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Improving Pitch Recognition by Fading Visual Prompts

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by

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Abstract

Title: Improving Pitch Recognition by Fading Visual Prompts

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Behavioral Science and Applied Behavior Analysis (ABA) provides tools and technologies that can be used by players, coaches, and researchers to enhance the traditional training for student athletes. The current study was designed to examine whether stimulus prompts would facilitate collegiate baseball player's accuracy of pitch identification for three pitches. A secondary measure was to decrease the latency from the launch of a pitch to identification of the pitch. Decreases in the latency of a hitter recognizing a pitch and increases in pitch recognition accuracy were noted using visual analysis. Stimulus fading showed mixed results across participants. Future directions and implications of the current project are discussed for players and coaches.

Keywords: pitch recognition, stimulus fading, ABA

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Chapter 1

Introduction

Baseball is a major sport played across the globe, having professional leagues in the United States, Japan, Korea, and several other countries. Additionally, baseball is arguably a key component of American culture. A large part of baseball's popularity can be attributed to hitting, as hitting opens opportunities for home runs, scoring runs, and essentially, winning games (Cairney et al., 2023). There are many challenges, though, to hitting as it requires multiple complex behaviors that occur at the same time. A hitter's swing is compiled of multiple gross and fine muscle movements which are shaped through reinforcement, punishment, and repetition. Hitting is dependent on adjunctive behavior to pitch recognition (Harvey, Houvouras, & Baxter, 2024). A pitch can be categorized by the velocity of the pitch, and the trajectory of the pitch, as well as the spin of the pitched ball. This alone is difficult as the fastest pitch speeds give the hitter only about 250 milliseconds to see the ball, identify the pitch, and decide on whether to swing (Higuchi et al., 2016).

Pitch Recognition

The ability to recognize the pitch type allows the hitter to predict its trajectory and track the course of flight (Sherwin et al., 2012). Only with clear recognition of the pitch can a hitter take the appropriate actions to contact the ball.

Traditional methods to practice hitting included excessive repetitions, followed by feedback/critique that are associated with boredom and disengagement. “Keep your elbow up”, or “keep your eye on the ball” were common phrases used by coaches to critique swings. These phrases and many others focus specifically on the physical attributes of a swing but neglect the adjunctive behavior that occurs before and during the batter’s swing. Pitch recognition is a key component to the swing; efficacious methods to teach pitch recognition are desired by both players and coaches. Applied Behavior Analysis has a variety of teaching methods that are just now being applied to sports, including baseball.

Behavioral Science and Sports

The science of behavior has been applied to many socially significant settings including centers for disabled individuals, business, or substance abuse centers. The use of behavioral science to affect change in sports is increasing. Training technologies experimentally validated through behavior science can be used by coaches and players to increase skill sets needed to excel in sports such as baseball. A review of the behavior analytic literature in sports highlights several tools that can be used to train athletes, including baseball players.

Luiselli, Woods, and Reed (2011) assessed the use of behavior analytic principles to improve performance in sports. This review focused on research that directly treated performers and used consultations from coaches and trainers.

Stickers and praise functioned as positive reinforcement and shaped desired tackling behaviors in two high school football players (Stokes et al., 2010). Tackling behaviors were broken down into a 10-step task analysis. Colored helmet stickers were provided each time a player matched or exceeded their previous correct tackling percentage. Reinforcement also included praise and attention (to the stickers) from teammates and coaches. For the first participant, the mean correct tackling percentage increased from 35% to 75%; the second increased from 26% to 58%. Performance was generalized by both participants to game conditions. These results support the use of behavioral interventions to increase sports performance and their generality to game scenarios. With positive results analyzing the pitch recognition of hitters, generality can be a topic of future research.

Teaching with acoustical guidance (TAG) and video recording were used to improve blocking skills of offensive lineman by providing positive and corrective feedback (Stokes, Luiselli, & Reed, 2010). Stokes and colleagues analyzed blocking behavior of five high school football players using a multiple baseline design. Blocking behaviors were broken down into a 10-step task analysis. Coaches met with each player following each session and either provided descriptive feedback by itself or combined descriptive feedback with video feedback. After, TAG was implemented with four out of five participants. Each targeted step performed correctly was followed by a siren lasting one second. No feedback was provided following this intervention. Results revealed that descriptive feedback alone did not improve pass blocking, but the combination of descriptive and video feedback was effective across all five participants. Following the use of TAG, all participants demonstrated further improvements and performance generalized to game conditions. However, the effects of TAG were unclear as the combination of increasing trends, short assessment phases, and the aggregation of the data created confounds.

Another tool used by behavior analysts to assess sports performance is the generalized matching law. The matching law is used in ABA to analyze behavior based on previous response and reinforcement rates. Statistical analysis is used, using an equation from Herrnstein (1970), that compares the rates of behavior in relation to reinforcement rates of that behavior to see if a significant relationship exists. The creation of this equation has assisted in applied practice in which reinforcers for maladaptive behavior could be determined. Poling et al. (2011) stated how quantitative predictions about how an organism allocates its time and behavior can be made only if there is 1) sufficient data to solve the equation and 2) similar conditions to when the equation was solved. So, if these requirements are met, then the matching law may be a beneficial tool for behavior prediction.

Sports is a common area of research when it comes to the Matching Law and behavior prediction. Vollmer and Bourret (2000) used the matching law to predict shot selections in basketball players. Division 1 male and female basketball players were assessed across two-point and three-point ranges. The rate of reinforcement, in terms of shots made, was used to predict the future shot selections of the basketball players. To adjust for the reinforcer value of a three-point shot (versus a two-point shot), the matching equation was adjusted so that the three-point shot was 1.5 times greater than the two-point shot. Results revealed that the matching equation was reliable in identifying the participants' shot selections. With Vollmer and Bourret (2000) using collegiate athletes to predict shot selections in basketball shots, analyzing the pitch selections of collegiate athletes in baseball can be used for supportive research.

The matching law has also been used in American football. Stilling and Critchfield (2010) analyzed offensive play calling from 192 football games over the span of eight months. The levels of analysis included season-aggregate data and play-by-play data. Season-aggregate data was recovered from the 2006-2007 National Football League (NFL) season including data from all 32 teams. Play-by-play situations were categorized based off the current down, game time remaining, yards needed, score, and field position. Stilling & Critchfield (2010) showed that the generalized matching equation provided accurate and operant explanations for play-calling behaviors (demonstrating how behavioral interventions have been used to analyze performance in sports.

Luiselli, Woods, and Reed (2011) demonstrated how positive reinforcement, goal setting, modeling, and feedback could be used to improve athlete performances in baseball, football, hockey, basketball, swimming, and tennis, but call for the further evaluation of these principles to other sports. A more recent review of sports performance was conducted by Schenk and Miltenberger (2019) in which they focused on the use of interventions involving behavior analysis. Schenk and Miltenberger reviewed over 100 studies that used a variety of interventions and procedures across multiple sports (baseball, basketball, football, golf, gymnastics, hockey, etc.). Interventions included feedback, token economies, chaining, behavioral rehearsal, behavioral skills training (BST), modeling, self-monitoring, and other antecedent/consequence procedures. Nearly all the studies reviewed by Schenk and Miltenberger (2019) produced discernible improvement in desired behaviors, but some required further evaluation.

Schonwetter et al. (2014) used self-monitoring and verbal feedback to increase laps swam by competitive swimmers. Seven high school swimmers were tasked with recording the number of laps completed on a whiteboard following a practice. Participants were given a specific number of laps to complete based on experience and skill level. The first intervention phase used only self-monitoring, and increased percentages of laps completed were seen for most of the participants. The second intervention used self-monitoring and the addition of verbal feedback using praise statements like ‘nice work’ or ‘thanks for writing down the amount you swam, I appreciate it’. Schonwetter et al. (2014) concluded that the addition of descriptive verbal feedback showed higher increases in work output when compared to self-monitoring alone but noted that reactivity was a limitation for the study.

Wack et al. (2014) used graphical feedback as well as verbal feedback and goal setting to increase the running distance of collegiate female athletes. Five women participated in the study, who all were given long-term and short-term goals for their running sessions. A changing criterion design was embedded into a multiple baseline across participants design to determine each participant’s running goals throughout the study. The first intervention phase used daily goal setting and feedback while the second intervention used weekly goal setting and feedback. Two out of the five participants met their weekly goals on at least 80% of opportunities during the first intervention. The other three participants met their weekly goals on at least 80% of opportunities during the second intervention phase. No significant effects were seen between daily and weekly goal setting. Miltenberger (2012) supported the use of goal setting and feedback as it can serve as an establishing operation for goal achievement.

Tai and Miltenberger (2017) used behavioral skills training (BST) to teach appropriate tackling skills in youth football players. Six players who used unsafe tackling techniques were selected to participate. A 10-step task analysis was developed to identify the appropriate tackling behaviors. BST was implemented by the researcher by providing instructions on how each step was completed, followed by modeling the target behaviors. Modeled behaviors included having a ready position (e.g., weight on toes, knees bent, etc.), running towards the opponent, leading with the shoulder, wrapping arms, etc. Next, participants would rehearse the behaviors with a 'tackle dummy', and feedback would be provided following the trial. Positive and corrective feedback were both provided. Players were subsequently reassessed with another player instead of the dummy. After a highly variable baseline across participants, BST showed improvements in safe tackling behaviors. Percentages of correct steps for each tackle increased and maintained during treatment. Tai and Miltenberger (2017) denoted that BST and behavioral principles can be applied in a sport setting to teach target behaviors.

Schenk and Miltenberger (2019) highlighted multiple studies that suffered from a publication bias in which positive results were the sole focus. Lerner et al. (1996) reported improvements in free-throw shooting when using a goal-setting intervention but failed to report on the secondary intervention (self-imagery) that was used in conjunction with goal setting. Osborne et al. (1990) prioritized the positive results of the intervention and failed to address the baseline conditions that showed lower performances (following treatment). Overall, the review from

Schenk and Miltenberger (2019) provided support for the further research of sports using a wide range of behavior analytic interventions. The need for further research is addressed frequently, though, as studies (as mentioned prior) involving sports and behavior analytic research have had limitations which hinder its credibility.

Behavioral Science and Baseball

The use of behavior analytic tools and technologies in the game of baseball is much less researched. Historically, a baseball player's success in the game was often explained through mentalisims (Gmelch, 1992). Mentalisms attribute human responses to internal factors within "the mind." For example, performing well in baseball is often attributed to superstition, good luck, or good practice. Performing poorly can be attributed to bad luck ('slumps') and superstitious behavior. Traditional baseball players and coaches may be hesitant to identify new ways to enhance their skills due to these mentalistic explanations that have been used for generations. Conversely, ABA uses observation and data to identify stimuli in the immediate environment that are associated with behavior. Behavioral science identifies variables that can be manipulated - potentially providing new most efficacious techniques to train baseball players.

Heward (1978) studied the relation between behavior technologies and baseball. Heward examined the effect on player performance when monetary incentives were introduced. An ABAB design was used to record the effects of the intervention. Nine players were observed, and the top three performers received monetary incentives for a higher ‘efficiency average’. This was identified as the overall increase in offensive production and efficiency, which was determined by a hitter’s number of walks, hits, runs, runs batted in (RBI), sacrifice flies, etc. Six players increased their efficiency average, four players decreased their efficiency average when baseline was reinstated, and only four players increased efficiency after the intervention was implemented again. Potential benefits of the intervention included increased team run production and efficiency, but no functional relation between the variables was determined. Heward (1978) demonstrated how behavior analytic principles can be applied to baseball to potentially increase performance.

Operant conditioning is just one technique used by behavior analysts; other techniques may have greater influence on manipulating a player’s performance and further research could help uncover significant changes in the game. Results from Heward (1978) suggest that variables effecting the data were present outside the intervention, as seen by the lack of a functional relation, but the current study can show strong treatment effects if results show a functional relation and have differed results between baseline measures. This can allow for the effects of stimulus fading to be observed while maintaining a functional relation between the variables.

With a scarcity of research using behavior analytic procedures to improve aspects of the game of baseball, other outputs were sought out for significant purposes. Kohmura et al. (2019) analyzed the effects of visual training on hitting performance in 46 participants (six groups). In these groups, multiple pitch speeds and types were utilized in 12 training sessions over four weeks. Kohmuara found that combining batting practice with visual training served as an effective way to improve batting ability and pitch recognition. Even though behavior analysis is not specifically mentioned in the work done by Kohmuara, behavior analytic principles can still be identified. As hitters adjust their swing or timing, shaping was used to reinforce successive approximations to the desired behavior (barrel percentage, contact percentage, etc.).

Cox (2017) analyzed the application of the matching law to pitch selection in professional baseball. The matching law quantifies the relation between relative responding and reinforcement rates. In the context of baseball, Cox (2017) aimed to identify if pitch selection for pitchers occurred due to previous hitter outcomes. For example, the pitch selection of a curveball may be reinforced more than a fastball if the curveball produces more desired outcomes ("getting the batter out"). This law was assessed for five professional baseball pitchers during the 2014 Major League Baseball (MLB) season and results showed that the generalized matching law was successful in describing pitch selection across a variety of game contexts. Limitations were due to the players' skill levels (four of the participants were sent to the minor leagues during the study), but the research showed potential for generalization for baseball in the natural context. Cox (2017) aimed to generalize the natural game environment by analyzing pitch selection from an array of multiple types of pitches.

Falligant et al. (2020) systematically replicated Cox (2017) by expanding to major league pitchers. Six different pitchers were selected into Group A ("higher-skilled" pitchers) and Group B ("lower-skilled" pitchers) from the 2019 MLB season. Results were like that of the original study, revealing that the generalized matching law is a robust descriptor of pitch selection and can be generalized to naturalistic settings (Falligant et al., 2020). Research of the generalized matching law relates to the current study as it can be used to affect the performance of hitters. If the most likely pitch selection can be calculated using the matching law, coaches can use this information to predict the most likely pitches for a given pitching group. Coaches can start training with the most likely array, building fluency before introducing additional pitches.

Stimulus Prompts

Stimulus prompting involves introducing a supplemental discriminative stimulus to elicit a response (Dietz & Malone, 1985). A stimulus prompt is designed to help the learner evoke a desired response. As part of the current research project, a blue coloring agent will be used to enhance the saliency of the red seams on the baseballs during intervention. The seams of the baseball provide a visual cue to the hitter that helps them in identifying the spin and trajectory of the ball. Providing a contrasting color around the seams of the baseball should help batters see the spin of the ball during flight. The stimulus prompt, the size of the coloring, will be reduced so that stimulus control is transferred back to the red seams of the baseball.

Stimulus Fading

Commonly applied in clinical treatment programs, stimulus fading, or prompt fading, involves gradually decreasing the saliency of the stimulus prompt which evokes a desired response (Martin & Pear, 2019). This procedure is used to transfer stimulus control from one stimulus to another, or one prompt to the relevant stimulus. Different than the term 'stimulus shaping', stimulus fading focuses on transferring control to one feature of a stimulus rather than an entirely new stimulus (Dietz & Malone, 1985). The intervention for the current study is labeled as stimulus fading as it aims to manipulate the color of the baseball seams versus the configuration of the seams.

Stimulus fading was selected for appropriate skill acquisition as previous research has revealed advantages over response prompting and simultaneous prompting strategies. In a review of prompt-fading procedures, Cengher et al. (2017) revealed that prompt-fading interventions were generally effective in producing skill acquisition. They also noted that stimulus prompting was shown to be more effective than response prompting. Dorry and Zeaman (1973) compared stimulus fading to a simultaneous prompting strategy when teaching vocabulary to individuals with disabilities. Two groups of nine children were used. Participants were first given a word list and taught using stimulus fading on the simultaneous prompting strategy. Next, both groups of participants were given a new set of words, and a simultaneous prompting strategy was used. After testing for acquisition, results revealed that participants learned more effectively using the stimulus fading procedure.

In clinical treatment, it has commonly been used to differentially reinforce an alternative response (DRA). Schlichenmeyer et al. (2015) used a stimulus fading procedure following the implementation of a DRA procedure to further decrease rates of problem behavior (e.g., screaming, aggression, etc.) while increasing rates of an appropriate alternative. On the other hand, stimulus fading has also been used and revealed significant effects when reinforcement was absent. Fields (2018) analyzed stimulus control with pigeons and results showed that six out of eight pigeons responded to the discriminative stimulus during fading when no reinforcement was provided. This suggests that reinforcement is not required for fading to be successful and that a respondent component may be present during stimulus fading. Reinforcement was absent during fading in the current study to assess the respondent effects of the intervention. Hitters do not usually receive immediate feedback or reinforcement when correctly identifying a pitch.

Fields et al. (1976) assessed the stages of acquisition in stimulus fading in pigeons using a stimulus fading procedure. Four naïve White Carneaux pigeons were first taught red-black discriminations by providing reinforcement under red stimulus conditions and extinction under black stimulus conditions. In the next condition, after one or two presentations of red, a white line was presented without scheduled consequences. Next, the red stimulus compound was faded out systematically until no responding occurred for the red stimulus and 95% or more responding occurred in the presence of the white line. Responses were then controlled by different white lines on a black background. Results showed that the lines did not evoke any responding before or after being faded in. Once the red stimulus faded out, control of responding was first acquired by the compound stimulus (red line), and then, by a characteristic of the new stimulus (orientation of the line). The original red stimulus did not lose control once reapplied even though the new white line stimulus acquired control. Results suggest that new stimuli acquired stimulus control in two stages. This was suggested by Ray and Sidman (1970), and Sutherland and Mackintosh (1971); first stage of stimulus control transfer including a compound of the original stimulus and new stimulus, with the original stimulus having control, and the second stage being that the new stimulus acquires control after the original is faded out.

Another use of a stimulus control transfer procedure was used by Doran and Holland (1979) when giving discrimination problems to sixteen children. Each participant was given the instruction to touch a circle in which reinforcement was provided. In subsequent sessions, the children were tasked to touch the same circle when presented with circles of different sizes and luminance. This methodology was used to assess whether the size of the circle, or the luminance of the circle, controlled participant responding. Two probes were given after ten trials of discrimination problems. The first included a circle of the same size but of different luminance. The second included a circle with the same luminance but of a different size. Results showed that when dual control was established, fading was successful. If only one variable controlled responding (e.g., luminance), then fading could not be properly established (e.g., size discrimination unnoticed).

Results from the stimulus fading research provide support towards the methodology of the current study. If dual control is required for proper fading, then multiple stimuli are required to be present at once during treatment. This was shown through the second intervention phase in which 50% of the baseball seams were manipulated, leaving blue and red stimuli on the ball. After successive intervention phases, the original stimulus from the first intervention phase was faded out leaving a second stimulus (natural seam color) with control over the response.

Training Using Stimulus Prompts and Stimulus Fading

Simek and O'Brien (1988) used a chaining-mastery, discrimination training program to teach little leaguers how to hit a baseball. This procedure involved delivering the baseball at a slow speed and short distance, and then when mastered, increasing the speed and distance to regulation standard (for little leaguers). The experimental and control group consisted of two teams with boys between the ages of eight and twelve. 10 boys from the experimental team were trained with the chaining-mastery intervention. The control team did not receive this training and toned their skills using standard practices at the regulation distance. Data was extracted at the end of the little league season for the control group. Results showed increases in batting average following the intervention phase for the experimental group, while the control group saw no increases. A discrimination training intervention was then used to teach hitters how to identify hittable balls (strikes). This included praising the correct response from the hitter and putting any incorrect responses on extinction. Results showed increases in 'walks' following the discrimination training. Also, batting averages for the experimental group increased consistently throughout both interventions. These results suggest positive impacts from using behavioral principles to increase pitch recognition skills. While the repeated practice that occurred during discrimination training may contribute to the overall results, discrimination training proved more effective than traditional training (Simek & O'Brien, 1988).

Osborne, Rudrud, and Zezoney (1990) utilized behavioral procedures by using visual cues to improve hitting a curveball. The subjects included five undergraduate varsity baseball players. An alternating treatments design was used to assess unmarked balls (natural) and two treatment conditions using 1/4 in. and 1/8 in. orange stripes. Results indicated that hitters had a higher contact percentage under the treatment conditions compared to the baseline condition, indicating that visual cues may be a vital tool to improving the performance of hitters. The participants also reported improvements in pitch recognition following the study (Osborne et al., 1990).

Osborne and colleagues also made two observations following analysis of the results of their study. First, the average of unmarked balls hit during the treatment conditions was lower than the average of unmarked balls hit during the baseline condition. Osborne attributed this difference to a contrast effect in which the more salient, orange-marked balls provided a stimulus that could be hit more proficiently compared to the unmarked balls. Additionally, the contrasting color of the markings may have had an effect on the spin or rotation that was perceived. This observation supports the methodology of the current study in which the seams were specifically manipulated. This adjustment would focus on enhancing visibility while also maintaining the natural spin, rotation, and trajectory of the ball.

The second observation made by Osborne et al. (1990) is how the mean increase in hitting marked balls was higher in the 1/4 in. condition compared to the 1/8 in. condition, revealing how the results did not maintain across treatment conditions. This was mentioned to systematically replicate the study, manipulating variables to isolate what is necessary or sufficient. Osborne et al. (1990) randomly alternated between conditions out of the 20 balls recorded in a session. This brings concerns about the fading procedure as it is rapid and may not result in proper discrimination. The current study addresses this by separating treatment conditions into blocked trials. Each condition had three sessions across one day which allowed for slower stimulus fading. Even though multiple pitches were used, the saliency of the markings remained the same across intervention sessions.

Purpose of Current Study

Baseball is one of the few games that kids from any background can play; however, the skill level of baseball players can be enhanced through coaching and training. The science of behavior has been used to identify effective methods for training and refine the behavior of athletes across sports (Schenk & Miltenberger, 2019). The current study analyzed the pitch recognition of hitters by using two behaviorally based procedures (a) stimulus prompts and (b) stimulus fading.

Investigators designed the current project to task analyze and teach pitch recognition to baseball batters. Investigators hope to evaluate stimulus fading on the accuracy and quickness of recognizing a pitch. Latency was used as a measure as pitch recognition and subsequent batter responses are time sensitive – fluency and a quick response is critical in identifying a pitch and taking the appropriate actions to hit the ball. Improving the 'eye' in hand-eye coordination is one small step to maintaining the excitement and thrill that the game of baseball has to offer.

Osborne et al., (1990) focused on using visual stimuli to shape hitting techniques. The current study proposed to use visual stimuli so that pitch recognition can be improved for collegiate level athletes. By assessing pitch recognition in isolation, validity issues concerning the participants' effort level over time can be controlled. Another vital difference to be discussed between the studies includes the use of colored stimuli, which focuses on increasing the magnitude of the discriminative stimulus so that hitter may quicker recognize the pitch. Visual prompts were then faded until the naturalistic setting (no color manipulation) is present. Each hitters' swing is compiled of many variables that can essentially affect their contact percentage (timing, stance, etc.). To eliminate errors of internal validity, solely pitch recognition was assessed. Multiple variations of pitches were added to attest to resemble a more natural game environment. Blue coloration was also used, instead of orange, to provide a more salient stimulus (Osborne et al., 1990). The changes to be made in the replication of Osborne et al. (1990) aimed to better analyze the effects of ABA on a hitter's skills so that performances may generalize to game scenarios.

Chapter 2

Method

Participants

The principal investigator recruited five male baseball players from the Florida Institute of Technology varsity baseball team. All were informed of the purpose of the study. Player ages range from 20-23 (μ =21). All subjects were "position players" – nonpitchers who play one of the other eight positions on the field and who frequently participate in hitting. Pitchers were excluded from the selection criteria as they do not participate in hitting at the collegiate level and do not use this skill in games (social validity). Additional exclusion criteria included participants with colorblindness as color manipulation is the focus of the intervention. The average years of experience was 15 years (see Figure 1). All competed in travel baseball leagues, playing year-round with only small periodic breaks in practices and tournaments for several years. All five players also received individual hitting instruction but none of the participants received specific instruction in pitch recognition. Upon completion of the study, participants received a $10 gift card to the restaurant of their choice for partaking. Each participant had the option to discontinue their participation at any time throughout the study without penalty.

Measures

The measures for the current study included latency to pitch recognition, and percent correct.

Latency is the time from the offset of a stimulus to the onset of the response. To maximize accuracy of the latency measure, audio was recorded using Voice Memos to identify when the pitch is ejected from the machine and when the hitter recognizes the pitch using a clicker. Voice Memos is an application available to all owners of an iPhone that captures and stores audio. For this study, an iPhone 13 Pro was used to run this application. The software used for data analysis was also Voice Memos, as it has a built-in timer that records time to the hundredths of a second. This allows for more precise data collection. Two audio cues need to be captured to calculate latency. First, being the audio from the pitching machine (ball ejection), and second, being the audio from the clicker from which the participant used to identify the pitch. The time between these two audio cues was analyzed in Voice Memos using the editing software. A shorter latency translates to quicker pitch recognition as the hitter can identify the pitch faster.

Accuracy was the second measure, as quicker pitch recognition is not valuable unless accurate. Each hitter held a clicker in their hand and was instructed, “Click for ___ (the particular pitch). The data collector marked correct if the participant clicked for the target pitch and when refraining from clicking for a pitch other than the target pitch. The data recorder marked incorrect if the participant clicked for a pitch other than the target pitch or when they failed to click for the target pitch.

Research Design

Researchers utilized a multiple-probe technique, a variation of the multiple-baseline across participants single case research design. Visual analysis was conducted within phases, across phases, and across tiers. This variation was used to better analyze the initial levels of performance for each phase of the intervention as well as the across-phase comparisons. It also helped in analyzing each participant's results before and after training was applied (Horner & Baer, 1978). The use of randomized pitches produced the need for averaged results as there were a different number of target pitches per session. Averaged results produced a visual similar to a probe-like design in which performance could be analyzed across phases. Comparisons were made within each participant's results as well as between test and control participants.

Setting and Materials

Sessions were conducted in the batting cages on the Florida Institute of Technology campus. The pitching machine used was a Junior Hack Attack. This machine specializes in delivering fastballs, curveballs, changeups, etc., and only requires dials to be adjusted to alternate between different pitches. Within a few seconds, the machine can be adjusted to a different pitch. The machine was placed at the regulation distance away from the hitter (60ft, 6 in). The baseballs used were Wilson A1030s, the official ball used in Division II Sunshine State Conference game play replicating the naturalistic (game) stimulus. The type of baseball remained the same over the study to account for validity concerns. The visual prompt used in the intervention requires a blue neon acrylic paint that covered the seams. Blue was used so that the visual is different and salient compared to the natural seam color (red). An alternative machine was also turned on to provide background noise to account for any patterned noise that the pitching machine made when adjusting to different pitches. Participants also wore noise-cancelling headphones in case the background noise did not control for the differential noise of the pitching machine across different pitches.

Procedures

A modified multiple baseline across participants was used in the study. In this experimental design, baseline(s) will be staggered which also staggers the implementation of the intervention. The results are compared between each subject's baseline and intervention data. By doing so, validity concerns will not arise regarding each hitter's response times and their previous learning histories of recognizing pitches. This design was also chosen to have a built-in control group.

Each participant progressed to intervention phases at a different point throughout the study to account for learning effects. The modification of the multiple baseline design involved the baseline for the first participant to be a single session with the remaining three participants being exposed to two baseline conditions. This was done primarily due to accommodate the schedule of the participants and the time demands of collegiate athletes. The multiple baseline design helped identify whether a hitter has shorter latency measures due to the intervention or due to the time engaging in the target behavior. Participant 5 served as the control participant and did not have intervention data.

Verbal Instructions

During baseline and intervention phases, players entered a covered, lit batting cage and were read a script. The primary researcher stated, "You are about to see some pitches while in the batter's box. The pitch will either be a curveball, fastball, or changeup." A fastball is the most frequent pitch used in baseball. It is the fastest of the three and has a straight trajectory. A curveball is thrown much slower than a fastball and has a downward diagonal movement pattern. If the pitcher is right-handed, the diagonal pattern will start at their right hand (release point) and finish down and to the right of that release point. If the pitcher is left-handed, the diagonal pattern will start at their left hand and finish down and to the left of that release point. For the current study, a right-handed pitcher will be simulated. A changeup is typically thrown at a velocity in between a fastball and a curveball. Its movement pattern is typically downward and slightly to the opposite side of the pitcher's release point (Pitch Types | Glossary | MLB.com, n.d.). So, for the current study, the change-up will move downward and slightly to the right from the hitter's point of view.

The researcher continued to state, "You will stand in your normal batting stance, but you will not swing at the pitch. Each session will have a target pitch which you will solely be looking for. Out of three sessions, one will be a fastball, one will be a curveball, and the last will be a change-up. Your job is to 'click' the clicker when you recognize the target pitch that was ejected from the pitching machine. 'Click' as fast as possible once you recognize the target pitch." The players wore helmets to replicate practice and game conditions, as well as to ensure participant safety. Bats were not held as participants would not be able to engage in the target behavior. The machine delivered pitches in 10-second intervals (intertrial interval). This interval allows time for the operator of the machine to switch to a different pitch (if necessary). If the pitch type did not change, the feeder pretended to adjust the dials so that participants could not pick up any differences. Pitches were randomly assigned using a randomizer (randomizer.org). The operator of the machine followed the random assignment of pitches, which was created in entirety before the trials began.

Each batting session consisted of 12 pitches with each participant receiving three sessions per day. Audio of each session was recorded, and latency was measured from the time the pitch is ejected to when the hitter provides a response using the clicker. Accuracy was also recorded. Between each batting session, participants would exit the cage area to help avoid players observing marked balls prior to them entering the specific baseline or experimental condition.

Baseline

During baseline, no color manipulation was used. Each pitch consisted of a standard Wilson A1030 baseball. 12 pitches were given for each session. Audio, as well as accuracy, were recorded throughout the session. Three out of five participants had an additional baseline session to account for the multiple baseline design. The control participant remained in baseline and had five baseline sessions.

Intervention

During the visual training sessions, 12 marked balls were presented for each session (blue coloration). Players ‘clicked’ once they recognized the target pitch, and it was scored as “correct” or “incorrect.” There were three intervention phases. The color of the seams was manipulated as they assist the hitter in recognizing the spin and trajectory of the baseball. Spin and trajectory both assist the hitter in identifying which pitch was ‘thrown’. Blue coloration was used as it is abnormal to the Wilson A1030 baseballs. An abnormal color is used with the intention to make the visual stimulus more salient.

The first intervention phase included painting 100% of the seams blue and testing. The second included painting 50% of the seams, and the third included painting 25% of the seams. Systematically decreasing the surface area of the colored baseball seams exemplifies the visual prompts that were faded. After the intervention sessions concluded, a maintenance probe was run (no manipulation) to compare with the original baseline results of each participant.

Social Validity

A social validity questionnaire was given to all participants after the completion of the study. This was provided to assess how each participant valued the study and its effects on their pitch recognition skills (see appendix A).

Interobserver Agreement (IOA)

A staff member from the School of Behavior Analysis at the Florida Institute of Technology served as a second observer to calculate interobserver agreement (IOA), a measure of credibility. Agreement meant both observers recorded a correct or incorrect response for a particular pitch trial. Trial-by-trial IOA data was collected by counting the number of agreements over the total number of trials. There were 900 total pitches delivered in the study, with 648 observed by two observers for 72% of sessions. Overall, IOA was 98%. The results for each participant are as follows: Participant 1's agreements were 139 of 144, an IOA of 97%; Participant 2 agreements were 209 of 216, an IOA of 97%, Participant 3 agreements were 189 of 192, an IOA of 98%, Participant 4's agreements were 24 of 24, an IOA of 100%; Participant 5's agreements were 71 of 72, an IOA of 99%.

Chapter 3

Results

Pitch Recognition Accuracy

Figure 2 visually displays each participants' accuracy when identifying pitches across baseline, intervention, and probe phases.

Participant 1 received only one baseline session followed by three intervention sessions and one maintenance probe. In baseline, the average accuracy for the fastball was 92%, curveball 66%, and changeup 75%. When in the first intervention phase (100% of seams colored), the average accuracy for the fastball was 75%, curveball 92%, and changeup 50%. When in the second intervention phase (50% of seams colored), the average accuracy for the fastball was 66%, curveball 83%, and changeup 92%. When in the third intervention phase (25% of seams colored), the average accuracy for the fastball was 92%, curveball 66%, and changeup 66%. In the final maintenance probe, the average accuracy for the fastball was 75%, curveball 83%, and changeup 100%.

Participant 2 received two baseline sessions followed by three intervention sessions and one maintenance probe. In the first baseline, the average accuracy for the fastball was 75%, curveball 50%, and changeup 42%. In the second baseline, the average accuracy for the fastball was 83%, curveball 92%, and changeup 66%.

When in the first intervention phase (100% of seams colored), the average accuracy for the fastball was 92%, curveball 66%, and changeup 58%. When in the second intervention phase (50% of seams colored), the average accuracy for the fastball was 83%, curveball 75%, and changeup 58%. When in the third intervention phase (25% of seams colored), the average accuracy for the fastball was 92%, curveball 75%, and changeup 75%. In the final maintenance probe, the average accuracy for the fastball was 92%, curveball 66%, and changeup 92%.

Participant 3 received two baseline sessions followed by three intervention sessions and one maintenance probe. In the first baseline, the average accuracy for the fastball was 66%, curveball 92%, and changeup 75%. In the second baseline, the average accuracy for the fastball was 92%, curveball 100%, and changeup 66%. When in the first intervention phase (100% of seams colored), the average accuracy for the fastball was 100%, curveball 100%, and changeup 92%. When in the second intervention phase (50% of seams colored), the average accuracy for the fastball was 92%, curveball 100%, and changeup 66%. When in the third intervention phase (25% of seams colored), the average accuracy for the fastball was 92%, curveball 100%, and changeup 92%. In the final maintenance probe, the average accuracy for the fastball was 92%, curveball 92%, and changeup 100%.

Participant 4 received two baseline sessions followed by three intervention sessions and one maintenance probe. In the first baseline, the average accuracy for the fastball was 50%, curveball 75%, and changeup 66%. In the second baseline, the average accuracy for the fastball was 50%, curveball 58%, and changeup 50%. When in the first intervention phase (100% of seams colored), the average accuracy for the fastball was 75%, curveball 75%, and changeup 66%. When in the second intervention phase (50% of seams colored), the average accuracy for the fastball was 75%, curveball 58%, and changeup 50%. When in the third intervention phase (25% of seams colored), the average accuracy for the fastball was 92%, curveball 83%, and changeup 58%. In the final maintenance probe, the average accuracy for the fastball was 66%, curveball 66%, and changeup 92%.

Participant 5 received five baseline sessions. Participant 5 served as the control participant as they maintained a consistently high accuracy across all baseline sessions across all pitch types. In the first baseline, the average accuracy for the fastball was 66%, curveball 58%, and changeup 58%. When in the second baseline, the average accuracy for the fastball was 100%, curveball 100%, and changeup 92%. When in the third baseline, the average accuracy for the fastball was 92%, curveball 92%, and changeup 83%. When in the fourth baseline, the average accuracy for the fastball was 83%, curveball 92%, and changeup 92%. In the final baseline, the average accuracy for the fastball was 92%, curveball 100%, and changeup 92%.

Pitch Recognition Latency

Figure 3 visually displays each participants' latency when testing their ability to identify pitches across baseline, intervention, and probe phases. A lower latency value represents quicker recognition of the pitch.

During baseline, Participant 1's average latency for the fastball was 0.37, curveball 0.38, and changeup 0.36. When in the first intervention phase (100% of seams colored), the average latency for the fastball was 0.37, curveball 0.36, and changeup 0.32. When in the second intervention phase (50% of seams colored), the average latency for the fastball was 0.28, curveball 0.38, and changeup 0.38. When in the third intervention phase (25% of seams colored), the average latency for the fastball was 0.32, curveball 0.38, and changeup 0.49. In the final maintenance probe, the average latency for the fastball was 0.27, curveball 0.36, and changeup 0.32.

During baseline, Participant 2's average latency for the fastball was 0.28, curveball 0.34, and changeup 0.34. In their second baseline, the average latency for the fastball was 0.25, curveball 0.32, and changeup 0.36. When in the first intervention phase (100% of seams colored), the average latency for the fastball was 0.25, curveball 0.32, and changeup 0.40. When in the second intervention phase (50% of seams colored), the average latency for the fastball was 0.34, curveball 0.34, and changeup 0.29. When in the third intervention phase (25% of seams colored), the average latency for the fastball was 0.26, curveball 0.33, and changeup 0.30. In the final maintenance probe, the average latency for the fastball was 0.16, curveball 0.26, and changeup 0.32.

During baseline, Participant 3's average latency for the fastball was 0.33, curveball 0.37, and changeup 0.44. In their second baseline, the average latency for the fastball was 0.34, curveball 0.41, and changeup 0.36. When in the first intervention phase (100% of seams colored), the average latency for the fastball was 0.40, curveball 0.28, and changeup 0.44. When in the second intervention phase (50% of seams colored), the average latency for the fastball was 0.35, curveball 0.35, and changeup 0.39. When in the third intervention phase (25% of seams colored), the average latency for the fastball was 0.32, curveball 0.35, and changeup 0.39. In the final maintenance probe, the average latency for the fastball was 0.36, curveball 0.36, and changeup 0.34.

During baseline, Participant 4's average latency for the fastball was 0.24, curveball 0.23, and changeup 0.25. In their second baseline, the average latency for the fastball was 0.27, curveball 0.33, and changeup 0.34. When in the first intervention phase (100% of seams colored), the average latency for the fastball was 0.21, curveball 0.24, and changeup 0.25. When in the second intervention phase (50% of seams colored), the average latency for the fastball was 0.25, curveball 0.27, and changeup 0.31. When in the third intervention phase (25% of seams colored), the average latency for the fastball was 0.22, curveball 0.32, and changeup 0.30. In the final maintenance probe, the average latency for the fastball was 0.31, curveball 0.23, and changeup 0.20.

During baseline, Participant 5's average latency for the fastball was 0.30, curveball 0.59, and changeup 0.40. When in the second baseline, the average latency for the fastball was 0.28, curveball 0.35, and changeup 0.38. When in the third baseline, the average latency for the fastball was 0.30, curveball 0.31, and changeup 0.36. When in the fourth baseline, the average latency for the fastball was 0.24, curveball 0.29, and changeup 0.34. In the final maintenance probe, the average latency for the fastball was 0.30, curveball 0.36, and changeup 0.40.

Social Validity

Each participant was provided with a questionnaire comprised of eight Likert-scale questions. Answer options included strongly disagree (1), disagree (2), neutral (3), agree (4), and strongly agree (5). All participants completed the questionnaire. Participant 5 did not provide answers to the questions involving the treatment condition as this participant remained in baseline throughout the study. When asked whether the intervention was an acceptable way to increase the pitch recognition skills of a hitter, the mean score was 4.75 (4-5). When asked if participants would use this intervention in future training, the mean score was 4.75 (4-5). The mean score when rating their enjoyment of the procedures was 4.75 (4-5). When rating the efficiency of the intervention to increase pitch recognition skills, the mean score was 4.75 (4-5). For the simplicity of the intervention, participants had a mean score of 5. When asked if participants could envision this training used for hitters of all ages, the mean score was 4.8 (4-5). When asked if this intervention worsened or had no effect on their pitch recognition skills, the mean score was 2 (1-4). When asked if participants recommended this training to be used by others, the mean score was 4.8 (4-5).

Chapter 4

Discussion

The current project adds to the growing literature on the use of behavioral science to improve athletic performance. The use of stimulus prompts to increase pitch recognition was effective, and the fading of the stimulus prompt to the natural stimulus properties of the baseball was completed but may require further refinement. The latency between pitch release and pitch recognition should be targeted by coaches and should be the focus of future replications of the current research. Future directions are offered to help players and coaches make informed decisions about training procedures to increase pitch recognition at latencies that correspondent to the average pitch speeds found across playing levels (e.g., little league vs. collegiate). While the current study showed promising results, a ceiling effect was noted. The limitations and applications of the current research project are discussed for both research and application.

The results from this study support the findings from Osborne et al. (1990) in which visual prompts positively impacted the skills of a hitter. Although the results for some participants did not show the effects of stimulus fading, it can be supported that the addition of a stimulus increased the level of performance across all pitches. Areas of future research mentioned by Osborne et al. (1990) included the generalization of their results to other pitches, the rate of fading cues, and the training procedures used. This study not only addressed these limitations by using other pitches and by fading the enhanced stimulus, but also by eliminating the physical aspect of hitting and focusing on pitch recognition itself. In addition, this research also isolated the stimulus on the baseball that hitters have been trained to identify (seams). It can be argued that fading the stimulus would be simpler when fading the intensity of the seams versus the painted stripes that were introduced in Osborne et al. (1990). The present study also used a control participant, unlike Osborne et al. (1990), to assess whether performance was impacted over repeated trials. Since the current research provided results that oppose the use of a visual prompt intervention, it can be argued that the treatment from Osborne et al. (1990) may not have impacted curveball hitting as intended due to the lack of a control for repeated trials.

The use of a clicker to signal pitch identification served as a good analogue for pitch recognition. A hitter must respond very quickly to the stimulus of a pitched baseball. If the hitter had to use vocals or use a bat to contact the ball, other variables would arise that would affect the credibility of the study. Training one's pitch recognition skills using a clicker can be an example of breaking down the components of a swing (visual vs. physical) allowing researchers to target a specific behavior dimension.

Participant 1 showed decreases in latency across all three pitches indicating quicker pitch recognition when the stimulus prompt was added. The results for stimulus fading was mixed; however recognition of the change-up and curve ball were more accurate post intervention. Accuracy of pitch recognition may be less crucial than latency at the collegiate level. That is, a collegiate batter needs to make a rapid response when the pitch is thrown, and if the response requirement (i.e., to swing at the pitch) is the same across two pitch types, latency may be deemed more significant.

Participant 2 also showed decreases in latency across all three pitches, suggesting quicker pitch recognition. Intervention results for latency suggest that the enhanced stimulus may not have significantly impacted the results for this participant. The enhanced stimulus positively impacted the accuracy of pitch recognition for participant 2 as accuracy increased, from baseline to intervention. However, accuracy decreased when the stimulus prompt was faded.

Participant 3 showed decreases in latency for the curveball and changeup, suggesting quicker pitch recognition for those pitches. Latency for the fastball was not as affected. Participant 3's results for latency suggest that the enhanced stimulus may have significantly impacted the results for the curveball for this participant as an increasing trend highlights the theorized effects of the intervention. In opposition, the fastball and changeup's decreasing trends raise concerns regarding the effects of the intervention; repeated trials, machine reliability, or the use of an unnatural stimulus are potential explanations for these results. Between baseline and probe phases when assessing accuracy, participant 3 showed increases when recognizing the fastball and changeup. The fastball stayed above the mastery criteria of 90%.-Results from the intervention data suggest that the enhanced stimulus may have positively impacted the accuracy of the participant, as shown by increased accuracy that was maintained post-intervention.

Participant 4 showed decreases in latency for the curveball and changeup, but not the fastball. When it comes to participant 4's intervention data for latency, the results suggest that fading the enhanced stimulus may have significantly impacted the results for this participant. This is shown by the increases in latency as the stimulus was faded away. Participant 4 also showed increases in accuracy when recognizing the fastball and changeup and decreases in accuracy when recognizing the curveball. When analyzing accuracy data during the intervention phases, the fastball and curveball revealed no trend and high variability. High variability questions the power of the stimulus for this participant as its effects are unknown. Increases in accuracy are shown post-intervention for two out of three pitches, suggesting that the intervention itself had less effect on their performance compared to repeated trials, or other external variables. Accuracy significantly increased in the 25% condition, though, which also suggests that the participant may have taken longer to attend to the novel stimulus.

Participant 5 served as the control for the study and remained in baseline throughout its duration. When analyzing their latency data, results revealed slightly decreasing trends with low variability across all pitches. This suggests that through repeated trials, latency may decrease, without the use of stimulus prompts. While stimulus prompts were associated with increased accuracy and pitch recognition for the participants, the efficacy of intervention needs to supersede the effects of repeated practice.

Participants expressed their support for the usage of the stimulus fading intervention as social validity results revealed strong agreements. Inter-observer agreement between two observers was also strong (98%) across 72% of sessions.

Limitations

As there are many takeaways from the current research, there are also limitations to address that may have affected results. First, each participant actively used their pitch recognition skills outside of treatment, both in practice and games. Anecdotally, the primary researcher noted that each hitter engaged in 'hitting' six days a week throughout the treatment process. Three of those six days were typically during collegiate level games. The researcher was not able to control for practice effects or participants using pitch recognition outside of sessions. No stimulus prompts were used during collegiate games and the fading sequence continued as planned by the principal investigator. This led to the modification of the multiple baseline design, though, as practice, game-time commitments, and academics limited the availability of the participants. Similarly, the number of baseline sessions had to be adjusted.

In addition to consistently seeing pitches, each participant had years of experience seeing pitches and training their skills. Results may not have large differences as these players all had prerequisite pitch recognition skills. The use of a younger population may result in larger increases in accurate pitch recognition. Participants also have advanced repertoires as they can identify more than three pitches that the study included. For example, during the curveball session, a player failed to click and said, “That was a slider,” a pitch whose spin closely resembles that of a curveball. The players were informed of the three pitches being assessed and, as aforementioned, received instruction, “Click for a curveball” but the amount and/or type of spin combined with the developed visual recognition of the players may have periodically resulted in demonstrating responses outside of those being evaluated in the study. Coaches who used stimulus prompts and prompt fading should choose disparate pitches, at least during initial training.

Another limitation is created from the use of repeated trials. This threat to internal validity exists due to the repeated testing of the participants' pitch recognition skills. It is possible that hitters decreased their pitch recognition latency/increased their accuracy from repeated practice as likely as it is from the effects of the intervention. This possibility was evident from using a control participant, which revealed increases in performance across baseline sessions. It can be argued, though, that each participant may have responded differently to the stimulus fading intervention.

The use of a pitching machine also provided much variability in the spin and trajectory of a pitch. Multiple participants reported variation in the curveball, as some pitches were ejected faster, and spun harder, than other curveballs. The distinction between fastballs and changeups was also noticed by hitters as some fastballs were delivered with less spin than other fastballs, producing the look of a changeup. This may have forced hitters to shift their focus towards the velocity of the pitch versus the spin and trajectory of the pitch. The inconsistency of the pitching machine serves as a limitation to the study, but it could also be argued that it provides a more game-like situation, as pitchers can also be inconsistent with the spin, trajectory, and velocity of their pitches as they produce pitches coming at different release points, arm angles, and speeds. Calibration of the pitch machine is a consideration for coaches who teach pitch recognition.

The use of paint on the seams may have contributed to inconsistencies in spin and trajectory. Spin is created from the pitching machine's wheels that eject the baseball. As paint was applied to the seams, it may have created a smoother, slicker surface that limits the friction of the machine-to-baseball contact. Thus, affecting the spin. Coaches need to make sure all stimulus prompts surround the seams but are not applied directly to the seams of the baseball.

Future Research

Additional replication of stimulus prompting and stimulus fading as an instructional procedure for teaching pitch recognition is needed. One direction could focus on a certain participant's low performance area. For example, participant 2 had higher accuracy and lower latency when the target pitch was the fastball, compared to the other pitches. In future research, the researcher could target the other pitches and develop a shorter training geared to improve performance to that pitch. For that player, stimulus fading for the curveball and changeup might be employed. This would be dependent on the participant's results as each participant had specific results for each measure. In addition, researchers could also change the sequence of intervention so that each target pitch was intervened on before transitioning to another pitch. For example, after conducting baseline for a fastball, immediately transition to the stimulus fading intervention before testing the baseline for the curveball, or changeup. This may assist with the transfer of stimulus control when using stimulus fading.

In addition, researchers could also transition to a specific intervention phase based on a fixed result that is generated during the baseline phase. For example, since participant 3 had baseline results just below mastery criteria, they could transition into the 25% intervention phase to assess whether it would produce mastered results, omitting the 100% and 50% interventions. This would make fading simpler and potentially more efficient as there would be less of a stimulus to fade away. The full intervention could be given to performers who scored 10% or lower than mastery criteria.

Another direction of future research would be to alter the coloring of the seams to a color not used in this study. The current study used blue paint as the discriminative stimulus, but other colors could be used to see if there is one that has a more significant effect. This also would be dependent upon the participant as each participant may have different reactions to different colors. In addition, the form of the color manipulation could be adjusted to account for confounds created by using paint (spin inconsistency). Instead, researchers could consult with baseball manufacturers to produce baseballs that have blue seams instead of red. Baseballs resembling the stimulus fading intervention could also be produced. Although more costly, these baseballs would account for using paint that provides limitations to the research. Paint manipulation would also be more temporary compared to the lengthened lifespan of a typical baseball.

The form of pitch delivery could also be changed. A pitching machine can simulate a pitcher throwing a particular pitch, but it does create inconsistencies when it comes to the spin, trajectory, and velocity of the ball. When using a live pitcher, though, it would be important to develop the methodology in which fatigue would be accounted for. A pitcher can only throw a certain number of pitches over the course of a session with consistency and accuracy, so a longer treatment period would be required. The same pitcher would have to be used to account for the variation in pitch spin, trajectory, and speed.

Another direction of future research could be to conduct the study outside of the baseball season. This would allow the opportunity for more extended baseline conditions and the implementation of intervention only after baselines stabilized. The “offseason” as it is called would enable more extended data collection and, consequently, more experimental control. Additionally, a researcher would gain a better grasp of the effects of the intervention by accounting for validity concerns that arise when practicing ‘hitting’ on a consistent basis outside of the treatment period.

Collegiate baseball players have pitch recognition skills that have little room for improvement. This “ceiling” effect may be less likely if younger, less experienced players were included in the current study. With a younger population, larger, more significant results could be acquired. This could also account for the participants’ learning histories. Suggested populations include those who have less experience than the current participants who also see a variety of pitches in the game. Youth participants (ages 12 and under) typically would not require the need for recognizing different pitches as curveballs and changeups are rarely used at that age.

During data collection, Participant 4 vocally corrected his mistakes by saying, “That wasn’t a ___ (whatever pitch he clicked for). That was a ___.” Throughout all sessions, Participant 4 self-corrected 21 times. Had experimenters allowed for correction, results may have been closer to mastery criteria. The rationale behind not counting the correction as correct responding was based off the idea the hitter must recognize a pitch and begin swinging in far less than 1 second. It is unrealistic to think one can recognize a pitch and attempt to self-correct in that brief window, demonstrating the use of the clicker as a solid indicator of pitch recognition. This opens the door to using feedback as an area of future research. Praise or other types of reinforcement could be provided to participants for correct/faster responses to pitches. Also, corrective feedback could be given if the participant answers slowly or incorrectly, and error correction could be used to intervene on the trial. Results from this proposed intervention could be compared to that of the stimulus fading intervention.

Conclusion

In summary, the accuracy and latency of a hitter were evaluated when introduced visual prompts were faded. This research was an extension of Osborne et al. (1990) in which discrimination training and prompt fading were used to increase the contact percentage of hitting curveballs. In the current study, other pitch types were used, the intervention was fully faded, and the visual aspect of hitting (pitch recognition) was isolated for validity concerns. Results varied across participants, as some showed decreases in latency while others showed increases in accuracy. These results were dependent upon the participant, measure, and pitch type. An exposure effect was probable as participants showed increases in performance throughout baseline and intervention data. The control participant also showed improvements in performance, but their results stabilized after the first session, calling for an elongated study. It can be argued that performance may have also improved due to the stimulus intervention as the intended results were also seen. Overall, the results of the intervention provide support for the use of stimulus fading in improving a hitter's pitch recognition skills.

Limitations were seen regarding the inconsistencies from the pitching machine, the paint manipulation, and the use of participants with advanced repertoires and learning histories. Also, the consistent practice and repetition of their pitch recognition skills may have had an influence on results. These limitations provide opportunities for future research, which include changing the form of pitch delivery or the color of the enhanced stimulus. Other populations or settings of research could also be pursued. The stimulus fading intervention could also be manipulated to address low or high performers, depending on where they struggled or thrived, and the length of treatment could be altered to fit each participant's needs.

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Figure 1

Years experience playing baseball

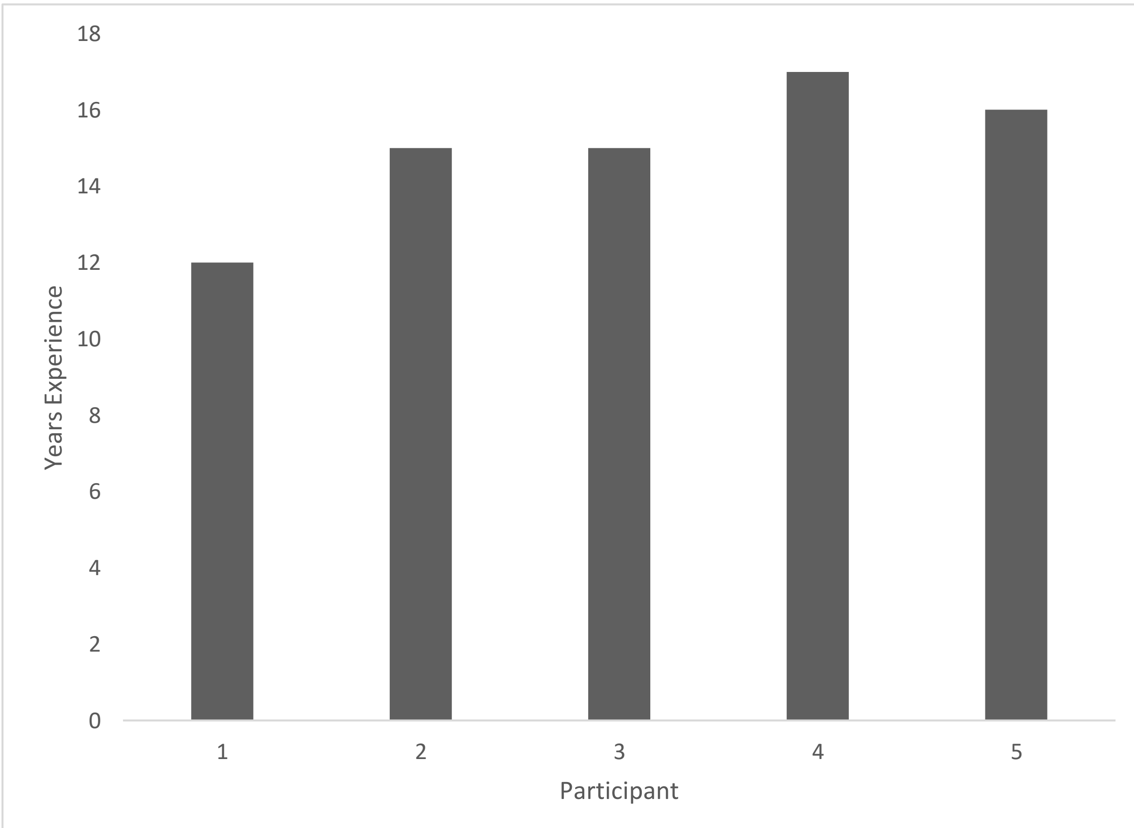


Figure 2

Results of the accuracy measure

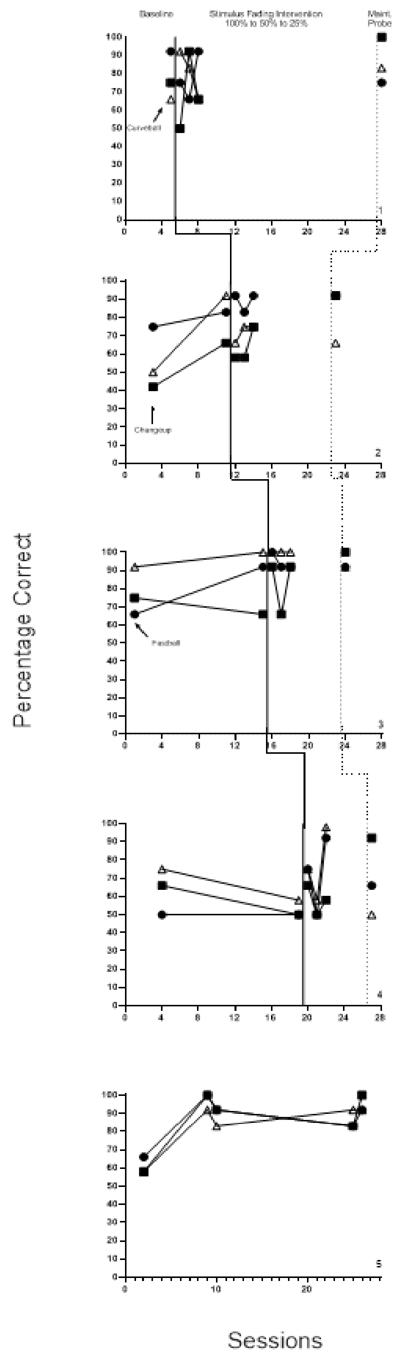
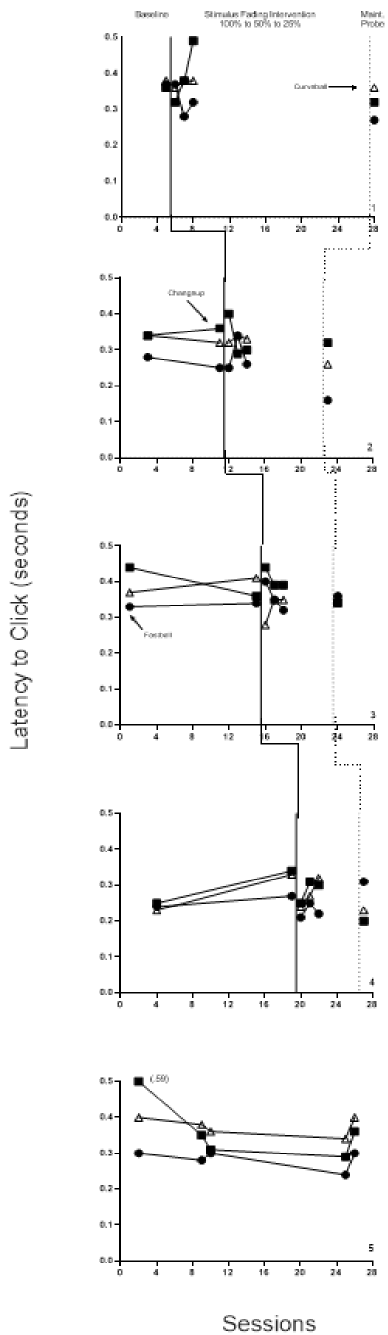


Figure 3

Results of the latency measure



Appendix

Social Validity Questionnaire

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I find this intervention to be an acceptable way of increasing the pitch recognition skills of a hitter					
I would be willing to use this intervention in future trainings					
I like the procedures used in this intervention					
I believe this intervention is effective in increasing my pitch recognition skills					
I believe that this intervention was easy and simple to use					
I believe that this training can be useful for hitters of all ages					
I believe that this intervention worsened or did not affect my pitch recognition skills					
I would recommend this training to be used by others					