loss (Pratley et al., 1994). More importantly, resistance training can reduce the symptoms of many chronic conditions, such as diabetes, heart disease, back pain, arthritis and depression (Seguin & Nelson, 2003). Perhaps surprisingly, this type of training has valuable benefits specifically for older adults (Seguin & Nelson, 2003). Just as resistive stress builds muscles, the same stimuli build bone tissue which triggers significant increases in bone mineral density and has been shown to reduce and/or delay the onset of osteoporosis (Watson, Weeks, Weis, Horan, & Beck, 2015). Resistance training, which reduces the speed of aging muscle loss also develops better body mechanics (i.e., stability; Clark, Clark, & Law, 2016) contributes to better balance and a reduction in the risk of falls (Liu-Ambrose et al., 2004). In addition to the many advantages of resistance training in the recreational world, there are substantial benefits for the competitive athlete and is an important adjunct training for improving performance for sport-specific athletes (Haff & Triplett, 2016).

The use of free weights can be beneficial for athletes who train for strength and power sports such as throwing events, volleyball, and American football, to name a few

(Hori, Newtown, Nosaka, & Stone, 2005). Runners, who used to "just run" in order to become better competitors, are now spending training time in the gym using free weights to increase structural fitness (Chtara et al., 2005). This cross-training approach not only grows the muscles necessary for running faster, further and for powering sprints with less fatigue, but also trains bones and tissues to withstand the sheer impact of running (Chtara et al., 2005). Weightlifting has also become an area of interest to recreational athletes in the sport of CrossFit®, a high intensity workout and competition based on functional movements that draw from the best elements of many varying athletic programs. The many benefits of free weight training have led to the growing popularity of this form of conditioning. However, the practice also has the potential for injuries (Mazur, Yetman, & Risser, 1993).

Safety is the primary concern when coaching resistance training movements to a beginner. According to a study conducted by Weisenthal, Beck, Maloney, DeHaven, and Giordano (2014) that surveyed 386 CrossFit athletes, the overall injury rate was 19.4%, with males (22.9%) being injured more frequently than females (14%). Acute (severe and sudden-onset) injuries sustained when performing weightlifting movements include strains, sprains, bone fractures, ruptured disks, and trauma to nerves (Stone et al., 1994). Acute injuries are typically sustained as a result of an athlete lifting more volume (weight) than they are capable of, or using the incorrect technique for the lift. Poor coaching, such as a providing inappropriate or ill-timed cues (Herrick & Stoessel, 1993), can cause the athlete to lose concentration during a movement which can lead to an incorrect and dangerous technique. Weightlifting athletes can also develop chronic (i.e.,

long-developing and persistent) injuries including tendinitis and bursitis; most chronic weightlifting injuries are sustained by the overuse of the body's tissues through repetitive actions (Herrick and Stoessel, 1993). These chronically recurring injuries develop over time due to the athlete using poor technique or a high intensity (amount of repetitions and sets) or volume (amount of weight; Herrick and Stoessel, 1993; Kibler, Chandler, and Strecener, 1992) or returning to training too soon after sustaining an injury (Stone et al., 1994). Injury avoidance and performance improvement is thus dependent on learning proper form from the outset of training.

Far from the old expression of "picking things up and putting them down," proper execution when weight lifting is actually a series of precise movements designed to improve performance (i.e., be able to add more weight in the future) and reduce injury (Chilibeck, Calder, Sale, & Webber, 1997). Like learning to walk prepares us for running, mastering these movements can correct muscle imbalances and weaknesses and develop neural adaptations/patterns upon which to build up to the many other variant movements that will be more complex and thus more dangerous (Chilibeck, Calder, Sale, & Webber, 1997). The American College of Sports Medicine (ACSM) offer guides, demonstrations, and information regarding safety and proper techniques for executing resistance training/lifts. These resources detail the proper technique that must be executed in order to perform a safe lift; what is not provided is a standard and systematic method for teaching and perfecting proper technique. Because there are no published standards for teaching the proper techniques of resistance training movements at the beginner level, currently used coaching strategies for teaching lifting technique vary

widely. At its simplest level, training an athlete in a new movement, such as the front squat, overhead press and the deadlift, currently relies on the coach providing verbal instruction, modeling the movement, then prompting the trainee to perform the defined basic movement patterns using simple verbal "cues" (Shapiro & Shapiro, 1985). The coach's response to athlete performance errors may include re-modeling and review, but it often includes unpleasant verbal reprimands. The focus of the training feedback on lifting technique is on correcting the global aspect of skill acquisition (e.g., the athlete successfully lifts the barbell) rather than providing immediate feedback on the smaller skills that comprise the lift. Such nonspecific coaching feedback can hinder skill acquisition (Shapiro & Shapiro, 1985). Imprecise training not only increases the likelihood of injury, it also decreases the athlete's ability to achieve his or her performance proficiency. Neither of these damaging outcomes will serve to increase or maintain participation in the sport for either the athlete or the coach. The impetus for expanding interest and participation must start with the coaches; addressing their lack of confidence in traditional coaching techniques is an imperative. This can be especially true for sport-specific coaches who want to include resistance training in their athletes' overall training program.

Although there are many benefits to incorporating resistance training movements into a training program for other sports, many coaches are hesitant to utilize them because they do not know how to teach their athletes the proper technique (Stone, Fry, Ritchie, Stoessel-Ross and Marsit, 1994). A coach's hesitation to teach resistance training movements is justified when considering that coaching proper technique is the

most important factor in preventing injuries (Stone, Fry, Ritchie, Stoessel-Ross & Marsit, 1994). The worst-case scenario arises when untrained or improperly trained coaches attempt to train athletes in these potentially injurious movements without standard coaching guidelines. For both the untrained coaches and the coaches looking for a more safe, effective, and consistent method of coaching, the three basic resistance training techniques outside of elite-level programs, a new approach utilizing existing behavioral coaching techniques specifically applied to this sport may be efficacious.

Behavioral coaching utilizes the basic tenet of operant conditioning: using reinforcement/consequences to control behaviors (Skinner, 1938). Skinner posited that behavior that is reinforced increases and behavior that is not reinforced is likely to decrease. Athletic skills training using these core principles emphasizes reinforcement of correct performance, while de-emphasizing punishing incorrect performance. While traditional coaching employs an emphasis on error-correction with negative punishment, behavioral coaching offers a positive, less aversive, and expectedly more productive learning environment for both the athlete and coach.

This instructive approach to athletic skills training has evolved over the last 45 years, from the inception of the behavioral coaching concept by Rushall and Siedentop (1972), to the procedural refinement of adding acoustical guidance (to behavioral coaching), to the development of a total treatment "package," TAGteach. This broadly applicable teaching method as applied to coaching, consists of a standardized teaching method that uses a clicker as the immediate auditory feedback. TAGteach is the most recent advancement in the field of behavioral coaching and has sought to address the

limitations of its predecessors while preserving and improving upon the core goals of behavioral coaching: to provide the most safe, positive, effective, standard and expeditious form of sports skills training.

CHAPTER 2

REVIEW OF LITERATURE

Behavioral Coaching

Rushall and Siedentop (1972) recommended using behavior modification principles could be effective for athletic coaches for improving the performance of their athletes. Based on that recommendation, Martin and Hrycaiko (1983) identified six defining characteristics that align with the seven dimensions of applied behavior analysis as defined by Baer, Wolf and Risley (1968). The six defining characteristics of behavioral coaching are as follows: (1) measurement of athletic performance, (2) distinction between developing and maintaining behavior, (3) encouragement to improve against performance, (4) emphasis on coaching as a science, (5) behavior modification for the coach, and (6) social validation (Martin & Hrycaiko, 1983). These characteristics, as described by Martin and Hrycaiko (1983), are summarized below.

Measurement of athletic performance. Athletic performance should be defined in terms of observable and measurable behavior. The form, or topography, of the behavior is the unit of measure rather than the result of the behavior (e.g., goals scored, distance thrown, etc.). Focusing on the results of athletic behavior rather than form does not help coaches address the behavior that caused those results. The continuous measurement of athletic performance allows coaches to evaluate the effectiveness of their own coaching strategies (i.e., teaching interventions) and make changes using data-based decisions.

Distinction between developing and maintaining behavior. Behavioral coaching, as is typical in behavior analysis, has specific procedures that are used for the different

skill levels of athletes. Novice athletes will need more instruction and immediate reinforcement to shape new skills; a more experienced athlete will need more intermittent reinforcement and will utilize more self-monitoring strategies to maintain correct athletic performance.

Encouragement to improve against performance. As in behavior analysis, behavioral coaching should use an individual's behavior as the unit of measurement by which to improve. Behavioral coaching shifts athletes' focus from competing against other athletes to competing against their own previous behavior by setting goals and monitoring those goals. Goal setting is important at all athletic skill levels, especially for novice athletes. Less experienced athletes may take some time to become more skilled which does not allow them to experience the natural reinforcement that more skilled athletes experience through correct performance. When the focus is placed on competing against other athletes, they may experience failure and pair that sport, and possibly all athletic performance, with punitive outcomes. This pairing could cause novice athletes to quit a particular sport and avoid engaging in similar sports.

Emphasis on coaching as a science. Behavioral coaching is a science rather than an art. Behavioral coaching utilizes observable and measurable behaviors, collecting continuous data on behaviors, and making decisions based on those data. This systematic approach mimics the scientific process; the procedures used are objective and specific, which allow them to be replicated across many different sports. Taking a scientific and data-based approach allows coaches to avoid using mentalistic explanations for an athlete's behavior.

Behavior modification for the coach. The same approaches that coaches may use with their athletes can be utilized by coaches to monitor their own coaching behavior. Just as athletes review film from their games, coaches can continuously monitor their coaching strategies using a checklist. Other observers can evaluate a coach's performance as well, a practice that is utilized in behavioral research called *treatment integrity*.

Social validation. Staying true to the first dimension of applied behavior analysis (Baer, Wolf, & Risley, 1968), behavioral coaching seeks to change socially significant behavior (Martin & Hrycaiko, 1983). In the case of behavioral coaching, socially significant behaviors are those that are important to coaches and athletes, and are effective in their respective sport to achieve desired results. As in applied behavioral research, behavioral coaching must evaluate the social validity of goals of athletic behavior change, coaching procedures, and the results achieved through coaching procedures.

Based on the generalized characteristics of behavioral coaching, as defined above by Martin and Hrycaiko (1983), behavioral coaching strategies were subsequently developed as specific teaching interventions. The *Journal of Applied Behavior Analysis* and other behavior analytic academic journals have published peer-reviewed articles on behavioral strategies for teaching and improving performance in a variety of different sports. These studies approach coaching and sport performance from a behavior analytic perspective by applying the basic principles of learning to evaluate the effects on performance in different sports (Luiselli, Woods & Reed, 2011). A variety of behavior

analytic coaching strategies have been presented in various published academic journals. These include goal setting, task analysis, modeling, and feedback. Not all strategies are use in every behavioral coaching plan, but examples of each strategy can be found in the body of literature, employed to varying degrees of success.

Behavioral Coaching for Skilled Athletes

In their second characteristic of behavioral coaching, Martin and Hrycaiko (1983) assert that the principles used to change athletic behavior can either develop or maintain behavior. The proper assessment of the skill level of an athlete is a first-line variable in developing a behavioral coaching plan. Athletes who are more experienced and who execute athletic behavior with a higher level of proficiency, won't need to focus toward on improving the topography of their behavior, but will focus on either maintaining or further increasing the frequency with which their behavior occurs. One way to accomplish this is to utilize strategies that increase motivation to engage in an athletic behavior per certain criterion.

For example, Smith and Ward (2005) compared the effects of three interventions on three football skills and evaluated whether or not performance generalized to game play. The study implemented three treatment phases: public posting plus verbal feedback, goal setting plus verbal feedback, and public posting plus verbal feedback plus goal setting. Results of the study demonstrated a clear functional relationship between the implementation of the treatment phases and increased performance although no determination could be made as to which of the three interventions was more effective than the others. This was due to high percentages achieved during the initial baseline,

ranging between 50% - 80%, allowing for only a small increase in performance, from 80% to 100% during treatment phases. Results also indicated that correct performance during the treatment phases not only increased during practice but also maintained a high level of accuracy during game situations. One participant achieved perfect performance during all possible game situations. This study, unlike others, defined the dependent measures not only by the correct execution of the topography of behavior but also in terms of outcomes. Specifically, in football, it is important to take both topography and outcomes into account due to the fact that, although the topography of a behavior may be executed correctly, outcomes are sometimes affected by play calling and the behavior of a quarterback.

Utilizing another goal setting procedure with collegiate rugby players, Mellalieu, Hanton and O'Brien (2006) implemented a goal setting intervention that consisted of three stages: goal determination, goal setting, and goal reviewing. The first half of the rugby season was used as each participant's baseline and used to determine attainable goals for each behavior. Players then selected one behavior out of five total performance behaviors that they felt needed improvement and set their goal for the second half of the season. The players then reviewed their performance prior to each match to determine their progress toward their goal. The study utilized a pretest and posttest evaluation to examine the effects of the intervention on targeted behaviors. The researchers examined the data collected on non-targeted behaviors to indirectly evaluate experimental control. Results showed improved scores from pretest to posttest scores; four of the five participants were able to exceed their goal. Although non-targeted behaviors did slightly

improve during the treatment phase, the non-experimental design (i.e., pretest and posttest) used in the study makes it unclear as to whether or not there was a functional relationship. Researchers suggested future studies utilize a multiple baseline across participants or behaviors to demonstrate more clear experimental control.

Behavioral coaching interventions can not only be used to increase motivation for athletic performance during game situations, it can also be used to increase performance during practice (e.g., McKenzie and Rushall, 1974). Athletes simply engaging in a higher rate of behaviors, as is done in practice conditions, will maintain their performance and/or increase endurance. This is particularly important in the sport of swimming. McKenzie and Rushall (1974) conducted the first study to implement behavior analytic procedures in the athletic realm and evaluated the use of two behavior analytic interventions on the attendance and work output behavior of swimmers. The study conducted two separate experiments, the first targeting the attendance of the swimmers at practices, and the second targeting the completion of training units (work output). The study utilized public posting of self-recorded progress. The first experiment utilized a multiple baseline across behaviors design to target attendance. Swimmers were required to record, on a publicly posted attendance board, their present cumulative attendance and their best cumulative attendance total. The experiment included two additional phases in which late arrivals and early departures were targeted. The result of using the attendance board with the swimmers decreased absences 45% from baseline conditions, late arrivals decreased 63%. Swimmers leaving early from practice was completely eliminated. The second experiment targeted the number of training units

completed by each swimmer. This experiment again utilized the public posting of individual progress by requiring the swimmers to check off training units as they completed them and then record the total number of laps completed in a practice. All eight participants demonstrated improvements in their work output during the treatment conditions. The participants increased their work output as a group on an average of 27.1% from baseline conditions; researchers stated this increase is approximately equivalent to an additional 619 yards per swimmer.

While interventions that target the maintenance of athletic behaviors are important for more experienced athletes, behavior analytic principles can be applied with novice athletes wanting to acquire a new skill (Downs et al., 2015; Fogel, Weil, and Burris, 2010; Levy, Pryor, and McKeon, 2015) or inexperienced athletes who need to remediate or improve the topography of their existing athletic skills (Allison & Ayllon, 1980; Harrison and Pyles, 2013; Kladopoulos & McComas, 2001; Komaki & Barnett,1977; Konttinen, Mononen, Viitasalo, & Mets, 2004; Quinn, Miltenberger, and Fogel, 2015; Scott, Scott & Goldwater, 1990; Shapiro & Shapiro, 1985; Stokes et al., 2010). Again, a behavioral coaching package for novice athletes should satisfy the six generalized characteristics, but will employ differing interventions to achieve the desired skill acquisition. The first step in the design of a treatment package for these types of athletes requires the coach to break a complex skill down into smaller skill components as part of a task analysis.

Performance Feedback of Skill Components

Creating a task analysis forces coaches to meticulously evaluate the discrete movements that go into executing a skill and allows them to coach their novice athletes more objectively and precisely. Studies utilizing a task analysis (Allison & Ayllon, 1980; Downs et al., 2015; Kladopoulos & McComas, 2001; Komaki & Barnett, 1977; Moore & Quintero, 2019; Shapiro & Shapiro, 1985) break down a complex athletic skill into smaller components in order to shape accurate performance.

Moore and Quintero (2019) utilized a task analysis in the training of two Olympic weightlifting lifts (snatch and clean) in four participants from a CrossFit exercise program. The study compared forward chaining to backward chaining. Each lift was taught in segments of four; t each had their individual substeps. Each participant was randomly assigned one lift to either be taught with forward or backward chaining. Training was initiated for the lifts simultaneously to compare forward and backward chaining in an adapted alternating treatment design. Training consisted of a typical CrossFit training session format with the addition of feedback from the trainer while viewing their video recorded performance. All participants achieved mastery criteria (80% accuracy of a segment) on the lifts trained with forward chaining but did not meet mastery criteria on lifts trained with backward chaining. Once training on the lifts was changed from backward to forward chaining, each participant was able to reach mastery criteria. Authors of the study hypothesized that forward chaining for these explosive movements was more successful than backward chaining because it ensured the initial skills of a lift were mastered before moving forward. By mastering the initial skills of a

lift, an athlete is able to produce physical momentum that is cannot be produced when training segments employ backward chaining. The physical momentum of mastered initial skills also produce visual and kinesthetic discriminative stimuli that occasion subsequent responses that are unable to be produced through backward chaining. This study, which isolated the specific component of chaining, was particularly applicable to weightlifting studies in that it showed that training a task analysis using forward chaining was more effective in improving performance than backward chaining for this skill.

Task analyses are also used in conjunction with some form of feedback being provided to the athlete based on their performance of the component skills of a task analysis. Performance feedback can be delivered through many different methods such as checklist review (Komaki & Barnett, 1977), "freezing" (Allison & Ayllon, 1980; Shapiro & Shapiro, 1985), descriptive praise (Kladopoulos & McComas, 2001), and video self-evaluation (Downs et al., 2015). Each method displayed varying degrees of success.

Komaki and Barnett (1977) targeted the execution of three offensive plays on an inexperienced youth football team. Each play was broken down into smaller stages in the form of a checklist that was used to not only coach the players on the play, but could also be used as feedback. During the treatment phase, coaches gave verbal instructions on each stage of a play using the checklists and had the players run the play at a walking speed with the coach modeling some key movements. The players then ran the play at full speed as the coaches used the play checklists to score each stage as either being performed correctly or incorrectly. Immediately after completing a play, the players were

given feedback on their performance by reviewing the scored checklist with the coach. The coach explained the stages that were executed incorrectly and also provided verbal feedback on the stages that were executed correctly. The players were able to improve their execution of all three plays not only during practice, but also during game situations. Researchers noted that during the baseline condition, perfect execution (100% accuracy) of plays (during both practice and games) was achieved for 2 out of 84 total attempts of all plays. Following the implementation of the treatment phase, perfect execution increased to 22 out of 89 total attempts and did not drop below 60% accuracy. More importantly, accuracy of play execution during game situations never dropped below 60% out of 29 possible attempts in contrast to 9 plays below 60% accuracy occurring during baseline. Utilization of the checklist as a form of performance evaluation within a behavioral coaching package proved to be an effective method for both correct and incorrect executions and the method was enthusiastically valued by both athlete and coach.

A subsequent study (Allison & Ayllon, 1980) also employed positive verbal feedback for correct executions but focused on a different feedback technique for skill remediation that involved "freezing" the athlete in motion at the point of error. Allison and Ayllon (1980) compared standard coaching procedures and a behavioral coaching package to remediate errors of complex skills in the sports of football, gymnastics, and tennis. Skills were identified for each sport and then broken down into the smaller skill components. The behavioral coaching package included five steps: giving verbal instructions on how to execute the skill based on each task analysis, having the athletes

perform the skill, yelling “freeze” requiring the athletes to stop in their current position, describing the error made by the athlete, having the coach model the correct positioning, and finally, having the athlete imitate the correct positioning modeled by the coach. Results of the experiments demonstrated a clear functional relationship between the implementation of the behavioral coaching package and increased accuracy in skills. A reversal design was used for all three sports. For gymnastics and tennis experiments, it was observed that as athletes were exposed to more sessions using the behavioral coaching package, skills maintained although at a slightly lower level as during the baseline condition. Though the authors noted that both athletes and coaches considered the “freeze” component of the package to be aversive as it was physically strenuous and was sometimes difficult for the athletes to freeze at all, they nevertheless considered the behavioral coaching package to be effective.

Shapiro and Shapiro (1985) extended the findings of Allison and Ayllon (1980) by also comparing standard coaching methods and employing the same five-step behavioral coaching package for skills remediation. Three skills were targeted for one male and two female high school track athletes: conditioning, form, and starts. Each skill was broken down into a task analysis to be utilized during the intervention and data collection. Correct skill execution was acknowledged with verbal feedback. If the demonstrated skill was incorrect, the runner was immediately instructed to "freeze" in position so that the coach could describe the error, model the correct skill and allow the athlete to imitate the correct movements from the beginning of the task sequence. This five-step behavioral coaching package (execute, judge, describe, model, and imitate)

continued until the runner perfected the desired skill. Probe data were collected on the athletes' 100m and 200m dash times approximately every 10 or 11 days throughout all conditions of the study. In addition to improving skill performance, all participants' 100m and 200m dash times decreased. A multiple baseline design across skills design demonstrated a clear functional relationship between the implementation of the behavioral coaching package and an increase in accurate performance of skills. However, given the study's broad focus of comparing standard coaching to a five-step behavioral coaching package, the authors considered it difficult to isolate the effectiveness of each of those five steps. To eliminate this limitation, a consequent study exclusively employed a behavioral coaching package and used e different methods of performance feedback.

As observed by Shapiro and Shaprio (1985), it was not possible to isolate the individual effectiveness of the five components of the behavioral coaching package. In a study conducted by Sewall, Reeve, and Day (1988), researchers utilized a more limited behavioral coaching package to analyze the effectiveness of practicing a particular weightlifting movement (the power clean) in front of a mirror as a form of feedback. All instruction was delivered via an instructional video that participants viewed before practice sessions. No verbal feedback or modeling was offered. Although participants who practiced with the mirror scored higher on the posttests than participants who did not practice with a mirror, scores were lower on the posttest conducted without a mirror. It was also found that the participants who practiced with no mirror scored lower on the posttest conducted with a mirror. Since the same level of performance could not be

maintained in the posttest when the mirror was removed, the authors could not conclude that concurrent mirror feedback was a preferable form of feedback.

Studying a different form of feedback, while also utilizing a limited behavioral coaching package, Kladopoulos and McComas (2001) used a multiple baseline across participant design to analyze the effectiveness of verbal instruction and descriptive praise on proper foul-shooting form (as defined by a five-step task analysis) and foul-shooting performance (shots made). Specifically, the performance feedback design provided positive verbal praise when an athlete successfully exhibited the correct form with a descriptive such as "Good job keeping your feet in the same position throughout the shot." If the desired skill was incorrect, corrective verbal feedback was not given; the instructor simply reviewed the instruction. This remediation continued (with the instructor repeating the instructions) until the athlete's skill was deemed as correct. Results of the study demonstrated an immediate increase of proper foul-shooting form after implementation of descriptive praise and instructional feedback with two participants increasing and maintaining 100% accuracy and one participant maintaining accuracy between 90% and 100%. All participants were able to maintain a mean average of 60% accuracy through the following season of play which was an improvement from the participants' pre-study accuracy of 40%. This increased accuracy was comparable to the rest of the team and allowed the three players to return as starters for the team. The success of the combined approaches of positive descriptive praise and neutral re-instruction as a remediation technique provided validation for these performance feedback procedures.

While Kladopoulos and McComas (2001) relied on performance evaluation provided by a coach via verbal praise, Mulqueen (2014) evaluated the effects of video feedback on Olympic weightlifting movements (snatch and the clean and jerk). All three participants had less than one year of Olympic weightlifting experience and were between ages of 30-39. During the intervention, participants would view a video of an expert performing one of the two lifts and would then attempt the lift while their performance was then video recorded. The participants were then able to review their performance side-by-side with the expert model. As they viewed the video, they received positive and corrective feedback from their coach for approximately one minute. Performance for all participants in both of the lifts improved post-intervention from baseline averages and maintained 1 week and 4 weeks post intervention and 6 weeks for one participant. Although none of the participants were able to achieve 100% accuracy, all participants achieved at least 80% accuracy for each lift. Participants rated their preference for the intervention and commented on the ease of including the intervention in their current training routine. It was also anecdotally noted that other members of the gym commented on the participants' improvement. The authors concluded that the video feedback was an effective method for improving athletic skills.

A year after the above study was published, Downs et al. (2015) conducted a study to determine the effects of video self-evaluation on skill acquisition of yoga poses (as opposed to performance evaluation delivered by the coach via video). Two novice participants video recorded their performance of three yoga poses immediately followed by independently reviewing and self-evaluating their performance using a task analysis

for each pose. Participants were trained to evaluate their performance against the task analyses that were designed by yoga instructors. During the self-evaluation phase, no feedback was provided by the researcher or instructor. Video self-evaluation increased the percentage of correct steps on the task analysis for both participants and maintained relatively high percentages for one of those participants. Given the small increase in performance during the self-evaluation phase for one participant, an additional phase of video feedback was implemented in which the participant received feedback from the instructor concurrently reviewing the video. The authors acknowledged a limitation of this design: the success of self-evaluation and the resultant self-correction of errors is only as effective as the participant's perception of what constitutes perfect execution. Though the study did validate self-evaluation as an effective feedback mechanism, it also highlighted the importance of high treatment integrity and coach oversight during the treatment phase. The authors also suggested that future research study the effectiveness of more immediate delivery of performance feedback. This imperative would lead to a vital advancement in behavioral coaching: immediate performance feedback.

Consistent with Martin and Hrycaiko's (1983) six characteristics, one variable that all behavioral coaching interventions include is performance feedback for the athlete. As seen in the above studies, various forms of feedback have been utilized. Although performance feedback has proved to be an effective intervention for improving athletic performance, one thing is clear in the literature: feedback is often delayed. Interventions such as the checklist, "freezing," descriptive praise and video self-evaluation, were all delayed responses. Even with an athletic skill broken down into clear, observable, and

measurable skill components, if feedback is provided with even a small delay, skill acquisition can be stunted which could cause frustration for both athletes and coaches. Any delay in reinforcement, even as little as a few seconds or the time it takes to say "good job!" can limit the effectiveness (Cooper, Heron & Heward, 2007). One behavioral coaching technique aimed specifically at this shortcoming is a form of "clicker training" where acoustical feedback is immediately issued for responses that are a part of a larger response chaining.

Auditory Feedback

Auditory feedback was first evaluated with animal behavior. These studies shaped new skills utilizing an auditory stimulus (a clicker) as a conditioned reinforcer after the clicker had been routinely paired with food. For example, Ferguson and Rosales-Ruiz (2001) targeted the trailer loading of horses using target training. Researchers paired the sound of a clicker with food prior to target training. Horses were then trained to touch a target, using the clicker and a variety of food items. Once a horse reached the criterion, the target was moved to the trailer and successive approximations of loading were reinforced with a clicker until horses were able to be loaded in the trailer without any occurrence of problem behavior. Researchers also noted that unmeasured problem behaviors, such as running from the visual stimuli of a halter or lead rope prior to loading, also decreased or were completely eliminated.

Given the importance of delivering immediate feedback for a desired behavior in athletic skills training, researchers began utilizing an audible generalized conditioned reinforcer (such as a beep) in their behavioral coaching interventions. In the first study

that used auditory feedback in sports, Scott, Scott, and Goldwater (1990) utilized a treatment package of prompting and an auditory stimulus to improve correct arm extension at take-off in the sport of pole vaulting. The athlete received a vocal prompt of "reach" prior to reaching the plant position. Feedback was provided using a photo-electric beam that would sound an audible beep when broken, signaling that the athlete achieved correct performance. A changing criterion design was used. Once each criterion for height requirement for arm extension was met, the height requirement was gradually increased until the athlete reached the maximum possible height. Results of the study showed that the treatment package of prompting and the auditory stimulus increased correct arm extension which then had an effect on the maximum height jumped. Although the treatment package had a positive effect on correct arm extensions, the auditory stimulus was not delivered in isolation so it is unclear whether or not the prompt prior to take off had control or whether the beep alone reinforced correct arm extension. This limitation would lead to further studies that would isolate the auditory stimulus in an attempt to eliminate the interfering variable of the vocal prompt.

Utilizing an auditory stimulus but without vocal prompting, Konttinen, Mononen, Viitasalo & Mets (2004) examined the effects of augmented auditory feedback (AFb) on skill acquisition in precision shooting. Participants received an auditory stimulus through headphones during the aiming phase of shooting at a target; the auditory stimulus increased in frequency the closer their aim was to the center of the target. At the conclusion of a 4-week acquisition phase, the results of the study found that AFb increased shooting scores, higher than participants just having knowledge of their results (KR), and higher than the

control group (no training). The researchers also measured skill performance 10 and 40 days following the acquisition phase, and found that the AFb athletes retained their skills at a higher rate than that of the KR and control group. The authors concluded that the exclusive use of the auditory stimulus was an effective intervention for teaching accurate shooting skills.

Coaching of sports skills to novices has evolved from error-centric positive punishment to behavioral coaching to a more refined intervention that built on previous behavioral coaching interventions with the addition of immediate auditory feedback. Each step of this evolution has improved upon the previous method as borne out by the chronology of studies referenced herein. However, the current body of literature reveals a remaining shortcoming: the lack of a comprehensive and standardized treatment package that would utilize current best practices of behavioral coaching (including immediate auditory feedback). This critical next step, the development of a systematic treatment package of TAGteach, would be taken on by Theresa McKeon and Karen Pryor in 2003.

TAGteach

Teaching with Acoustical Guidance, or TAGteach, is a systematic teaching method that is predicated on breaking down desired behavior in to smaller components (task analysis) and delivering non-verbal feedback in the form of a click ("tag") as a form of positive reinforcement for successful execution of each of the component steps (TAGteach International, 2012). TAGteach is derived from clicker training, a

methodology that utilizes an auditory click as a conditioned reinforcer to shape animal behavior.

The history of clicker training can be traced back to the WWII effort by B.F. Skinner and two graduate students, Marian and Keller Breland, who developed a program to train pigeons to launch Pelican missiles (Skinner, 1960). It would take decades before the method would resurface as a means to train dogs. In 1984 and after 20 years of research, Karen Pryor published "Don't Shoot the Dog," a treatise and guide to clicker training. As her experience and fame grew, she was contacted in the early 2000s by Theresa McKeon who was having trouble training an unruly horse. The horse was successfully trained utilizing Pryor's clicker training methods but the collaboration between Pryor and McKeon would continue in a new and ground-breaking direction. McKeon, also a national-level gymnastics coach, saw an opportunity to transfer the training method to the training of her young gymnasts. As the clicker training with the young girls proceeded, however, they found that parents were averse to having their children being “trained like dogs.” In response, they made a purely semantic change: the clicker would now be called a "tag" and their new training method for the gymnasts would be known as TAGteaching.”

More than just a new name, the TAGteach method we know today is very different from its predecessor, clicker training. One of the main differences is that TAGteach does not use pure shaping as heavily as is needed with animals, but more so a combination of shaping, chaining, and instructions. TAGteachers break down a global behavior into smaller components and tag each component in isolation. Each component,

although part of a larger complex skill, is a skill the learner can perform. For example, though a gymnastics athlete may not be able to perform a perfect handstand, she is able to kick up on to her hands briefly which is the first component needed to perform a handstand. Another major difference between TAGteach and clicker training was the development of a very precise and systematic language (the TAGteach Phraseology; Appendix A) that is used throughout a TAGteach session. The instructional and positive phrase, "the tag point is…," remains constant no matter what behavior is being targeted. This phrase turns the learner's attention to the exact criteria that will get them a tag. In the event that the target behavior is not performed (and no tag is delivered), the athlete must self-assess and determine their own adjustments in order to repeat, achieve, and receive the tag. This puts the athlete in charge of their progress, requires minimal interjections from her coach and drastically reduces any perceived "nagging." In short, TAGteach humanized clicker training.

TAGteach in a Treatment Package

Since its inception in 2003, TAGteach has been utilized in applied human studies to target socially significant behaviors in sports and a variety of other fields. Alternative to the full TAGteach treatment package implemented by a certified coach, TAG utilizes some or even a single component of TAGteach without employing the entire treatment package as stipulated by the TAGteach International (2012). One such study, Persicke, Jackson and Adams (2014) used a multiple treatment reversal design to compare the effects of a correction procedure with correction + TAG for frequent or idiopathic toe-walking in a 4-year-old child with Autism. Baseline data were variable with a range of 0-

100% of accurate steps. During the correction only phases, flat-footed steps increased from a baseline mean of 24.6% to a mean of 63.6% that only slightly demonstrated more stability. Once correction + TAG was introduced, the data demonstrated an immediate effect and the percentage of flat-footed steps increased to a mean of 90.5% and no percentage below 73%. Flat-footed steps remained above 73% throughout all correction + TAG phases, as well as two fading conditions (FR2 and FR4) and two generalization probes. The author concluded that the correction procedure may not have been needed in addition to TAG, as the differential reinforcement of flat-footed steps may have yielded the same results.

Also using TAG as part of a treatment package, Stokes et al. (2010) targeted offensive line pass-blocking skills. A multiple baseline across participants was used to evaluate the effects of three behavioral coaching strategies: descriptive feedback, descriptive feedback + video feedback, and TAG. All participants improved their blocking skills from the baseline condition once descriptive feedback + video feedback was implemented with four of the five participants achieving all data points within the criterion range. Participants that received TAG following both descriptive feedback alone and descriptive feedback + video feedback further increased performance at or above criterion (above 90% accuracy) from previous treatment phases. Although there was an increase for all participants that received TAG, it is difficult to pinpoint TAG as the cause of the increase due to the short implementation phase and an increasing trend during the descriptive feedback + video feedback phase. Due to this limitation, authors called for more research to directly evaluate the effectiveness of the TAG as an

independent intervention in order to isolate its effects on athletic performance in football and other sports.

Other studies continued to utilize TAG as part of a teaching package (e.g., Harrison & Pyles, 2013). For example, Harrison and Pyles (2013) evaluated the effects of verbal instruction and TAG within a shaping procedure using a multiple baseline across participants design on the tackling skills of three high school football players. The shaping procedure consisted of four sub-phases (one phase for each component skill) in which participants received verbal instructions on the component skill being taught prior to the tackling drill. A beep from a megaphone was delivered contingent on the component being performed correctly. Once all four components were taught, a progressive speed phase was implemented in which a tackling drill was conducted at increasing speeds (walk, jog, and run). Baseline data were low for all participants (50% accuracy or below) of the study, but demonstrated an immediate effect for two participants once verbal instructions and TAG were introduced. Data also revealed that correct tackling skills generalized to full speed tackling drills. Although the study did not implement the explicit TAGteach method, the study used verbal instruction based on the components of the task analysis for tackling which is a basic component of the TAGteach method.

With the purpose of studying the TAGteach tagger component in isolation, Young (2017) also did not implement the full TAGteach method. This study attempted to evaluate the effects of utilizing the clicker alone (with no verbal exchange) to shape performance of a complex athletic skill. The researcher compared the immediate

feedback of a clicker alone as a coaching procedure to traditional coaching in two high school shot putters. The results of the study found that the clicker alone actually decreased athletes' performance in three out of six glide drills for one participant and two out of six glide drills for the other participant. Results of social validity of the clicker alone procedure revealed that both participants disliked the strategy and would be unlikely to choose it in the future. One participant reported that the absence of the clicker made her feel as though the coach was disappointed in her. The author hypothesized that the complete absence of a verbal exchange is unnatural for athletes who have only had experience with coaching procedures that included a verbal exchange. The participant feedback accentuates the possible risk of low social validity when isolating a particular single component of a behavioral coaching treatment package for the sake of future research. This study's conclusions offered two valuable conclusions for TAGteach alone: verbal exchange may maintain the social validity of a behavioral coaching procedure, and the tagger component cannot stand on its own.

TAGteach Alone

The current body of literature has demonstrated the effectiveness of behavioral coaching interventions that provide immediate feedback to athletes following the performance of targeted athletic skills. Although TAGteach provides a more immediate form of feedback for correct performance than traditional behavioral coaching interventions, minimal research has been conducted that directly evaluates the effectiveness of the TAGteach method as a stand-alone intervention on athletic skills.

Levy, Pryor & McKeon (2015) worked directly with the TAGteach team to design their own study that would utilize acoustical guidance as an independent intervention, but the study did not incorporate the TAGteach "script" in the training sessions. This study was designed to teach two surgical skills (tying the locking, sliding knot and making a low-angle drill hole) to postgraduate and second year medical students. The effects of acoustical guidance (adapted from TAGteach) were compared to the traditional teaching method that utilized modeling alone. The results of the study demonstrated that the group that was taught using acoustical guidance performed the target behaviors with more accuracy than the control group. It was noted that the students who were taught to tie the locking, sliding knot using acoustical guidance took longer to complete their first knot than the control group. However, after 15 minutes of additional practice, there was no difference in the mean amount of time for the test and control groups to complete 10 knots. This was still a desirable outcome; although the control/traditional group performed the skill faster, the group taught using acoustical guidance quickly caught up and, more importantly, this group showed greater accuracy.

To date there are only three published studies that evaluate the full TAGteach methodology when applied to athletic performance (i.e., Ennett, Zonneveld, Thomson, Vause, & Ditor, 2020; Fogel, Weil, & Burris, 2010; Quinn, Miltenberger, & Fogel, 2015). A recent study (Ennett et al., 2020) was able to utilize a less common research design than used in previous TAGteach studies and allowed the researchers to isolate an individual component while also maintaining social validity for participants. The study evaluated the effectiveness and efficiency of the error-correction component of

TAGteach in teaching beginner yoga poses in adults. With the explicit purpose of attempting to streamline the coaching process, the researchers compared standard TAGteach error-correction procedures (i.e., practicing a tag point three times), to TAGteach with reduced practice (i.e., practicing a tag point once), while also utilizing a control condition. Results of the study found that both standard TAGteach and reduced practice TAGteach error-correction procedures were effective in increasing the performance of yoga poses. This suggests TAGteachers could achieve the same results without the need for additional practice that is the standard requirement as defined by TAGteach International (2012). However, reduced practice also yielded an average of 19% more errors in the process of achieving mastery criteria. It could be argued that an approach that allows participants to repeat undesirable behaviors at a higher rate runs the risk of reinforcing errors. This study was the first of its kind in the TAGteach literature in that it validated one component of the TAGteach procedure (the error-correction procedure) with empirical support, while also utilizing the full TAGteach method.

Fogel, Weil, and Burris (2010) also used the explicit TAGteach method to teach a novice golfer with no prior golf experience to swing a golf club. The golf swing was broken down into five skill sets that were then each broken down into a task analysis that would be used as tag points. Using forward chaining, each skill set was taught using a 5-iron club in isolation and in its naturally occurring sequence. Results demonstrated that skill acquisition was achieved for four of the five skill sets, and skills also generalized to a different club (a driver) that was not used during teaching trials. Skills also maintained in four of the five skill sets following the intervention phase. Limitations of the study

were that there was no treatment integrity assessment, and the need for coach training. In the study, no treatment integrity assessment was conducted; future research should include such measures to ensure that the TAGteach method is being implemented consistently and accurately across all sessions. The authors also called for future research on the TAGteach method to be conducted to determine if the same effects can be achieved if implemented by coaches. This would fill a gap in the current body of literature on TAGteach that would assess whether or not coaching behavior has an effect on athlete performance.

Extending the TAGteach literature and the findings of Fogel et al. (2010), Quinn, Miltenberger and Fogel (2015) examined the effects of TAGteach on three dance skills (turn, leap, and kick) of four female dance students. This study included more participants than Fogel et al. and the dance instructors implemented the intervention rather than the researcher. Personalized task analyses were created for each participant for all three dance skills in collaboration with the dance instructors. Results of the study revealed an increase in the performance of correct steps for three of the participants. The fourth participant did not show an improvement in performance once TAGteach was introduced and required the addition of tokens to the intervention. The participant earned a point for each correct tag point and was able to exchange those points at the end of a session for a back-up reinforcer that was identified using a preference survey. Once TAGteach + tokens was implemented, her performance increased to levels above the baseline mean. Social validity measures indicated that TAGteach was a favorable intervention for both the dance instructors and students. The results of the study

demonstrate the effectiveness of TAGteach as an intervention for not only improving performance of the students but also that TAGteach was able to be taught to the instructors in a relatively short time and still be used effectively. The author called for additional research to evaluate the effects of TAGteach when implemented by coaches. One limitation of this study was the absence of procedural fidelity checks throughout the course of the study, a shortcoming that should be addressed in prospective studies.

Current Study Rationale and Purpose

Though a review of the progression of various behavioral coaching studies has demonstrated many effective interventions over the past 45 years, the current body of literature shows a dearth of research utilizing the explicit and systematic TAGteach method. In consideration of the effectiveness of studies that utilized many, but not all, components of the TAGteach method, the logical next step was to design a study with the specific purpose of testing the precise TAGteach method in its entirety. Future research must also record data on the procedural fidelity of the TAGteach method to ensure it is being implemented with consistency and accuracy according to the TAGteach International (2012) standards.

The purpose of the present study is to add to the current body of behavioral coaching literature by extending the findings of Fogel et al. (2010) and Quinn et al. (2015) by evaluating the effectiveness of the full TAGteach method in isolation. The present study will evaluate the effectiveness of the TAGteach method as a stand-alone intervention on the performance of three resistance training movements (i.e., front squat, deadlift, and overhead press) on novice adult athletes. The present study sought to

improve upon previous studies that did not include a measure for procedural fidelity. The present study also aimed to evaluate the maintenance of accurate performance post-intervention phase as well as generalization of skills to heavier weights than those used during training sessions. Specifically, the concentration will be on the four essential patterns of human movement: squat, hinge, push, pull. Three basic free weight barbell maneuvers that include those four basic patterns will be included: the front squat, the deadlift, and the overhead press. One of these movements satisfies a singular pattern; two encompass multiple patterns. The front squat is an example of a squat and hinge and is a knee-dominant maneuver. The deadlift is a hip-dominant movement that includes hinge, push and pull movements, and the overhead press is a basic push pattern (Chilibeck, Calder, Sale, & Webber, 1997). The front squat, deadlift and overhead press are three very common foundational maneuvers trained to novice lifters and will provide benefits to casual gym goers, older adults and all levels of athletes (Mazur, Yetman, & Risser, 1993).

The research questions for the present study are as follows: Is the implementation of TAGteach, an effective intervention for improving accurate performance of three resistance training movements (front squat, deadlift, and overhead press) in novice adult athletes? Will skills learned through TAGteach maintain post-intervention and generalize to performance with heavier weights?

CHAPTER 3

METHOD

Setting and Materials

The following materials were used to conduct each training session: task analyses for the front squat, deadlift, and overhead press, an unweighted PVC pipe, weighted PVC pipes (loaded with lead shot, wooden dowels, and two 2.5-pound weighted plates) at five and 10 pounds, iPhone 8 with slow motion capability, iPhone tripod, tagger, chalk, two step stools (9 inches in height) and tape. The study was conducted at Core Creek Park, a public park in Langhorne, Pennsylvania. The park has multiple areas that have the coverage of a pavilion in the event of inclement weather.

Participants

Participants included three healthy adults: Tom, a 60-year-old male, Anne, a 54-year-old female, and George, an 18-year-old male. Tom's training history included high school track and field when he was younger and he currently walks three miles each day. Anne's training history included high school basketball and adult league softball. George's training history included eight years of baseball and one year of high school lacrosse. Once a potential participant expressed interest (from an online recruitment flier) in participating in the study, the researcher reviewed the inclusion criteria and obtained informed consent. Inclusion criteria for the study required individuals be between the ages of 18-65 years of age, in good physical health as determined by the completion of the PAR-Q (Appendix B), at no/low risk for health issues or injuries as

determined by the completion of the PAR-Q, had no experience performing the front squat, deadlift, and overhead press, were interested in learning resistance training movements, planned to participate in the study until criteria were met, and planned to participate in a minimum of two sessions per week.

Dependent Measures

The dependent variable of the study was the percentage of tag points performed accurately in each movement (front squat, deadlift, and overhead press). Each movement was broken down through a task analysis that detailed each tag point that made up that movement. See Appendices C, D, and E for these task analyses. Each task analysis is a list of the sequential steps (i.e., tag points) that comprise the movement (i.e., global behavior) and tag points are operationally defined and targeted during TAGteach training sessions. Tag points of each lift were created by the researcher and were approved by two certified personal trainers to ensure the validity of each task analysis. The personal trainers and the student researcher initially met in person to review the steps of each task analysis that needed to be included. The student researcher then received corrective feedback via email until each task analysis was finalized using a checklist (Appendix F). In order to create each tag point so that it met the WOOF (what behavior you want, observable/measurable, one criterion, and five words or less) criteria as defined by TAGteach International (2012).

Data collection. Data for the dependent variable were collected by reviewing video footage of probe sessions and TAGteach training sessions and scoring each attempt

(with an unweighted PVC pipe) using the task analysis for that movement. Generalization data were also collected during all probe conditions, using a weighted PVC pipe (five or 10 pounds) to assess generalization effects. The observer (i.e., the student researcher/first author) used event recording to collect data on whether or not each tag point of a movement was performed correctly using a "+" for correct performance and "-" for incorrect performance. Each data point represented one attempt at a movement. Data were summarized by calculating the percentage of tag points performed correctly in each movement by dividing the number of tag points performed correctly by the total number of tag points in the movement multiplied by 100. For example, if a participant performed nine tag points of the squat correctly, the calculation of the percentage of tag points performed correctly would be as follows: 9 correct / 11 total tag points $\times 100$ = 82% tag points performed correctly.

Experimental Design

A multiple probe across movements was utilized to evaluate the effectiveness of TAGteach on three resistance training movements (i.e., front squat, deadlift, and overhead press) within each participant. An initial probe condition (Probe 1) was conducted on all movements until baseline data were stable. Data were considered stable when 80% of data points fell within 20% of the median of all the data points in the phase. When probe data were stable, TAGteach was introduced for the first movement. The first movement that reached stability was the first movement that contacted the TAGteach procedure. TAGteach was implemented until the data reached criteria (80% of tag

points performed accurately for three consecutive attempts). TAGteach data were only collected on the movement that was targeted during that session. Once criteria were met for the first movement, a second probe condition (Probe 2) was conducted on all three movements. This sequence continued until each movement contacted the TAGteach condition. Probe conditions, aside from the initial probe, served as baseline probes for the movements that had not contacted TAGteach and post-TAGteach probes for the movements that had contacted TAGteach. A final probe condition was conducted once each movement had contacted the TAGteach condition and served as a post-TAGteach condition for all three movements.

Procedure

Probe conditions. During probe conditions, participants met with the researcher and were asked to perform three attempts at each movement. For example, the researcher would say, "Using the PVC pipe, show me the front squat." Participants did not receive any feedback on their performance during probe conditions other than being asked to repeat each movement until three attempts had been recorded. If a participant asked a question about their performance during the probe conditions, the researcher responded by saying, "If you have any questions, we can make sure to address them during our next training session." Following the three attempts with the unweighted PVC pipe, the participant took a five-minute break before performing the next three attempts with a weighted PVC pipe that was used to assess generalization effects. Probe condition sessions occurred at the beginning of each session, prior to any TAGteach training.

TAGteach. Participants were taught all three movements using the TAGteach method, as defined by TAGteach International (2012). The first author of the study completed the TAGteach International Online Certification course and received a Level 1 certification.

During the first TAGteach training session with each participant, the researcher introduced TAGteach to the participant by explaining how the tagger works and giving the participant an opportunity to play two games (e.g., tagging when the researcher holds up a certain number of fingers, and tagging a specific word in a song) to become familiar with the TAGteach procedure. The researcher began by saying, "This is a tagger and this is the sound it makes [click], which is called a tag. I will provide you with an instruction, called a tag point. If you perform that instruction correctly, you will hear a tag [researcher clicked the tagger]. If you don't hear a tag, that simply means to try again. If you don't hear a tag after three attempts, I will reteach that tag point. Do you have any questions?" After answering any questions the participant had about TAGteach and the tagger, the researcher then had the participant play at least two practice games. To begin practice games the researcher would say, "We are going to play a game to help you become familiar with tagging. I'll demonstrate. The tag point is two fingers." The researcher would then have the participant hold up two fingers in a random order, and the researcher would tag each time the participant held up two fingers. The researcher then had the participant tag by saying, "Now it's your turn to tag." The researcher and participant then used this same sequence for a second practice game using a different tag point. During the practice games the researcher paired the sound of the tagger with vocal

praise such as, “Good job!” or “That’s right!” each time the participant would tag a behavior (i.e., holding up two fingers or a word in a song) correctly. When the participant was familiar with the procedure, the researcher would ask if they are ready to move on to training the first movement.

Each TAGteach training session focused on training one movement and tagging each tag point in isolation. Training on a movement continued until 80% of the tag points in a movement were performed accurately for 3 consecutive attempts. Using forward chaining, the researcher began each session by teaching the first tag point in the task analysis for the movement. Training continued on a single tag point until the participant correctly performed the tag point for three consecutive attempts, at which time the tag point was added to the response chain and the next tag point in the sequence was taught. Correct performance of a tag point received a tag from the researcher with no additional feedback such as verbal praise (e.g. “good job,” clapping, thumbs up, etc.). Incorrect performance received no tag and no corrective feedback based on their performance.

The researcher began each training session by reviewing the TAGteach procedure (sound of the tagger means “yes, correct” and the absence of the tagger means “self-assess and try again”) and introducing the final result of a movement, by demonstrating the full response chain. For example, the researcher would say, “Today, we’re going to learn the overhead press. Here is what it looks like [researcher demonstrates the overhead press].” The researcher then introduced the first tag point in the task analysis by demonstrating the tag point and having the participant tag their performance of the tag

point. For example, the researcher would say, “First, we’ll work on pushing your hips forward as you press overhead. In the overhead press, you need to push your hips forward to be able to push the bar straight overhead without contacting your chin. Let me demonstrate. The tag point is hip forward [the researcher demonstrates the tag point while the participant tags each time the tag point is performed correctly].” The researcher would then have the participant perform the tag point and tag each correct performance of the tag point. For example, the researcher would say, “Now it’s your turn. As you overhead press you are going to push your hips forward as you move the bar overhead. We are going to do it three times. The tag point is hips forward.” Once the participant performed the tag point correctly for three consecutive attempts, the researcher asked the participant if they were ready to move on to the next tag point. If the participant was ready to move on, the first tag point was placed into the response chain, and training began on the next tag point in the sequence. If the participant was not ready to move on, they were given three additional opportunities to practice that tag point until they were ready to move on. If the participant did not achieve a tag after three consecutive attempts, the researcher would reteach the tag point by either modeling the tag point again, having the participant tag their performance, or breaking the skill down into a smaller step. This occurred four times for Anne on the front squat and twice for Tom on the overhead press. For Anne, the tag point was modeled again and she was given another three attempts for the first occurrence of the three-try rule. When she again was unsuccessful, the skill was broken down and she was then able to achieve mastery. For Tom, the tag point was modeled again and he was able to achieve mastery. To break a

skill down, the researcher would isolate that tag point from the complete movement. For example, if the participant was having trouble moving their hips far enough forward to press overhead, the researcher could have the participant push their hips forward without pressing overhead and tag each time the hips were in the appropriate position. Once this new tag point was performed accurately three times, the participant would attempt to perform the overhead press again. This sequence was used for each tag point within a movement and training continued until all tag points were taught.

Generalization Probes. The study also examined the generalization of skills to a weighted PVC pipe, either five or 10 pounds. Each participant began with five pounds during generalization probes and only increased to 10 pounds if they maintained mastery criteria for 3 consecutive attempts and if they were comfortable increasing the weight. The goal of resistance training is to progressively increase weights to improve strength and adding more weight will be closer to moving toward other resistance training equipment such as barbells, kettlebells, or dumbbells. Participants performed all three movements for three attempts with a weighted PVC pipe during each probe condition. No training sessions were conducted using a weighted PVC pipe. Generalization data collection occurred during probe conditions (prior to TAGteach sessions during intervention conditions) immediately following the execution of three attempts with the unweighted PVC pipe and a five-minute break.

Procedural Fidelity

To assess the consistent and accurate implementation of the TAGteach procedure (Appendix G) and probe conditions (Appendix H), procedural fidelity data were collected using a checklist scored by the student researcher. The TAGteach checklist included s the same criteria that were used to evaluate the student researcher's implementation of the TAGteach method during the assessment piece of TAGteach International's Level I certification. The student researcher reviewed video footage from TAGteach training sessions and probe sessions and utilized a procedural fidelity checklist to ensure the procedures were implemented with fidelity.

Procedural fidelity data for probe sessions was reflected by the percentage of checklist items performed correctly, by dividing the number of correct items by the total number of checklist items and multiplying by 100. Probe session procedural fidelity for Tom was 97%, 99% for Anne, and 99% for George.

Procedural fidelity data for the TAGteach phase of the study were collected on TAGteach phrasing, TAGteach session delivery, and tag delivery. The procedural fidelity of TAGteach phrasing and session delivery ensured the phrasing and delivery used in each session was consistent and met the criteria established by TAGteach International (2012). Procedural fidelity data for TAGteach phrasing and session delivery were reflected by the percentage of checklist items performed correctly, by dividing the number of correct items by the total number of checklist items and multiplying by 100. Procedural fidelity data of TAGteach phrasing and session delivery were collected for 100% of TAGteach sessions. TAGteach phrasing and session delivery

was implemented with fidelity for Tom at 95%, 92% for Anne, and 96% for George. Errors in procedural fidelity of TAGteach phrasing and session delivery occurred at the highest rate during Anne's front squat session as well as Tom's overhead press. Errors included providing attention to errors (e.g., student researcher pairing vocal description to a non-example, or error, when modeling a tag point) coupled with not delivering instructions with neutral phrasing as well as extraneous talking. These errors were identified and corrected with the next session after some research on Anne's physical limitation (i.e., physical restriction due to shorter arms) and introduction of the cross grip. Errors in procedural fidelity with Tom and George included not using neutral phrasing.

The procedural fidelity of tag delivery was scored by recording either an agreement or disagreement for each attempt of a tag point by a participant. An agreement was defined as the sound of the tagger and tag point being executed correctly, or the absence of the sound of the tagger and tag point being executed incorrectly. A disagreement was defined as the sound of the tagger and tag point being executed incorrectly, or the absence of the sound of the tagger and the tag point being executed correctly. Procedural fidelity data of tag delivery were reflected by the percentage of tag delivery agreements, by dividing the total number of items completed correctly by the total number of items and multiplying by 100. Procedural fidelity data of tag delivery were collected for 100% of TAGteach sessions. Tag delivery was implemented with fidelity for Tom at 97% (range, 92-100), 93% (range, 84-100) for Anne, and 98% (range, 93-100) for George. Procedural Fidelity data were calculated after each training session by reviewing the video footage of the training session.

Interobserver Agreement

A research assistant (an Applied Behavior Analysis master's student familiar with data collection and 2.5 years of experience with resistance training) was trained to score each lift by the student researcher. After five practice opportunities, the research assistant obtained a score of 80% out of five testing opportunities, to be included in the study to collect IOA data. The use of an inclusion criteria checklist (Appendix I; Quinn et al., 2015) was used to ensure the research assistant was properly trained and felt comfortable scoring each movement using the respective checklist. To collect interobserver agreement data, the primary observer (student researcher) and a secondary observer (research assistant) independently viewed the recorded movements and scored them using the task analysis for that specific movement. An agreement was defined as both observers recording that a tag point occurred or did not occur. Interobserver agreement was calculated by dividing the number of trial by trial agreements by the number of agreements plus disagreements and multiplying by 100. Interobserver data were collected for 30% of all attempts for the deadlift, 31% of all attempts for the overhead press, and 31% of all attempts for the front squat. The mean IOA for the deadlift was 97% (range, 85-100), 96% for the overhead press (range, 92-100), and 95% for the front squat (range, 82-100).

Social Validity

Social validity for goals was collected by obtaining a normative sample of the percentage of steps performed correctly for each movement by two experienced and two

novice athletes not involved in the study. The student researcher asked acquaintances to video record their performance of three attempts of the front squat, deadlift, and overhead press. The two experienced athletes included a 41-year-old male and a 30-year-old female who each had two years of experience with the front squat, deadlift, and overhead press. The two novice athletes included a 52-year-old male and a 24-year-old female who had experience in running but not experience with the front squat, deadlift, or overhead press. The student researcher and research assistant scored the lifts using the task analyses. The scores were then averaged to obtain the normative sample which can be found in Table 1. The normative sample obtained for the deadlift was 73%, with 96% for experienced and 50% for novice athletes. The normative sample for the overhead press was 66%, with an 81% average for experienced and 50% for novice athletes. The normative sample for the front squat was 63%, with 82% for experienced and 44% for novice athletes.

Social validity of the study's procedures was evaluated using a questionnaire participants completed anonymously at the beginning (Appendix J) and at the completion (Appendix K) of the study.

Finally, social validity of the results of the study were evaluated by having a personal trainer view the movements performed during baseline, before any skill had contacted the treatment phase, and also movements performed after all skills have been trained using TAGteach. Videos were presented in a random order to the personal trainer to score all steps of the task analysis for the front squat, deadlift, and overhead press. Table 2 details the personal trainer's mean scores for each movement of all participants.

CHAPTER 4

RESULTS

The results shown in Figures 1, 2, and 3 and Table 3 demonstrate that the execution of each lift increased following training on each movement with the TAGteach procedure for all participants. Results also showed that improved performance was maintained post-intervention, and skill acquisition on an unweighted PVC pipe generalized to weighted PVC pipes for all participants. Means were calculated for all baseline and maintenance probes and for the last four attempts of each TAGteach session. The last four attempts reflect the overall acquisition obtained over the course of the training session.

Table 1
Normative Sample of Accurate Performance by Experienced and Novice Athletes

Skill Level	Overhead Press	Deadlift	Front Squat
Experienced	81%	96%	82%
Novice	50%	50%	44%
Average	66%	73%	63%

Table 2
Social Validity of Results of Personal Trainer Scores

	Deadlift		Overhead Press		Front Squat	
	Pre	Post	Pre	Post	Pre	Post
Tom	28%	77%	31%	87%	37%	78%
Anne	36%	87%	46%	79%	39%	84%
George	51%	90%	41%	82%	47%	88%

Table 3
Mean Scores for Overhead Press, Front Squat, and Deadlift

		Unweighted			Weighted	
Participant	Movement	Baseline	TAGteach[a]	Maintenance	Baseline	Maintenance
Tom	Overhead Press	27%	89%	88%	23%	95%
	Front Squat	44%	88%	77%	43%	82%
	Deadlift	26%	87%	85%	33%	87%
Anne	Front Squat	37%	88%	88%	41%	88%
	Deadlift	35%	90%	92%	46%	90%
	Overhead Press	45%	88%	82%	43%	100%
George	Deadlift	54%	83%	94%	54%	93%
	Front Squat	50%	94%	93%	51%	100%
	Overhead Press	38%	96%	85%	43%	90%

Note. Movements are listed in the order in which they were targeted for each participant.
[a]Mean calculated based on the last four data points of phase.

Results for Tom are shown in Figure 1. Accurate performance for Tom increased across all movements once TAGteach was implemented. For the overhead press, the baseline mean was 27% (range, 23-31), the TAGteach session mean was 89% (range, 85-92), and the maintenance mean was 88% (range, 77-100). For the front squat, the baseline mean was 44% (range, 35-47), all values of TAGteach session data were 88%, and the maintenance mean was 77% (range, 76-82). For the deadlift, the baseline mean was 26% (range, 23-31), the TAGteach session mean was 87% (range, 85-92), and all values of maintenance sessions were 85%. Although improved performance did not maintain at the rate achieved during training sessions for Tom in the front squat, performance during maintenance never returned to baseline levels post intervention. Generalization data for the overhead press had a baseline value for all data points of 23%, and a maintenance mean of 95% (range, 85-100). Generalization data for the front squat had a baseline mean of 43% (range, 41-47) and all values of maintenance data were 82%. Generalization data for the deadlift had a baseline mean of 33% (range, 31-38) and a maintenance mean of 87% (range, 85-92). Generalization data for Tom reflected the same increases in performance with no teaching being conducted with a weighted PVC pipe.

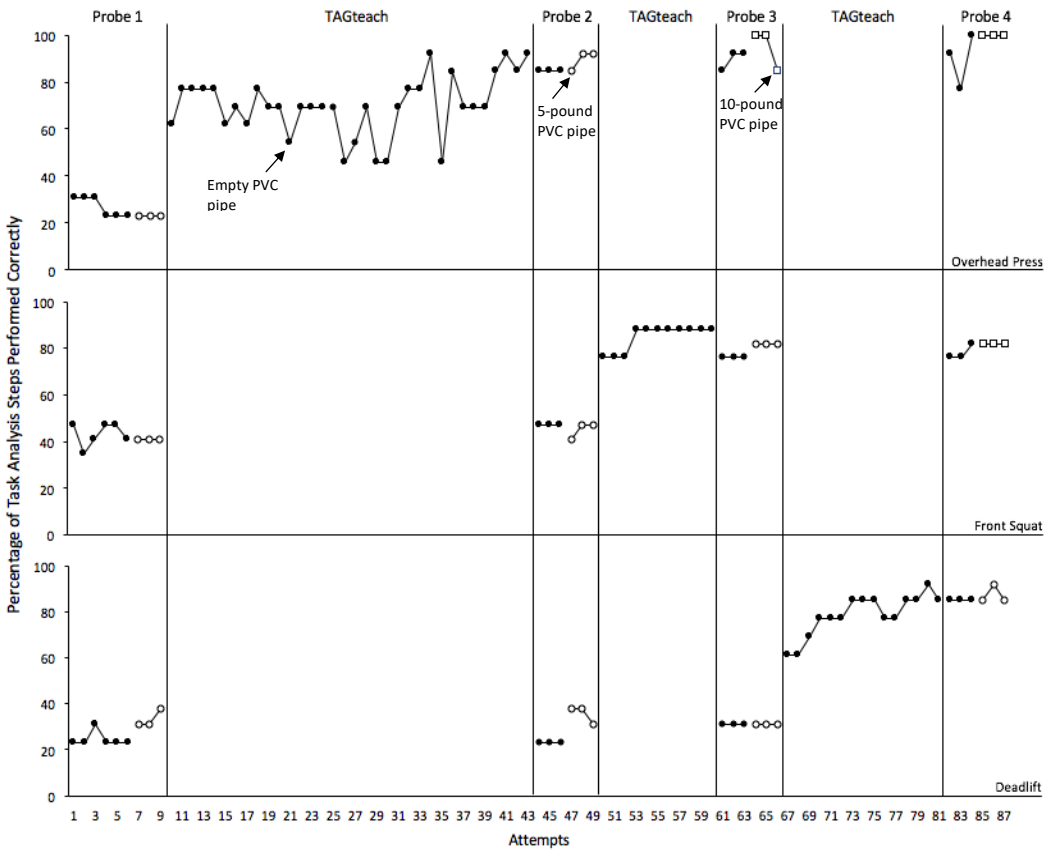

Figure 1. Percentage of task analysis steps performed correctly for Tom.

Results for Anne are shown in Figure 2. Accurate performance for Anne increased across all movements once TAGteach was implemented, although, upon visual analysis, the percentage of overlapping data points for the front squat is 4%. During the TAGteach training session for the front squat, Anne had difficulty getting her elbows up in the correct position. After the first session, the researcher consulted with a personal trainer about the problem and was instructed to have her switch to a cross grip (folding arms criss-cross over the bar with elbows up). The personal trainer explained that some athletes, have a physical restriction with the standard grip due to shorter arms and shorter stature. This was the case with Anne given the fact she is only 5'0" in height. During the second session of TAGteach training the cross grip was used and data further increased to master criteria. For the front squat, the baseline mean was 37% (range, 35-41), all values of TAGteach session data were 88%, and values for maintenance data were 88%. For the deadlift, the baseline mean was 35% (range, 31-38), the TAGteach session mean was 90% (range, 85-92), and values for maintenance data were 92%. For the overhead press, the baseline mean was 45% (range, 38-54), the TAGteach session mean was 88% (range, 77-92), and the maintenance mean was 82% (range, 77-85). Generalization data for the front squat had a baseline value of 41% for all data points and a maintenance value of 88% for all data points. Generalization data for the deadlift had a baseline mean of 46% (range, 46) and a maintenance mean of 90% (range, 85-92). Generalization data for the overhead press had a baseline mean of 41% (range, 38-46) and a maintenance value of 100% for all data points. Generalization data reflected the same increases in performance with no teaching being conducted with a weighted PVC pipe.

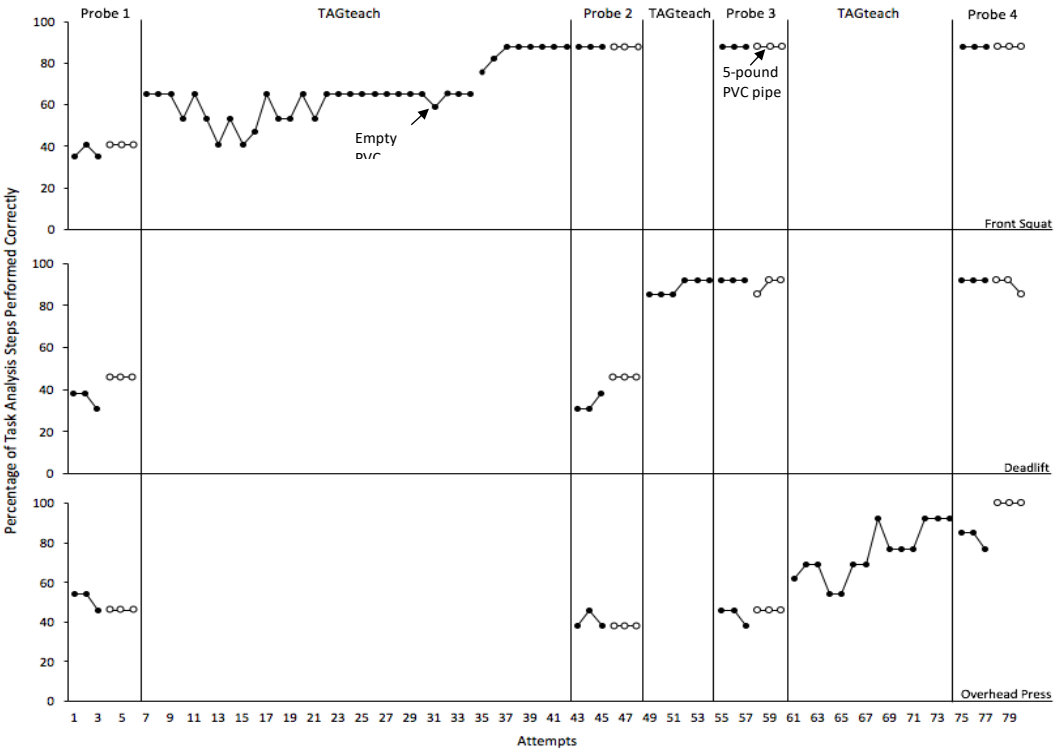

Figure 2. Percentage of task analysis steps performed correctly for Anne.

Results for George are shown in Figure 3. Accurate performance for George increased across all movements once TAGteach was implemented. For the deadlift, the baseline data were 54% for all data points, the TAGteach session mean was 83% (range, 77-85), and the maintenance mean was 94% (range, 92-100). For the front squat, the baseline mean was 50% (range, 41-53), the TAGteach session data were 94% for all data points, and the maintenance mean was 93% (range, 88-94). For the overhead press, the baseline mean was 38% (range, 23-54), the TAGteach session mean was 96% (range, 85-100), and the maintenance data were 85% for all data points. An increasing trend can be observed during TAGteach for the deadlift and the front squat. Although a slight decreasing trend is observed in George's data during TAGteach for the overhead press, there are 0% overlapping data points with baseline data. There was a decrease in performance during TAGteach for the overhead press on the eighth attempt. The skill targeted during this attempt was to look straight ahead which was targeting an observed error of George looking up at the sky. By looking straight ahead, this affected four of the five remaining tag points (excluding locking elbows at the top). Generalization data for the deadlift had a baseline value of 54% for all data points and a maintenance mean of 93% (range, 85-100). Generalization data for the front squat had a baseline mean of 51% (range, 47-59) and a maintenance value of 100% for all data points. Generalization data for the overhead press had a baseline mean of 43% (range, 23-54) and a maintenance mean of 90% (range, 85-92). Generalization data reflected the same increases in performance with no teaching being conducted with a weighted PVC pipe.

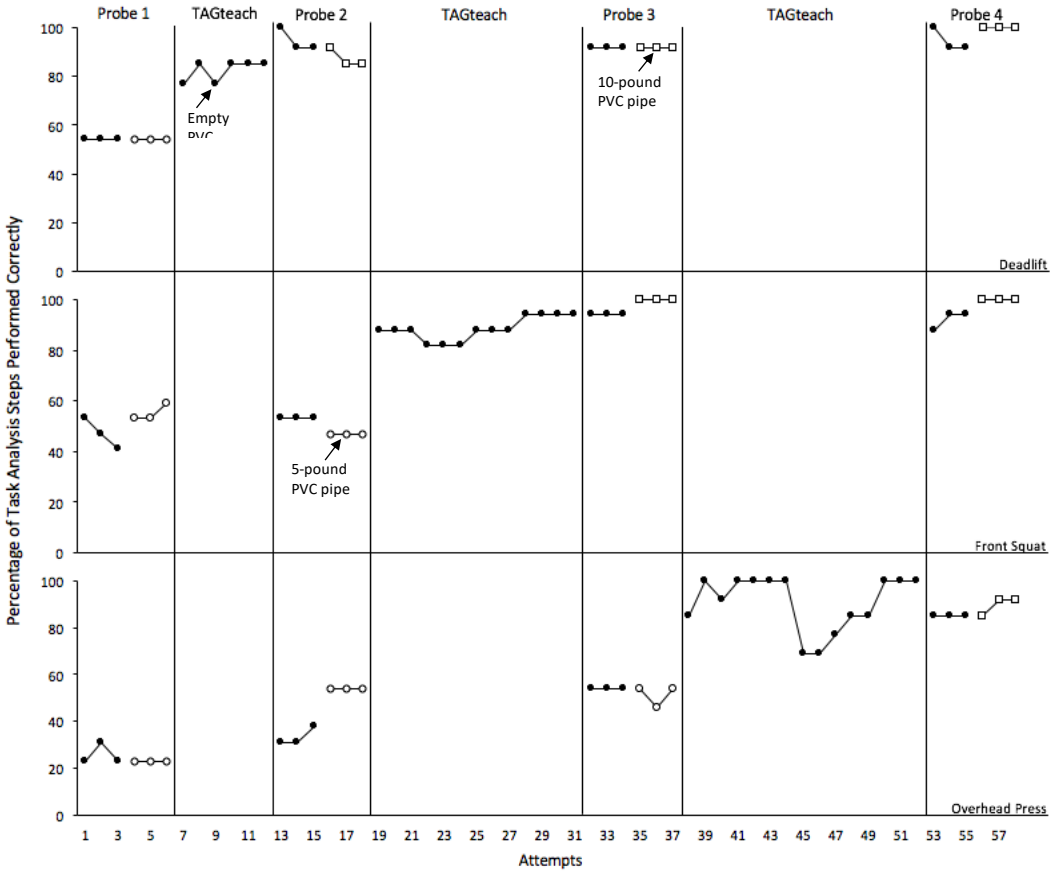

Figure 3. Percentage of task analysis steps performed correctly for George.

Results of the final social validity questionnaire revealed that all three participants expressed a positive experience and felt that their athletic skill related to these movements had improved. Two participants pointed out that they had never had a coach break down skills into finite tasks. They felt that attempting to perform a global skill without even understanding the minute tasks required to get from point A to point B inhibited their ability to easily and confidently process and perform the required movement. Most importantly, they each indicated that what they learned would provide them the confidence to pursue further training in a gym using TAGteaching with other participants. The positive results and social validity would suggest that TAGteach has the potential to be an efficacious strategy for athletic skills training across a variety of competitive and recreational sports.

CHAPTER 5

DISCUSSION

The present study evaluated the effectiveness of the TAGteach method as a stand-alone intervention on the performance of three resistance training movements (front squat, deadlift, and overhead press) in novice adult athletes. All three participants improved their performance of each movement from baseline performance and maintained above baseline levels. Their improved performance generalized to heavier loads than those used during training sessions and for certain movements improved. It should be noted that baseline data with a weighted PVC pipe for the deadlift for both Tom and Anne were higher than those performed with the unweighted PVC pipe. This could be because it more weight on the PVC pipe provides more feedback for the participants to use to self-assess their performance even during probe conditions in which no feedback is provided by the student researcher. An increasing trend was observed during baseline of the overhead press for George. This, again, could be due to the increased weight providing more feedback to an athlete. This is especially the case with the overhead press, as it does not include substantial body weight in the movement that the deadlift and front squat require.

This study supports the findings of previous studies that empirically established TAGteach to be an effective procedure for teaching athletic performance (Ennett et al., 2020; Fogel et al., 2010; Quinn et al., 2015; Sniffen, 2017). Although other studies evaluated the effects of other behavioral coaching interventions on more complex resistance training movements (i.e., Olympic weightlifting; Moore & Quintero, 2019;

Mulqueen, 2014; Sewall et al., 1988), this is the first known study to evaluate the effects of TAGteach as a stand-alone coaching procedure on the less explosive and foundational resistance training movements.

These positive findings are consistent with the current body of behavioral coaching literature as a whole. A review of behavioral coaching literature by Schenk and Miltenberger (2019) found that there is a publication bias that reports very few negative results. Based on their review, the authors suggest that a possible reason for the abundance of positive results could be due to the fact that the majority of behavioral coaching procedures are a treatment *package*. When implementing a coaching procedure that involves multiple components, one or more is bound to have an effect on athletic performance; thus, the rather consistent positive results.

Although the present study improved on athletic performance and, therefore, extended the findings of the current body of literature on TAGteach, there were limitations that need to be taken into consideration. One limitation became apparent early in this study: the normative sample for the movements was lower than the mastery criteria for the study. Though the average for experienced athletes was 80% or above for each movement, the normative sample for each lift was below the set mastery criteria for the study. This could be a factor in the lengthy sessions for the overhead press for Tom and the front squat for Anne. The disproportionate length of the session may have been influenced by the mastery criteria being set too high for each movement given that the participants were novice athletes requiring more repetitions of the movement to achieve mastery. Consequently, the increased length of the front squat session proved to be a

point of frustration that Anne noted on her social validity questionnaire. Based on this limitation, it could be hypothesized that if the mastery criteria had been a percentage of increase in performance (i.e., increase of 20% of baseline mean) based on the participants' baseline mean, the ratio strain experienced for Anne and Tom may have been avoided.

Another limitation of this study, also highlighted by the participants, occurred during probe sessions when using the unweighted PVC pipes. All three participants expressed their frustration with the inability to accurately self-assess with the overhead press using the unweighted PVC pipe. Participants felt that it was easier to self-assess their performance, specifically the overhead press, using the weighted PVC pipe. Given the importance of maintaining high social validity in order to encourage performance and maintain participation, using heavier weights during training sessions should be considered in future weightlifting studies.

Another limitation of the study was that the student researcher was the only observer evaluating the procedural fidelity checklists which may have created a bias in the data. Future research should include a secondary observer that is Level 1 TAGteach certified, to provide IOA data collection for procedural fidelity.

In addition to the issue related to bar weights and procedural fidelity data, another limitation of this study was the inconsistent and sometimes excessive gaps of time (e.g., 3 weeks to 4 weeks) between training and maintenance probes. Participants often needed a reminder as to which movement was which and the student researcher needed to model the movement (with no additional feedback or training) prior to the collection of probe

data. Aside from frequent rescheduling due to participant commitments, this study required rescheduling due to weather - since all sessions were conducted in a local park. This setting did not lend itself to evenly spaced and timely sessions. Future research should consider holding the sessions indoors and should create a mutually agreed upon schedule of sessions (ideally 1 week apart) so as to avoid the need to review the movements with participants prior to maintenance probes. Conducting a future study in a more natural setting (such as a gym) with a natural schedule should provide more valuable results, more applicable to a mainstream setting.

Other studies that have evaluated TAGteach as a stand-alone procedure (Ennett et al., 2020; Fogel et al., 2010; Quinn et al., 2015; Sniffen, 2017) suggest isolating and evaluating individual components in order to determine which TAGteach component is most (or least) effective in improving athletic performance. Similarly, the results of the current study also warrant this call for future research not only for the purpose of improving performance but also for offering an improvement in the time it takes to achieve mastery. Both of these goals are fundamental for real world athletic training. Only by analyzing the effectiveness and the efficiency of each component of TAGteach, (i.e., immediate feedback, modeling, and chaining) will research be able to establish an evidenced-based best practice for athletic performance training.

Schenk and Miltenberger (2019) suggest that the reason the behavioral coaching literature widely evaluate treatment packages is largely due to the simple fact that they are effective. Nevertheless, there have been three studies targeting athletic performance that have attempted to answer this call for individual component analysis, but these

studies have yielded mixed results. Moore and Quintero (2019) for example, were able to effectively isolate the specific component of chaining and concluded that forward chaining was more successful in improving performance than backward chaining for Olympic weightlifting lifts. In contrast to this study, Young (2017) attempted to evaluate the validity of the acoustical feedback component as a coaching procedure in two high school shot putters. The authors ultimately concluded that isolating the tagger alone procedure was viewed as unnatural and aversive to athletes and also decreased athletes' performance. However, in a very recent study, (Ennett et al., 2020), the researchers were able to successfully isolate and evaluate the error-correction component while also maintaining social validity for adult yoga participants. This study was the first of its kind in the TAGteach literature in that it validated one component of the TAGteach procedure with empirical support. Based on the results of these three studies and the results of the present study, it would warrant future research to expand further by replicating the design used by Ennett et al. (2020) to evaluate the validity of the other TAGteach components while also maintaining the social validity of the procedure.

Another component that might be studied in isolation would be to evaluate the effects of personalized tag points compared to coach-assigned tag points. Interestingly, one of the participants in the present study made a point of indicating their preference for the personalized tag points in their social validity questionnaire. Isolating this particular component of personalized tag points would be of particular interest and would add to the current body of literature.

While the findings of this current study support the current body of literature that suggests TAGteach is an effective intervention for enhancing sports performance, the positive results of this study showed a considerable increase in level of accurate performance most likely due to the fact that the resistance training movements are relatively uncomplicated and most performance gains are seen at the very beginning of training. This demonstrates a need for future research to target other domains of weightlifting (such as Olympic weightlifting and powerlifting) with more advanced and competitive athletes. The training for these types of athletes would seek to fine tune their technique and increase the volume of weights (the ultimate goal of weightlifters). Additionally, such a study involving more advanced participants and more complex and dangerous movements should consider "training the trainer" in the TAGteach method. This approach would also attempt to answer questions related to the portability of TAGteach to mainstream use: can coaches be effectively and quickly trained on using the TAGteach method and implement it with fidelity? Would the results be similar? Would both the coaches and the participants find the TAGteach method effective, efficient and preferable? Only if future studies and their subsequent replications answer these questions affirmatively will this method of athletic coaching have the potential for mainstream use, which is ostensibly the goal and justification for the myriad and rigorous studies on this highly structured coaching technique.

To conclude, this study effectively improved the performance of novice participants in the three resistance training foundational movements and was a seen as a positive coaching experience by all participants. Given the cultural and wellness appeal

of athletic participation at any level, finding a method that will facilitate skill acquisition will aid all individuals to participate safely, confidently, and to some degree of expertise in their chosen athletic pursuit.

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APPENDIX A

TAG Phraseology

TAGteach triangle: the three components of TAGteach: identify, mark, and reinforce.

Tagger: the handheld device that emits a clear, precise, and consistent acoustical stimulus (tag) to mark the desired behavior as it occurs (generalized conditioned reinforce).

Tag point: an achievable and objective behavior that is marked with a tag contingent on its occurrence. The TAGteach methodology requires that only one behavior is targeted at a time. Once the behavior that is being tagged occurs consistently, the next target behavior or successive approximation of the desired behavior can be targeted (shaping).

WOOF: the criteria used to create a tag point. A tag point must be what behavior you want, observable/measurable, one criterion, and five words or less.

Tag: the "tic-tac" sound produced by the tagger. Learners are taught that a tag means "yes," and the absence of a tag means, "self-assess and try again." No additional feedback is provided to the learner other than a tag.

Break it down: the process of identifying the ultimate goal or behavior (complex behavior) and dividing it into smaller behaviors (discrete behaviors) that can be easily achieved and observed. This is how TAGteachers identify and define a tag point (task analysis)

Three-try rule: a procedure that is implemented when a learner has failed to perform a tag point after three consecutive attempts. This procedure involves the teacher breaking down the tag point into a new tag point(s) that is(are) more achievable for the learner.

Value-Added tag point: a single tag point that produces more than one behavior within that behavior chain (behavioral cusp).

Focus funnel: the technique used in planning and teaching; beginning with the broad lesson, then information is reduced into more concrete instructions, and finally reduced again to a precise tag point.

Debrief: an interaction between teacher and learner in which the learner is asked if they are ready to move on to the next tag point.

Point of success: a learned behavior to begin with or return to, in which the learner is guaranteed a tag.

Forward chaining: the process of teaching each discrete behavior (tag point) that make up a complex behavior, in the naturally occurring sequence. The first tag point in the sequence is taught until it occurs consistently, and then the next tag point in the sequence is taught. This process continues until all tag points have been taught.

APPENDIX B

Physical Activity Readiness Questionnaire (PAR-Q)

Data Collection Sheet

NAME: _____ DATE: _____

HEIGHT: n/a in. WEIGHT: n/a lbs. AGE: _____

PHYSICAL ACTIVITY READINESS QUESTIONNAIRE (PAR-Q)

	Questions	Yes	No
1	Has your doctor ever said that you have a heart condition and that you should only perform physical activity recommended by a doctor?		
2	Do you feel pain in your chest when you perform physical activity?		
3	In the past month, have you had chest pain when you were not performing any physical activity?		
4	Do you lose your balance because of dizziness or do you ever lose consciousness?		
5	Do you have a bone or joint problem that could be made worse by a change in your physical activity?		
6	Is your doctor currently prescribing any medication for your blood pressure or for a heart condition?		
7	Do you know of any other reason why you should not engage in physical activity?		

If you have answered "Yes" to one or more of the above questions, consult your physician before engaging in physical activity. Tell your physician which questions you answered "Yes" to. After a medical evaluation, seek advice from your physician on what type of activity is suitable for your current condition.

APPENDIX C

Task Analysis: Deadlift

	Task Analysis Steps	Tag Point	+/-
Set-up	Feet hip-width stance, toes pointed slightly outward		
	Bar sits over middle of the foot (over middle of shoelaces)		
	Hands grip bar just outside of feet		
	Lower hips until shins touch bar		
	Pull shoulders back and down		
	Back straight with neutral spine		
	Elbows locked (straight)		
Pull	Neck in neutral alignment with spine		
	Chest and hips raise together		
	Bar drags along body		
	Stop at top with neutral spine (do not lean back)		
	Chest up throughout		
	Elbows locked (straight) throughout		

APPENDIX D

Task Analysis: Front Squat

	Task Analysis Steps	Tag Point	+/-
Set-up	Hands grip bar just outside of shoulder width		
	Elbows up (triceps parallel to ground)		
	Feet hip-width stance with toes pointed slightly outward		
	Pull shoulder blades back and down		
	Back straight with neutral spine		
	Look straight ahead		
Descent	Break at the hip and push bottom back		
	Knees remain over feet (do not collapse inward)		
	Elbows up throughout		
	Chest up throughout		
	Back remains straight with neutral spine		
	Squat until hips are below knees		
Ascent	Drive knees out knees out (do not collapse inward)		
	Elbows up throughout		
	Chest up throughout		
	Back remains straight with neutral spine		
	Hips and knees extend (raise) simultaneously		

APPENDIX E

Task Analysis: Overhead Press

	Task Analysis Steps	Tag Point	+/-
Set-up	Hands grips just outside shoulder-width		
	Bar sits on heel of the palm		
	Elbows and forearms in vertical position (perpendicular to bar)		
	Elbows slightly in front of bar		
	Bar rests on shoulders		
	Feet hip-width stance		
	Look straight ahead		
	Pull shoulders back and down		
	Chest up		
Push	Lean back by pushing hips forward		
	Push bar in a straight line overhead (close to face)		
	Push torso forward until head is directly under bar		
	Lock elbows at the top		

APPENDIX F

Personal Trainer Survey of Task Analyses

Personal Trainer Survey		YES	NO
1	I have reviewed the task analyses for the following movements:		
	• Front squat		
	• Deadlift		
	• Overhead press		
2	I have made suggestions for changes when needed based on my professional knowledge of the movements.		
3	These suggestions have been applied by the researcher.		
4	The following task analyses are accurate and consistent with industry standards.		
5	I feel the movements selected are beneficial for a novice athlete to learn to execute accurately.		

Initials: _____Date: _____

APPENDIX G

Procedural Fidelity Checklist: TAGteach Sessions

Assessment Criteria	+/-
Session begins from a point of success	
All tag points meet WOOF Criteria	
Instructions are given with neutral phrasing (see chart below) **Record +/- for each opportunity**	
Tag points are delivered with neutral phrasing (see chart below) **Record +/- for each opportunity**	
"The tag point is..." is the last phrase spoken before the learner takes their turn **Record +/- for each opportunity**	
There is no extraneous talking by the teacher	
Errors are ignored by teacher	
Teacher demonstrates the skill for the learner **Record +/- for each opportunity**	
Learner gets a chance to be the teacher **Record +/- for each opportunity**	
Each tag point repeated at least 3 times before moving on **Record +/- for each opportunity**	
3 try rule is obeyed (if there are errors)	
Session ends on a high note (accurate performance/receives a tag)	
TOTAL	/
PERCENT	**%**

TAGteach Phrasing	Does not Meet Criteria
The instructions are stand with your feet on the yellow line, hold up your right hand and take your turn when the person before you is finished.	**I want** you to ... **I would like** you to ... Here's what **I want you** to do...
The tag point is fingertips on ball	**I want** you to ... **I would like** you to ... Here's what **I want you** to do... **... you ... ... I ...**
Let me demonstrate	I will tag myself
It's your turn to tag	You tag me
It's my turn to tag	I will tag you
It's Peter's turn to tag (or be the teacher)	Peter will tag you
It's your turn to be the teacher (or to tag)	You will tag Peter

Tag Delivery

Tag Point	Agreement (A)/ Disagreement (D) –Each attempt

TOTAL AGREEMENTS	/
PERCENT AGREEMENTS	**%**

Agreement: sound of the tagger and tag point being executed correctly, or the absence of the sound of the tagger and tag point being executed incorrectly.
Disagreement: sound of the tagger and tag point being executed incorrectly, or the absence of the sound of the tagger and the tag point being executed correctly.

APPENDIX H

Procedural Fidelity Checklist: Probe Sessions

	+/-
1. Participant performs 3 lifts with empty barbell	
• NO feedback provided	
• NO training provided	
• Rest- 5 minutes	
2. Participant performs 3 lifts with loaded barbell	
• NO feedback provided	
• NO training provided	
TOTAL	/
PERCENTAGE	**%**

APPENDIX I

Proficiency Checklist: Research Assistant Training

**This checklist will be used to ensure that you have been trained properly as a Research Assistant. *In order to be able to act as a Research Assistant on this study, a score of 80% agreeability (out of 5 test rounds) on scoring a sample Task Analysis checklist must be obtained.*

1. **TAGteach PowerPoint presentation training**.

YES_____ NO_____

- Instructions of TAGteach methodology
- Modeling of TAGteach procedures by lead researcher teaching RA a novel skill using TAGteach.
- Role play of TAGteach procedures with lead researcher and using practice videos.

- Feedback of RA's performance of their role-play by lead researcher.
- At least 3 opportunities to practice provided.
- RA asked if they have any questions about the procedures before moving on.

2. **TAGteach practice games:**

YES_____ NO_____

3. **Training of the sample task analysis by the lead researcher to the research assistant:**

YES_____ NO_____

- Instructions for completing the task analysis including visual descriptions of each tag point in the task analysis.
- Modeling by the lead researcher and the lead RA of how to complete the task analysis via a live demonstration.
- Role Play of completing the task analysis on behalf of the RAs via live modeling and also observing performance videos on YouTube. (The lead researcher and lead RA will have pre-scored these videos using the task analysis).
- Comparison of the scores on the task analysis of the RAs with the lead researcher's and feedback provided of how to improve the score/ any missed aspects of the performance.
- At least 5 practice opportunities will be provided.
- Following the 5 practice opportunities, 5 test rounds will be provided where the RAs score videos on their own.

4. **RA demonstrated at least an 80% agreeability with the lead researcher on 5 testing opportunities of scoring following the training of the task analysis**:

YES_____ NO_____

5. **RA was provided an opportunity to ask questions of the lead researcher regarding the task analysis:**

YES_____ NO_____

I accept my responsibility as a research assistant on the study: "The Effects of TAGteach™ on the Execution of Olympic Weightlifting Technique." My roles and responsibilities have been clearly explained to me by the lead researcher and I have been provided an opportunity to ask questions and know if I have any future questions I am to contact Alexa. I have been trained on the sample task analysis checklist and provided multiple opportunities to practice. I understand that this training will occur for each of the individualized task analysis constructed in the study and I agree to attend further trainings throughout the study to ensure I am proficient in my data collection.

_____

Research Assistant Signature & Date

_____

Lead Researcher Signature & Date

APPENDIX J

Social Validity Questionnaire: Initial

1. What coaching procedures have you experienced and how would you describe them in terms of difficulty and fun?
2. What did you like most about your previous experience with coaching procedures?
3. What if anything, did you dislike about your previous experience with coaching procedures or what would you change?
4. Would you recommend that coaching procedure to a friend?
5. Additional comments?

	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
My athletic skills were improved with this coaching procedure.					
I was more confident in my athletic skills.					
I felt safer executing skills.					
I would like my coach and/or future coaches to use this procedure during my training sessions.					

APPENDIX K

Social Validity Questionnaire: Final

1. How did the TAGteach procedure compare to a typical training session as far as difficulty and fun?
2. What did you like most about the TAGteach procedure?
3. What if anything, did you dislike about the TAGteach procedure or what would you change?
4. Would you recommend the TAGteach procedure to a friend?
5. Additional comments?

	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
My lifting has improved following the TAGteach procedure.					
I am more confident in executing lifts.					
I feel safer executing lifts with more weight on the bar.					
I would like my coach and/or future coaches to use TAGteach during my training sessions.					