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Using Auditory Feedback to Improve Striking for Mixed Martial Artists

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Using Auditory Feedback to Improve Striking for Mixed Martial Artists

by

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A thesis submitted in partial fulfillment
of the requirements for the degree of
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Table of Contents

List of Tables ii

List of Figures iii

Abstract iv

Chapter One: Introduction 1

Chapter Two: Method 8

 Participants and Setting 8

 Dependent Variable 9

 Data Collection 9

 Inter-Observer Agreement (IOA) 10

 Materials and Equipment 12

 Treatment Integrity 12

 Social Validity 13

 Experimental Design Experimental Design and Procedures 13

 Baseline 13

 Auditory Feedback Training 13

 Follow up 16

Chapter Three: Results 17

Chapter Four: Discussion..... 20

References 25

Tables and Figures 28

Appendices..... 33

 Appendix A: Visual Representation of the Right Cross 33

 Appendix B: 20 Step Task Analysis of the Right Cross 34

 Appendix C: Data Sheet 35

 Appendix D: Treatment Integrity Data Sheet 36

 Appendix E: Participant Social Validity Right Cross 37

 Appendix F: Coach Social Validity 38

 Appendix G: Area Coach Social Validity Right Cross 39

 Appendix H: Inter Observer Agreement Right Cross 40

List of Tables

Table 1: 20-Step Task Right Cross11

Table 2: Treatment Integrity18

Table 3: Social Validity of Participants for the Procedure19

Table 4: Social Validity for Participant's Coach.....20

Table 5: Social Validity of Coaches21

List of Figures

Figure 1: Percentage of Correct Behaviors Engaged in by Participant for Each Trial.....23

Abstract

The purpose of this study was to evaluate, auditory feedback as a training procedure to increase the effectiveness of throwing a "right cross." Auditory feedback was evaluated in multiple baselines across behaviors design with 4 mixed martial arts students, two males and two females, 25-54 years old. The percentage of correct steps of the right crosses." was stable .during baseline for all participants improved substantially following the introduction of the auditory feedback, and maintained at 90 percent or more for all participants during follow-up.

Chapter One: Introduction

The science of human behavior has progressively grown its evidence base for over a century. Although many people perceive the science as a set of principles used exclusively to modify the behaviors of individuals with disabilities, the technology of applied behavior analysis (ABA) has gone much further. Many fields including economics, health, business, education, and sports have benefited by utilizing principals of applied behavior analysis. Focusing on sports, ABA has been used as a method of teaching for many different sports and activities including dance (Clarkson, James, Watkins, & Foley, 1986) , swimming (Hazen, Johnstone, Martin, & Srikameswaran, 1990), horseback riding (Kelly & Miltenberger, 2016), gymnastics (Baudry, Leroy, Thouvarecq, & Chollet, 2006; Boyer, Miltenberger, Batsche, & Fogel, 2009), capoeira, an Afro-Brazilian martial art technique (Benitez-Santiago & Miltenberger, 2016), football (Smith & Ward, 2006; Stokes, Luiselli, Reed, & Fleming, 2010), tennis (Buzas & Ayllon, 1981), golf (Fogel, Weil, & Burris, 2010), and yoga (Downs, Miltenberger, Biedronski, & Witherspoon, 2015; Andrews & Miltenberger, 2015).

One sport that has only very recently received attention from practitioners in the field of ABA is mixed martial arts (MMA) (Merlino, 2015). As a result of mass media's focus on MMA, it is now touted as the fastest growing spectator sport in the world today (Estelami, 2014). As MMA increasingly becomes embedded into mainstream culture, applied behavior analysis has much to offer the sport, from skill acquisition, to building fluency, and increasing performance. Given a focus on human performance, applied behavior analysis possesses a

wealth of strategies to support coaches and athletes to enhance performance. A few of the strategies include self-monitoring, video feedback, and auditory feedback often referred to as TAGteach (Andrews & Miltenberger, 2015; Quinn, Miltenberger, & Fogel, 2015). In each of these studies, feedback was shown to be an effective procedure for enhancing athletic performance.

Schonwetter, Miltenberger, and Oliver (2014) evaluated the effects of using self-monitoring boards to improve lap completion of seven high-school swim team members and found increases in the percentage of assigned laps for most participants. The addition of feedback in the form of positive comments to the self-monitoring procedure was found to increase performance and accuracy in self-reporting. Results from the social validity questionnaire completed by the participants at the completion of the study showed the swimmers responded positively to the self-monitoring procedure.

Kelley and Miltenberger (2016) evaluated video feedback to improve behaviors that comprise three correct horseback riding positions of advanced riders. The intervention consisted of the participant reviewing the video with the instructor immediately upon completion of the targeted behavior. Positive and corrective feedback was provided to the participant by the instructor on each part of the rider's body and corresponding position. Positive feedback included specific praise for aspects of the performance that were performed correctly. Corrective feedback consisted of identifying aspects of the performance that were incorrect and how to improve execution. Results showed that providing feedback in conjunction with a typical lesson format substantially increased the performance of the three targeted skill positions from baseline. Other researchers also showed that video feedback can increase the performance of athletic skills

such as gymnastics (Boyer et al., 2009), martial arts maneuvers (Benitez-Santiago & Miltenberger, 2016) and yoga poses (Downs et al., 2015)

A study combining video modeling by experts with video feedback was found to enhance skill performance more quickly than participation in regular practice sessions and traditional coaching in four female competitive gymnasts (Boyer et al., 2009). In addition to reducing the number of practice sessions required to demonstrate improved physical skills, the study showed that the participants maintained higher levels of previously practiced skill performance after the intervention. Although the gymnasts were able to evidence improvement above baseline levels throughout intervention, they were unable to demonstrate near mastery of the targeted skill (80% to 100% correct).

Benitez-Santiago and Miltenberger (2016) evaluated the effect of video feedback in enhancing performance in capoeira, an Afro-Brazilian martial art technique. Participants were filmed and provided immediate feedback utilizing the video recording. Positive and corrective feedback was provided by the instructor as the video was reviewed. The results suggested that the intervention improved skill performance above baseline for each of the targeted skills. Moreover, results suggest that the addition of video feedback to traditional coaching techniques decreased the number of sessions required to evidence skills improvement and increased the percentage of movements completed correctly. Similar to the results from Boyer et al. (2009), however, near flawless skill performance (80% to 100% correct) was achieved only occasionally.

Downs et al. (2015) evaluated the effects of video self-evaluation on the acquisition of three common yoga poses. Steps in a task analysis were recorded as the participant practiced a pose. The participant and the researcher then viewed the video together, and the researcher provided feedback on each step in a task analysis. After this initial training, the participants

evaluated their performance in the videos without assistance from the researcher. Results indicated a substantial increase in the percentage of correctly performed yoga poses for five of the six targets.

Another form of feedback recently shown to enhance athletic performance is auditory feedback, often referred to as TAGteach (teaching with acoustical guidance). Auditory feedback, a method of providing feedback through an auditory device to reinforce correct steps in the task analysis of targeted athletic skills, has been demonstrated to be an effective process for developing skills in athletes across several sports including dance (Quinn et al., 2015), golf (Fogel et al., 2010), football (Stokes et al., 2010), yoga (Andrews & Miltenberger, 2015), and judo (Ferguson, Crosland, & Miltenberger, 2014).

Quinn et al. (2015) evaluated the effectiveness of auditory feedback (AF) in improving dance step proficiency in four female students of jazz dance. Results indicated that the use of AF produced higher percentages of correctly performed dance movements. In addition to increased accuracy, the results further demonstrated that teachers with no experience using AF could be easily instructed in the use of AF techniques in a relatively short amount of time. Andrews and Miltenberger (2015) also evaluated the effectiveness of using AF techniques in teaching yoga poses to beginning yoga practitioners. All participants evidenced an increase from baseline once AF was implemented. Furthermore, all participants maintained positive improvements in the absence of AF and effects were generalized to the traditional yoga class setting.

Research has demonstrated that auditory feedback is an effective strategy for accelerating skill development in athletes. More specifically research showed that AF has been effective in an array of sports activities including yoga, dance, football, golf, and judo. Two additional

benefits of AF are that it does not require the participant to stop or pivot away from instruction such as when using visual feedback and most traditional coaching styles and it allows immediate feedback for the correct step in the task analysis being demonstrated. With the growing popularity of MMA mixed martial arts, it is possible that the use of AF can help the participants improve performance and the acquisition of new skills.

MMA training, as well as training in many other sports, is about achieving gradual improvements, both in terms of strength and conditioning but more importantly in terms of skills. To achieve consistent improvements in specific skills, a good part of training is devoted to improving these skills in a systematic and structured way referred to as drills. Striking instructors do repetitive drills using multiple repetitions during practice. A primary purpose of drills is to substitute an instinctive response such as closing your eyes and turning away with something useful, for instance a jab, ducking, or an instant attack with long range body punches. Both striking and defensive stances are, in many ways, absolutely dependent upon fluency (aka, immediate stimulus control, muscle memory). By making a practical and useful defensive or offensive action fluent, you give yourself the maximum chance of success as a fighter.

These drills are often done in large groups with an instructor modeling the desired skill, allowing the student to practice the skill and the coach making corrections when errors are made and providing feedback when done correctly. Other methods are done in front of a mirror or reviewing video tapes after a fight or practice. The coach critiques the fighter's style and skills, providing feedback for what was done correctly and incorrectly. When mistakes are made the coach identifies the mistake, then models the correct procedure and the fighter practices through repetition. This repetition strengthens the skill and builds muscle memory (fluency), as muscle

memory builds overtime; the fighters' skills start to appear natural or innate. This muscle memory allows a fighter to react with what appears to be instinct. While this type of coaching is effective for many fighters, what are often overlooked are minor mistakes or omissions that the fighter might make (not pivoting the back foot while throwing a right cross). This error (forgetting to pivot) may be repeated hundreds of times without correction, muscle memory doesn't discriminate errors from proper form. When errors are repeated over and over again these errors are inadvertently reinforced and strengthened, making it harder to change after multiple repetitions. A person's body learns how to perform both simple and complex physical actions through repetition. If you keep repeating the correct skill (and reinforcement occurs), your body will first learn how to do it correctly and eventually your body will learn how to do it without any thought at all. The same applies to poor techniques. The more you practice poor technique the more permanently engrained into you that poor technique will become.

Traditional coaching doesn't always allow for an effective and efficient, systematic breakdown of a target behavior. After watching numerous videos of strikes such as the "right cross," it becomes evident that most coaches and videos do not break down the skill into small enough steps. By breaking these drills down (task analyzing) into small skill steps teaching to fluency, we can train more efficiently which will result in a much more effective skillful fighter with great "muscle memory."

A right cross, which may take only a second or less to complete during a fight, can be broken down into many smaller steps (20 skill steps), these smaller skill steps can be taught in order and reinforced only after proper execution, using auditory feedback and forward chaining procedures to shape and build a much more effective and efficient fighter.

When looking at the sport of MMA, both defensive posture and effective striking are critical skill sets required to win fights and avoid injury. These skills can be strengthened by reinforcing proper body positioning and execution of various steps of a skill. This study evaluated a forward chaining procedures and immediate auditory feedback to improve the right cross of the fighters while producing a safer training environment for participants in this sport by teaching the fighter to return to a correct defensive position immediately following the right cross. The purpose of this study was to evaluate the effectiveness of AF conducted by the MMA coach, to train both novice and beginner individuals who currently were not throwing an effective or efficient right cross. Target behavior consisted of a 20-step task analysis of the right cross.

Chapter Two: Method

Participants and Setting

Four participants Kelsey, Christine, Brian, and Robert were chosen for the study. Each participant was categorized as beginner (no prior MMA training) or novice (training 6 months or less). Kelsey, a 25 year old female, and Christine, a 54 year old female, were beginners. Brian, 43 year old male, and Robert, a 31 year old male, were novices. All showed an interest in mixed martial artists and participated at an internationally recognized gym. Selection of the participants was based on the striking coaches' recommendations based on the identification of potential participants who displayed patterns of unsuccessful defense or substandard offense concerning the skill-set of the right cross. The coach more specifically looked for participants who consistently dropped their right hands and or did not rotate and pivot on their rear foot when throwing the right cross. The study started with 10 participants. Participants in the study needed to score a maximum of 60% during baseline on the 20-step task analysis; participants scoring higher than 60% were eliminated from the study. Six participants who participated in baseline were not chosen for this study due to this criterion.

None of the chosen participants was attending current trainings at the MMA gym at this time, but all were interested in pursuing training. The researcher met with each individual interested in the study, explained the study, and answered any questions. The participants then signed the consent forms. Inclusion criteria for this study also included a willingness to come to the gym for assessment and intervention sessions. The intervention took place at a local

American Top Team MMA training center in Vero Beach and Port Saint Lucie Florida. A letter of consent from this establishment to conduct the research was provided and included in the IRB application.

Dependent Variable

The dependent variable was the right cross; it was divided into 20 sequential steps. All steps in the task analysis were based on a sequence of behaviors described by the instructor (see Appendix A and Appendix B) and verified by three MMA instructors (although many striking instructors teach various techniques/styles for throwing a right cross, all three instructors agreed that these 20 steps were consistent in throwing an effective right cross).

Data Collection

All data were collected using the 20-step task analysis checklist (Appendix C) during the participants' 10-min sessions at the gym. Recording from video took place for data collection by the primary observer and a second observer for interobserver agreement during all three phases of the study - baseline, AF intervention, and follow up. Assessment consisted of a minimum of five trials during each assessment session in which the participant demonstrated the targeted behavior. A trial consisted of the participant starting from a standing position 5 feet away from an "X" marked on the mat. This placed the participant at an arm's length away from the coach holding mitts (which were placed in front of the individuals' chest approximately 12 inches away from the chest) To start the trial, the coach instructed the participant to "Walk up to the "X" on the mat and show me your right cross." These assessment trials were recorded and scored after each session by the primary investigator and separately scored by an independent observer trained in the right cross task analysis. Data were reported as the percentage of correct steps in the task analysis.

As a measure of generalization, simulated sparring with the striking instructor occurred intermittently between regular assessment trials and was scored across all phases of the study. Simulated sparring was defined as a simulated match with the coach, in which the striking instructor acted as another fighter providing the opportunity for the individual to utilize the right cross. The opportunity to evoke a right cross, was provided a minimum of five times while moving around the mat with each round lasting under 1 min. Data were only collected when the participant actually threw the right cross (omission of throwing right cross was not scored). When the right cross was thrown, data were collected on each step demonstrated by the participant during the simulated sparring then an average was taken to be represented as one simulated sparring trial (represented by a triangle in figure 1). Data were collected for each step the participant demonstrated during the match. The recorded video was scored after each session by the primary investigator and separately scored by an independent observer trained in the right cross task analysis. Data were reported as the percentage of correct steps in the task analysis.

Interobserver Agreement. A second observer viewed recorded video of random sessions across all phases (Appendix H). The second observer was trained on each component of the task analysis to discriminate correct and incorrect performance of each step. Interobserver agreement (IOA) was evaluated based on the results from scoring the 20-step task analysis of the right cross. The second observer was asked to score each step as either correct or incorrect based on video recording taken of each of the participant's performance. Agreement was defined as both observers independently recording the occurrence or non-occurrence of the 20 steps in the target behavior. The number of agreements was divided by 20 (the number of skill steps in the task analysis) and multiplied by 100. IOA was collected for 66% of the sessions. The percentage of IOA during baseline was 80% for Kelsey, 98% for Christine, 81% for Brian and 83% for Robert. IOA collected during the auditory feedback phase resulted in a score of

87% for Kelsey, 82% for Christine, 94 % for Brian, and 96% for Robert. The percentage of IOA during follow up was 93% for Kelsey, 86% for Christine, 99% for Brian and 98% for Robert.

Table 1: 20-Step Task Right Cross

	Steps	Description
Fight Stance	1. Feet Apart	Feet shoulder width apart
	2. Lead Foot Flat	Lead foot is flat on the ground pointed forward
	3. Rear Foot 45	Rear foot is pointed at a 45 degree angle
	4. Heal Up	Rear heel slightly raised off the ground
	5. Posture	Torso is full erect
	6. Knees Bent	Knees 45 degree bend
	7. Hips 45	Hips 45 degree angle
	8. Hands Up	Hands closed fist by cheeks with knuckles facing each other
Right Cross	9. Hips 90	Rotate to hips forward to a 90 degree angle
	10. Rear Pivot	Pivot the rear foot from 45 to a 90 degree angle and shift weight to lead foot
	11. Strike	Propel the right hand from the cheek ballistically forward with left hand held at temple
	12. Knuckles Down	Rotate the knuckles down
Return to Fight Stance	13. Feet Apart D	Feet shoulder width apart
	14. Lead Foot Flat D	Lead foot is flat on the ground pointed forward
	15. Rear Foot 45 D	Rear foot is pointed at a 45 degree angle
	16. Heal Up D	Rear heel slightly raised off the ground
	17. Posture D	Torso is fully erect
	18. Knees Bent D	Knees 45 degree bend
	19. Hips 45 D	Hips 45 degree angle
	20. Hands Up D	Hands closed fist by cheeks with knuckles facing each other

Materials and Equipment. The materials used in this study were a clicker, a small hand-held device that makes a click sound when pressed, and a video camera for data collection purposes. All participants brought or were provided with necessary MMA equipment which consists of 7oz MMA training gloves and headgear to be worn and used as safety equipment during training sessions. An MMA mat was used for all assessment and intervention sessions.

Treatment Integrity. To ensure treatment integrity was maintained, a checklist was created for the coach, and primary researcher to check off each step of the intervention to ensure that the intervention was implemented and scored correctly and consistently in each session (see Appendix E). Treatment integrity was assessed by having the researcher score the training session using the checklist of steps. Treatment integrity was calculated by dividing the number of steps completed by the number of steps on the treatment integrity checklist. However Interobserver agreement was not conducted for treatment integrity. The results are shown in Table 2. The results show a high level of treatment integrity between 91.6% - 100%. The researcher believes that this is a result of the, the primary researcher training the striking instructor prior to starting the study and continuing to provide follow up training prior to each AF session with the participants (The Striking instructor is also a BCaBA with over 12 years experience). Visual prompts were also used by the primary researcher to remind the coach which skill step was next and how many repetitions were still needed. The primary researcher also held up cards with the name of each skill step to remind the coach which skill step was to be used next, and held up a finger for each step that was completed correctly and clicked by the coach. All prompts were only visible by the coach and not the participant. The coach used a written script to ensure the proper directions were given to each participant while introducing AF intervention.

Social Validity. A social validity measure (Wolf, 1978) was administered to assess the degree to which performance improvement efforts were perceived by the striking coach and martial arts student to have had a beneficial impact. The participants were surveyed to assess how much they liked the intervention, how effective they believe it was, whether they would like to continue using it, whether they would recommend it to a fellow fighter, and how difficult it was to learn the skill with the procedure. Participants were instructed to rate their answer on a 7-point Likert scale (Appendix E). The coach was surveyed to assess opinions about the ease of use of the procedure, how effective he thought the procedure was, how much he liked using the procedure, and whether he would continue using the procedure with future students (Appendix F). Another social validity measure was used to assess the improvements in skills following training. Two additional coaches used a scale to rate the fluidity of the motion and quality of completion. They viewed six videos of each participant three from baseline and three from follow up presented in random order and used the scale in (Appendix G) to evaluate the performance in the videos.

Experimental Design and Procedures

A noncurrent multiple baseline across participants design was used to demonstrate experimental control.

Baseline. During baseline, data were taken during assessment sessions and simulated sparring sessions prior to intervention

No feedback was given for correct or incorrect strikes. The coach simply thanked the participant for demonstrating the strikes.

Auditory feedback intervention. After baseline and prior to the first intervention session, the coach introduced auditory feedback (AF) to the participant by providing a verbal description.

The coach read the following script, "This is a clicker. I will provide you an instruction to do something, we call this a skill step and, when it's done correctly, you will hear this sound (coach clicked the clicker). The absence of a click will mean you need to try again. If you are still not getting it right after a few attempts that indicates to me that I will need to reteach that specific skill. Do you have any questions?" If the participant had questions, the coach answered accordingly. The participant was taught that the "click" sound means, "Yes that is correct." The participant was also told that an absence of "click" means "try the skill again" and that no feedback will be provided by the coach. The "click" sound became a conditioned reinforcer for the participant's specific skill and substituted for traditional praise "good job," "nice," "that's it," etc. from the coach. The intervention consisted of the coach starting a session by telling the participant what specific step was to be clicked during the session. The coach tested the participant's understanding of each step by having the participant click the coach modeling the appropriate step prior to the participant receiving AF in the session. For example, the coach might have said, "the step is: 'Lead Foot Flat.'" The coach then modeled this for the participant, and had the participant show the correct skill step, the coach used verbal instruction, modeling, and physical and verbal prompts when necessary, after the coach was comfortable that the participant understanding of the skill step he asked the participant to, state the step back to the coach and then click the coach demonstrating all steps before and including the current step (Feet apart and Lead Foot Flat). The coach stated, "The step is..." then the coach stated, "walk up to the 'X' on the mat (this placed the participant at an arm's length away from the coach holding mitts) and show me (Feet Apart, Posture, etc.). Next, the participant performed the step, and the coach clicked the behavior if it was performed correctly. If the step was not performed correctly, the coach said nothing, and the participant attempted the skill again. If following three

attempts, the step was still not performed correctly, the coach stopped and retaught the skill with the participant, by breaking down the step, determined which step to start from, and then repeated the process as stated above. If the step was performed correctly, again, the coach clicked the clicker but provided no verbal feedback, and had the participant perform the step four more times correctly to build fluency. The coach then asked the participant if he or she was ready to move on to the next step. If the participant said that he/she was not ready, the coach continued to click the same step until the participant stated he/she was ready to move on to the next step. If the participant was ready, the coach and participant moved onto the next step. The coach then told the participant what the new step was, and repeated the procedure as stated above. The session continued to follow this pattern until the AF session was completed. Once the new step had been successfully taught, the participant was asked to perform all the prior steps learned during previous sessions and the new step with no additional auditory feedback. This helped to determine if the behaviors maintained over time. During data collection session in the AF intervention phase, no feedback was given for correct or incorrect steps. The researcher simply thanked the participant for demonstrating the strikes as in baseline. To start the trial, the coach instructed the participant to "Walk up to the X on the mat and show me your right cross." The participant's behavior was recorded for data collection. During simulated sparring the coach moved around the mat presenting his mit (raising the right mit up) prompting the participant to throw a right cross while both the participant and coach continued to move around the mat, after a right cross was thrown the coach continued to move until an average of five right crosses were thrown and averaged together as a single data point represented by a triangle in figure 1.

Follow-up. After intervention, follow-up data were taken during simulated sparring and trial sessions as in baseline. These sessions occurred 2 weeks after intervention sessions had ended.

Chapter Three: Results

Results are shown in figure 1. After participating in the auditory feedback intervention, the right cross immediately increased from baseline levels to consistently higher levels for all participants, remaining stable across all participants. Kelsey's right cross scores increased from a baseline mean of 40% (range = 40% - 41%) to an intervention mean of 90.45% (range = 84% - 95%), and increased again during follow up to a mean of 100%. Kelsey participated in three AF sessions over a 4 week period . Christine's right cross scores increased from a baseline mean of 14.16% (range = 10% - 35%) to an intervention mean of 71% (range = 50% - 100%) although her mean score was 70% the last ten data points during AF intervention were 81% -100%, and then increased again during follow up to a mean of 90.57% (range = 85% - 100%). She participated in six AF sessions over an 8 week period. Brian's right cross scores increased from a baseline mean of 30% (range = 30% - 30%) to an intervention mean of 95.76% (range = 90% - 100%), and increased again during follow up to a mean of 99.77% (range = 99% - 100%). He participated in three AF sessions over a 3 week period. Roberts's right cross scores increased from a baseline mean of 43.18% (range = 35% - 65) to an intervention mean of 96.13% (range = 70% - 100%), and increased again during follow up to a mean of 100%. He participated in three AF sessions over a 5 week period. Across participants, AF sessions averaged approximately 10 min each.

The social validity questionnaire results for all four participants are found in Table 3. Overall, the participants liked using auditory feedback to learn the right cross. All participants

agreed and strongly agreed that the AF procedures improved their right cross at a faster rate than typical training would and they all would recommend this procedure to others. The four participants all said that they would like to participate in other trainings using AF, because the breakdown of steps made it easy to see immediate gains and felt they truly understood the steps of the right cross.

The social validity questionnaire results from the MMA striking instructor conducting the AF sessions can be found in Table 4. Although this type of training is atypical in MMA, the coach is a behavior analyst with over 12 years experience. The coach reported that he already incorporated many of the procedures into his daily coaching (instruction, modeling, task analysis, forward chaining, feedback, and reinforcement). He did not, however, typically break down the skills into so many steps, use a clicker, or graph this level of data on performance. Although he reported he liked deliberately practicing isolated skill steps, he would probably cut out at least half of the steps for efficiency. The coach also reported that he believes that all the participants' right cross improved following the use of AF, and that the students would be better able to execute the right cross in a match. Furthermore the coach would recommend this procedure to other coaches that are looking to improve their student's right cross.

Two additional MMA Striking instructors were shown six different videos gathered during baseline and follow up for each of the four participants (three during baseline and three during follow up total of 24 videos). The videos were placed in random order and the coaches were unaware of which phases were reflected in the videos. The coaches were instructed to rate each video for fluidity of motion and quality of completion through the use of a 10-point Likert scale (see Appendix G). Both coaches were consistent in scoring the videos from the follow-up

phase with higher than they scored the videos from baseline. The coaches' mean scores can be found in Table 5.

Chapter Four: Discussion

Research has shown that auditory feedback (sometimes referred to as TAGteach – teaching with acoustical Guidance) can be used to enhance athletic performance. Auditory feedback, a method of providing feedback through an auditory device to reinforce correct steps in the task analysis of targeted athletic skills, has been demonstrated to be an effective process for developing skills in athletes across several sports including dance (Quinn et al., 2015), golf (Fogel et al., 2010), football (Stokes et al., 2010), yoga (Andrews & Miltenberger, 2015), and judo (Ferguson, Crosland, & Miltenberger, 2014). The purpose of this study was to examine the effects of auditory feedback on the performance of the right cross as thrown by individuals interested in learning MMA fighting techniques. The results indicate that all participants improved their right cross substantially following the use of auditory feedback intervention. All four participants' right cross improved to levels well above baseline immediately during the AF intervention phase. Three of the four participants' (Kelsey, Brian, and Robert) right cross showed substantial gains immediately which continued throughout the study, while one participant (Christine) showed a more gradual gain over time. All participants' follow up data showed maintenance after AF training sessions were complete. Participants also reported that they enjoyed the procedures in this study. Although participants reported they felt the procedures were more effective than traditional MMA classes, only Robert had experienced prior formal MMA training. However, all participants had other family members training at the gym and had observed MMA training sessions.

This current study had similar results to previous studies utilizing auditory feedback in sports (e.g., Fogel et al., 2010; Quinn & Miltenberger, 2015). In a study similar to the current study, Andrews and Miltenberger (2015) evaluated the effectiveness of using AF techniques in teaching yoga poses to beginning yoga practitioners with little experience. As in the current study, all participants in that study showed a substantial increase in the percentage of correct performance from baseline once AF was implemented. Furthermore, participants maintained improvements in the absence of AF and effects were generalized to the traditional yoga class setting.

In the current study each participant spent 30 min to 60 min in the AF intervention phase and the intervention substantially increased the percentage of the skill steps completed correctly. These results suggest the procedure is not only effective but efficient, producing increases in few training sessions requiring little time. Based on these results and the results of other studies (e.g., Andrews & Miltenberger, 2015; Quinn et al., 2015) adding auditory feedback to typical coaching and practice techniques could accelerate skill acquisition, thus reducing the number of class sessions required to improve targeted MMA skills. Furthermore, the coach implemented the intervention with great fidelity. Similar to Quinn et al. (2015) this study shows that auditory feedback can be implemented successfully by coaches to produce large increases in performance. More research is needed to establish the generality of auditory feedback used by coaches across a variety of sports.

The auditory feedback intervention enhanced the skill performance to levels substantially above baseline, to nearly flawless levels. Right cross performance of 90% to 100% correct was achieved by the four participants in this study. Christine showed more gradual improvements and variability in the data, she also required more AF sessions than the other

participants. This variability may be due to difficulty of the specific components of the movement as, Christine was also preparing for hip surgery to take place shortly after the conclusion of this study. These results are similar to the increases in performance reported by Andrews and Miltenberger (2015) with novice yoga practitioners. However, the results are different from those reported by Quinn et al. (2015) with young dancers. In Quinn et al. the dancers did not routinely score 90-100% on the task analysis, likely because such performance would be possible only from top dancers with excellent physical skills who are able to meet the physical demands of correct performance in the task analysis. In the current study, as in Andrews and Miltenberger, 90% to 100% performance on the task analysis was within the physical capabilities of all participants once they learned the skills steps and received feedback on their correct performance.

There were a few limitations in this current study. The first limitation is potential observer reactivity. While viewing some of the tapes, the primary researcher noticed that occasionally the coach would noticeably analyze various body positioning such as the participant's foot to make sure it pivoted, or the left hand to ensure proper placement during defense. While the precise effect is unknown, it is possible that this slight gaze may have actually prompted the participant to make an adjustment or correction. This could possibly be eliminated during future studies by requiring the coach to wear an apparatus such as sunglasses to conceal the coaches eyes. The second limitation would be the lack of collecting interobserver agreement for treatment integrity.

Another limitation was the inability to observe whether the new skill set would generalize into more traditional MMA trainings. Andrews and Miltenberger (2015) not only evaluated the effectiveness of using AF techniques to teach the yoga poses, but they assessed the

behaviors to see if they generalized to the traditional yoga class setting. Future researchers may want to conduct a similar study with beginner and novice students who are attending current MMA training.

In both the current study and the Andrews and Miltenberger (2014) study the participants were relatively new to the sport (Yoga and MMA). More research could be conducted with fighters who are missing key skill steps that are common amongst seasoned fighters. The current study showed substantial increases under trial and simulated sparring sessions; however due, to the participants beginner and novice status, the researchers could not place them in a true sparring match due to the potential bodily harm involved in MMA. Six fighters with more experience were not selected for the study as a result of their high baseline scores. The researcher and coach believe that AF could be used to increase precision of skill steps that require minor adjustments as raising slightly dropped hands or increasing foot rotation when throwing the right cross.

The MMA gym can be a loud and crowded environment. This was initially a concern because the sound of the clicker is required as a conditioned reinforcer. However, the clicker worked well as evidenced by the participants reporting no issues hearing the click. This is perhaps because the clicker was a novel stimulus in the environment. The ability for the participants to hear and respond to the sound of the clicker in such a loud environment is promising; this will allow other researcher to conduct similar studies in environments without distracting other classes or students. In future research, follow-up assessments might be conducted to evaluate whether the improvements are maintained over time such as months after. Lastly, the right cross skill steps parallel with many other MMA techniques. Future researchers might explore focus on this technique as a potential behavioral cusp (Rosales-Ruiz & Baer,

1997). by measuring the acceleration of learning and skill acquisitions of other techniques following the initial AF intervention of the right cross.

The present study evaluated the effects of using auditory feedback to improve the right cross. This study demonstrated that the MMA participants improved their performance of each movement of the 20- step task analysis. All participants learned the steps quickly and gained fluency of movement across each steps of the skill. Auditory feedback was highly liked by the participants and was found to be helpful in learning these movements. Based on these results, it is hypothesized that this intervention has the potential to improve other skills for other MMA techniques as well.

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Tables and Figures

Table 2

Treatment Integrity for Baseline and Auditory Feedback Intervention

	T/I Coach
Baseline/Data Collection	100%
Verbal Instruction	100%
No Verbal Feedback	
Auditory Feedback	100%
Verbal Description of Auditory Feedback 1 st session only	
Coach starting a session by telling the participant what specific behavior or step will be clicked during the session by indicating what the step will be for that session.	91.6%
The coach modeled step, and the participant verbally stated the step back to the coach and clicked the coach demonstrating all steps before and including the current step.	100%
The coach stated, "The step is..." then stated "walk up to the "X" on the mat and show me (Strike. Posture D etc.)	91.6%
The coach "clicked" the behavior if it is performed correctly. If not performed correctly, the coach said nothing, and the participant will attempted the skill again.	100%
If following three attempts, the step is still not performed correctly, the coach stopped and retaught the skill with the participant	100%
If performed correctly, again, no verbal feedback was provided, and the coach had the participant perform the step five more times, then ask the participant if he was ready to move on to the next step	100%

Note. Percent of trials done correctly

Table 3

Social Validity of Participants for the Procedure

	Kelsey	Christine	Brian	Robert
This procedure improved my right cross at a faster rate than during typical training	6	7	7	7
I enjoyed participating in these training procedures.	7	7	6	7
I am more comfortable with executing the right cross in trainings	7	7	6	7
I am more likely to use the right cross in a match.	5	7	6	7
I would like my coach to include this procedure in future practices	6	7	6	7

Note. A score of 1 = Strongly Disagree, 2 = Disagree, 3 = Slightly Disagree, 4 = Neutral, 5 = Slightly Agree, 6 = Agree, 7 = Strongly Agree

Table 4

Social Validity Score for Participant's Coach

	Coach
My student's ability to use the right cross has improved following the procedure	6
I liked using this procedure for training my fighters	4
I see myself incorporating this procedure into daily practices	4
My students will be better able to execute the right cross in a match	5
I would recommend this procedure to other coaches	5

Note. A score of 1 = Strongly Disagree, 2 = Disagree, 3 = Slightly Disagree, 4 = Neutral, 5 = Slightly Agree, 6 = Agree, 7 = Strongly Agree

Table 5

Social Validity of Area Coaches for MMA Striking

	Kelsey	Christine	Brian	Robert
	Mean Instructor Score	Mean Instructor Score	Mean Instructor Score	Mean Instructor Score
Fluidity of Motion				
Coach 1				
BL	1.33	1	2.66	3.66
FU	6.33	6	6.66	7
Coach 2				
BL	3	1.33	4	2.33
FU	6.66	5.33	6.66	7
Quality of Completion				
Coach 1				
BL	1.33	1	2.66	3.66
FU	6.33	5.33	6.66	7
Coach 2				
BL	2.33	1	4	2.33
FU	7.66	6.66	7	7

BL=Baseline FU=Follow Up

Note. A score of 1 = Not Fluid, 10 = Entirely Fluid

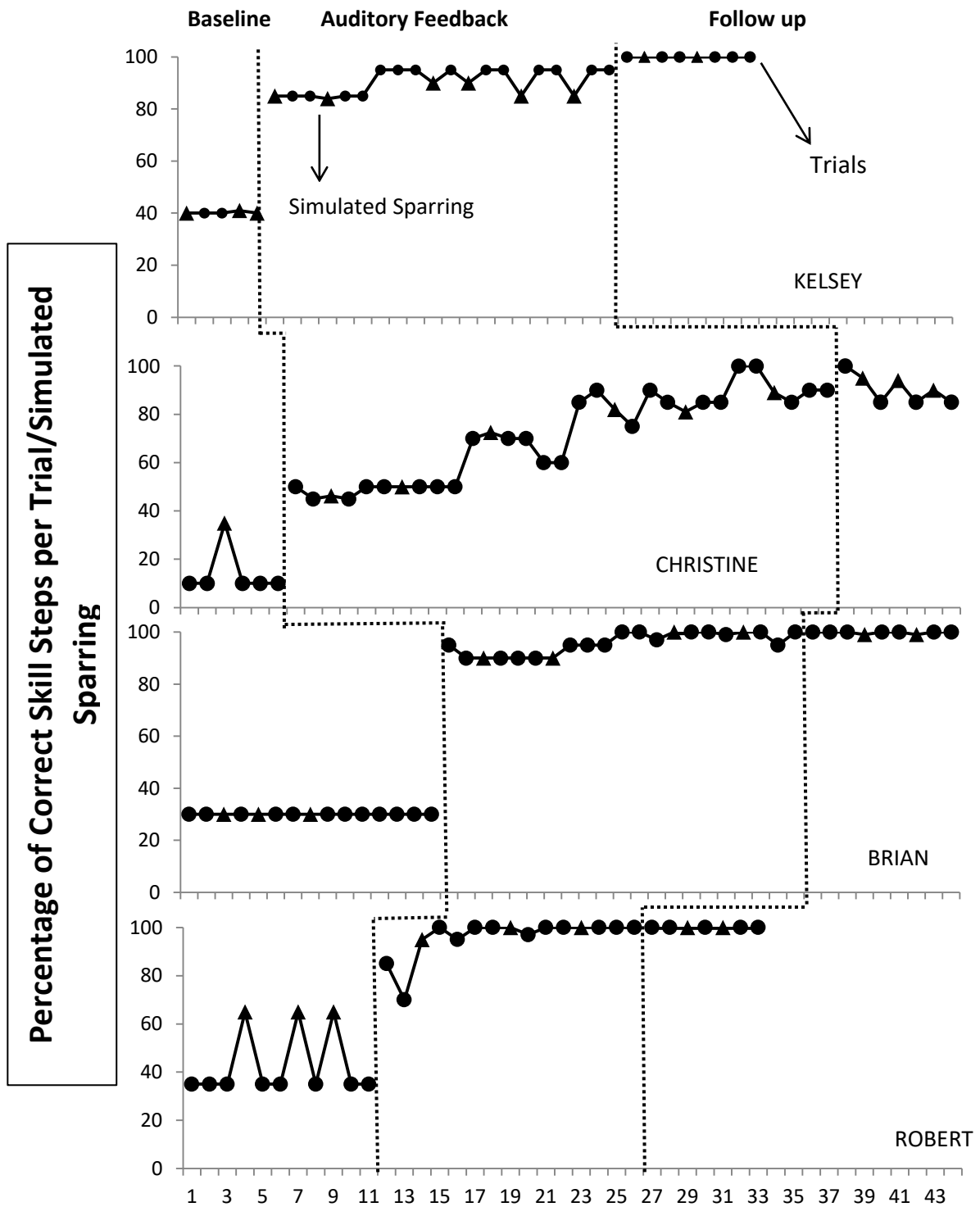






















Figure 1. This figure shows the percentage of correct behaviors engaged in by the participants for each trial.

Appendices

Appendix A: Visual Representation of the Right Cross

			
Feet Apart	Lead Foot Flat	Rear Foot 45	Heal up
			
Posture	Knees Bent	Hips 45	Hands Up
			
Hips 90	Rear Pivot	Strike	Knuckles Down
			
Feet Apart D	Lead Foot Flat D	Rear Foot 45 D	Heal up D
			
Posture D	Knees Bent D	Hips 45 D	Hands Up D

Appendix B: 20 Step Task Analysis of the Right Cross

Right Cross		
Skill	Skill Step	Description
Fight Stance	1. Feet Apart	Feet shoulder width apart
	2. Lead Foot Flat	Lead foot is flat on the ground pointed forward
	3. Rear Foot 45	Rear foot is pointed at a 45 degree angle
	4. Heal up	Rear heel slightly raised off the ground
	5. Posture	Torso is full erect
	6. Knees Bent	Knees 45 degree bend
	7. Hips 45	Hips 45 degree angle
	8. Hands Up	Hands closed fist by cheeks with knuckles facing each other
Right Cross	9. Hips 90	Rotate to hips forward to a 90 degree angle
	10. Rear Pivot	Pivot the rear foot from 45 to a 90 degree angle and shift weight to lead foot
	11. Strike	Propel the right hand from the cheek ballistically forward with left hand held at temple
	12. Knuckles Down	Rotate the knuckles down
Return to Fight Stance	13. Feet Apart D	Feet shoulder width apart
	14. Lead Foot Flat D	Lead foot is flat on the ground pointed forward
	15. Rear Foot 45 D	Rear foot is pointed at a 45 degree angle
	16. Heal up D	Rear heel slightly raised off the ground
	17. Posture D	Torso is full erect
	18. Knees Bent D	Knees 45 degree bend
	19. Hips 45 D	Hips 45 degree angle
	20. Hands Up D	Hands closed fist by cheeks with knuckles facing each other

Appendix C: Data Sheet (SKILL STEPS: Right Cross)

	Trial	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Fight Stance	1. Feet Apart																					
	2. Lead Foot Flat																					
	3. Rear Foot 45																					
	4. Heal Up																					
	5. Posture																					
	6. Knees Bent																					
	7. Hips 45																					
	8. Hands Up																					
Right Cross	9. Hips 90																					
	10. Rear Pivot																					
	11. Strike																					
	12. Knuckles Down																					
Return to Fight Stance	13. Feet Apart D																					
	14. Lead Foot Flat D																					
	15. Rear Foot 45 D																					
	16. Heal Up																					
	17. Posture D																					
	18. Knees Bent D																					
	19. Hips 45 D																					
	20. Hands Up D																					
Percent Correct																						

CHECK BLOCKS WHEN SKILL STEP WAS DONE CORRECTLY

Appendix E: Participant Social Validity Right Cross

Participant Satisfaction Survey

1. What did you like most about this procedure?
2. Would you recommend this procedure to a friend or MMA student?
3. How did this procedure compare to your typical training?
4. Was there anything you disliked about the procedure? (Please explain)
5. What, if anything, would you change about the procedure?

	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
This procedure improved my right cross at a faster rate than during typical training							
I enjoyed participating in these training procedures.							
I am more comfortable with executing the right cross in trainings							
I am more likely to use the right cross in a match.							
I would like my coach to include this procedure in future practices							

Appendix F: MMA Coach Social Validity

Coach Satisfaction Survey

1. How did this procedure compare to your typical training?

2. What did you like most about this procedure?

3. If you were to use this procedure again, what if anything would you change?

	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
My student's ability to use the right cross has improved following the procedure							
I liked using this procedure for training my fighters							
I see myself incorporating this procedure into daily practices							
My students will be better able to execute the right cross in a match							
I would recommend this procedure to other coaches							

Appendix G: MMA Coaches Social Validity Right Cross

Please rate the following videos of a right cross to the best of your ability.

On a scale of 1-10, please circle the number that best identifies your opinion.

The video clips have been placed in random order and are not in the order in which the study was conducted.

Fluidity of Motion- Please rate how fluid was the motion of the right cross in each video clip.

Clip 1	1 Not Fluid	2	3	4	5	6	7	8	9	10 Entirely Fluid
Clip 2	1 Not Fluid	2	3	4	5	6	7	8	9	10 Entirely Fluid
Clip 3	1 Not Fluid	2	3	4	5	6	7	8	9	10 Entirely Fluid
Clip 4	1 Not Fluid	2	3	4	5	6	7	8	9	10 Entirely Fluid
Clip 5	1 Not Fluid	2	3	4	5	6	7	8	9	10 Entirely Fluid
Clip 6	1 Not Fluid	2	3	4	5	6	7	8	9	10 Entirely Fluid

Qualities of Completion- Please rate how fluid the student's completion of the right cross was in each video clip.

Clip 1	1 Not Fluid	2	3	4	5	6	7	8	9	10 Entirely Fluid
Clip 2	1 Not Fluid	2	3	4	5	6	7	8	9	10 Entirely Fluid
Clip 3	1 Not Fluid	2	3	4	5	6	7	8	9	10 Entirely Fluid
Clip 4	1 Not Fluid	2	3	4	5	6	7	8	9	10 Entirely Fluid
Clip 5	1 Not Fluid	2	3	4	5	6	7	8	9	10 Entirely Fluid
Clip 6	1 Not Fluid	2	3	4	5	6	7	8	9	10 Entirely Fluid

Appendix H: Observer (video clip) Inter Observer Agreement Right Cross

Please rate the following videos of a right cross. The number 1-20 correspond with the steps on the task analysis of the “Right Cross”. (Appendix B) Circle each step that you see in the video performed correctly and in correct sequence.

The video clips have been placed in random order and are not in the order in which the study was conducted.

Clip 1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Clip 2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Clip 3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Clip 4	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Clip 5	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Clip 6	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Clip 7	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Clip 8	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Clip 9	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Clip 10	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Clip 11	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Clip 12	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Clip 13	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20