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Mark R. Dixon
Southern Illinois University, mdixon@siu.edu

Kelly N. Paulson
Southern Illinois University

Becky L. Nastally
Southern Illinois University

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RECREATIONAL AND PATHOLOGICAL GAMBLERS' PREFERENCES FOR SLOT MACHINES YIELDING UNEQUAL REINFORCEMENT

Mark R. Dixon, Kelly, N. Paulson, and Becky L. Nastally
Southern Illinois University

The present study examined the effects of relational training and the transformation of stimulus function on the slot machine preferences of non-problem and problem gamblers. In order to extend previous research, the present study programmed the slot machines with unequal payouts values and employed a relational training reversal phase in order to enhance experimental control. Results showed no significant differences between the response allocations of non-problem and problem gamblers; however, results did indicate significant differences in response allocations between the three slot machine tasks.

Keywords: gambling, slot machine, relational frame theory, addiction

Contemporary behavior-analytic accounts of gambling have questioned the degree to which direct contingencies of reinforcement can fully account for this behavior. Having a verbal repertoire has been suggested to have a large impact on gambling behavior (Dixon & Delaney, 2007), and empirical demonstrations have mostly evaluated the repertoire's effects of response allocation across concurrently available games (e.g. Hoon Dymond, Jackson & Dixon, 2008). A concurrent slot-machine paradigm has frequently been used to initially assess preference of a player among a series of games. Following a baseline evaluation of the player's response allocation, often a comparative relational-training procedure is implemented with hopes of altering subsequent response allocation to the concurrent slot machines in the absence of any direct contingency manipulations. The "shifts" in responding across the games by a player from the initial baseline exposure to the post-relational training procedure have been claimed to be due to a transfer or transformation of stimulus functions (Hoon et al., 2008; Zlomke & Dixon, 2006).

This phenomenon suggests that the function of a stimulus that is developed in one context may transfer or transform to a novel context sharing some stimulus properties to the original context. For example, in the Zlomke and Dixon (2006) study, participants completed a slot machine pretest to evaluate their preferences between two concurrently available slot machines, one yellow and one blue. Each slot machine was programmed on a random-ratio (RR) schedule of reinforcement with a winning probability of .50. Following the slot machine pretest, participants completed a conditional-discrimination-training phase for the relations of greater than and less than. Three comparison stimuli were presented on a colored panel (yellow or blue) underneath a sample stimulus. Participants were differentially reinforced for selecting the "greater than" comparison stimulus when the panel color was yellow and the "less than" comparison stimulus when the panel was blue. During a test phase, three novel stimulus sets were combined with the three trained

Address Correspondence to:
Mark R. Dixon
Behavior Analysis and Therapy Program
Rehabilitation Institute
Southern Illinois University
Carbondale, IL 62901
Email: mdixon@siu.edu

stimulus sets; however, no feedback was provided to the participants. A post-test that was identical to the slot machine pretest assessed whether participants allocated more responses to the yellow slot machine following the conditional discrimination training. Results showed that 8 of the 9 participants allocated more responses to the yellow slot machine following the conditional discrimination training; therefore, results suggested that the function of the yellow and blue contextual cues established during the conditional discrimination training transferred to the colors of the slot machines for the majority of participants.

Hoon, Dymond, Jackson, and Dixon (2007; 2008) conducted a total of four experiments to replicate and extend the findings of the original Zlomke and Dixon (2006) study. The variations here included only two comparison stimuli, stimulus sets unrelated to gambling, a sorting task of stimuli into "bins" prior to exposure to the post slot machine choice task. Similar results to the original study were found. An additional replication by Johnson and Dixon (2009) extended the external validity of the original Zlomke and Dixon (2006) findings by having seven children play a computerized racecar game. The children were given the instructions to earn as many points as possible and that to earn points they had to beat the computerized racecar to the finish line. Children were given the choice of rolling either a red or blue die on each turn. The two dice were identical except for the color and were both programmed to randomly generate a number between one and six. The participants were then exposed to a relational training condition in which the colors of the two dice were used as contextual cues to train the relations of greater than and less than. Following a sorting task, the children played the computerized car game again. Results showed that 6 of the 7 children allocated the majority of their responses to the red die during the second game exposure, which was the color that had been paired with the relation of greater than during the relational training; therefore, this study demonstrated a transformation of stimulus function from the color of the contextual cue to the color of the dice.

Most recently Nastally, Dixon, and Jackson (2010) compared problem and non-problem gamblers and added a contingency reversal phase in order to enhance experimental control from the prior published research. Once again, results showed that all seven non-problem gamblers demonstrated a shift in preference to the colored slot machine that was trained as greater than during posttest 1 and reversed their preference after the relational training reversal phase. In contrast, only 4 of the 7 problem gamblers showed a shift in preference. Furthermore, the problem gambler group took five times as many trial blocks to complete the initial relational training phase than did the non-problem gamblers.

The purpose of the present study was to extend the findings of past research on slot machine preferences and the transformation of stimulus function (Hoon et al., 2007; Hoon et al., 2008; Nastally et al., 2010; Zlomke & Dixon, 2006). Three primary procedural modifications were used in the current study. First, the slot machines in the current study were programmed with two different payout values (.70/.30) whereas previous studies programmed the two slot machines with equal payout values (.50/.50). Second, a contingency reversal of baseline discriminations was implemented in order to enhance experimental control. Third, all participants were prescreened for problematic gambling behavior, and results between non-problem gamblers and problem gamblers were compared.

METHOD

Participants

Twenty one participants (10 non-problem gamblers and 11 problem gamblers) completed the experiment. Pathology was determined by the South Oaks Gambling Screen

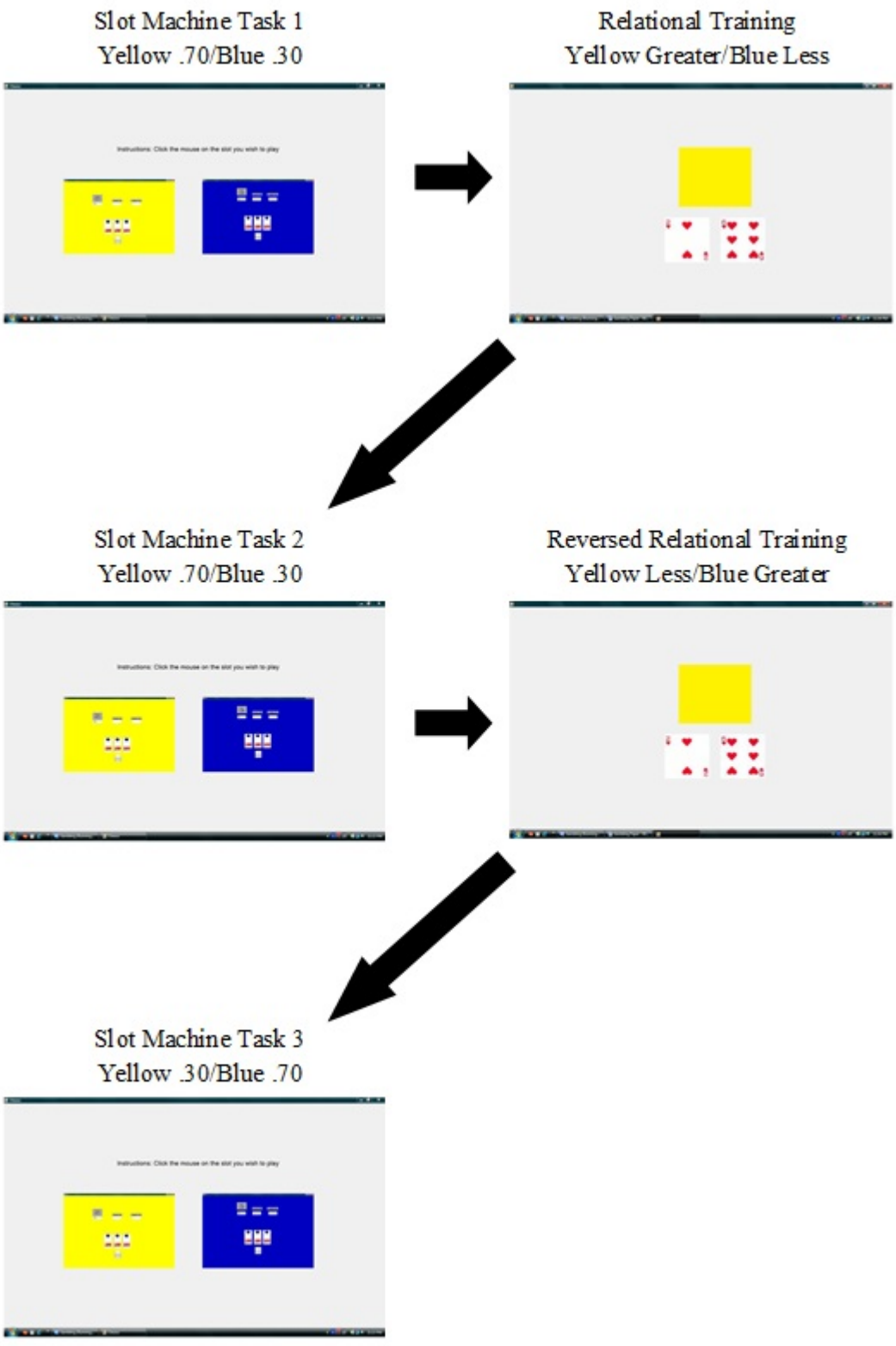

Figure 1. Flow chart of procedure.

(SOGS; Lesieur & Blume, 1987), which is the most commonly used assessment tool to assess problematic gambling. A SOGS score between 0 and 2 indicated that the participant did not have a potential gambling problem and a score of 3 or above indicated that the participant did have a potential gambling problem. The non-problem gamblers' scores ranged from 0 to 2 (*M*: .50; *SD*: .71) and the problem gamblers' scores ranged from 3 to 9 (*M*: 4.27; SD: 2.00). Participants were recruited through personal contacts and through a student center located on a university campus. The non-problem gamblers consisted of 5 males and 5 females ranging from age 22 to 56 (*M*: 38.30; *SD*: 15.87). The problem gamblers consisted of 1 female and 10 males ranging from age 18 to 28 (*M*: 21.91; *SD*: 3.04).

Setting and Apparatus

The setting of the current study varied across participants and was completed at a location convenient for them. Settings included public locations (e.g., a coffee shop) and a small room on campus. Although measures were taken to limit the distractions in the public locations, this was not always successful.

Three laptop computers programmed with Microsoft® Visual Basic 2008 Express Edition were used for the presentation of this study. This program was used to both present the stimuli as well as to collect the data.

Experimental Design

The design used in the current study was a within-subjects pretest/posttest group design with a contingency reversal of baseline discriminations. Five conditions were implemented in this study (see Figure 1). The first condition was Slot Machine Task 1 (pretest) and was used to assess whether participants had a baseline preference for either the yellow or the blue slot machine. The second condition was a relational-training phase in which the participants behavior was differentially reinforced for selecting the relation of greater than in the presence of a yellow contextual cue and the relation of less than in the presence of a blue contextual cue. The third condition was Slot Machine Task 2 (posttest) and was identical to Slot Machine Task 1. Slot Machine Task 2 was implemented in order to assess whether the participants allocated more responses to the yellow slot machine following the relational training condition of yellow is greater than. The fourth condition was reversed relational training, in which the participants were differentially reinforced for selecting the relation of greater than in the presence of the blue contextual cue and the relation of less than in the presence of the yellow contextual cue. Slot Machine Task 2 (posttest contingency reversal) was then completed by each of the participants in order to assess whether the participants reversed their slot machine preferences following the contingency reversal.

Slot machine task 1. The purpose of this task was to collect baseline data on the participants' responding to two concurrently available slot machines. One slot machine was yellow and was programmed with an RR schedule of reinforcement with a winning probability of .70, and the second slot machine was blue and was programmed with an RR schedule of reinforcement with a winning probability of .30. The magnitude of reinforcement for each spin was held constant at one credit net gain or loss to account for extraneous sources of control. Participation on this task began with the following instructions: "Click the mouse on the slot machine you wish to play. You may switch back and forth between slot machines. Click 'Continue' when you are ready." Participants were informed that the study would take approximately 1 hr. and that they would earn a gift card for their participation in the study. Additional questions were answered by repeating relevant sections of the instructions.

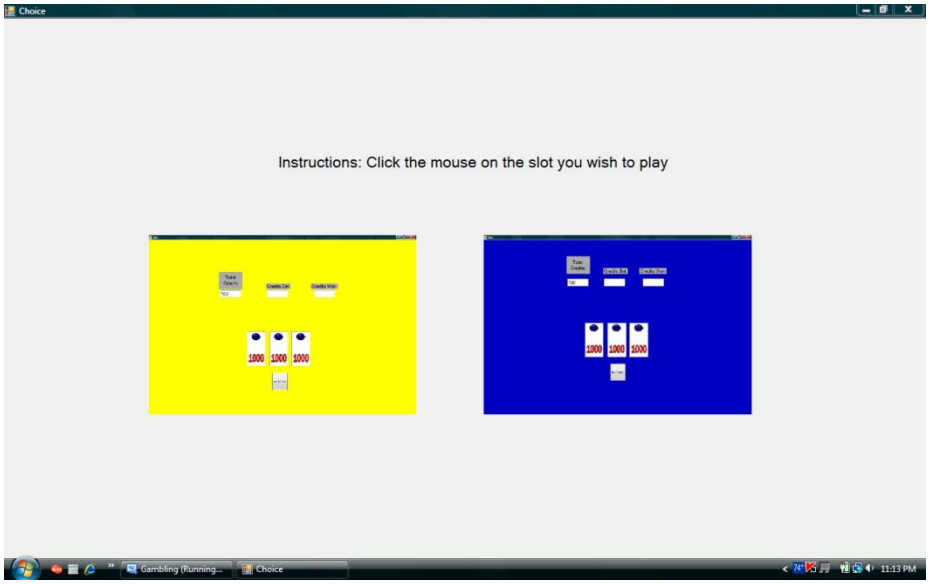

Figure 2. Participant view of the concurrently available slot machines.

At the start of each trial, two slot machines were concurrently available, one yellow and one blue (see Figure 2). The position of the slot machines was randomized across trials in order to prevent a position bias. When the participant clicked on either the yellow or blue slot machine, a new screen appeared in which that color slot machine was the only one available (see Figure 3). On this screen, there were three text boxes that tracked the total number of credits earned, the number of credits bet, and the number of credits won per spin. Above each of these text boxes were the following labels, respectively: "Total Credits," "Credits Bet," and "Credits Won." This allowed the participant to monitor the number of credits he or she had earned throughout the slot-machine task.

For the participant to play on the machine, he or she clicked the button that read "Bet 1 Credit". The "Bet 1 Credit" button then disappeared and a new button that read "Spin" appeared. In addition, one credit was added to the bet credit textbox and one credit was subtracted from the participant's total number of credits. After the participant clicked "Spin," the slot-machine reels spun for a total of 3 s. If there were three identical symbols shown on the reels when they stopped spinning, this was considered a win and two credits were added to the participant's total number of credits. If there were not three identical symbols shown on the reels, this was considered a loss and the participant did not earn any credits. A button that read "Continue" then appeared on the screen and when clicked, the choice screen with both the yellow and blue slot machines reappeared. The participant again clicked one of the two slot machines, in which a new screen appeared with only the one slot machine available. The number of trials in the slot machine phases was randomly determined between 50, 70, and 90 prior to each participant beginning the study by drawing a number out of a cup.

Relational training. The purpose of relational training was to establish the relations of greater than and less than using the contextual cues of yellow and blue. Before beginning the relational training, the participants were given the following instructions:

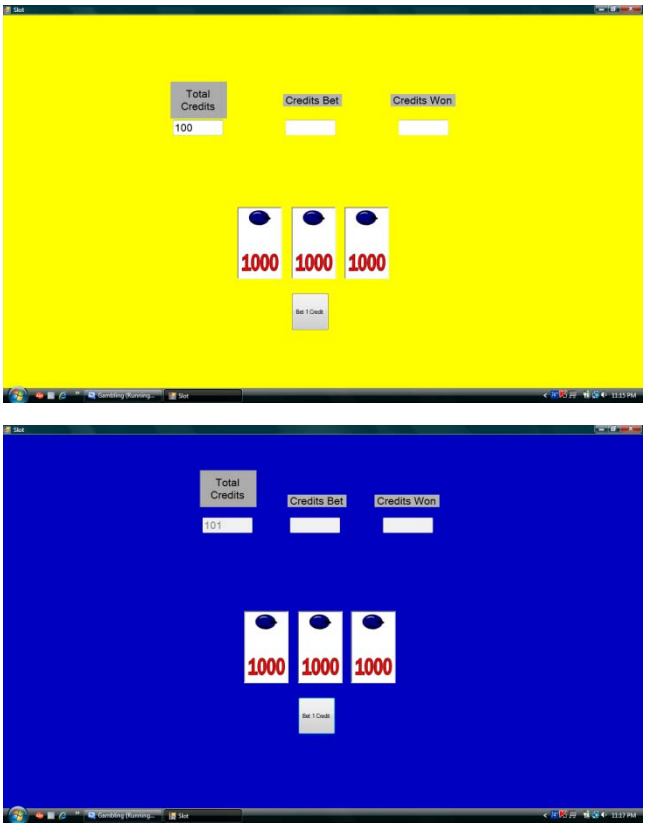

Figure 3. Visual Basic view of the yellow slot machine (top) and the blue slot machine (bottom).

> You are going to see three images presented on your screen: one image will be presented first followed by two additional images. Your job is to choose one of the two images on the bottom of the screen by clicking on it with the mouse. The more you get correct, the quicker you will finish. There will be parts of the experiment where feedback is not given. The computer is still keeping track of your responses so continue to do your best.

The participants completed two phases of relational training: mixed training and mixed testing. The comparison stimuli used during the training and testing represented values along a continuum from less than to greater than (see Figure 4). There were three sets of training stimuli: Set A consisted of coins (penny, two pennies, nickel, dime, quarter), Set B consisted of playing cards (two, six, nine, jack, king), and Set C consisted of poker chips ($5, $10, $25, $100, $500). There were also three sets of testing stimuli: Set D consisted of written dollar values ($5, $10, $20, $40, $80); Set E consisted of dollar bills ($1, $5, $10, $20, $50); and Set F consisted of places in a contest (5th place, 4th place, 3rd place, 2nd place, 1st place). These stimuli were chosen in order to parallel stimuli that were typically associated with gambling.

For the mixed training and mixed testing relational training phases, a yellow or blue box was presented on the top of the screen for 1.5 s. This box then disappeared and two comparison stimuli appeared on the bottom of the screen until a response was made by the participant (see Figure 5). The top box was used as a contextual cue for either greater than or less than, and the bottom two boxes

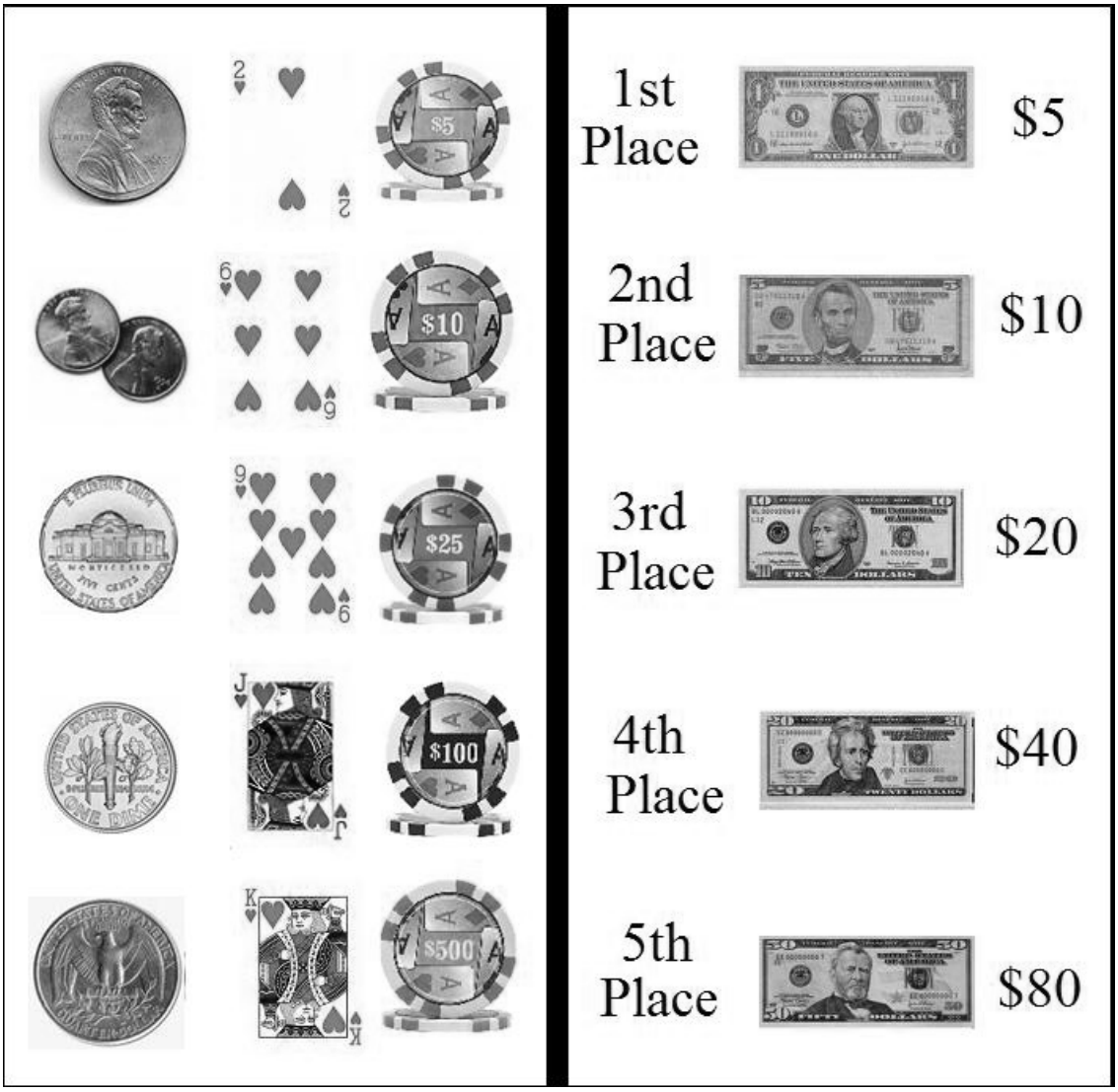

Figure 4. Training (left) and testing (right) stimuli used during the relational training.

consisted of the training or testing stimuli which were randomly presented across trials.

Mixed greater than and less than training. During this phase, yellow was greater than training trials and blue was less than training trials were interspersed. In the presence of the yellow contextual cue, visual and audiodifferential reinforcement for selecting the stimulus with the relation of greater than occurred. For example, if there was a yellow contextual cue followed by a nickel and quarter, clicking on the quarter resulted in reinforcement. In the presence of the blue contextual cue, visual and audio differential reinforcement for selecting the stimulus with the relation of less than occurred. For example, if the two stimuli presented on the bottom were a one-dollar bill and a twenty-dollar bill, clicking the one-dollar bill resulted in reinforcement. After the participant clicked on one of the two comparison images, a feedback panel became visible that either read "Correct" simultaneously presented with a chime or "Wrong" simultaneously presented with a buzzer. The feedback panel was displayed for 2 s, followed by an intertrial interval of 2 s.

The yellow and blue contextual cues were randomly rotated so that the participants

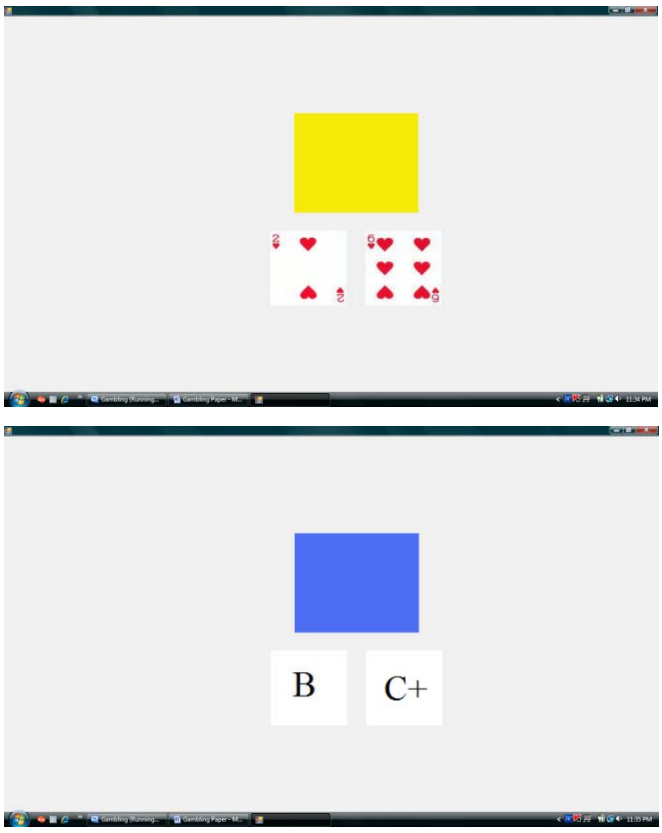

Figure 5. Visual Basic view of the yellow relational training (top) and blue relationaltraining (bottom).

had to make the discrimination between the two colors, both of which were presented 18 times each. Stimuli from Sets A, B, and C were randomly presented 12 times each for a total of 36 mixed training trials. If the participant met criterion of 89% of the trials correct, he or she advanced to the testing phase with novel stimuli and no feedback. If the participant did not meet the criterion, he or she completed another block of 36 trials. This procedure was repeated until the participant met the criterion. If the participant failed to meet the criterion within 10 trial blocks, they were dropped from the study.

Mixed greater than and less than testing. Presentation of the test stimuli was identical to that in the mixed training. This phase was implemented to test whether the contextual cues of yellow is greater than and blue is less than transferred to novel stimuli. The yellow and blue contextual cues were again presented 18 times each. During the test phase, novel stimuli from Sets D, E, and F were randomly presented 12 times each for a total of 36 trials. No feedback was provided to the participant during this phase and there was no criterion that needed to be met in order to advance to the next slot machine task. After the participant clicked on a comparison image, a 2-s intertrial interval passed before the next trial began.

Slot machine task 2. Slot Machine Task 2 was identical to Slot Machine Task 1 and was completed to determine whether the participants allocated more responses to the yellow slot machine following the relational training

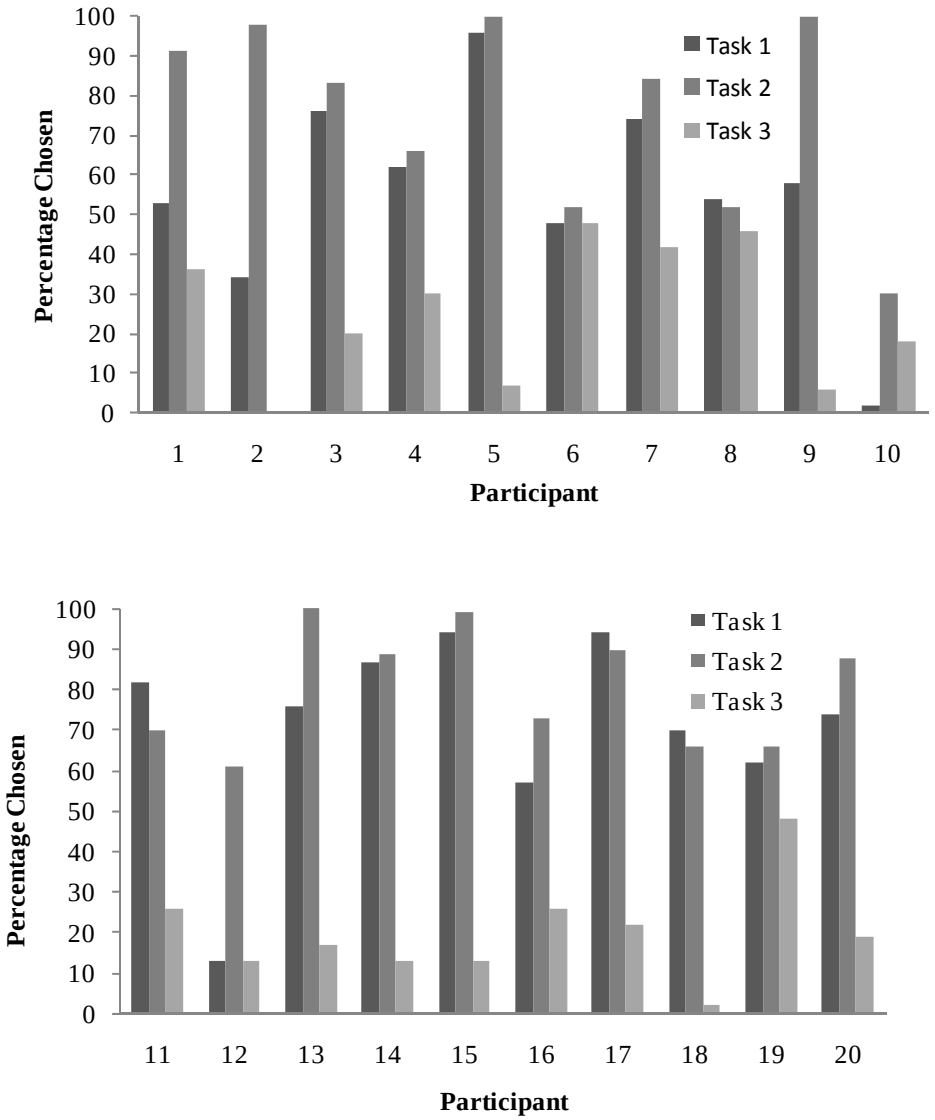

Figure 6. Percentage of responses allocated to the yellow slot machines across all three slot machine tasks for non-problem gamblers (top) and problem gamblers (bottom).

of yellow is greater than. The yellow slot machine was still programmed on an RR schedule of reinforcement with a winning probability of .70, and the blue slot machine was still programmed on an RR schedule of reinforcement with a winning probability of .30. Slot Machine Task 2 continued for 50, 70, or 90 trials as determined prior to the study, after which the participants then advanced to the reversed relational training.

Reversed relational training. Following Slot Machine Task 2, the participants advanced to the reversed relational-training condition. The instructions and procedures

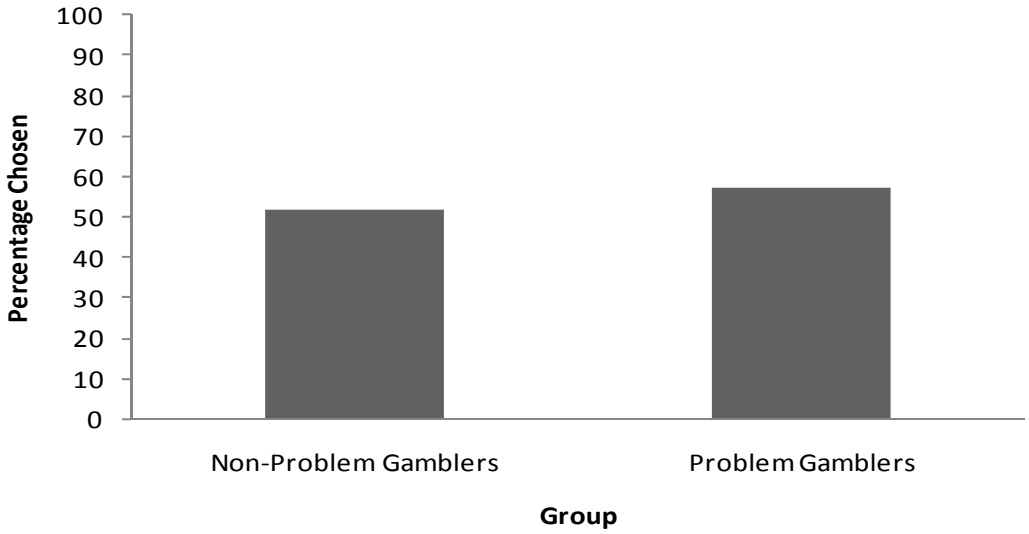

Figure 7. Average percentage of responses allocated to the yellow slot machine across all three slot machine tasks for non-problem and problem gamblers.

were identical to those during the relational training; however, the contingencies were now reversed. The blue contextual cue was now trained as greater than and the yellow contextual cue was now trained as less than. Individuals first participated in the mixed training of blue is greater than and yellow is less than follow by the mixed testing phase. The procedure, criterion, and feedback methods were identical to those in the initial relational-training phase.

Slot machine task 3. During Slot Machine Task 3, the winning probability of each slot machine was reversed. The blue slot machine was now programmed on an RR schedule of reinforcement with a winning probability of .70, and the yellow slot machine was now programmed on an RR schedule of reinforcement with a winning probability of .30. Other than the reversed probabilities, this task was identical to the previous two slot machine tasks. This condition was implemented to observe whether the participants' preferences would reverse from the yellow slot machine to the blue slot machine following the reversed relational training. This task continued for 50, 70, or 90 trials as determined prior to the study, after which the experiment ended and the participants were thanked for their participation in the study.

RESULTS

The top of Figure 6 shows the percentage of responses allocated to the yellow slot machine for the non-problem gamblers across all three slot-machine tasks. Nine of the ten non-problem gamblers showed an increase in responses allocated to the yellow slot machine following the yellow is greater than training and then reversed their preferential responding to the blue slot machine following the blue is greater than training. The average percentage of responses to the yellow slot machine across all non-problem gamblers during Slot Machine Task 1, Slot Machine Task 2, and Slot Machine Task 3 was 56%, 76%, and 25%, respectively.

In contrast, the bottom of Figure 6 shows the percentage of responses allocated to the yellow slot machine for problem gamblers across all three slot machine tasks. Participant 21 was dropped from the study because he failed to pass the initial relational training condition after 10 trial blocks; therefore, his

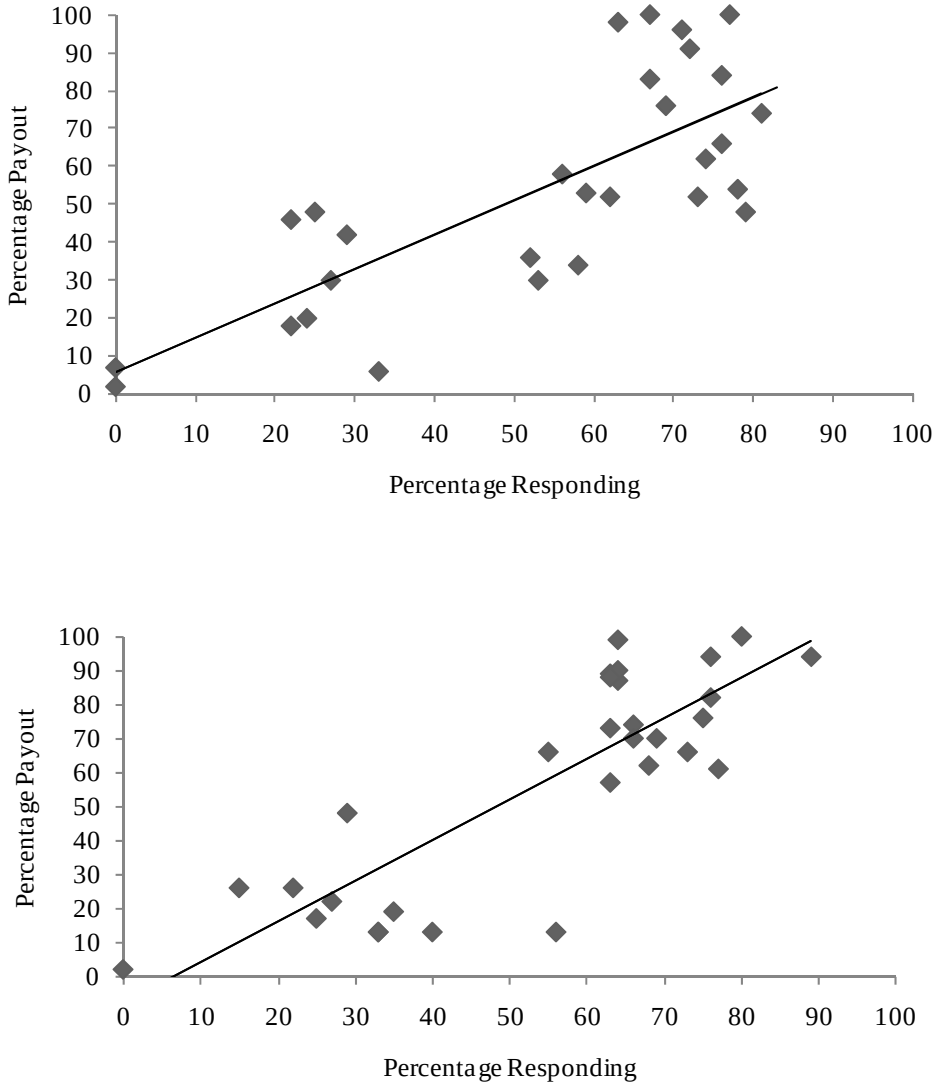

Figure 8. Scatterplot comparing the correlation between the percentage of responding to the yellow slot machine for non-problem gamblers (top) and problem gamblers (bottom).

data were not graphed or reported in the statistical analyses. In addition, Participant 14 did not complete the entire study. He was randomly assigned to 70 slot machine trials prior to beginning the study. However, during Slot Machine Task 3, he only completed 40 of the 70 trials before dropping out of the study. His data were included in all analyses, but were based on 40 trials rather than the 70 trials during Slot Machine Task 3. Of the 10 problem gamblers, 7 showed a greater response allocation to the yellow slot machine following the yellow is greater than training and then reversed their preference to the blue slot machine following the contingency reversal. The average percentage of responses to the yellow slot machine during Slot Machine Task 1, Slot Machine Task 2, and Slot Machine Task 3 was 71%, 80%, and 20%, respectively.

Figure 7 shows the average percentage of responses allocated to the yellow slot machine for non-problem and problem gamblers across all three slot machine tasks. Non-problem gamblers allocated an average of 52% of responses to the yellow slot machine and problem gamblers allocated an average of 57% of responses to the yellow slot machine. Additionally, a 2 x 3 (Group x Slot-Machine Task) mixed factorial ANOVA indicated that there was not a significant main effect between the response allocations of non-problem gamblers and problem gamblers ($F(1, 19)= 0.836$, $p = .365$). However, results showed that there was a significant main effect for the slot-machine task ($F(1, 19) = 39.726$, $p < .001$). An interaction effect between the group and slot-machine task was not significant ($F(1, 19) = 1.283$, $p = .285$). A Fisher's LSD *post-hoc* comparison was conducted in order to further evaluate the significant main effect between the slot machine tasks. Results indicated that there was a significant difference between Slot Machine Task 1 and Slot Machine Task 2 ($p = .027$), Slot Machine Task 1 and Slot Machine Task 3 ($p < .001$), and Slot Machine Task 2 and Slot Machine Task 3 ($p < .001$).

Although the .70 and .30 winning probability contingencies were programmed through Microsoft® Visual Basic 2008 using a random number generator, the contingencies that were actually generated for each participant were not always consistent. The discrepancy between the programmed and actual contingencies generated could have had an adverse effect on the results; therefore, it is important to discuss the actual contingencies encountered by each of the participants. Two scatterplot graphs showing the correlation between the percentage of responses and the percentage of payout encountered on the yellow slot machine are shown in Figure 8. The Pearson product-moment correlation showed a significant correlation between the percentage of responses and the contingencies encountered for the non-problem gamblers ($r = .77$, $p < .05$) as well as for the problem gamblers ($r = .84$, $p < .05$).

The results of the relational training varied across participants. If a participant did not meet the criterion during any one of the relational training phases, he or she was re-exposed to that phase; each re-exposure was considered a trial block for the purpose of this discussion. For non-problem gamblers, the number of trial blocks completed before meeting the criterion during the relational training phase ranged from 1 to 5 (*M*: 2.50, *SD*: 1.35) and during the reversed relational training phase ranged from 1 to 2 (*M*: 1.2, *SD*: 0.42). The percentage correct for the relational testing phase with no feedback or criterion ranged from 61% to 100% correct (*M:* 0.92, *SD:* 0.12) and for the reversed relational testing phase ranged from 64% to 100% correct (*M:* 0.94, *SD:* 0.11). The number of trial blocks problem gamblers completed before meeting the criterion during the relational training phase ranged from 1 to 8 (*M*: 2.20, *SD*: 2.15) and during the reversed relational training phase ranged from 1 to 3 (*M*: 1.30, *SD*: 0.67) The percentage correct for the relational testing phase ranged from 92% to 100% correct (*M:* 0.96, *SD:* 0.03) and for the reversed relational testing phase ranged from 92% to 100% correct (*M:* 0.98, *SD:* 0.03).

A one-way ANOVA indicated that there was not a significant difference between the number of trial blocks needed to meet criterion for non-problem and problem gamblers during the relational training phase ($F(1, 19)= 0.139$, $p = .715$) or during the reversed relational training phase ($F(1, 19)= .016$, $p = .696$). Moreover, there was no significant difference between groups for the percentage correct during the relational testing phase ($F(1, 19)= 1.463$, $p = .242$) or during the reversed relational testing phase ($F(1, 19)= 1.621$, $p = .219$).

DISCUSSION

The current study extended previous research in three primary ways. First, a contingency reversal of baseline discriminations was included in order to enhance experimental control. Second, the winning programmed probabilities were unequal for each slot machine. Third, the current study compared the responding of both non-problem gamblers and problem gamblers.

The mixed factorial ANOVA indicated that there was a significant difference in responding between the three slot-machine tasks. Due to this difference, a claim can be made that both non-problem and problem gamblers altered their responses significantly in accordance with the relational training phases; therefore, the conclusion can be made that the majority of participants responded based on the transformation of stimulus function from the color of the contextual cue to the color of the slot machine. Nine of the ten non-problem gamblers and 7 of the 10 problem gamblers allocated more responses to the yellow slot machine following the relational training phase and more responses to the blue slot machine following the reversed relational training phase. Overall, there was no significant difference between the responding of non-problem gamblers and problem gamblers. Although the slot machine payouts came close to averaging out at the programmed contingencies, individual participants did not always encounter the programmed .70/.30 contingencies. Regardless of the contingencies encountered, the majority of participants still allocated their responses in accordance with the relational training phases. In addition, the scatterplot data and Pearson's product-moment correlation show that the correlation between the participants' responding and the contingencies encountered were significant. It is therefore not likely that the results of this study were altered by the inconsistent contingencies encountered by each participant.

The results of the current study replicate and extend the findings of past research by showing that a transformation of stimulus function from the color of a contextual cue to the colors of a slot machine is possible (Hoon et al., 2007; Hoon et al., 2008; Zlomke & Dixon, 2006), and that the participants' slot machine preferences could be altered following a reversed relational training condition (Nastally et al., 2010). The procedures used in the current study most closely followed those in Nastally et al. (2010). The primary difference between the two studies was that unequal payout values were used on each colored slot machine. The results of this study differed slightly from those reported by Nastally et al. First, Nastally and colleagues found that it took problem gamblers on average five times as many trial blocks to meet the relational training criterion than did non-problem gamblers; whereas in the current study there was no significant difference between the trials blocks to criterion between the two groups. Secondly, Nastally and colleagues found that problem gamblers did not allocate their responses in accordance with the relational training phases as often as non-problem gamblers. Again, there was no significant difference between non-problem gamblers and problem gamblers in the current study. These differences, however, could have occurred because Nastally et al. used a SOGS problem gambler cutoff score of 5 whereas the current study used a SOGS problem gambler cutoff score of 3; therefore, there may have been a larger discrepancy between the two groups in the study by Nastally and colleagues than in the current study.

The current study did however suffer from potential limitations that should be addressed in future research. The small sample size that was used may have failed to detect a difference in groups that may have actually existed. Future studies should improve here by the utilization of a greater number of research participants as well as attempting to

screen them for similar levels of gambling pathology (as measured by similar SOGS scores). However, the greatest weakness of the current study was that the reversal training also involved a shift in the reinforcement distribution. Thus, one is unable to determine from the results whether participants' behavior was controlled by the training, their contact with the contingencies, or both. A follow-up study should be conducted whereby reinforcement rate is held constant and contingencies are reversed to determine the relative impact of each on subsequent performance. For example, if the participants were differentially reinforced for responding to the relation of greater than in the presence of a yellow contextual cue, the slot machine task would be programmed with a higher winning probability for the blue slot machine.

In conclusion, the current study supports a behavior analysis of problem gambling. In addition to previous studies on gambling behavior, the present study demonstrates that problem gambling behavior is not limited to any one variable. Problem gambling behavior can come under the control of various stimuli including self-rules, externally derived rules, and the transformation of stimulus function. If we can understand the role that these stimuli play in maintaining an individual's gambling behavior, we can target these relations to treat individuals who engage in problem gambling behavior. The results of the current study provide a bridge between past research on the transformation of stimulus function with equal slot machine payout values and future research on the transformation of stimulus function with unequal slot machine payout values.

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