“Get on the Line”: Improving Pass-Naming in Collegiate Women’s Lacrosse Using Negative Reinforcement and Signaling

by

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Abstract

"Get on the Line": Improving Pass-Naming in Collegiate Women's Lacrosse Using Negative Reinforcement and Signaling

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This study examined the separate and combined effects of negative reinforcement and signaling to improve the athletic performance of college athletes. Eleven female varsity lacrosse players who attended a private college in the southeastern United States participated in the study. The team coaches requested help with increasing "pass-naming," (i.e., saying the name of an intended receiver before the ball was passed), to alert her of an incoming pass. The following procedure included a negative reinforcement component, whereby players could reduce daily required sprints by calling out intended receivers' names to alert them of incoming passes. An additional procedure included affixing a colorful band on players' sticks near the head—an area they frequently look at to ensure proper orientation—to prompt them to name passes. Results were evaluated using a reversal design, and showed the combined intervention phase—negative reinforcement plus signaling—was most effective at increasing pass-naming.

Table of Contents

List of Figures

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Dedication

I dedicate this paper to my parents, Jan and George DePaolo. It was my father who ignited the inner athlete in me and my mother who made sure that athlete was also a scholar. Thank you both for your unconditional love and support.

"Get on the Line": Improving Pass-Naming in Collegiate Women's Lacrosse Using Negative Reinforcement and Signaling

Behavior analysis includes a long history of research related to improving sports performance (Luiselli, Woods, & Reed, 2011). Research has included athletes participating in a wide range of sports such as football (Stokes, Luiselli, & Reed, 2010; Stokes, Luiselli, Reed, & Fleming, 2010; Smith & Ward, 2006), baseball (Osborne, Rudrud, & Zezoney, 1990), swimming (Hume & Crossman, 1992), dancing (Quinn et al., 2017), and gymnastics (Boyer, Miltenberger, Batche, & Fogel, 2009). In addition, the available research spans a wide range of skill levels from beginner youth (Koop & Martin, 1983) to proficient professional athletes (Reed, Critchfield, & Martens, 2006). Common interventions to improve athletic performance primarily include positive reinforcement approaches, and typically involve multi-component treatments that include goal-setting, graphic and verbal feedback, public posting, teaching players self-talk, and modeling. Other procedures, such as negative reinforcement, or punishment approaches—including positive and negative punishment—remain understudied in the research literature.

Although widely mentioned in textbooks on physical education and athletics, punishment procedures—including positive and negative

punishment—have not been systematically studied in the literature. A few references exist on potential long-term psychological or physical harm with punishment procedures, including reducing enjoyment of sports, increasing quitting behavior, and elevated risk of injuries (Albrecht, 2013; Richardson, Rosenthal, & Burak, 2012).

Still another procedure, negative reinforcement, is unreferenced in the available research literature on applied behavior analysis in sports. Similar to the literature on positive reinforcement, references to negative punishment are typically embedded within other approaches or part of a multi-component treatment package. Two examples within other package interventions included avoidance of critical feedback by a coach (Stokes & Luiselli, 2010; Stokes, Luiselli, & Reed, 2010). In a study by DePaolo, Gravina, and Harvey (2018), the authors sought to investigate the effects of contingent removal of running laps (as a potentially aversive condition) on pass-naming behavior in lacrosse. A review of the literature revealed no other direct references to negative reinforcement, involving the contingent removal of exercise, which is the focus of the present investigation.

In this paper, I will first provide an overview of commonly used behavior analytic approaches to enhance athletic performance. I will discuss separate and combined applications of reinforcement approaches, which are amongst the most commonly used procedures in athletics. I will also present a summary of the background on positive and negative punishment

procedures applied to sports. Third, I will present an overview of the game of lacrosse to familiarize the reader with key terms and rules. Finally, I will propose a study to evaluate the effects of negative reinforcement and signaling in college women's lacrosse to improve communication between players on the field.

Positive Reinforcement in Sports

Positive reinforcement involves the application of a consequence following a response that results in an increase in the likelihood of the response occurring. Of the research previously conducted on sports performance, the majority has examined positive reinforcement approaches. Stokes, Luiselli, and Reed (2010) researched one of the more common types of positive reinforcement in football, the delivery of helmet stickers. Upon completion of a superior game or an above-average play, as designated by the coach, the players on the team received a small sticker to place on their helmets. Delivery of the sticker was then followed by acknowledgement in the form of praise from other coaches and players. The system, which had been in place for multiple years, was intended to improve performance based on the hypothesis that the stickers would function as conditioned reinforcers for desired athletic performance.

The researchers evaluated results using a multiple baseline across participants, with generalization probes during games. Although prior to the

intervention, coaches delivered stickers to players during or immediately following games, Stokes and colleagues instructed the head coach to use them during practice drills. The coach selected two linebackers who were performing poorly, and used the helmet sticker intervention to improve their tackling percentages. In this study, players completed 10 tackling drills per practice for 22 days. The coach gave the two players one sticker each for every practice that they reached a new "personal best" for percentage of completed tackles. The coaches also withheld negative comments for missed tackles. Both players in the study showed rapid and dramatic improvements in performance, furthermore, improvements generalized from practices to games.

In a second football study, Stokes and et al. (2010) evaluated coaching procedures for improving offensive line pass-blocking skills. Participants included five students on a public high school's varsity football team. The coaching staff identified them as the lowest performers on the team. Participants ranged in age from 15 to 17 years old and had no more than five years of football experience. In the study, the coaches defined blocking according to a 10-step task analysis. The dependent measure included the percentage of steps the players correctly executed during pass-blocking drills and league games. The offensive line coach collected data during weekly drills and researchers collected data during games. A multiple baseline across participants design was conducted.

During baseline, the offensive line coach instructed participants on proper execution of tackles and reminded them about previously learned techniques. He provided praise when players blocked correctly, and critical remarks when they executed blocks poorly. During intervention, the authors evaluated different coaching procedures, including descriptive feedback, descriptive feedback plus video feedback, and teaching with acoustical guidance (TAG). In brief, TAG procedures involved coaches sounding a bullhorn as auditory feedback when a player emitted a desired tackling response (See: Konttinen, Mononen, Viitasalo, & Mets, 2004; Pryor, 1999). Descriptive feedback included reviewing movements the player executed correctly and incorrectly via instructions, modeling, and physical prompts. The descriptive feedback plus video component entailed reviewing videos with each player, praising and correcting his performance. Steps differed across participants, depending upon the missing skills identified by the coaches. The meeting ended with each player performing the pass-blocking sequence one time, without praise or correction. TAG was performed with four of the five participants. Immediately after participants executed the previously selected "tagged" steps of the blocking sequence, the coach sounded a bullhorn siren for 1 s. No other feedback or reinforcement was given.

Results showed that descriptive feedback proved to be the least successful procedure for improving tackling behavior. Only one player's

performance improved in this phase, during which the player and coach watched videos of the drill while the coach provided constructive criticism and positive reinforcement in the form of praise. Descriptive feedback plus video feedback proved to be the most effective intervention. TAG procedures demonstrated further improvements in tackling performance across all participants; however, limitations in interpreting results included short phases of implementation and ascending trends prior to implementation of the TAG intervention phase. The coaches reported that all participants' performance improved to levels comparable to advanced athletes on the team.

Hume and Crossman (1992) also researched positive reinforcement with six high school swimmers. Their study was conducted during their "dry land" portion of practice, during which swimmers engaged in various exercises or feedback sessions with coaches. During dry land practice time, coaches found that the athletes often engaged in disruptive and off-task behavior. Researchers randomly assigned swimmers to either a contingent reinforcement group or non-contingent reinforcement group, and evaluated the effects of a music intervention using a reversal design. In the contingent music group, the coaches allowed swimmers to listen to music during dry land training, if they had high levels of training productivity the prior practice day, as designated by 15% improvement from baseline. The coach set a group contingency, whereby, all swimmers had to achieve the minimum

criterion level to access music the following day. The non-contingent music group played music during dry land training regardless of their performance the previous day.

During the contingent music condition the swimmers showed marked improvements in productive behaviors, relative to baseline conditions. Three of the five swimmers demonstrated higher levels of productive behaviors in the contingent music condition (i.e., practicing skills as instructed, performing related physical activity, and demonstrating skills to others). In contrast, swimmers overall showed less productive, and more nonproductive behavior during the noncontingent music phases of the study. Following the study, all swimmers rated the music as enjoyable, further confirming preference for the music intervention, and improvement in performance for three swimmers indicated the likelihood it functioned as positive reinforcement. The social acceptability rating of the music in the study was interesting, because relatively few studies on sports interventions have included data on acceptability of the intervention (Luselli, Woods, & Reed, 2011).

Applications of Punishment in Sports

Perhaps the most controversial and highly stigmatized form of behavior management in sports involves the application of punishment, including positive and negative punishment procedures. Positive

punishment, by definition, involves the presentation of an aversive stimulus following a response that results in a decrease in the future probability of the response occurring. Negative punishment, in contrast, includes the removal of a stimulus contingent upon a response, that results in decreases in the future probability of a response. A comprehensive search of the research literature in applied behavior analysis in sports revealed no direct references to either positive or negative punishment in sports; however, a few available publications from national-level sports associations and coaching textbooks referenced the applications of positive and negative punishment. For instance, the National Collegiate Athletic Association (NCAA, 2013) and the Society for Health and Physical Educators (SHAPE, 2009) advise against either form of punishment to motivate athletes, whether to improve performance, or to cease undesired behavior. In contrast, a coaching textbook by Schempp (2013) refers to contingent exercise as an important learning experience or as athletic conditioning that should not be referred to as punishment at all, regardless of whether coaches use it to correct undesirable behavior or sports performance. Still other authors include no discussion of punishment procedures in sports (e.g., Luiselli & Reed, 2015), or advise against the use of punishment due to potential injuries or lowered morale in players (Albrecht, 2013).

The absence of evidence on the effectiveness of punishment in sports research is unsurprising, with numerous charges of unethical, or even

criminal behavior of coaches who use it as a practice. Nonetheless, many athletes know the phrase, “get on the line,” signaling contingent laps following a missed shot, a lost game, or breaking a team rule. A further potential reason research on punishment is hard to find is that punishment procedures typically comprise only one element of a combined treatment package (Luiselli & Reed, 2015). For instance, in a previously cited study by Stokes et al. (2010), the coaches provided “critical comments” for poorly executed tackles during one phase of their experiment. The effect of the intervention resulted in no improvement in the players studied. Another example of punishment involves the coach requiring players to “sit out” of a game as a form of negative punishment for misbehavior (e.g., Schempp, 2013). A survey of 189 physical education teachers and coaches conducted by Richardson, Rosenthal, and Burak (2012) revealed that more than 60% of respondents used contingent exercise as punishment with their players. However, research supporting the effectiveness of this coaching strategy is lacking. Though it can be argued that by using punishment as a coaching tactic, the coach is then seen as a signal for punishment.

Negative Reinforcement in Sports

Negative reinforcement involves the removal of a stimulus contingent upon a response, that results in an increase in the future probability of the response (Crosbie, 1998). While a search of the literature revealed no

published studies on negative reinforcement in sports, the roots in basic research reveal much about the processes of negative reinforcement in nonhuman subjects, and a few applied studies with human participants exist. In basic research, the earliest investigations of negative reinforcement included the presentation of scheduled painful shocks to nonhuman animals, via an electrified grid in the floor of an operant chamber (Sidman, 1953; Skinner, 1938). Investigators discovered that rats readily learned to press a lever to postpone shocks, and that their performance improved when a signal (i.e, a click, or buzz) sounded in the chamber (Sidman, 1962). The organisms' behavior of lever-pressing increased, such that they avoided time-based shocks consistently. Other applications of the Sidman avoidance procedure included primates, and even goldfish (Behrend & Bitterman, 1963; Sidman, Herrnstein, & Conrad, 1962).

In consideration of the stigma associated with aversive control within applied research with human participants, it is perhaps unsurprising that a paucity of research on negative reinforcement exists. In 1987, Iwata called for researchers in the field of behavior analysis to conduct investigations on the effects of negative reinforcement in applied settings. The author noted the relevance of escape, avoidance, or postponement of aversive stimuli in a variety of contexts involving human interactions. To date, there have been few studies since Iwata's call for further research on the topic of negative reinforcement.

In one current applied example, Groskreutz, Groskreutz, Bloom, and Slocum (2014) found generalization of negatively reinforced mands, in children with autism. Following an initial assessment in order to determine aversive stimuli for the children, using the Negative Reinforcement Rating Scale (Zarcone, et al. 1999). The investigators found that the children engaged in problem behavior with the presentation of specific sounds commonly encountered in their daily routines and that they were idiosyncratic for participants, such as a buzzing alarm clock, a dustbuster, or singing the "Happy Birthday" song. The purpose of the study was to conduct training sessions to teach the children to appropriately request escape from the aversive sounds. During these sessions, aversive stimuli were removed when the participant emitted a sign language signal to "stop." After training with two stimuli, results showed cross-stimulus generalization, with the participants using the sign for "stop" for both aversive sounds.

In our everyday lives, most people encounter a variety of aversive situations we prefer to avoid. In the past 30 years, common literature examples on negatively reinforced responding include approaches that incorporate functional communication training (FCT) to teach alternate methods of escaping, or temporarily avoiding aversive situations or contexts (e.g, Carr & Durand, 1985; Fisher et al., 1993; Hagopian, Fisher, Sullivan, Acquisto, & LeBlanc, 1998; Lalli, Casey, & Kates, 1995). Extending the literature base to athletic behavior potentially extends the field of knowledge

on negative reinforcement, where the procedure commonly occurs, but is seldom referenced. The coaching literature includes mixed opinions on the benefit or detriment of using positive punishment (e.g., contingent exercise) and negative punishment (e.g., requiring a player to sit out of a game) as a method of curtailing problem behavior in athletes (Albrecht, 2013; Richardson, Rosenthal, & Burak, 2012; Schempp, 2013). The lack of sports research on negative reinforcement, combined with the positive results found in other applied settings, led the authors to conduct a pilot study to investigate the effects of negative reinforcement on improving pass-naming behavior in women's lacrosse.

In an initial pilot investigation, conducted by DePaolo, Gravina, and Harvey (2018), the authors studied the effects of negative reinforcement in college women's lacrosse. The study involved the application of negative reinforcement, via reducing required daily conditioning sprints following team practices, contingent on desired performance. The dependent variable included increasing the frequency of players calling out intended recipients' names, or "pass-naming," to alert them to incoming passes. A correct instance of pass-naming was defined as calling out the name of an intended receiver before the ball was caught.

Results were evaluated within a reversal design. During baseline phases, the players completed five daily 65-yd (or approximately 60 m) sprints at the conclusion of each practice. The coaching staff delivered no

programmed consequences for pass-naming, but occasionally reminded players to “put names on passes” as a method of improving team communication. Data was collected on a total of 100 consecutive passes per practice. Intervention phases involved the reduction of one sprint per 20 named passes. At the conclusion of each practice, the researcher informed players of the number of named passes, and the number of reduced conditioning sprints.

During baseline, players demonstrated low levels of performance, averaging only two names per practice. During the first intervention phase, players increased their pass-naming responses to an average of 55 times per practice. During the return to baseline, behavior declined to an average of four named passes. A brief return to the intervention phase, due to the short lacrosse season and reaching the national playoffs, resulted in an increase in pass-naming to an average of 72 named passes. Results suggested the negative reinforcement intervention led to an increase in desired performance. In consideration of the prior research project, the investigator contacted the women’s lacrosse coach about methods to enhance communication on the field using a similar approach the following year.

In the present investigation, the authors sought to reduce the effects of potential aversive control in the form of running sprints, and contingent removal of sprints, by using signaling as an antecedent manipulation. The researchers applied a brightly colored band to the players’ sticks, on a location they tend to look at when

passing the ball, to ensure appropriate positioning of the stick. The purpose of the band was to signal players to call out the names of intended receivers and thereby orient them to incoming passes.

The conditioning of stimuli in basic research has an extensive history in human and nonhuman applications. For instance, multiple schedules signal changes between two or more independent variables, with some change in a stimulus condition that correlates with each independent variable (Catania, 1984). Repeated presentations of a salient, discriminable stimulus (e.g., a change in the color of a key the presence or absence of a sound), followed by an organism's response, and delivery of a consequence, determine whether future responding will increase, or decrease in frequency. Over repeated presentations, the organism's behavior changes to meet the schedule requirements in effect, i.e., demonstrating stimulus control under the presence of the relevant discriminative stimuli. Demonstrations of similar multiple schedule arrangements in applied research show that human participants come under similar types of stimulus control.

The use of signaling in sports is also quite common. For instance, goalies wear yellow jerseys, and umpires wear black and white stripes. During practices, coaches direct players to wear opposing team colors to simulate the roles of "offense" and "defense." Other examples include the use of numbers that designate the positions of players on the field and their roles (NCAA, 2017). Considering the widespread use of colors in sports, it is

surprising that a search of available literature revealed only one study that included signaling as an antecedent manipulation to improve performance.

Signaling in Sports

In a study by Osborne, Rudrud, and Zezoney (1990), the authors added orange marks to baseballs to improve curveball hitting performance in a collegiate team. Results were analyzed using a multi-element design, whereby the investigators evaluated hitting performance on a combination of unmarked balls, balls with a 1/4-in a 1/8-in orange strip on the seam of the ball. The coach set criteria for performance, based on distance, area of the field, and swinging mechanics. Performance improved with the mix of marked and unmarked balls, and all batters showed better performance with the larger strip. Notably, the authors did not attempt to fade the colorful tape from the balls as a further measure of the effects on performance, nor were probes of performance during games measured. Nonetheless, the application of signaling in sports represented an important hallmark in the field of applied behavior analysis. As an extension of the research on signaling in sports by Osborne and colleagues, the author sought a method of transferring stimulus control from negative reinforcement to the use of a colorful band in the game of college women's lacrosse.

Background on Women's Lacrosse

Lacrosse is played all over the world; yet, there is very little research literature involving the game. In collegiate women's lacrosse, 12 players per

team participate on the field at a time. Players include four attackers, three midfielders, four defenders, and a goalie. The rules specify that no more than seven offensive players may be present on the "attacking third" of the field, to avoid an "offsides" penalty. Due to the offsides rule, the present study included only midfielders and attackers since they are typically the only players in the attacking third of the field, on the side closest to the opponent's goal, approximately 30 yds (27 m) in length, and between 60 to 70 yds (55 to 64 m) in width (NCAA, 2017).

In a fast-paced game like lacrosse, a successful team approach involves passing and catching the ball quickly and moving it down the field to score goals. From the moment of possession, players have only 90 s to shoot on their opponents' net, in compliance with newly passed NCAA rules (2017). Failure to pass within 90 s results in the team in possession forfeiting the ball to the opponent. For this reason, the game tends to move quickly and passes often happen less than 1 s apart from each other.

Women's lacrosse rules specify a very small "pocket" in the player's sticks to hold the ball. According to NCAA regulations for women's lacrosse, the ball must be visible from the side from front to back while in the pocket, with no spaces greater than 1.5 in (3.81 cm) (NCAA, 2017). From a beginner's level, coaches prompt players to look at their sticks when passing, catching, and cradling (i.e., moving the stick from side to side while running, and keeping the ball from falling out of the stick). When a player calls for a pass,

the receiver holds her stick up in the proper orientation, showing preparation for the pass. Due to the constant looking at one's stick, as well as the stick of the intended player one passes to, the current researchers thought it appropriate to affix a colorful signaling band directly below the pocket. It should be noted that when playing lacrosse, players throw and catch with one hand placed approximately one-third of the way down the stick and the other at the bottom of the stick. Thus, the signal was significantly higher than the participants' hands when throwing and catching, and would not interfere with passing or catching.

The coaches in the present investigation sought a strategy to potentially improve receptions, to improve communication. A specific procedure to accomplish this goal involves calling out the names of intended receivers to alert them to incoming passes. This not only allows the receiver to prepare for the pass, but also alerts surrounding teammates about the movements of the other players and the ball. Communication between players on a team is critical, especially in the attacking section of the field as a team nears the opponent's goal. Following the improved performance in pass-naming during a prior project with a women's lacrosse team (DePaolo, et al., 2018), the first author discussed extending the study during the team's following year.

Specific Aims

The present study sought to evaluate the separate and combined effects of negative reinforcement and a signaling condition during team practices to increase the frequency of women's lacrosse players naming passes. Similar to the first study by DePaolo and colleagues (2018), the coach implemented a negative reinforcement condition, whereby players could reduce the number of daily required conditioning sprints during practice for naming a specified number of passes. A second condition added a signaling component—affixing a colorful band to the end of the players' sticks, which was intended to serve as a cue to players to name passes.

The purpose of this study was to determine whether negative reinforcement, signaling, or a combination of the two procedures, would result in increases in pass-naming responses during lacrosse practices. A further objective was to evaluate if effects observed during practice would generalize to games.

Method

Participants and Setting

Participants in this study included 11 female athletes, who played positions as either attackers or midfielders, on a women's varsity lacrosse team at a university in the southeastern United States. The athletes' ages ranged from 18 to 22 years old and their lacrosse experience ranged from

four to 10 years. Sessions occurred during the last half hour of full practices on the team's practice field. The coaches and researchers agreed to implement the procedures during every practice, except when practices fell on the day before a game. Data were also collected during the second half of one game per phase as a measure of generalization.

Materials

Materials for this study included electronic recording devices (e.g, smart phones and tablets) for data collection. Red and white rubber bands were used as signals on the players' sticks. Bands were 0.5 in (1.27 cm) wide, to ensure good visibility by the players.

Dependent Variable and Data Collection

The dependent variable for this study was 'pass-naming,' defined as a player saying the name of the intended receiver of a pass before the ball was in the air. Based upon this definition, if a name was called before the ball was in the air, it was counted as a successful instance of "pass naming." Any instance of calling out a name after the ball was in the air or caught by a receiver was counted as a missed opportunity. The goal of pass-naming was to alert a player to an incoming pass, potentially increase the likelihood of catching the pass, and thus increase the team's chances to score goals and win games.

Each session took place on the team's practice field during an end-of-practice scrimmage, lasting for 100 consecutive passes. The start time of each session was randomized. Thus, the first pass of the scrimmage was not always the start of data collection. Taking into account that 100 passes may take anywhere from 10-20 min., data collection did start within the first two min. of each scrimmage. Sessions lasted approximately 10 to 20 min. Data were collected discreetly by an assistant coach (who also served as the primary researcher) using a computerized application on an electronic device. The app, Behavioral Observation Tool (BOT, Simonton, 2017) allowed for scoring of correctly or incorrectly named passes. The use of a data collection application allowed for the observer to press a button to score named or un-named passes, by coding "yes" or "no" responses.

Procedure

Assessment

The primary researcher developed an assessment tool, and administered it to the assistant coaches. This assessment was based on the Performance Diagnostic Checklist (Austin, 2000). The PDC, briefly, functions as an assessment of an individual's skill repertoire and actual performance of the skill. The PDC helps investigators rule out skill deficits as well as problems with compliance with designated skills to be performed. The sports-based PDC was modified to assess whether players were able to name

passes or needed further instructions, versus those who possessed the skill, but failed to engage in the desired behavior. The PDC also assessed potential competing behaviors and any current consequences in place for naming, or failing to name, passes.

Experimental Design

Results of the study were evaluated using an A-B-BC-C-A-BC withdrawal design. The combined and separate effects of two interventions—negative reinforcement, signaling, and negative reinforcement plus signaling—were assessed. Results indicated that the combined phase produced the highest number of named passes. Based on data collection during the study, the final phase incorporated a "best" phase, as indicated by the highest level of observed performance with stability. The study ended with the season end, after which time all practices and games also concluded.

Baseline

During baseline, athletes participated in a 30-min scrimmage during practice in their usual manner. The coach required all players to run five sprints after each practice for conditioning. Each sprint consisted of running one way across the field, approximately 65 yd (i.e., 60 m). One data probe in

this phase was collected during a game to test for potential differences in performance from practices to games.

Negative Reinforcement Only

At the start of the first intervention phase, the primary researcher met with the players and explained the goals of the study, to extend prior research on improving pass-naming. The investigator also explained the importance of pass-naming to alert players when the ball is coming to them to improve receptions, and also to avoid interceptions by the opposing team.

In the negative reinforcement-only phase, attackers and midfielders were told that for every 20 named passes, one end-of-practice sprint would be removed. Due to the fast pace of the game, the number of named passes was aggregated as a group contingency. Thus, the coach required all players to run between zero to five daily sprints, depending on the number of named passes during their end of practice scrimmages. One data probe in this phase was collected during a game to test for potential differences in performance from practices to games.

Negative Reinforcement Plus Signal

The negative reinforcement intervention resumed in this phase, with the addition of a red and white band to the participants' lacrosse sticks. The bands were applied approximately 2 cm away from where the ball is held in

the stick and therefore highly visible. The researcher explained to the players that the purpose of the bands was to function as a reminder to the passer to say the name of the intended receiver before passing the ball. One data probe in this phase was collected during a game to test for potential differences in performance from practices to games.

Second Baseline

The second baseline phase was identical to the first. Players were told that the study had ended. One data probe in this phase was collected during a game to test for potential differences in performance from practices to games.

Signal Only

In the signal-only phase, the experimenter returned the red and white bands to each player's lacrosse stick, but the negative reinforcement contingency was removed. The experimenter explained that when the bands were removed, the frequency of named passes decreased and now the coach wanted to evaluate the effects of the signal alone. Players were told that they would still run their mandatory conditioning sprints during this phase, regardless of how many passes they named. The purpose of this phase was to determine any individual effects of the bands as a potential conditioned stimuli, due to repeated pairings with negative reinforcement in the prior

phase. One data probe in this phase was collected during a game to test for potential differences in performance from practices to games.

Negative Reinforcement Plus Signal

The final phase of the experiment consisted of the negative reinforcement plus signal phase, since it yielded the highest results for pass-naming. The phase was identical to the prior negative reinforcement plus signal phase. Players were informed that they were once again eligible to reduce required sprints, contingent on naming passes. As before in the negative reinforcement plus signal phase, the coach agreed to reduce one sprint per 20 named passes. One data probe in this phase was collected during a game to test for potential differences in performance from practices to games.

Interobserver Agreement

Fellow graduate students scored interobserver agreement for frequency of pass-naming per 100 passes during all phases of the experiment. Experimenters attended a practice session prior to taking data to observe the behavior directly in the context and ask questions of the principal investigator as needed. All data collectors underwent thorough training with the researcher prior to data collection to demonstrate proficiency on correctly scored pass-naming. IOA data were scored using the

total count method (i.e., the number of agreements divided by disagreements, multiplied by 100) during 43% of sessions and yielded a score of 96% (range: 95 to 100%).

Due to the regulations in NCAA collegiate sports, only players, coaches, and athletic trainers are allowed on the sidelines during games. For this reason, no IOA data were collected for game probe data.

Social Validity Measure

After the study was complete, the experimenter emailed a survey to participants. The surveys included eight questions related to the efficacy, acceptability, and feasibility of the study. (Refer to appendix A). The experimenter included two additional questions, which were optional. One question asked if players liked or disliked the bands on their sticks. A second question asked whether they had other suggestions for signals. This question was targeted specifically at a few players who complained they did not prefer the signaling band.

Participants rated each question using a Likert-type scale, from: (1) strongly disagree, to (5) strongly agree, regarding intervention one (negative reinforcement in the form of removing required sprints), intervention 2 (signaled responding), or a combination of the two (negative reinforcement plus signaled responding). Questions focused on the following parameters of each intervention: (a) appropriate for improving pass-naming behavior, (b) if

it should be used in future practices, (c) if it helped them remember to say a player's name when passing during a game, and (d) which they preferred—negative reinforcement or signaled passing.

Results of the survey indicated 80% agreed or strongly agreed that negative reinforcement helped them remember to name passes during practices. The other 20% neither agreed nor disagreed. Only 50% agreed or strongly agreed that negative reinforcement helped them remember to name passes in games.

Regarding signaling, 40% agreed or strongly agreed that signaling helped them remember to name passes in practices, and 30% agreed or strongly agreed that signaling helped them remember to name passes in games. Multiple players gave suggestions for other signals; however, the NCAA rules place strict limits on many suggestions that were made.

The head coach and primary assistant coach completed the same social validity surveys. Both reported that negative reinforcement increased pass-naming behavior in practices. One coach reported the strategy should continue in the future. One coach reported that the signals helped players remember to name passes, while the other neither agreed nor disagreed. Both coaches stated that the signaling strategy would not be used in the future, but gave no suggestions for a different signal to use.

Results

Results are shown in figure 1. Pass-naming improved from baseline to intervention phases, with the highest level observed in the negative reinforcement plus signaling phase. Initial baseline data on pass-naming averaged approximately seven names per 100 passes (range: 5 to 10). Players named five passes during the game probe for generalization. Next, in the negative reinforcement only phase, the average number of named passes was 53 (range: 48 to 60). The number of named passes in the game probe was 11. In the first negative reinforcement plus signal phase, players averaged approximately 55 named passes (range: 47 to 62), with a game probe of 17 named passes.

During return to baseline, pass-naming returned to a low level, although higher than in the first baseline phase. Players averaged 16 named passes (range: 14 to 20) and six during the game probe in this phase. In the next phase, signal alone, pass-naming increased to an average of 44 names (range: 43 to 50), with a game probe of eight named passes. Results were the highest in the final phase, the negative reinforcement plus signal phase. Players averaged of 61 named passes (range: 58 to 65) during practices, and 10 during game probes.

Discussion

Similar to a prior study by DePaolo and colleagues (2018), the researchers observed improved responding under negative reinforcement contingencies in a collegiate women's lacrosse team. The added component of signaled responding showed additional improvement in pass-naming, and shows promise as a potential conditioned negative reinforcer. Although team performance did not show robust generalization from practice to game performance, it is important to note that the negative reinforcement contingency was removed for games. That is, the coaches exempted players from all sprints, regardless of pass-naming behavior before or after games. It should also be noted that game probe data, though lower than practice data, still followed the trend observed during the practice phases.

Historically, data show that maintenance of negative reinforcement effects under the control of conditioned stimuli require relatively few pairings of conditioned stimuli across nonhuman participants, and that the effects improve with exteroceptive stimuli, relative to the absence of signaling stimuli (Rachlin & Hineline, 1967; Sidman, 1953). To extrapolate these findings to human participants engaging in complex responses with multiple concurrent operants in effect, it is possible that more sessions with exposure to the negative reinforcement contingency are needed to establish stimulus control. Furthermore, effects during practices and games in the present investigation may have also been enhanced with establishment of

rules delivered to players before each practice and game, noting the presence of the bands on their sticks, and of the desired behavior to name passes. Several examples exist of improving performance with establishment of rules in high verbal individuals and in complex settings (Mallott, 1993; Tarbox, Zuckerman, Bishop, & Olive, 2011). Further investigation of signaling is warranted to improve pass-naming, in the presence and absence of negative reinforcement, to limit potential effects of aversive control (Sidman, 2001). Results of this study highlight the potential applied significance of negative reinforcement approaches in athletics, as a method of motivating players to improve performance. A discussion of implications of the present research, benefits, and limitations follows.

A review of the literature shows that many of the present investigations on athletic performance include multi-component treatment packages, most of which integrate positive reinforcement and feedback (Hume & Crossman, 1992; Luiselli, Woods, & Reed, 2011; Stokes et al. 2010; Stokes, Luiselli, & Reed, 2010). Although the application of behavior analytic principles to athletics is not entirely new, it remains understudied, with research spanning the past 40 years. Few studies to date have included a component analysis of the necessary and sufficient treatments involved in improving athletic performance. The present study included a reversal design that emphasized separate and combined effects of the treatments. Upon completion of an initial baseline, the negative reinforcement contingency was first examined alone. Then, the interventions were combined, in hopes of pairing the

signal with the negative reinforcement. After a return to baseline, the signal was then examined alone. A final "best" phase was then conducted. This phase was determined to be the combination of negative reinforcement and signaling, based on this phase having previously yielded the highest rates of named passes.

Further research is warranted to comprehensively assess performance of athletes and the effects of interventions that are necessary and sufficient to yield desired performance by conducting component analyses within single-case designs.

In the present investigation, the author conducted a sports-oriented PDC (Austin, 2000), that was specifically modified by the author for the sports study as a method of determining players' skills and follow-through on naming passes prior to beginning intervention. The use of a PDC appeared to be appropriate, considering team play as a form of organizational performance. Implementation of the PDC for a sports intervention is unique, and may lead the way for other researchers to conduct similar assessments of performance in athletics. The PDC included questions regarding whether the players understood the expectations of the coaches to name passes, whether they had the necessary equipment, if they could describe the task and consequences, as well as identify any potential competing behaviors to the task.

Some researchers also used auditory or visual cues as methods of signaling or reinforcement to improve performance in athletes (e.g., Osborne, Rudrud, & Zezoney, 1990; Stokes, Luiselli, Reed, & Fleming, 2010). Luiselli and Reed (2015)

noted the need for better assessment-derived interventions, coaching strategies, treatment integrity, and social validity in their review of sports interventions. The differential effects of signaling as an antecedent manipulation on athletic performance may offer fruitful areas for future research, particularly when aversive procedures are employed. While negative reinforcement is not always an option in college athletics, this study showed that brief pairing of signal(s) with a negative reinforcement contingency resulted improved performance even after the reinforcement contingency was withdrawn. Though effects in the signal only phase were higher than in baseline, they were not as high as the combined effects of negative reinforcement plus signaling. This suggests that signaling may be a promising intervention procedure to reduce the reliance on negative reinforcement but more research on strategies to strengthen the effectiveness is needed.

Limitations

In this study, the overall level of pass-naming performance was lower than in a prior study by DePaolo and colleagues (2018). One potential reason for the differences might have been due to a change in the operational definition of the dependent variable. In the present investigation, the ball had to still be in the player's stick while a name was called, to count as a named pass. In the previous study, the ball could be in the air. Thus, some passes that would have been scored as a correct in the previous study were scored as incorrect instances in this study. The reason for the change in the

dependent variable was that the coaches and researchers agreed it was appropriate, and would be beneficial, to have passers call a name sooner, before throwing the ball. Future investigators in lacrosse or other team sports involving movement of a ball between players may wish to consider adopting a less stringent operational definition of a named pass.

The observation that pass-naming was lower during game probes may have been attributed to a few factors. First, there was no negative reinforcement contingency present on game days to run sprints. Players were aware the coach would not require them to run after games, which may have altered their performance. The purpose of the red and white bands affixed to the lacrosse sticks was to serve as a conditioned stimulus after pairing during the negative reinforcement plus signaling phase. Although the highest effects of the intervention were observed in the presence of the combined approach, the signal alone resulted in performance at levels above baseline. A second reason for the potential reduction in pass-naming during games was the short lacrosse season. The length of the athletic season only allowed for three to four data points per phase. Longer exposure to the negative reinforcement plus signaling phase might have led to better results and allowed for fading of the negative reinforcement condition.

It is noteworthy that the primary researcher was also an assistant coach who played on the team during the prior year, which may have posed a limitation to the study. Some players may have demonstrated reactivity as a

result of the researcher participating on the team. Although participation as a researcher is a cited limitation, her involvement may also have been beneficial in the study, allowing for better collaboration with coaches and players, as well as experience playing the sport.

Anecdotally, some players noted dissatisfaction with the signal affixed to their sticks in the signaling phases. Players expressed concern about adding anything that altered their sticks. Although the bands were approved by the coaches and acceptable according to the NCAA rules, one player refused to continue using the signal during the signal-only phase, or the final negative reinforcement plus signal phase, reporting that it interfered with her positioning of the stick during certain plays. Other considerations regarding signaling that are acceptable to players and that comply with rules of the game might be considered in future investigations.

Future Directions

The findings of the present study lend support for further investigation of the effects of negative reinforcement as a method of improving sports performance. Although signaling alone did not result in sustained improvement in pass-naming during this study, it did result in an improvement from baseline. Future research should be conducted on sports with longer seasons or across multiple seasons, and include adoption of other forms of signaling that are acceptable to players and coaches.

Furthermore, researchers could consider adding fluency training, or repeatedly practicing the skill until it can be demonstrated quickly and without hesitation (Binder, 1996), to increase pass-naming during practices while the signal is in place to see if that increases the likelihood that pass-naming will occur in games. Fluency training has been shown to create more durable behavior change in academics (Haughton, 1980) and other training (Binder, 1996). Additionally, it is possible that more trials of pass-naming during practice with the signal in place would strengthen the signal and therefore, have a stronger influence over pass naming in games.

Future studies may examine rule governance and delayed consequences for players' performance during games to ensure contact with relevant contingencies at a later time. For instance, coaches might inform players that the negative reinforcement contingency will be applied during a subsequent practice based on game performance.

Moreover, future research could compare a negative reinforcement intervention with a positive reinforcement intervention to determine which is more feasible and results in the largest behavior change. For example, coaches could provide group level rewards for the team, such as pizza after practice, when goals are met in practices and games.

To date, this is the second study on an application of behavior analytic research on the sport of lacrosse, in an extension of prior research by DePaolo and colleagues (2018). The results presented suggest that negative

reinforcement, via decreasing the number of less preferred conditioning activities, plus a signaling component was effective at improving pass-naming during practices. Future investigations may include evaluations of a similar approach in other group or individual sports.

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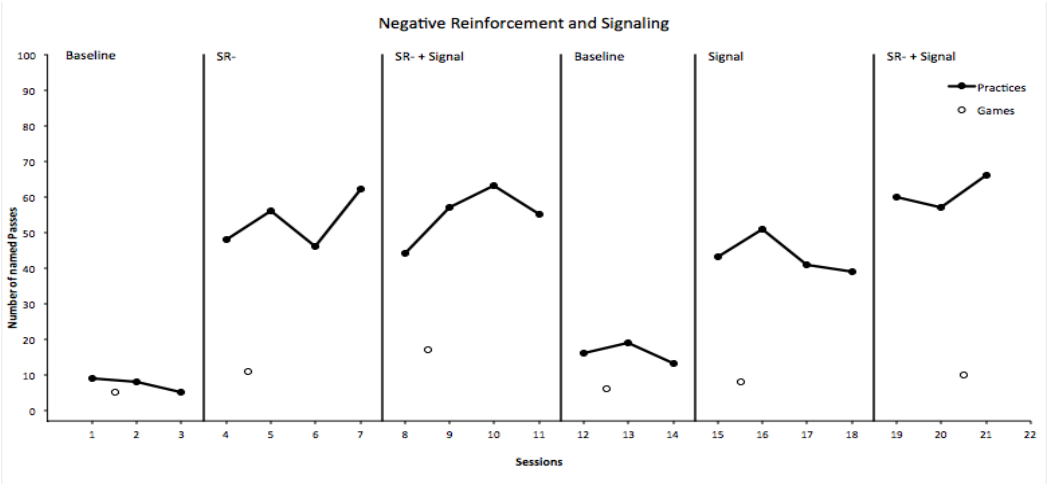

Figure 1: Named passes per 100 passes. Black circles represent practice data while open circles represent game probes.