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The Analysis of Gambling Behavior (AGB) is a peer-reviewed publication that contains original general interest and discipline specific articles related to the scientific study of gambling



## *Content of the Analysis of Gambling Behavior*

The Analysis of Gambling Behavior (AGB) contains general interest and discipline specific articles related to the scientific study of gambling. Articles appropriate for the journal include a) full-length research articles, b) research reports, c) clinical demonstrations, d) technical articles, and e) book reviews. Each category is detailed below along with submission guidelines:

***Research Articles*** – a manuscript of full length (20-30 double-spaced pages approximately), which may contain multiple experiments, and are original contributions to the published literature on gambling.

***Research Reports*** – a manuscript of reduced length (no more than 10 double-spaced pages and a single figure or table page), which may be less experimentally rigorous than a Research Article, a replication of or failure to replicate a prior published article, or pilot data that demonstrates a clear relationship between independent and dependent variable(s). The Results and Discussion sections of Reports should be combined.

***Clinical Demonstrations*** – a manuscript of reduced length (no more than 8 double-spaced pages and a single figure or table page) which lack the rigor of a true experimental design, yet do demonstrate behavior change of persons with gambling disorders under clinical care. This manuscript should contain an Introduction, Methods/Treatments, Results, and Discussion sections. The Results and Discussion sections of Clinical Demonstrations should be combined.

***Technical Article*** – a manuscript of either full or reduced length, depending on necessity, that describes either a new technology available that would be of interest to researchers or a task-analysis style description of how to utilize existing technology for the conducting of research. Examples of appropriate topics may include, but are not limited to, the rewiring of a slot machine for the collection of data or controlling of win/losses, how to use computer software to simulate a casino game, or the way in which neuroimaging devices may interfaced with an experimental apparatus.

***Book Review*** – a review of a contemporary book related to gambling not more than three years after the publication data of the book to be reviewed. The review should be no more than 15 doubled-spaced pages in length.

# ANALYSIS OF GAMBLING BEHAVIOR

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## *Research Reports*



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# *RATS PLAYING A SLOT MACHINE: A PRELIMINARY ATTEMPT AT AN ANIMAL GAMBLING MODEL*

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Due to certain ethical and procedural considerations, it is not possible to conduct certain experimental studies on human gambling behavior. Animal models of gambling may hold some utility because they can possibly overcome these considerations. The present experiment was a first attempt to establish an animal model of gambling by having rats play a "slot machine." Rats pressed a lever on a fixed-ratio 5 schedule of reinforcement. In the Cue conditions, a bank of stimulus lights flashed after the completion of the ratio, with the pattern of lights that subsequently remained illuminated signaling what consequence would be received (i.e., a "loss" or small, medium, or large "win"). In the No-Cue conditions, the stimulus display was not used and the consequences were not signaled. Results showed that, in terms of preratio pausing, the rats displayed a similar pattern of behavior as shown by humans playing an actual slot machine. However, this pattern of behavior did not vary as a function of the presence or absence of the "slot" stimuli as one might expect to observe with human gamblers. Thus, the procedure shows some promise as an animal model of gambling, but additional modifications are necessary before it can be considered an adequate model.

*Keywords*: Gambling, Post-reinforcement Pause, Fixed-ratio Schedule, Lever Press, Rats.

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Gambling occurs when one risks a valued commodity, such as money, on a probabilistic outcome over which the gambler has little or no control. Many people will gamble at least some point in their lives and, on most occasions, the behavior is not especially harmful. Of special concern, however, is a minority of individuals suffering from pathological gambling. According to Petry (2005), the prevalence of pathological gamblers likely ranges from 1-3% of the world population.

Although thousands of articles have been published to date on the topic of pathological gambling, the origins of the problem are not yet well understood. We believe that for significant progress to be made in addressing the problem, it is necessary that more investigations be experimental in nature[1]. One reason, perhaps, why more experimental investigations are not performed is that it is illegal in many parts of the United States to possess gaming equipment, even if only for research purposes. Also, while sound experimentation requires control over the situation, such as the outcome of individual gambles, such control is inconsistent with the goal of establishing external and/or face validity (but see MacLin, Dixon, & Hayes, 1999). Finally, certain aspects of a gambling situation cannot be replicated in the laboratory. Researchers, for example, cannot ethically allow participants to

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[1] A literature search using the search engine SCOPUS, conducted on January 22, 2007, yielded 1,660 articles when using a keyword search with the term "gambling." However, only 29 articles were obtained when the term "experiment" was cross-referenced with "gambling."

risk their own money or to go into debt due to their participation. Likewise, the researcher has no control over the participants' pre-experimental learning histories that might contribute to gambling behavior (see Weatherly & Phelps, 2006, for a more detailed discussion). Although changes in the law and advances in technology can help address some shortcomings of conducting laboratory gambling research, other shortcomings, such as the inability to recreate actual financial risk, are intractable. As with other fields of study, when ethical considerations preclude the use of human participants, nonhuman animal models may be of use (e.g., see Madden, Ewan, & Lagorio, 2007, for a recent review).

In one of the first attempts to model gambling in animals, Kendall (1987) gave two food-deprived pigeons repeated opportunities to choose between two food-reinforced alternatives. One alternative was a "sure thing" that, if chosen, provided food on a fixed-ratio (FR) 30 schedule of reinforcement. The other choice was a "gamble" that led to either a FR 10 schedule of reinforcement for a period of time or a 60-s timeout. In other words, under the gambling option, subjects could potentially "win" or "lose" a greater or lesser, respectively, rate of reinforcement. Results indicated that the gambling option was preferred and that preference was determined principally by the probability of the FR 10 schedule rather than the length of time the FR 10 schedule remained in effect (i.e., the probability of a "win" was more critical than its size). In a later study, Kendall (1989) manipulated the length of the timeout period. Once again, the probability of the FR 10 schedule was found to be the critical variable and the size of the "loss" had little impact on behavior.

In a similar investigation, Christopher (1988), gave pigeons concurrent access to FR and variable-ratio (VR) schedules of food reinforcement in a closed economy. The FR schedule provided 3-s access to food reinforcement, and the VR schedule provided reinforcers of variable durations (i.e., 3 s to 15 s). Early in training, the duration of reinforcement on the VR schedule was typically long. Under these conditions, the subjects tended to choose the VR option and gained weight as a result. Later, however, the average duration of reinforcement was reduced until it was less than that offered by the FR alternative. Nevertheless, subjects continued to choose the VR alternative and lost weight as a result. Ultimately, Christopher had to discontinue the VR alternative because subjects reached dangerously low body weights. This tendency for the subjects to persistently gamble despite "losing" is analogous to the problems suffered by pathological gamblers.

In addition to research featuring variable consequences for completion of the ratio, there is a large literature comparing responding on FR and VR schedules of reinforcement (i.e., a schedule in which the reinforcer is delivered at predictable times with one in which it is not). Although research of this kind is not intended explicitly to model gambling, it nevertheless reveals mechanisms likely affecting gambling choices. For example, Madden, Dake, Mauel, and Rowe (2005) had pigeons respond on FR or random-ratio (RR) schedules (a variant of VR schedules) for food reinforcement within a closed economy. When the ratio was relatively small, both schedules maintained similar levels of operant behavior. However, at large ratios (e.g., 3 food pellets per 384 responses), the RR schedule maintained much greater levels of responding. In fact, pigeons made over 35,000 more responses per day on the RR schedule than on the equivalent FR schedule at the largest response requirement. Results such as this suggest that reinforcers delivered by RR or VR schedules are more valuable than those delivered by FR schedules (see Madden et al., 2007, for a discussion which attributes prefe-rence for VR reinforcement to the manner in which organisms discount delayed rewards).

Unlike previous studies of gambling-like behavior in nonhumans, the present study used a procedure that was an attempt to more closely mimic the basic features of slot-machine gambling on the human level than these previous attempts at animal models. For humans, slot-machine gambling entails the deposit of a number of tokens into the machine, pushing a button (or pulling a handle) to initiate the gamble, the appearance of spinning symbols on multiple reels, and the final display of a symbol array that indicates whether the person lost or how many tokens the person won. By comparison, in the present study a rat was required to press a lever a certain number of times (a small FR schedule was in effect). Once the response requirement was complete, a 3 X 3 grid of lights located above the lever began to flash. After the flashing ceased, three lights remained illuminated and the arrangement of these lights indicated the outcome. If the lights appeared in a diagonal fashion, the subject “lost” and no reinforcer was delivered. If the first, second, or third columns of lights were illuminated, then a “small,” “medium,” or “large” amount of the reinforcer, respectively, was delivered.

Unlike the research of Kendall or Christopher, the procedure was not designed to determine whether subjects would choose to gamble despite losses. Instead, all subjects were required to “gamble” throughout the procedure and the variables of interest concerned the specific patterning of behavior during the session. Observations of gambling in humans suggest that the latency from one gamble to the next is short when the outcome of the gamble is a loss. The latency increases when the result is a win, and the longest latencies tend to follow the largest wins (Delfabbro & Winefield, 1999; Schreiber & Dixon, 2001). To determine whether rats would show an analogous response pattern, we measured the preratio pause before each gamble (i.e., the latency from the end of the previous consequence to the first response on the following ratio). Furthermore, we observed the rate at which each ratio was completed to determine whether the speed of a gamble would be affected by the consequences delivered on the previous ratio.

The FR task described above for rats captures many of the aspects found in human slot machine gambling; however, some features are also absent. For instance, the rat does not deposit tokens nor does it “lose” anything beyond the effort expended to press the lever. However, the goal of the present study was not to perfectly mimic the human situation. Rather, the goal was to determine whether the behavior of a rat faced with this situation would resemble that of a person playing a slot machine. We predicted it would (i.e., shorter pauses after losses and longer pauses after wins). Of secondary interest was also whether the rats’ behavior would come under the control of the “slot” stimuli, as these stimuli arguably contribute to human gambling behavior (e.g., see Ghezzi, Wilson, & Porter, 2006). In this regard, we predicted that the rats’ behavior would differ between conditions in which the procedure presented or did not present the “slot” stimuli. If these goals are not met, then further pursuit of this paradigm can be dropped. If they are met, then further intricacies could be built into the procedure so as to better model the actual situation faced by a person who is gambling.

## METHOD

*Subjects*

The subjects were seven experimentally experienced male Sprague-Dawley rats originally obtained from the Center for Biomedical Research on the campus of the University of North Dakota. Subjects were approximately 14 months of age at the beginning of the study. All had experience pressing a lever for liquid sucrose and food pellets delivered by a random-interval schedule of reinforcement. Subjects were maintained at approximately 85% of their free-feeding weights via post-session feedings or daily feedings on days that sessions were not conducted. Because the subjects were experienced, their food-restricted weights had been established prior to the present study. Those weights were continuously maintained. The rats were housed individually with water available only in the home cage. They experienced a 12/12 hr light/dark cycle. Experimental sessions were conducted during the light portion of the cycle. All care and maintenance of the rats conformed to the guidelines published by the National Research Council (1996).

*Apparatus*

Subjects responded in an experimental chamber for rats (Coulbourn Instruments) that measured 30.5 (L) by 25.0 (W) by 28.5 cm (H). The chamber was equipped with one response lever that was located on the left side of the front panel, 2.5 cm from the left wall and 6.5 cm above the grid floor. The lever was 3.5-cm-wide by 0.1-cm-thick and extended 2 cm into the chamber. The lever required a force of approximately 0.25 N to depress. Five cm above the lever was a panel of three stimulus lights (red, yellow, and green from left to right). Each light was 0.6 cm in diameter. The yellow light was centered on the panel, with the red and green lights 0.6 cm to the left and right, respectively. A second panel of stimulus lights was located 5 cm above the first, and a third panel was located 5 cm above the second. Together, these panels formed a grid of nine stimulus lights. Centered on the front panel, 2 cm above the grid floor, was a 3.3-cm-wide by 3.8-cm-high by 2.5-cm-deep opening that allowed access to a trough into which reinforcers were delivered. Liquid sucrose was delivered to the trough by a syringe pump that was located outside of the chamber and attenuating cubicle. Food pellets were delivered to the trough by a dispenser that was located behind the front panel. A 1.5-cm-diameter houselight provided general illumination during the session. The houselight was centered on the back wall of the chamber, 2.5 cm below the ceiling.

The chamber was located inside a sound-attenuating cubicle equipped with a ventilation fan to mask outside noise. The experimental events were programmed, and data were recorded, by a desktop computer that was connected to a Coulbourn Instruments Universal Linc and that ran Graphic State software (Coulbourn Instruments). The control equipment was located in a room adjacent to the one housing the experimental chamber.

*Procedure*

Subjects were experimentally experienced and were therefore immediately placed on the procedure. Subjects responded in two types of sessions, Cue and No Cue. The Cue sessions were those in which the “slot” stimuli were presented. A FR 5 schedule was in effect at the beginning of each of these sessions. Once the subject completed the response requirement, the nine stimulus lights above the lever flashed. The lights simultaneously alternated between on and off every 0.2 s for a total of 5 s. After 5 s, the lights stopped flashing and three lights remained illuminated in one of four combinations. Specifically, the left, center, or right column of lights was illuminated or three lights in a downward diagonal pattern were illuminated. These patterns were displayed for 1 s (in an attempt to enhance their salience), after which one of four consequences occurred. One consequence was a “small” win. This outcome occurred when the left column of (red) lights was illuminated and consisted of 0.05 ml of 5% liquid sucrose (v/v mixed with tap water) being delivered to the trough. The second was a “medium” win, which occurred when the center column of (yellow) lights was illuminated and consisted of 0.2 ml of 5% sucrose. The third was a “large” win, which occurred when the right column of (green) lights was illuminated. The large win was a

45-mg food pellet (Research Diets, Formula A/I). These three types of "wins" were chosen based on previous work, both published (e.g., Weatherly, Stout, Rue, & Melville, 2000) and unpublished, from our laboratory that indicated that rats respond at higher rates for food pellet reinforcers than for 5% sucrose reinforcers and for 0.2 ml of 5% sucrose than 0.05 ml of 5% sucrose. The final outcome was a "loss." The loss occurred when the diagonal pattern was displayed and resulted in no reinforcement.

After the occurrence (or non occurrence in the case of a loss) of the programmed consequence, the FR 5 schedule was again in effect. The stimulus display from the prior trial continued to be illuminated until the FR 5 was completed. Once completed, the lights again flashed for 5 s, etc. The session progressed in this fashion until the subject completed 101 ratios. For data analysis purposes, the first ratio was discarded because it did not allow for the calculation of a post-reinforcement pause. The final trial ended after completion of the FR 5 (i.e., the consequence was that the session ended). Thus, subjects experienced 100 outcomes per session. The start of the session was signaled by the illumination of the houselight, which was continuously illuminated throughout the session. The end of the session was signaled by extinguishing the houselight.

The No-Cue sessions were identical to the Cue sessions with the exception that the "slot" stimuli were not presented. Specifically, when the subject completed the FR 5, only the left/red light on the lowest stimulus panel flashed for 5 s. That light was continually illuminated when the consequence was delivered regardless of whether the consequence was non-reinforcement or a small, medium, or large reinforcer (identical to those described above). As in the Cue conditions, reinforcers were delivered 1 s after the light ceased flashing. No-Cue sessions were conducted to determine whether the behavior of the subjects came under the control of the "slot" stimuli in the Cue condition or was controlled by the different outcomes. Subjects responded in a total of four conditions. In the initial two conditions, the probability of each type of "win" was 20%, and the probability of a loss was 40%. In the final two conditions, the probability of each type of "win" was decreased to 15%, and the probability of a loss was increased to 55%. These different probabilities were chosen so that part of the time the probability of winning exceeded that of losing (i.e., the 20% conditions) and part of the time the probability of losing exceeded that of winning (i.e., the 15% conditions). Four subjects completed these four conditions in the sequence Cue, No-Cue, Cue, No-Cue. The remaining three subjects experienced conditions in the sequence No-Cue, Cue, No-Cue, Cue. All conditions were conducted for 23 consecutive sessions, with sessions conducted daily, five to six days per week.

## RESULTS

Figure 1 shows the mean preratio pause duration as a function of type of consequence experienced following the previous ratio during each condition. The data were derived from the final five sessions of each condition. The error bars represent one standard error of the mean across subjects for that particular consequence in that particular condition. The figure shows that pause durations were shorter following non-reinforcement than following reinforcement. When reinforcement was delivered, the duration of the pause increased across the small, medium, and large "wins."

Results from statistical analyses supported this description. A three-way (Cue condition by Win percentage by Outcome type) repeated measures ANOVA, conducted on the pause durations of individual subjects, produced a significant main effect of outcome type, $F$ (3, 18) = 20.32, $p < 0.001$. The linear-polynomial contrast for the effect of outcome type was also significant, indicating that

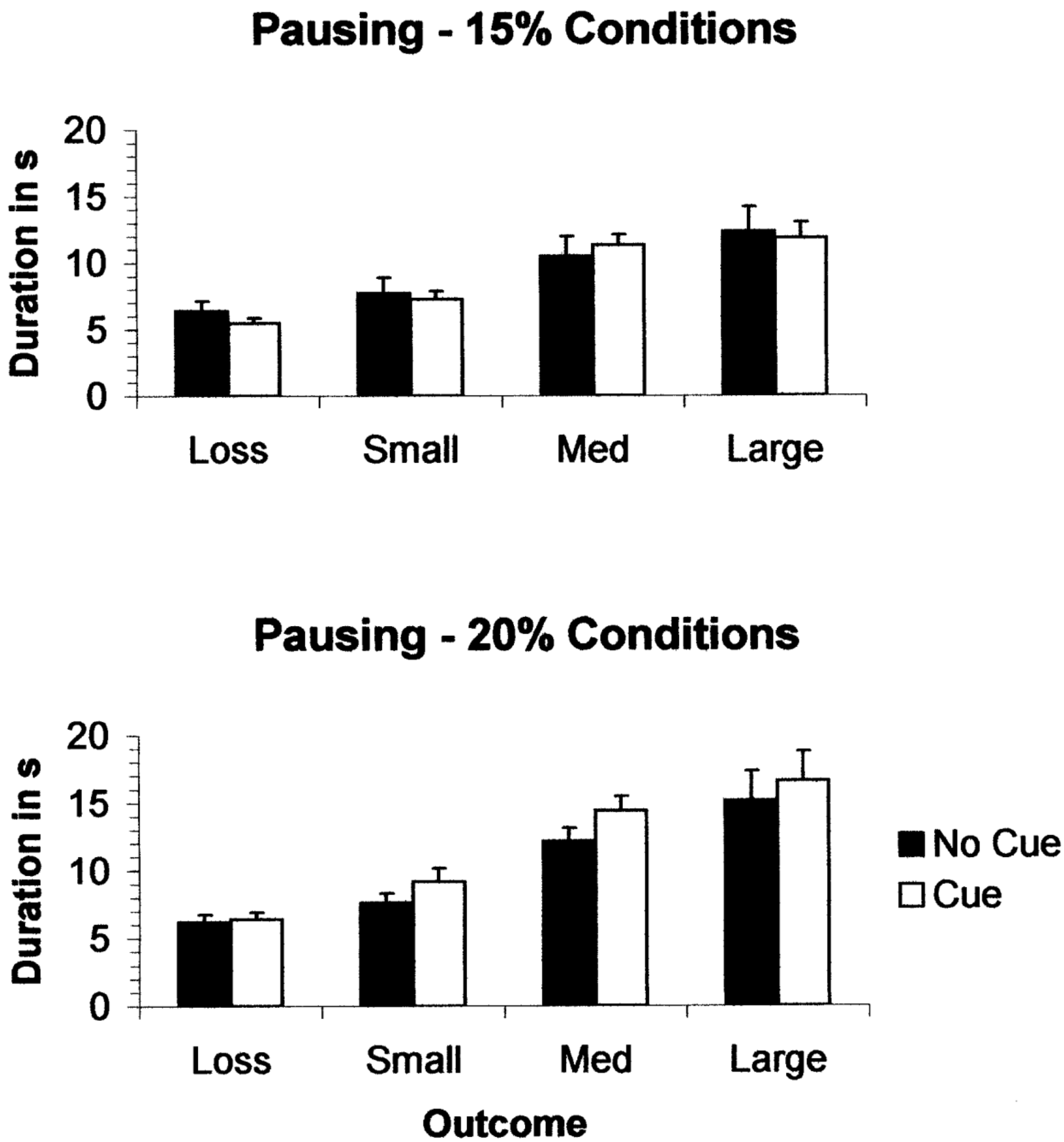


Figure 1. Presented are the post-consequence pauses for the mean of all subjects for each type of outcome in each of the conditions.

pausing increased linearly across the four outcomes, $F\ (1, 6) = 44.20$, $p = 0.001$. The main effect of cue condition was not significant (i.e., $p < 0.05$), but significant differences were obtained for the main effect of win percentage, $F\ (1, 6) = 7.64$, $p = 0.033$, and the interaction between win percentage and outcome type, $F\ (3, 18) = 7.03$, $p = 0.003$. As can be seen in Figure 1, pause durations in the 20% conditions, especially following the medium and large "wins," were longer than in the 15% conditions. None of the interactions

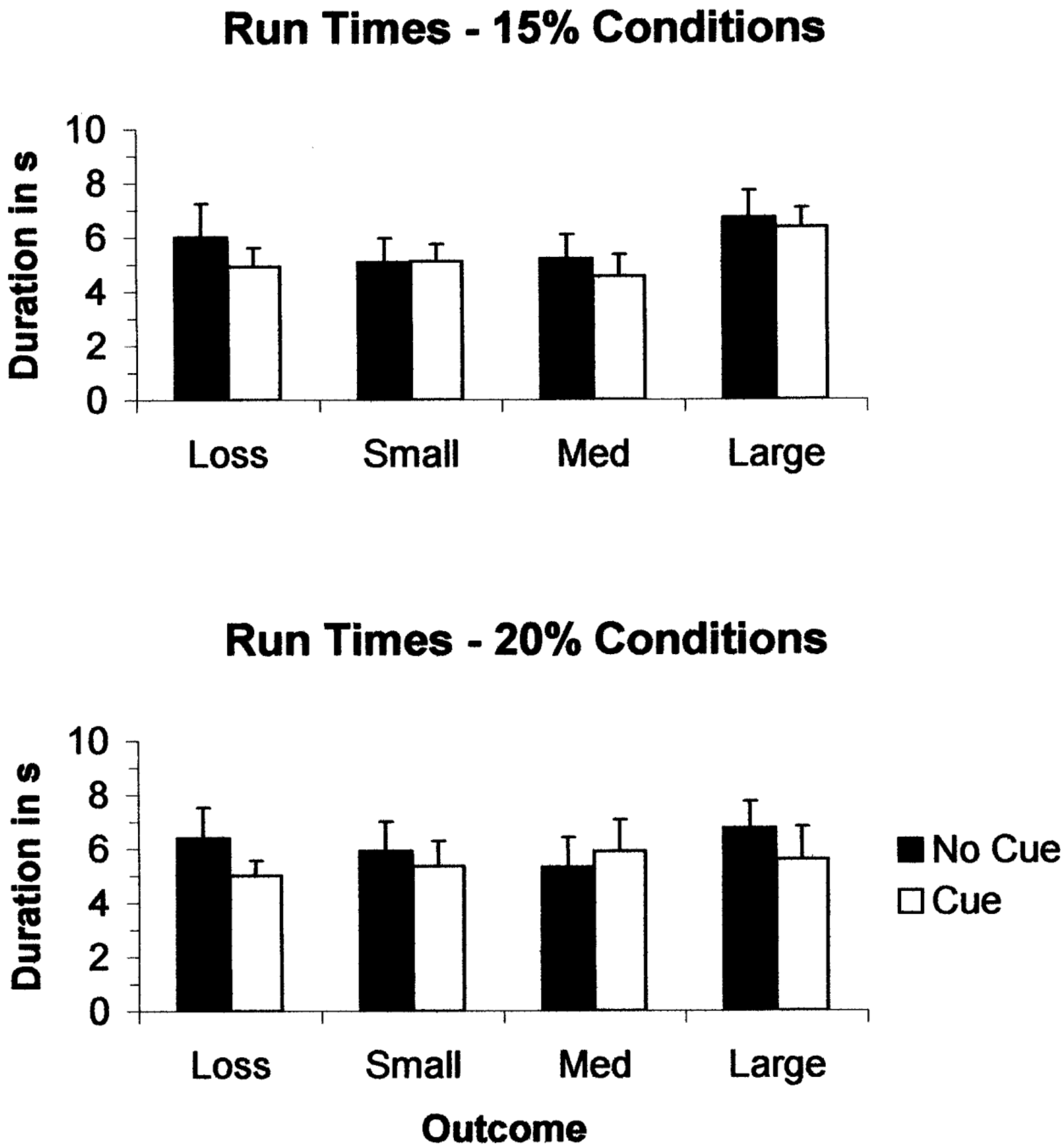


Figure 2. Presented are the run rates for the mean of all subjects for each type of outcome in each of the conditions.

involving cue condition were significant.

Figure 2 shows run rates observed under the various conditions and types of consequences. It was constructed similarly to Figure 1. The data in Figure 2 offer little to suggest that there were systematical differences in behavior across conditions. A three-way (Cue condition by Win percentage by Outcome type) repeated measures ANOVA did yield a significant main effect of outcome type, $F$ (3, 18) = 3.28, $p$= 0.045. For this effect, the cubic polynomial contrast was significant, $F$ (1, 6) = 6.31, $p$=0.046. As can be seen in Figure 2, this outcome was largely driven by longer run rates after large "wins" than after the other consequences. None of the other main effects or interactions was statistically significant.

## DISCUSSION

The present experiment was an attempt to establish whether the procedure was a legitimate potential animal model of gambling. To this end, the results were mixed. On the positive side, the observed pattern of behavior did resemble that of people who play slot machines. On the negative side, this pattern of behavior did not appear to be controlled by the presence of the "slot" stimuli, as documented by the similar pattern of behavior observed between the Cue and No-Cue conditions.

As previously reported for people playing slot machines (e.g., Delfabbro & Winefield, 1999; Schreiber & Dixon, 2001), the pause durations of the rats was shortest following "losses" and longest following large "wins." The exact ramification of this outcome can be debated because both outcomes would be considered consistent with the broader literature on ratio schedules of reinforcement. For example, finding shorter pauses following non-reinforcement than following reinforcement is not surprising, if only because there is no reinforcer for the subject to stop and consume. Previous studies using percentile schedules of reinforcement have found that the preratio pause following non-reinforcement is only a small fraction of that following reinforcement, including at small ratios (Baron & Derenne, 2000). This finding would suggest that the factors responsible for pausing are mostly absent following non-reinforcement. In fact, the differences in pausing after non-reinforcement and reinforcement in the present study were not extremely large relative to those previously reported. The reasons for this outcome are not immediately clear, and it is possible that the present procedure played a role in that outcome.

On its face, the finding that pause durations increased as a function of the size of the previous win is also consistent with findings from basic research on ratio schedule performance (e.g., Lowe, Davey, & Harzem, 1974), at least when the size of the upcoming reinforcer is not signaled (Perone & Courtney, 1992). A somewhat longer pause may be expected after large reinforcers because a larger reinforcer requires more time for consumption than a small one. However, the terms small, medium, and large "wins" in the present study do not necessarily correspond linearly to the amount of time subjects needed to consume them. For instance, it would seem reasonable to conclude that the subjects needed more time to consume the medium (i.e., 0.2 ml) than the small (i.e., 0.05 ml) "win." However, it is possible that the time needed to consume the 45-mg food-pellet large "win" was actually less than that for either the small or medium "wins" because the pellet could be placed completely in the rat's mouth, allowing it to be eaten while the rat oriented back toward the lever. The liquid reinforcers had to be licked from the trough. Thus, the present differences in pausing are not the obvious outcome of differences in reinforcer size.

It is also the case that previous studies point to factors other than the amount of reinforcement *per se* as being responsible for the change in preratio pausing. Pausing may partially be the result of conditioned inhibition elicited by the previous reinforcer. That is, the previous reinforcer signals the beginning of a period of time in which subsequent reinforcement is unavailable. Large previous reinforcers may act as particularly salient stimuli prompting longer-than-average pauses. Also possible is that once subjects receive the largest possible win, the probability that the subsequent response requirement will yield a less favorable outcome is very high. Therefore, pausing may be longer because the subject is transition from a more-to-a-less favorable situation (cf. Galuska, Wade-Galuska, Woods, & Winger, 2007, for specific examples of this kind).

As was the case with comparison of reinforcement and non-reinforcement, the difference in pausing following the different win amounts was small compared to findings from analogous studies designed to examine ratio schedule performance. It is possible that this outcome was mitigated by some features of the present procedure. For example, the small response requirement may have minimized the contribution of conditioned inhibition to pausing, and the cue stimuli may have overshadowed the signal provided by the reinforcer. In other words, while gambling may entail elements similar to ratio schedules of reinforcement, those elements may not be of the kind that evokes long pauses in responding. Regardless, the present results on pausing are a novel contribution to the basic literature. We are not aware of previous work on ratio schedule pausing that has manipulated both quality and quantity of reinforcement within the same procedure.

The present procedure also failed to produce easily interpreted changes in run rates (see Figure 2). Run rates after "large" wins exceeded those after other outcomes. Although systematic, these differences were not large (i.e., 1 s at the greatest discrepancy). Overall, run rates are less sensitive to schedule parameters than pause durations (e.g., Baron & Derenne, 2000), so this outcome was not necessarily unexpected. Indeed, once the pause has been terminated, the most efficient possible response pattern is to complete the response requirement in the shortest possible time.

Despite the present results being consistent with the overall literature on pausing, we believe the present procedure still retains potential utility as an animal model for gambling. For instance, one topic that has received considerable interest in the gambling literature is the effect of "near misses" on a slot machine (e.g., Ghezzi et al., 2006; Kassinove & Schare, 2001). A near miss occurs when all but one winning symbols appear on the win line of the slot machine, with the remaining winning symbol just off the win line (e.g., one spot above or below where it would need to be for a win to occur). Much of the research in this area has focused on what function the near miss plays in maintaining gambling behavior (e.g., a conditioned reinforcer), but a universally accepted conclusion has yet to emerge. The present procedure could aid this research process. That is, it should be possible using the stimulus array to present the animal with a "near miss." One can then design an experimental procedure to assess the function of the "near miss" stimuli. If, for instance, the near miss is serving as a conditioned reinforcer, then it should be possible to teach the animal a new operant response using the presentation of the "near miss" stimulus as the reinforcer.

Before such research takes place, however, another deficit in the present procedure must be addressed. Although the rats displayed a pattern of behavior similar to that observed when humans play a slot machine, the rats' behavior did not vary as a function of the presence of the slot stimuli. This outcome may have occurred for a number of different reasons. One possibility is that the rats simply did not attend to the stimuli and, instead, oriented toward the food trough once the stimulus light(s) started flashing (i.e., goal tracking; e.g., see Farwell & Ayres, 1979). A second, and potentially related, possibility is that the present procedure induced certain behaviors between the completion of the FR schedule and the delivery of the consequence (i.e., adjunctive behaviors; Staddon & Simmelhag, 1971). Adjunctive behaviors would have competed with the rats' ability to attend to the stimuli. This possibility is an interesting one given that people have been shown to display adjunctive behaviors when gambling (e.g., Clarke, 1977).

Alternatively, the failure of the stimuli to control behavior may have simply been related to our choice of subject: the Sprague-Dawley rat. We had these rats available in our colony prior to the experiment and therefore they were subjects of convenience. However, Sprague-Dawley rats are albino rats that are not visually oriented. At best, the rats would have attended to the location and arrangement of the lights in the slot array, not to their color. It is possible that stimulus control by the "slot" stimuli would have emerged if a visually adept subject had been used (e.g., a different strain of rat or a different species altogether, such as pigeons). Regardless of which of the above possibilities may be correct, demonstrating such stimulus control would be a necessary step before the present procedure could be used to pursue other research questions such as the near-miss effect.

As noted above, the present procedure lacks many of the variables that one would find in the human gambling scenario. However, many of these variables could be added on to the procedure. Humans are given myriad choices (e.g., gamble vs. not gamble; slot machine X vs. slot machine Y) whereas the present procedure did not incorporate choice. This difference could be rectified by providing access to a second lever that produced a fixed reinforcer for a fixed price and no "slot" stimuli. Human gamblers lose money and can possibly go into debt. The rats in the present procedure expended only effort and were maintained at a constant body weight regardless of the outcomes experienced during data collection. Both, however, could be changed. One could arrange a "bank account" of responses (e.g., the rat can only respond 100 times per session) or train the animals to use tokens. Likewise, one could mimic "debt" by allowing the subjects to lose weight if they "gambled" and "lost," much as did Christopher (1988; and see Madden et al., 2007, for a discussion of "closed economies" in animal models of gambling).

Thus, although the present attempt at an animal model of gambling was not wholly successful, the procedure shows some promise. It generates behavior patterns similar to those observed when people play slot machines. Complexities can be added that make it even more similar to the human gambling situation than just the presentation of "slot" stimuli. Finally, because the experimental can control both the environment and the history of the subject, developing a successful animal model may lead to answering questions about gambling that may not be possible or ethical when studying humans (and see Madden et al., 2007, for additional arguments in favor of animal models). Additional research with the present model is certainly necessary. It would also seem warranted.

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# *ASSESSING AND MANIPULATING THE ILLUSION OF CONTROL OF VIDEO POKER PLAYERS*

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The present investigation explored the presence of illusory control in recreational video poker players. Using a multi-monitor computer which allowed for two different types of games to be presented concurrently, one on each monitor, players were allowed to freely choose which game they wished to play. One option allowed for the player to select the cards they wished to hold and discard, while the other option was designed such that the computer automatically selected the most probabilistically optimal sequence of cards to hold and discard. In the first experiment, two groups of ten participants were exposed to one of two rules (accurate or inaccurate) regarding the chances of winning. No differences in response allocations between the games were found. In the second experiment, thirteen participants were sequentially exposed to a non-rule baseline followed by an inaccurate and subsequently accurate rule. Twelve of the thirteen players preferred the self-selecting game, and following the introduction of an experimenter given rule that was designed to strengthen the illusion (i.e., that the self-selecting option was better), most players increased their preference for this option. However, following the introduction of an experimenter given rule that attempted to weaken the illusion, only about half the participants followed that rule and reduced playing the self-selecting option. Variability across participants was able to be explained by examining each player's verbal talk which was emitted overtly throughout the duration of the experiment. Implications for understanding the illusion of control and the verbal behavior of gamblers are presented.

*Keywords:* risk taking, gambler's fallacy, protocol analysis, video poker, rule-governed behavior.

Changing forms of gambling continue to evolve with the advent of computer technology. One of the most popular forms of gambling, the three reel slot machine, is slowing being replaced with computerized versions consisting of a video display of virtual reels, many times with more than the original three (MacLin, Dixon & Hayes, 1999). Payoffs are possible on the traditional middle display line, along with permutations of diagonals, top line, bottom line, and so on. Other slot machines incorporate "higher level" wagering possibilities whereby gamblers, after obtaining a given display on the reels, have an opportunity to take additional chances by spinning a wheel or selecting items from a video display (MacLin et al., 1999). Computer technology has not only advanced the characteristics of the slot machine, it has also allowed for table games to be played by anyone individually using a computer terminal. Computerized versions of blackjack, roulette, and craps can be found in various casinos throughout the world. The most popular computerized table game however, is video poker. In fact, video poker continues to grow in popularity in many states year after year,

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while slot machine play remains relatively constant (Ghezzi, Lyons, & Dixon, 2000).

Video poker offers players a unique feature the traditional slot machine does not possess. This feature is the ability to select cards from the initially dealt cards which then can be held or discarded in hopes of changing the chances at a winning hand. The ability to select cards crates somewhat of an illusion for the player, the illusion that with enough practice or skill they will be able to "beat" the game. In reality, given the payout structure of most video poker games, not even the best video poker strategy can keep a player from losing money in the long run. Instead the optimal strategy can do no more than slow down the losing process.

The perceived ability to alter chance circumstances has been termed the "Illusion of Control" (Langer, 1975) and this phenomenon has been recognized by psychological researchers studying gambling for some time (Dixon, Hayes, & Ebbs, 1998; Dixon, 2000). Perceptions, or illusions, of control have been shown to alter individual's behavior in clearly observable ways. For example, Dixon et al. (1998) showed that when roulette players were given the opportunity to wager chips on self-selected numbers or experimenter-selected numbers, all players chose to select their own numbers. In reality, there was no logical reason for a preference for one option over another as the outcome of a gamble at roulette is random. No number has any better chance of being "hit" than any other. Interestingly, in this study the roulette players chose to select their own numbers even when they were required to forfeit chips in order to do so, thus illustrating the strength of illusionary control. Other researchers have shown that gamblers will wager more, take larger risks, or both (Dixon, 2000) when under the belief they have control over game outcomes.

A preference for illusionary control may be detrimental to the gambler. First, the player may seek out gambling opportunities which possess illusionary characteristics over those that do not, and as a result may gamble for longer periods of time, thus risking and probably losing more money than initially expected or budgeted. Second, the player may believe their own idiosyncratic strategy of responding may be able to somehow beat the house, when in fact, it actually contains many probabilistic flaws and errors in judgment. Treatment of pathological gamblers often targets attempting to reduce the client's tendency to engage in illusionary control as part of the recovery process (Petry, 2005).

A debate in the published literature appears to exist as to if the illusion of control is a personality characteristic of a gambler (e.g., Knee & Zuckerman, 1998; Kroeber, 1992; Taylor & Brown, 1988) or simply an illogical rule or description of how the world works which, thorough appropriate conditioning, can be altered (Presson, & Denassi, 1996; Dixon, et al., 1998; Chau & Phillips, 1995; Ladouceur & Sevigny, 2005). The findings of Dixon, (2000) suggest that players will indeed reduce their tendency towards illusionary control when given a set of strategies by the experimenter. Yet the Dixon, (2000) findings were preliminary and only may hold for roulette players. The degree to which an individual video poker gambler may reduce illusionary control is still rather unclear, and further more it is unknown to what degree strategies or rules that the gambler him/herself might be saying internally to them could impact the ability for an experimenter's (or clinician's) instructions to take hold of behavior. As video poker continues to rise in popularity, and more and more persons each year are being diagnosed for problem gambling (Dixon & Schreiber, 2002), it seems that a logical step would be to evaluate the relative preference for illusionary control of a group of video poker players, give them accurate rules or instructions that the illusion is just that – an illusion, and see how performance may change. Furthermore, because a gambler does not just wait for someone else to tell them what to do, they must in fact be telling themselves how best to play the game at any given time. Understanding the illusion without incorporating the gambler's own thoughts and rules about play appears incomplete, and thus must be included in any comprehensive analysis.

There are a variety of means by which an experimenter might tap into the self-talk or self-generated strategies that may govern an individual while they gamble. One might ask the individual, upon completion of play, what the reasons for doing the things they did were. The researcher could ask how they played, why they played, and why they quit. Yet, while appearing straightforward, such techniques often yield less than promising results. Instead, many subjects queried by these methods fail to recall accurately what in fact governed their performance (Dixon & Schriber, 2002). Another method for assessing self-generated strategies of a gambler is to take a running transcription of their own self-dialogue during an entire gambling episode. This technique is called "Protocol Analysis" (Ericsson & Simon, 1993) and essentially involves having the subject speak aloud everything they are thinking to themselves. For over twenty years much discovery has come from using the protocol analysis technique outside of gambling (e.g., Dixon & Hayes, 1998; Hayes, 1986), and therefore seems promising to apply it within a gambling context to examine the strategies utilized by individual players.

Therefore the purpose of the present study was to conduct an experimental analysis of the illusion of control between groups of gamblers, as well as within individual gamblers playing a computerized version of video poker. The first experiment investigated the impact of an experimenter delivered rule that was either accurate or inaccurate on performance across groups of participants. It was hypothesized that participants whom were given an accurate rule about the game would follow the rule and demonstrate less of an illusion of control.

The second experiment further explored the role of instructions to alter the illusion of control by utilizing a single subject design that allowed for successive presentation of rule types within an individual participant. The experimental analysis in the second experiment described above, was supplemented by the utilization of a protocol analysis which allowed for an examination of the self-generated rules or strategies that a player may have while playing video poker as well as how those rules might verbalize the illusion of control. It was hypothesized that all players when given the choice between a video poker game that allowed for card selection and a game that did not permit card selection, that all players would favor the option that allowed selection – thus demonstrating an illusion of control. After the introduction of inaccurate rules about the game, essentially attempting to strengthen the illusion of control, it was hypothesized that players would favor the illusionary poker game even more so. Finally, it was hypothesized that upon receiving more accurate rules about the poker game, and that the illusion of control really was just an illusion, which players would find the two poker games equally favored. It was also believed that each individual player's self-rules may mitigate our experimenter delivered rules, thus making the original hypotheses about game preference only initial and tentative.

## EXPERIMENT 1
## METHOD

*Participants*

Twenty undergraduates from a large Midwestern university participated in the hour long study for course extra-credit and a chance for a monetary bonus based upon performance. Demographic information was recorded for 17 of the 20 participants (remaining three were lost due to experimenter failure). Random assignment of participants to two experimental groups yielded: Group 1 (7 female, 1 male, 2 w/o data, 6 w/ associates degrees, 2 High School/GED, 2 unknown, 7 with incomes < $10,000, 1 $20,000-$30,000, 1 $30,000-$40,000 USD, 2 unknown, Mean Age = 24 years; SD = 6.7); Group 2 (7 female, 2 male, 1 w/o data, 7 w/ associates degrees, 2 High School/GED, 1 unknown, 6 with incomes < $10,000, 1 $20000-$30000, 1 > $50,000 USD, Mean Age = 22 years (SD = 0.7).

*Setting, Materials, & Apparatus*

All experimental sessions took place in a 10 ft by 10 ft room which contained a variety of microcomputers and office furniture. Participants were run on the current experiment individually, and no other person was in the experimental room during the running of any participant. A video camera was located directly behind the participant who was seated at a 5 ft by 3 ft desk containing one microcomputer and two 20" video monitors.

All experimental procedures were programmed on a Windows XP capable microcomputer. A second video card was installed on the computer which allowed for a two monitor display. A two monitor display functions identical to a standard one monitor display with the added ability of opening and interacting with a second piece of computer software on the second monitor which may be different (or identical) to the software displayed on a single monitor. A demographics survey, the South Oaks Gambling Screen (SOGS; Leisure & Bloome, 1987), and the Gambling Functional Assessment (GFA; Dixon & Johnson, 2007) were presented in electronic formats programmed in Microsoft Visual Basic 2005. The commercially available video poker software "Bob Dancer's Win Poker (Dancer, 2004) was installed on the experimental computer and was opened twice – once on each of the two monitors that were used in the present study. The game "Deuces Wild" was used for both instances of WinPoker. This version of video poker consists of a single line game of 5 card draw poker in which 2s can be used as wild cards and features a payout structure that results in a payback percentage of 100.7620% for perfect play. One instance was set to Autohold the correct cards on all hands, while the other was setup so that participants could choose which cards to hold. These two instances of the software will be referred to as the Autohold and Free Play instances respectively throughout this paper.

*Procedure*

Participant assignment to rule groups and the left right position of the Autohold and Free Play instances of WinPoker were determined by a random drawing in the following manner. 20 slips of paper were placed in a cup, with 10 with the text rule 1, 10 with the text rule 2, with 5 slips in each group with the Text Autohold Left and 5 slips in each group with the Text Autohold Right.

Upon completion of an informed consent participants were assigned to a rule group by the methods described above. Participants then completed the SOGS and GFA before the two instances of WinPoker were opened. Participants were supplied with 300 credits on both instances of video poker and given the following instructions via the experimenter:

> Before you are two screens showing a video poker game. On one screen, the computer is set to choose your cards for you (indicate which screen this is to the participant) and the other is set so you can choose your own cards (tell them which screen). Your task is play a game of poker. You can play hands on either of the screens at any time, but please play on only one screen at a time. For example, you could play one hand on the left screen, and the next hand on the right screen.
>
> Imagine that you have two machines in front of you. You may choose to play some hands on one machine, and some hands on the other

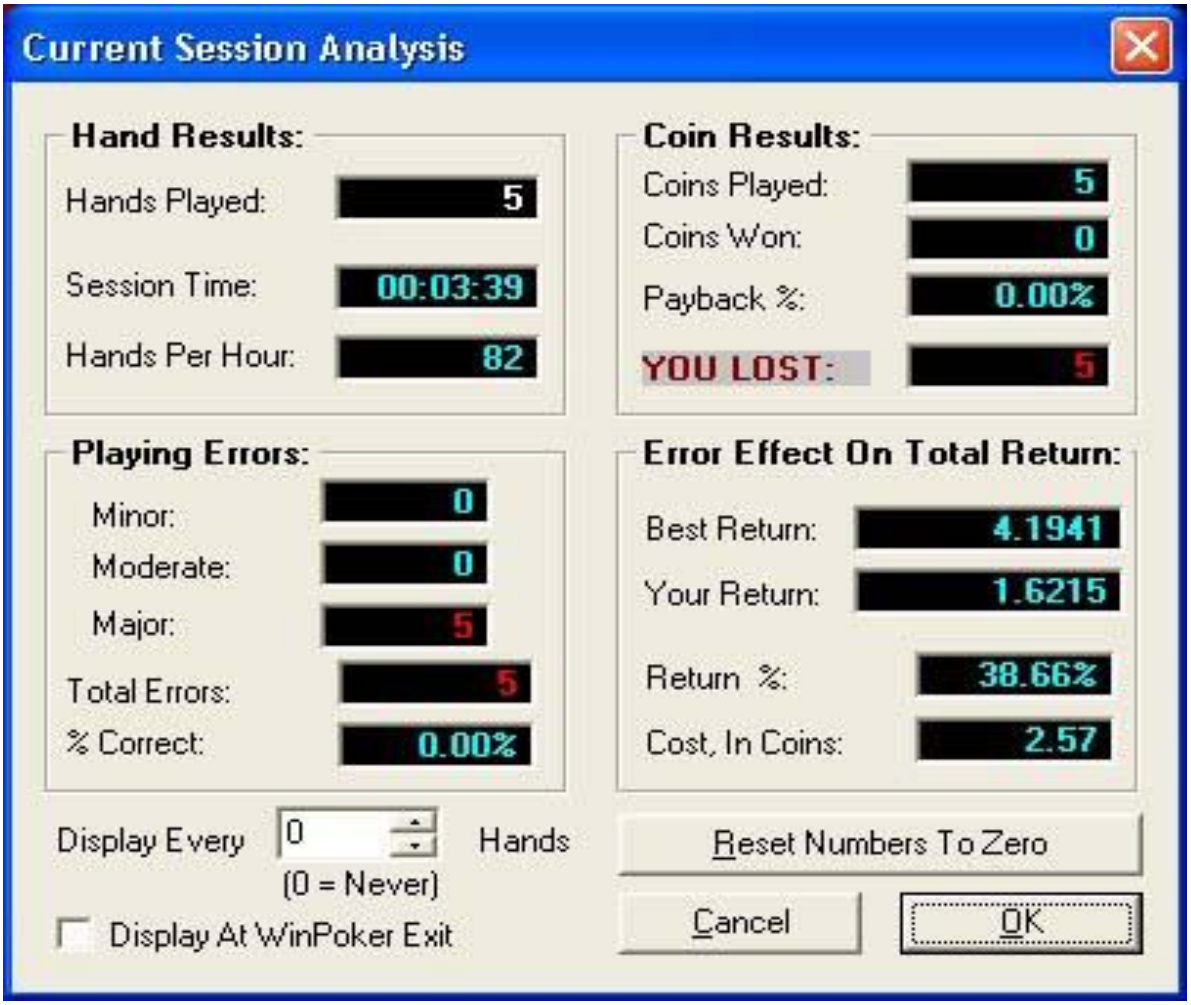


Figure 1: Screen capture of the session analysis window.

machine, but it would be difficult to play both at the same time. Similarly, you can play as many hands on one screen as you choose, and you can switch over and play on the other screen at any time, and keep on switching back and forth if you wish. Just play on one screen at a time.

To play the game, you need to make a bet of coins. You can choose to bet up to five coins at a time. The screen shows the return on the bets you make if you win with a certain hand of cards. To make a bet, click on the bet one coin button, up to a maximum of five times, or press the max bet button. The maximum number of credits you can bet at a time is 5. Then, press the deal/draw button."

The computer will deal you five cards. You will then choose to hold cards that you want to keep.

To hold cards, click on the cards that you wish to have held, or click on the HOLD buttons beneath those cards. After you have selected a card you wish to keep, press the DEAL/DRAW button. The cards that you have chosen to hold will remain in your hand, and the others will be discarded. Then, click on the deal/draw button again.

On the free play screen, you may choose to hold whatever cards you want to. On the autohold screen, you don't need to choose which cards to hold, as the computer does it for you. (Indicate which screen is which.)

After the instructions participants were read the following rule based on the rule group to which they were assigned:

Inaccurate Rule:
"If you pick your own cards, you have a better chance of winning."

Accurate Rule:
"The computer does not make mistakes and can increase your chances of winning."

Participants were then instructed to play 100 hands across the two instances of video poker. Participants could freely switch between the Autohold and Free Play instances of video poker with the only stipulation being that they complete the hand on the instance they were currently playing prior to switching. Upon the completion of a total of 100 hands across the two video poker games, participants were debriefed on the purpose of the study and thanked for their participation. The experimenter then recorded data from the session analysis screens of both video poker games including the number of hands played on both the Autohold and Free Play instances of video poker, percentage correct play, number of errors made, coins played, coins won, and payback percentage.

*Dependent Variable Integrity*

All data were either collected directly by the software program which later was recorded by an experimenter. The number of trials played on each screen, number of errors made, defined as deviations from statistically optimal plays, and other performance characteristics were produced by the poker game and displayed in a "Session Analysis" after the player completed the experiment. An example of a Session Analysis is found in Figure 1.

## EXPERIMENT 1 RESULTS AND DISCUSSION

A one-way Analysis of Variance with rule group as the factor revealed no significant differences between groups for age, F(1, 16) = .735, p = .405, SOGS score, F(1, 17) = .000, p = 1.000, GFA Sensory function, F(1, 17) = .248, p = .626, GFA Escape function, F(1, 17) = .197, p = .663, GFA Attention function, F(1, 17) = 1.181, p = .239, or GFA tangible function, F(1, 17) = .120, p = .734, suggesting that the makeup of the two groups did not differ in any significant way.

The number of coins played and won for all participants in each group on each of the two poker games is presented in Table 1. In general, regardless of the rule given, participants played more hands on the Free Play version of video poker, thus demonstrating a preference for the option which allowed them to select their own cards. Participants in Group 1 averaged 21.10 hands (SD = 32.729) and 78.90 hands (SD = 32.729) on the Autohold and Free Play instances of video poker respectively. Participants in Group 2 averaged 23.20 hands (SD = 29.630) and 67.10 hands (SD = 29.726) on the Autohold and Free Play instances of video poker respectively. Analysis of the mean differences for hands played on the Autohold and Free Play options using a one-way Analysis of Variance with rule group as the factor failed to reveal significant differences, Autohold: F(1, 19) = -.751, p = .398, Free Play: F(1, 19) = .712, p =.410. Figure 3 displays group means and standard error for all participants on the number of hands played for both the Autohold and Free Play instances of video poker.

The results of Experiment 1 failed to find any differences in the number of hands played on either the Autohold or the Free Play across groups regardless of the fact that one group was directly instructed that playing on the Autohold option would increase their chance of winning. This result may suggest that self generated rules regarding one's ability to better effect the outcome of hands by self selecting the cards, i.e. the illusion of control, may affect responding to a greater degree than experimenter delivered rules. However, a fair degree of individual participant variability within a given participant group can be seen

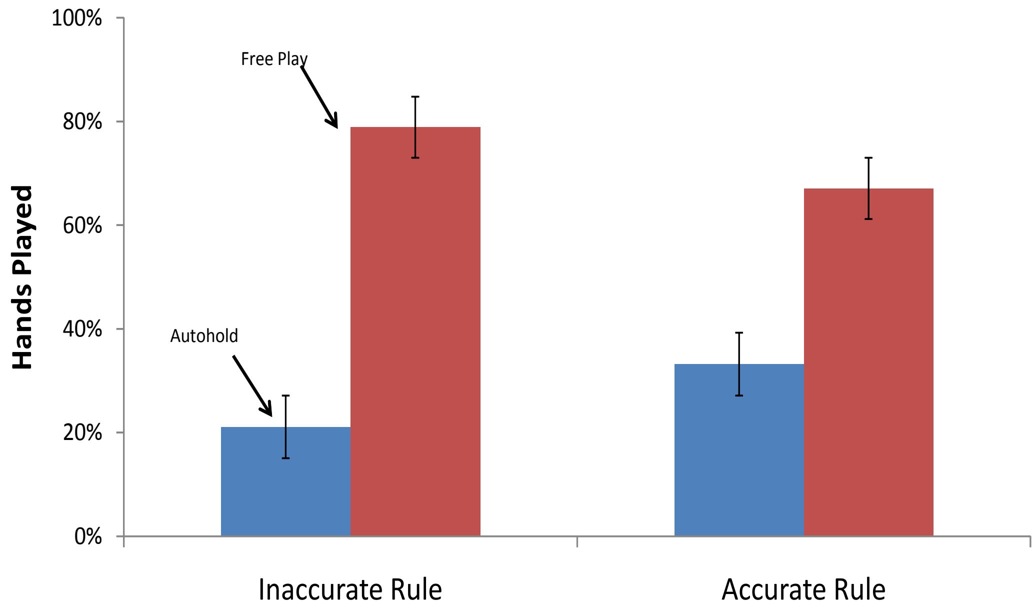


Figure 2: Experiment 1 individual participant data for selection of the Free Play option.

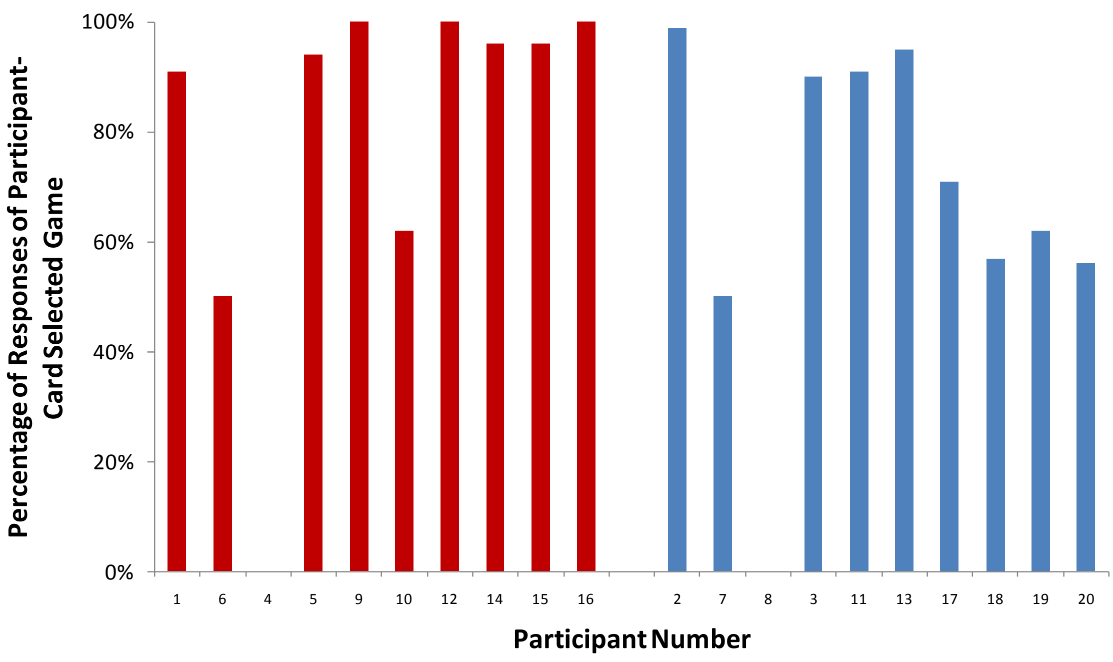


Figure 3: Experiment 2 individual participant data for selection of the Free Play option across baseline, inaccurate, and accurate rule conditions.

Table 1
Each Experiment 1 participant's number of coins played / number of coins won across both the Autohold and Free Play games.

| *Inaccurate Rule Group* | | | *Accurate Rule Group* | | |
|---|---|---|---|---|---|
| *Participant* | *Autohold* | *Free Play* | *Participant* | *Autohold* | *Free Play* |
| 1 | 45/50 | 455/320 | 2 | 1/1 | 105/109 |
| 6 | 113/130 | 97/79 | 7 | 250/195 | 250/165 |
| 4 | 500/480 | 0/0 | 8 | 169/146 | 0/0 |
| 5 | 6/9 | 94/79 | 3 | 23/8 | 254/242 |
| 9 | 0/0 | 493/523 | 11 | 26/39 | 442/351 |
| 10 | 76/85 | 130/108 | 13 | 11/0 | 321/304 |
| 12 | 0/0 | 242/222 | 17 | 150/90 | 350/255 |
| 14 | 20/5 | 480/385 | 18 | 215/110 | 285/205 |
| 15 | 20/30 | 480/385 | 19 | 44/20 | 69/68 |
| 16 | 0/0 | 457/157 | 20 | 172/191 | 280/275 |

Table 2
Each Experiment 1 participant's number of plays on the participant controls card selection (Free Play) number of probability errors during the experiment. Percentages Correct play statistic shown in parentheses.

| *Inaccurate Rule Group* | | *Accurate Rule Group* | |
|---|---|---|---|
| *Participant* | *Free Play* | *Participant* | *Free Play* |
| 1 | 91/52 (42.86%) | 2 | 99/43 (56.57%) |
| 6 | 50/22 (56%) | 7 | 50/28 (44%) |
| 4 | 0/0 | 8 | 0/0 |
| 5 | 94/49 (47.89%) | 3 | 90/50 (44.44%) |
| 9 | 100/53 (47%) | 11 | 91/46 (49.45%) |
| 10 | 62/37 (40.32%) | 13 | 95/29 (69.47%) |
| 12 | 100/45 (55%) | 17 | 71/33 (53.52%) |
| 14 | 96/48 (50%) | 18 | 57/22 (61.4%) |
| 15 | 96/40 (58.33%) | 19 | 62/36 (41.94%) |
| 16 | 100/95 (5%) | 20 | 56/16 (71.43%) |

in Figure 3. In summary, some participants within a group followed the rule to a greater degree than other participants within the group. From analysis of Table 1 and 2, these differences in response allocation appear unaccounted for by greater reinforcement probability on one option over another. It is possible that some participants believed the rule given by the experimenter to a greater degree than others did, that perhaps a type of self-generated rule was created by the participant that directed performance differently than what would be predicted by the experimenter delivered rule, or had stronger illusions of control than others. Experiment 2 attempted to further explore these issues in more detail by exposing each participant to various rule-types and concurrently recording self-generated rules via a talk-aloud procedure.

## EXPERIMENT 2
## METHOD

*Participants, Setting, and Apparatus*

Thirteen college undergraduate students who expressed an interest in gambling and had a history of playing video poker participated in the current study. No participants were actively seeking treatment for problems with excessive gambling. All experimental sessions took place in a 10 ft by 10 ft room which contained a variety of microcomputers and office furniture. Participants were run on the current experiment individually, and no other person was in the experimental room during the running of any participant. A video camera was located directly behind the participant who was seated at a 5 ft by 3 ft desk containing one microcomputer and two 17 in video monitors.

*Procedures*

Win Poker was set to run the standard 5 card draw poker game on both monitors, and on the right monitor it was set with the parameters of 100 coins and the "Autohold" feature enabled. This Autohold feature allowed for the player to have the computer select the optimal cards to be held and discarded upon the dealing of the initial 5 cards of the poker hand. Win Poker was set on the left monitor to run with 100 coins and the "Autohold" feature disabled. The disabling of this feature resulted in Win Poker operating identically to that of a commercially available draw poker game whereby upon the dealing of the initial 5 cards, the player was able to select which cards he/she wished to hold and discard prior to the remaining cards being dealt by the computer. Both versions of Win Poker were fair probability 1 deck of 52 cards. The participant in the experiment was able to move the computer mouse freely between the two instances of the game. Figure 4 displays an example of the video poker game.

Upon completing a consent form to participate in the present study, all participants were instructed that the computer in front of them was designed such that they could play either video poker game they saw displayed on the two monitors. On the left monitor, they could select which cards they wanted to hold and discard, while on the right monitor, the computer would select the cards for them. The participants were then told to try and earn as many points as possible, as the high score for the experiment would result in a cash prize from the researchers. All participants were additionally compensated with course extra credit for completing the experiment. The entire experiment lasted no longer than 1 hour.

*Baseline*. All 13 participants were exposed to varying lengths of baseline contingencies which consisted of five "test" plays on each plays in which they could switch back and forth between monitors and play whichever they preferred. The rationale for exposing participants to varying lengths of baseline conditions was to control for the potential violations of internal validity which could occur if participants were all exposed to the same number of baseline trials. For example, if all were exposed to baseline for 30 trials, then on the 31st trial changes were shown when a new condition was instated, the change in condition the change in conditions is confounded with the length of baseline; as something might happen to a poker player after 30 trials. The varying lengths of baseline used in the present experiment is more formally noted as a "*non- concurrent multiple baseline across subjects*" research design (Bloome, Fisher, & Orme, 1999), and has


Figure 4. Screen capture of the game play screen.

been used previously in some previous gambling studies (i.e., Dixon, 2000).

*Inaccurate Rules*. Following each participant's individualized number of baseline trials, an inaccurate rule condition was instated whereby the experimenter re-entered the room and stated to the participant: "*If you pick your own cards you have a better chance of winning.*" These instructions were repeated if the participant had any additional questions, but were not elaborated on by the experimenter. A copy of the instructions was posted above the computer screen on a piece of paper. Each participant was then instructed to once again play the two poker games freely and was told to continue playing until the experimenter re-entered the room. As in the baseline conditions, each participant was exposed to an individual amount of trials during this condition with a range of around 40 trials. No alterations of any type were made to the computer interface, thus the consequences of playing each game were identical as they were during baseline.

*Accurate Rules*. Following each participant's inaccurate rule trial exposure, the experimenter re-entered the room and stated to the participant: "*The computer does not make mistakes and can increase your odds of winning.*" These instructions were repeated if the participant had any additional questions, but were not elaborated on by the experimenter. A copy of the instructions was posted above the computer screen on a piece of paper. Each participant was then instructed to once again play the two poker games freely and was told to continue playing until the experimenter re-entered the room. As in the previous conditions, each participant was exposed to an individual amount of trials during this condition with a range of around 40 trials. No alterations of any type were made to the computer interface, thus the consequences of playing each game were identical as they were during baseline and inaccurate rules.

*Talk-Aloud.* At the onset of the experiment, prior to exposure to baseline conditions, all participants were instructed to speak aloud everything that they were thinking during the entire experiment. They were told a video camera would be behind them, capturing their play, and recording their voice. Participants were also informed that if they were quiet for too long they would be required to start the experiment over again. The experimenter assured the participant there was no right or wrong thing to say, and that they should just say anything that was on their mind.

*Dependent Variable Integrity*

All data were collected as described in Experiment 1. Participants were not shown the session analysis data between experimental phases, but were asked to look at the back of the room, while the experimenter prepared the next experimental condition. A video camera was also used to capture the talking-aloud of each participant. Each resulting verbal behavior was transcribed word-for-word by an experimenter. Following the transcription, independent clauses were classified into the following categories:

1. Statements regarding the participant's performance. For example, "I am going to hold the 10 and the Jack", or "I am hitting the Draw button right now."
2. Statements regarding reinforcement. For example, "I just won five coins", "That was a good hand", or "No win on that game."
3. Statements related to forecasting the upcoming game outcome. For example "I need a Jack.", or "Come on 2 Queens please."
4. Inaccurate rules about Video Poker. For example, "It has been a while since I won, so a win is sure to come.", or "This game always gives me Aces."
5. Accurate rules about Video Poker. For example, "It does not matter what cards you like, the game is random.", or "Each trial is independent of the next."
6. Comments directly related to the illusion of control. For example, "I need to stay on the left game because I can do better than the computer", or "I pick better cards than the computer can on the right screen."
7. Comments unrelated to the game. For example, "It is hot in here.", "The experimenter is cute.", or "I need to eat lunch."

Inter-observer reliability was assessed on five sessions whereby a second independent observer coded the transcripts themselves and then this new coding was compared to the original observer's classifications. No changes were made post-hoc to either observer's classification, and the degree to which they agreed was assessed. The resulting overall agreement between the two observers was 89%, and was calculated by dividing the number of agreements (for each trial) by the number of agreements plus disagreements, thus suggesting high reliability in protocol content classification.

## EXPERIMENT 2 RESULTS AND DISCUSSION

Table 3 displays a summary of the contingencies which all participants in the experiment were exposed to. The left screen, or Free Play, option allowed the participant to select their own cards which would be held or discarded, while the right screen, the Auto-hold option, auto-selected the optimal card combination. Each participant played both screens from time to time, but in general, every participant preferred the left computer screen over the right screen. The only exception to this pattern across participants was #13. The second number depicted in each cell of the Table 3 is the number of coins won. In general, participants played more coins than they won. As with commercial video poker, in the long run, all players would lose coins. Table 4 depicts only the trials which were played on the left screen, or the participant

Table 3
Each Experiment 2 participant's number of plays per game (Free Play; Autohold) / number of coins won during the three conditions of the experiment; baseline, inaccurate rule, and accurate rule.

| *Participant* | *Baseline Free Play* | *Baseline Autohold* | *Inaccurate Free Play* | *Inaccurate Autohold* | *Accurate Free Play* | *Accurate Autohold* |
|---|---|---|---|---|---|---|
| 2 | 72/82 | 12/6 | 41/29 | 0/0 | 42/72 | 0/0 |
| 3 | 66/36 | 0/0 | 40/40 | 0/0 | 0/0 | 43/34 |
| 4 | 27/37 | 8/4 | 38/44 | 0/0 | 27/18 | 18/11 |
| 5 | 19/19 | 1/1 | 42/38 | 2/0 | 58/50 | 0/0 |
| 6 | 61/61 | 19/14 | 40/24 | 5/1 | 18/18 | 22/29 |
| 7 | 71/66 | 20/24 | 47/46 | 0/0 | 2/0 | 39/41 |
| 8 | 134/74 | 27/23 | n/a | n/a | n/a | n/a |
| 9 | 42/23 | 5/2 | 42/42 | 0/0/ | 53/53 | 2/2 |
| 10 | 64/78 | 18/43 | 42/47 | 2/4 | 35/41 | 6/4 |
| 11 | 65/46 | 0/0 | 39/49 | 0/0 | 47/27 | 0/0 |
| 12 | 24/12 | 19/27 | 40/25 | 7/1 | 44/33 | 3/6 |
| 13 | 57/42 | 109/102 | n/a | n/a | n/a | n/a |
| 14 | 105/117 | 55/49 | n/a | n/a | n/a | n/a |

card selecting game. In addition, this Table highlights the number of probability errors that were made by the participant during each experimental condition. Interestingly, all participants made a fair number of errors, ranging from 21% to 98% of trials with an error, thus their overall winnings during this experiment were drastically reduced due to participants frequently making card selections which were not statistically optimal.

The Wilcoxon Signed Rank test for ordinal data was used to compare the percent-age of trials played on the self selection screen during baseline and after the introduction of the inaccurate rule. Results revealed a significant change in the percentage of hands played on the self selection screen (Z = -2.52, p = .012), indicating that participants played a significantly greater percentage of trials on the self selection screen following the inaccurate rule stating that they could win more if they selected their own cards. The Wilcoxon Signed Rank test for ordinal data was also used to compare the percentage of trials played on the self selection screen after the delivery of the inaccurate rule and after delivery of the accurate rule. Results failed to reach significance (Z = -1.829, p = .069) indicating that the introduction of an accurate rule stating that the computer did not make mistakes in selecting cards failed to significantly reduce or change the percentage of responses allocated to the self selection screen across all participants.

The changing experimental conditions from baseline to Inaccurate Rule did impact all 10 participants' behavior. Participants 8, 13, and 14 remained in Baseline throughout, to serve as experimental controls. Figure 5 depicts the clear preference for the left computer screen by participants, and displays the percentages of selection for this option separated by each experimental condition of the current study. It can be seen from this figure that all participants increased their percentages of play on the left computer screen following the introduction of the Inaccurate rule condition. The only exceptions are where there was already a 100% preference for this option during Baseline by a participant. The changing experimental conditions from Inaccurate Rule to Accurate Rule failed to yield as

Table 4
Each participant's number of plays on the participant controls card selection (Free Play) / number of probability errors during the three conditions of the experiment; baseline, inaccurate rule, and accurate rule. Percentages of trials with errors are shown in parentheses.

| *Participant* | *Baseline Free Play* | *Inaccurate Free Play* | *Accurate Free Play* |
|---|---|---|---|
| 2 | 72/27 (38%) | 41/14 (34%) | 42/14 (33%) |
| 3 | 66/41 (62%) | 40/24 (60%) | 0/0 (0%) |
| 4 | 27/9 (33%) | 38/10 (26%) | 27/7 (26%) |
| 5 | 19/8 (42%) | 42/26 (62%) | 58/33 (57%) |
| 6 | 61/24 (39%) | 40/17 (43%) | 18/6 (33%) |
| 7 | 71/66 (93%) | 47/46 (98%) | 2/0 (0%) |
| 8 | 134/94 (70%) | n/a | n/a |
| 9 | 42/9 (21%) | 42/11 (26%) | 53/14 (26%) |
| 10 | 64/23 (36%) | 42/13 (31%) | 35/14 (40%) |
| 11 | 65/32 (49%) | 39/17 (44%) | 47/22 (47%) |
| 12 | 24/16 (67%) | 40/26 (65%) | 44/34 (77%) |
| 13 | 57/36 (63%) | n/a | n/a |
| 14 | 105/50 (48%) | n/a | n/a |

robust of an effect across all participants. Upon introduction of the Accurate rule condition, participants 3, 4, 6, 7, 9, and 10 followed the rule given to them by the experimenter and decreased their playing of the left computer screen, and participants 2, 5, 11, and 12 continued to play the left computer screen at high rates even after given the rule by the experimenter. These data show the strength of what an inaccurate rule about Video Poker can do to game preference, yet produced mixed results regarding accurate rules.

In order to further understand the observed differences between participants during the Accurate rule condition, verbal protocols were analyzed phase by phase to assess individual participant differences. Tables 5-7 display the summary data by experimental condition for each participant. Data were classified into 7 content categories with the measurement unit of the independent clause rather than a sentence, which might contain two or more clauses. As a result, each trial may have contained one or more content emissions. In general, all participants spoke primarily about performance or reinforcement during all experimental conditions.

Using the obtained data in Figure 5 and conventions established in previous work on rule following (Wulfert, Greenway, Farkas, Hayes & Dougher, 1994), participants' verbal protocols were either classified as "Rule Followers" or "Non-Rule Followers" depending on if their percentages of selection for the left computer screen increased or decreased during the final condition of the experiment. Using this classification of participants, mean verbal utterances were computed for each group and are displayed in Table 8. The obtained data suggest differences between the Rule Followers and Non-Rule Followers' verbal behavior. Rule Followers talked less about performance than the Non-Rule Followers, talked more about reinforcement, and also emitted more irrelevant statements about the game. Rule Followers also tended to speak more often about accurate rules about the game, and emit statements about illusory

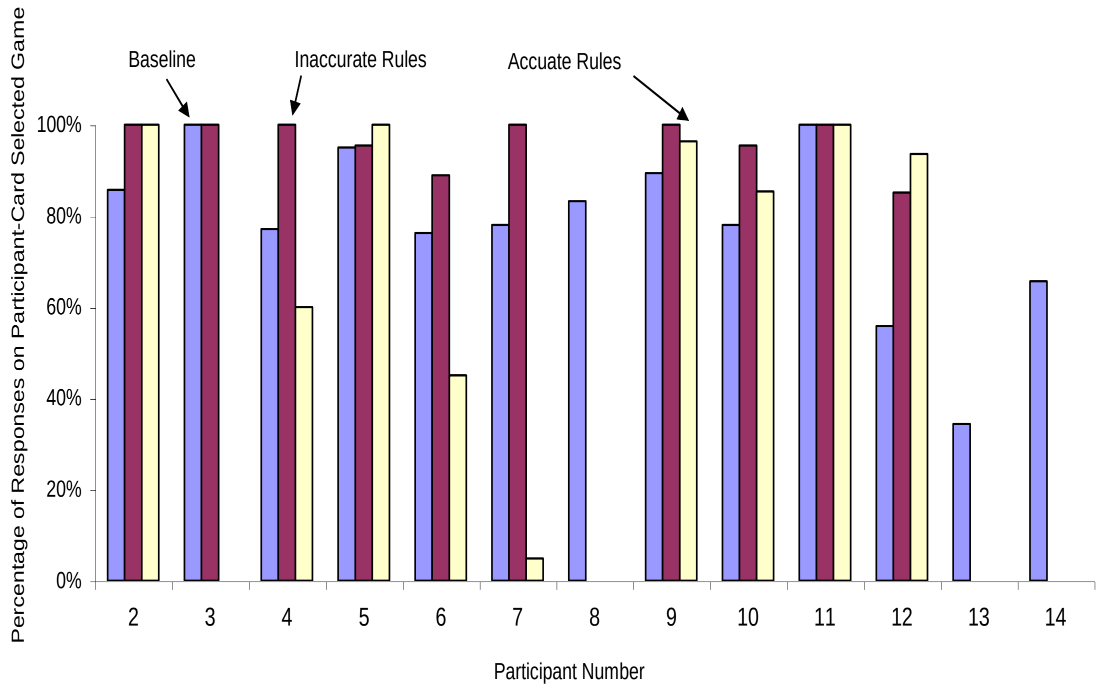


Figure 5: Experiment 2 individual participant data for selection of the Free Play option across baseline, inaccurate, and accurate rule conditions.

Table 5
Verbal protocol analysis summary data for each participant during the baseline conditions of the present experiment. Values are depicted in percentages of total verbal behavior emitted in each category.

| *Participant* | *Performance* | *Reinforce-ment* | *For-casting* | *Inacc. Rules* | *Acc. Rules* | *Illusion* | *Unrelated* |
|---|---|---|---|---|---|---|---|
| 2 | 59 | 23 | 7 | 0 | 0 | 0 | 11 |
| 3 | 100 | 21 | 0 | 0 | 0 | 0 | 1 |
| 4 | 48 | 33 | 15 | 1 | 0 | 0 | 3 |
| 5 | 46 | 49 | 3 | 0 | 0 | 0 | 3 |
| 6 | 35 | 23 | 10 | 13 | 1 | 0 | 18 |
| 7 | 49 | 31 | 6 | 1 | 1 | 1 | 11 |
| 8 | 14 | 49 | 2 | 4 | 0 | 1 | 1 |
| 9 | 42 | 41 | 15 | 0 | 1 | 0 | 2 |
| 10 | 41 | 47 | 3 | 2 | 0 | 0 | 5 |
| 11 | 68 | 22 | 5 | 0 | 0 | 0 | 1 |
| 12 | 86 | 7 | 0 | 0 | 0 | 0 | 7 |
| 13 | 37 | 41 | 9 | 0 | 5 | 0 | 17 |
| 14 | 24 | 35 | 6 | 1 | 2 | 0 | 0 |
| Mean | 46 | 30 | 6 | 2 | 1 | 0 | 6 |

Table 6
Verbal protocol analysis summary data for each participant during the inaccurate rule conditions of the present experiment. Values are depicted in percentages of total verbal behavior emitted in each category.

| *Participant* | *Performance* | *Reinforce-ment* | *For-casting* | *Inacc. Rules* | *Acc. Rules* | *Illusion* | *Unrelated* |
|---|---|---|---|---|---|---|---|
| 2 | 47 | 31 | 10 | 6 | 0 | 0 | 7 |
| 3 | 100 | 16 | 2 | 2 | 0 | 0 | 0 |
| 4 | 52 | 34 | 9 | 3 | 0 | 0 | 2 |
| 5 | 42 | 47 | 9 | 2 | 0 | 0 | 0 |
| 6 | 18 | 27 | 4 | 7 | 2 | 5 | 38 |
| 7 | 40 | 27 | 11 | 5 | 0 | 1 | 16 |
| 9 | 42 | 40 | 9 | 0 | 5 | 0 | 5 |
| 10 | 51 | 41 | 5 | 0 | 0 | 3 | 3 |
| 11 | 65 | 30 | 2 | 5 | 0 | 0 | 0 |
| 12 | 80 | 16 | 0 | 4 | 0 | 0 | 0 |
| Mean | 49 | 28 | 6 | 3 | 1 | 1 | 6 |

Note: Participants 8, 13 and 14 remained in baseline throughout the entire experiment, thus they are not depicted in the below table.

Table 7
Verbal protocol analysis summary data for each participant during the accurate rule conditions of the present experiment. Values are depicted in percentages of total verbal behavior emitted in each category.

| *Participant* | *Performance* | *Reinforce-ment* | *For-casting* | *Inacc. Rules* | *Acc. Rules* | *Illusion* | *Unrelated* |
|---|---|---|---|---|---|---|---|
| 2 | 62 | 23 | 0 | 2 | 0 | 2 | 11 |
| 3 | 39 | 39 | 0 | 2 | 4 | 4 | 9 |
| 4 | 45 | 42 | 6 | 4 | 0 | 1 | 2 |
| 5 | 43 | 46 | 7 | 0 | 1 | 2 | 1 |
| 6 | 19 | 28 | 5 | 5 | 7 | 9 | 28 |
| 7 | 41 | 27 | 7 | 0 | 7 | 7 | 14 |
| 9 | 44 | 38 | 0 | 1 | 2 | 9 | 2 |
| 10 | 41 | 38 | 6 | 1 | 1 | 4 | 9 |
| 11 | 66 | 32 | 0 | 0 | 0 | 2 | 0 |
| 12 | 72 | 14 | 3 | 2 | 0 | 5 | 0 |
| Mean | 43 | 30 | 3 | 2 | 2 | 4 | 7 |

Note: Participants 8, 13 and 14 remained in baseline throughout the entire experiment, thus they are not depicted in the below table.

Table 8
Mean percentages of verbal behavior content in each category displayed for participants that followed the accurate rule during the final condition of the experiment.

| *Condition* | *Group* | *Perfor-mance* | *Rein-forcement* | *Fore-casting* | *Inacc.* | *Acc.* | *Illusion* | *Unrelated* |
|---|---|---|---|---|---|---|---|---|
| Baseline | Rule Followers | 0.525 | 0.326 | 0.081 | 0.028 | 0.005 | 0.001 | 0.066 |
| | Non Rule Followers | 0.647 | 0.252 | 0.037 | 0 | 0 | 0 | 0.055 |
| Inaccurate Rules | Rule Followers | 0.500 | 0.336 | 0.065 | 0.028 | 0.011 | 0.013 | 0.088 |
| | Non Rule Followers | 0.612 | 0.297 | 0.057 | 0.032 | 0 | 0 | 0.005 |
| Accurate Rules | Rule Followers | 0.413 | 0.353 | 0.030 | 0.018 | 0.025 | 0.050 | 0.100 |
| | Non Rule Followers | 0.587 | 0.312 | 0.040 | 0.025 | 0 | 0.022 | 0.005 |

control. These group mean differences were consistent across all experimental conditions.

## GENERAL DISCUSSION

Taken together, the two studies presented here have explored the degree to which an illusion of control exists for video poker players, and how instructional stimuli may mitigate that illusion. In Experiment 1, we employed a group design to explore the differential effects of accurate and inaccurate rules on which type of game participants would allot the majority of their responses to. There were slight differences between groups, yet in general results showed that regardless of the rule given, most participants played the majority of trials on the game which allowed them to select cards themselves. These results indicate that a preference for illusory control may exist for video poker players, even when such a preference results in play that deviates from the statistically optimal.

The second study further examined the extent to which recreational video poker players would prefer a game which allowed player card selection over a game which had the computer control card selection, even when the computer option would result in statistically optimal play, and thus more winning games. In baseline of Experiment 2, 12 of 13 players preferred the self-selected card game. These findings suggest that the illusion of control (Langer, 1975) does in fact exist for the majority of video poker players, even when that illusion is detrimental to overall obtained winnings. No player in our study played statistically optimal, thus preference for the illusionary option had detrimental effects on overall winnings. These findings add to the published literature on illusionary control in gambling (Dixon, 2000; Dixon, Hayes, & Ebbs, 1998; Presson, & Denassi, 1996), and suggest that control is highly preferred even if the odds of a positive outcome are reduced by its presence. Future research might wish to add economic variables to the current study whereby players might need to wager more for identical outcomes if they want the illusionary option, or the payoffs for winning poker hands are less than they are for the computer controlled game. It may have also been possible that our participants preferred the illusionary game option because it was simply somewhat more entertaining or "fun" than just having the computer select cards for them. A future study may also attempt to control for this possible confound by making the card selection of our computer controlled option coupled with a concurrent task the participant would do during the trial time (e.g., like clicking the computer mouse on a section of the computer screen).

Of greater interest in this current investigation is the impact that experimenter delivered instructions had on resulting gambling behavior of our video poker players. Upon the delayed introduction of an experimenter rule about how the computer selected option was not an ideal choice, all of our participants increased the percentage in which they played the illusionary game option. These findings support the ability to experimentally modulate the illusion of control which was demonstrated in roulette players by Dixon (2000). Thus it appears very clear that when given information by others that illusionary behavior should be engaged in, video poker players will increase their tendency to do so. In our study we only gave our participants a one sentence rule about playing the illusionary option. Imagine the extensive rules that a real poker player is exposed to upon entry into a casino. Other players tell him or her to try this or do that, or play a game that is hot and stay away from one that is not. Such rules are more elaborate than the ones used in the current study, and it appears possible that their complexity may result in even greater desire of poker players to engage in illusionary control. Future research should explore the incorporation of more detailed inaccurate rules which are designed to strengthen illusionary control than the one sentence rule used in the current investigation. While some notions of the illusion of control suggest that it is a static fallacy or trait, our data in fact suggest that this construct can be modified through experimental manipulations.

It should also be noted that the order of the rules given could possibly have had an impact on the obtained results. In the current study the Inaccurate rule condition preceded the Accurate rule condition for all participants. While this same order has been used in previous research on the illusion of control (Dixon, 2000), it is possible that the contradiction implied by presenting an accurate rule after first presenting an inaccurate rule may have contributed to the obtained results. Future studies may address this limitation by counterbalancing the presentation of inaccurate and accurate rules across participants. Future studies may also consider randomizing the position of computer monitors across subjects such that a position bias may be experimentally controlled for.

The rather simple rule used in the present study may have also been in part responsible for the relatively mixed findings obtained during the accurate rule condition of the present investigation. The fact that such a simple rule could alter 6 of our 10 experimental participants suggests that this minimal intervention could result in behavior change for a fair number of our participants. The deviations obtained between participants were clarified when conducting more detailed investigations of each participant's verbal behavior. Without the inclusion of our protocol analysis data, we would have been unable to account for variations. Yet, though our incorporation of the protocol analysis we were able to determine that there were some subtle differences between those participants that followed the accurate rule and those that did not. Our classification of participants' verbal behavior into those that followed the rule and those that did not revealed small, but interesting differences between these two participant groups. First, the rule following participants talked less about performance and more about reinforcement. This finding suggests that perhaps gamblers who are very attentive to their current financial standing on a game are more prone to follow the advice of others. Our experimenter may have been perceived as an expert of sorts, and those players who wished to maximize their winnings tended to follow the directions. Those participants who did not follow the experimenter given accurate rule tended to talk more about their trial by trial performance. It is possible that these participants may have been somewhat less attentive to their winnings and losses, and instead were interested primarily in the cards they had in hand. Perhaps the lack of attention to the current financial standing is a feature which results in continued preference for illusionary control, when in fact, that control can be working against the player in terms of potential winnings. As was seen by all our participants, the illusion did cost the player potential winnings, as the many errors made could have been prevented by selecting the computer controlled game option.

In summary, the illusion of control is present in many video poker players. As opposed to other gambling contexts which the illusion may do no harm to the player (e.g., selecting one's own numbers at roulette or keno), self-selecting cards at video poker often result in errors from probabilistically optimal play. While computer selected card games are not available in many casinos, it remains clear that gamblers may seek out gaming devices which allow the illusion of control to be engaged in. Rising numbers of video poker players and decreasing numbers of slot machine players suggest that changing game preferences could be partially accounted for by the illusionary characteristic of video poker.

The present data are also promising first steps in designing potential treatment strategies for problem gamblers. If illusionary control can be brought under the persuasion of experimenter given rules about the game, then perhaps it can also be brought under the control of treatment providers seeking to reduce their clients' excessive gambling. Our data suggest that if gamblers begin to pay greater attention and think (or talk) about the wins and losses they encounter on a trial by trial basis, they may be more prone to follow the instructions of others. When those instructions are from treatment providers, it may be possible that the problem gambler will be more apt to listening. As the number of problem gamblers continues to increase and successful treatments are few, the time seems right to explore innovative means by which the treatment of this pathology can be enhanced.

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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.

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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

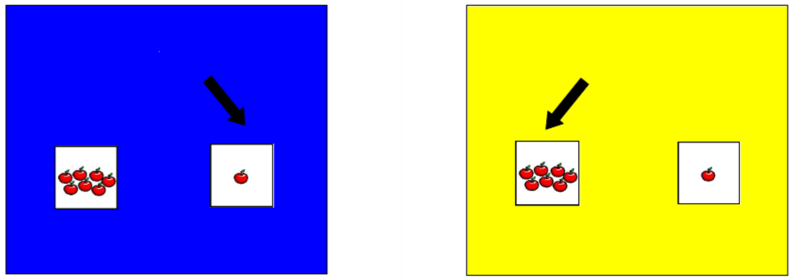

Figure 1: Examples of the screen layout from the nonarbitrary relational training and testing phases. The screen on the left shows an example of a trial used to train contextual functions of LESS-THAN for the blue background color, while the screen on the right shows an example of a trial used to train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

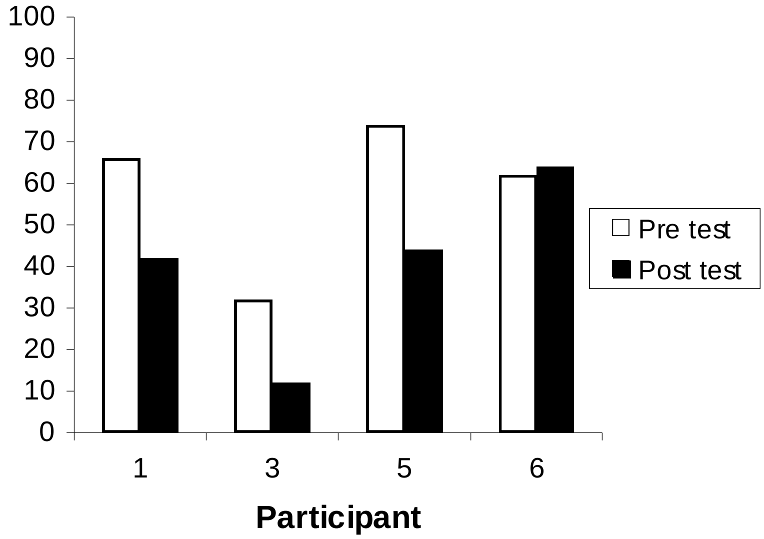


Figure 2: Percentage of responses allocated to the preferred yellow (more than) slot machine during pretest and posttest exposures for the four participants who passed nonarbitrary relational training and testing in Experiment 1.

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.

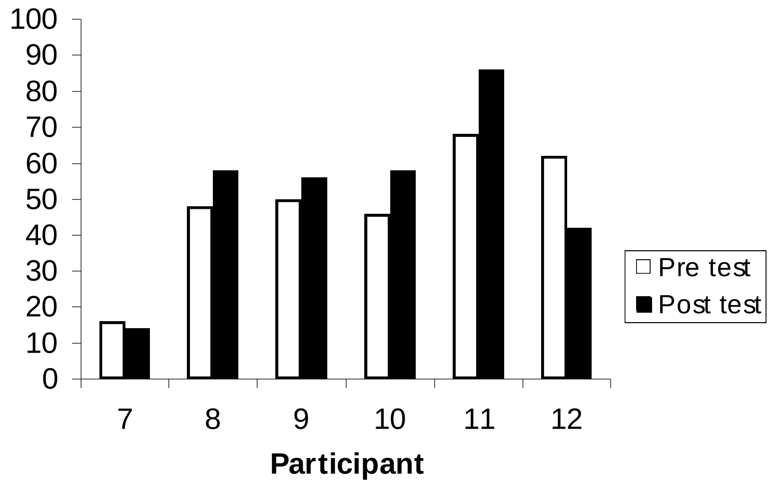


Figure 3. Percentage of responses allocated to the preferred yellow (more than) slot machine during pretest and posttest exposures for all participants in Experiment 2

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).

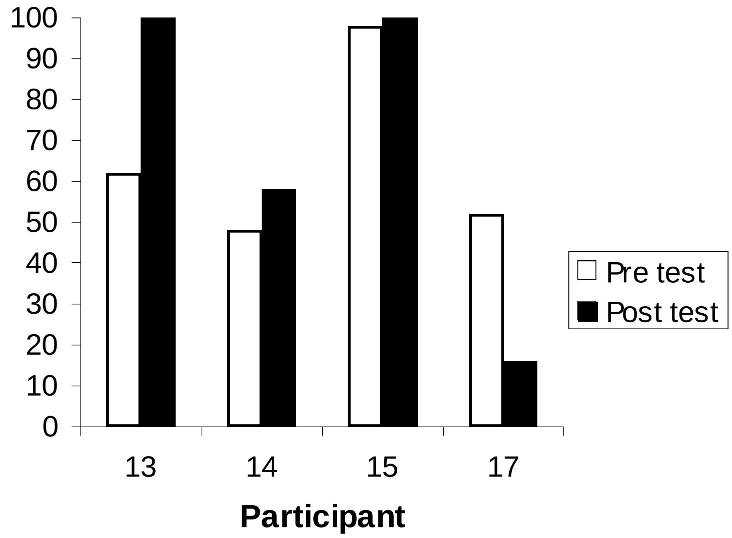


Figure 4. Percentage of responses allocated to the preferred yellow (more than) slot machine during pretest and posttest exposures for the four participants who passed nonarbitrary relational training and testing in Experiment 3.

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

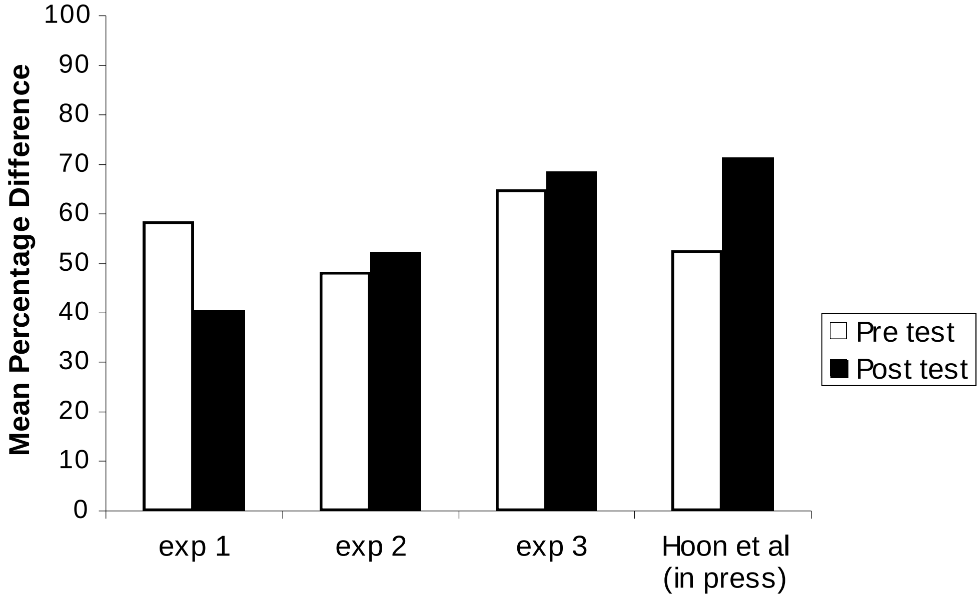


Figure 5. The mean percentage difference in responses allocated to the preferred yellow (more than) slot machine during pretest and posttest exposures for each of the four Experiments (note that Experiment 4 refers to data from the Hoon et al., in press, study).

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.

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Authors' Footnote

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# *PERCEPTIONS OF LUCK: NEAR WIN AND NEAR LOSS EXPERIENCES*

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Current research examining gambling behaviors has tended to focus on structural features such as the "near miss" phenomenon. Until now this research has focused mainly on a near "win" situation and ignored what can be considered a near "loss" situation (Wohl & Enzle, 2003). The present study compared the effects of participants' (N=132) near win/loss situations when playing a Wheel of Fortune slot-machine program designed to manipulate near wins and near losses. Near win/loss events were presented at a rate of 15, 30, or 45 percent of the total trials during an acquisition phase. Participants experiencing near win situations at the 45% levels persisted in their gambling behaviors more than the participants in other conditions. A better understanding of the impact of the structural variables of a slot machine, such as a near win and loss events can help explain gamblers' continued tendencies to gamble.

*Keywords:* gambling, slot simulation, near miss, luck, extinction.

Many forms of gambling exist, from casino gambling such as blackjack, bingo and craps to pull tabs, scratch offs, and lottery tickets. Gambling has become a popular hobby for many Americans, and it is estimated that 94% of Americans gamble in their lifetime and more than 10 million people in the U.S. encounter a problem with gambling during their lifetimes (Petry, 2005). Though many gamblers are aware that the odds are against them, some continue to place low probability bets because they want to "strike it rich," break even, escape from stressful life events, are high sensation seekers, or because of some other social or personal reason (Daughters, Lejuez, Lesieur, Strong, & Zvolensky, 2003). What causes gamblers to continue gambling despite repeated losses? Research in the areas of perceptions of luck (Darke & Freedman, 1997a; Teigen, 1998; Wohl & Enzle, 2003), and counterfactual thinking (Medvec, Madey, & Gilovich, 1995; Mellers, Schwartz, Ho, & Ritov, 1997; Wolfson & Briggs, 2002) may provide important insight as to why gambling behaviors persist in certain people and not others.

*Perceptions of Luck*

Understanding the relationship between perceptions of luck and gambling is one way to understand why gamblers continue to gamble, even when the odds are set against them. Perceptions of luck may develop from negative or positive hypothetical thoughts of alternative outcomes in the environment (Teigen, 1998), and may serve as antecedent stimuli. For example, if Jack thinks that most people win about 10 times in one hour on a slot machine, then this thought will likely be salient when he gambles on any slot machine. He will likely perceive himself as a lucky person if he wins more than 10 times and unlucky if he wins less than 10 times. Of course, there are other external variables to which Jack may

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attribute the differences between his alternative and actual outcome, such as superstitions, personal skill, personification of the machine (i.e., the machine has human emotions or qualities), or rationalizations of near losses (Delfabbro & Winefield, 2000). If luck is made salient, however, an individual's perception of the stability and origin of luck becomes important in explaining persistent gambling behavior (Darke & Freedman, 1997a).

*Near Loss Situations*

One situation that has been found to cause variations in how people perceive luck is a near loss situation (Wohl & Enzle, 2002; 2003). The current definition of a near loss is "…a special kind of failure to reach a goal, one that comes close to being successful" (Reid, 1986, p.32). This definition, however, does not fully explain either near win or near loss experiences and their affect on behavior. A near win event on a slot machine has for example, the first two reels stopped on the jackpot and the last reel has stopped on a blank symbol just above the jackpot. This fits Reid's (1986) definition of a near loss in that the event is characterized as a failure (i.e., no payout), but it came close to obtaining a specific goal (i.e., all three reels landing on the jackpot). Conversely, one could conceptualize a near loss event as one that nearly results in a negative outcome whereas a near win event could be conceptualized as one that nearly results in a positive outcome.

Kassinove and Schare (2001) observed 180 undergraduate psychology students to examine the effects of the near win on persistence of play on a four-reel slot-machine simulation. Participants were required to play the slot machine for 50 trials, during which near wins were programmed into the machine at a rate of 15, 30, or 45 percent of the total trials or reel spins, followed by the extinction phase where the computer was programmed not to win or land on a near win event. Kassinove and Schare's (2001) findings indicate that participants exhibited the most persistence in the 30% (i.e., 30% of the trials were near wins) condition, as opposed to the 15% and 45% conditions.

There are three main arguments that have been presented as to why people tend to gamble longer on a 30% near win machine. Kassinove and Schare (2001) argue that the persistence in the 30% condition could be explained by operant conditioning. In other words, the near win is paired with a win enough times that it begins to serve as a secondary reinforcer. Individuals in the 15% condition may have extinguished faster than the 30% condition because they were not able associate the near win with an actual win due to the low occurrence of the near win events. Participants in the 45% condition, however, may have extinguished faster because the near win was made so salient that they began to realize that no true association between the near win and an actual win ever existed. The 30% condition appears to provide the greatest resistance to extinction.

Another explanation for the resistance to extinction in the 30% condition may be explained by using Langer's (1975) idea of an illusion of control. An illusion of control is an irrational belief that one has control over the outcome of uncontrollable situations. Reid (1986) distinguished chance and skill-based near win situations by stating that, in a skill-based near win, an individual can use the situation as a learning experience to help him/her maintain control over future experiences. For example, if an individual gets closer to a bulls eye while throwing darts, he can learn from that experience. He can remember to point his toes forward, throw straight at the target, and grip the dart through his thumb and forefinger.

Chance-based near win situations, however, should have no implications for future successes/failures because past events are independent of future events. In other words, no matter how a person presses the button on a slot machine or taps on his/her cards before looking at them, these strategies should not improve the chance for success. Individuals in Kassinove and Schare's (2001) 30% condition may have been more likely to misattribute the situation to one that involves skill, as opposed to random chance, due to internal/stable perceptions of luck.

Dixon and Schreiber (2004) suggested that a near win situation is actually a verbal event that has been reinforced by previous near win situations. Their reasoning for why near win events are reinforcing is that the culture responds to such situations with verbal sayings such as "Wow" and "Keep trying you will get it." In other words, as children grow they are shaped with close approximations to the desired behavior. Peoples' behavior has been reinforced in these types of situations and will thus continue to persevere. Therefore, a near miss situation is one that we have learned to learn from. The effects near win situations have on persistence, or resistance to extinguishing gambling behaviors, are important to understanding gambling behaviors.

*Counterfactual Thinking*

Understanding the concept of counterfactual thinking may help explain why a near win event has such an influence on persistence in behaviors such as gambling. According to Lim and Tan (2001), counterfactual thinking is a term used for the "consideration of alternative versions of past events." These thoughts are very much focused on behavior in the form of "I should/would/could have done something differently." Mandel (2003) identified two types of counterfactual thoughts: upward and downward. Upward counterfactual thoughts are those where the imagined situation is better than the actual situation. Downward counterfactual thoughts are those where a worse alternative than that which actually occurred is imagined.

Perceptions of luck and counterfactual thinking relate to each other in that perceptions of luck are often contingent on alternative situations. Teigen (1998) found that many negative situations are seen as lucky. In other words, when a negative event occurs, people tend to think of worse possible outcomes (downward counterfactuals), which lead them to attribute the actual event as lucky. For example, consider two very serious automobile accidents. In the first, no one was injured, but both cars were completely destroyed. The individual may attribute this scenario to bad luck, being in the wrong place at the wrong time. However, if another passenger happened to be killed, in the same accident, the person may then see herself as lucky because she was not killed. The salience of the more extreme negative outcome often causes the individual to feel extremely relieved and fortunate that the situation was not worse. For example, Medvec, et al., (1995) found that bronze medalists in the Olympics were more relieved and felt more fortunate than silver medalists because they thought of the alternative outcome of not winning a medal at all.

Relating perceptions of luck, counterfactuals, and near win/loss events to gambling, Wohl and Enzle (2003) asked, "Who would feel luckier, someone who just missed a jackpot, or someone who just missed a bankrupt?" Participants were asked to spin a Wheel of Fortune type game in which they either nearly missed a bankrupt or nearly missed a jackpot. They were then asked to place a bet on a game of roulette. After the bet was made, participants were asked to complete the BIGL scale and various questions regarding counterfactual thoughts. The results supported the notion that luck is related to specific counterfactual thoughts in that narrowly missing the bankrupt caused individuals to use downward counterfactual thoughts more often, to have a higher belief in personal good luck (measured on the BIGL), and to wager more on the subsequent roulette game. Narrowly missing the jackpot caused individuals to use upward counterfactuals more often and have a lower belief in personal good luck, leading to lower wagers on the roulette game. The information above provides a link between the near win/loss event and perceptions of luck, which can be important in explaining gambling persistency and betting patterns.

*Extinction*

In order to understand why certain people persist in gambling, it is important to address the concept of extinction. Extinction is "the procedure of withholding reinforcement for a previously reinforced response" (Pierce & Cheney, 2004, p. 100). This procedure causes the specific behavior to decline and eventually terminate. However, during the early stages of extinction, the behavior is sometimes emitted at a rate faster than the rate during reinforcement. After this "extinction burst," the participant will slowly decrease the frequency of the behavior until it has been completely terminated. It has been shown that different schedules of reinforcement can impact the rate at which a particular behavior is extinguished (Pierce & Cheney, 2004). For example, intermittent schedules of reinforcement are much more resistant to extinction than continuous schedules of reinforcement because the individual is not expecting reinforcement every time the behavior is produced. For gambling behaviors, it is believed that variables, such as a near win event, can decrease the rate of extinction (Kassinove & Schare, 2001).

*The Current Study*

The current study examined the impact of near win and near loss situations on perceptions of luck and resistance to extinction on a Wheel of Fortune slot-machine simulation. Participants were in a 15, 30, or 45 percent condition and either a near win, near loss, or control condition. Other than near wins, near losses, and wins, all other trials were consistent throughout the conditions. After the first 200 trials/spins, the computer began an extinction phase, during which no near win/loss or winning outcomes occurred. Extinction trials were the same for all participants. During the extinction phase, participants were allowed to terminate slot play at their accord. After terminating play, participants were given the BIGL and Locus of Control scales. These scores were compared across all six conditions to determine the impact a near win/loss had on an individual's perception of luck, locus of control, and resistance to extinction. It was hypothesized that participants in the high density (45%) near win condition would continue to play longer during extinction.

## METHOD

*Participants*

Students signed up to participate using the Psychology Study Participant Manager, an online database through which students at the university receive credit in psychology classes for participating in research. The sample consisted of 132 undergraduate students from the University of Northern Iowa (66 males and 66 females). The age of the participants ranged from 18 to 52 with the majority falling between 18 and 21 (82.6%). Eligible participants were those who indicated that they had gambled on a slot machine (online or at a casino) within their lifetime, to ensure general familiarity with slot machines. Participants were also prescreened for pathological gambling and those people were not allowed to participate.

*Design*

The study employed a 2 (near win/ near loss) X 3 (15%, 30%, 45% of near win/loss events/trials) between-subjects design and an additional control group. The dependent measures included scores on the BIGL and Levenson's Locus of Control Scale, as well as the number of trials participants play on the slot machine during an extinction phase.

*Materials*

*South Oaks Gambling Screen (SOGS).* The SOGS is a 16-item questionnaire commonly used as an assessment for potential problem gamblers and considered to be a highly valid and reliable test for measuring pathological gambling (Lesieur & Blume, 1987; Cote, Caron, Aubert, Desrochers, Ladouceur, 2003). The SOGS was used as a prescreening tool to ensure that no probable pathological gamblers participated in the study.

*Locus of Control Scale.* Levenson's Locus of Control Scale is a 24-item questionnaire used to measure the level of an individual's perception of control over various life events (Levenson, 1981). The questionnaire contains three subscales including an internal scale, a powerful others scale, and a chance scale. The internal subscale measures an individual's belief that he or she has control over contingencies in the environment. The powerful others and chance subscales measure an external locus of control, but are distinct in that one measures unpredictable (i.e., chance) perceptions, and the other measures predictable (powerful others) perceptions.

*Belief in Good Luck Scale.* The BIGL is a 15-item questionnaire designed to measure perceptions of luck (Darke & Freedman, 1997b). The BIGL has been shown to be a reliable and valid instrument for measuring belief in good luck (Darke & Freedman, 1997b). Researchers have found that higher scores on the BIGL are associated with greater expressed expectations of positive outcomes in future situations (Darke & Freedman, 1997a; Watt & Nagtegaal, 2000).

*Apparatus*

The simulated three-reel slot machine, called Wheel of Fortune, was created using Visual Basic.Net and is a modified version of one created by MacLin, Dixon, Robinson, and Daugherty (2005). Using this simulation, the researcher has the ability to vary the slot machine simulation to display different backgrounds, symbols, sounds, and reinforcement schedules. Each reel consists of five possible symbols. The reel configuration from top to bottom is \$1, 25¢, 50¢, bankrupt, 50¢, \$2, \$1, 25¢, \$1, 25¢, jackpot, 50¢, and 25¢. Between each symbol is a blank position/space. Above each of the reels is a Wheel of Fortune image. Below the reels is a "Credits" display box and a "Win" display box that displays the total number of credits the user has left and the amount won for each spin, respectively.

The slot-machine simulation is operated by a spin button located directly below the second reel. Clicking on the spin button with the mouse deducts 1 credit from the credits box and activates all three reels, causing them to move/spin from top to bottom. The program reads an input file that contains numbers, which represent the stopping position of each reel after a set amount of time, has elapsed. Each reel stops independently after an allotted time. If the three reels stop with the same numbers/symbols on the pay line, a win or loss equal to that amount will be added to or subtracted from the "Credits" display box. On any given spin the user can win or lose their entire total credits by three jackpots or bankrupts coming to a stop on the payout line. Along the bottom of the screen is a "cash-out" button that will terminate the program upon being clicked. Sounds are included during each click of the spin button, during spin time, and each time a reel stops. There are also sounds that occur when a jackpot or a bankrupt symbol stops on the payout line. The simulation records the number of trials during extinction, the number of total trials/spins, the number of credits, the stopping points of the reels for each spin, the total amount won, and the total number of near win/loss events.

*Procedure*

Participants were asked to sign an informed consent form providing an overview of the study. Participants were then administered the SOGS, BIGL, and the Locus of Control Scale. Participants receiving a SOGS score of 5 or higher were asked to perform a non-gambling-related task and were not used for the current study. After each participant completed the surveys, the participants were given instructions about the slot-machine game they would be playing, the number of credits they would start with (100), and how to terminate play. They were also instructed regarding the remaining questionnaires they would fill out during the session, as well as the prize for which they would be competing with other participants ($10 gift certificate to go to the person who cashed out with the highest number of credits).

After the participants were read the instructions, they were led into separate 8 ft by 13 ft lab rooms. Each room had at least one computer with a similar setup of multiple desks. Once the participant was seated, the research administrator showed him/her where the cash out and spin buttons were, as well as the light switch that was used to inform the administrator that the individual had ceased play. Participants began the experiment with 100 credits. When the participant pressed the spin button, 1 credit was subtracted from the total credits and the three reels began in motion from top to bottom. The first 50 trials, or the acquisition phase, included 15 separate wins: three were $0.25, eight were $0.50, and four were $2. The participants were directed to continue play until they decided to stop playing.

A separate input file was created for each condition/group. Two phases occurred during the study: the acquisition phase and the extinction phase. The acquisition phase consisted of 50 trials, 28 of which were identical across all conditions. Of these 28 trials, 15 wins occurred: three 25¢ wins, eight 50¢ wins, and four $2 wins. This programming was done to ensure that each participant would win at a rate comparable to a casino slot machine. The remaining trials that were identical throughout the conditions were all losses. Depending on the condition, the input files were created to present near win or near loss events at a rate of 0, 15, 30, or 45 percent of the remaining 22 trials during the acquisition phase. For those conditions less than the 45%, the remaining trials were losses with a maximum of one symbol on the payout line. A near win event was defined as an occurrence of a jackpot symbol stopping on the payout line for the first two reels and the third reel jackpot symbol stopping before or after the payout line. A near loss event was defined as an occurrence of a bankrupt symbol stopping on the payout line for the first two reels and then the third jackpot symbol stopping before or after the payout line. Any of the 28 trials that did not consist of a near win/loss event were the same throughout conditions.

On trial 50, the slot simulation went into an extinction phase. The extinction phase consisted of 200 additional trials with no wins or near win/loss events. Once participants decided to cease play, the researcher administered the BIGL. Participants were then asked to wait quietly until everyone else had finished, at which point the person with the top score was paid the $10 gift certificate.

## RESULTS

Because we were interested in responding during extinction, participants who terminated the session prior to the extinction phase (i.e., 50 trials) were excluded from all subsequent analyses, thus eliminating 24 of the original 132 participants. A repeated measures analysis for changes in BIGL scores from pre to post test across nears and density determined that there was a significant difference, $F$ (1, 86) = 6.512, $p$ < .05, MS = 57.91. There was no difference in the interaction between the nears and density of the nears, $F$ (2, 86) =

.871, *p* = .422, MS = 7.75, or from just the density alone, *F* (2, 86) = .984, *p* = .392, MS = 8.43. However, the nears alone may have some affect on BIGL scores though the difference was not statistically significant, *F* (1, 86) = 3.890, *p* = .052, MS = 34.59.

A significant difference was found between pre and post BIGL scores in three of the seven conditions. The near win 15%, F(1, 18) = 2.27, p = .150, MS = 17.54, near win 30%, F (1,15) = .004, p = .952, MS = 8.00 E-02, near win 45%, F (1,13) = .387, p = .545, MS = 3.316, and near loss 30% conditions, F (1,15) = .929, p = .350, MS = 5.355, were all not significantly different from pre to post test. However, the near loss 15%, F (1,12) = 6.80, p < .05, MS 39.61, near loss 45%, F (1,13) = 16.602, p < .01, MS = 52.066, and control conditions, F (1,14) = 6.921, p< .05, MS 60.854, were all significantly different from pre to post test.

Near win conditions were not more resistant to extinction than the near loss conditions. No significant differences were found for age, *F* (12, 107) = .1.240 *p* = .268, MS = 1378.74, gender, *t* (106) = 1.262, *p* = .210, MD = 8.21, year in school, *F* (4, 107) = .381 *p* = .822, MS = 444.97, or ethnicity, *F* (3,107) = .791 *p* = .502, MS = 908.26, in regards to the number of trials played. A 2 X 3 ANOVA revealed no significant difference in trials played for the interaction between nears and density, *F* (2, 86) = 2.19 *p* = .118, MS = 2502.31, or just the nears alone, *F* (1, 86) = .053 *p* = .819, MS = 60.60. However, a significant difference across density was found, *F* (2, 91) = 3.49, *p* < .05, MS = 4002.13 (see Figure 1). A Post Hoc analysis using Tukey's HSD indicated that the 30% condition was significantly less than the 45% condition (*p* < .05, SE = 8.41).

There was no significant difference between the near loss 15% and 30%, *t* (27) = -.591, *p* = .560, the near loss 15% and 45%, *t* (25) = -.187, *p* = .853, or the near loss 30% and 45%, *t* (28) = -.414, *p* = .682. Though there was also no significant difference between the near win 15% and 45%, *t* (31) = 1.527, *p* = .137, there was a difference between the near win 45% and the near win 30% (*t* (28) = -3.173, *p* < .01), and the difference between the near win 15% and near win 30% approached significance (*t* (33) = -1.96, *p* = .058).

Finally, scores on the BIGL and the external subscale of the LOC were significantly positively correlated (*r* = .316, *p* < .01). The external subscale was also significantly correlated with the internal subscale (*r* = -.290, *p* < .05) and the powerful others subscale (*r* = .447, *p* < .01).

## DISCUSSION

The present study examined the relationship between near win/loss situations, perceptions of luck, and resistance to extinction on a slot-machine simulation. The current results suggest that a higher density (45%) of near win and near loss trials lead to a greater resistance to extinction than the lesser densities. However, further investigation suggests that most of this variance between densities may be explained in the near win situation and not the near loss (i.e., the near win 45% is significantly different from the near win 30%). Kassinove and Schare (2001) argued that near wins serve as a secondary reinforcer and the current data partially support this notion. The reason the data only partially support this argument is because the only significant differences were in the near win 45% condition.

An explanation may be that the 45% conditions can be experienced as both exciting and frustrating. The stimulation may stem from what Cote et al. (2003) attribute to outcome expectancy. In other words, the gambler is actually anticipating a win or a loss and will often experience mixed emotions during near experiences. Immediately following an increase in arousal, the gambler experiences the opposite emotion. For example, in the near win experience, frustration comes after realizing that they have not obtained the outcome they desired (i.e. the jackpot). Now the gambler has two choices, he/she could: 1) stop playing the machine or 2) continue to play the machine.

Research suggests that people may continue to gamble due to an irrational belief that they have control over the outcome of the situation. This 'illusion of control' is often confused by the gambler with skill based events and is probably learned through verbal reinforcements in the culture (Langer, 1975). The persistence in the near win 45% may be a result of the gamblers fallacy, or the belief that the odds for a win increase or decrease based on previous outcomes. It is likely that the higher number of near win situations presented will cause an increase in the salience of a jackpot. Therefore, the associations and salience of the jackpot will be much stronger in the near win 45% than in the near win 30% and 15%. In the near win 45% condition the associations and salience of a jackpot lead to verbal behavior, such as "A jackpot must be just around the corner." It is likely that the participants in the 45% condition have carried over this verbal behavior to the extinction phase causing them to play longer. In the other near win conditions, the jackpot is not as salient and the verbal behavior is probably focused more on how much they were losing, causing them to terminate play much earlier.

This differs from Kassinove and Schare (2001) in that 30% near wins were causing the most resistance to extinction in slot play. It is likely that the 45% near wins in this study were leading to an over-saturation of near wins (reinforcements). One explanation for why this did not occur in the current studies' 45% condition is because bankrupts existed and to some extent took away from the 'near win' factor. This could be why the 30% condition was not significantly different in this study, but was in Kassinove and Schare's (2001). Another reason for this difference could be the combination of the payout rate with the percentage of near wins. In other words, if the individual is winning more frequently and experiencing near win situations, he or she may gamble more frequently. Future studies will need to address this issue and control for different payout rates in relation to the percentage of near wins.

There were no significant differences across density in the near loss conditions. One explanation to account for this is that a near loss is in the same stimulus class as a normal loss (i.e., both experiences result in a loss). Therefore, there should be no difference between the near loss conditions and the control condition, because the near loss does not appear to function beyond the 'loss' stimulus class. In other words, the gamblers in the near loss conditions are experiencing very similar situations to those in the control condition.

Another finding of the current study is that BIGL scores were positively correlated with the external subscale of Levenson's locus of control questionnaire. Darke and Freedman (1997b) found a similar correlation when constructing the BIGL and suggest that people who report that outcomes in their lives are mostly determined by external factors, such as luck, also are reporting a higher perception of good luck. Darke and Freedman (1997b) also suggest that the BIGL is an assessment of a stable perception of luck over time, however, our results challenge this notion. The results indicate that scores on the BIGL changed from pre to post test, similar to the findings of other research examining between subjects differences (Wohl & Enzle, 2002; Wohl & Enzle, 2003).

The current results do not fully support Wohl and Enzle's theory (2002), which argues that games of chance deprive people of any way of asserting control over the outcomes. Possessing an illusion of control that one can manipulate luck to work in his/her favor during these games may be one way that people manage these situations. Though Wohl and Enzle (2003) have been successful in manipulating their participants' perceptions of luck, we have not been able to replicate their findings (Brummer, Daugherty, & MacLin, 2004; Sauceda, Pisney, Decker, Daugherty, & MacLin, 2004). Their findings indicate that individuals tend to feel more personal luck when avoiding something aversive (i.e. the bankrupt) and less luck when avoiding something rewarding (i.e. the jackpot). The current findings offer a more extensive explanation in that perceptions of luck do vary systematically across conditions. In each condition the pre and post test scores on the BIGL drop, with the exception of the near win 45%. However, the differences in pre to post test on the BIGL systematically decrease as the number of near win experiences increases. Most importantly, the near win 45% condition actually reports a higher post test BIGL score. It appears that the near wins are maintaining the internal quality of luck.

According to Teigen et al., (1999) bad luck situations are more likely to be defined as a bad event that got worse, whereas a good luck is situation is usually defined as a bad situation turned good. The near win is a stimulating event that has been shown to increase gambling persistency. Participants experiencing a higher density of near wins may actually start to believe that the jackpot is "just around the corner" and feel prematurely lucky. These individuals will use luck to manipulate the outcome of the situation on higher near win density machines, more so than lower density machines.

The near loss conditions, again, are likely to be in the same stimulus class as a normal loss, and therefore participants should report similar difference scores on the BIGL in the near loss and control conditions. In Wohl and Enzle's (2002) near loss condition participants still won something (i.e. ten tokens). This is a situation that would fit perfectly into Teigen et al.'s (1999) definition of what a lucky event should entail. The near loss experience in the current study is much similar to what Teigen et al. (1999) define as a bad luck situation. Participants not only lost on each of the near loss events, but these events continued to occur throughout the study.

It may also be true that counterfactual thoughts also change or become less salient with the repeated exposure of the nears. This may be why the current study has found different results than what previous research has. The near win conditions may be using a counterfactual "I almost won the jackpot", while the near loss condition counterfactual may be much less positive. Future research could examine the specific thought processes occurring during the near win/loss events using a think out loud method. The current study extends the knowledge on the relationship between specific gambling situations, perceptions of luck, and resistance to extinction.

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*Action Editor:* Jeffrey N. Weatherly

# *STUDYING GAMBLING EXPERIMENTALLY: THE VALUE OF MONEY*

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Determining whether "gambling" behavior in the laboratory differs as a function of whether or not participants are risking actual money is important because the outcome will determine whether results from laboratory research can be generalized to actual gambling. Eighteen participants played video poker in two separate sessions. In one, they risked credits that had no monetary value and in the other they risked credits worth money. Results showed that participants played a similar number of hands and played with similar accuracy regardless of whether or not the credits had monetary value. However, participants risked significantly fewer credits when the credits were worth money than when they were not. These results suggest that findings from studies on gambling that do not have participants risk real money may indeed generalize to actual gambling, but that making such generalizations should be done with caution as the amount of risk people are willing to take may be overestimated.

*Keywords*: Gambling, Money, Motivation, Video Poker, Risk.

The research literature on gambling is not small. A literature search of the PsycINFO database, conducted on November 11, 2007, using the word "gambling" in an all-text search, identified 3,441 sources. Although impressive, this literature is nearly devoid of experimental research. A second search of the same database that cross-referenced "gambling" and "experiment" yielded only 172 sources (not all of which directly studied gambling, represented actual experiments, or both). Even at the most liberal level of analysis, these searches support the conclusion that only approximately 5% of the published scholarly works on gambling are experimental in nature. Importantly, this low percentage is not the product of using the incorrect database. A search for "gambling" on PubMed conducted on November 11, 2007, yielded 2,144 sources. A search for "gambling" and "experiment" yielded a mere 48 sources.

Given the popularity of gambling and the problems that can be associated with it (e.g., the worldwide prevalence rate of pathological gambling likely ranges between 1 – 2%, see Petry, 2005, for a review), the overall lack of experimental research might be surprising. After all, experiments arguably represent the most direct and straightforward procedure for determining cause-and-effect relationships. If scientists and practitioners in the field are interested in understanding the factors that promote and maintain gambling behavior, as well as identifying the potential causes of pathological gambling, then one would perhaps expect a larger amount of experimental research on gambling than currently exists.

There are, however, legitimate reasons for the paucity of experimental research on gambling (see Weatherly & Phelps, 2006, for a review). In the United States, for instance, it

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is against the law in many states to own modern casino equipment (e.g., slot machines) unless you are a licensed casino. This drawback can be partially circumvented by using software simulations that accurately mimic what gamblers would experience in a real casino (e.g., MacLin, Dixon, & Hayes, 1999). Even with realistic simulations, one also encounters difficulty in mimicking the consequences faced by the actual gambler. Specifically, actual gamblers face the possibility of losing (their own) money. For research purposes, many investigators are constrained by laws that prevent them from having participants risk money. Even when it is possible, the money participants risk is not their own. Rather it is staked to them by the experimenter (e.g., Dannewitz & Weatherly, 2007).

These issues gain in importance because research from our laboratory suggests that the presence of money in the procedure can influence the results of the experiment. For instance, Weatherly and Brandt (2004) had participants play a simulated slot machine. Across groups (Experiment 1) or sessions (Experiment 2), the participants played the simulation with credits that were worth $0.00, $0.01, or $0.10 each. Results of both experiments demonstrated that participants' betting behavior varied as a function of the monetary value of the credits. Specifically, participants played more trials and bet more credits *the less* the credits were worth. Participants were most conservative when the credits were at their highest monetary value (i.e., $0.10 each).

Weatherly, McDougall, and Gillis (2006) showed that even showing participants money can alter their behavior. In their procedure, participants were asked to play a slot-machine simulation. One group was told that they had been staked with 100 credits worth $0.10 each (i.e., $10). The second group was shown a $10 bill and told that it could be used to secure 100 credits worth $0.10 each on the simulation. The final group was handed the $10 bill and told that, if they wanted to play the slot-machine simulation, they could return the bill in exchange for 100 credits worth $0.10 each. Results showed that 3 of the 36 participants chose not to gamble and simply keep what they had been staked. All three participants were from the final group who had physically handled the money. Furthermore, participants in the group who had handled the money bet fewer credits when playing the simulation and quit earlier than did participants in the other groups.

Such results are not limited to our own laboratory. For instance, McCall and Belmont (1996, Experiment 1) demonstrated that customers left larger tips for wait staff when the tip tray was emblazoned with the emblem of a major credit card versus when it was not. These results can be considered consistent with those of Weatherly et al. (2006) in that credit cards are a step removed from actual cash money. Thus, consistent with the results of Weatherly and Brandt (2004), results from other studies indicate that participants' become more conservative as the salience of money is increased.

More recent research suggests that the influence of money in experiments designed to study gambling may extend beyond simply how much people bet. Weatherly, Austin, and Farwell (2007) recruited self-identified experienced and novice poker players to play three different types of video poker. Perhaps surprisingly, "experts" and novices did not differ in how accurately they played. Both groups committed the most errors (i.e., holding or discarding cards that reduced their rate of return below the optimal) when playing "Loose Deuces," a five-card draw game in which Two's are wild.

Dixon, Jackson, Pozzie, Portera, Johnson, and Horner-King (2007) recently reported a systematic replication of Weatherly et al. (2007). They recruited participants to play "Loose Deuces" video poker. After taking baseline measures of accuracy of play, these researchers attempted improve participants' performance through training. Their attempt was successful. Relevant to the present study, however, was the baseline measure of accuracy. Whereas participants in Weatherly et al. (2007) played at nearly 70% accuracy, participants in Dixon et al.'s study had a baseline accuracy rate of less than 50%. One potential explanation for this difference is the underlying motivation of the participants. Participants in Weatherly et al. (2007) played for money and could increase their winnings by performing well. Participants in Dixon et al. (2007) played for extra course credit, but not for money.

It is worth noting that this issue is not new. For instance, Anderson and Brown (1984) reported that changes in participants' heart rate when "gambling" was influenced by the amount of money being risked. Indeed, a number of physiological changes (e.g., cortisol levels) have been shown to vary as a function of the value of the risk involved (see Petry, 2005, for a discussion). However, the issue has not been systematically pursued or resolved, likely because so little of the research on gambling involves the use of experimentation. Furthermore, although research indicates that the stakes influence physiological measures, to the best of our knowledge it has not been directly demonstrated that the stakes influence gambling behavior.

If laboratory research on gambling is going to inform us as to the mechanisms and processes that contribute to and control gambling behavior, then the validity of the procedures used in such research should be established. Given research results to date, how people "gamble" in laboratory situations may differ depending on the consequences they face during the procedure. Namely, participants may "gamble" differently when they are risking money than when they are not. If true, then one could legitimately question whether research results from experiments on gambling than do not have participants risk money will generalize to gambling in the "real world."

The present experiment was designed to assess the importance of using money as a consequence when participants gamble in a laboratory setting. Participants were given two opportunities to play video poker. On one occasion, the credits they were staked had no monetary value. On the other occasion, the credits were worth $0.05 each and the participants could win or lose money by playing the game. Based on prior research, we predicted that participants would play more hands, bet more credits, and make more mistakes in play when gambling credits with no monetary value than when gambling credits with monetary value.

## METHOD

### *Participants*

Eighteen individuals (11 females, 7 males) were recruited from the psychology department participant pool at the University of North Dakota. To participate in the gambling sessions, individuals needed to be 21 years of age or older, score below 5 on the South Oaks Gambling Screen (SOGS; Lesieur & Blume, 1987), and have the ability to operate a computer mouse. Participants ranged in age from 21 to 44 years of age (mean = 25.72 years old, SD = 6.47 years). SOGS scored ranged from 0 to 2 (mean = 0.39, SD = .70). One participant self identified as Hispanic/Latino, one as American Indian, and the remaining 16 as White. Twelve of the 18 participants indicated that their annual income was less than $15,000.

### *Materials*

Participants completed three separate survey measures. The first was a demographic questionnaire that asked the participant's sex, age, marital status, race/ethnicity, and annual income. This information was collected because these factors are known risk factors for pathological gambling (see Petry, 2005). The second questionnaire was the SOGS (Lesieur & Blume, 1987), which is a 20-item measure designed to assess the person's gambling history. It is the most widely used survey measure for pathological gambling (see Petry, 2005), with a score of 5 or more indicating the potential presence of pathology. The final measure was the Gambling Functional Assessment (GFA; Dixon & Johnson, 2007). The GFA is a 20-item measure that is designed to assess the consequences that may maintain the person's gambling behavior. Four possible consequences are assessed: escape, monetary rewards, the sensory experience, and attention.

The experiment was conducted in a windowless room that measured approximately 2 m by 2 m. The room contained two tables and two chairs, with a personal computer on each table. The same video-poker software (Zamzow Software Solutions, 2003) was loaded on to each computer. The researcher programmed the software to play a five-card-draw poker game called "Loose Deuces." This game is a variation of a standard, Jacks-or-Better poker game with the exception that Two's are wild cards. The player is dealt five cards, can choose which of those to hold or discard, and then draw. The five cards held after drawing new cards determines the outcome of the gamble. The game allowed the participant to bet one to five credits per hand. Obtaining at least three of a kind was required to return the player's original bet. In addition to regular poker hands (i.e., Straight, Flush, Full house, etc.), the game paid for Five of a kind (15-1 odds), a Royal flush with Two's (25-1 odds), and Four two's (500-1 odds).

In terms of dependent measures, the software recorded a variety of measures during play. Measures included the number of hands played, number of coins bet, number of coins won, and number of errors made during play. On each particular hand, the optimal play was the one that maximized the player's rate of return given the five original cards that had been dealt. All plays that reduced the player's average rate of return were recorded as errors despite the possibility that the player could win credits by making an "error." Players were not notified as to what the best play was for a given hand or as to whether they had made the optimal choice. The only information provided to participants was the pay table that appeared on the screen above where the cards were displayed (see Jackson, 2007).

*Procedure*

Participants were run individually. At the beginning of the session, the researcher initiated the informed consent process. Once the participant provided informed consent, the researcher had the participant complete the three questionnaires. The researcher immediately scored the SOGS. If the participant scored 5 or more on the SOGS, the researcher provided the participant with extra credit for the person's psychology course (if applicable) and dismissed the participant. One participant was dismissed because of a SOGS score greater than 5. This participant was replaced (i.e., 18 participants completed the gambling sessions).

The researcher then seated the participant in front of one computer and read the participant the following instructions:

> You will now be given the opportunity to play video poker. Specifically, you will be playing a game called Loose Deuces, which is a 5-card-draw poker game in which 2's are wild. You have been staked with 100 credits. Your goal should be to end the session with as many credits as you can. The game will end when you have lost all your credits, you choose to quit, or 15 min has elapsed. Do you have any questions?

Questions were answered by repeating the appropriate portion of the instructions.

Each participant played poker in two sessions, with the second session conducted immediately after the first. In one session, the 100 credits had no monetary value. In the other session, the credits were worth $0.05 each.

In the session in which the credits had no monetary value, the researcher read the following instructions at the point the asterisk appears in the above instructions:

> These credits have no monetary value, but please play as if they did.

In the session in which the credits were worth money, the research read the following at the point the asterisks appears in the above instructions:

> The credits you have been staked are worth five cents each. Thus, you have been given $5 to gamble. You will be paid in cash at the end of the experiment for the number of credits you have won or have remaining.

The order of sessions was counterbalanced across participants so as to counteract any carryover effects that play in the first session might have had on play in the second session. Nine participants played first with credits with no monetary value followed by the session in which the credits were worth money. The remaining nine participants played for money first, followed by the session in which the credits had no monetary value.

For each session, participants played video poker until one of the three criteria for ending the session was met. After the first session, the participant was then situated in front of the second computer and was read the appropriate instructions for that session. After completing the second poker session, the researcher asked the participants whether they thought they had played differently when the credits had monetary value vs. when the credits had no monetary value. The participant was then debriefed, compensated with extra course credit (if applicable), paid for the number of credits remaining after the session in which the credits were worth money, and dismissed.

## RESULTS AND DISCUSSION

Three dependent measures from the poker sessions were analyzed. The first was the number of hands played during the session, which can be viewed as a measure of duration. The second was the total number of credits bet across the session, which can be viewed as a measure of risk. The third was the percentage of hands correctly played during the session, which can be viewed as a measure of accuracy. Each measure was analyzed by conducting a one-way repeated measures ANOVA using the data from individual participants. Results showed that the number of hands played per session (M = 58.33 when credits had monetary value; M = 57.50 when credits had no monetary value) did not differ significantly between the two sessions, $F(1, 17) = .01$, $p=.926$ ($\eta^2 = .001$). Participants bet significantly fewer credits across the session when the credits had monetary value than when they did not, $F(1, 17) = 4.64$, $p=.046$ ($\eta^2 = .214$). Figure 1 graphically presents the difference observed in the credits bet per session. Lastly, the difference in the percentage of hands played accurately did not differ when the credits had (M = 56.68% correct) or did not have monetary value (M = 57.62% correct), $F(1, 17) = .16$, $p=.691$ ($\eta^2 = .010$). Results from these analyses, and all that follow, were considered significant at $p<.05$.

When responding to the question of whether they had played differently when the credits had monetary value versus when they did not, 7 of the participants responded that they had played differently; the remaining 11 responded that they had not.

Pearson product-moment coefficients were calculated for the factors asked on the demographic questionnaire, SOGS score, scores on the four categories measured by the GFA, and the gambling measures in each video-poker session. Two correlations were worthy of note. The first was the correlation between age and SOGS score ($r = 0.507$, $p$

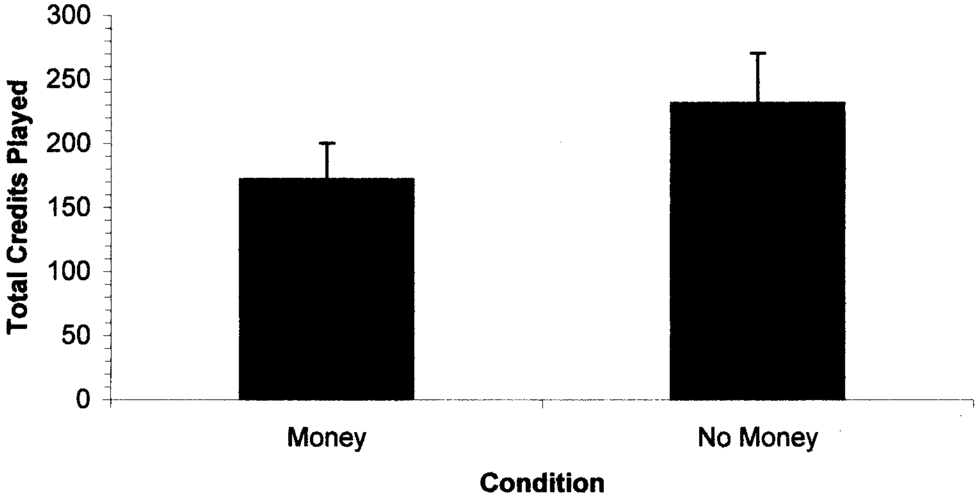


Figure 1. Presented are the total number of credits bet across the session when the credits did or did not have monetary value. The error bars represent one standard error of the mean across participants in that particular condition.

=.032). This relationship is opposite of the larger research literature (see Petry, 2005), but was likely influenced by the limited range of SOGS scores in the present sample and/or the exclusion of pathological participants. The second was between the number of credits bet during the session in which the credits had monetary value and the consequence of sensory experience on the GFA ($r$ = 0.606, $p$ = .008), indicating that participants who scored high on gambling for the sensory experience tended to risk more money.

The present experiment investigated whether participants' "gambling" behavior would differ as a function of whether or not they were risking actual money. Consistent with previous results (Weatherly & Brandt, 2004), participants in the present study risked fewer credits when the credits had monetary value than when they did not. However, how many hands of video poker participants played and how well they played them did not differ as a function of monetary value of the credits the participants were risking.

The present results are important because it is not feasible for many researchers who study gambling to have participants risk actual money (i.e., it may be against the law). If "gambling" behavior occurred differently when participants risked money vs. when they did not, then the applicability of results from studies that did not involve money could be potentially questioned. Thus, the results of the present study provide relatively positive news. That is, participants played a similar number of hands, and played with similar accuracy, regardless of whether or not the credits they were betting were worth money. These findings suggest that results from studies on gambling that do not involve risking money may still generalize to actual gambling behavior.

Of course, one must be wary of placing extensive confidence in non-significant, or null, results. It is possible that if some aspect of the present procedure had been altered, then the effect of money would have emerged for the measures of hands played or accuracy of play. One could potentially argue, for instance, that the present procedure simply did not employ enough participants to uncover a significant effect. That argument, however, can be countered by estimating effect sizes and then extrapolating the number of participants that would have been necessary to produce a significant effect. For both the measures of hands played and accuracy of play, the value of Cohen's *F* (Cohen, 1988) was zero. With that effect size, no number of participants would have resulted in a significant effect. Thus, the present results do not appear to be the outcome of using too few participants.

The present experiment did find one significant effect of money. That effect was participants were more conservative in their betting when the credits had monetary value vs. when they did not. Given that the monetary value of the credits did not influence the number of hands played or how well they were played, finding a significant effect on the number of credits risked should be taken as a warning for researchers who study gambling. Namely, procedures in which participants are not risking money may overestimate the risk they would actually take were they actually risking money. Finding that just under half of the participants indicated that they had played differently when the credits had monetary value than when they did not further underscores the need for researchers to take this procedural factor into account when designing their studies and drawing conclusions from their results.

It is also worthy of noting that the amount of money that was at stake in the present experiment was not substantial. Although the effect sizes found for the non-significant effects were very small, it is certainly possible that other effects of money would have emerged had participants been playing for larger sums (e.g., $100). Because of limited funding, it seems unlikely that many researchers would be able to sustain a programmatic line of research by staking participants with large sums of money. However, investigating this possibility is warranted because individuals who suffer from gambling problems are not risking small sums of money.

Finally, the present results shed light on two potentially opposing "effects" that have been reported in the broader literature. One is the "house effect," which is the finding that people tend to be more risky with money that they have been staked (i.e., house money) than they are with their own money (e.g., Ackert, Charupat, Church, & Deaves, 2006). The other is the "endowment effect," which is the finding that people who are gifted something, such as money, take ownership of it and treat it as if it were their own (e.g., Kahneman, Knetsch, & Thaler, 1990). The present results would appear to be at least somewhat at odds with "house effect" in that, although participants may have taken more risks with the money they had been staked than they would have with their own money, they took less risk with staked money than they did with valueless credits. Finding that participants risked fewer credits when the credits had monetary value than when they did not would appear completely consistent with the "endowment effect."

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# *A CASE STUDY OF A PATHOLOGICAL GAMBLER WAGERING AT GOLF*

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The present single case design explored the degree to which a pathological gambler's golf performance would be affected by monetary consequences. Using an AB design, a twenty-three year old pathological gambler initially hit 10 golf balls on a computerized golfing game that interfaced with Playstation2's "Tiger Woods PGA Tour 2006". Following baseline, the participant was informed that he would be paid 20 dollars if his next 10 swings were closer to the golf hole than the prior 10 swings. The introduction of the monetary consequences resulted in the participant increasing shot variability and decreasing shot accuracy.

*Keywords: gambling, wagering, golf, choke response*

Wagering takes place in many contexts outside of the typical casino. Gamblers often wager on many activities from racing cars, finishing highest on a test, acquiring a bar patron's phone number, and performance at sporting events. One sport well known to occasion gambling is that of golf (Smith & Paley, 2001). While celebrity golfers often draw the headlines of newspapers and television (Leahy, 2004), other less known golfers share the same tendency to wager during play. Bets may be made on overall course play, single holes, execution of a particular shot, or any combination thereof.

When the stakes are high, often times athletic performance suffers. In the sport psychology literature, "choking" is frequently attributed to athletes who report substandard performance under pressure to do well (Lewis & Linder, 1997). Understanding the autonomic nervous system and the associated physiological responses of anxiety and stress are critical to success in any competitive sport. This is especially true in golf because players of all skill level will often play for salient monetary rewards and they have ample time to reflect on their thoughts and emotions as they play. In the context of golf, players often describe muscle tension, poor coordination, trembling hands, accelerated heart rate, racing thoughts, and loss of mental focus as correlates of "choking' (Valiante, 2005). In a previous investigation by Bordieri and Dixon (under review), it was demonstrated that when novice golfers were allowed to putt from a distance of 5 feet, participants performed better when no financial stakes were on the line. Exploring the interaction of waging and golf with individuals suffering from pathological gambling has not yet been shown in the published literature. As a result, the present investigation assessed a self-reported avid golfer for potential pathological gambling and observed his golf performance during monetary and non-monetary conditions to determine if a choking response would occur.

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## METHOD

### *Participant*

A twenty-three year old male graduate student who self-reported frequent and regular play at local golf courses was recruited for the study. Percy was assessed for potential pathological gambling with the South Oaks Gambling Screen and yielded a score of 14 (5 or more indicates potential pathological gambler). Percy disclosed playing golf at least 1 time per week and wagering an average of $50 per round when he gambled on the golf course. He gambled in various formats, including golf, on a weekly basis and reported very frequently that he wished he did not spend as much money as he did on his gambling activity.

### *Apparatus and Setting*

Session took place in a 16 x 20 ft room containing an observation mirror and chairs. Golf swings took place using a hardware device that contained a golf ball and various micro-sensors that captured ball travel across a 1ft platform when struck by the club. The device, "Tiger Woods PGA Tour 2006," was interfaced with a Sony PlayStation2 video game system connected to a 32 inch LCD monitor. Figure 1 displays a photograph of the experimental apparatus. Data were collected by an observer that was positioned 4 ft from the LCD monitor and away from the participant swinging the club.

### *Independent and Dependent Variables*

The independent variable of the study contained two levels: presence or absence of monetary consequences contingent upon golf swing accuracy. The dependent variable was the distance the golf ball was from the hole (in yards) after the swing.

### *Procedure*

The single session took place by initially having the participant complete an informed consent form explaining the general purpose of the study. Percy was than instructed how to operate the apparatus, which specifically included how to align the golf ball on the attached tee and to swing as he would normally on the golf course. The computer would then record the swing, transfer that information to the PlayStation2 and automatically swing the player's club accordingly on the LCD monitor.

*Phase 1: Baseline.* During baseline Percy was instructed to take 10 swings and attempt to hit the ball as close to the golf hole as possible. The par 3 seventeenth hole at Pebble Beach Golf Links was selected from the "Tiger Woods PGA Tour 2006" computer simulation. After each swing, the ball was returned to the tee, and a subsequent swing was taken. Ten swings in all were completed by Percy. Data in the form of distance from the golf hole in yards were recorded from the visual display on the computer monitor by the observer. The observer also repositioned the golf ball on the electronic apparatus between swings for Percy.

*Phase 2: Intervention.* During the intervention condition Percy was instructed to take an additional 10 swings as done during baseline. However at this time, Percy was informed the following:

> Please take 10 more swings as you just did. Yet, if you are able to come closer to the hole/cup during these 10 swings than you were during the past 10 swings, we will provide you with a 20 dollars gift card to a local retailer. Your mean or average distance for the 10 swings will be used to determine if you earned the money or not.

All other aspects of Phase 2 were identical to Phase 1.

## RESULTS & DISCUSSION

During the non-monetary conditions of Phase 1, Percy obtained a mean distance from the golf hole of 12 yards (SD = 7yds). Upon the introduction of the monetary conditions of Phase 2, Percy's performance declined to an

Figure 1. Image of the golfing interface.

average of 20 yards (SD = 12yds). Thus, both shot accuracy and consistency declined upon the introduction of the potential financial compensation. Both measures of performance have been considered evidence of "choking" in the golf literature (e.g., Lewis, & Linder, 1997), and it appears quite possible that Percy did in fact choke when placed in a gambling-type situation.

While our data are compelling there are a variety of shortcomings that the study suffers from. First, the experimental design, an AB, is rather weak and cannot control for maturation, fatigue, or various other threats to internal validity. A future study should consider using stronger designs such as an ABAB reversal design. Second, our participant's performance may not necessarily hold true for other pathological gamblers exposed to a similar experimental situation. Future research should go beyond the present single-case and use a larger number of participants in the study. Third, we did not have a true element of "loss" in the study's "monetary" phase. While we offered Percy $20 for performing better than baseline, he did not have to pay us $20 if he did not. While having a pathological gambler actually gamble with personal money for the purposes of the experiment may seem to hold the greatest external validity, we thought it must be compromised for ethical standards. A future study might consider having non-pathological gamblers wager their own money during the task and see if the choke response becomes more pronounced (i.e. shot accuracy declines and variability increases).

Another limitation of the study was that we are not sure as how nonpathological gamblers may differ under conditions of monetary reward at golf. Instead our data should be considered preliminary, and thus a stimulus for more research that explores the wagering that takes place by athletes of various sorts. Many of which are pathological gamblers. Comparative analyses between nonpathological gamblers and pathological gamblers are warranted as well. The procedures that we employed along with the current software and hardware configurations allow for a wide variety of future studies. For example, researchers may wish to explore how money and no money contingencies vary on every shot, and how changing magnitudes of money may impact shot accuracy.

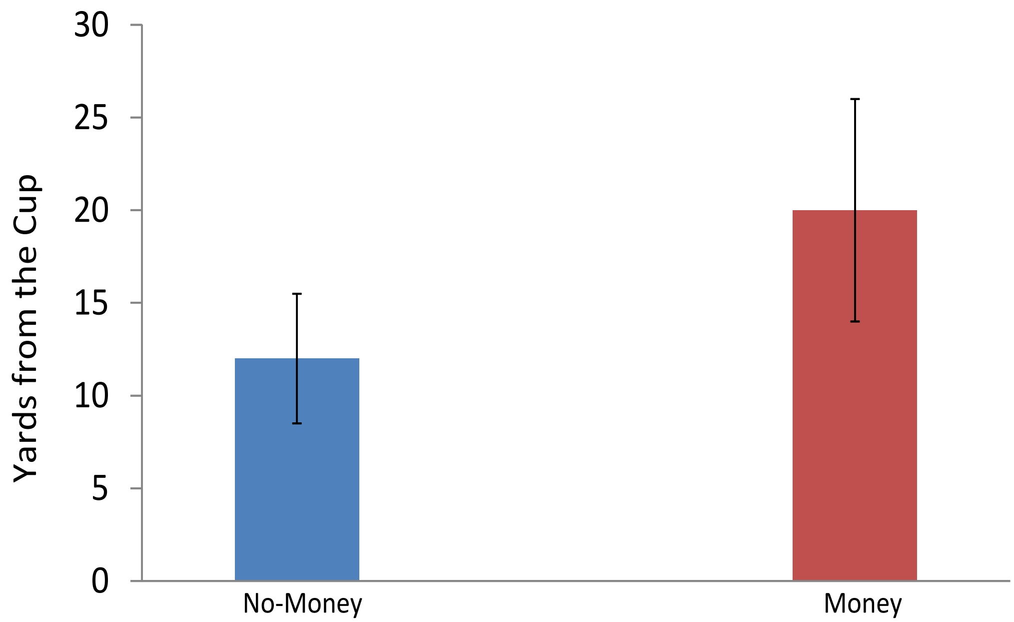


Figure 2. Percy's performance on the golfing task in "yards from the cup."

In summary, examining gamblers that wager at various performance sports seems possible, and doing so extends the published literature on gambling. While sound decision making has been shown to suffer in pathological gamblers, the present study also shows that when face with potential financial gains, the motor performance of the gambler suffers as well.

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# *REVIEW OF "GAMBLING: BEHAVIOR THEORY, RESEARCH, AND APPLICATION" BY PATRICK M. GHEZZI, CHARLES A. LYONS, MARK R. DIXON, AND GINGER R. WILSON (EDS.)*

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Behavior analysis has not devoted much research attention to understanding or treating gambling behavior, yet it clearly has much to offer. Recently, the advent of this journal and other developments has helped to increase the need for, and relevance of, behavior analytic approaches to the study of gambling behavior. The edited volume by Ghezzi, Lyons, Dixon, and Wilson (2006) is testimony to this growing interest. In an effort to further delineate the behavior analysis of gambling behavior, Ghezzi and colleagues have produced a compelling and timely scholarly overview of behavioral research on understanding and treating disorders associated with gambling. The book should serve to stimulate continued research interest in gambling behavior from within the behavioral community.

Key words: behavior analysis, gambling, review.

Gambling on the outcomes of games of chance has been a common feature of human culture for centuries. The available evidence suggests that occasional gambling is not intrinsically harmful. However, the behavior can become problematic when it occurs frequently enough to cause financial and social consequences that adversely impact on daily functioning. Precisely what variables are responsible for this often-abrupt transition from occasional, recreational gambling to pathological gambling are unclear (Petry, 2005).

The prevalence of pathological gambling, which is a recognized disorder in the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-IV TR*; American Psychiatric Association, 2000), varies across countries. In the United States, conservative estimates suggest that between 1% and 3% of the population has a problem with gambling (National Gambling Impact Study Commission, 1999). In the United Kingdom, where recently legislation liberalizing gambling has been enacted, the prevalence rate is approximately 1% when people who exclusively play lottery games are excluded (British Gambling Prevalence Survey, 2007).

It is interesting to note that the prevalence of pathological gambling within the general population is higher than that reported for many other disorders, including autism. However, gambling historically has not generated comparable levels of research or clinical interest within the behavior analytic research community. There are potentially two main reasons why behavior analysts have not

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extensively studied gambling behavior. First, the clinics and outpatient centers where pathological gamblers tend to seek services are not settings that typically employ behavior analysts, at least as front-line staff. It might also be speculated that the high comorbidity between pathological gambling and substance abuse disorders means that gamblers usually seek front-line psychiatric and psychotherapeutic services before they encounter behavior analysts, if at all. Second, behavior analysts have lacked a coherent conceptual and empirical approach to studying gambling behavior, in all of its forms. In much the same way as the behavior-analytic explanation that slot machines operate according to variable ratio schedules of reinforcement was found to be incomplete and technically inaccurate (Crossman, 1983; Madden, Ewan, & Lagorio, 2007), the same can be said for an analysis of the "very complex control" (Skinner, 1953, p. 396) exerted by a gambler's reinforcement history in initiating and maintaining gambling. The emphasis on direct-contingency explanations of gambling, combined with the absence of an empirical research agenda on verbal behavior, has clearly hampered basic and applied behavioral analyses of the environmental determinants of vulnerability to pathological gambling, and allowed other research and intervention approaches to dominate (Weatherly & Dixon, 2007).

Despite these obstacles, behavior analysis clearly has much to offer the scientific investigation of gambling. The relevance of behavior analytic approaches to the study of this behavior has become increasingly evident over the past few years, with both the publication of empirical studies in behavior analytic outlets (e.g., *Journal of Applied Behavior Analysis*, *The Psychological Record*) and the development of this journal which is devoted to publishing such research. In an effort to further delineate the role of behavior analysis in understanding gambling and potentially treating disorders associated with the behavior, an edited volume by Ghezzi, Lyons, Dixon, and Wilson (2006) has brought together experts from the burgeoning behavioral research literature to review the existing research and to discuss priorities for the future. The behavior-analytic investigation of gambling is important because of the potential it offers to alleviate many of the problems related to disordered gambling. Indeed, behavior analysts routinely improve the lives of individuals with other disorders by a rigorous scientific approach based on demonstrating experimental control over basic behavioral processes and then extrapolating findings to the treatment of problems of social importance. This potential that behavior analysis has for understanding and treating gambling behavior is fast being realized, and the book by Ghezzi and colleagues is testimony to this growing interest. Indeed, the book should serve to stimulate more research interest in this topic from within the behavioral community. The book includes twelve chapters arranged into three parts: *Theory*, *Research* and *Application*.

*Theory*: In the first chapter, Lyons considers what gambling might reveal about the nature of addiction. In a cogent review of the historical development of the DSM system of syndromal classification, he reviews the similarities and differences shared between substance-abuse addictions and gambling. Lyons concludes with a call for research that integrates the biological, psychological, environmental and historical contexts that contribute to individual vulnerability to problem gambling. In Chapter 2, Porter and Ghezzi review the main theories of pathological gambling, including psychoanalytic, biomedical, psychosocial, and cognitive behavioral approaches. Their discussion sheds further light on the relative dearth of behavior-analytic contributions to the study and treatment of gambling. As the authors aptly note, "how pathological gambling is conceptualized ultimately determines how the problem is treated and prevented" (p. 20). Porter and Ghezzi acknowledge that, from a behavior analytic perspective, a coherent empirical analysis of gambling is currently lacking. More importantly, however, they note that our historical reliance on relatively simple, direct-contingency explanations of the behavior might be at least partially to blame. Specifically, they discuss the "major barrier … set by Skinner, who took the position that an analysis of the prevailing contingencies of reinforcement is both necessary and sufficient to understanding how gambling is acquired and maintained and how excessive play may be reduced or eliminated (Knapp, 1997)" (p. 35). The authors also note striking similarities between historical behavior-analytic conceptualizations of gambling and those used to study verbal behavior. Specifically, they note that the development of a behavior-analytic approach to gambling behavior has been impeded by the field's prevailing strategic assumptions in much the same way as occurred in the domain of verbal behavior (Dymond, Roche, & Barnes-Holmes, 2003). However, once researchers ventured beyond Skinner's (1957) initial conceptualizations, our understanding of the behavior increased exponentially. Porter and Ghezzi speculate that same will ultimately be true of gambling behavior. In addition, they highlight the importance of the study of verbal behavior for informing research on gambling.

In Chapter 3, Mawhinney describes the use of an Applied Theoretical Cultural Analytic (ACTA) paradigm to analyze legalized gambling in the United States. His molar analysis of the metacontingencies involved in governmental, societal, and individual involvement in gambling is thought provoking and insightful, and, once again, highlights the need for "closer conceptual analysis of the rule-governed response classes associated with gambling" (p. 83). The central role of verbal behavior in initiating and maintaining gambling outcomes that are, ultimately, measured at the molar level remains an important research objective in behavior analysis. Mawhinney's ACTA paradigm offers a novel means of approaching the study of gambling across a range of cultural contexts.

*Research*: In Chapter 4, Lyons considers the methodological issues involved in undertaking behavioral research on gambling. He acknowledges that laboratory research might lack ecological validity because of ethical and practical limitations. Quite obviously, these limitations make it difficult if not impossible to allow research participants to win or lose vast amounts of money in the same way as they might in real-world gambling situations. To attenuate some of the threats to the external validity of gambling research, Lyons presents two broad categories of alternative approaches. The first category involves undertaking naturalistic observation and analyzing public gambling (e.g., lottery) data, both of which have proven useful in understanding gambling behavior. The second category involves undertaking hypothetical wagers during a laboratory task, such as a delay-discounting task, or actually simulating gambling, such as using computer simulated slot machines in the laboratory. Lyons' chapter is a cogent account of the defining features of the behavioral approach to gambling and should prove an invaluable resource to new researchers in designing laboratory-based analogues of gambling.

Weatherly and Phelps' Chapter 5 offers a review of the pitfalls of studying gambling behavior in a laboratory situation. The authors address the myriad variables that one finds in a typical gambling situation (e.g., the choice of playing games of differing payout probabilities and magnitude, etc.) and provide some potential strategies for recreating such variables in laboratory settings. Further, they discuss the relative merits of animal models in overcoming some of the limitations that arise when working with humans. The authors then attempt to synthesize these issues in order to focus future experimental research. The crux of the issue for Weatherly and Phelps, and the challenge for laboratory research to overcome in the future, is exemplified by the following; "because a researcher cannot allow participants to leave an experiment with less money than they arrived with, laboratory research will seemingly always fail to replicate the potential for debt that casino gamblers could face" (p. 114). They conclude with a call for sustained, systematic lab-based research on gambling, in which animal models have an important role to play (see also Madden et al., 2007).

Given the limitations of studying gambling in naturalistic settings, the development of laboratory simulations is essential. However, if one is not trained in the development of such simulations, gambling research may ultimately prove difficult and costly. In Chapter 6, MacLin, Dixon, Robinson, and Daugherty provide detailed, step-by-step instructions for writing a simple slot machine simulation using Visual Basic.NET®. And it works: students from the first author's lab, who had never programmed before, wrote their first slot machine simulations in a matter of weeks using this chapter, supplemented with another recommended text by Dixon and MacLin (2003). This chapter should prove to be an excellent resource for novice programmers interested in undertaking a program of gambling research. The authors' efforts undoubtedly will assist in the proliferation of gambling studies by reducing the response effort involved with programming simulations.

The next two chapters in this section move from general issues to issues surrounding specific topics in the study on gambling. In Chapter 7, Ghezzi, Wilson, and Porter provide an excellent review of research conducted on the "near-miss" effect in slot machine gambling. "Near-miss" refers to manipulations of the probability of winning, which usually entail varying the number and positioning of symbols on or around the payout line. Ghezzi and colleagues outline the findings of several experiments from their lab that have compared the effects of the number of forced choice trials, percentage of near-miss trials, magnitude of reinforcement (i.e., the "big win"), and the form of the near-miss on choice play. Their findings suggest that, despite the near-ubiquity of behavioral explanations of the near-miss effect (e.g., Skinner, 1953), more research is needed to identify the conditions under which near-misses actually sustain extended slot machine gambling.

In Chapter 8, Dixon and Delaney discuss the impact of verbal behavior research on our understanding of gambling. In particular, they provide an analysis of why the importance of verbal behavior historically might have been underestimated within the gambling literature. Consistent with points made earlier in the book by Porter and Ghezzi (Chapter 2), Dixon and Delaney note that the field's reliance on Skinner's (1957) definition of verbal behavior potentially could have impeded its incorporation into analyses of gambling behavior. The authors remind us that Skinner's conceptual analysis sought to extend basic behavioral principles from the nonhuman laboratory to the domain of human verbal behavior where "consequences were delivered by a listener to a speaker, which differed from the programmed consequences delivered in a laboratory by an experimenter. Skinner's definition of verbal behavior was one where the behavior of a speaker is mediated by the behavior of a listener" (p.172). However, as many scholars have argued, this seemingly straightforward operant definition meant that there was, in fact, no distinction between verbal behavior and other forms of social behavior (e.g., Chase & Danforth, 1991; Hayes, 1994). It is likely that Skinner himself accepted this, since he admitted that a nonhuman responding for food that is delivered or mediated by an experimenter who has been conditioned precisely to do so constitute, "a small but genuine verbal community" (1957,

p. 108). Adopting such a broad definition of a integral feature of human behavior inevitably lead researchers back to explanations of gambling behavior that were based on direct-contingencies. However, this was an explanatory device available prior to Skinner's analysis and on which research was already well underway in the nonhuman laboratory (Dymond et al., 2003; Hayes, 1994). It seems, then, that without a specific, functional definition of verbal behavior, the behavior analysis of gambling was always going to be restricted.

Dixon and Delaney are cognizant of such limitations, however, and their chapter serves as a veritable call-to-arms for behavior analysts to continue undertaking basic research on the impact of verbal behavior on gambling by adopting contemporary definitions of "rules" and other "verbal stimuli" that are based on functional-analytic criteria (e.g., Hayes, Barnes-Holmes, & Roche, 2001). Their account of gambling as "verbally mediated behavior" (p. 185) involving the transformation of stimulus functions is an example of the empirical and conceptual promise offered by contemporary approaches to the behavior analysis of gambling. The authors also make the case for the need to include pathological gamblers in behavior-analytic research, to devise more experimental analogues or simulated gambling tasks, to offer more salient reinforcers (where ethical constraints allow), and to seek out research collaboration with non-behavioral colleagues.

*Application*: Given the barriers to studying gambling within naturalistic environments and the central role of verbal behavior in understanding the behavior, researchers often must incorporate a range of measures to provide a more comprehensive analysis of the variables influencing gambling. As a result, traditional psychometric measures relying on self-report often are used. Analyzing the usefulness of such measures in measuring gambling behavior is therefore imperative. In Chapter 9, Wood and Clapham present the findings of research employing the *Drake Beliefs about Chance Inventory* (DBC) and the *Gambling Behavior Questionnaire*. Both instruments have been used to investigate the nature of gambler's erroneous beliefs and to determine whether such beliefs correspond with particular patterns of gambling. Although correlational in nature, the authors' findings support the continued use of self-report scales such as the DBC in measuring gamblers' erroneous beliefs. Nonbehavioral approaches to the study of gambling place considerable emphasis on the role of private events such as erroneous or irrational beliefs in maintaining gambling (Delfabbro, 2004). Supplemental measures of this behavior either through self-report scales or, concurrent "talk-aloud"/protocol analysis (Ericsson & Simon, 1984), is consistent with the book's oft-repeated need to incorporate verbal behavior into the analysis of gambling. A key limitation of purely self-report scales, however, is that they are restricted in the types of information they reveal about gambling behavior. For example, they are unlikely to predict which individuals are at risk for engaging in pathological gambling or what the consequences maintaining gambling actually are. Despite their usefulness in helping researchers discern particular variables associated with gambling, perhaps an equally important contribution is that they illuminate the complexity of gambling and the need for further refinement of measures designed to capture the myriad of factors influencing gambling behavior.

Another important factor in analyzing gambling behavior is understanding the populations in which this behavior is likely to occur. For instance, one of the six known risk factors (or establishing operations, see Weatherly & Dixon, 2007) for pathological gambling is gender, in that the behavior is most prevalent among adult males. In Chapter 10, however, Knapp and Crossman provide a compelling review of the research on gambling in children and adolescents. According to some estimates, 86% of children in 4th, 5th and 6th grade had bet money before and 61% had bought a lottery ticket (Ladoucer, Dube, & Bujold, 1994). The authors note that gambling during childhood can occasion problems with the behavior in adolescence. For instance, an estimated 34,000 underage gamblers were escorted from New Jersey casinos alone in 2003. Further, Knapp and Crossman reveal that approximately two thirds of 18-20 year olds have gambled on at least one occasion at casinos. Given the extensive evidence for underage gambling problems, the authors propose that intervention programs should be developed on university campuses. Indeed, while the literature on gambling in children and adolescents has grown almost as rapidly as the gambling industry, a satisfactory research-based understanding of the factors that lead these groups to gamble still is lacking. In a call for more research into these issues, the authors claim, “the opportunities for research are nearly as rich as the owners of the casinos” (p. 225).

Research has shown that the incidence of pathological gambling is proportional to the availability of, and access to, gambling (e.g., Orford, Sproston, Erens, White, & Mitchell, 2003; Petry, 2005). In analyzing such trends, it is important not only to determine factors contributing to the rise in the behavior, but also its effects on individuals and societies. In Chapter 11, Dixon and Moore discuss the economic, social and political impact associated with the development of gambling establishments on Native American reservations. As noted by the authors, Native American reservations are sovereign states; therefore, all gambling profits are tax-exempt. As a result, a number of new contingencies have been put in place for American society. Dixon and Moore offer a behavioral analysis of these contingencies in terms of the discounting of delayed consequences from both tribal and state perspectives. For example, the authors analyze factors that might induce tribal leaders to establish gambling establishments, despite the risks associated with such endeavors. Perhaps most importantly, the authors reveal how these contingencies ultimately lead to an overdependence on gaming revenue, an increase in problem gambling among tribal and community members, and an increase in crime. The authors’ analysis paints a compelling picture of how the detrimental effects of gambling extend beyond the individual and affect society as a whole.

In several chapters of the book, various authors describe the problems associated with pathological gambling. Moreover, they emphasize the dire need for more behavior-analytic research aimed at extending our understanding of the behavior, as well as how to intervene when it becomes problematic. It seems fitting, therefore, that the final chapter reviews the extant literature on effective treatment approaches. In Chapter 12, Petry and Roll describe a cognitive-behavioral treatment for pathological gambling, the aim of which is to develop ways to restructure the environment to reinforce non-gambling behaviors. The authors provide a concise analysis of the environmental factors that might contribute to pathological gambling, and show how these factors can be incorporated into the development of an effective treatment. The authors describe a therapeutic treatment package that includes such strategies as self-reinforcement for non-gambling , identification of the environmental triggers for gambling, and working through the positive and negative outcomes associated engaging in gambling behavior. As noted by the authors, early analyses of the effectiveness of this type of cognitive-behavioral treatment suggest positive outcomes both during treatment delivery, and throughout a 12-month follow-up period. Despite these positive outcomes, there is clearly much work to be done. Petry and Roll’s chapter no doubt will serve as a catalyst for occasioning further treatment research within the field of behavior analysis.

Overall, the contributors to this edited volume are to be commended for producing a representative, informative, and timely account of research on the behavior analysis of gambling. The absence of a previous volume on this topic makes comparisons or evaluations of progress difficult. Moreover, to do so might actually miss the point. Perhaps what is most important is that this book clearly demonstrates that behavior analysts *can* make meaningful contributions to the analysis and treatment of gambling behavior, and that they already are doing so. This book confirms that there is much to be gained by an incorporation of behavioral methodology for understanding the origin, maintenance and treatment of gambling problems. Only the future will reveal whether or not our research efforts have proven useful.

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