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MANIPULATING CONTEXTUAL CONTROL OVER SIMULATED SLOT MACHINE GAMBLING

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Situational or contextual factors involved in slot machine gambling, such as colors, are assumed to play an important role in initiating and maintaining gambling. However, there is little empirical evidence for this assumption. The present study sought to investigate the effects of manipulating two contextual factors (the background colors of computer-simulated slot machines) on participants' responding to two concurrently available slot machines. Following a pretest, a nonarbitrary relational training and testing procedure was used to establish contextual functions of MORE-THAN and LESS-THAN for two cues. During posttest, participants allocated the majority of their responses to the slot machine that shared nonarbitrary properties with the contextual cue for MORE-THAN, despite the identical payout probabilities of the slot machines. Overall, the present findings demonstrate that participants' preferences for one of two concurrently available slot machines may come under contextual control. The advantages of the present approach to investigating the role played by situational factors such as colors in maintaining slot machine gambling are discussed.

Key words: situational factors, background colors, nonarbitrary relational training and testing, slot machines.

It is widely assumed that the situational or contextual factors involved in slot machine gambling, such as lights, colors, and sound effects, play an important role in either initiating or maintaining gambling (see Parke & Griffiths, 2006; in press). However, empirical support for these assumptions is limited. Indeed, a recent report by the British Medical Association (2006), highlighted that, although situational characteristics are "thought to influence vulnerable gamblers, there has been very little empirical research into these factors and more research is needed before any definitive conclusions can be made about the direct or indirect influence on gambling behaviour and whether vulnerable individuals are any more likely to be influenced…" (p. 13). Therefore, further research on the role played by contextual factors in initiating and maintaining gambling is needed.

One way of manipulating contextual factors is to employ a laboratory simulated gambling task, such as a slot machine, and to vary features such as background colors while keeping all other aspects of the gambling environment constant. It may then be possible to identify occasions under which the contextual control exerted by such features influences the likelihood that gamblers come into contact with the programmed

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contingencies. This was the approach adopted by the present study.

Our aim was to investigate the effects of manipulating two contextual factors (the background colors of computer-simulated slot machines) on participants' responding to two concurrently available slot machines. Specifically, we sought to replicate and extend a previous study by Zlomke and Dixon (2006), who showed that contextual functions of more-than and less-than attached to two background contextual colors (yellow and blue, respectively) systematically altered participants' preferences for one of two concurrently available slot machines. Following a pretest assessment of participants' responding to two concurrently available slot machines that differed only in background color, participants received a nonarbitrary relational training and testing intervention that established the yellow and blue colors as contextual cues for MORE-THAN and LESS-THAN responding, respectively. Specifically, selecting a comparison gambling stimulus (e.g., playing cards, U.S. money) of greater quantity than the sample was reinforced in the presence of a yellow background and selecting a comparison of a lesser quantity than the sample was reinforced in the presence of a blue background. Training was conducted using three stimulus sets and testing subsequently occurred with three novel sets without feedback. Then, during a posttest phase, Zlomke and Dixon showed that participants allocated more responding to the slot machine with the background color that had the contextual functions of MORE-THAN, despite both machines having identical schedules and magnitudes of reinforcement.

The findings of Zlomke and Dixon provide empirical support for the role played by situational factors in maintaining slot machine gambling. Indeed, the effectiveness of the brief nonarbitrary relational training intervention suggests a novel way of further investigating the relational contextual involved in gambling functions (Dixon & Delaney, 2006; Hayes, Barnes-Holmes, & Roche, 2001). Nonarbitrary relational training and testing procedures are a defining feature of research on multiple stimulus relations (e.g., Dymond & Barnes, 1995; Roche & Dymond, in press; Whelan, Barnes-Holmes, & Dymond, 2006). Studying multiple stimulus relations first involves training specific functions for contextual cues using nonarbitrary stimuli related along formal, physical dimensions. Imagine, for example, that we wish to train and test the multiple stimulus relations of more-than and less-than. In the nonarbitrary training phase, a contextual cue, a sample, and two or more comparison stimuli are usually presented on each trial. For instance, Dymond and Barnes (1995) established three cues as contextual cues for the nonarbitrary relational functions of same, more-than and less-than, respectively, by reinforcing selections of stimuli of differing quantities depending on which cue was presented. For example, in the presence of the MORE-THAN cue, a 6-star sample, and 3-star and 9-star comparisons, selecting the 9-star comparison was reinforced. On the other hand, given this task arrangement, in the presence of the LESS-THAN cue selecting the 3-star comparison was reinforced. Participants were trained in this manner with several stimulus sets and were tested with novel sets without feedback. The next stage in a study on multiple stimulus relations is to then employ the contextual cues to establish arbitrarily applicable relations among stimuli that are not formally related. However, because Zlomke and Dixon were only concerned with the first stage, we will not address the second, arbitrary stage (see Barnes-Holmes, Hayes, Dymond, & O'Hora, 2001; Dymond and Barnes, 1995).

When training MORE-THAN and LESS-THAN cues it is important that reinforcement is contingent on selecting comparisons that are physically more than and less than the sample stimuli, respectively (e.g., Dymond & Barnes, 1995; Whelan et al., 2006). Zlomke and Dixon used nonarbitrary stimulus sets consisting of gambling-relevant stimuli (e.g., playing cards) and monetary values (e.g., US dollar bills and coins). Similarly, it is important when training MORE-THAN and LESS-THAN that only two comparisons be used because if three comparisons of differing size are presented and selections of one are reinforced, the stimulus control governing the other two comparisons remains unspecified.

A central feature of Zlomke and Dixon's procedure may, in fact, have contributed to their findings because during nonarbitrary relational training, three comparison stimuli were presented on each trial. As specified above, this is problematic because it may lead to the ambiguous situation in which, for example, given the MORE THAN cue with $5 as the sample and $1, $10 and $20 as the comparisons, there would be two correct choices (i.e., $10 and $20 are both more than the $1 sample). In order to address this, we set about systematically replicating Zlomke and Dixon (2006) using a nonarbitrary relational training and testing procedure in which two comparisons were presented on every trial. In what follows, we report the findings of three experiments that systematically manipulated features of the nonarbitrary relational training and testing phases in order to shift participants' preferences for one of two concurrently available slot machines.

EXPERIMENT 1
METHOD

Participants

Six undergraduates (1 male, 5 female), with a mean age of 20.17 years (*SD*: 1.47), participated for course credit. All participants completed the *South Oaks Gambling Screen* (SOGS; Lesieur & Blume, 1987), which is the most commonly used assessment instrument to reveal potential problems with gambling. Participants' SOGS scores ranged from 0-3 (*M*: 0.67; *SD*: 1.21) indicating that none had a pathological gambling problem (i.e., a score of 5 or higher).

Apparatus and Setting

The experiment was conducted in a small room containing a computer programmed in Visual Basic 2005 that controlled all stimulus presentations and recorded all responses. The first author (A.H) recruited participants and conducted all experiments.

Procedure

There were three phases; a slot machine pretest, nonarbitrary relational training and testing, and a slot machine posttest.

Slot machine task pretest: This phase was near-identical to that of Zlomke and Dixon (2006). Participants were presented with the following 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, participants were presented with a grey screen that contained a red button in the centre of the screen with the instruction, "click here". Clicking the red button took the participants to a new screen presenting a blue rectangular box labelled Slot Machine 1, and a yellow rectangular box labelled Slot Machine 2. These boxes were approximately 6 cm by 2.5 cm and were randomly positioned on opposite sides of the bottom of the screen across trials.

To play a slot machine, participants clicked on the "bet credit" button, which enabled the "spin" button to become

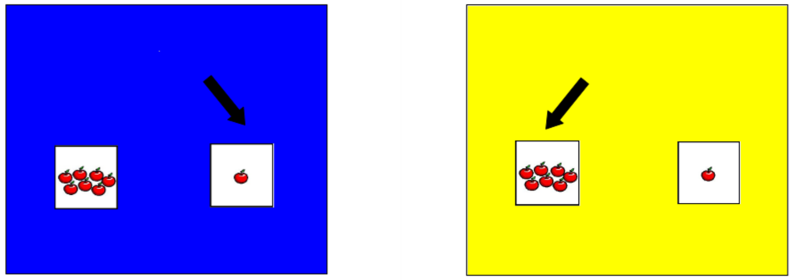

Figure 1: Examples of the screen layout from the nonarbitrary relational training and testing phases. The screen on the left shows an example of a trial used to train contextual functions of LESS-THAN for the blue background color, while the screen on the right shows an example of a trial used to train contextual functions of MORE-THAN for the yellow background color. Arrows indicate the predicted correct comparisons.

available. All participants started with 100 credits and could only bet one credit at a time. Clicking the spin button caused the reels to spin. The reels spun for approximately 3 s. Sound effects resembling actual slot machines were played as the reels spun. A winning spin consisted of three identical symbols on the pay off line, and resulted in one credit being awarded to the participant in the "Total Credits" box at the top left of the screen and one credit being displayed in the "Amount Won" box at the top right of the screen. A losing spin consisted of two matching symbols or no matching symbols and one credit was subtracted from the Total Credits. After playing a slot machine, a button instructing the participant to "Click here to continue" became highlighted and took the participant back to the initial grey screen.

A concurrent random ratio schedule of reinforcement was in effect with a probability of reinforcement of .5 (i.e., every response had a 50% probability of a win). Each component of the schedule required one credit to spin, and the magnitude of reinforcement was held constant (i.e., one credit net gain or loss) such that all participants ended the task with the same number of credits. The components differed only in color (i.e., yellow or blue). This phase consisted of 50 trials.

Nonarbitrary relational training and testing: The aim of this phase was to establish the contextual functions of MORE THAN and LESS THAN for the yellow and blue background colors, respectively. There were three sets of three stimuli. Each set of stimuli consisted of three images representing three different quantities; least amount, intermediate and most. This generated three trial types for each set of stimuli: Less-than (least)/more-than (intermediate), less-than (least)/more-than (most) and less-than (intermediate)/more-than (most). Because each trial was presented with both contextual cues, this generated six trials for each set of stimuli. The three sets of stimuli were apples (1, 4, 7), basketballs (1, 2, 8) and beakers (1, 3, 6). Each image was approximately 5cm by 4cm.

The contextual cue (background screen color) appeared first followed by the two comparison stimuli side by side at the bottom of the screen. During training, feedback (i.e., "correct," "wrong") was immediately presented in the center of the screen for 1.5 s following a response. All trials were followed by an intertrial interval of 2.5 s. When the MORE THAN contextual cue (i.e., yellow) was presented, selecting the greater, relative quantity comparison was reinforced. When the LESS THAN contextual cue (i.e., blue)

Table 1
Showing the number of correct responses made by participants during the nonarbitrary relational training and testing phases in Experiment 1. [1] Indicates pass or fail status for test block (F = fail; P = pass).

Participant	Nonarbitrary relational training Correct responses out of 36 (min. 32)	Nonarbitrary relational testing Correct responses out of 36 (min. 36)
1	21	
	34	36P[1]
2	20	
	22	
	34	17F
	28	
	33	23F
	30	
	29	
	32	18F
3	14	
	19	
	37	36P
4	30	
	33	0F
	33	5F
	36	15F
5	29	
	35	34F
	36	36P
6	34	36P
Mean	29.47	23.27
SD	6.5	13.3

was presented, selecting the lesser, relative quantity comparison was reinforced (see Figure 1).

Participants were given the following instructions:

> During this phase of the experiment you will be presented with two images on screen surrounded by another image. You must learn to always choose the correct image on the screen.

There were a total of 36 trials and participants had to reach a criterion of 32 successive correct responses before progressing to the testing phase. If a participant did not reach criterion responding, they were exposed to the training phase again. If a participant failed to achieve criterion after three consecutive training blocks then the program terminated and the participant was excused.

Immediately upon reaching criterion, participants were exposed to the nonarbitrary relational test in which the following three novel stimulus sets were presented: toy blocks (1, 3, 7), red dots (3, 5, 9) and hats (1, 3, 7). No feedback was presented after any trial, and participants had to respond correctly across 36 consecutive trials in order to progress to the next phase. If a participant failed to

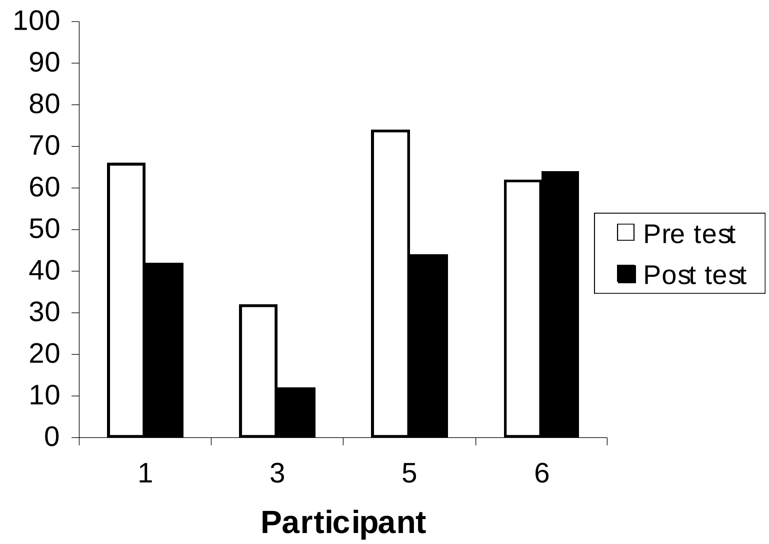

Figure 2: Percentage of responses allocated to the preferred yellow (more than) slot machine during pretest and posttest exposures for the four participants who passed nonarbitrary relational training and testing in Experiment 1.

achieve this criterion, he/she was re-exposed to the nonarbitrary relational training before again receiving the nonarbitrary relational test for a maximum of three times. It is important to note that during the nonarbitrary relational training and testing phase, the colors of the MORE-THAN and LESS-THAN cues were not counterbalanced across participants.

Slot machine task posttest: Again, this phase was identical to pretest and that of Zlomke and Dixon (2006).

EXPERIMENT 1 RESULTS & DISCUSSION

Table 1 shows that Participants 2 and 4 failed to achieve criterion by their third exposure to the nonarbitrary relational testing phase and were excused from the experiment. The remaining participants required either one or two exposures to the nonarbitrary relational test to meet criterion.

Figure 2 shows the percentage of responses allocated to the yellow slot machine at pretest and posttest. It can be seen that three participants showed a decrease in the percentage of responses allocated to the yellow slot machine. Indeed, only Participant 6 showed a 2% increase in preference for the yellow slot machine.

Experiment 1 failed to replicate the findings of Zlomke and Dixon (2006). There are several possible explanations for this. First, a total of six stimulus sets were used during nonarbitrary relational training and testing. Previous research has employed up to eight stimulus sets, and results suggest that nonarbitrary contextual control may be more readily acquired using a greater number of relevant exemplars (e.g., Dymond & Barnes, 1995; Whelan et al., 2006). Second, in order to test whether the background colors were functioning as contextual cues for MORE-THAN and LESS-THAN, a sorting task was introduced following nonarbitrary training and testing. In the sorting task, which was based on unpublished procedures used by Zlomke and Dixon (2006), participants were presented with novel stimuli (e.g., the word "Jackpot") and were instructed to select one of the two slot machines, blue or yellow. As no feedback was presented following any trial, the sorting task allows for a procedural check that the two slot machines are functioning as contextual cues for MORE-THAN and LESS-THAN when presented in a novel, matching-to-sample (MTS) format. Previous findings from research on stimulus class formation demonstrate a close correspondence between MTS test outcomes and sorting tasks (e.g., Smeets, Dymond, & Barnes-Holmes, 2000). Therefore, Experiment 2 sought to use eight stimulus sets during nonarbitrary relational training and testing and to employ a sorting task prior to the slot machine posttest phase.

EXPERIMENT 2
METHOD

Participants

Six participants (all female), with a mean age of 20.4 years (*SD*: 0.55), participated for course credit. Participants' SOGS scores ranged from 0-1 (*M*: 0.33; *SD*: 0.52).

Procedure

The procedure for Experiment 2 was identical to that of Experiment 1 except for the following important differences. First, new instructions were employed at the outset of the nonarbitrary relational training and testing phase. These instructions were:

> Later, you will be required to do complete a learning task. You must learn to choose the correct stimulus. For the first part of the task you will be given feedback and points will be awarded. For the second part, no feedback will be given, however the computer is still logging your score so please continue to choose the correct stimulus. Please note the change in the background color on the screen. The harder you try, the faster you will finish.

Second, eight sets of stimuli were used in the nonarbitrary relational training and a further eight novel sets were used in the nonarbitrary relational test. The eight sets of stimuli were: apples (1, 4, 7), basketballs (1, 2, 8), beakers (1, 3, 6), toy blocks (1, 3, 7), red dots (3, 5, 9), hats (1, 3, 7), cherries (4, 6, 18) and ladybirds (2, 4, 8), pictures of leaves (1, 3, 5), traffic lights (1, 3, 4), boats (1, 2, 3), pencils (1, 2, 3), pigs (3, 12, 18), tractors (1, 2, 3), turtles (2, 3, 4) and pumpkin lanterns (1, 2, 3). A total of 48 trials were presented in both the nonarbitrary relational training and testing phases. In the training phase, participants were required to emit 43 correct successive responses in order to progress to the test phase. To complete the test phase, participants were required to emit 48 correct responses to achieve criterion. The predetermined exposure criterion for the nonarbitrary relational test was omitted for Experiment 2.

Third, a sorting task was introduced following the nonarbitrary relational test phase. Participants were given the following on screen instructions:

> Your job is to put each image at the top of the screen into the correct box. Click on the image and drag into one of the two boxes at the bottom of the screen. You will not receive any points for your response. Do your best to place the images correctly.

Participants were presented with an on-screen blue rectangular box labeled Slot Machine 1 and a yellow rectangular box labeled Slot Machine 2. Situated directly above the two rectangles were two smaller images approximately 3cm by 3cm. Three of these images were randomly taken from the stimulus sets used during the nonarbitrary relational training and testing phase, while another three were novel stimuli consisting of the words 'Save'/'Gamble', 'Jackpot'/'Bankrupt' and 'Good'/'Bad'. Participants were required to click on each image, drag it and drop it using the computer-mouse on to one of the two rectangular boxes labeled Slot Machine 1 or Slot Machine 2. A total of 28 trials were presented and no

Table 2
Showing the number of correct responses made by participants during the nonarbitrary relational training and testing phases. [1] Indicates pass or fail status for test block (F = fail; P = pass).

Participant	Nonarbitrary relational training Correct responses out of 48 (min. 43)	Nonarbitrary relational testing Correct responses out of 48 (min. 48)
7	28	
	28	
	22	
	31	
	39	
	49	48P[1]
8	25	
	21	
	31	
	44	47F
	48	48P
9	21	
	23	
	47	48P
10	25	
	28	
	20	
	37	
	49	48P
11	47	48P
12	47	48P
Mean	33.81	47.86
SD	10.89	0.38

feedback was given.

EPERIMENT 2 RESULTS & DISCUSSION

Table 2 shows that all participants passed the nonarbitrary relational training and testing phase, with only one participant (P8) requiring a second test exposure. Because the sorting task phase involved a fixed number of trials with no feedback, no results will be described for this phase.

Figure 3 shows the percentage of responses allocated to the yellow slot machine at pretest and posttest. It can be seen that four out of six participants showed an increase in the percentage of responses allocated to the yellow slot machine.

The findings of Experiment 2 improved upon those obtained during Experiment 1 and bear more of a resemblance to those obtained by Zlomke and Dixon (2006). The use of eight stimulus sets during nonarbitrary relational training and a further eight novel sets during nonarbitrary relational testing clearly facilitated all participants in passing the relational test. As such, these findings support those of previous studies on multiple stimulus relations (e.g., Dymond & Barnes, 1995; Whelan et al., 2006) and extend the effect to slot machine gambling. The use of the sorting task may also have facilitated the results of Experiment 2.

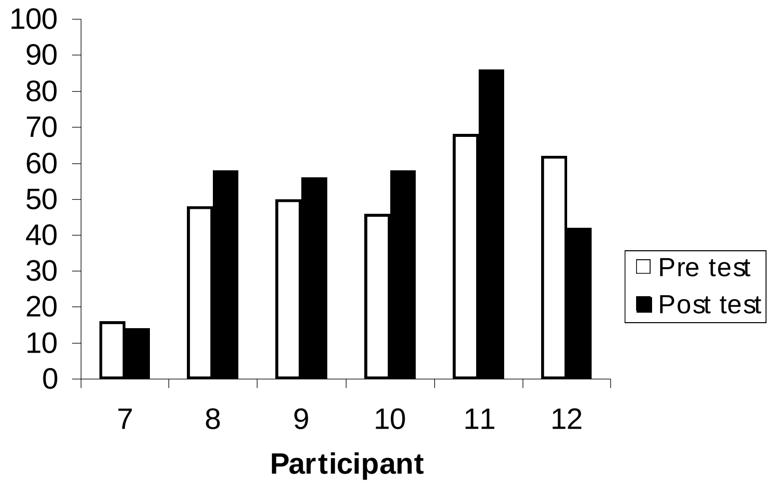

Figure 3. Percentage of responses allocated to the preferred yellow (more than) slot machine during pretest and posttest exposures for all participants in Experiment 2

At this stage in our efforts to replicate Zlomke and Dixon, we had shown that participants' slot machine preferences may come under the contextual control of two color cues that were established using a nonarbitrary relational procedure in which two comparisons, not three, were presented and that a greater shift in preferences was observed when a greater number of stimulus sets were employed. However, a key difference remains between the procedures used by Zlomke and Dixon and those used in Experiment 2. Zlomke and Dixon used gambling-relevant stimuli during nonarbitrary relational training and testing in order to establish the relational frame of comparison (i.e., more-than/less-than), whereas the current experiments have employed nonarbitrary stimuli that differed in terms of quantity. From the perspective of relational frame theory, comparative relational frames are involved whenever one event is responded to in terms of a quantitative relation along a specified physical dimension with another event (Hayes et al., 2001). The stimuli used in Experiments 1 and 2 differed along the physical dimension of quantity, which, while effective in establishing contextual cue for the background colors, are not the only way of training and testing nonarbitrary contextual control for use in a gambling context. As Zlomke and Dixon showed, stimulus sets from a gambling context like monetary amounts may also be used because the physical dimension is clearly specified. Experiment 3 aimed to see if using gambling-relevant stimuli would lead to participants showing a greater increase in preference for the yellow slot machine as a result of the two-comparison nonarbitrary training and testing task.

EXPERIMENT 3
METHOD

Participants

Six participants (5 male, 1 female), with a mean age of 21.4 years (*SD*: 1.14), participated in return for £5. Participants' SOGS scores ranged from 0-1 (*M*: 0.33; *SD*: 0.52).

Procedure

The procedure for Experiment 3 was identical to Experiment 2 except for the

Table 3
Showing the number of correct responses made by participants during the nonarbitrary relational training and testing phases. [1] Indicates pass or fail status for test block (F = fail; P = pass).

Participant	Nonarbitrary relational training Correct responses out of 48 (min. 43)	Nonarbitrary relational test Correct responses out of 48 (min. 48)
13	46	48P[1]
14	43	48P
15	45	48P
16	22	
	29	
	30	
	32	[withdrew]
17	42	
	48	48P
18	20	
	24	
	27	
	35	
	43	47F
		[withdrew]
Mean	34.71	47.80
SD	9.67	0.45

following two important differences. First, gambling relevant nonarbitrary stimuli were employed. Participants were trained with the following eight sets of stimuli in the nonarbitrary relational training phase: coins (1p, 20p, £1), pound notes (£5, £20, £50), dice (1, 4, 6), jackpots (5 million, 10 million, 20 million), poker chips ($5, $25, $500), positions (1st, 8th 10th), playing cards (4, 9 and King of spades) and letter grades (A+, C+, D-). Second, unlike in Experiment 2, participants in Experiment 3 were not presented with novel stimuli during the nonarbitrary relational test. Instead, the eight stimulus sets were presented in the absence of feedback for a total of 48 trials.

EXPERIMENT 3 RESULTS & DISCUSSION

Table 3 shows that four of six participants passed the nonarbitrary relational test on their first exposure. The remaining two participants withdrew from the experiment; P18 after making 47/48 correct responses during the test and P16 before being exposed to the test. Because, as in Experiment 2, the sorting task phase involved a fixed number of trials with no feedback, no results will be described for this phase.

As shown in Figure 4, three participants showed an increase in the percentage of responses allocated to the yellow slot machine, and one participant showed an increased preference for the blue slot machine. It appears, therefore, that the modifications incorporated into Experiment 3 resulted in the predicted performance (an increase in preference for the yellow slot machine at posttest) in three of the four participants.

GENERAL DISCUSSION

The findings of the present series of experiments systematically replicate and extend those of Zlomke and Dixon (2006).

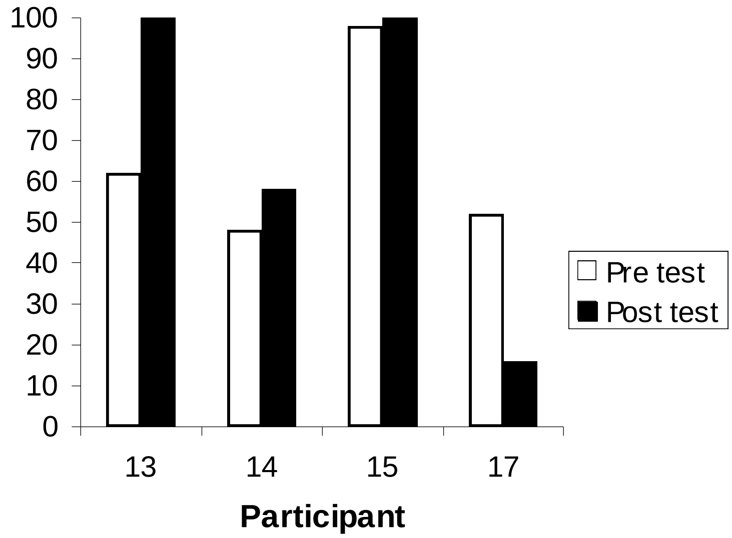

Figure 4. Percentage of responses allocated to the preferred yellow (more than) slot machine during pretest and posttest exposures for the four participants who passed nonarbitrary relational training and testing in Experiment 3.

Experiment 1 showed that a nonarbitrary relational training and testing procedure in which two comparisons were presented on every trial was sufficient to establish contextual control for the two background colors. However, the use of six stimulus sets during the nonarbitrary relational phase may not have been sufficient to establish contextual control as none of the participants produced the predicted performance. Experiment 2 employed eight stimulus sets and a sorting task prior to the slot machine posttest phase and four out of six participants showed an increase in the percentage of responses allocated to the yellow slot machine. Experiment 3 replicated the finding of Experiment 2 with eight sets of gambling-relevant stimuli. Overall, the present findings demonstrate that participants' preferences for one of two concurrently available slot machines may come under contextual control by ostensive situational factors (background colors). Furthermore, the findings show that participants' preferences may come to be controlled by these contextual factors even though the concurrently available slot machines were identical in payout probability and magnitude of reinforcement.

At this stage in our efforts to replicate and extend Zlomke and Dixon's study, we conducted one final experiment in which participants were presented with four stimulus sets of gambling-relevant stimuli during nonarbitrary relational training and another four novel stimulus sets during nonarbitrary relational testing. We also omitted the sorting task phase. The findings of that final experiment demonstrated that all six participants allocated the majority of their responses to the slot machine that shared nonarbitrary properties with the contextual cue for more than (Hoon, Dymond, Jackson, & Dixon, in press). Figure 5 summarizes the findings of the present study, along with those of Hoon et al. (in press), by showing the mean difference percentage of responding allocated to the yellow slot machine at pretest and posttest. As can be seen, the mean percentage difference increased from Experiment 2, with the greatest difference being observed in the

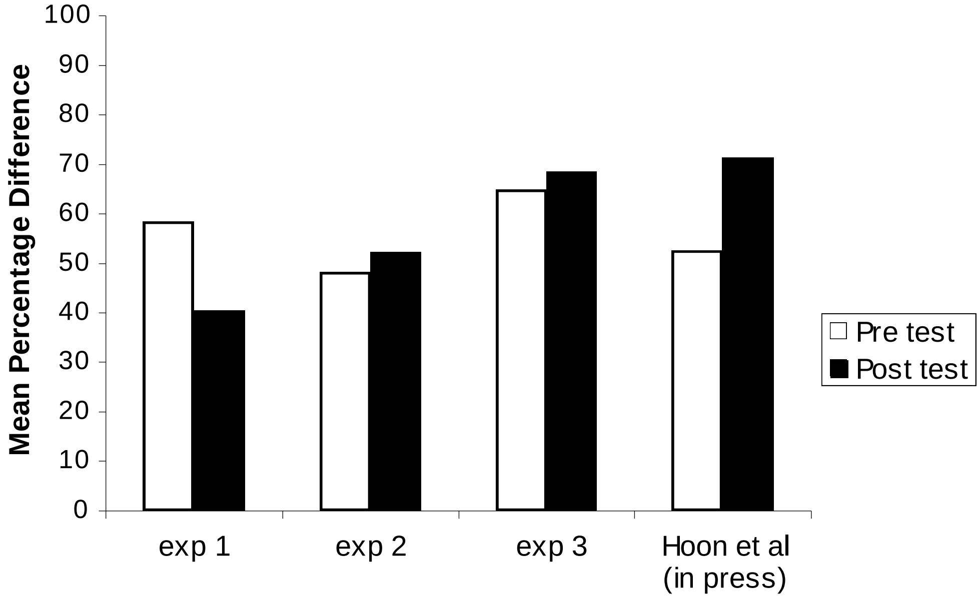

Figure 5. The mean percentage difference in responses allocated to the preferred yellow (more than) slot machine during pretest and posttest exposures for each of the four Experiments (note that Experiment 4 refers to data from the Hoon et al., in press, study).

Hoon et al. (in press) study (Experiment 4). This demonstrates that our systematic manipulation of situational factors – background colors of slots machines – lead to predictable increases in the proportion of responses allocated to the slot machine that was formally similar to the MORE-THAN contextual cue. The relational training and testing intervention increased in effectiveness across the experiments reported here and that of Hoon et al. (in press), as measured by the number of participants who passed the test block and the resulting difference in slot machine preferences at posttest. Our findings indicate that nonarbitrary contextual control of more-than and less-than relational responding is best acquired using a two-comparison arrangement in which multiple exemplars of stimuli differing in gambling-relevant physical dimensions are employed.

What then are the implications of the present study for understanding the development and maintenance of gambling preferences in naturalistic settings? Do the procedures, borrowed from research on derived relational responding, speak to the verbal, rule-based processes that constitute much of human gambling (Weatherly & Dixon, 2007)? Research on derived relational responding provides a functional-analytic definition of verbal stimuli as stimuli that acquire some of their functions by virtue of participation in relational frames. Functionally defining verbal behavior in this way allows for an empirical investigation of the intriguing possibility that, for verbally able humans, all gambling is derived, verbal activity. By this, it is meant that many of the events that induce and maintain gambling are "discriminative-like", or verbally constructed, and that the behavioral processes involved differ from those seen with nonhumans. In the context of the present study, it is important to note that none of the effects observed were *derived*. That is, the contingencies at pretest/posttest were identical and the contextual cues were directly trained. We did not, for instance, establish the cues as stimuli in a derived equivalence relation and test with presentations of the remaining stimuli. To this end, the present approach should be replicated with stimuli that participate in derived relations. Also, because no effects were derived in the present study, it is possible that the procedures could be adapted for use with nonhumans. Virtually all nonhuman species studied have yet to unequivocally demonstrate derived relational responding, yet a vast literature attests to the ability of nonhumans to emit nonarbitrary relational responding that is controlled by formal features of the environment (e.g., Reese, 1968). Therefore, future research on gambling should seek to extend the present analyses to derived relational responding and to paradigms adapted for nonhuman research. The two approaches can work in tandem because, while nonhuman research still has an important role to play in the behavior analysis of gambling, it is in the arena of human operant behavior that further understanding is needed (Weatherly & Dixon, 2007).

The present findings suggest that the types of self-rules emitted by gamblers (e.g., “this is my favorite slot; it always pays out way more than the others”) may, in fact, actually be better considered fallacies because payout probabilities were identical for both slot machines in the pretest and posttest phases. This suggests that self-rules may persist despite the relatively low reinforcement of such rules. The fact that fallacies such as this can develop in non-pathological gamblers may help to illustrate how easy it would be for pathological gamblers to develop an illogical self-rule, especially as it has been suggested that part of the reason pathological gamblers develop problems with gambling is due to their irrational beliefs (Delfabbro, 2004). The present series of experiments offers one means of investigating, from a behavior-analytic perspective, the role of such beliefs, rules, or other verbal activity in the maintenance of slot machine gambling.

The present study has several limitations that future research should address, such as the fact that the contextual functions were not counterbalanced across participants. An alternative intervention to counterbalancing the contextual cues might be to explicitly target the non-preferred color of slot machine at pretest as the MORE THAN cue. Additionally, future studies might employ a research design such as a nonconcurrent multiple baseline design in order to overcome the limitations of the pretest/posttest design. Indeed, another way of demonstrating functional control over participants’ preferences and helping to eliminate the possibility of whether or not participants surmised the purpose of the posttest exposure to the slot machine phase would be to employ a group of ‘relational control’ participants who do not receive the nonarbitrary relational training and testing phases (see Dymond & Rehfeldt, 2000). If the proportion of responses allocated at “pretests” and “posttest” are similar, then it suggests that the nonarbitrary relational phases were necessary for the predicted performances to emerge. Future research might also consider manipulating the payout probabilities of the slot machines and juxtaposing the reinforcement schedules with the trained contextual cues; would the reinforcement schedules or contextual cues control the greatest shift of preferences? The long-term stability of the posttest performance should also be examined, particularly under extinction contingencies that differ from pretest. In sum, much work remains to be conducted on the role of contextual factors in initiating and maintaining slot machine gambling.

REFERENCES

Barnes-Holmes, D., Hayes, S. C., Dymond, S., & O'Hora, D. (2001). Multiple stimulus relations and the transformation of stimulus functions. In Hayes, S. C., Barnes-Holmes, D., & Roche, B. (Eds.), *Relational frame theory: A post-Skinnerian account of human language and cognition* (pp. 51- 71). New York: Kluwer Academic/Plenum.

British Medical Association. (2006). *Gambling addiction and its treatment within the NHS: A guide for healthcare professionals*. BMA: Board of Science.

Delfabbro, P. (2004). The stubborn logic of regular gamblers: Obstacles and dilemmas in cognitive gambling research. *Journal of Gambling Studies*, *20*, 1-21.

Dixon, M. R. & Delaney, J. (2006). The impact of verbal behavior on gambling. In P. M. Ghezzi, C. A. Lyons, M. R. Dixon, and G. R. Wilson (Eds.), *Gambling: Behavior theory, research and application* (pp. 171-190). Reno, NV: Context Press.

Dymond, S., & Barnes, D. (1995). A transformation of self-discrimination response functions in accordance with the arbitrarily applicable relations of sameness, more than, and less than. *Journal of the Experimental Analysis of Behavior*, *64*, 163-184.

Dymond, S. & Rehfeldt, R. (2000). Understanding complex behaviour: The transformation of stimulus functions. *The Behavior Analyst, 23,* 239-254.

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.

Hoon, A., Dymond, S., Jackson, J., & Dixon, M. R. (in press). Contextual control of slot machine gambling: Replication and extension. *Journal of Applied Behavior Analysis.*

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.

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

Parke, J., & Griffiths, M. D. (in press). The role of structural characteristics in gambling. In G. Smith, D. Hodgins, and R. Williams (Eds.), *Research and measurement issues in gambling studies*. New York: Elsevier.

Reese, H. W. (1968). *The perception of stimulus relations: Discrimination learning and transposition*. New York: Academic Press.

Roche, B., & Dymond, S. (in press). A transformation of functions in accordance with the nonarbitrary relational properties of sexual stimuli. *The Psychological Record*.

Smeets, P. M., Dymond, S., & Barnes-Holmes, D. (2000). Instructions, stimulus equivalence, and stimulus sorting: Effects of sequential testing arrangements and a default option. *The Psychological Record, 50*, 339-354.

Weatherly, J. N., & Dixon, M. R. (2007). Toward an integrative behavioral model of gambling. *Analysis of Gambling Behavior*. *1*, 4-18.

Whelan, R., Barnes-Holmes, D., & Dymond, S. (2006). The transformation of consequential functions in accordance with the relational frames of more than and less than. *Journal of the Experimental Analysis of Behavior*, 86, 317-335.

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.

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