Efficacy of TAGteach® Interventions: Comparing the Effects of Verbal and Audible Feedback

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Efficacy of TAGteach® Interventions: Comparing the Effects of Verbal and Audible Feedback on Skill Acquisition of Volleyball Skills

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Abstract

TAGteach® (based on principles of teaching with acoustical guidance) is an emerging behavioral coaching strategy that utilizes verbal instructions, visual models, and audible feedback to promote skill acquisition of a variety of skills (e.g., sports, activities of daily living, and occupational skills). Extending the findings of previous research, the current study compared the effects of audible feedback (inherent in TAGteach and verbal feedback on the skill acquisition of two volleyball skills. Five female adolescents participated in the study. Results indicated that, for all participants, implementation of TAGteach procedures (regardless of the topography of feedback), produced increases in task analysis steps performed correctly, and those increases maintained for up to two weeks. Results further indicate that performance inconsistently generalized to the natural setting (i.e., inclusion of a volleyball). Results are discussed in terms of crucial components of TAGteach and the analysis of efficient behavioral instruction.

Keywords: TAGteach, sports, behavioral instruction, feedback

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Chapter 1: Introduction

The application of behavior analysis involves the implementation of principles followed by a continual collection of data that allows professionals to not only measure any and all behavior changes but also guides decisions regarding intervention proprieties and procedures (Baer et al., 1968). The principles and procedures embedded within applied behavior analysis have been successful across a wide range of domains (Kessler, 1984) including assessment and treatment of autism spectrum disorder (e.g., Fisher & Zangrillo, 2015), staff training (Lerman et al., 2015), safety skills (Miltenberger et al., 2015), and gambling (e.g., Daar & Dixon, 2015).

Behavior analytic principles have aided in the development of instructional procedures for several years (Chase, 1985). Skinner (1984) asserted that schools relied on inadequate implementation of principles including a heavy reliance on punishment procedures (e.g., verbal reprimands), use of delayed reinforcement (e.g., not getting test results back quickly), improper use of shaping procedures, and application of thin schedules of reinforcement. A behavior analyst would suggest that a student's ability to learn, is based not solely on personal attributes (e.g., motivation, preparedness), but rather the design of the educational curriculum and the teaching procedures (Vargas & Vargas, 1991). More specifically, behavior analysis provides an empirical foundation for which educational curricula are designed and implemented; the student's success, or lack thereof, shapes the way an instructor presents materials in the future (Vargas & Vargas, 1991). Key components embedded within behavioral or programmed instruction include: (1) indicating course targets or objectives; (2) including the learner within the education process; (3) overseeing possibilities to safeguard a positive environment (includes schedules of reinforcement); (4) analyzing data on a regular basis to deliver performance-based feedback; (5) presenting learning materials on a consistent schedule (or at a high rate); (6)

requiring mastery of material taught; (7) presenting materials that are clearly written; and (8) designing a curricula that promotes individual paced learning (Ruskin & Ruskin, 1977; Vargas & Vargas, 1991). .

Over the decades, behavior analysts have extensively researched the variables surrounding effective learning and have developed several different behaviorally based packages, including (1) Computer-Assisted Instruction (CAI), (2) Contingency Management (CM), (3) Precision Teaching (PT), and (4) Personalized System of Instruction (PSI; Ruskin & Ruskin, 1977). Computer Assisted Instruction (CAI) is defined as the delivery of educational materials online (Zhang et al., 2007). Two key behavioral components integrated within this behavioral approach include individualized paced learning and immediate feedback (Zhang et al., 2007). The complexity and delivery system of CAI varies; while some programs adapt to varying student abilities, others restrict advancement until mastery of study objectives are achieved (Bennet, 2012). Moreover, while some programs remove student-instructor interactions completely, other programs include remote face-to-face instructions (e.g., Bennet, 2012). These blended CAI packages are referred to as teacher-directed CAI and are emerging within the educational enterprise (Cengage, 2020). In an attempt to compare computer-assisted instruction to typical face-to-face instruction, Zhang and colleagues (2007) reviewed the literature, and found that both forms of instructional packages were equally effective in terms of student outcome measures (Zhang et al., 2007). Liao (2004) and Zhang et al (2007) conducted meta-analyses comparing CAI to traditional face-to-face instruction on student achievement (e.g., grade point average) and results indicated that computer-assisted instruction was as or more effective than traditional instruction.

Contingency Management (CM) involves the systematic use of behavioral consequences to promote desired behavior change (Higgins & Silverman, 2008). Based on operant conditioning principles, contingency management focuses primarily on the contingency, or relationship between behavior and its consequences, currently maintaining behavior (Berman, 1971). Contingency management is most widely known for its effectiveness in the treatment and maintenance of substance use disorders (Higgins & Silverman, 2008). The use of contingency management dates back to the 1960's, where researchers reduced the frequency with which smokers smoked cigarettes by delivering contingent monetary reinforcers (Higgins & Silverman, 2008). Key components of contingency management include: (1) behavioral contracting; (2) objectively quantified behaviors; (3) consistency; (4) frequency; (5) shaping; (6) priming; (7) immediacy; and (8) systematic increase of reinforcers (Petry, 2000). A behavioral contract outlining the target behavior(s) and contingencies imposed is central to all applications of contingency management (Petry, 2000).

In general, contingency management promotes desired changes in behavior via the delivery of positive reinforcement (e.g., monetary-based voucher) for meeting goals written in the behavioral contract (e.g., Higgins & Silverman, 2008). For example, Dunn and colleagues (2010) delivered contingent and non-contingent reinforcement in the form of monetary vouchers for not smoking (measured via testing). Participants receiving non-contingent reinforcement were provided monetary vouchers independent of smoking statues. Results indicated that participants receiving contingent reinforcement (i.e., contingency management) abstained from smoking meaningfully longer than those receiving non-contingent reinforcement (Dunn et al., 2010). In a systematic review of voucher related contingency management interventions for substance use disorders, Davis and colleagues (2016) found that CM seems to be an effective

procedure indicating (1) improved behavior change both during and after treatment, (2) high treatment efficacy, and (3) applicability of procedures to a wide range of SUD's (i.e., substance use disorders), populations, and settings (Davis et al., 2016).

Precision Teaching (PT) is best described as a procedure to be combined with an already existing curriculum to maximize learning (Kubina et al., 2002; Lindsley, 1991). Precision teaching was first implemented by Lindsley who applied the use of count per minute measures to measure behavior (Binder, 1990). The design and implementation of precision teaching involves the identification of (1) objective performance goals, (2) specific consequences, and (3) the functional relationship between the behavior of interest and the environmental consequences currently maintaining the behavior (Breuing, 1978). The learning sequence embedded within precision teaching includes the presentation of small behavioral units or steps that are continually assessed and measured via the Standard Celeration Chart (Brent, 1977; Breuning, 1978). These performance assessments function as a diagnostic tool for both students and teachers to evaluate performance progression necessary to proceed to the subsequent step in the behavioral chain (Breuing, 1978). These frequent assessments also allow students to receive immediate feedback on their performance, thereby reinforcing correct performance. The standard celeration chart utilized in PT is a refinement of a multiply-divide chart, which graphically displays relative changes in behavior without distortion (Brent, 1977). That is, percent gains (in behavior) are displayed equally on the chart.

The addition of precision teaching procedures has resulted in the establishment of interventions that showed to be effective in many contexts including populations with and without disabilities, in school-wide implementations, and in individual-specific studies (Kubina et al., 2002). Ramey and colleagues (2016) indicated that the use of PT for individuals with

developmental disabilities is an emerging treatment. For example, Datchuk (2017) evaluated the effectiveness of precision teaching and direct instruction on sentence construction for 15 middle school students. The intervention involved providing explicit instructions as well as continual assessment and measurement of student performance via the standard celeration chart. Presentation of instructional material during the intervention was based on progress (or lack thereof) charted. Implementation of precision teaching procedures resulted in increased average number of correct sentences across all students.

Personalized System of Instruction

Another example of behavioral instruction is the Personalized System of Instruction (PSI), otherwise known as the Keller Plan (Keller & Sherman, 1974). Keller and Sherman (1974) emphasized that their original intent was to create a curriculum that allowed students to naturally progress through learning materials independent of a calendar or clock. PSI is defined by five key components: (1) individual-paced learning to promote flexibility in completing course work, (2) mastery criteria to ensure understanding of course material before progressing to new or novel material (typically measured via multiple small quizzes), (3) lectures, that when used, are aimed at motivating students to explore novel topics rather than cramming a bunch of information at the students, (4) the use of written instructions to provide objective study goals, and (5), the use of proctors whose sole purpose is to increase one-to-one interactions by means of reinforcing student behaviors, evaluating study performance, and delivering performance feedback in a timely manner (Fox, 2004; Fuller, 2005; Keller & Sherman, 1974). By design, PSI creates several opportunities to access reinforcement, some of which include (1) working ahead of schedule, (2) completing small work assignments, (3) receiving immediate feedback, and (4) interacting with the proctor (Keller & Sherman, 1974).

There are three reasons for creating a curriculum that is student-paced. First, students have their own obligations outside of school (e.g., childcare, occupations) that require their time (Buskit et al., 1991). As such, allowing students to create their own schedule, in terms of course work, could increase the quality of time spend completing that work. Second, the literature has repeatedly demonstrated that students learn information at different rates, and thus, could benefit most from this type of curriculum (Buskit et al., 1991). Third, for some students, the opportunity to complete a course ahead of schedule (or before the official semester end date) could function as a highly preferred reinforcer (Buskit et al., 1991; Keller & Sherman, 1974). In an attempt to evaluate the effects self-paced learning can have on performance, Tullis and Benjamin (2011) conducted an experiment on word recollection. Researchers divided participants into two groups, one of which allowed students to allocate their own time (i.e., self-paced), and the other whose time was predetermined by the researchers. Results indicate that participants permitted to allocate their own time substantially outperformed those whose time was determined by the researchers.

Mastery criteria for accurate responses is best conceptualized in two ways (Fuller & Fienup, 2018). First, it assesses level of performance in terms of correct versus incorrect responding. Second, it considers the number of observations at which the learner performed at a certain level. Mastery of information is typically measured by the completion of multiple unit quizzes that are comprised of multiple-choice, fill-in-the-blank, and short answer questions (Buskit et al., 1991; Keller & Sherman, 1974). Often times, students are given the opportunity to retake quizzes (contingent of poor performance), until they can demonstrate mastery. To evaluate the effects varying levels of mastery criteria can have on performance, Fuller and Fienup (2018) employed three different mastery criteria's: 50%, 80%, and 90% accuracy. After each participant

met their specific mastery criterion, maintenance of skills taught were assessed 3 to 4 weeks later. Results showed higher levels of maintenance for the participant who had been exposed to a mastery criterion of 90%. In comparison, lower levels of mastery criteria (i.e., 80% and 50%) produced lower levels of response maintenance. These results are further supported by Ruskin and Ruskin (1977) who suggested that student performance fluctuates with varying levels of mastery criteria. That is, students tend to perform to the level expected of them.

The third main component embedded within PSI are lectures. These lectures, often brief, serve two main functions: synthesize course material and answer student questions (Buskit et al., 1991). Keller & Sherman (1974) emphasized that the removal of lectures from an instructor's day to day routine allows for more time spent on other, more valuable tasks, such as answering student questions or designing learning materials. In general, communication between the student and instructor takes place predominantly via written mediums. (Buskit et al., 1991). This creates an opportunity for students to actively engage in the course, and further requires instructors to make quizzes that evoke superior academic behavior (Keller & Sherman, 1974). An example of written material includes study guides, which identify learning objectives and potential questions (Grant & Spencer, 2003; Keller & Sherman, 1974). Last but not least, the PSI program utilizes proctors (typically undergraduate students) to increase testing opportunities, provide immediate feedback, and promote social relationships between the students and instructors (Buskit, et al., 1991; Fuller, 2005; Keller & Sherman, 1974; Ruskin & Ruskin, 1977). It has been suggested that the inclusion of proctors is what sets PSI apart from other behavioral instruction models (Keller & Sherman, 1974; Ruskin & Ruskin, 1977).

In a meta-analysis assessing the effectiveness of PSI, Buskit et al (1991) collected data on (1) student achievement based on final exam scores, (2) final grades, (3) student satisfactory

ratings, (4) course completion rates, and (5) total amount of time needed for students to complete the course work (Buskit et al., 1991). Implementation of PSI resulted in considerable improvements across all five categories. It is also important to note that variability across final test scores was reduced as a result of PSI procedures (Buskit et al., 1991). Additional parametric and component analyses revealed that the mastery requirement, immediate performance feedback, and study objectives were the three most influential variables responsible for high quality performance (Buskit et al., 1991).

As the research clearly shows, behavioral instruction has been successful in shaping the academic performance of students (Buskit et al., 1991; Davis et al., 2016; Fuller, 2005; McPherson et al., 2018). Such methods have been successfully used to teach a diverse group of learners a wide variety of verbal knowledge/information and skills. The positive impact of these strategies could be considered due to the conceptualization of learning problems from the radical-behavioral perspective or worldview. This perspective has demonstrated to be effective when resolving performance or learning difficulties and has expanded beyond the educational system and into many other domains, including sports. Sport problems (e.g., poor coaching, poor sport performance, etc.) can be viewed as operant problems, to which the three-term paradigm can apply.

Chapter 2: Literature Review

Behavioral coaching describes a method of teaching athletic skills using behavior analytic principles and strategies to develop: (1) strategies for breaking down complex skills into small behavioral units, (2) instructional models for shaping complex behaviors, and (3) reinforcement procedures to shape and maintain target responses (Martin & Hrycaiko, 1983; Schenk & Miltenberger, 2019; Seniuk et al., 2013). Examples of behavior analytic procedures used include but are not limited to verbal instruction, immediate feedback, reinforcement (both positive and negative), and positive practice (Allison & Ayllon, 1980; Ruiz, 2015; Schenk & Miltenberger, 2019). A behavioral approach to coaching was first implemented by Komaki and Barnett (1977; cited by Seniuk et al., 2013) who sought to improve the verbal behavior of coaches during practice. They taught coaches how to (1) deliver direct instruction, (2) deliver verbal feedback, and (3) model correct performance. In addition to improving the verbal behavior of coaches, results showed improved athletic performance, suggesting that behavioral coaching may be superior to traditional coaching methods.

To evaluate the effectiveness of behavioral coaching, as an intervention strategy, Allison and Ayllon (1980) taught five male football players how to accurately block using verbal instructions, verbal feedback, modelling prompts, and positive practice. The dependent variable was the percentage of blocks performed correctly out of 10 trials. The coach began each play with explicit verbal instructions regarding target behavior. If the athlete performed the target response correctly, the coach delivered verbal praise. If, however, in emitting the target response, the athletic performed the skill incorrectly, the coach prompted the athlete to freeze, thereby giving the coach the opportunity to provide corrective feedback. Following the delivery of corrective feedback, the coach modeled the target response and then prompted the athlete to

practice performing the skill again. Results indicated that percentage of blocks performed correctly increased following the implementation of behavioral coaching procedures.

Stokes and Luiselli (2010) further extended the literature related to behavioral coaching by illustrating the crucial role functional analyses could have in the development of a behavioral coaching intervention. The purpose of the study was to assess the effects functional analysis (FA) and behavior coaching intervention had on tackling skills of a high school football athlete. Prior to implementing an intervention, Stokes and Luiselli (2010) conducted a functional analysis with the participant to objectively assess different reinforcement consequences potentially maintaining optimal performance. Conditions implemented included (1) no specific feedback provided by coach following performance, (2) attention from coach following a correct tackle, (3) attention from peers following a correct tackle, and (3) escape from corrective feedback. Results of the FA suggested that the participant's correct tackling performance was maintained by escape (Stokes & Luiselli, 2010); that is, when the participant performed the skill correctly, the coach did not provide any feedback whereas, when the participant performed the skill incorrectly, verbal feedback was immediately delivered. During the intervention, researchers prompted the coach to deliver delayed written feedback after practice and subsequent results showed an increase in percent of correct tackling both during practice and in games.

In a component analysis of behavioral coaching strategies, Bonavita (2019) compared the effects of antecedent intervention (i.e., the use of video modeling), consequence intervention (i.e., verbal feedback), and a combination of both on various skating behaviors. Speed of performance was also assessed. The dependent variable was the correct performance of three components necessary for accurate skating performance (Bonavita, 2019). During the antecedent intervention, the investigators showed a video of an individual accurately performing the skating

movement to the participants, then required them to attempt the athletic skill independently. No feedback was delivered during this condition. During the consequence intervention, the participants were prompted to remember how to accurately perform each component, and then attempted to emit the behaviors independently. A verbal praise statement was delivered contingent on the correct performance of a component and no feedback was delivered following the incorrect performance of a component. During the combination condition, both forms of intervention were implemented. Results showed that video modeling seemed to be the most effective variable in improving athletic performance. Moreover, changes in behavior generalized to game-like situations. Results alluded to the essential role antecedent intervention may have on athletic performance (Bonavita, 2019). In sum, the body of literature pertaining to athletic performance indicates that behavioral coaching can efficiently improve a wide variety of athletic skills (Schenk & Miltenberger, 2019; Seniuk et al., 2013).

The sport environment is a welcoming but generally undiscovered naturalistic research domain for behavior investigation and intervention (Smith & Smoll, 1991). Although sports have been researched for over 30 decades, it was not until recently that researchers began empirically evaluating the effectiveness and utility of behavior analytic procedures (Luiselli & Reed, 2015; Luiselli et al., 2011; Martin et al., 2004; Martin & Thompson, 2011). Luiselli and Reed (2015) identified three main characteristics of behavioral sports psychology. To begin, applicability of ABA and sports includes recognizing target behavior of competitors and/or coaches to be improved, characterizing those behaviors in a way so that they can be objectively measured, and utilizing changes in behavior as the leading indicator of the degree to which the beneficiary's behavior(s) have changed. A second characteristic is that ABA interventions with competitors depend on standards and strategies of both respondent and operant conditioning. Third, most

ABA-sports investigations have depended on single-case test strategies as a procedure for assessing experimental control.

Current sports that have utilized behavior analytic interventions include but are not limited to football (e.g., Allison & Ayllon, 1980; Ward & Carnes, 2002), swimming (e.g., Koop & Martin, 1983), track and field (e.g., Scott et al., 1997), and gymnastics (e.g., Wolko et al., 1993). With a focus on both skill acquisition and improved performance of athletes, researchers have used a variety of procedures including explicit instructions (e.g., Allison & Ayllon, 1980; Koop & Martin, 1983; Scott et al., 1997; Ward & Carnes, 2002; Wolko et al., 1993), modeling (e.g., Allison & Ayllon, 1980; Ward & Carnes, 2002), public posting (e.g., Ward & Carnes, 2002; Wolko et al., 1993), goal setting (e.g., Ward & Carnes, 2002), error-correction trials (Allison & Ayllon, 1980; Koop & Martin, 1983; Scott et al., 1997), and verbal feedback (Allison & Ayllon, 1980; Koop & Martin, 1983). Results obtained from the previously-mentioned studies showed improved athletic performance following the implementation of interventions and emphasized that the applicability of behavior analytic procedures can shape the behavior of individual athletes as well as teams and can accommodate the needs of beginner, intermediate (or developing), or experienced athletes (Schenk & Miltenberger, 2018).

One largely consistent finding among ABA-sports interventions is the use of feedback in shaping and maintaining athletic performance. Current literature suggests that the mechanisms underlying feedback parallel those defining operant procedures (Mangiapanello, & Hemmes, 2015). That is, research proposes that feedback may function similar to: (1) positive reinforcers or negative punishers; (2) direct instruction; (3) a discriminative stimulus; (4) a verbal rule; or (5) a motivational operation (Mangiapanello & Hemmes, 2015). While the definition of feedback varies within the literature, Klugar and DeNisi (1996) broadly defined it as information

concerning one or more aspects of performance (Klugar & DeNisi, 1996). Feedback can be given to the athlete through (1) verbal, (2) auditory, (3) visual, (4) text, or (5) a combination of these modalities (e.g., Hawkins et al., 2008; Keller and Sherman, 1974). Feedback can be given by coaches (i.e., external agents) or the athletes themselves (e.g., Normand, 2008)

TAGteach® (based on principles of teaching with acoustical guidance) is a behavioral coaching strategy that utilizes verbal instructions, visual models, and audible feedback (acoustic sound produced by the tagger) to promote skill acquisition (Fogel et al., 2010). TAGteach evolved from clicker training, a behavior-analytic intervention used in animal training that involved using an audible sound to "mark" (i.e., reinforce) target behavior as it occurred (Fogel et al., 2010). The tagger (i.e., audible stimulus) functions as a conditioned reinforcer through pairing with: (1) primary reinforcers such as food, (2) conditioned reinforcers such as tokens, and (3), generalized conditioned reinforcers such as feedback (Fogel et al., 2010). Within an intervention, the tag (i.e., acoustic sound produced by the tagger) is the most critical communication tool (Karen Pryor Clicker Training, 2004). The occurrence of a tag is contingent upon the learner performing the target behavior. The instructor uses the tag to mark the correct behavior (TAGteach International, 2012). The advantage of using a tagger to provide feedback to the learner is that the instructor can consequate the behavior in extremely close temporal proximity to the desired behavior (i.e., immediacy of reinforcement; Skinner, 1951). Additional benefits of using TAGteach include simplicity of implementation for the instructor, and precise instructions and feedback for the learner (Arnall, 2018). TAGteach can be used as a stand-alone intervention (Fogel et al., 2010) or part of a behavioral treatment package, where the instructor incorporates additional forms of feedback (e.g., video feedback, token economies) to promote skill acquisition (Sniffen, 2017; Quinn et al., 2015).

While TAGteach is comparatively new in terms of application, its philosophical roots can be traced back to the 1940's, and B.F. Skinner (TAGteach International, 2010). Stated differently, TAGteach is founded on B. F. Skinner's science of behavior and notions of operant conditioning (TAGteach International, 2016). Skinner's theory of operant conditioning emphasizes the critical role consequences have on behavior; behavior preceded by reinforcement (i.e., positive consequences) is likely to occur again in the future (under similar environmental conditions) whereas behavior that is followed by punishment (i.e., aversive consequences) is not likely to occur again in the future (McLeod, 2018).

TAGteach procedures were first implemented by Theresa McKeon in 2003. She was a gymnastics coach, who after attempting to use clicker training with a horse, began using it with her gymnasts (TAGteach International, 2010). McKeon began posting information about her "experiments" (naturalistic use of the clicker to shape her gymnast's performance) online, and eventually collaborated with Joan Orr, Karen Pryor, and Beth Wheeler. By 2016 (about two years after the TAGteach organization was established), there were more than 40 scholarly research studies and presentations at various behavior analysis conferences (TAGteach International, 2016).

In behavior-analytic terms, TAGteach procedures utilize three main components of operant conditioning: task analysis, behavioral chaining, and shaping. Fogel and colleagues (2010) referred to the task analysis process as "BID," or "break it down." This involves a detailed assessment of a complex behavior where the instructor breaks down the behavior into smaller, teachable, components (Cooper et al., 2007). The result is a sequentially ordered list of tasks or behaviors, essential for proper skill acquisition (Cooper et al., 2007).

The second primary component of TAGteach is chaining. This procedure requires the instructor to create task analyses that sequentially outline discrete responses embedded within a terminal, or targeted behavior. There are three standard ways to teach a behavior chain: (1) forward chaining, (2) backward chaining, or (3), total task chaining (e.g., Smith, 1999). Forward chaining involves teaching a skill in its naturally occurring order, requiring the learner to master initial skill components before progressing to subsequent steps in the chain (e.g., Fogel et al., 2010). Backward chaining procedures mimic those implemented with forward chaining, but in the opposite order (i.e., mastering the final steps of a behavior prior to learning previous steps). Lastly, total task chaining requires the learner to perform all the skill components in their naturally occurring occur. Prompts are used when necessary to ensure accurate performance. Smith (1999) compared all three procedures when he taught 75 undergraduate students a long sequence of motor behaviors (e.g., karaoke, marching, and directional stepping). Participants were divided into three groups based on the chaining procedure used. During the forward chaining condition, the researcher began by demonstrating the first eight steps of the sequence and then had the participants perform those steps until mastery. Contingent on the participants meeting mastery criteria, the instructor demonstrated the next eight steps. This pattern continued until the participants were able to perform the entire motor action sequence in its naturally occurring occur. The backward chaining procedure mimicked those implemented in the forward chaining procedure except in reverse. The researcher began by demonstrating the last eight steps of the motor action sequence followed by the second to last set of eight steps. During the total task condition, participants were shown the entire motor action sequence and then prompted to begin performing the steps from the beginning. The researcher modeled motor actions and

prompted when necessary until the participants were able to perform all motor actions in their naturally occurring sequence.

The third behavior-analytic component, shaping, involves reinforcing successive approximations of a target behavior while withholding reinforcement (i.e., extinction) for the non-occurrence of the target behavior (Cooper at al., 2007). The responses that are followed by positive reinforcement are more likely to occur in the future than those that receive no consequences (Galbicka, 1994).

The applications of TAGteach continue to evolve, with current literature utilizing this procedure to increase the skill acquisition of (1) activities of daily living such as toe walking (Hodges et al., 2019; Persicke et al., 2014) and dressing (Olsen et al., 2018), (2) occupations such as orthopedic surgery (Levy et al., 2016), and (3), sports such as dance (Arnall, 2018; Arnall et al., 2019; Quinn et al., 2015), golf (Fogel et al., 2010), and yoga (Ennett et al., 2019). For example, Fogel et al (2010) taught a novice athlete how to adequately swing a golf club. To do this, the researchers created a task analysis which outlined the skill sets (e.g., grip, address position, etc.) comprising a swing and the specific behaviors embedded within each skill set (e.g., how to grip the golf club). The dependent variable for this study was percent of task analysis steps performed correctly. Data were not taken during the teaching sessions that used TAGteach procedures, but rather obtained from videos and pictures collected before and after each teaching session. Before the teaching session began, Fogel and colleagues asked the participant to perform the entire skill (swing the club) five times. Data collected from these videos or pictures represented both baseline for skills not yet taught and maintenance of skills already mastered during previous teaching sessions. The same procedures were implemented after the teaching session was over. The data collected from this video represented skill

acquisition of skills taught during the TAGteach session. During the session, Fogel and colleagues (2010) utilized a modified forward chaining procedure to teach the target behavior. Each TAGteach session focused on one skill set (e.g., grip, address position, etc.) at a time. Furthermore, each tag point (specific skill embedded within the skill sets, e.g., how to grip the golf club) was taught in isolation and then, contingent on meeting mastery criteria (i.e., performing the skill correctly six times), the participant was required to perform all tag points learned up to that point, while meeting a new mastery criteria of six. Stated differently, contingent on the participant meeting the mastery criteria for tag point two (i.e., second skill embedded within the first skill set), she then had to perform the same tag point correctly six times while also performing tag point one. This pattern continued until each tag point, or skill within a skill set was taught. The results showed that TAGteach procedures were effective in teaching the participant how to appropriately swing a golf club, with generalization to multiple golf clubs as well. A limitation worth noting however, was that one tag point (i.e., skill) was not mastered – an arm (swing) that occurred in the upper portion of the body. Within the TAGteach intervention, researchers taught lower and upper body movements separately due to the task analysis created at the beginning of study. However, when emitting these behaviors in real time, both the upper and lower body needed to produce synchronized movements. Therefore, it was conceivable that learning these movements independently of one another brought about uncoordinated movements when put together (Fogel et al., 2010).

Another study which highlighted the effectiveness of TAGteach as a stand-alone procedure was Elmore et al (2018) who used a multiple probe design across hockey passing skills (e.g., ruck pass, trap pass, hold pass, and direct pass) to evaluate the effectiveness of TAGteach procedures. The dependent variable was the percentage of task analysis steps

performed correctly for each of the four passing skills. During each teaching session, participants were required to perform each tag point correctly six times before progressing to the next tag point within the task analysis. In addition to measuring the percentage of task analysis steps performed correctly, Elmore and colleagues (2018) calculated and evaluated the speed at which each participant passed the puck. For all four participants, percentage of task analysis steps performed correctly substantially increased following the implementation of TAGteach procedures. In addition, results demonstrated an increase in speed with which one participant passed the puck. Such results indicate that TAGteach procedures may not only increase the accuracy with which athletes perform complex skills, but also the fluency, or speed with which the skill is performed. Binder (2003) spoke to the importance of fluency by noting that "merely making the right move or being able to execute a play correctly is not sufficient for success. There is always a need for quickness, smoothness, and a lack of hesitation in sporting performances" (p. 14).

TAGteach procedures can also be part of a treatment package that incorporates additional forms of reinforcement (i.e., token economies) to promote skill acquisition of complex behaviors. Quinn et al (2015) sought to teach four dance students how to perform three dance movements (i.e., turn, kick, and leap). All four students had taken part in dance lessons for six months prior to the study and continued to do so during the intervention. A multiple baseline across skills (i.e., turn, kick, and leap) was used to evaluate the effectiveness of TAGteach procedures. The dependent variable for this study was the percentage of task analysis steps performed correctly for each of the three dance movements. Similar to the way in which data were collected by Fogel et al (2010), Quinn and colleagues (2015) did not take data during the TAGteach sessions. Instead, researchers had the participants perform each dance move four

times after the TAGteach session was complete. Data collected from these videos represented skill acquisition of tag points (i.e., skills) taught during that TAGteach session. During the TAGteach sessions, the participant had to perform the targeted tag point four times correctly in order to move on to the next tag point. Results indicated that TAGteach procedures produced skill acquisition of dance movements for three of the four students. For the fourth participant, level of performance did not increase following implementation of TAGteach procedures. It was hypothesized that the sound produced by the tagger did not function as a reinforcer on its own (Quinn et al., 2015). For this reason, researchers introduced a token system which involved delivery of a token following the correct performance of a tag point. Tokens were either exchanged immediately for a small reinforcer (e.g., candy, sticker) or saved until the next session for a larger reinforcer (e.g., gift card. Results indicated an instant increase in skill acquisition following the addition of the token system. These results suggested that TAGteach procedures utilized, as part of treatment package rather than as a stand-alone procedure, may be more effective for some individuals.

Sniffen (2017) also implemented TAGteach intervention with supplementary procedures. In an effort to evaluate whether TAGteach procedures could efficiently improve skills already in one's repertoire but not yet mastered, Sniffen taught two female fastpitch softball players a fastball (pitch already in their repertoire but not yet mastered), with one participant also taught a change-up (novel pitch). The dependent variable was the percentage of each softball pitch performed correctly with data collected after each teaching session. During TAGteach sessions, skills were taught in accordance to TAGteach International standards (2012). However, video feedback, which has not been typically utilized in TAGteach interventions, was used when necessary to promote skill acquisition. More specifically, if participants continued to perform tag

points incorrectly, Sniffen (2017) allowed the participant to watch a video recording of themselves performing the skill, the function of which was to allow the subjects to visually observe their own correct or incorrect performance. In order to progress to the next tag point within the task analysis, participants were required to perform each tag point correctly three times in a row. Implementation of TAGteach procedures and video feedback resulted in an increase in percentage of task analysis steps performed correctly for all skills taught for both participants. Results further generalized to game situations for one of two participants.

Additional research has been conducted to evaluate individual components of TAGteach methodology. Ennett et al (2019) investigated the error-correction procedures (following an incorrect tag point) inherent in TAGteach procedures to teach yoga skills. Specifically, a learner is typically required to perform a tag point three additional times following an incorrect performance, before progressing to the next tag point. However, TAGteach International has recognized that this procedure was arbitrarily established (Ennett et al., 2019). Thus, Ennett and colleagues conducted a parametric analysis where participants were taught three different skills, one which was associated with "standard" error-correction procedures (i.e., perform the skill three times following an incorrect performance), one associated with a reduced error-correction procedure (i.e., performed the skill one time following an incorrect performance), and one associated with no error-correction procedure which mirrored the baseline condition (for experimental control purposes). The dependent variable for this study was percentage of independent tag points performed correctly. Results illustrated that both error-correction procedures increased skill acquisition of yoga postures. Performance during the control condition (i.e., no error-correction procedure) remained relatively low, staying within baseline levels. Stated differently, both the standard and reduced error-correction procedures produced increased

percentage of tag points performed correctly. The findings were inconclusive however, about which procedure was more effective as the data were inconsistent across participants.

Another TAGteach component that has been assessed is the topography of feedback. Arnall (2018) compared randomized vocal consequences (e.g., “good job,” and “yes, that’s right”) to audible consequences (i.e., acoustic sound produced by the tagger) embedded within TAGteach procedures and added to Precision Teaching procedures when teaching dance steps. The dependent variable for this study was the percentage of correctly performed steps embedded within the task analyses per participant (Arnall, 2018). Each participant was taught three dance movements (order taught was counterbalanced across participants); two participants were exposed to TAGteach procedures while the other two were exposed to TAGteach plus Precision Teaching procedures. Each participant, regardless of the instructional procedure, was exposed to verbal consequences (e.g., “good job,” “yes, that’s right”) immediately following baseline. After several attempts with either zero celeration or a decreasing trend (i.e., participants were not acquiring the skills using verbal consequences), the researcher began utilizing audible consequences instead. Results indicate an immediate increase in skill acquisition following implementation of audible consequences, embedded within TAGteach procedures. Compared to randomized vocal consequences (e.g., “great,” “not quite”), TAGteach, and the combination of TAGteach procedures with Precision Teaching, was demonstrated to be more effective for all participants.

Overall, TAGteach seems to provide an effective intervention for increasing skill acquisition of complex movements in sports (Arnall, 2018; Ennett et al., 2019; Fogel et al., 2010; Sniffen, 2017). TAGteach methodology provides (1) procedures that are easy to implement, (2) clear and concise instructions, and (3) immediate feedback (Arnall, 2018). Although effective,

there are still more questions to be answered regarding which variables are responsible for behavior change. Research evaluating the individual components embedded within TAGteach is limited, with only apparently two studies currently available (i.e., Arnall, 2018; Ennett et al., 2019). Component analyses are designed to compare the effects of individual variables included within a treatment package with the hopes of identifying the variable(s) responsible for changes in the dependent variable (Cooper et al., 2007; Ward-Horner & Sturmey, 2010). Behavior analysis benefits from component analyses by eliminating potentially ineffective or invasive procedural components, thereby increasing the efficiency and effectiveness of behavioral interventions (Cooper et al., 2007; Ward-Horner & Sturmey, 2010). Thus, the purpose of the current study was to compare the effects of audible feedback (embedded within TAGteach procedures) and verbal feedback on the skill acquisition of two volleyball skills. This study extends the results obtained from Arnall (2018) who compared the effects of randomized vocal consequences to TAGteach and a combination of TAGteach and Precision Teaching on the skill acquisition of novel dance movements. In the current study, the only variable manipulated was the topography of feedback used within the standard TAGteach procedures.

Chapter 3: Method

Participants & Setting

Five female 12-15-year-old adolescents participated. Three had played volleyball for at least one year and two were completely novice. A qualification assessment was conducted to ensure that each participant had a skill deficit (defined as performing less than 50% of each volleyball skill correctly). A sixth participant was excluded from the study as she did not have a skill deficit in both skills. Each participant was exposed to two sessions with the first session dedicated to TAGteach and the second to retention and generalization assessments. All TAGteach sessions lasted one hour and were conducted in the lower gym in a rural high school in central Kansas. All maintenance and generalization sessions lasted no more than 10 minutes and were conducted at a local fitness facility in the same town. Informed consent was obtained from each participant and their respective parents/guardians.

Materials & Apparatus

The following materials were required for the study: a tagger (i.e., audible stimulus used to deliver audible feedback), a volleyball (for generalization probes), and a laptop with a front camera (to record the research session). One strip of athletic tape was placed on the floor and used as a visual cue for participants to orient themselves during assessment probes. The strip of tape was placed at a slight angle so that the participant's right shoulder was slightly closer to the camera then their left shoulder. Additional materials used during the TAGteach sessions were data collection sheets, a TAGteach script, and two task analyses – one that outlined the steps needed to accurately perform a volleyball pass and the other a volleyball serve (see Appendices A and B). In response to the increased health concerns associated with the pandemic, face masks,

gloves, Lysol, and alcohol wipes were included and used during all retention and generalization probes.

Dependent Variables and Data Collection Procedures

The dependent variable was the percentage of task analysis steps performed correctly for each volleyball skill. The first volleyball skill was a standard pass (see Appendix A). The steps involved in passing a volleyball include: (a) placing the athlete's feet one step wider then shoulder width apart with the toes of the left foot falling in the in-step of the right foot, (b), bending the athlete's knees to a 45 degree angle, (c) flattening the back with shoulder's forward until they are in front of the toes of the right foot, (d) extending both arms out in front of the athlete until hands are in line with the athlete's hips, (e) internally rotating wrists until palms facing each other, (f) taking two consecutive steps forward, first with their left foot then their right, (g), realigning athlete's feet into previously described position (i.e., one step wider then shoulder's with left foot in the in step of the right foot), (h) bringing both arms into the athlete's midline (i.e., in line with their belly buttons) while pressing the heels of both hands together and simultaneously grasping the fingers with the thumbs pointed down (creating the platform for which the volleyball contacted), (i) transferring of weight from left foot to right foot, and (j) shrugging of the athlete's shoulders into their chin.

The second volleyball skill was a standing serve (see Appendix B). Serving a volleyball included the following steps: (a) placing all weight on their dominant foot (evidenced by standing with a straight leg) with non-dominant leg bent so that only the toes are touching the floor, (b) bending hips slightly forward to a 10-degree angle with back in a neutrally flat position, (c) bending of the dominant arm to a 90-degree angle with elbow next to hip, (d) diagonally raising up the athletes non-dominant hand until it is shoulder height and in line with

their dominant shoulder, (d) laterally raising up of the athletes dominant arm until elbow is eye level with palm facing forward, (e) vertically raising the athletes non-dominant hand up about 5-inches, (f) stepping forward with the athletes non-dominant foot, (g) internally rotating the athletes dominant shoulder until elbow is facing forward with palm also facing forward, (h) diagonally lowering the non-dominant arm back down to the athlete's non-dominant hip, (i) extending the athlete's dominant arm up and then vertically swinging down until arm returns to the athletes dominant hip, and (j) sliding the toes of the athlete's dominant foot forward along the floor until the athletes knees are next to each other.

Both task analyses were created by the researcher. Moreover, both task analyses were created the same way. That is, each volleyball skill was broken down into three skills sets and each skill set had the same number of tag points (skill set 1 had six tag points, skill set 2 had four tag points, and skill set 3 had two tag points). To determine if both skills were equivalent in difficulty, the researcher contacted four volleyball coaches. The task analyses were presented to each and the coaches were asked to rate whether (1) they agreed with the steps included within each task analysis, (2) one skill was more difficult than the other, and (3) both volleyball skills were essentially the same level of difficulty. All coaches agreed with the steps embedded within both task analyses and all four indicated that both skills were equivalent in difficulty.

The dependent variable was measured in a manner similar to previous TAGteach literature (i.e., Fogel et al., 2010; Quinn et al., 2015; Sniffen, 2017). Each assessment session involved the participants performing each volleyball skill nine times in trial blocks of three (i.e., pass three times then serve three times). Percentage of task analysis steps performed correctly was calculated by dividing the number of tag points (i.e., task analysis steps) performed correctly within the skill set by the total number of tag points in that skill set. For example, if Participant 1

performed all six tag points correctly on the first and second attempt but only performed four tag points correctly on the third attempt, the percentage of tag points performed correctly would be 89% ((6 + 6 + 4 = 16)/18=89). Data were collected before and after teaching each skill set.

Experimental Design

An alternating treatment design embedded within a multiple baseline across skill sets (Perone & Hursh, 2013) was used to evaluate effectiveness of audible and verbal feedback on skill acquisition of volleyball skills. Conditions were implemented in the following order: baseline, TAGteach, maintenance, retention, and generalization. All five participants were first assessed in a baseline condition to determine preexisting competence in both volleyball skills. Once baseline was established to be low and stable, the researcher implemented TAGteach procedures for skill set one of both volleyball skills, while continuing to assess baseline performance for remaining skill sets. Contingent on the participants meeting mastery criteria for skill set one (i.e., defined as performing 80% or more of the target skill set correctly), the researcher implemented TAGteach procedures for skill set two of both volleyball skills while assessing continuation of performance (i.e., maintenance) of skill set one and baseline performance of skill set three of both volleyball skills. This pattern continued until all skill sets were taught and mastered. Retention and generalization probes were implemented consecutively one- or two-weeks post-intervention. Each participant was taught both skills using TAGteach methodology. However, one skill was associated with audible feedback (typically embedded in TAGteach) while the other involved verbal feedback (e.g., “yes, that’s right” and “try again”). Order of teaching and topography of feedback was counter-balanced across participants to increase experimental control and reduce internal validity threats (see Appendix C).

Procedures

Video footage was collected of each TAGteach session except for the first 30 minutes which was allotted to warm-ups and watching the introduction video. During researcher-led warm-ups, the participants jogged two laps around the lower gym (to increase blood flow), and performed about 10 dynamic exercises (e.g., high knees, butt kicks, karaoke, etc.). The purpose of the warm-ups was to increase blood flow throughout the body and reduce potential risk of injury.

Introduction to TAGteach.

Once warm-ups were complete, the participants watched an introduction video created by the researcher regarding TAGteach procedures and terminology. This portion was designed to inform the participant of the various components and rules embedded within TAGteach methodology as well as to establish the audible stimulus as a conditioned reinforcer. The researcher began by providing a brief description of TAGteach such as "TAGteach is a teaching strategy that utilizes audible feedback, rather than verbal feedback, to teach various complex skills." The researcher then showed the participants a video that provided an overview of the following components: TAGteach Triangle, Focus Funnel, WOOF, the three-try rule, and point of success (https://www.youtube.com/watch?v=reSg8-ELW6g&t=1s). In the video, the researcher stated that TAGteach sessions will be implemented in accordance to the Focus Funnel, which involves (1) a lesson where the researcher provides the learner with key information related to the target perform (e.g., "this skill is important because…"), (2) instructions for accurately performing the target behavior (e.g., "the instructions are…"), and (3) labeling a tag point or a very specific description of the target behavior (e.g., "the tag point is…"). Each tag point should also comply with the acronym WOOF: (1) what you want, (2) one

thing, (3) observable, and (4) five words or less. The researcher then informed the participants of the three-try rule which stated that if, after being asked to perform a specific movement, the athlete incorrectly performed the skill three times, the researcher broke down the skill further. For example, if participant one incorrectly performed the hand movement (collapsing the heels of the palms then grasping finger with thumbs point down) three times, the researcher backed up and taught just collapsing of the heels before teaching grasping of the fingers with thumbs down. The next component the researcher described was point of success, which stated that each TAGteach session will begin with a skill the participant had already mastered from the previous session. The mastered skill should be the behavior that immediately precedes the next skill to be taught. The final information provided in the video was the purpose of the tagger. More specifically, the researcher informed the participants that the tagger was designed to inform the participant whether they performed the skill correctly or not. Stated differently, the researcher informed the participant that if they heard the sound produced by the tagger, they had performed the skill correctly. On the other hand, if the participant did not hear the sound, that meant that they did not perform the skill correctly and to try again within 5 seconds.

In order to demonstrate the use of the tagger, the researcher gave the participant the tagger and allowed them to visually analyze and/or play with the device. The researcher then asked the participant to engage in simple motor actions such as “touch nose with index finger,” “clap hands,” and “raise both arms laterally to shoulder height.” Contingent upon the participant emitting the target behavior, the researcher “tagged” the behavior in extreme close temporal proximity to its occurrence (simultaneously with the emittance of the response). The roles were then reversed, i.e., the researcher gave the participant the tagger and had the participant attempt

to tag the researcher's performance. This process lasted roughly 15 minutes. Following the completion of this process, the researcher began the teaching session.

Baseline.

The data that represented baseline performance were obtained from the video collected prior to the TAGteach session. Using trial blocks of three, the researcher asked the participant to perform one of the volleyball skills three times followed by the other skill three times and repeated this pattern until the participant had performed three trial blocks of each skill for a total of nine attempts per skill. No programmed feedback or prompting was provided during this condition. If after three trial blocks, stability or decreased performance was obtained (i.e., zero celeration or decreasing trend), the researcher proceeded to the next condition.

TAGteach.

During the intervention phase, the researcher systematically taught all five participants how to serve and pass a volleyball using TAGteach methodology described above (see Appendix D). Based on what TAGteach International (2012) refers to as the TAGteach triangle, the basic method involved (1) identifying a specific behavior that when performed correctly, can be easily and clearly identified as occurring, (2) "tagging" the correct behavior as it occurs in real time, and (3) reinforcing the target behavior (i.e., the tag point) by use of the tagger (TAGteach International, 2012). The beginning of the TAGteach session started with the researcher explaining what volleyball skill the participant was going to learn, why it was important, and modeled the behavior. The remaining TAGteach session was implemented in a similar manner, starting with the researcher identifying the first component they would work on followed by a demonstration of the target behavior by the researcher (e.g., "we are first going to learn how to ____, let me demonstrate"). Following this step, researcher informed the participant that it was

their turn to “tag” (i.e., “It’s your turn to tag”). After giving the tagger to the participant, the researcher stated what the current tag point was and then modeled the behavior. The researcher performed each tag point an average of three times; two attempts were always correct, and one attempt was always incorrect. The purpose of performing the tag point incorrectly one time was to ensure that the participant could discriminate between correct and incorrect occurrences of the target response. If the participant incorrectly tagged the researcher’s performance (i.e., pressed the tagger or stated “yes, that’s right” when the researcher performed the tag point incorrectly), the researcher verbally stated why the performance was incorrect and then implemented one error-correct trial (i.e., performed the tag point incorrectly again to evaluate understanding). The fourth and final step involved the participant performing the skill. More precisely, the researcher verbally stated (1) the instructions provided earlier in the sequence (i.e., “the instructions are ___”), (2) how many times they were to perform the skill (i.e., “we are going to do this five times”), and (3) what the specific tag point was (i.e., “the tag point is ___”). It is important to note that the same procedures were used when teaching the skill associated with verbal (“yes, that’s right,” or “try again”) and audible feedback (i.e., the tagger). However, instead of stating “It’s your turn to tag” and “It’s my turn to tag,” the researcher stated, “It’s your turn to give feedback,” and “It’s my turn to give feedback.” Contingent on the participant performing the skill correctly, the researcher “tagged” it (i.e., pressed the button on the tagger, producing a cricket-like sound or stating “yes, that’s right”). If the skill was not performed correctly, the researcher withheld pressing the tagger (or delivered verbal feedback, i.e., “try again”), thereby signaling that the skill was performed incorrectly and to try again within five seconds. If the participants performed the skill incorrectly three times, the researcher broke down the skill further to promote skill acquisition. This was accomplished by reviewing the task analysis and

dividing the incorrectly performed tag point into smaller behavioral units, (or into two or more tag points). Before teaching the newly created tag point, the researcher started with a tag point that the participant had already mastered. The participant was required to meet mastery criteria (i.e., correctly performing the tag point five times) of the current targeted tag point before moving onto the next.

The researcher was level-one certified in TAGteach methodology. As part of that certification, the researcher was required to create multiple videos where she either described the various components embedded within TAGteach procedures or independently implemented TAGteach procedures with a volunteer. This training facilitated high procedural fidelity and TAGteach competency.

TAG*.

For Participant 5, additional teaching was required following skill set two as she did not meet mastery criteria (i.e., performed at least 80% of skill set correctly across three trial blocks) to transition to the next phase. Within this additional teaching session, TAGteach procedures were implemented for three tag points within skill set two that were not performed correctly. Following the completion of the teaching session, skill acquisition probes were conducted again to assess mastery. It is important to note that while the participant only received additional teaching on one volleyball skill (i.e., pass), data were plotted for both volleyball skills. This was done so in order to maintain procedural fidelity throughout the study.

Maintenance.

Maintenance (during the teaching session) data were collected from the video obtained prior to teaching a new skill set. Thus, maintenance data for skill set one were not collected until just prior to teaching skill set two. In other words, the video obtained prior to teaching a skill set

(with the exception of skill set one) served two purposes: baseline for the skill set about to be taught and maintenance for the skill set(s) just previously taught.

Retention.

Retention data were intended to be collected two weeks following the completion of the TAGteach session for each participant. However, due to Coronavirus19, three out of the five participants (Participants 2, 3, and 4) requested to conduct sessions early to reduce exposure and abide governmental recommendations regarding social distancing and in-home isolation. Thus, for those three participants, maintenance sessions were conducted one week after the TAGteach session was complete. This phase involved the participants performing each volleyball skill a total of nine times (in trials blocks of 3). No feedback was provided during this phase.

Generalization.

Because a volleyball was not used during TAGteach sessions, a generalization phase was conducted following maintenance. This phase replicated the procedures in the retention condition, except it included a volleyball. The participants were asked to perform each volleyball skill a total of nine times (in trials blocks of 3) with the volleyball. For the passing condition, the researcher tossed the participant a ball to pass and in the serving condition, the researcher gave the participant a ball and had them serve it. Similar to the maintenance condition, generalization trials were conducted one week early for three of the five participants.

Social Validity

Social validity surveys were provided to all participants following the completion of maintenance and generalization probes (Appendix E). Questions addressed include (1) whether the participants liked the procedures used during the intervention, (2) whether the procedures used were easy to understand and follow, (3) whether there were any negative side effects felt as

a result of the TAGteach procedures, (4) whether participants found verbal (“yes, that’s right” and “try again”) and audible feedback (acoustic sound produced by tagger) helpful in learning the target responses, (5) whether they would use TAGteach procedures in the future to learn other skills, and (6) whether they felt confident that they adequately learned the skills. A rating scale of 1 to 6 (with 1 being strongly disagree and 6 being strongly agree) was used to assess preference for TAGteach procedures.

Interobserver Agreement (IOA)

Interobserver agreement was calculated by having two observers independently (and separately) watch each video and score each tag point equally across all phases for 33% of total data (see Appendix F). Each observer’s scores were compared to the researcher’s original scores. Prior to the study, both observers were trained to accurately collect data using behavioral skills training procedures (e.g., Parsons et al., 2013). The researcher used two videos obtained during pilot testing to train and assess skill acquisition of the observers. Each observer watched the first video with the researcher to review the data collection process as well as answer any questions the observers had. The second video was used to assess skill acquisition. The data sheet provided to the data collectors included a description of each tag point with bolded words to reduce observer drift throughout the study. With a mastery criterion of 90% accuracy, observer one scored a 95% and observer two scored 100%.

Videos were separated throughout the study in accordance to how they would be used during the data collection process. There were six assessment videos created (i.e., baseline, after skill set one, after skill set two, after skill set three, retention, and generalization) for each participant and watched by either one of the two observers. When watching the videos, the researcher identified the specific volleyball skill and trial (i.e., three attempts) where IOA was

required. Trials where IOA data were collected were counterbalanced across participants and phases. The observers collected data in the same manner as the researcher (i.e., put a plus sign if the participant performed the tag point correctly versus a negative sign if the participant performed the tag point incorrectly). The trial by trial method for calculating IOA (Reed & Azulay, 2011) was used.

For Participant 1, IOA across both volleyball skills was 100% for passing and serving. For Participant 2, average IOA across both volleyball skills was 99% (100% for passing and 97% of serving). For Participant 3 and 4, IOA across both volleyball skills was 100% for both passing and serving. For Participant 5, average IOA across both volleyball skills was 99% (100% for passing and 98% for serving). When assessing all participants together, the average IOA across both volleyball skills was 99.6%.

Procedural Fidelity

Procedural fidelity was calculated by having two independent observers independently watch each video and score whether the researcher implemented TAGteach procedures correctly (in accordance to the TAGteach script) across all phases for 50% of total study (see Appendix G). Videos were separated throughout the study in accordance to how they would be used during the data collection process. There were three videos created (i.e., teaching skill set one, teaching skill set two, and teaching skill set three) for each participant and watched by either one of the two observers. Prior to watching the videos, the researcher identified one volleyball skill for either one of the two observers to watch. Observers watched the entire teaching session and collected procedural fidelity on that one volleyball skill. Target volleyball skills were counterbalanced across participants. When collecting data, the observers used check marks and X’s to label the correct or incorrect verbal statements emitted by the researcher. In other words,

if the researcher followed each step of the TAGteach script correctly, a check mark would be placed to the right of each step. If the researcher failed to follow one or more of the steps embedded within the TAGteach script, the observer placed an "X" in the appropriate location. Additional variables addressed were (1) whether the researcher used the appropriate topography of feedback to mark the occurrence of a correct performance, (2) whether the researchers appropriately withheld audible feedback (or verbally stated "try again" during the verbal feedback condition) following the incorrect performance of a tag point, and (3) whether the researcher incorrectly tagged (via the tagger or verbal praise statement) the incorrect performance of a tag point. An abbreviated version of yes and no (i.e., "Y" for yes and "N" for no) was used to answer these questions. Trial by trials data were collected to assess IOA. To increase procedural fidelity, the researcher created instructional cards (see Figure 1) that she laminated and put on a lanyard to be worn during all TAGteach sessions. The lanyard held three instructional cards: (1) the TAGteach script, (2) the passing TA, and (3) the serving TA. Each card was 5 by 7 in size and could be easily clipped to the researcher's shirt for reference during the session. For Participant 1, 2, 3, and 5, procedural fidelity was 100%. For Participant 4, procedural fidelity was 97%.

Chapter 4: Results

Chapter Overview

Trial blocks were scaled along the X-axis while percentage of task analysis steps performed correctly was scaled along the Y-axis. Because the researcher was measuring percentage of task analysis steps performed correctly for the entire volleyball skill (pass and serve), data were plotted for each skill set following every trial block (i.e., three attempts). Each data point represents a trial block, or three attempts to perform both volleyball skills. Thus, three data points equated to nine attempts. Participant performance data during the TAGteach session itself were not collected or represented on the graph.

Participant one's data are depicted in Figure 2. Order of teaching for participant one was as follows: Pass (verbal feedback "yes, that's right" or "try again") then serve (audible feedback; acoustic sound produced by the tagger). Participant 1 was a novice with no volleyball experience prior to participating in the study. Baseline levels were 0% across all skill sets and across both volleyball skills. Implementation of TAGteach procedures resulted in increased performance in both passing and serving (with averages of 99.3% and 99.7% respectively). Baseline levels remained at 0% across trials for skill sets two and three. Following the completion of teaching skill set two, average percentage of tag points performed correctly for both pass and serve increased (100% and 86% respectively). Baseline levels remained at 0% across trials for skill set three and percentage of task analysis steps performed correctly for skill set one remained high (average of 99% for pass and 96% for serve). Lastly, implementation of TAGteach procedures for skill set three resulted in increased performance of both passing and serving tag points (100% of passing tag points and 83% serving tag points). Performance remained relatively stable for remaining skill sets across both volleyball skills.

For Participant 1, retention and generalization probes were conducted two weeks following the completion of the intervention. Although this participant was completely novice to volleyball, she retained a majority of tag points taught across both volleyball skills. For skill set one, Participant 1 retained an average of 94% of the passing tag points and 81% of the serving tag points correctly. For skill set two, she retained an average of 78% of the passing tag points correctly and 91% of the serving tag points correctly. For skill set three, this participant retained 100% of passing tag points included within skill set three correctly and an average of 89% of the serving tag points. With the inclusion of an actual volleyball (i.e., generalization phase), the percentage of TA steps performed correctly decreased, performing an average of 88% of passing tag points and 65% of serving tag points correctly across skill sets. Verbal feedback appeared more efficient for this participant in terms of average percentage of task analysis steps performed correctly across skill sets.

The data for Participant 2 are depicted in Figure 3. The order of teaching was as follows: Serve (verbal feedback "yes, that's right" or "try again") than pass (audible feedback; acoustic sound produced by the tagger). Prior to participating in the study, Participant 2 had one year of volleyball experience. Average baseline levels for each skill set were as follows: skill set one (16% of passing tag points and 18% of serving tag points), skill set two (0% of passing tag points and 25% of serving tag points), and skill set three (0% for both passing and serving tag points). Implementation of TAGteach procedures for skill set one resulted in increases in both passing and serving (with averages of 100% and 83% respectively). Baseline levels increased slightly within skill set two (0% to 25%) while remaining low within skill set three. Following the completion of teaching skill set two, percentage of tag points for both pass and serve increased (with averages of 100% and 99% respectively). Percentage of skill set one tag points (for both

pass and serve) remained high and stable and baseline performance remained low. Lastly, implementation of TAGteach procedures for skill set three resulted in perfect skill acquisition of both volleyball skills. Participant 2 continued to perform close to 100% of tag points embedded within skill set one and skill set two of both volleyball skills.

For Participant 2, retention and generalization probes were conducted one week after the intervention. In the retention condition, Participant 2 retained nearly 100% of TA steps across both volleyball skills (average of 94% of passing tag points and 89% of serving tag points embedded within skill set one). For skill set two, Participant 2 retained an average of 94% of passing tag points and 100% of serving tag points across trials. For skill set three, this participant retained 100% of both passing and serving tag points taught. With the inclusion of a volleyball (i.e., generalization probes), percentage of TA steps performed correctly remained relatively high, performing an average of 90% of passing tag points and 89% of serving tag points correctly across skill sets. Verbal feedback appeared more efficient for this participant in terms of average percentage of task analysis steps performed correctly across skill sets.

The data for Participant 3 are depicted in Figure 4. Order of teaching was as follows: Pass (verbal feedback “yes, that’s right” or “try again”) then serve (audible feedback; acoustic sound produced by the tagger). Prior to participating in the study, Participant 3 had one year of volleyball experience. As such, Participant 3 consistently performed 16% of both pass and serve tag points embedded within skill set one. Baseline data for the remaining skill sets (two and three) were stable and low across trials. Implementation of TAGteach procedures resulted in increases in percentage of TA steps performed correctly within skill set one for both skills (100% of pass and serve tag points). Baseline levels remained low for skill set two and three. The same results were obtained following the implementation of TAGteach for skill set two. That is,

Participant 3 consistently performed 100% of all tag points embedded within skill set two across both volleyball skills. Participant 3 continued to perform 100% of both passing and serving tag points embedded within skill set one and slight increased performance (0% to 33%) of serving tag points embedded within skill set three (which was not yet taught). Percentage of passing tag points within skill set three remained stable and low. Lastly, Participant 3 performed 100% of all tag points embedded within skill set three following the implementation of TAGteach procedures. Performance remained relatively stable for remaining skill sets across both volleyball skills.

For Participant 3, retention and generalization probes were conducted one week after the intervention. For skill set one, Participant 3 retained 100% of passing tag points and 85% of serving tag points within skill set one. For skill set two, Participant 3 retained an average 83% of passing tag points and 100% of serving tag points within skill set two. For skill set three, this participant retained 100% of passing tag points and 89% of serving tag points. With the inclusion of a volleyball (i.e., generalization probes), percentage of TA steps performed correctly decreased slightly, performing an average of 90% of passing tag points and 83% of serving tag points correctly across skill sets. Verbal feedback appeared more efficient for this participant in terms of average percentage of task analysis steps performed correctly across skill sets.

The data for Participant 4 are depicted in Figure 5. Order of teaching was as follows: Serve (audible feedback; acoustic sound produced by the tagger) then pass (verbal feedback "yes, that's right" or "try again"). Participant 4 was novice with no volleyball experience prior to participating in the study. Baseline levels remained low and stable across skill sets for both volleyball skills. Implementation of TAGteach procedures for skill set one resulted in increases in percentage of TA steps performed correctly within skill set one across both volleyball skills.

More specifically, Participant 4 consistently performed 100% of passing tag points and 83% of serving tag points within skill set one. Baseline levels increased slightly (from 0% to 33%) within skill set two but remained low within skill set three. Following the implementation of TAGteach procedures for skill set two, Participant 4 performed 100% of all tag points embedded within skill set two for both volleyball skills. Increase in serving performance led to 100% accuracy of all tag points within skill set one and continuation of low baseline levels within skill set three. Lastly, implementation of TAGteach procedures for skill set three resulted in increased performance of both passing and serving tag points (100% for both volleyball skills). Performance remained high and stable for remaining skill sets across both volleyball skills.

For participant 4, retention and generalization probes were conducted one week following the completion of the intervention. In the retention condition (without the ball), Participant 4 performed nearly 100% of all tag points across all three skill sets for both volleyball skills. For skill set one, Participant 4 retained 100% of all tag points embedded both volleyball skills. For skill set two, Participant 4 retained 100% of serving tag points and an average of 83% of passing tag points. For skill set three, this participant retained 100% of all tag points embedded within both volleyball skills. With the inclusion of a volleyball (i.e., generalization probes), percentage of TA steps performed correctly remained relatively high, performing an average of 86% of passing tag points and 100% of serving tag points correctly across skill sets. Audible feedback appeared more efficient for this participant in terms of average percentage of task analysis steps performed correctly across skill sets.

The data for Participant 5 are depicted in Figure 6. Order of teaching was as follows: Pass (verbal feedback “yes, that’s right” or “try again”) then serve (audible feedback; acoustic sound produced by the tagger). Prior to participating in the study, Participant 5 had one year of

volleyball experience. However, with the exception of passing tag points embedded within skill set one (33%), Participant 5 consistently performed 0% of all tag points embedded within all skills sets across both volleyball skills. Implementation of TAGteach procedures for skill set one resulted in increased performance in both passing and serving tag points (100% for both volleyball skills. Baseline levels remained low for remaining skill sets across both volleyball skills. Following implementation of TAGteach procedures for skill set two, three types of responses were observed. First, baseline levels for skill set three remained stable and low across trials. Second, while Participant 5 maintained 100% of serving tag points embedded within skill set one correctly, average percentage of passing tag points performed correctly dropped to 66%. Third, when assessing skill acquisition of tag points taught within skill set two, it was observed that Participant 5 performed 100% of serving tag points and an average of 47% (with a decreasing trend) of passing tag points correctly. As a result of not meeting mastery criteria, an additional teaching session was conducted in which the specific tag points that Participant 5 performed incorrectly (within skill set two only) were retaught. No feedback or teaching was provided on any other tag point during this teaching session. Implementation of additional teaching (i.e., TAG* on graph) resulted in increases in percentage of passing tag points performed correctly. In addition, percentage of passing tag points within skill set one increased slightly. Baseline levels for skill set three remained stable and low (0%) across trials for both volleyball skills. Following implementation of TAGteach procedures for skill set three, Participant 5 performed an average of 94% of passing tag points and 83% of serving tag points correctly. Performance remained relatively stable for remaining skill sets across both volleyball skills.

For Participant 5, retention and generalization probes were conducted two weeks following the completion of the intervention. For skill set one, Participant 5 retained 100% of serving tag points and 83% of passing tag points. For skill set two, Participant 5 retained 97% of serving tag points and 72% of passing tag points. For skill set three, Participant 5 retained 39% of serving tag points and 22% of passing tag points. With the inclusion of a volleyball (i.e., generalization probes), percentage of TA steps performed correctly decreased, performing an average of 42% of passing tag points and 70% of serving tag points correctly across skill sets. Audible feedback appeared more efficient in terms of average percentage of TA steps performed correctly.

From visual analysis of the graphs, it appeared as though verbal and audible feedback were, for the most part, indistinguishable in terms of skill acquisition. That is, there were several instances where audible and verbal feedback produced the similar changes in behavior (measured by percentage of TA steps performed correctly). Table 1 depicts the average percentage of TA steps performed correctly within each experimental condition (e.g., baseline, TAGteach, maintenance, etc.) and comparing those values across skill sets for all participants. To calculate average percentage of TA steps performed correctly across all phases (except for generalization), the researcher totaled the average percentage of TA steps performed correctly within phase (with the exception of baseline values) and then divided that by the total number of experimental conditions (i.e., TAGteach, maintenance, retention, and generalization). For example, Participant one's average percentage of TA steps performed correctly across all phases was calculated as follows: [(99 + 99 + 96 + 93) = 387/4] = 97%.

For Participants 1-4, verbal feedback appeared slightly more efficient for acquiring and maintaining tag points embedded within skill set one with average percentages being 97%, 99%,

100%, and 100% respectively. These values were compared to 92%, 88%, 96%, and 96% (respectively) which were obtained via audible feedback. For Participant 5, audible feedback appeared more efficient at teaching and maintaining serving tag points embedded within skill set one with an average percentage of 100% versus 84% for passing tag points. For all participants, audible feedback appeared more efficient in teaching and maintaining tag points taught within skill set two. Average percentage of TA steps performed correctly across all phases were as follows: Participant 1 (92% for audible and 91%% for verbal), Participant 2 (99% for audible and 98% for verbal), Participant 3 (100% for audible and 99% for verbal), Participant 4 (100% for audible and 94% for verbal), and Participant 5 (92% for audible and 67% for verbal). Lastly, for Participants 1, 3, and 5, verbal feedback appeared to be more efficient then audible feedback at teaching and maintaining tag points embedded within skill set three. More specifically, average TA steps performed correctly across all phases were as follows: Participant 1 (100% for verbal and 86% for audible), Participant 3 (100% for verbal and 95% for audible), and Participant 5 (78% for verbal and 71% for audible). For Participants 2 and 4, topography of feedback was indistinguishable in that both resulted in 100% accuracy of tag points embedded within skill set three for both volleyball skills.

For all five participants, social validity results showed that they not only enjoyed the procedures used and found them easy to understand, but also no negative side effects were noted (see Figure 7). With the exception of Participant 5, similar results were obtained (i.e., all participants circled 5's and 6's) regarding feedback preference. All five participants stated that they found the audible stimulus (i.e., the tagger) helpful in learning either volleyball skill. In comparison, four of the five participants (all but Participant 5) also expressed that they found verbal feedback equally helpful. Participant 5 indicated that she did not find verbal feedback

helpful in learning the target volleyball skill. This statement was supported by her performance data as audible feedback appeared more effective at teaching and maintaining serving tag points across skill sets. Participant 2, 3, 4, and 5 identified that they would very much like to use these procedures (i.e., TAGteach) in the future to learn other new skills. Participant 1 slightly agreed with this question. Lastly, all five participants identified that they strongly agree with the following questions: (1) “Session length was adequate for learning the skills,” (2) “I am confident that I have learned these skills and can use them in the future,” and (3) “these procedures were effective in teaching these skills.” Overall, social validity results are positive, suggesting that all five participants enjoyed the use of TAGteach procedures and would use them in the future.

Chapter 5: Discussion

The purpose of this study was to compare the effects of audible feedback (inherently embedded within TAGteach) to verbal feedback (typically used in naturalistic settings) on the skill acquisition of volleyball skills. Five female adolescents participated in the study, two completely novice (i.e., had no prior experience) while three had one year of volleyball experience. During TAGteach sessions, all five participants were systematically taught how to pass and serve a volleyball. Order of teaching and topography of feedback (verbal versus audible) was counterbalanced across participants. An alternating treatment design embedded within a multiple baseline design across skill sets was used to evaluate the efficiency of audible and verbal feedback. Implementation of TAGteach procedures, regardless of the topography of feedback, resulted in discriminable increases over baseline in percentage of TA steps performed correctly. When embedded within TAGteach procedures, verbal and audible feedback seemed equally effective in promoting skill acquisition of volleyball skills.

Only one other study to date has compared the effects of audible feedback (acoustic sound produced by the tagger) to other topographies of feedback (Arnall, 2018). She sought to compare the independent effects of randomized vocal consequences to TAGteach procedures which inherently utilizes audible feedback to mark the correct performance of a tag point. As such, Arnall (2018) began by employing only verbal feedback following baseline performance levels. When responding did not increase to a considerable degree, Arnall (2018) implemented TAGteach procedures for two of the participants and a combination of TAGteach and Precision Teaching for the other two participants. Results demonstrated that both TAGteach and TAGteach plus Precision Teaching were superior to randomized vocal consequences. In contrast, the current study demonstrated that when employing only procedures naturally

embedded within TAGteach and varying only the topography of feedback delivered (verbal versus audible), neither form of feedback was found to be superior to the other.

While efficiency of different topographies of feedback (i.e., verbal and audible) seemed to be indistinguishable via visual analysis, the data illustrated that behavior differentiation was observed when analyzing each skill set separately (see Appendix H). More specifically, verbal feedback appeared to be more efficient in teaching and maintaining tag points within skill set one regardless of which volleyball skill was being taught. On the other hand, audible feedback was most efficient for all participants in the teaching and maintenance of tag points taught within skill set two. Finally, verbal feedback appeared more efficient than audible feedback at teaching and maintaining tag points within skill set three. However, there was an interesting observation regarding skill set three. In order to accurately perform the serving tag points embedded within skill set three, the participant had to toss the volleyball in the air at the right height and distance in front of them. Tossing of the volleyball was not directly taught during the intervention, thus, is it hypothesized that the lack of accuracy in tossing the ball led to reduced percentages of TA steps performed correctly. This is also illustrated by the average percentage of TA steps performed correctly across all phases. More precisely, prior to the generalization probe (i.e., the inclusion of the volleyball), the highest and lowest average percentage of serving tag points performed correctly for any participant was 100% and 71% respectively. Following generalization probes, the highest and lowest average percentage of serving tag points performed correctly for any participant was 96% and 60% respectively. These values were then compared to those obtained from passing tag points taught within skill set three. Prior to the generalization probe (i.e., the exclusion of the volleyball), the highest and lowest average percentage of passing tag points performed correctly for any participant was 100% and 78% respectively. When a

volleyball was tossed to the participants (i.e., during generalization probes), a maximum of 100% and minimum of 59%. These findings suggest that variability within the data increased following the inclusion of a volleyball; more so when serving than when passing.

Another interesting observation from the present study was the different effects topography of feedback had on static and dynamic movements. Static movements are those that "exert muscles at high intensities without movement of the joints" while dynamic movements are characterized as those that "keep joints and muscles moving" and "involve controlled movements through a complete range of motion" (At-Home Fitness, 2019, p. 1). In terms of the task analyses created for this intervention, skill set two and three were comprised of dynamic movements (e.g., movements involved in actually passing and serving the volleyball) while skill set one was composed of static movements (e.g., movements involved in getting ready to pass and serve the volleyball). Apart from skill set three, results suggest that perhaps the verbal feedback is more efficient at teaching and maintaining static movements while audible feedback was more efficient at teaching and maintaining dynamic movements. It is hypothesized that regressions in performance within skill set three was due to added complexities brought on by including a volleyball rather than inability to perform the volleyball skill correctly.

Finally, experience level and age demographics of participants seemed to play a minimal role of skill acquisition (see Appendix I). That is, all participants demonstrated mastery of tag points taught regardless of age and prior volleyball experience. With that being said, Participant 5 (who had one years' worth of volleyball experience) required additional teaching within the intervention to meet mastery criteria. It is hypothesized that this particular participant may have had some physical restrictions (i.e., was moderately overweight) that reduced the likely of continually performing tag points (both static and dynamic) that involved bending her knees,

holding arms out in front of themselves, and/or maintaining appropriate back or chest postures. An additional variable to consider was related to this participant's motivation; when asked why they volunteered to participate in the study, the participants expressed that they either wanted to learn a new skill (Participant 1 and 4) or wanted to improve their current performance (Participant 2 and 3). Participant 5, on the other hand, verbally stated that she was excited to participate in the study because the flyer (which was available at her school) said that each participant would earn $20 for their participation and she wanted to go try the new Reese's Extreme ice cream from Sonic. Moreover, apart from skill two (in which audible feedback was most efficient for all participants), efficiency of feedback topographies varied across participants. More specifically, both topographies of feedback were demonstrated more efficient at one point in time (i.e., for a specific skill set) for each participant, regardless of experience level.

This study is not without limitations that could lower the confidence in the causal relationship between the improved performance and the TAGteach procedures. First, average percentage of serving TA steps performed correctly were generally lower than those obtained during the passing condition, suggesting that participants generally had a harder time accurately performing all the serving tag points correctly across all three skill sets. It is hypothesized that this specific volleyball skill required more body awareness and coordination than did the pass. For instance, while passing, the athlete needed to focus primarily on lower body (e.g., feet, legs, hips) movements whereas serving requires that the athletes focuses on the entire body (e.g., feet, legs, back, arms, shoulders, and elbow). For this reason, it is possible that participants did not possess the dexterity (i.e., control or coordination) to emit all tag points consecutively and fluently. However, prior to the study, the researcher reached out to other volleyball coaches in the area to obtain social agreement. That is, "experts" in the sport of volleyball not only agreed

with the tag points embedded within each task analysis, they also stated that both volleyball skills were equivalent in difficulty. However, in future studies, more care might be taken in selecting the skills to teach.

Second, there seemed to be some carryover effect of tag points not yet taught. More specifically, there were three possible instances for Participant 2, 3, and 4. After teaching skill set one, both Participant 2 and 4 were observed subsequently performing one tag point embedded within skill set two (that had not yet been taught) correctly. Interestingly, it was the same tag point that they performed correctly during skill acquisition probes (i.e., "Bring arms into midline"). During the teaching of skill set one, the researcher taught the participants to extend both arms out in front of them until their hands were in line with their hips and palms facing each other. When actually passing a volleyball, the athlete would then have brought both arms into their midline (i.e., directly in line with their belly buttons), creating the platform for which the volleyball contacts. However, that skill (i.e., the bringing together of the arms) was the first tag point that was going to be taught in skill set two. Therefore, when running skill acquisition probes following skill set one, Participant 2 and 4 spontaneously brought both arms together to pass the ball. This was not surprising for Participant 2 as she had previous experience playing volleyball and so based on learning history, was more likely to perform that tag point correctly. Participant 4 on the other hand, had no prior volleyball experience yet still performed that tag point correctly without teaching. The reason the remaining participants did not follow suit (i.e., did not also perform this tag point correctly) was because they emitted additional, adjunctive behaviors such as bending their elbows before bringing their arms into their midline. Carry-over effect was also observed with Participant 3 following the completion of teaching the serving tag points embedded within skill set one. More specifically, one of the tag points outlined in skill set

one involved the athlete, with a straight arm, raising their left arm up diagonally across their body until it is in line with their right shoulder and shoulder height. When actually serving a volleyball, an athlete should diagonally lower their left arm back down to their left hip after tossing the volleyball in the air. For Participant 3, after being taught to place her left arm in the appropriate location (i.e., in line with her right shoulder and shoulder height), she spontaneously lowered it back down to her hip during skill acquisition probes of skill set one (which simultaneously represented baseline of skill set three). This change in behavior is predicted to be a product of learning history as Participant 3 had one years' worth of experience prior to starting the intervention. Similar to conclusions drawn by Fogel et al (2010), it is hypothesized that such carry-over effects were a product of the way the task analyses were written rather than lack of treatment integrity or experimental control.

A third potential limitation was the exclusion of a volleyball during the teaching session. As mentioned previously, participants were not taught how to accurately toss the volleyball in the air when serving, nor where to position their body in relation to the volleyball when passing. This may have influenced the participant's performance of tag points embedded within skill set three for both skills, but more specifically for serving. Conceptually, what is the point of teaching without a volleyball if target responses do not generalize to natural environmental settings? The decision to teach without a volleyball was based on (1) standard teaching strategies (Art of Coaching Volleyball, 2020) and (2) minimize the potential impact of autoshaping on the correct performance. First, beginning learners are typically taught how to perform the athletic movements first, without a volleyball, and then with a volleyball. Second, a volleyball was excluded to negate the potential reinforcing effects a volleyball may have on performance. Results of the current study suggest that solely teaching volleyball skills without a volleyball

may not be sufficient for generalization. Instead, further teaching will probably be needed with a volleyball to assess the impact on generalizability of results. With that being said, the primary focus of this study was to evaluate the effects varying topographies of feedback had on the skill acquisition of tag points embedded within both task analyses. Therefore, it is neither concerning nor surprising that the participants were unable to accurately emit either behavior. Even then, it is important to note that all participants continued to perform an average of 66% of serving tag points 78% of passing tag points embedded within skill set three.

A fourth potential limitation is the combination of the experimental design and the modelling component inherently embedded within TAGteach procedures. More specifically, the researcher utilized a forward chaining procedure to systematically teach both volleyball skills. As such, when the researcher modeled the target tag point during the TAGteach session, she simultaneously modeled tag points already mastered. For example, when modeling tag point 3 of a pass (i.e., bending of the hips), the researcher also modeled tag point 1 and 2 (i.e., spread out feet one step wider than shoulder width and bent knees to appropriate angle). With that being said, no additional instructions or feedback were provided for tag points 1 and 2. Instead, the researcher continued implementing TAGteach procedures for tag point 3 in accordance to the TAGteach script. There were two instances where participants (Participant 4 and 5), who previously performed one or more tag points incorrectly, eventually performed them correctly during skill acquisition probes. It is hypothesized that these behavior changes were an indirect result of the model prompts.

The final potential limitation was the fact that retention and generalization probes were not conducted two weeks post-intervention for all participants, due to the pandemic and the concern by some participants about social distancing. A longer-term retention test was desired

for a more valid assessment of maintenance of skill. While one-week was sufficient for a demonstration of retention and generalization of tag points taught, a more ideal representation of long-term skill retention would have been obtained at the two-week mark.

Although the TAGteach literature is expanding, more research is needed to more fully identify the variables responsible for behavior change. Future research endeavors should focus on the limitations noted in the current study. For example, it is recommended that future research efforts involving complex volleyball movements make sure to teach the prerequisite skills necessary for generalization of tag points embedded within skill set three. This can be accomplished by teaching how to accurately toss the volleyball (i.e., distance and height) when serving and where to place one's body in relation to the volleyball when passing. This could improve the analysis of whether verbal or audible feedback is more efficient at teaching and maintaining the dynamic movements (or tag points) included within skill set three of both volleyball skills. Similar to the previous suggestion, future research could compare the effects of TAGteach procedures with and without a volleyball. For instance, rather than teaching without a volleyball, research could be done in which a volleyball is used during the teaching session. Information provided from this research could emphasize the importance of teaching with a volleyball. In addition, more component analyses of TAGteach variables seems necessary to evaluate the effects of discrete teaching procedures within TAGteach, such as model prompts, the number of error correction trials, and the type of audible feedback.

Lastly, future research could compare the effects TAGteach procedures have on static and dynamic movements. Results obtained from the current study allude to the idea that TAGteach procedures are more efficient for teaching and maintaining dynamic movements. This

is vital as most complex athletic movements are dynamic in nature. Future research on this topic could aide in the identification of a teaching procedure that is not only effective but efficient.

Conclusion

Although TAGteach is relatively new, there is a growing body of literature illustrating its efficacy and applicability across a wide range of behavioral domains. A careful behavioral analysis of instructional procedures will yield information that will improve the efficacy of those procedures and thus produce better outcomes for the learners. In terms of sports and behavioral coaching, such evaluations will benefit the athletes themselves, the coaches, those who watch sports, and the analysis of behavior.

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Appendices

Appendix A: Pass TA

Volleyball passing footwork	
Instruction	**Tag Point**
Skill Set One – Ready	
Feet one step wider than shoulder width apart with **left foot in the instep of the right foot**	Feet apart, left foot instep
Knees bent at a 45-degree angle	Knees bent at 45-degrees
Hips back so that they are **behind heels of left foot** with back in a neutrally flat position	Hips back, back flat
Lean shoulders forward so that they are **in front of the toes** on the right foot	Shoulders in front of toes
Raise both arms forward until **hands are directly in line with hips**	Arms up, hands to hip
Internally rotate wrists until **palms are facing each other**	Palms facing each other
Skill Set Two – Left/Right	
Take one step (measured by athlete's foot) forward with left foot	Step forward with left foot
Take one step forward with right foot so that when complete, **left foot realigns in the instep of the right foot**	Step forward with right foot
Keeping palms facing each other, bring both arms together until **hands are directly in line with athlete's belly button**	Bring arms into midline
Press the heels of both hands together and then grasp the fingers with the **thumbs pointed down**	Press, grasp, thumbs down
Skill Set Three - Weight shift	
Upon contact with ball, raise hips up vertically and forward until **the heel of the left foot raises slightly (roughly 1 inch)**	Weight shift onto right foot
When passing the ball, shrug **shoulders up towards chin**	Shrug shoulders to chin

Appendix B: Serve TA

TA for standing volleyball serve (Right-handed athlete)	
Instruction	**Tag Point**
Skill Set One – Ready Position	
Feet should be hips length apart with right leg straight and left leg bent with only **toes touching ground and in line with right toes**	Right leg straight, left bent
Hips slightly hinged back at a 10-degree angle with back in a neutrally flat position	Hips back, back flat
Keeping right **elbow next to right hip, bend right elbow to 90-degrees**	Bend elbow to 90-degrees
With **arm straight and palm straight up**, raise left arm up diagonally across body from left hip until the left hand is **directly in line with right shoulder and shoulder height**	Left arm to right shoulder
Keeping right elbow bent, raise right arm up and back **until elbow in eye level and behind body**	Elbow to eye, behind body
Keeping hands open wide, extend right wrist upward until **palm is facing forward**	Palm forward with open hand
Skill Set Two – Lift/Step	
Starting with left arm up at shoulder height and in line with the right shoulder, **vertically raise left arm 5 inches**	Raise left arm 5 inches
Take one step forward with left foot until **left knee is over the heal of left foot**	Left step, knee over heal
Internally **rotate right shoulder until elbow is facing forward** (palm should still be facing forward)	Rotate right elbow forward
Lean forward with shoulders and **slide right foot along ground until right knee is next to left knee** and only toes of right foot touching the ground	Slide right foot forward
Skill Set Four - Hit	
Lower left arm diagonally across body until it **returns to left hip**	Lower left arm to hip
Swing arm vertically down until **right hand is next to right hip**	Swing down, hand to hip

Appendix C: Order of teaching/Topography of feedback

	Order of Teaching	Topography of Feedback
Participant 1	Pass	Verbal
	Serve	Audible
Participant 2	Serve	Verbal
	Pass	Audible
Participant 3	Pass	Verbal
	Serve	Audible
Participant 4	Serve	Verbal
	Pass	Audible
Participant 5	Pass	Verbal
	Serve	Audible

Appendix D: TAGteach Script

STEP	WHAT YOU SAY	WHAT YOU DO
1	**Today we're going to learn _____** **This is important because _____** **Here's what it looks like**	**Give the lesson** **Demonstrate the final result**
2	**First, we'll work on _____** **Let me demonstrate** **The tag point is _____**	**Explain the tag point** **Demonstrate the tag point** **Tag your own action**
3	**Now it's your turn to tag** **The tag point is _____**	**Give tagger to learner** **You do the action**
4	**Now it's my turn to tag** **The instructions are _____** **We're going to do it _____ times** **The tag point is _____**	**Take the tagger back** **Give the instructions** **Indicate the number of reps** **Tag the learner's action**

Appendix E: Social Validity Survey

	Strongly Disagree	*Disagree*	*Slightly Disagree*	*Slightly Agree*	*Agree*	*Strongly Agree*
1. I liked the procedures used in the intervention	1	2	3	4	5	6
2. The procedures used were easy to understand and follow	1	2	3	4	5	6
3. This intervention did *not* result in negative side-effects for the participant If negative side-effects were felt, please explain here:	1	2	3	4	5	6
4. I found the audible stimulus (i.e., tagger) helpful in learning a new skill	1	2	3	4	5	6
5. I found the verbal feedback (e.g., "good job," and "try again") helpful in learning a new skill	1	2	3	4	5	6
6. In the future, would you like to learn additional skills using these procedures	1	2	3	4	5	6
7. Session length was adequate for learning the skills	1	2	3	4	5	6
8. I am confident that I have learned these skills and can use them in the future	1	2	3	4	5	6
9. These procedures were effective in teaching these skills	1	2	3	4	5	6
10. Provide any comments:						

Appendix F: IOA Sheets

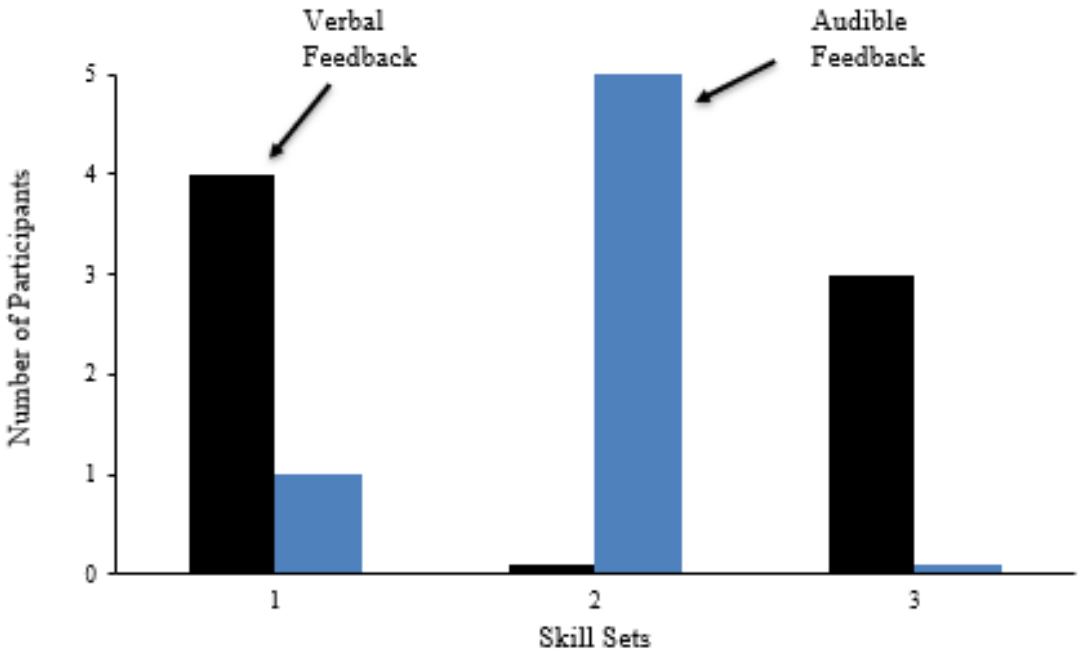
Volleyball passing footwork		Data Collection																					
Instruction	**Tag Point**	**@ Beg**			**After SS1**			**After SS2**			**After SS3**			**2 wks**			**2 wks**					
Skill Set One – Ready		**Before**			**Skill Cont.**			**Skill Cont.**			**Skill Cont.**			**Maint.**			**Gen.**					
Feet one step wider than shoulder width apart with **left foot in the instep of the right foot**	Feet apart, left foot instep																						
Knees bent at a 45-degree angle	Knees bent at 45-degrees																						
Hips back so that they are **behind heels of left foot** with back in a neutrally flat position	Hips back, back flat																						
Lean shoulders forward so that they are **in front of the toes** on the right foot	Shoulders in front of toes																						
Raise both arms forward until **hands are directly in line with hips**	Arms up, hands to hip																						
Internally rotate wrists until **palms are facing each other**	Palms facing each other																						
Skill Set Two – Left/Right		**Before**			**Before**			**Cont.**			**Cont.**			**Maint.**			**Gen.**					
Take one step (measured by athlete's foot) forward with left foot	Step forward with left foot																						
Take one step forward with right foot so that when complete, **left foot realigns in the instep of the right foot**	Step forward with right foot																						
Keeping palms facing each other, bring both arms together until **hands are directly in line with athlete's belly button**	Bring arms into midline																						
Press the heels of both hands together and then grasp the fingers with the **thumbs pointed down**	Press, grasp, thumbs down																						
Skill Set Three - Weight shift		**Before**			**Before**			**Before**			**Cont.**			**Maint.**			**Gen.**					
Upon contact with ball, raise hips up vertically and forward until **the heel of the left foot raises slightly (roughly 1 inch)**	Weight shift onto right foot																						
When passing the ball, shrug **shoulders up towards chin**	Shrug shoulders to chin																						

TA for standing volleyball serve (Right-handed athlete)		Data Collection																					
Instruction	**Tag Point**	**@ Beg**			**After SS1**			**After SS2**			**After SS3**			**2 wks**			**2 wks**					
Skill Set One – Ready Position		**Before**			**After**			**Cont.**			**Cont.**			**Maint.**			**Gen.**					
Feet should be hips length apart with right leg straight and left leg bent with only **toes touching ground and in line with right toes**	Right leg straight, left bent																						
Hips slightly hinged back at a 10-degree angle with back in a neutrally flat position	Hips back, back flat																						
Keeping right **elbow next to right hip, bend right elbow to 90-degrees**	Bend elbow to 90-degrees																						
With **arm straight and palm straight up**, raise left arm up diagonally across body from left hip until the left hand is **directly in line with right shoulder and shoulder height**	Left arm to right shoulder																						
Keeping right elbow bent, raise right arm up and back **until elbow in eye level and behind body**	Elbow to eye, behind body																						
Keeping hands open wide, extend right wrist upward until **palm is facing forward**	Palm forward with open hand																						
Skill Set Two – Lift/Step		**Before**			**Before**			**After**			**Cont.**			**Maint.**			**Gen.**					
Starting with left arm up at shoulder height and in line with the right shoulder, **vertically raise left arm 5 inches**	Raise left arm 5 inches																						
Take one step forward with left foot until **left knee is over the heal of left foot**	Left step, knee over heal																						
Internally **rotate right shoulder until elbow is facing forward** (palm should still be facing forward)	Rotate right elbow forward																						
Lean forward with shoulders and **slide right foot along ground until right knee is next to left knee** and only toes of right foot touching the ground	Slide right foot forward																						
Skill Set Four - Hit		**Before**			**Before**			**Before**			**After**			**Maint.**			**Gen**					
Lower left arm diagonally across body until it **returns to left hip**	Lower left arm to hip																						
Swing arm vertically down until **right hand is next to right hip**	Swing down, hand to hip																						

Appendix G: Procedural Fidelity Sheet

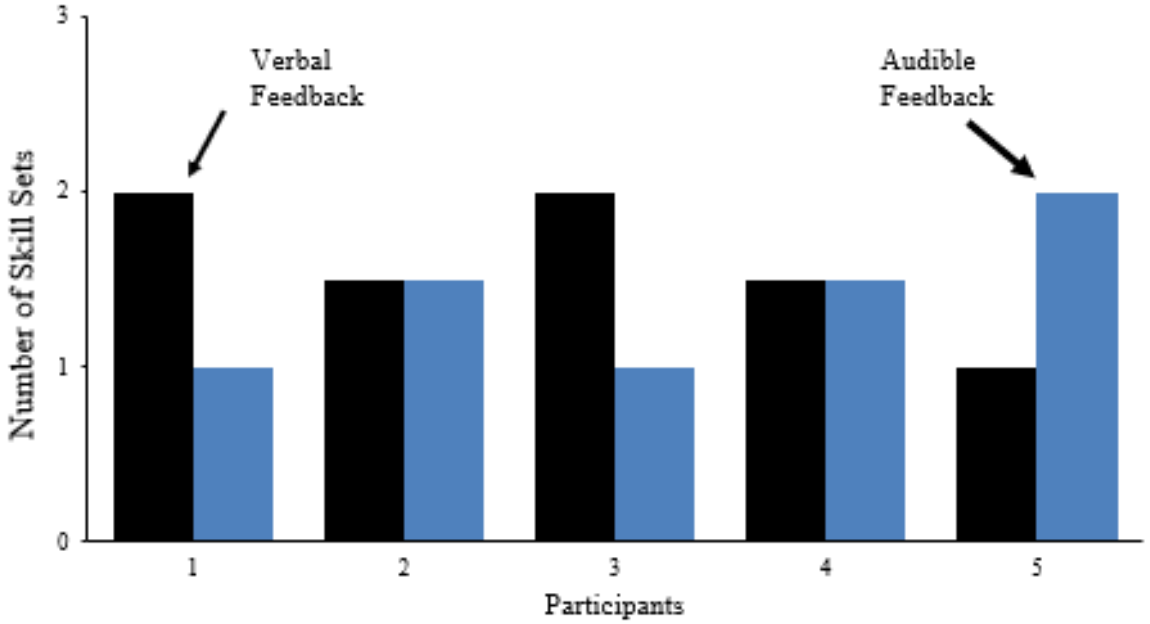
STEP	WHAT YOU SAY	WHAT YOU DO	Data Collection							
			1	2	3	4	5	6	7	8
1	Today we're going to learn _____ This is important because _____ Here's what it looks like	Give the lesson Explain why it's important Demonstrate the final result								
2	First, we'll work on _____ Let me demonstrate The tag point is _____	Explain the tag point Demonstrate the tag point Tag your own action								
3	Now it's your turn to tag The tag point is _____	Give tagger to learner You do the action								
4	Now it's my turn to tag The instructions are _____ We're going to do it _____ times The tag point is _____	Take the tagger back Give the instructions Indicate the number of reps Tag the learner's action								
When tagging, did the instructor used the appropriate topography of feedback (i.e., verbal or audible)?										
When tagging, did the instructor tag the correct behavior?										
If the subject made an error, did the instructor tag it?										
If the participant incorrectly performed the tag point three times, did the instructor implement the three-try rule?										

Appendix H: Analysis Across Skill Sets



Appendix G. This graph depicts the number of participants where either verbal or audible feedback appeared to be more efficient per skill set. Data based on average percentage of TA steps performed correctly.

Appendix I: Analysis Across Participants



Appendix I. This graph depicts the number of skill sets where either verbal or audible feedback appeared to be more efficient per participant. Data based on average percentage of TA steps performed correctly.

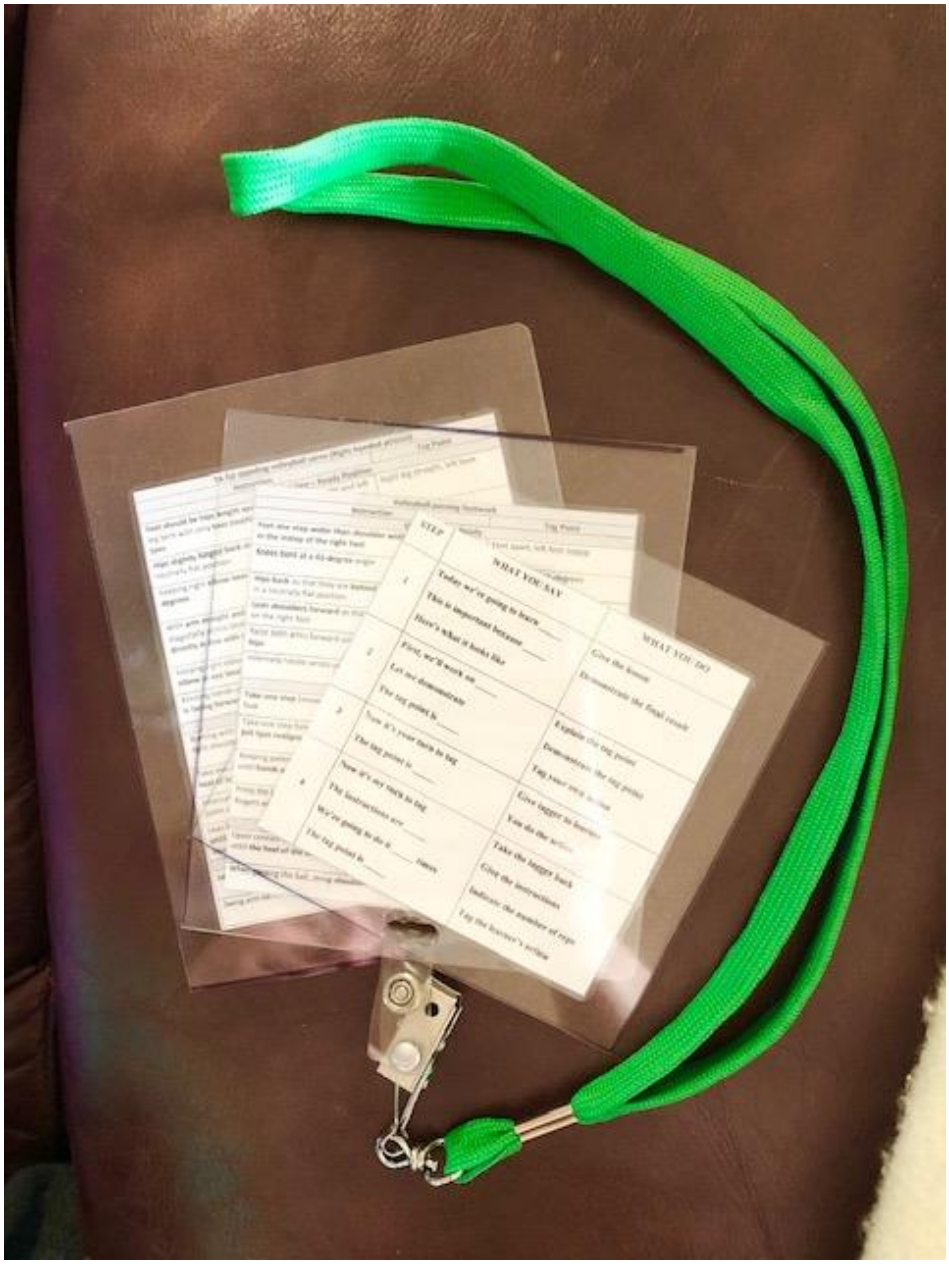


Figure 1. This figure depicts the instructional cards used during TAGteach sessions.

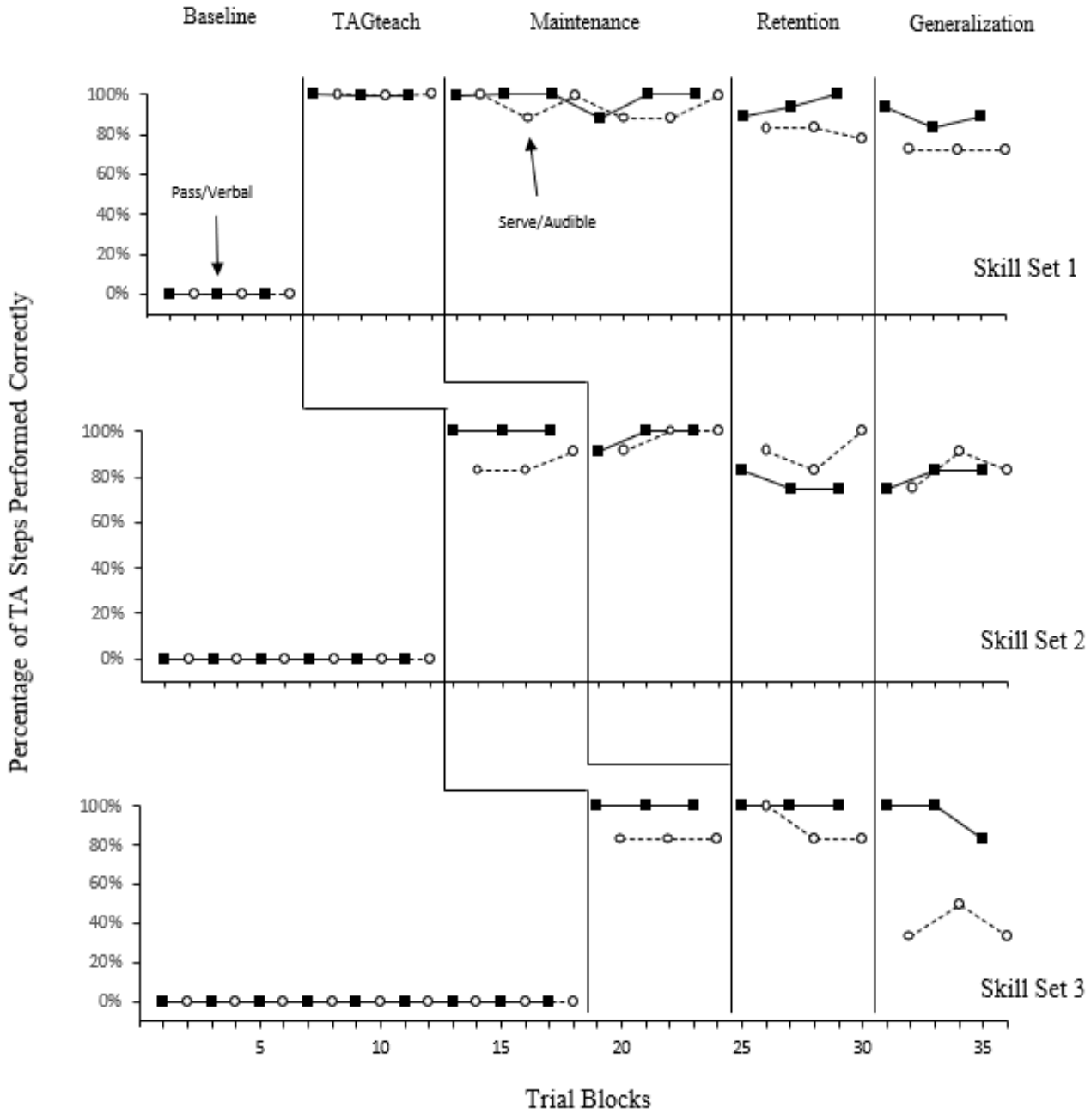


Figure 2. This graph depicts data obtained for Participant 1.

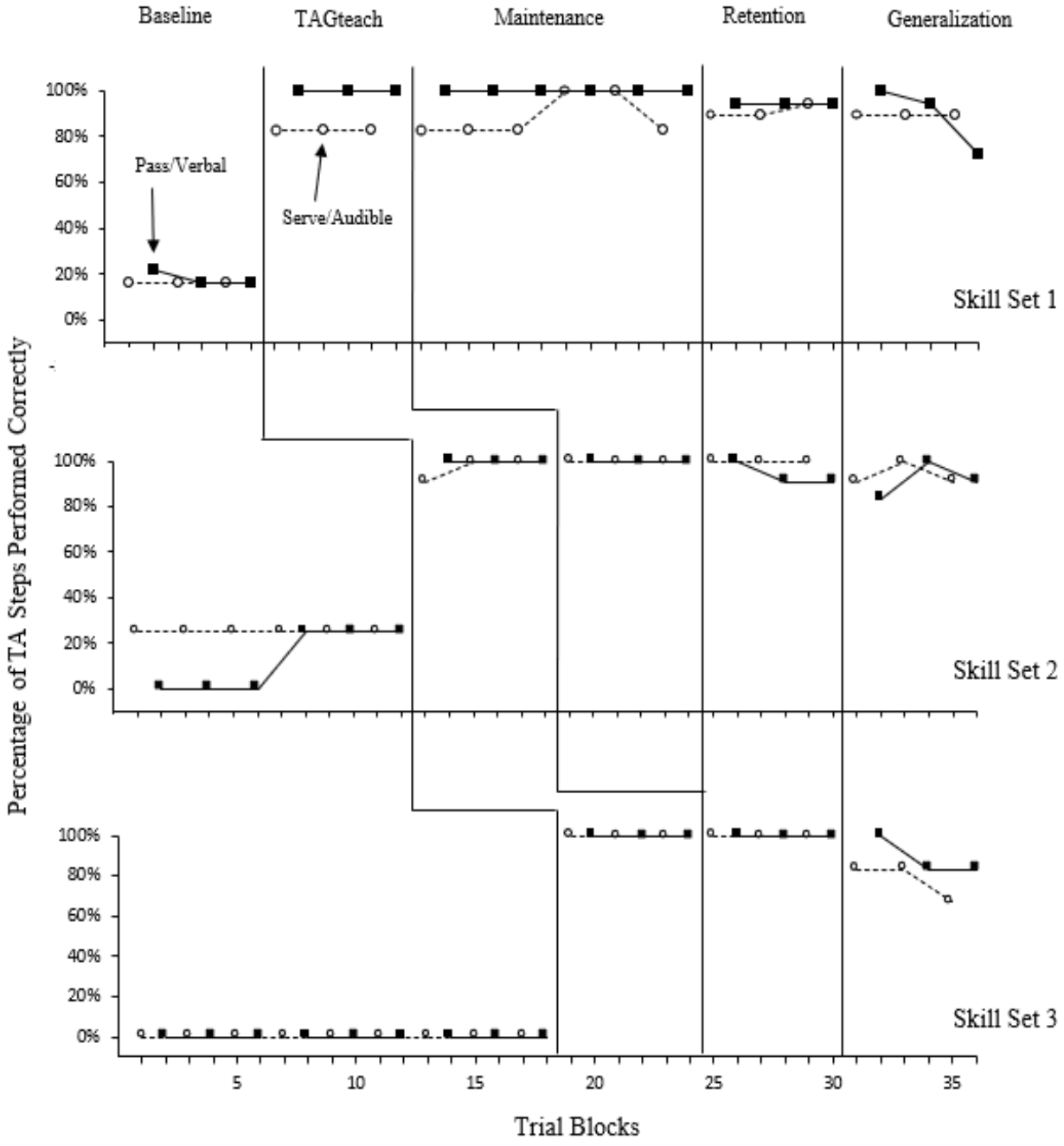


Figure 3. This graph depicts the data obtained for Participant 2.

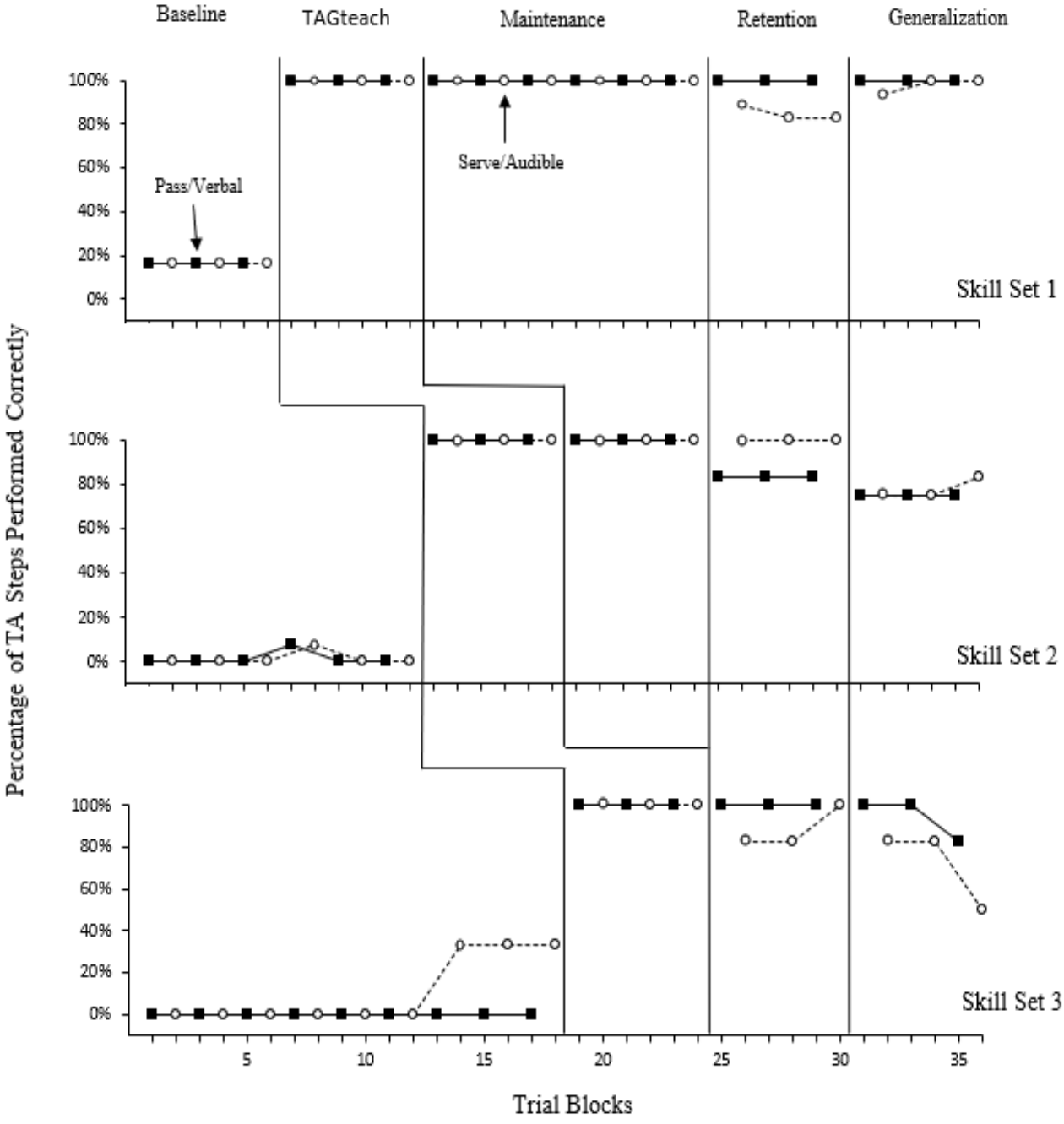


Figure 4. This graph depicts the data obtained for Participant 3.

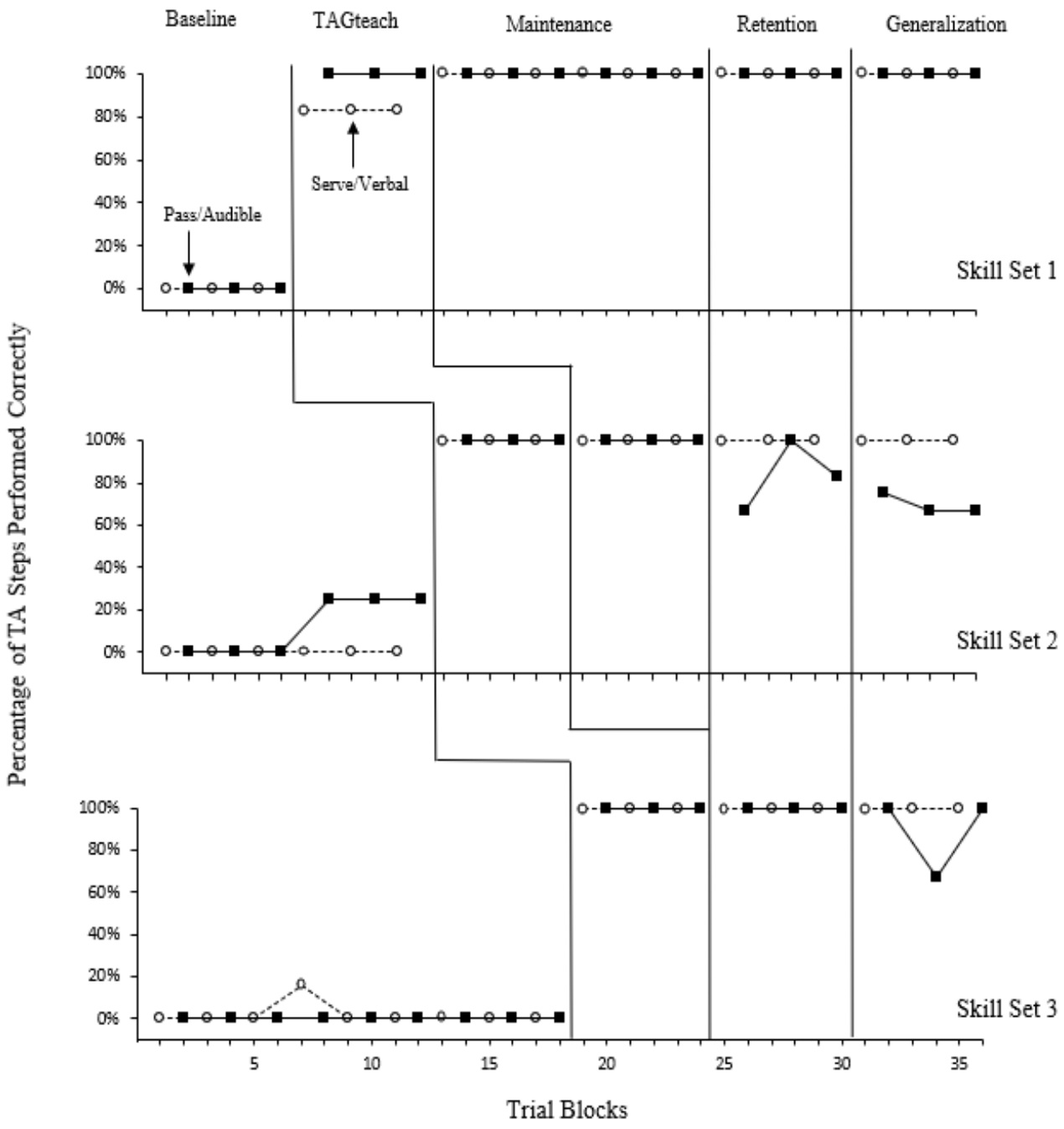


Figure 5. This graph depicts the data obtained for Participant 4.

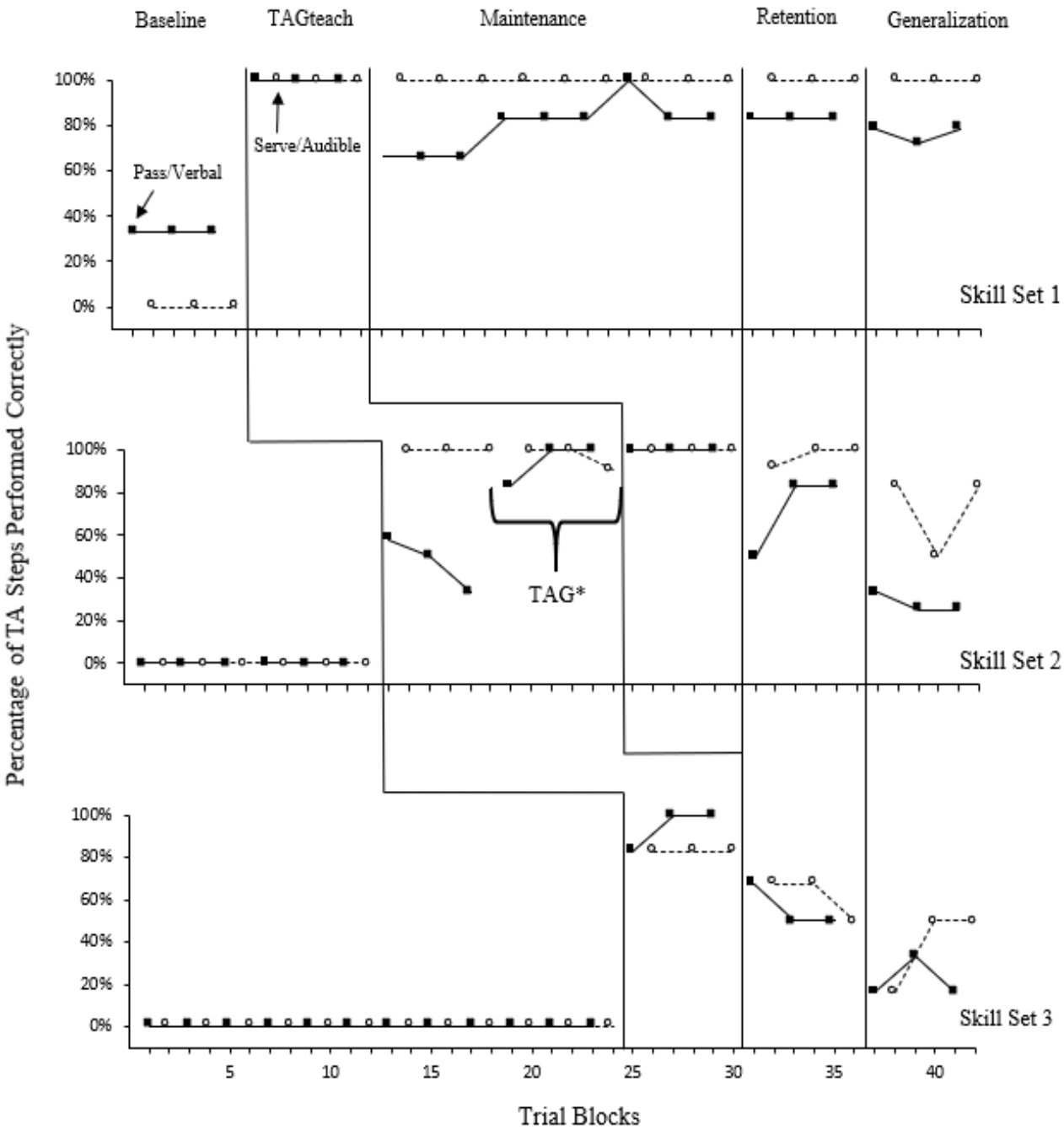


Figure 6. This graph depicts the data obtained for Participant 5.

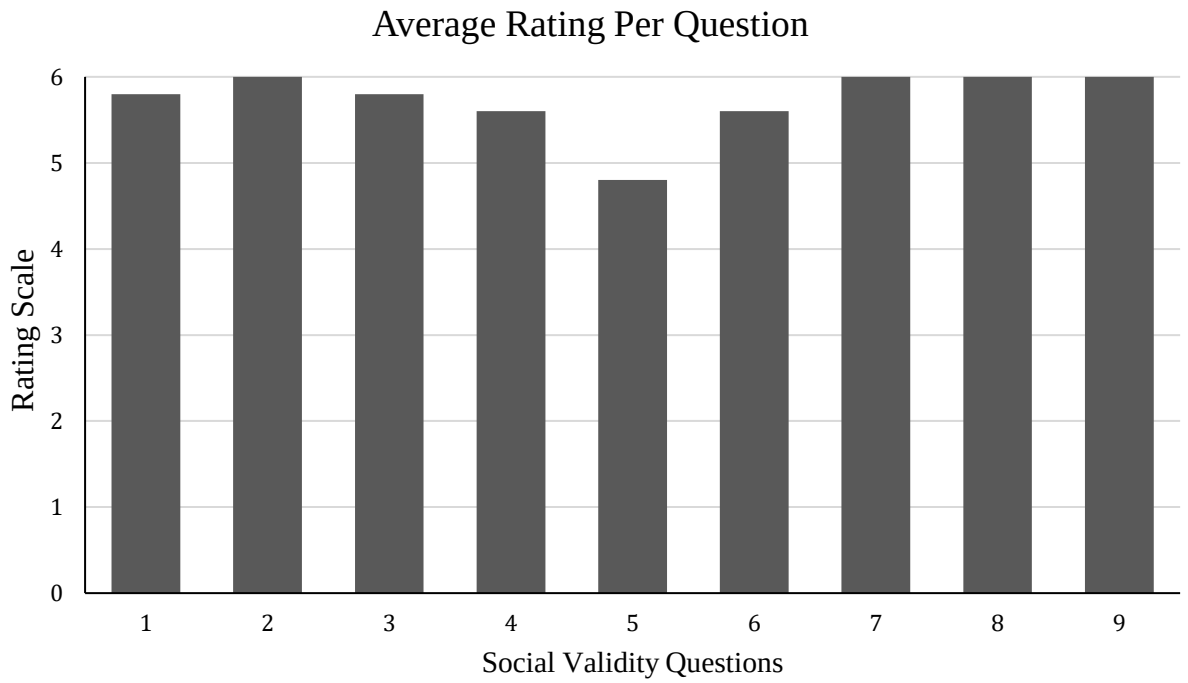


*Figure 7***.** This table depicts the average rating of each question on the social validity questionnaire. See Appendix E for specific questions.

Average Percentage of TA Steps Performed Correctly Within Each Phase							
Participants	Skill Set One		Skill Set Two		Skill Set Three		Most Effective
	Pass	Serve	Pass	Serve	Pass	Serve	
Participant one	0%	0%	0%	0%	0%	0%	SS1 = V SS2 = A SS3 = V
	99%	99%	0%	0%	0%	0%	
	99%	96%	100%	86%	0%	0%	
	96%	92%	97%	97%	100%	83%	
	93%	81%	78%	91%	100%	89%	
Participant two	16%	18%	25%	0%	0%	0%	SS1 = V SS2 = A SS3 = V
	83%	100%	25%	25%	0%	0%	
	83%	100%	97%	100%	0%	0%	
	94%	100%	100%	100%	100%	100%	
	91%	94%	100%	94%	100%	100%	
Participant three	16%	16%	0%	0%	0%	0%	SS1 = V SS2 = A SS3 = V
	100%	100%	3%	3%	0%	0%	
	100%	100%	100%	100%	0%	33%	
	100%	100%	100%	100%	100%	100%	
	100%	83%	83%	100%	100%	89%	
Participant four	0%	0%	0%	0%	0%	0%	SS1 = V SS2 = A SS3 = A
	83%	100%	25%	0%	5%	0%	
	100%	100%	100%	100%	0%	0%	
	100%	100%	100%	100%	100%	100%	
	100%	100%	100%	83%	100%	100%	
Participant five	33%	0%	0%	0%	0%	0%	SS1 = A SS2 = A SS3 = V
	100%	100%	0%	0%	0%	0%	
	66%	100%	47%	100%	0%	0%	
	83%	100%	94%	97%	0%	0%	
	89%	100%	100%	100%	94%	83%	
	83%	100%	28%	72%	61%	59%	

Table 1. This table depicts the average percentage of task analysis steps performed correctly across skill sets. Far right column indicates topography of feedback which appeared most effective. V = verbal feedback. A = audible feedback.