Altering Preferences for Concurrently Available Simulated Slot Machines: Nonarbitrary Contextual Control Over Gambling Choice

Alice E. Hoon & Simon Dymond
Swansea University

Structural characteristics of slot machines, such as color, have been implicated in the maintenance of problem gambling. Behavior-analytic research has demonstrated that preferences for identically programmed, concurrently available simulated slot machines can be brought under contextual control, which may provide a functional account of the control exerted by structural characteristics. Specifically, when participants were trained that the color yellow was a contextual cue for 'more than' and the color blue was a contextual cue for 'less than', participants showed an increased preference for the yellow slot machine, despite both machines being identical in schedule and magnitude of reinforcement. The present experiments sought to replicate and extend these findings in several ways. First, we sought to overcome limitations of pretest/posttest designs by employing a nonconcurrent multiple baseline design, counterbalancing the contextual cues, and employing problem gamblers as participants. Experiments 1 and 2 found that slot machine preferences could be altered in accordance with contextual cues in problem gamblers, and Experiment 3 reported that these preferences could be reversed. All three experiments found that extended exposure to the payout contingencies of a slot machine may weaken the control exerted by the contextual cues.

Keywords: Slot machine; Contextual control; Nonarbitrary; Problem gamblers; Experiment

---

The structural characteristics of slot machines or electronic gaming machines have been implicated in the persistence and maintenance of problem gambling (Griffiths, 1990). The term "structural characteristic" encompasses many features including lights, colors, sounds, and bill payment options. Adding or removing some of these features has associated effects on persistence and levels of self-reported enjoyment in slot machine play (Loba, Stewart, Klein, & Blackburn, 2001; Sharpe, Walker, Coughlan, Enerson, & Blaszczynski, 2005). For instance, Loba et al. (2001) reported that video lottery terminals that had fast reels and produced sounds were played for longer periods of time than those that had slower reels and no sound.

Behavior-analytic gambling research on the effects of structural characteristics has sought to investigate how color may influence slot machine choice. Zlomke and Dixon (2006) conducted a study in which participants were presented with two concurrently available computer simulated slot machines identical in schedule and magnitude of reinforcement and differing only in color (one slot machine was yellow and the other was blue). The slot machines paid out according to a random ratio 0.5 schedule, such that each spin was independent of the last and a winning trial occurred on 50% of trials. Magnitude of reinforcement was held constant such that one

---

The present experiments were submitted as part of the requirement for Alice E. Hoon's doctoral thesis.
Address all correspondence to:
Alice E. Hoon
College of Medicine
Swansea University
Singleton Park
Swansea SA2 8PP, United Kingdom
a.e.hoon@swansea.ac.uk

credit was required to play a slot machine, therefore one credit was lost on a losing spin, and one credit was won for a winning spin. Participants showed no particular preference for either slot machine, allocating approximately equal responding to both machines. Participants were then given a nonarbitrary relational training task in which the color yellow was established as a contextual cue for more than and the color blue was established as a contextual cue for less than. Following this training, participants were given a further 50 slot machine trials to play under identical conditions as before. It was found that participants allocated increased responding to the yellow slot machine, despite both slot machines being identical in payout probability (Zlomke & Dixon, 2006).

Researchers have replicated and extended these findings (Fredheim, Otterson, & Arntzen, 2008; Hoon, Dymond, Jackson, & Dixon, 2007, 2008; Johnson & Dixon, 2009; Nastally, Dixon, & Jackson, 2010). For instance, Fredheim et al. (2008) used an identical procedure to Zlomke and Dixon (2006) with non-problem gamblers and found that only four out of twelve participants showed an increased preference for the more than slot machine at posttest. In a second experiment, the authors altered the way in which instructions were presented so that individuals who had not reached criterion responding for nonarbitrary training and testing within one hour had the instructions repeated to them. Secondly, a brief interview was conducted following the experiment to identify whether participants had attended to the contextual cue (the Color Group) or simply responded to the comparison stimuli independent of the contextual cue (the Number Group). Results were analysed in terms of whether participants were assigned to either the Color Group or the Number Group. It was found that in the Color Group, eight out of twelve participants showed increased preference for the more than (yellow) slot machine at posttest whereas in the Number Group only two participants out of six showed increased preference towards the more than slot machine at posttest (Fredheim et al., 2008).

The original nonarbitrary relational training procedure used by Zlomke and Dixon (2006) has potential limitations, which may explain the finding of Fredheim et al. (2008). Specifically, during relational training, participants were presented with the contextual cue (a yellow or blue colored screen) followed by three comparison stimuli. For example, the screen appeared yellow and then \$1, \$5, and \$10 notes were presented. This method has been criticised because, firstly, it is ambiguous due to there being two correct responses (both \$5 and \$10 are more than \$1), and secondly, it may lead to the more than cue being established as a cue for 'opposite' (Hoon et al., 2007, 2008). It is possible that these factors may partly explain why Fredheim et al. (2008) only observed the predicted effect in a minority of participants because the ambiguity of the training task resulted in insufficient contextual functions having been established, which was unlikely to influence posttest performance.

In order to resolve these limitations, Hoon et al. (2007, 2008) employed a training task in which only two comparison stimuli were presented. This ensured there was only one correct response per trial. During baseline, participants did not show a particular preference for either slot machine; however, following the nonarbitrary relational training and testing phase, participants did show an increased preference for the yellow 'more than' slot machine. These results demonstrate that a preference for a structural characteristic such as color may override the direct payout contingencies of a slot machine.

While there are merits to the research already conducted on the influence of contextual cues in simulated slot machine gambling, there are some methodological limitations with the research designs that have been used.

First, the pretest/posttest design, which has been used in all of the previous research on this topic, does not remove all threats to internal validity because it may be subject to test/re-test sensitivity. Second, in previous experiments, all participants received an identical number of baseline exposures (50 trials) to the slot machine pretest phase. Any resulting changes in slot machine preferences may not have appeared stable because of the spontaneous change following a certain number of trials.

Within single case research, there are a number of alternatives to pretest/posttest designs that may overcome some of theses limitations. In particular, the non-concurrent multiple baseline design may be suitable in this regard (Harvey, May, & Kennedy, 2004; Kennedy, 2005; Watson & Workman, 1981). In a concurrent or non-concurrent multiple baseline design, participants receive differing lengths of baseline trials before the intervention is implemented. In this case, functional control is demonstrated when changes in behavior are seen only once the intervention is applied and not for any other reason. Another form of single case design is a reversal design. In a simple reversal design baseline levels of responding are recorded and once stability is achieved, treatment is implemented. These baseline data then act as a comparison condition to the treatment condition (Chambless & Hollon, 1998) to see if the behavior has changed as predicted.

To date, only one published experiment has used a design other than pretest/posttest to research gambling behavior (Dixon & Holton, 2009) and only one experiment has used a reversal procedure (albeit as part of a pretest/posttest design; Nastally et al., 2010). In a study on delay discounting, Dixon and Holton (2009) presented participants with hypothetical choices involving differing amounts of money with differing lengths of delay before receiving the money. On each trial the contextual cues, color pink or color purple, were simultaneously presented. Participants then completed a nonarbitrary training procedure that was similar to that of Zlomke and Dixon (2006) except that the two contextual cues (color pink and color purple) were trained as 'better than' and 'worse than'. In the final phase, participants were re-presented with the delay discounting task only this time the contextual cues had acquired functions of 'better than' or 'worse than', such that participants showed less frequent discounting (Dixon & Holton, 2009).

Nastally et al. (2010) adopted the same procedure as described in Hoon et al. (2008), except that a second nonarbitrary training phase was presented in which the contextual cue that had initially been trained as the more than cue became the contextual cue for less than. Additionally, the color slot machine that was most preferred during initial pretest was targeted at the less than contextual cue. It was found that participants' preferences for the slot machines reversed following the second nonarbitrary phase such that preference was now shown for the slot machine the same color as the cue trained as more than in the second phase, however this reversal effect was not seen in the pathological gambling group. Nastally et al. (2010) also reported that the problem gamblers took five times as long to reach criterion responding in the initial nonarbitrary task.

Studies conducted to date on contextual control of slot machine preferences may have implications for furthering understanding the role of verbal behavior in gambling. Early reports (e.g., Zlomke & Dixon, 2006) described the shift in response allocation towards the more than slot machine as indicative of "transformation of functions", even though the relational training intervention involved purely nonarbitrary relations. As others have outlined (e.g., Dymond & Roche, 2010; Dymond & Whelan, 2007), while these studies fall some way short of modern definitions of verbal behavior, they do emphasize the central role played by relational responding in generating the resulting effects. We will return to this issue in the General Discussion.

The present experiments sought to replicate and extend the findings of Hoon et al., (2007, 2008) using a non-concurrent multiple baseline design. In Experiment 1, the contextual cues were counterbalanced across participants. In Experiment 2, nonarbitrary training task was only implemented once responding became stable. In Experiment 3, a reversal design was incorporated to examine whether preferences could be shifted and reversed.

EXPERIMENT 1
METHOD

Participants

Three British participants (2 males, 1 female), aged 20 to 22 years (M = 21; SD = 1) attending Swansea University were recruited through personal contacts. Participants completed the *South Oaks Gambling Screen* (SOGS; Lesieur & Blume, 1987). A score on the SOGS of 3 or 4 indicates potential problem gambling, and a score of five or above indicates probable pathological gambling (Lesieur & Blume, 1987). P2 scored zero on the SOGS, while P1 and P3 both scored three (M = 2, SD = 1.41).

Apparatus

The experiment took place in a small room containing a desk, a desktop computer with 16-inch display, full sized keyboard and a two-button click mouse. Stimulus presentation and the recording of responses were controlled by the computer and were programmed in Visual Basic®.

Design

A non-concurrent multiple baseline across participants design was used and the contextual cues were counterbalanced so that two participants were trained that yellow was the more than cue and blue the less than cue, and one participant was trained that blue was the more than cue and yellow the less than cue. The color that was trained as the more than and less than cues were predetermined in Experiment 1, therefore participant preference in the baseline task did not influence the contextual cues that were to be established.

Procedure

There were three phases to the experiment; slot machine baseline trials, the nonarbitrary relational training intervention and slot machine trials post-intervention.

Slot machine Task: Baseline

The slot machine task was employed to obtain data on participants' baseline choices towards two concurrently available slot machines that were identical in schedule and magnitude of reinforcement and differed only in background color, one being predominantly yellow and the other being predominantly blue. Participants were presented with the following on-screen instructions:

> "On the following screen you will see a button in the middle of the screen. When you click on the button with your mouse two slot machines will be revealed. Click your mouse on the slot machine you would like to play and earn as many points as possible."

On clicking the button on the screen, participants were presented with a grey screen which revealed a red button in the centre of the screen containing the instructions *Click here*. Clicking the red button presented participants with a screen containing a blue rectangular box named Slot machine 1, and a yellow rectangular box named Slot machine 2. These boxes were randomly positioned on opposite sides of the screen throughout trials to control for position bias. To play a slot machine, participants clicked the *Spin* button on the left hand side of the screen. All participants started with 100 credits and only one credit could be bet at a time. On clicking the spin button the reels spun for three seconds and sound effects were heard which were similar to those of actual casino slot machines. A winning spin consisted of three identical symbols on the pay off line, and resulted in one credit being awarded in the *Total Credits* box at the top left of the screen. A losing spin consisted of two matching symbols or no matching symbols and one credit was subtracted from the *Total Credits* box. After playing a slot machine, participants were taken back to the initial grey screen with *Click here* button and a new phase began.

Each participant was presented with a different number of baseline trials, predetermined by the experimenter: P1 received 40 baseline slot machine trials, P2 received 80 baseline trials and P3 received 120 baseline trials.

Nonarbitrary Relational Training

This phase established more than and less than contextual functions for the background colors, yellow and blue. For P1 and P2, the color yellow was trained as the contextual cue for more than and blue was the cue for less than. This was counterbalanced for P3 so that blue was trained as the more than cue and yellow was trained as the less than cue.

During nonarbitrary training the background screen would appear either yellow or blue, then after approximately three seconds, two stimuli would appear on screen, one stimulus on the left and the other on the right (see Figure 1). The stimuli presented consisted of images which represented different quantities, for example a five dollar poker chip and a twenty five dollar poker chip. Participants were required to select an image by clicking on the image with a mouse. On selecting the correct stimulus, the word '*Correct*' was displayed on the screen for one second and a chime sound effect was heard, whereas following an incorrect response the word '*Wrong'* was presented and a buzzer sound effect was heard. One point was awarded for each correct response, which was displayed at the top centre of the screen. The computer programme automatically proceeded to the next trial. There were 48 trials in the training phase and participants had to respond correctly across 43 trials in order to progress to the test phase. If criterion was not met, they were exposed to the training phase again.

Overall, participants were trained with four different sets of stimuli in the relational training phase. The stimuli used were pound notes (£5, £20, £50), dice (1, 4, 6), poker chips ($5, $25, $500), and letter grades (A+, C+, D-). Two images were presented onscreen at a time (see Table 1 for a graphical display of all the training trials that were presented).

P1 and P2 learned to select the image that represented 'more than' when the background color was yellow and the image that represented 'less than' when the background color was blue. The reverse was true for P3 in the counterbalanced condition.

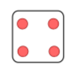
Nonarbitrary Relational Testing

The purpose of this phase was to test whether the more than and less than relations established during training would be applied to four novel sets of stimuli. The novel stimulus sets consisted of coins (1p, 20p, £1), playing cards (4 of spades, 9 of spades, king of spades), jackpots (5 million, 10 million, 20 million) and positions (1^{st}, 8^{th} 10^{th}). Participants were required to respond correctly across all 48 trials. If a participant failed the test phase, they were re-exposed to the training phase. The format of the test phase was identical to the training phase except that no feedback was given.

Slot machine Task: Post-Intervention

This phase was to investigate whether the nonarbitrary relational training task would increase responding to a particular slot

Table 1. Graphical representation of all the different trial types that were presented to participants during nonarbitrary relational training.

More £5 £20	More £5 £50	More £20 £50
Less £5 £20	Less £5 £50	Less £20 £50
More  	More  	More  
Less  	Less  	Less  
More $5 $25	More $5 $500	More $25 $500
Less $5 $25	Less $5 $500	Less $25 $500
More A+ C+	More A+ D-	More C+ D-
Less A+ C+	Less A+ D-	Less C+ D-

machine. P1 received 120 post-intervention slot machine trials, P2 received 80 slot machine trials and P3 received 40 slot machine trials. This ensured that all participants completed a total of 160 slot machine trials throughout the whole experiment.

RESULTS AND DISCUSSION

All participants completed the nonarbitrary relational training and testing. Criterion for the training phase required that participants obtain a score of at least 43 in order to progress to the test phase. Table 2 shows that P1 took the most number of training

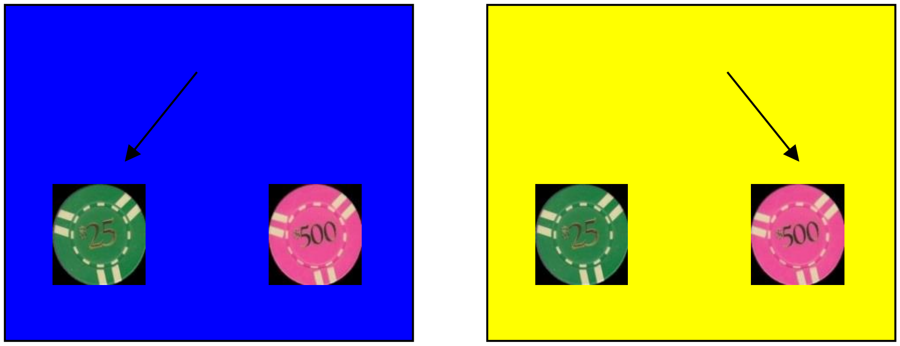


Figure 1. An example of a less than (left panel) and a more than trial (right panel) where blue is trained as the less than cue and yellow is trained as the more than cue. In the presence of the less than contextual cue, the image portraying the lesser quantity is reinforced (indicated with an arrow). In the presence of the more than contextual cue, the image portraying the greater quantity is reinforced (indicated with an arrow).

Table 2. The number and mean number (with standard deviation) of correct trials during nonarbitrary relational training and testing phase in Experiment 1.

Participant	Nonarbitrary Relational Training (/48)	Nonarbitrary Relational Testing (/48)
1	23	-
	27	-
	27	-
	23	-
	26	-
	24	-
	42	-
	48	48
2	26	-
	38	-
	48	48
3	36	-
	39	-
	48	48
Mean	33.93	48
Standard devtion	9.86	0

trials to successfully progress to the test phase, whereas P2 and P3 only required three exposures to training. The mean number of trials required to each criterion in the training was 33.93 (*SD* = 9.86). In the test phase participants were required to get all 48 trials correct to complete the task. All participants passed the test following only one exposure to the task.

Figure 2 depicts the number of responses allocated towards the more than slot machine (that is, the slot machine that was the same color as the more than contextual cue) during baseline and post-intervention. All participants showed relatively stable levels of responding during baseline, suggesting no marked preferences for either colored slot machine, however it should be noted that P2 initially showed a small preference for the slot machine that was to be targeted as the more than contextual cue. Following the relational training and testing intervention, two of the three participants (P1 & P2) showed an increase in the number of responses allocated to the more than slot machine. This increase remained stable for the remainder of the post-intervention phase. The participant (P3), who received the shortest post-intervention phase, showed a smaller increase in response allocation to the more than slot machine. Overall, the percentage difference in responding allocated towards the more than slot machine from baseline to post-intervention was 32.5% for P1, 30% for P2, and 5% for P3. The findings of Experiment 1 support those of Hoon et al. (2007, 2008) and Zlomke and Dixon (2006) that preferences for concurrently available slot machines may be altered in accordance with contextual cues.

Although there was a clear shift in slot machine preferences for P1 and P2, this effect was less evident for P3, who had received the lowest number of post-intervention trials. Thus, a limitation of Experiment 1 was that the participant who received the shortest exposure to the post-intervention trials also produced unstable responding. Accordingly, this made it difficult to assess the effects of the relational training intervention on slot machine preferences. If more trials had been given following the intervention then this may have resulted in stable responding towards one slot machine allowing any slot machine preference to be assessed. In order to overcome this limitation, the number of baseline trials should be determined on the basis of visual analysis (level and trend) and the intervention should be employed only once responding is stable. The same stability criteria could then be adopted during the post-intervention phase.

An additional limitation of Experiment 1 was that the color to be targeted as the more than contextual cue was pre-determined. It is possible that when presenting participants with a concurrent choice between slot machines, a preference for a particular colored machine may be seen during baseline. If that color is then targeted as the more than cue, a smaller effect size may be seen when comparing baseline and post-intervention slot machine preferences. To overcome this issue, Nastally et al. (2010) targeted the color slot machine that was the least preferred following baseline as the more than contextual cue, rather than predetermining the contextual cues for more than and less than.

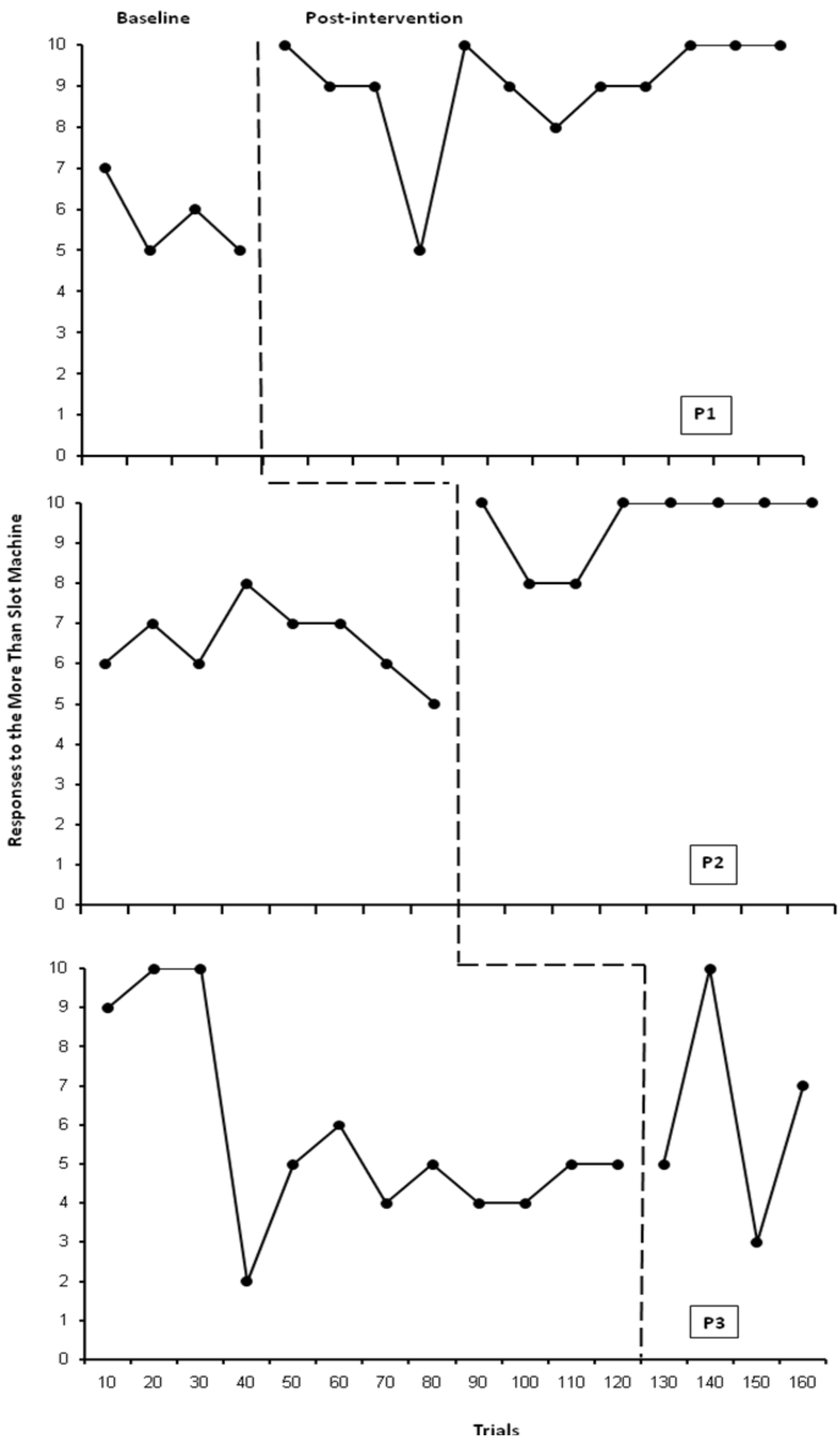
Experiment 2 was conducted to explore this issue in participants who met a SOGS classification of problem gambler. Additionally, in Experiment 2, similar to Nastally et al. (2010) the color of the least preferred slot machine during baseline was targeted as the contextual cue for more than in the nonarbitrary training task in order to rule out any resulting shift in preferences towards the more than slot machine occurring on the basis of pre-existing color preferences.

EXPERIMENT 2
METHOD

Participants

Three male participants of British and Asian descent aged 20 to 24 years (*M* = 22.67; *SD* = 2.31) were recruited through campus-wide email advertising the study. Only participants with a minimum SOGS score of 3 were recruited. Participants SOGS scores were 7, 6 and 3 (*M* = 5.33, SD = 1.70).

Figure 2. Response allocation to the more than slot machine in baseline and post-intervention in Experiment 1.



Procedure

The procedure of Experiment 2 was identical to that of Experiment 1 with the following exceptions. Firstly, participants were not given a pre-determined number of baseline trials. Instead, baseline slot preferences were monitored every 30 trials and once responding appeared stable the nonarbitrary relational training task was given. Responding was said to be stable when slot machine preferences fell within a range of two trials across three consecutive data points. This was assessed by the experimenter. Secondly, whereas in Experiment 1 the contextual cues had been counterbalanced across participants, in Experiment 2, the color of the least preferred slot machine during baseline was targeted as the more than contextual cue in the relational training intervention. Following the relational training intervention, participants were re-presented with the concurrent slot machine task. In the same way as the baseline task, responses were monitored every 30 trials and the experiment only ended once responses appeared stable. Finally, only individuals with a minimum SOGS score of 3, indicating a potential problem gambler, were recruited.

RESULTS AND DISCUSSION

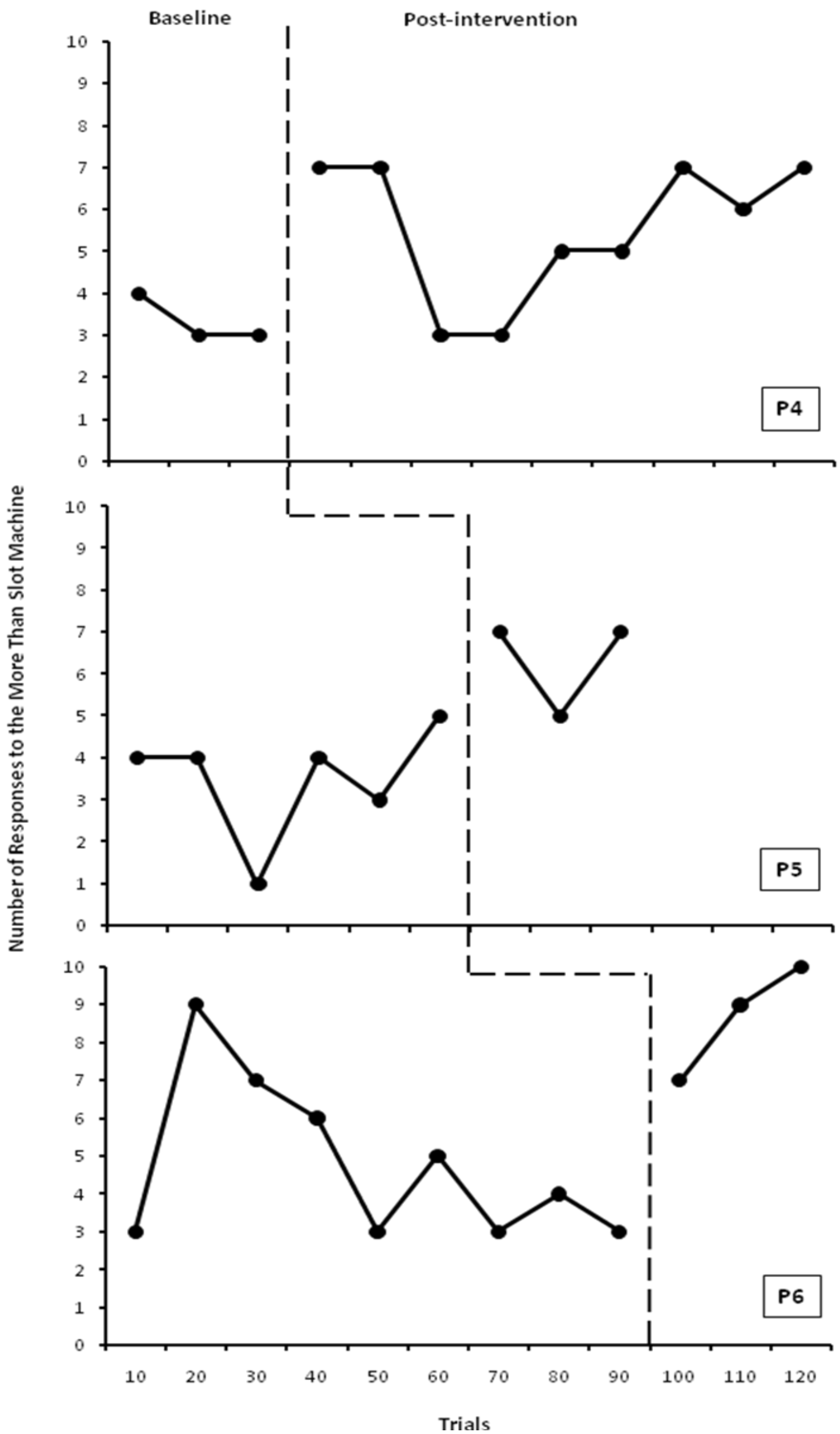
All participants completed the nonarbitrary relational training and testing phase (see Table 3). P4 and P5 required two exposures to the training task before progressing to the test phase, whereas P required three exposures. The mean number of trials required to meet criterion for the training phase was 41.86 (*SD* = 8.09). P4 and P5 passed the nonarbitrary test after only one exposure to the task, whereas P6 required two exposures.

Table 3. The number and mean number (with standard deviation) of correct trials during nonarbitrary relational training and testing phase in Experiment 2.

Participant	Nonarbitrary Relational Training (/48)	Nonarbitrary Relational Test (/48)
4	42	-
	48	48
5	26	-
	44	47
6	37	-
	48	46
	48	48
Mean	41.86	47.25
Standard deviation	8.09	0.96

Figure 3 shows that participants' preferences for concurrently available slot machines were altered, such that participants allocated most responding to the slot machine that was the same color as the more than contextual cue. The extent of this increase in preference varied across participants, with responding by P6 showing the greatest post-intervention increase. Post-intervention responses from P4 were initially variable but increased in level and trend by the fifth block of trials where an increase in preference is seen towards the more than slot machine. Responses then stabilised

Figure 3. Response allocation to the more than slot machine in baseline and post-intervention in Experiment 2.



whilst showing a fairly clear preference for the more than slot machine. The results for P5 are perhaps not as clear. Although P5 initially showed a slight preference for the more than slot machine, in his second block of trials P5 showed equal responding to either slot machine, and then in the last block of trials P5 showed a slight preference for the more than slot machine again. Unfortunately, P5 terminated his participation before additional post-intervention trials could be administered. For this reason, it is difficult to draw many clear conclusions regarding the preferences for P5. P6 required the highest number of baseline trials before the intervention was implemented, and then showed the most marked increase towards the more than slot machine during the final phase. It is important to note that in the first block of trials following intervention, all participants allocated increased responding to color slot machine that had been established as more than, despite this slot machine being least preferred during baseline. This suggests that the contextual cues that were established in the intervention are influencing responding. Overall, the findings of Experiment 2 demonstrated that problem gamblers' preferences for one of two concurrently available slot machines can be altered in accordance with a relational training intervention that targets the color of the least preferred slot machine, and rules out competing explanations in terms of pre-existing color preferences. It is possible therefore that in real world gambling, an individual may show a preference for a particular slot machine due to a feature of that machine being related in some way to something else in the gamblers behavioral repertoire. This suggests that the factors influencing a gambler's slot machine preferences may be highly complex.

In Experiment 3, an additional measure was incorporated: given that the presence of a nonarbitrary relational training task can alter participants' preferences for concurrently available slot machines, if the original task were then reversed and the contextual cue originally established as the more than cue now trained as the less than cue, it would be expected that preferences for the slot machines would shift accordingly. Therefore, Experiment 3 was a further modification of Experiment 2 with the addition of a reversal design.

EXPERIMENT 3

Experiment 3 employed a reversal design in which, following initial baseline, intervention and post-intervention trials, the color previously established as the more than cue was trained as the less than cue and vice versa in a second relational training intervention.

METHOD

Participants

In Experiment 3, there were two male British participants aged 25 and 27 (M = 26; SD = 1). Only individuals with a minimum SOGS score of 3 were recruited. One participant scored 6 on the SOGS (P7) and the other scored 5 (P8) indicating that both participants were potential pathological gamblers (M = 5.5, SD = 0.5).

Procedure

The procedure for Experiment 3 was identical for that of Experiment 2 with the exception of additional nonarbitrary training tasks that reversed the contextual cues. P7 was given 2 reversals (therefore, 3 training tasks in total) whereas P8 was only given one reversal. The number of reversal interventions given to the participants was predetermined. Participants were presented with a different number of reversals to examine the extent to which presenting multiple reversal training interventions would still exert control over responding. As in Experiment 2, the least preferred slot machine was targeted as the more than contextual cue for the first nonarbitrary training intervention, and this was only implemented once responding appeared stable (that is, preference feel within a range of two trials). The second (and third, in the case of P7) training intervention was also only implemented once stability had been achieved.

RESULTS AND DISCUSSION

Both participants completed the nonarbitrary relational training and testing phase (see Table 4). In the first nonarbitrary training task P7 completed the training phase after just one exposure to the task (i.e., 48 trials), whereas P8 required 2 exposures to the training task to the first nonarbitrary training task. Both participants passed the nonarbitrary test following just one exposure to the task. When presented with nonarbitrary training during the reversal interventions, both participants were able to respond accurately to the new relations that were established requiring only one exposure to pass both the nonarbitrary training and nonarbitrary testing tasks.

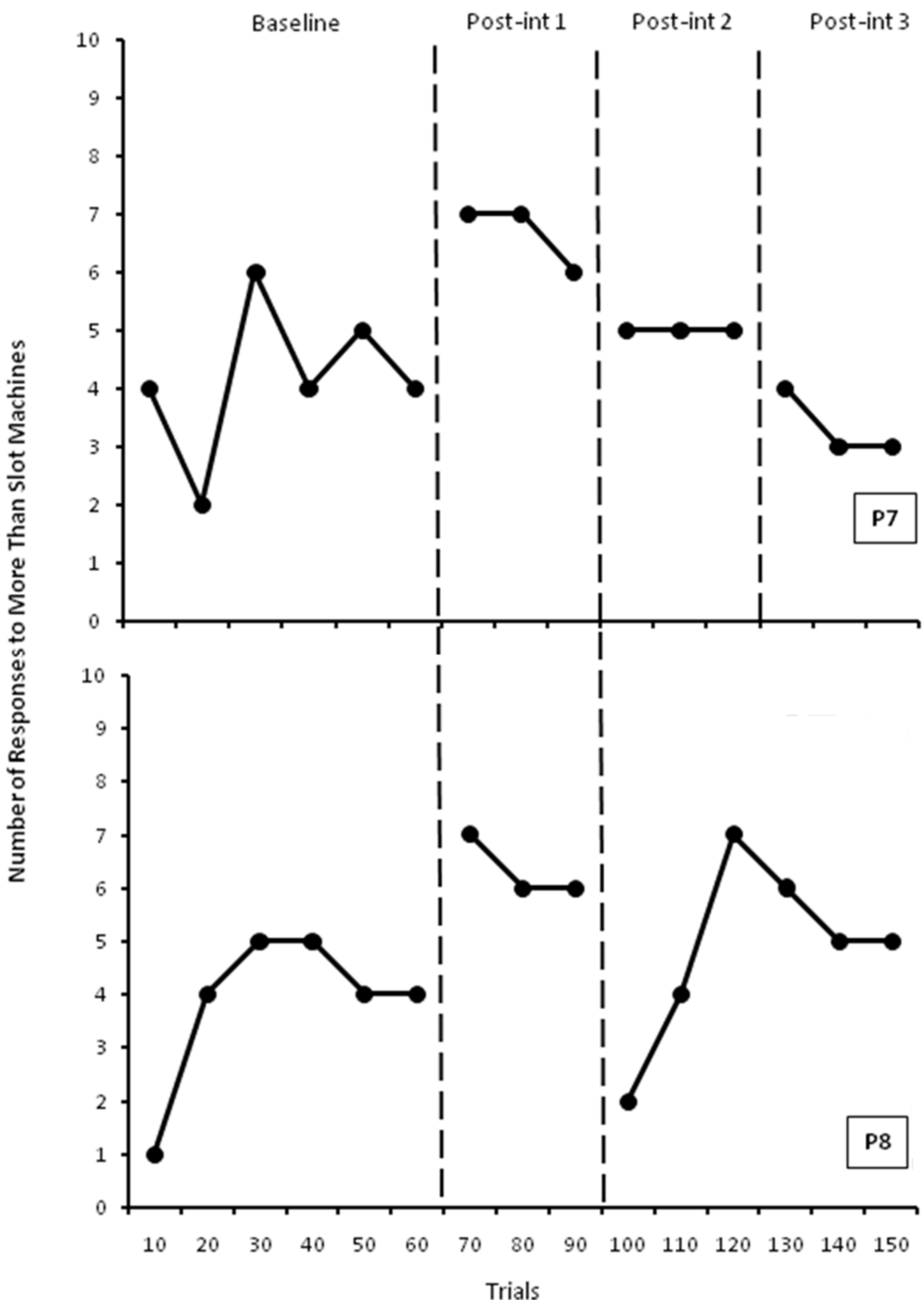
Figure 4 shows participants' preferences towards the more than slot machine. The upper panel depicts the responding made by P7, whereas the lower panel depicts responding made by P8. During baseline, both participants showed no clear preferences for either slot machine and responding stabilized after 60 trials. Following the first relational training intervention, both participants' preferences for the more than slot machine increased as predicted. Following the second relational training intervention, P7 showed equal response allocation to the more than slot machine, whilst responding by P8 approximated to that of the earlier post-intervention phase. P7 then received a third relational training intervention and subsequently showed a decreased preference for the more than slot machine. This is perhaps due to the interaction of the direct contingencies of the slot machines. From the data of P7 it appears that as more trials are undertaken, the effect of the contextual cue weakens and the payout probability exerts more control. In a similar way, P8 initially showed a slight increase for the more than slot machine following the first intervention, then following the second intervention showed a fairly equal preference for more than and the less than slot machine.

Overall, the findings of Experiment 3 demonstrated that problem gamblers' preferences for one or two concurrently available slot machines may be altered in accordance with a relational training intervention,

Table 4. The number and mean number (with standard deviation) of correct trials during the nonarbitrary relational training and testing phase in Experiment 3.

Participant	Nonarbitrary training (/48)	Nonarbitrary testing (/48)	*Reversal 1* Nonarbitrary training (/48)	*Reversal 1* Nonarbitrary testing (/48)	*Reversal 2* Nonarbitrary training (/48)	*Reversal 2* Nonarbitrary testing (/48)
7	45	47	43	47	43	48
8	35	-	43	48	-	-
	48	47	-	-	n/a	n/a
Mean	42.67	47	43	47.5	-	-
Standard deviation	6.81	0	0	0.71	0	0

Figure 4. Response allocation to the more than slot machine in baseline and post-intervention in Experiment 3. P7 is shown in the upper panel, and P8 in the lower panel.



however, where the contextual cues are reversed with an additional relational training and testing procedure the level of altered preferences decreases as further interventions are presented. This suggests that the effects of the intervention targeting the background colors interacted with the concurrent, matched schedule of programmed reinforcement, leading to diminished control by the background colors. Nastally et al. (2010) found that whilst nonproblems gamblers showed shifting preferences in slot machine preference when the contextual cues were reversed; this effect was diminished in the problem gambling group. Nastally et al (2010) suggested that these differences between the nonproblem gambling group and the gambling group could be the result of maladaptive rule formations (Delfabbro, 2004) and self –governed rule adherence which has been reported in clinical populations (Wulfert, Greenway, Farkas, Hayes, & Dougher, 1994). Given that the present study only employed potential problem gamblers, it is not possible to compare whether presenting additional reversals in which the contextual cues are switched, exerts more control in nonproblem gamblers compared to problem gamblers.

GENERAL DISCUSSION

The current experiments replicated the findings of Hoon et al. (2007, 2008) and extended them by using a design that allowed for a better demonstration of experimental control. In Experiment 1, a clear shift was seen in P1 and P2 who allocated the majority of trials to the more than slot machine following the nonarbitrary intervention. The effect was less clear in P3. Unfortunately, as P3 was given the shortest number of post-intervention trials, this did not allow for his responding to become stable and, therefore, preference cannot clearly be determined from his data. This participant also received the highest number of baseline trials and had therefore most experience of the direct contingencies of the slot machines prior to nonarbitrary training. For this reason, it is possible that the payout probabilities may have exerted greater control than the contextual cue. In Experiment 2, the number of baseline and post-intervention trials given to each participant were not predetermined, but instead responses were monitored until responding appeared stable. All three participants showed an increase in response allocation towards the more than slot machine following the intervention. Experiment 3 incorporated a reversal design and the results were particularly interesting, as the data show that with extended exposure to the contingencies of reinforcement and additional nonarbitrary training tasks, the control exerted by the nonarbitrary training intervention begins to diminish and the schedules of reinforcement appear to influence responding.

Across all experiments, every participant, except P3, showed an increase in preferences towards the more than slot machine in the first ten trials following the first intervention. This increased response allocation was not, however, always maintained during all post-intervention trials. The findings of the present experiments, particularly Experiment 3 are perhaps not quite as clear as the initial studies by Zlomke and Dixon (2006) and Hoon et al. (2007, 2008). The finding that participants do not always show a consistent preference for the more than slot machine following relational training is likely due to the payout probability of each slot machine: With the probability of the slot machines being 0.5, it is highly plausible that a participant may experience a string of losses on what has been trained as the 'more than' slot machine resulting in switching over to the slot machine that was the same color as the less than cue. A contextual cue can be trained to represent 'more than', however when that cue is paired with a random ratio schedule such as that of a slot machine, the direct contingencies of the schedule of reinforcement of that machine are also going to influence responding and may conflict with the individual's understanding of the properties of the contextual cue. Whilst it has long been understood that contingency-shaped behavior and the schedules of reinforcement are an important factor in gambling behavior (Skinner, 1974), the extent to which contextual cues may interact with or override direct contingencies of reinforcement are not clearly understood.

The interaction between the contextual cues and the contingencies of the slot machine highlight the need for research on the analysis of gambling behavior to present slot machine tasks under extinction (or, more accurately, non-reinforcement). Had participants only been able to play the slot machines but not actually experience any wins or losses (see Dymond, McCann, Griffiths, Cox & Crocker, 2012, for a related example), then the contextual cue may well have continued to control behavior. However, an obvious limitation of presenting trials under non-reinforcement is the challenge it presents to ecological validity: in a casino environment it is always possible that an individual will experience winning trials or variants of winning with conditioned reinforcement properties ("losses disguised as wins"; Dixon et al in Addiction). Thus, it remains an important empirical issue to ascertain the conditions under which partial and non-reinforcement interact with structural characteristics such as contextual cue in initiating and maintaining gambling choice. .

An alternative to presenting slot machines under non-reinforcement would be to vary the payout probability of the slot machine (Dymond et al., 2012). The payout probability of the slot machines in the present experiments was 0.5 with five credits being awarded for a winning spin; therefore participants were in credit at the end of the experiment. This is fairly generous compared to those of casino slot machines in which the payout probabilities favor the casino (Parke & Griffiths, 2006). It would be interesting to see to what extent the contextual cues exert control when the payout probability was set to 0.3 as wins would occur less frequently therefore the contextual cue may function as a more salient rule and continue to exert control over behavior.

Although the current findings may supplement the existing literature on the role of nonarbitrary contextual control of gambling behavior, such an explanation of gambling behavior is may not be complete. Electronic gaming machines are rarely, if ever, controlled solely by the formal properties of the stimuli and the nature of stimulus functions are beyond such formal characteristics. It has been suggested that for a more complete account of gambling behavior, the role of verbal behavior as defined by relational frame theory (RFT; Hayes, Barnes-Holmes, & Roche, 2001) must be addressed (Dymond & Roche, 2010). Although the studies by Zlomke and Dixon (2006), Hoon et al. (2008) and Nastally et al. (2010) have provided preliminary insight regarding how gambling may not be controlled solely by schedules of reinforcement alone, these experiments do not supplement a strictly verbal account of gambling as defined by RFT (Hayes et al., 2001). According to RFT, for an event to be considered a verbal event responding must be arbitrarily applicable. The training tasks in both of these experiments consisted of nonarbitrary relational responding, therefore non-humans should, in principle, be able to complete such tasks (see Reese, 1968) as the organism receives reinforcement for selecting the larger or smaller stimulus, and consequently, the organism is then able to respond to the relation between the stimuli (Hayes et al., 2001).

For these reasons, a nonarbitrary model of gambling cannot be considered a verbal account of gambling and experiments that aim to provide such an account must include the arbitrarily applicable nature of verbal behavior. Humans however, are able to respond to arbitrary relations in which there is no physical relation between the stimuli. For example, a human participant can be trained that stimulus B is 'more than' stimulus A, even though the physical properties of stimulus B are not any greater than stimulus A.

The second reason why the aforementioned studies are not true *verbal* experiments is that an integral component of the RFT account of verbal behavior is that of *derived* relational responding. In the present study, participants were directly trained that the color yellow was a contextual cue for more than and color blue was a contextual cue for less than. This training intervention is not dissimilar to non-human literature on identity matching to sample and oddity from sample, in which animals are trained to select the comparison stimulus that is the same (identity) in the presence of one sample stimulus, or the stimulus that is different (oddity) in the presence of another stimulus, through differential reinforcement (e.g., Cumming & Berryman, 1965). It is possible for humans, however, to derive relations between arbitrary stimuli that have not been directly trained. For example, if an individual is trained that stimulus B is more than A, and stimulus C is more than B; the individual is then able derive that A is less than B, and B is less than C. Furthermore, they can also derive that C is more than A, and A is less than C, therefore, from just two trained relations, the human participant is able to derive a further four untrained relations. Such principles have only been robustly demonstrated in human participants and may explain highly complex human behaviour where a direct contingency of reinforcement account falls short (Dymond et al., 2012; Dymond & Roche, 2010; Hayes et al., 2001). Given that it is unlikely that gambling behaviour can ever be wholly accounted for by schedules of reinforcement, it is vital that for a more complete account that includes the fundamental components of RFT outlined above be incorporated into further empirical research.

REFERENCES

Chambless, D. L., & Hollon, S. D. (1998). Defining empirically supported theories. *Journal of Consulting and Clinical Psychology, 66*, 1, 7-18.

Cooper, J. O., Heron, T. E., & Heward W. E. (2007). *Applied Behavior Analysis*. New Jersey: Pearson/Prentice Hall.

Cumming, W. W., & Berryman, R. (1965). The complex discriminated operant: studies of matching-to-sample and related problems. In D. I. Mostofsky (Ed.), *Stimulus generalization (pp. 284-330)*. Stanford: University Press.

Dixon, M. R., & Holton, B. (2009). Altering the magnitude of delay discounting by pathological gamblers. *Journal of Applied Behavior Analysis, 42*, 269-275.

Dixon, M. J., Harrigan, K. A., Sandhu, R., Collins, K., Fugelsang, J. A. (2010). Losses disguised as wins in modern multi-line video slot machines. Addiction, 105, 1819-1824.

Dymond, S., McCann, K., Griffiths, J., Cox, A., & Crocker, V. (2012). Emergent response allocation and outcome ratings in slot machine gambling. *Psychology of Addictive Behaviors*, *26*(1), 99-111.

Dymond, S., & Roche, B. (2010). The impact of derived relational responding on gambling behavior. *Analysis of Gambling Behavior, 4*, 38-53.

Eckerman, D. A. (1970). Generalization and response mediation of a conditional discrimination. *Journal of the Experimental Analysis of Behavior, 13*, 301-316.

Fredheim, T., Ottersen, K., & Arntzen E. (2008). Slot-machine preferences and self-rules. *Analysis of Gambling Behavior, 2*, 35-48

Griffiths, M. D. (1990). The acquisition, development and maintenance of fruit machine gambling in adolescents. *Journal of Gambling Studies, 6,* 193-283.

Harvey, M. T., May, M. E., & Kennedy, C. H. (2004). Nonconcurrent multiple baseline designs and the evaluation of educational systems. *Journal of Behavioral Education, 13*, 267–276.

Hayes, S. C., Barnes-Holmes, D., & Roche, B. (2001). *Relational Frame Theory; A Post-Skinnerian Account of Human Language and Cognition.* New York: Kluwer Academic/Plenum Publishers

Hoon, A., Dymond, S., Jackson, J. W., & Dixon, M. R. (2007). Manipulating contextual control over simulated slot machine gambling. *Analysis of Gambling Behavior, 1*, 109-122.

Hoon, A., Dymond, S., Jackson, J. W., & Dixon, M. R. (2008). Contextual control of slot machine gambling: Replication and extension. *Journal of Applied Behavior Analysis*, *41*, 467-470.

Johnson, T. E. & Dixon, M. R. (2009). Influencing children's pregambling game playing Via conditional discrimination training. *Journal of Applied Behavior Analysis, 42*, 73-81.

Kennedy, C. H. (2005). *Single-Case Designs for Educational Research*. Boston: Pearson Education/Allyn and Bacon,.

Lesieur, H. R., & Blume, S. B. (1987). The South Oaks gambling screen (SOGS): A new instrument for the identification of pathological gamblers. *American Journal of Psychiatry, 144*, 1184–1188.

Loba, P., Stewart, S. H., Klein, R. M. & Blackburn, J. R. (2001). Manipulations of the features of standard video lottery terminal (VLT) games: Effects in pathological and non-pathological gamblers. Journal of Gambling Studies, 17, 4, 297-320.

Nastally, B. L., Dixon, M. R., & Jackson, J. W. (2010). Manipulating slot machine preference in problem gamblers through contextual control. *Journal of Applied Behavior Analysis, 43,* 125-129.

Parke, J., & Griffiths, M. (2006). The psychology of the fruit machine: The role of structural characteristics (revisited). *International Journal of Mental Health Addiction*, 4, 151–179.

Sharpe, L., Walker, M., Coughlan, M., Enerson, K., & Blaszczynski, A. (2005). Structural changes to electronic gaming machines as effective harm minimization strategies for non-problem and problem gamblers. *Journal of Gambling Studies, 21*, 4, 503-520.

Skinner, B. F. (1974). *About behaviorism*, New York: Vintage Books.

Watson, P. J., & Workman, F. A. (1981). The non-concurrent multiple baseline across-individuals design: An extension of the traditional multiple baseline design. *Journal of Behavior Therapy and Experimental Psychiatry, 12*, 3, 257-259.

Zlomke, K.R., & Dixon, M.R. (2006) Modification of slot-machine preferences through the use of a conditional discrimination paradigm. *Journal of Applied Behavior Analysis,* 39, 351-361.

Action Editor: **Mark R. Dixon**