Analysis of Gambling Behavior

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

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Book Reviews: A review of a contemporary book related to gambling not more than 3 years after the publication date of the book. The review should be no more than 15 double-spaced pages in length.
Contents

Research Articles


Research Reports

Speelman, R.C., & Dixon, M.R. Risk as a Function of Response Effort to Gain Points. 71

Witts, B.N., Loudermilk, K., & Kosel, D. Adult Samples Suggest Slot Machine and Casino Characteristics are Possible Sources for Investigating the Illusion of Control. 79

Gunnarsson, K.F., Whiting, S.W., & Dixon, M.R. The Near-Miss Effect in Blackjack: Group Play and Lone Play. 87
Slot Machine Near Wins: Effects on Pause and Sensitivity to Win Ratios

Tadhg E. Daly, Gordon Tan, Lincoln S. Hely, Anne C. Macaskill, David N. Harper, & Maree J. Hunt
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When a near-win outcome occurs on a slot machine, stimuli presented resemble those presented when money is won, but no money is won. Research has shown that gamblers prefer and play for longer on slot machines that present near wins. One explanation for this is that near wins are conditioned reinforcers. If so, near wins would produce longer latencies to the next response than clear losses. Another explanation is that near wins produce frustration; if so, then near wins would produce shorter response latencies. The two current experiments manipulated win ratio across two concurrently available slot machines and also manipulated near win frequency. Latencies were longer following near wins, consistent with near wins functioning as conditioned reinforcers. We also explored the effects of near wins on sensitivity to relative win rate and found that higher rates of near wins were associated with greater sensitivity to relative win frequency, an effect also consistent with near wins as conditioned reinforcers.

Keywords: gambling, near win, near miss, response latency, generalized matching law

People who predominantly gamble with slot machines develop a pathological profile faster than gamblers favoring other gambling activities (Breen & Zimmerman, 2002). This suggests that features of the gambling medium contribute to the likelihood that an individual’s gambling will become problematic. Slot machines are controlled by payout algorithms with features likely to lead to persistent and frequent play. For example, all slot machines use random ratio schedules arranging intermittent reinforcement schedules that typically yield high rates of responding and high resistance to extinction (Ferster & Skinner, 1957; Jenkins & Stanley, 1950). Payout frequency (Dixon, Maclin & Daugherty, 2006), overall payback rate (Haw, 2008) and the delay between obtaining a win and receiving a payout (Chóliz, 2010) are other features of the slot machine medium that influence gamblers’ preference for and persistence on a given slot machine.

The presence of near wins may also influence preference for (Ladouceur & Giroux, 2006; Dymond & Roche, 2010) and persistence on (e.g. Côte, Caron, Aubert, Desrochers & Ladouceur, 2003; Kassinove & Schare, 2001) a given slot machine. A near win (also called a near miss) is a loss that resembles a win; for example, four matching symbols constitute a near win when the machine’s only winning combination is five matching symbols. Slot machines are programmed to produce a higher-than-chance proportion of near-win outcomes (Harrigan, 2007, 2008).

The processes through which near wins affect gambling behavior have yet to be identified. Kahneman and Tversky (1982) proposed that situations like near-win outcomes on slot machines produce more frustration than other losing outcomes because near wins...
make it easier to imagine having received a win. Loftus and Loftus (1983) suggested that this particular type of frustration, labeled “cognitive regret” by the authors, might be eliminated by continuing play. Amsel (1958) proposed that situation, such as near wins, that resemble those where rewards have previously been presented produce a frustration effect that increases the speed and strength of ongoing operant behavior, in this case, causing faster responses to escape frustrating near-win outcome stimuli. This idea was revisited by Dixon and colleagues (Dixon, et al., 2011; Dixon, MacLaren, Jarick, Fugelsang & Harrigan, 2013). Dixon et al. (2011) found that arousal as evidenced by variations in skin conductance responses and heart rate deceleration measures, was greater following near wins than other types of losses or actual wins. They argued that these findings, when considered in the light of prior research on the psychophysiological effects of frustration, were consistent with the idea that near wins elicit frustration. They further proposed that, although near wins lead to frustration and thus have no hedonic value, they negatively reinforce further play as gamblers seek to escape the negative arousing effect of these outcomes. Both Amsel and Dixon suggested that if near wins create a frustration effect, then response latencies (time from the outcome until the next response is made) following them would be shorter than those following other losses.

An often-proposed alternative mechanism (e.g. Griffiths, 1999; Ladouceur & Sevigny, 2002; Peters, Hunt & Harper, 2010; Reid, 1986; Skinner, 1953) through which near wins might affect gambling is conditioned reinforcement. Kassinove and Schare (2001) suggested that, if winning spins are occasionally preceded by near-win spins, the joy and elation experienced from the win stimuli would eventually spread to the near win. In fact, the random schedules arranged by real-world slot machines do not create the conditions needed to establish near wins as conditioned reinforcers in this way. Although the pairings described by Kassinove and Schare likely occur, they would be insufficient to establish near wins as conditioned reinforcers because contingency rather than mere contiguity is required for Pavlovian conditioning. This means that in order for pairings of consecutive spin outcomes to establish near wins as conditioned reinforcers it would be necessary for wins to be more likely to occur following near wins than following other losses. Slot machine outcomes are independent, that is, the probability of a win is identical following every spin and near wins do not signal any increased probability of a win occurring. Although there is a lack of contingency between near win spin outcomes and win spin outcomes, there is another portion of the sequence of events arranged by real-world slot machines that does arrange a contingency between near win outcomes and win outcomes. This occurs within a winning spin: between when the gambler presses the spin button and when the final outcome is presented. That is, because slot machine reels stop one-by-one from left-to-right, during every win sequence near win stimuli are displayed before the final reel stops spinning, displaying the win stimuli. This rapid pairing of near win with win stimuli during every win sequence is an ideal sequence of events for establishing near wins as conditioned reinforcers.

Alternatively, Delfabbro and Winefield (1999b) and later Peters et al. (2010) suggested Pavlovian generalization as a more straightforward process through which near wins might develop conditioned reinforcement effects. That is, if wins are (conditioned) reinforcers then stimuli that resemble them – near wins – may also become conditioned reinforcers through generalization. If near wins are conditioned reinforcers as a result of either or both of these processes, they would be expected to produce longer response latencies than other losses. Delfabbro
TADHG E. DALY ET AL.

and Winefield (1999a) recorded participants playing on real slot machines and found that response latencies were longer following wins than losses. Peters et al. (2010) found the same in a rat model of gambling. This is consistent with findings that reinforcers in general produce response latencies or “post-reinforcement pauses” that are longer than latencies following other responses (Ferster & Skinner, 1957).

Previous studies have found inconsistent effects of near wins on response latencies, meaning that it is not yet possible to determine whether near wins primarily increase persistence of play through conditioned reinforcement or through frustration. Dixon and Schreiber (2004) examined response latencies following near wins, wins, and losses on a real slot machine and found much between-individual variability in the effect of outcome type on latency length. Dixon et al. (2013) in a simulation with human participants found shorter response latencies following near wins than following other losses. Whereas Peters et al. (2010) found that rats responding on a slot machine analog task produced longer latencies following near wins than other losses.

The differences in results across these studies may partially reflect the species studied, however, there were several other differences in these studies that may be relevant and which point to features of the slot machine program as determinants of the effects of near wins on response latencies. One possible contributor to this variability is the patterns of symbols classified as near wins. Both frustration and conditioned reinforcement as explanations for the near win effect suggest that near wins with outcome sequences that resemble those presented on win trials for the longest portion of the sequence would produce a stronger near win effect. Differences in the length of reels across studies (Dixon et al., 2013 used three while Peters, et al., 2010 used five) might therefore account for some of the observed variability. This is also consistent with Dixon et al.’s finding that only “classic near wins” (two winning symbols followed by a different symbol) produced differential (shorter) response latencies (although Ghezzi, Wilson, & Porter, 2006 found inconsistent effects of the pattern of symbols comprising a win on persistence). This may also explain the variability in Dixon and Schreiber’s (2004) results as they used several types of near win but did not control the rates of each pattern and collapsed across them when calculating latencies. The current study used only near wins in which the first four symbols matched while the fifth differed.

Whether wins are presented during the session may also affect subjects’ responses to near-wins resembling them (Ghezzi, et al., 2006). Dixon et. al. (2013) assessed latencies following near misses where the first two of three symbols were the jackpot symbol. Participants never experienced Jackpots. If – as previously suggested – near wins obtain reinforcing effects during presentation of the win sequence, the near wins in Dixon et al. would not have become conditioned reinforcers because win sequences were never experienced. Furthermore in some procedures, for example, Kasinove and Schare, (2001) near wins are initially presented with wins and then presented without. In such procedures each near win presented in the absence of wins would act as an extinction trial, gradually eliminating any existing conditioned reinforcement effects. In the current study, participants experienced wins as well as related near wins and clear losses.

In addition, we inserted a behavioral choice paradigm into each game. A procedure developed by Davison and Baum (2000) was used to assess sensitivity to relative win frequency. This involved varying the proportion of wins allocated to each of two reels across a series of frequently-changing conditions. Lie, Harper, and Hunt (2009) successfully used this procedure to assess sensitivity to win ra-
tios in humans responding for hypothetical money. In this context, sensitivity refers to the extent to which individuals allocate their responses across two alternatives in proportion to the distribution of reinforcers received from those two alternatives. The generalized matching law was used to assess this sensitivity because it separates sensitivity to the rate of wins from bias toward one of the two slot machines for some other reason such as the symbol set used. Such biases are likely given that people have different histories with gambling contexts prior to taking part in the research. It is of interest to investigate the extent to which people are sensitive to the distribution of wins because gambling is a context in which people demonstrate an apparent insensitivity to reinforcement rate in that they continue to gamble although the mean result is a loss.

EXPERIMENT 1

In Experiment 1, participants played on computer-simulated slot machines that produced no near wins in one session and near wins on 50% of non-winning trials in another session. Within each session, relative win frequency was also manipulated across four conditions in order to assess sensitivity to win ratios. If near wins affect gambling behavior via conditioned reinforcement, we expected response latencies following near wins to be longer than those following other losses. Conversely if near wins affect gambling behavior via frustration, we expected response latencies following near wins to be shorter than those following other losses.

METHOD

Participants

Twenty-nine first year psychology students from Victoria University of Wellington participated voluntarily in partial fulfillment of a course requirement. Three participants did not complete the required conditions in the time allotted for either of the two sessions, one elected to leave before a session ended, and another was excluded because of their high Problem Gambling Severity Index (PGSI) score (see below). Therefore, we included 24 participants in the final experiment.

Apparatus and Materials

Participants completed the PGSI, a nine-item subscale of the Ferris and Wynne (2001) Canadian Problem Gambling Index (CPGI). For each item on the PGSI people respond on a four point scale ranging from ‘never’ (0) to ‘almost always’ (3). The total PGSI score ranges from 0 to 27, with a score of 3 or higher signifying a potential gambling problem. None of the 24 participants included scored above 3. One additional student signed up to participate and received a score above this threshold. Therefore they were given an alternative non-gambling-related task to complete and were not included in the study. An absence of gambling problems was an inclusion criterion for the current experiment because of ethical concerns with exposing problem gamblers to gambling-related stimuli.

Four desktop Dell PC dual-core Pentium® computers were arranged in the corner of a room (two along each wall). Each had a mouse attached that participants used to make responses. The slot machine simulations were programmed in Visual Basic 6®. The sounds of the slot machines were presented via the computer speakers.

Procedure

Up to two participants completed the experimental tasks simultaneously in the testing room. Participants first completed an informed consent form, and the PGSI. The experimenter then introduced the slot machine task, and instructed participants to try to win as much money as possible, to switch freely between the two available reels while playing on each computer, and to move to the next computer when a message on the screen instructed them to do so. The experimenter also
told participants to read the instructions on the screen, these read:

“This is a slot machine task. You start with $5. On each spin you can bet between 10c and 30c and you can choose whether to play ‘SLOT 1’ or ‘SLOT 2’ (you can freely switch back and forth between the two slot lines). When all five pictures in a row match each other you win 50c for every 10c you bet (e.g. 10c bet = 50c win, 20c bet = $1 win etc.). The task will automatically stop after 10 mins of play or 12 wins (whatever happens first). When the task stops please wait until told what to do next. Any questions?”

Participants clicked a button labeled “Start Task” to advance to the playing screen. There were two five-symbol slot machines presented vertically aligned on the playing screen each with radio buttons displayed to their right that could be used to select a bet amount of 10c, 20c or 30c (see Figure 1). The symbols on each reel were from a visually distinctive set.

At the start of each trial, participants selected a reel to play, chose an amount to bet, and then clicked the associated play button in order to initiate a “spin” on the selected reel. When this button was clicked, slot machine spinning sounds played while a slot-machine animation occurred. During this animation, all slot stimuli were removed for 150ms and were then displayed for 150ms creating a flashing effect. For the first 600ms, different symbols were presented in every position during each flash. After 600ms, the left-most symbol became fixed, and one additional symbol became fixed every 300ms until the five symbols associated with the trial outcome were presented.

The number of matching symbols from the left was associated with the outcome of the spin. Three types of outcome were possible: win, near win, and clear loss. If a win occurred, five matching symbols were presented, a ringing bell sounded, and participants saw a message stating that they had won five times the bet amount (e.g. bet 30c and win $1.50). Note that money bet and won was hypothetical. On near-win trials the four left-most symbols matched, and on clear loss trials either two or no matching symbols were presented (no spin ever resulted in three matching symbols). On near-win and clear loss trials no money was won, and participants saw a message stating that they had won $0. After each outcome the participant’s current “total balance” was updated on screen. Additionally, after the computer displayed an outcome, all the screen elements reappeared and the computer de-selected the bet selection radio buttons.

The current experiment manipulated two independent variables in a within subjects, 2 x 4 factorial design producing 8 conditions. Each condition lasted for 12 wins (obtained from both slot reels) or 10 minutes, whichever came first. Of the 192 conditions completed in Experiment 1 (8 conditions for each of the 24 participants), 154 finished after all 12 wins were obtained and 38 finished after reaching the 10-minute time limit.

The first independent variable was the probability of a near win occurring on a trial on which a win was not programmed. Whether a near win was presented was determined randomly with replacement for each non-win trial for each participant. During one session this probability of a near win occurring on a non-win trial was 0, and in the other 0.5. For the session including near wins, this arrangement of outcomes meant that there was no contingency between near wins and wins. That is, near wins signaled nothing about the likelihood of a win on the following trial. Analyses of outcomes actually experienced by
the current participants confirmed that they were independent in this way. Sessions were no more than one week apart.

The second independent variable was the distribution of the 12 wins across the two reels. Wins were presented according to a dependently-scheduled variable-interval (VI) 10 schedule and the proportion of wins allocated to each reel was manipulated within each of the two sessions. A one-spin changeover delay was in effect meaning that, even if a win had been allocated to a given reel, it was not presented until the second spin made on that reel following a switch. The four win distributions were 2:10, 10:2, 4:8, and 8:4, where the first number indicates the number of wins allocated to the top reel and the second the number allocated to the bottom reel.

Each of the eight conditions was associated with a different background screen color and presented on a different computer. When participants completed a condition, the computer displayed an end screen prompting them to move to the next computer to complete the next condition. Twelve participants completed the conditions in the order: 2:10, 10:2, 4:8, and 8:4; the remaining 12 completed the conditions in the order: 4:8, 8:4, 2:10, and 10:2. Which near win frequency participants experienced during their first session was also counter-balanced. Neither changes in win distribution within each session nor changes in the probability of near wins between sessions were accompanied by any additional stimulus changes. Dependent variables were the proportion of spins, amount bet, and response latencies for each reel. The response latency was defined as the duration between a trial outcome on trial ‘n’ and the response to initiate the spin on the subsequent trial ‘n+1’.

**RESULTS AND DISCUSSION**

We calculated the median response latencies following wins, near wins and clear losses for each participant for each of the eight conditions. We averaged the means of these median response latencies to produce mean response latencies for each participant.
for each outcome type for each near-win condition. In order to assess the effect of outcome type on response latency, each participant’s mean response latency for a given outcome type was partially normalized by subtracting their mean response latency for that condition from it. The means of these difference scores are presented in Figure 2.

As can be seen in Figure 2, in both conditions, the mean response latency following wins was longer than that following losses and in the near-win present condition mean response latency following near wins was longer than that following losses but not as long as that following wins. The direction of the difference in response latencies between near-win and clear loss outcomes was very consistent at the individual level with 91% of the participants showing this effect.

Inferential statistics also confirmed this pattern of results. A paired samples $t$-test revealed a significant difference between mean win and clear loss response latencies in the near-win-absent condition ($t(23) = 8.71$, $p < 0.05$, $d = 1.91$). A repeated measures ANOVA also revealed a significant effect of outcome type on response latencies in the near-win-present condition ($F(2, 46) = 33.36$, $p < 0.05$, $\eta^2_p = .59$). In addition, three post-hoc paired samples $t$-tests revealed significant differences between win and clear loss response latencies ($t(23) = 7.57$, $p < 0.05$, $d = 1.92$), win and near win response latencies ($t(23) = 4.67$, $p < 0.05$, $d = 1.46$) as well as near win and clear loss response latencies ($t(23) = 3.41$, $p < 0.05$, $d = 0.81$) in the near-win-present condition.

These results are consistent with near wins as conditioned reinforcers and not consistent with near wins as producing frustration in the current procedure. This result was consistent with that of Peters et al. (2010) who found rats produced longer latencies following near wins than following losses on a slot machine analog task. In contrast, this result differs from Dixon and Schreiber (2004) who found no consistent effect of near wins on response latencies, and from...
Dixon et al. (2013) who found shorter response latencies following near wins. These differences suggest that features of how outcomes are arranged on slot machines influence the behavioral effects of near wins. These features will be discussed further in the general discussion. Consistent with previous research Experiment 1 also found that participants paused longer after experiencing wins than after experiencing clear losses (Delfabbro & Winefield, 1999a; Peters et al., 2010).

The effect of the presence of near wins on sensitivity to win ratio

The matching law (Baum, 1974) was used to characterise each subject’s sensitivity to the relative frequency of wins on each reel. The matching law refers to the following relationship between the distribution of responses across two alternatives and the distribution of reinforcers across those two alternatives:

\[
\log \left( \frac{B_1}{B_2} \right) = a \log \left( \frac{R_1}{R_2} \right) + \log k
\]  

In the current experiment, \(B_1\) was the number of spins of the last 30 in a given condition made on the top reel, and \(B_2\) the number of spins of the last 30 in a given condition made on the bottom reel. \(R_1\) was the total number of wins delivered on the top reel during a condition and \(R_2\) the total number delivered on the bottom reel. The mean number of spins made in a condition was 76, and therefore the last 30 spins represented 39% of each condition on average (range: 29% -52%). If plotted, Equation 1 is the formula for a straight line, and \(a\) is the slope of that line which also describes how sensitive the distribution of a subject’s behavior was to the distribution of wins. Occasionally, participants either made no responses on one of the two reels during a condition or received no wins from one of the two reels during a condition. When this occurred, we added 0.25 to each of \(R_1, R_2, B_1\) and \(B_2\) in order to allow Equation 1 to be used.

We calculated two sensitivity values for each participant using linear regression: one for conditions during which near wins were present, and another for conditions during which no near wins were present. The mean sensitivity value was 0.20 (range:-0.93 to 0.73) when near wins were absent and 0.39 when near wins were present (range: -0.15 to 1.27). The average r-squared value was 0.47 (range: 0.01 to 0.99) when near wins were absent and 0.57 (range: 0.08 to 0.99) when near wins were present. Figure 3 presents differences in the individual participants’ sensitivity values when near wins were present and their sensitivity values when near wins were absent. As Figure 3 indicates, approximately two thirds of participants were more sensitive to the relative distribution of wins when near wins were also present in the condition than when they were absent. A paired samples t-test \((t(23) = 2.19, p < 0.05, d = 0.45)\) confirmed that sensitivity values were significantly greater during the condition in which near wins were present.

The majority of sensitivity values greater than zero demonstrate the sensitivity of participants to the ratio of wins presented on a slot machine analog task. This is consistent with the findings of Lie et al. (2009) who found that humans were sensitive to the rate of reinforcers in a similar rapidly-changing choice paradigm in a non-gambling context. The current experiment and the results of Lie et al. confirm the utility of this procedure for efficiently assessing humans’ sensitivity to changing reinforcement rate in a given context, extending the use of this procedure, originated by Davison and Baum (2000), to a context of applied relevance.

As displayed in Figure 1 the top slot on each version of the slot machine was
always fruit symbols and the bottom slot was always Viking symbols. The matching law analysis allowed an assessment of whether participants showed a bias towards one or other of these reels. A bias is a preference for one of the response alternatives (here, responding on one of the two reels) that is unrelated to the rate of reinforcement (wins) presented by those two alternatives (Baum, 1974). There was no consistent across-participant pattern of biases to one or other of the reels, suggesting that neither the position (top or bottom) of a reel nor the symbol set presented on that reel consistently affected participants’ preference for that reel.

**Figure 3.** Differences between sensitivity to relative win frequency when near wins were present and sensitivity to relative win frequency when near wins were absent for each participant. Bars above the x axis indicate participants exhibited higher sensitivity to win rate ratios when near-wins were also present in the condition, those below the axis indicate participants were more sensitive to relative win frequency when near wins were absent.

**EXPERIMENT 2**

Experiment 2 investigated whether response latency and sensitivity to wins were affected by changes in the frequency of near-win outcomes. Kassinove and Schare (2001) found that increases in the proportion of near wins initially increased but later decreased persistence of play. Decreases may therefore also occur in sensitivity to the relative frequency of wins or in response latency length when the proportion of near wins experienced is above a particular value. To investigate this possibility we conducted a second experiment identical to Experiment 1, except that players experienced one session where near wins were present on 25% of non-win trials and another where they were present on 50% of non-win trials. These values were selected because previous
research indicates that persistent play effects are greatest when the near win frequency lies somewhere between 25 and 50% (Chan
tal, Vallerland, Ladouceur & Ferland, 1996; Côte et al., 2003; Kassinove & Schare, 2001).

METHOD

Participants
Twenty-four first year psychology students from Victoria University of Wellington completed Experiment 2 in partial fulfill-
ment of a course requirement.

Apparatus
The materials used were as for Experiment 1.

Procedure
The procedure was as for Experiment 1, except participants completed one session during which near wins occurred on 25% of non-win trials and another where near wins occurred on 50% of non-win trials. The order in which participants experienced these two conditions was counterbalanced. Of the 192 conditions played in Experiment 2, 159 ended due to the acquisition of 12 wins and 32 conditions ended after reaching the 10-
minute time limit for the condition. Data from one of the 192 conditions were lost due to a recording error.

RESULTS AND DISCUSSION
Mean response latencies were calculated as for Experiment 1. The within-condition pattern of mean response latencies found in Experiment 1 was replicated in Experiment 2 with response latencies for near wins falling between those for wins and losses in both conditions (see Figure 4). A clear majority of participants showed this difference in response latency in each condition, and there was no difference in the distribution of response latencies between conditions. A 2 (25% near wins, 50% near wins) x 3 (clear loss, near win, win) repeated measures ANOVA confirmed that there was no significant interaction of near win proportion by outcome type ($F(2, 46) = 1.69, p = 0.20, \eta_p^2 = 0.068$) and no significant main effect of near win proportion on response latencies ($F(1, 23) = 0.58, p = 0.46, \eta_p^2 = 0.025$). The 2x3 ANOVA did however reveal a significant main effect of outcome type on response latencies ($F(2, 46) = 27.70, p < 0.05, \eta_p^2 = 0.46$). Following this, post-hoc $t$-tests revealed significant differences between mean response latencies of wins and clear losses ($t(23) = 8.28, p < 0.05, d = 1.31$), wins and near wins ($t(23) = 5.00, p < 0.05, d = 0.94$), as well as near wins and clear losses ($t(23) = 3.15, p < 0.05, d = 0.52$).

The pauses following win, near win and clear loss outcomes in Experiment 2 replicate the pattern of results found in Exper-
iment 1, extending this finding to an additional near win frequency (25%). Pause length was not affected by the relative pro-
portion of near wins experienced. The inconsistent effects of near wins on pause length in Dixon and Schreiber (2004) is therefore unlikely to be due to differences in the proportions of near wins experienced by each participant.

As in Experiment 1, sensitivity values were calculated for each participant in each near win frequency condition. In Experiment 2, the mean number of spins made in a condition was 71, and therefore the final 30 spins that were included in calculations of sensitivity represented 42% (range: 29% to 66%) of the condition on average. The mean sensitivity value was 0.09 (range: -0.34 to 0.64) when near wins were presented on 25% of trials and 0.20 when near wins were presented on 50% of trials (range: -0.17 to 0.71). For two participants, r-squared could not be calculated. For the remaining participants, the average r-squared value was 0.41.
Figure 4. Response latency for each outcome type. Latencies for each outcome type have been partially normalized by subtracting the mean response latency. Open bars indicate the condition with 25% near wins, and gray bars the condition with 50% near wins. Error bars are standard errors.

(range: 0 to 0.95) when near wins were absent and 0.44 (range: 0 to 0.9) when near wins were present. Figure 5 displays the differences in the individual participants’ sensitivity values when near wins were present on 50% of trials and their sensitivity values when near wins were present on 25% of trials. Bars above the x axis indicate that sensitivity was greater when near wins were present on 50% of trials. The majority of bars on Figure 5 are above zero indicating that most participants were more sensitive to the relative distribution of wins when near wins were presented on 50% rather than 25% of non-winning trials. A paired samples t-test ($t(23) = 2.484, p < .05, d = 0.51$) confirmed that sensitivity values were significantly greater in the 50% near win condition. This finding extends the results of Experiment 1 by indicating that incremental increases in near win frequency produce incremental increases in sensitivity to win frequency. As in Experiment 1, there was no consistent bias for either symbol set.

GENERAL DISCUSSION

The current study found that participants produced longer response latencies following near wins than following clear losses, an effect previously observed by Peters et. al. (2010) with rats but not previously observed with humans. The current study
also found that near wins increased sensitivity to rate of wins. These results are consistent with near wins acting as conditioned reinforcers rather than producing frustration in the current arrangement. If the near wins had produced frustration (Amsel, 1958) then pauses following them would have been shorter than those following clear losses, and no systematic effect on sensitivity to reinforcement ratios would have been expected.

The longer latencies observed in the current study differed from the results of Dixon and Schreiber (2004) who found no consistent pattern of response latencies, and from that of Dixon et al. (2013) who found shorter latencies following near wins than other losses. Together, these studies suggest that the behavioral effects of near wins depend on features of the slot machine program, and the outcomes and related symbols presented. In the current study, wins and near wins were both presented during play and near wins appeared to function as conditioned reinforcers. In Dixon et al.’s procedures near wins were presented without the wins they resembled and they appeared to elicit frustration. This may suggest that in the presence of wins, near wins develop conditioned reinforcement effects but in the absence of wins, near wins produce frustration. Future research systematically manipulating the frequency of wins and near wins could clarify this. Ghezzi et al. (2006) investigated the effects of multiple combinations of win size and near-win frequency on persistence of gambling. Results were incon-
sistent, underscoring the complexity of the issue.

Additionally, procedures in which near wins resemble wins for longer portions of outcome sequences may be more likely to establish those wins as conditioned reinforcers. In the current, five-symbol slot machine analog in which only near wins with four of five symbols matching were included, near wins resembled wins for larger portions of outcome sequences than they had in previous arrangements. The mixed results of Dixon and Schreiber (2004) may have reflected the fact that they did not separate out trial types on which the pattern of symbols presented differed in meaningful ways.

There is, however, a possible alternative explanation to conditioned reinforcement for the differential pauses we observed. The longer pauses following near wins might simply be an artefact of the sequential presentation of symbols in the outcome stimuli in combination with the fact that participants require some processing time before selecting their next bet amount and alternative. This processing time may begin when the outcome of the previous spin is known rather than when the opportunity to make the next spin is presented. If this is the case, then, following clear loss outcomes, this processing time may begin earlier, while the remaining symbols are displayed and thus produce apparently shorter pauses following these outcomes than near wins. This explanation, however, does not account for the difference in pause length between wins and near wins as both types of outcomes are revealed when the last symbol is displayed. Nevertheless this possible explanation remains and could be evaluated by replicating this study with simultaneous presentation of all symbols.

This study also found that higher rates of near wins produced increased sensitivity to the relative frequency of wins. Previous research suggests two possible explanations for this. Firstly, conditioned reinforcement may explain this effect as it does for the increased pauses. Alsop and Elliffe (1988) found that when pigeons were responding on concurrent VI VI schedules increasing the overall reinforcement rate while keeping the reinforcement rate ratios equal produced higher sensitivity values. This result suggests that increasing overall reinforcement rate in a gambling context may increase sensitivity. If near wins are conditioned reinforcers, then conditions in which they occurred more frequently had higher overall effective reinforcement rates, and, therefore perhaps, higher sensitivity. This conclusion is tentative given the difference in the procedure through which reinforcement rate was increased across the two studies (the current procedure added equal rates of near wins to both alternatives).

An alternative possibility is suggested by an experiment conducted by Madden and Perone (1999). In that study, requiring participants to attend to schedule-correlated stimuli increased sensitivity to reinforcement rate ratios. The addition of near wins may have had a similar effect because it led participants to increase their attentiveness to the gambling outcome stimuli in order to discriminate wins from physically-similar near-wins.

Although there are alternative explanations to conditioned reinforcement for the effects of near wins on both response latency and sensitivity to wins in the current study, conditioned reinforcement as an explanation has the advantage of parsimony in that it alone accounts for both response latency and reinforcement sensitivity effects. Future research could investigate the extent to which stimulus generalization or conditioning that occurs within a winning spin contribute by systematically varying the extent to which near wins are paired with, versus physically similar to, wins. The extent to which each of these processes contributes to
the near win effect has implications for understanding the importance of this effect for problem gamblers. If pairing is crucial, then the effect may be stronger in problem gamblers as they have experienced many win outcomes and therefore many pairings of near wins and wins.

An important novel feature of the current procedure was the application of a rapidly-changing choice procedure in combination with the generalized matching law to assess sensitivity to wins. Sensitivity values were between zero and one (undermatching) – consistent with previous findings with humans – but closer to indifference than those found by Lie, et al. (2009). Here, the strongest mean sensitivity of any condition was 0.38 (in the 50% near wins condition in Experiment 1), while the mean sensitivity they observed was 0.52. This may reflect the fact that behavior in the gambling context is uniquely influenced by factors other than reinforcement distribution such as inaccurate, self-generated verbal rules. Conditioned reinforcement and verbal rules may interact in determining the effect of near wins on gambling. Research (e.g. Dymond & Roche, 2010; Dymond, McCann, Griffiths, Cox & Crocker, 2012) has shown that derived verbal relations can influence gambling behavior. Directly relevant to near wins, Dixon, Nastally, Jackson and Habib (2009) found that participants who acquired a derived relation between an image of a near win and the word “almost” rated nears wins as more “win like” than they had before they underwent relational training. If gamblers have acquired the (inaccurate) verbal rule that near wins indicate that additional gambling is more likely to produce a win, then near wins might spur persistent play. Future research could identify experiences that lead near wins to increase the persistence of gambling through either or both of these processes.

The current findings suggest that near wins are conditioned reinforcers because they both produced longer pauses than clear losses and increased sensitivity to win frequency. The increased reinforcement rate created by slot machine operators’ addition of near wins is therefore likely the mechanism through which near wins increase the persistence of slot machine play. Future research that further investigates this process will contribute to the design of regulations and interventions to reduce the adverse social impact of slot machines by reducing persistence.

REFERENCES


Kassinove, J. I., & Schare, M. L. (2001). Effects of the “near miss” and the “big win” on persistence at slot machine gambling. *Addictive Behavior, 15*, 155-158.


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The amount of risk an individual is willing to take depends on many factors including payback probability, reward magnitude, context (Dixon, Jacobs, & Sanders, 2006), degree of impulsivity, value of the item being risked (Brandt, Sztykiel, & Pietras, 2013), previous investment in the matter (Arkes & Blumer, 1985), and individual history of gambling or gambling pathology (Dixon, Marley, & Jacobs, 2003). In the gambling context, material reinforcers are repetitively risked in contrived games of chance (Lyons, 2006). Many Americans gamble and as bookies and casinos are not in the business of providing favorable odds, money is typically lost. Petry (2005) reported that 5.4% of North Americans exhibit problem gambling at some point in their lifetime. Although only a fraction of gamblers develop pathology, the fraction equates to a substantial number of people. Due to the large number of people who engage in sub-optimal choices and take high degrees of risk, an analysis of such behavior is of value.

In the past, risk taking behavior has been studied empirically. Studying risk in a contrived casino setting, however, may be difficult. Mimicking the actual conditions found in a casino by allowing participants to wager their own money on games of chance poses an ethical dilemma due to the possible debt incurred by the participant (Weatherly & Brandt, 2004). Brandt et al. (2013) circumvented such ethical dilemmas by having participants earn points to later wager. The researchers then measured the level of risk when participants earned points versus when the experimenter gave them points. When provided with options to either earn or wager credits, Brandt et al. (2013) found that participants may wager more frequently if the experimenter freely provides money or credits versus when credits or money is earned. The amount of risk taken may be a function of where the money or points originated. Credits earned may have more value than credits given freely. Thaler and Johnson (1990) found a “house money effect” in which participants took greater risks after having experienced gains and conversely

Risk As A Function of Response Effort To Gain Points

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The amount of risk an individual is willing to take may be a function of the amount of work required to earn the item that is risked. Twenty-four competitive basketball players were recruited and randomly assigned to one of three groups each representing either a low, moderate, or high work requirement to earn points. Participants were then given shots of varying point values and degrees of difficulty in which to wager points. Results indicate participants who were given a low response effort to gain points took significantly more risk as evidenced by choosing shots with the least probability of success. Those that were required to earn their points took significantly less risk evidenced by choosing shots with the highest probability of success.

Keywords: risk, gambling, sunk cost, house-money effect
took less risk after having lost money. This finding suggests that losses may be experienced as less aversive when playing with “house money” thus contributing to greater overall risk. Weatherly and Brandt (2004) found that increasing the value of credits decreased bet size. Participants bet more when credits were worth $.01 or $0 compared to when credits were worth $.10. Increasing the value, whether subjectively by having participants earn credits or objectively by assigning a monetary value to them may decrease the amount of risk an individual will take with regards to credit wagering.

An investment of time, money or resources in acquiring a material reinforcer may increase the subjective value of the item. When the subjective value is increased, an individual may refuse or unwillingly surrender the items. This unwillingness to surrender the item may be because these losses are experienced as more aversive when compared with items that required less investment. An individual’s persistent commitment based not off of the future benefit but of the previous investment in the matter is known as a sunk cost (Arkes & Blumer, 1985). In such cases the persistent commitment is detrimental because there is little to no benefit for continuing the course of action. The individual’s persistence is based solely on the previous time, investment, and commitment in the matter. Alessandri, Darcheville, Delevoye-Turrell, & Zentall (2008) demonstrated that people show preference for a conditioned reinforcing stimulus following response requirements that were high compared to low response requirements. As money and points may function as conditioned reinforcers, it is likely that individuals will show a greater preference for them, thereby demonstrating less risk when points require a high response effort to attain. Following Alessandri et al. (2008) it was postulated that participants’ preference for points would be related to the amount of work required to earn the points.

In a research setting, experimenters may encounter legal dilemmas in allowing participants to gamble with their own money in contrived games of chance. As an alternative, sports such as the game of basketball may be used due to the subjective value of winning and scoring points amongst competitive basketball players. Similar to the lights, sounds, and celebratory feedback heard while playing a slot machine; hearing the point total, the crowd cheer or seeing a scoreboard light up may all serve as conditioned reinforcers that follow the behavior of making a shot. Gaining points or winning a game may serve as generalized conditioned reinforcers that lead to social contingencies of reinforcement (notoriety or bragging rights) and tangibles such as trophies. Risk is a fundamental part of sports and the aforementioned reinforcers are inherently risked through various courses of action in each game. Players are said to take “risky shots” and coaches are said to “gamble” on given plays when the probability of success for those behaviors are low. Points are of value amongst competitive athletes and can be awarded or taken away to produce reinforcing or punishing effects. The purpose of this study is to measure the level of risk as a function of response effort to gain points. Points earned may have more value than points given freely. Increasing the work requirement to earn points may increase the subjective value and as the subjective value increases participants may experience a loss of those points as more aversive. As a result, those who are not required to earn points may take more risk compared to those that must earn their points.

**METHOD**

**Participants**

Twenty-four college students were recruited at a student recreation center at a
Midwestern university. Inclusion criteria included previous experience playing competitive basketball: junior high, high school, college or other organized basketball league as well as no gambling pathology. Participants were screened using the South Oaks Gambling Screen (Lesieur & Blume, 1987) to account for any high degree of risk taking associated with pathological gambling. No participants scored higher than 3, suggesting potential gambling pathology. Of the 24 males recruited, 12 were African American, nine Caucasian, two Asian and one identified as other (non-Hispanic). Five had played basketball in junior high, 17 played in high school, one played in college, and one played basketball in another organized league. Participants ranged in age from 18-26.

Experimental Design and Measures

Participants were told they were playing a “hot shot basketball challenge” in which the object was to “earn and keep as many points as possible.” Baseline data were collected on free throw and three point shot accuracy prior to group assignment to account for accuracy as a determinant in shot selection. Participants were randomly assigned to one of three groups by the roll of a die. The groups were designed so that only the response effort to gain points varied across groups, and each group began with approximately the same number of points prior to wagering. Group one was awarded 60 points which represented low response effort to obtain points. Group two was given the opportunity to make as many baskets as possible in 40 seconds, for every shot made the participant earned three points. Group three was given the opportunity to make as many baskets as possible in 2 minutes, for each basket made the participant earned one point. Due to the number of points earned per shot, participants in group three were required to make three times as many shots (54 shots total) to gain the same average amount of points as those in group two. Participants in group two could have earned 54 points to wager after making just 18 shots.

After earning or being awarded points, each participant was given the opportunity to take 20 shots from anywhere on the court. Shots in front of the foul line (layups) were worth one point, shots behind the foul line (free throws) were worth two points, and shots behind the three point line were worth three points. Participants were told “If you make the shot, you get to keep the points, if you miss the shot you lose that many points. Your goal is to earn and keep as many points as possible. Pretend that you are playing a real game. You may shoot wherever you like.” Layups represented a low risk due to the high probability of making the shot, free throws represented a moderate risk and three-pointers a high risk. The independent variable was group assignment and the level of difficulty required to achieve initial points that would later be wagered. The dependent variable was shot selection: layups, free-throws or three-pointers.

Setting

Sessions took place in a large gymnasium containing three regulation sized basketball courts. The experimenter was granted permission to conduct the study during normal recreation center hours. The basketball used was a standard men’s regulation sized basketball. Courts were marked with the standard National Collegiate Athletic Association (NCAA) free throw line and three point arc. A single basket was used for the experiment. Students were permitted to use the other baskets throughout the course of the experiment. Data were collected by an observer using a clipboard and pen. The observer stood near the basket and inside the three point arc. Participants were told their point total following each shot throughout the experiment.
Procedure
After obtaining consent, and screening for basketball experience and potential gambling pathology, each participant shot 10 free throws and 10 three pointers to gauge their overall accuracy. Following baseline measures each participant was randomly assigned to a group by the roll of a die. To obtain points with which to wager, group one was given 60 points, group two earned three points for each basket made in 40 seconds and group three earned one point for each basket made in 120 seconds (2 minutes). Group two earned an average of 54.43 points (range 39-75), and group three earned an average of 53.33 points (range 39-69). After earning or being given points, each participant wagered their points by taking 20 shots of varying difficulty. Making a shot resulted in an addition of the shot value to the point total, missing a shot resulted in a deduction of the shot value from the point total. Participants were told shots in front of the foul line (layups) were worth 1 point, behind the foul line (free throws) were worth two points, and behind the arc (three-pointers) were worth three points. Participants were updated after every shot of their point total. Data were collected on shot selection, whether the shot was made or missed and point total following each shot. After 20 shots were taken, participants were debriefed as to the purpose of the study. A second independent observer scored shot selection for 32% of trials in which shots were taken. Inter observer agreement was calculated by dividing agreements by agreements plus disagreements and multiplying by 100%. Inter-observer agreement was 100% for all trials.

RESULTS AND DISCUSSION
A multivariate analysis of variance (MANOVA) was conducted to measure the effects of group assignment (points awarded, points earned with moderate difficulty, and points earned with increased difficulty) on shot allocation: layups, free throws, and three pointers. Significant differences were found between the three groups, Wilk’s Lambda of .26 is significant, \( F(6,38) = 6.19, p < .01 \) indicating that the dependent measures (shot selections) are significantly different for each group. The multivariate partial eta squared = .49 indicates that 49% of the variance is associated with the grouping factor.

Analyses of variances (ANOVA) were conducted as follow up tests to the MANOVA. The ANOVA comparing the number of layups taken (least amount of risk) in each group was significant \( F(2, 21) = 9.15, p < .05 \), partial eta squared = .47. The ANOVA comparing the number of free throws taken in each group was significant \( F(2,22) = 11.0, p < .05 \), partial eta squared = .51, and the ANOVA comparing the number of three pointers taken for the three groups was significant \( F(2, 22) = 7.83, p < .05 \), partial eta squared = .43. Post hoc analyses consisted of pairwise group comparisons that were tested at the bonferroni adjusted .017 level. A Tukey post hoc analysis to the ANOVA comparing the number of layups taken revealed significant differences between groups one and three as well as two and three, \( p < .017 \). Post hoc analysis to the ANOVA comparing the number of free throws taken in each group found significant differences between groups one and two as well as between groups two and three. Significant differences in the number of three pointers taken were found between groups one and two as well as one and three.

Taken together, these results indicate that group one (low response effort to gain points) took the most amount of risk as evidenced by taking a significantly greater amount of three-pointers (\( M = 11.44, SD = 5.57 \)) compared to groups two (moderate effort to gain points) (\( M = 2.67, SD = 2.42 \)) and three (high response effort to gain points) (\( M = 11.44, SD = 5.57 \)).
Figure 1. Shot allocation for groups one, two, and three.

points) \( (M = 3.44, SD = 5.55) \). Group three, who had to work the hardest to earn their points, took the least amount of risk evidenced by taking a significantly greater amount of layups \( (M = 13.22, SD = 7.28) \) then groups two \( (M = 3.17, SD = 3.82) \) and
one ($M = 4$ and $SD = 3.46$). These results support the conclusion that the level of risk can be experimentally manipulated. Shot accuracy did not vary between groups ruling out skill for each shot as a potential confound.

The purpose of this study was to investigate if risk varies as a function of response effort to gain points. Prior to group assignment, shot accuracy data indicated three point accuracy was 31.6% and free throw accuracy was 54% across groups. Figure 1 shows the mean and inter-quartile ranges for each shot across the three groups. Results indicate that participants who were given points to wager took more risk evidenced by selecting the most low percentage shots; three pointers. Given the probabilities of successful payout a participant who selected only three point shots would lose 27.6 points on average from there total given that misses resulted in point deductions. Shooting three pointers generally resulted in an overall net loss, therefore this choice represented the highest level of risk. Individuals who were freely given points shot significantly more three-pointers, resulting in the greatest net loss. Given the probability of making a free throw, a participant shooting only free throws would accrue four additional points on average. Participants in group two, who engaged in moderate effort to earn points, took significantly more free throws which represented a moderate risk. The shot yielding the most points, assuming 100% accuracy would be the layup. Participants shooting only layups would net 20 points total. Participants who were required to expend high amounts of effort to earn points (group three) took significantly less risk when wagering the points, indicated by shooting significantly more layups compared to participants who were given points; group one. Participants who were required to work for their points may have experienced losses as more aversive, resulting in less risk taken.

When points were simply given, participants took the most risk and lost the most points.

These results extend findings by Alessandri et al. (2008), Brandt et al. (2013) and Thaler and Johnson (1990). When presented with a repetitious task to shoot layups, participants who earned points continued to show a selective preference for shooting the layups when the consequence resulted in only one point compared to free throws that were worth two and three pointers that were worth three. Findings by Alessandri et al. (2008) suggest that although the points awarded were minimal for the low risk shot (layup), they may have functioned as a strong conditioned reinforcer for group three due to the high work requirement to earn each point. Thaler and Johnson (1990) suggested that losses may be less aversive when playing with house money. In this experiment, individuals given points were likely to take high amounts of risk resulting in the greatest amount of loss. The group given points (group one) wagered and lost the points by taking the most risky shots. It is possible that the points for participants in group one did not function as a strong reinforcer compared to participants in groups two and three. The group who had to commit the most effort to gain points took shots with the highest probability of payback. For members of this group, prior investment likely raised the value of each point. Shots that were missed for group three resulted in point deductions which may have been experienced as more aversive due to an increased prior investment.

A significant portion of the analysis of gambling behavior involves the study of choices and risk taking. Throughout sports, risk is inherent in the probabilistic outcomes of various choices or courses of behavior. The study of choice and risk taking may extend beyond the context of gambling into all contexts in which risk is taken. In the present study, the amount of risk was assessed
with basketball players to show the overall generality of the analysis of choice, risk, the house money effect, and sunk cost. Due to only a probabilistic nature of making a shot, the sunk cost error was likely high because players were not certain whether they would make or miss a shot. Additionally, players may give added value to an outcome that is more difficult to achieve (Alessandri et al., 2008). Such is the case when athletes win close games, play an “intense match,” or conquer a difficult opponent. The current data suggests that this sunk cost was high for participants who had a previous investment (high response effort) to gain and later wager their points.

Although points gained in basketball may serve as generalized conditioned reinforcers the points earned and wagered in this study were not tied to additional programmed rewards delivered by the experimenters. Despite this limitation, making shots and earning points while playing basketball may have been intrinsically reinforcing for the participants involved. Another limitation and unintended consequence of the current study was that the point allocation during the point earning phase for group two may have made selection of three-pointers and layups less desirable. The point value assigned to each shot by the experimenter may help explain the disproportionate amount of free throws shot by group two. Participants in group two earned three points for each layup made in a 40 second timed trial. After earning three points for each layup, shooting three-pointers when wagering may have been less appealing due to the same payout rate despite increased response effort and lower overall probability of success. Similarly, changing the value of the layup from three points (during the timed trial) to one point (when wagering) may have made the layup less appealing because the reward for making the shot had decreased. Nonetheless, the finding supports the conclusion that shot allocation and risk taken was a product of the amount of effort required to achieve points (Brandt et al., 2013).

REFERENCES


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Adult Samples Suggest Slot Machine and Casino Characteristics Are Possible Sources for Investigating the Illusion of Control

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The illusion of control is a phenomenon in which a gambler identifies his or her odds of winning as being more favorable than would be possible by chance—either through game/device choice or direct manipulation of the device or game-related objects (e.g., dice). To date, relatively little attention has been paid to the illusion of control in behavior analytic research on gambling. The authors’ aim is to provide researchers with a base from which to explore the illusion of control in slot machine gambling through analyzing two samples of college students and two samples of adults participants with respect to machine and casino characteristics.

Keywords: illusion of control, gambling, slot machine, casino

Bijou, Peterson, and Ault (1968) provided a framework for connecting descriptive field studies with experimental work. Bijou et al.’s primary argument was that, if executed correctly, descriptive studies can be useful in directing future experimental investigations. Within gambling research, descriptive analyses have been conducted that may prove useful for future investigations. For example, Witts and Lyons (2013) studied 20 online no-limit Texas Hold’em poker players who played for either low stakes ($0.01/$0.02) or medium stakes ($3/$6) and did so either sequentially (1 table played) or simultaneously (multiple tables played at the same time) by purchasing hand histories and analyzing them with commercially-available poker analysis software. One major finding in Witts and Lyons was that players tended to play longer when action, defined as the number of big-blind-sized bets being passed between players, and player win frequencies (regardless of win size) were high. Such findings prompt future researchers to consider these as potentially important variables when studying poker play in the laboratory.

It is possible, then, that descriptive investigations can yield data which will steer gambling research in more restricted paths. Because data from in-person—as opposed to online—gaming environments are difficult to obtain (see Lyons, 2006, cf. Witts & Lyons, 2013), knowing what specifically to investigate will benefit naturalistic descriptive analyses in that research efforts can be maximized by focusing only on variables more likely to produce meaningful results. The present investigation was designed to approximate a descriptive analysis of gamblers’ beliefs, accurate or inaccurate, regarding slot machines without the aid of naturalistic observations so that future research could be better refined prior to experimental analysis or naturalistic observation. In other words, prior to investigating gambling behavior related to inaccurate rules and slot machine play, a descriptive analysis provides a rationale for such work based on the verbal behavior of participants. The primary focus of the analysis was to assess beliefs regarding slot machine characteristics, some within the context of the casino itself, as
they relate to the probability of winning or losing. The belief that a player can alter his or her chances of winning, either through careful selection or differential play, falls under the larger term *illusion of control* (cf. Langer, 1975).

The illusion of control has been a topic of consideration in the behavioral literature (e.g., Dixon, 2000; Nastally, Dixon, & Jackson, 2009; Wong & Austin, 2008), though its coverage has been relatively limited. One reason for studying the illusion of control is that beliefs regarding gambling outcomes, whether accurate or inaccurate, can serve as rules which then alter how one gambles (cf. Dixon, 2000; Dixon, Hayes, & Aban, 2000). In fact, Dixon (2000) conceptualized the illusion of control as the outcome of a history of rule-following with respect to inaccurate rules. As an example of an inaccurate rule, the gambler’s fallacy suggests that after a series of one particular outcome, a different outcome is made all the more likely. In slot machine play the gambler’s fallacy would state that after a series of wins (or losses), the opposite outcome is more likely to occur on the next spin as compared to previous spins in the series under consideration. In the casino no such rule is accurate as each spin of the slot machine is independent of all other spins. As Weatherly and Meier (2008) correctly noted to some of their participants, “the machine does not ‘keep track’ of how you are playing” (p. 5).

With respect to Dixon’s (2000) conceptualization, efforts aimed at delivering accurate rules that compete with inaccurate rules could reduce or eliminate the illusion of control. Petry (2005) summarized the research on irrational or inaccurate rules while gambling and concluded that most gamblers, recreational and problem, tend to endorse inaccurate rules. However, as Petry stated, the exact nature, frequency, and relation to gambling behavior of these thoughts are yet to be demonstrated. Furthermore, inaccurate rules may hold more sway over gambling behavior than the actual contingencies (Dixon, et al., 2000), thus adding to the urgency of needing to address the illusion of control from outside sources (e.g., informational campaigns). However, it is important to note that what information is provided needs to be taken into consideration, as Dannewitz and Weatherly (2007) found that accurate information regarding which cards to play in a video draw poker game resulted in increased risk-taking (i.e., larger bet sizes). Video poker has some element of skill involved and thus accurate rules might instead lead to more-preferred outcomes through enhanced performance, whereas accurate information regarding games of pure chance (e.g., slot machines) tends to reduce gambling (coins bet, number of spins; Weatherly & Meier, 2008), at least in laboratory simulations.

When accurate and inaccurate rules are contacted may be of some interest as well. Consider that in Dixon, Jackson, Delaney, Holton, and Crothers (2007), rules that supported a preferred style of play increased preference for that same style more than contradictory rules that supported the alternative style (in this case, player-selected vs. computer-selected cards in a video poker simulation). Thus, depending on circumstances, interventions related to accurate rules after a period of play under the guidance of inaccurate rules may prove to be a difficult route to altering playing style. It is yet unclear if players who are first supplied with accurate rules who then operate in accordance to those rules would demonstrate the same resistance to change.

What is clear, then, is that cataloguing and subsequently addressing inaccurate rules with respect to gambling should be of interest to the research and treatment communities. To date, the behavioral investigations into the illusion of control, regardless of the game studied, have been conducted under...
laboratory conditions. It is in this light that we examined differences between two college samples and two online samples in an effort to begin the process of examining the intersection between slot machine gambling and the illusion of control. Specifically, question related to how one selects (e.g., machine location, day of the week) and interacts with (e.g., player’s club cards, vouchers, cash) slot machines was explored.

**METHOD**

**Participants and Settings**

Fifty students enrolled in undergraduate psychology coursework at a large Western university, 77 students enrolled in undergraduate psychology coursework at a mid-sized Midwestern university, and 117 United States adults enrolled in Mechanical Turk’s (MTurk) marketplace participated in this study. MTurk is a website created and hosted by Amazon.com in which individuals can sign up to earn Amazon.com credit to spend on Amazon.com’s products by completing assignments created by businesses and researchers. Due to an error in software copying, Western student and MTurk 1 (see below) demographic information were missing. Thus, a comparison between samples is not possible. These two samples (university student and MTurk users) were selected as convenience samples based on the idea that different samples (e.g., Gainsbury & Blaszczynski, 2011) and different recruitment procedures (e.g., Williams, Pulford, Bellringer, & Abbott, 2010) might produce different outcomes or serve to confirm general findings (e.g., consistency of beliefs across multiple samples).

**Materials**

A survey was created to assess popular incorrect rules that may be endorsed by gamblers. Survey items were created by two means: 1) the researchers created a list of commonly-heard beliefs regarding slot machine use, and 2) popular slot machine strategy books (e.g., Jensen, 2010) were read to identify incorrect slot strategies that gamblers may use (e.g., “it is prudent to first run a simple test to judge whether [the machine] is hot or cold” (Jensen, p. 67). Questions included items pertaining to machine selection and style of play. For example, participants were asked to answer true or false to the statement “If a machine has produced a series of small wins, it will continue to do so.” Individual questions are explored further in the results section and in Table 1.

**Procedure**

Students from the Western university were recruited through SONA systems online recruitment software in the spring of 2013. Students from the Midwestern university were recruited by having the third author attend undergraduate courses in the spring of 2014 and announce to the students the opportunity to participate in the project. Both samples of MTurk participants were recruited through the MTurk website and were compensated with $0.25 per survey completed. The first group of MTurk participants (MTurk 1) was recruited during the spring of 2013, and the second (MTurk 2) in the spring of 2014. Students were divided by geographical regions, and both MTurk samples were combined as no geographical data were provided save that they were all residing in the United States at the time of the survey.

Students from the Western university completed the survey through the SONA website as the survey for this group was created within that software package. Students from the Midwestern university and adults from the MTurk 2 group completed the survey through SurveyGizmo. Finally, adults

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1 The complete questionnaire can be obtained by contacting the first author
<table>
<thead>
<tr>
<th>Question</th>
<th>Response Options</th>
<th>Universities</th>
<th>MTurk</th>
</tr>
</thead>
<tbody>
<tr>
<td>The more lines I play on a slot machine, the more I will win</td>
<td>True 36.36% False 63.64%</td>
<td>MidWest n = 77 West n = 50 Combined n = 127 MTurk n = 117</td>
<td></td>
</tr>
<tr>
<td>If a machine pays out a large jackpot, it will</td>
<td>Stop paying out 57.89% False 42.11%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A series of small wins is a sign that a big win is coming</td>
<td>True 10.39% False 89.61%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>It a machine has produced a series of small wins, it will continue to do</td>
<td>True 15.58% False 84.42%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stopping the reels manually (hitting the “Spin” button again to stop</td>
<td>Increase my chances of winning 6.49% Decrease my chances of winning 7.79%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elite players are often given “Free Play” money from the casino. Using</td>
<td>Increase my chances of winning 23.38% Decrease my chances of winning 3.90%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>My chances of winning are greatest during</td>
<td>Weekdays (M-Th) 32.47% Weekends (F-Su) 16.88% Neither weekdays nor weekends are</td>
<td>MidWest n = 77 West n = 50 Combined n = 127 MTurk n = 117</td>
<td></td>
</tr>
<tr>
<td>If I start winning, I need to cash out or the machine will make me lose</td>
<td>True 46.75% False 53.25%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* n = n-1; ** n = n-2; λ n = 75; **Bold = p < .05; # = True (each symbol has a dedicated prize under it), False (the machine predetermines what I win and my choosing does not influence that outcome)

Table 1. Response distributions between samples for those questions that produced some degree of illusory belief endorsement. Chi-square analyses were conducted on the largest group of university participants (combined when possible) and the MTurk sample.
from MTurk 1 completed the survey through MTurk. While different survey features were explored during this study (e.g., SurveyGizmo allowed for rank ordering), only those questions that were delivered in a common format were included in the analysis.

When completing the survey, all participants were given an information sheet to read that was approved by the respective university’s IRB. Participants were then asked a series of questions related to slot machine gambling. While some questions varied between groups, questions common to both assessment times are presented here. Upon completion of the survey, non-university participants were either paid (MTurk 1) or given a code to enter for payment (MTurk 2). For participants in university settings, extra course credit was issued at the moment of consent, as required by both IRBs.

RESULTS AND DISCUSSION

Comparison data are presented in Table 1, divided by Western, Midwestern, Combined (i.e., Western + Midwestern), and MTurk samples. Chi-Square goodness-of-fit tests were performed on participant responses to individual survey items (equal proportions of endorsement for each response item were assumed) between the Combined and MTurk (combined) samples when possible, or between the Midwestern and MTurk 2 sample. Significant Chi-Square results were found between Midwestern students and MTurk 2 participants for the question “A series of small wins is a sign that a big win is coming.” (True/False), $X^2 (1, N = 152) = 6.70, p < .05$, such that MTurk 2 participants endorsed this as being true (26.67%) more than Midwestern students (10.39%). An additional significant difference was found between combined university students and combined MTurk samples for “Using an ‘Elite’ status player’s card, rather than the standard player’s card, will,” (Increase/Decrease/Have no effect on my chances of winning), $X^2 (1, N = 243) = 6.47, p < .05$ with more students endorsing an effect on winning and losing (26.98% and 4.76%, respectively) than their MTurk counterparts (16.24% and 1.71%, respectively). Non-significant Chi-Square results were not, however, unimportant. For example, 19.84% of combined university students and 15.38% of combined MTurk participants endorsed a belief that using a player’s card before betting will increase one’s chances of winning. Complete analyses can be found in Table 1.

Generally speaking, there were many differences found within and between samples, suggesting that there is no consensus regarding beliefs about slot machine outcomes given various circumstances. Some questions involved behaviors that could lead to a more profitable outcome, such as with staying on a machine that has produced a series of small wins. Other questions assessed the avoidance of monetary loss with questions like “If I start winning, I need to cash out or the machine will make me lose” (True/False). While no conclusive outcomes can be drawn here, several new lines of research are suggested.

Researchers have examined slot machine characteristics (e.g., manual reel stops) and how they relate to altered play (Ladouceur & Sevigny, 2005) or preference (Nastally et al., 2009). However, casino characteristics (e.g., slot machine location, player’s clubs) are less explored, and these results are especially interesting in this light. For example, we asked if a slot machine player was more likely to win on certain days, and 32.47% of the Midwestern sample and 26.67% of the MTurk 2 sample responded favorably to weekdays (Monday through Thursday) as being more profitable. Future research may find differences between weekday, weekend, and weeklong players.
There are various patterns of correlations between each sample’s responses that are of interest. If all samples fail to endorse the illusion, then it is likely that investigations into that particular belief would fail to produce meaningful results. If, however, samples are uncorrelated, then it stands to reason that one sample endorses the illusion, or at least a different aspect of it, than the other group. For example, the combined university samples was nearly split on whether continued winning would result in the machine making the participant lose, whereas 58% of the MTurk sample endorsed this belief (42% rejected). Finally, if all samples are in agreement regarding some illusory belief, then research into that specific fallacious rule is most likely to produce meaningful data, particularly as it relates to the alteration of the belief.

There are several ways in which this investigation could have been enhanced. For example, participant characteristic data were missing from the Western and MTurk 1 groups, which also included information on frequency of slot machine play. Of the Midwestern students, 71.43% (n = 55) reported having played a slot machine at least once, and of the MTurk 2 participants, 82.67% (n = 15) reported the same. Additional characteristics from the Western and MTurk 1 data would have permitted better comparisons between those who had and had not played slot machines. A final limitation involves the possibility of Type I errors given the numerous analyses conducted, though replications and extensions will help to address this concern. Despite these potential limitations, the results are still valuable in restricting future investigations into factors that may contribute to altered, preferred, or prolonged gambling either in the short- or long-term. Furthermore, these results are made all the more robust by the fact that student samples were recruited from two geographically-distinct campuses and that the MTurk samples were recruited at two separate times (spring 2013, spring 2014).

REFERENCES


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The Near-Miss Effect in Blackjack:
Group Play and Lone Play

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Previous research in blackjack has demonstrated that gamblers report outcomes that are closer to wins when the player's total approximates the dealer's total. However, additional comparisons, such as to another player's total or to 21, may affect the prevalence of a near-miss. The current study investigated the presence of a near-miss in blackjack while playing alone and with other players, and examined ratings in relation to the difference of the player's, dealer's, and another player's total from 21. College students played 25 hands of blackjack with only the dealer and another 25 hands with another player and the dealer and rated how close the outcome was to a win. The results demonstrated the presence of a near-miss effect as a function of the numerical distance from the player's and another player's total to 21, and the absence of a near-miss when the player busts.

Keywords: Blackjack, gambling, near-miss, social

The number of studies investigating pathological gambling has increased as researchers gradually learn more about the complex behavioral phenomena (Dixon, Nastally, Hahs, Horner-King, & Jackson, 2009). One significant emerging factor frequently examined in the gambling literature is the "near-miss" effect. For example, previous research has demonstrated that both non-gamblers and pathological gamblers alike demonstrate a near-miss effect, and that pathological gamblers exhibit similar physiological responses to near-miss and winning outcomes. In this way, near-miss outcomes may significantly influence gambling behavior as they function differently than a loss; a gambler's play may be altered and reinforced by near-misses as though they are wins (Habib & Dixon, 2010). Starting as a slot-machine phenomenon, a near-miss has been described as an outcome with matching symbols on a slot machine pay line with the final matching symbol just above or below the pay line (Dillen & Dixon, 2008; Dixon & Shreiber, 2004). Once the prevalence of the near-miss in slot machines had been observed, near-misses of various topographies have been observed in research on roulette play (Dixon, 2010), blackjack (Dixon et al., 2009), and it has been proposed to occur with scratch off tickets (Griffiths, 1999).

In an investigation of the near-miss in blackjack, Dixon and colleagues (2009) required participants to verbally rate each hand they played. The rating was placing a value (1-9) on the outcome of their hand (or score), highest value being closer to a win. The participants played 50 hands of blackjack and the results showed that when the participants' score was closer to the dealer score they rated their hand higher. When the participants did not bust they rated the losses higher than when they lost through a bust. Though a near-miss has been observed in blackjack, players in that study played alone which eliminates the many potential social
variables such as additional comparisons between the players total and the totals of other players, attention-based reinforcement, and bet sizes and wins and losses of other players. In a casino, two or even up to five players are often playing at the same table, thus the external validity of such findings may be limited. Also, people may compare their hands to other players at the table, or players may more likely compare their hands to 21, the optimal outcome for a blackjack hand. For example, they might be only three points lower than the dealer, but several other players might have been closer, or losing to the dealer by a factor of two with a total of 16 might be different than losing by a factor of 2 with a total of 19. There is body of literature demonstrating effects of social variables such as group influence on risk taking behavior in Blackjack, and effects of ethnicity and group play on slot machine gambling (e.g., Blascovich & Ginsburg, 1974; see McDougall, Terrance, & Weatherly, 2011 for more detail discussion). Though these investigations demonstrated similarities in their findings (McDougall, McDonald, & Weatherly, 2008) no study demonstrated how adding players to a blackjack game could affect near-miss scores.

Because other comparisons may potentially predict the presence of a near-miss effect and because players often play in a social setting rather than alone, these variables must be included in an examination of the near-miss in blackjack to further our understanding of controlling contingencies in gambling games like Blackjack and to further understand the factors responsible for the near-miss in a more true gambling simulation as multiple gamblers are often playing at one table. Thus, the purpose of the current study was to replicate and extend the study by Dixon and colleges (2009) by investigating the effects of group play on near-misses demonstrated by players and compare them to near-misses when they would play with a dealer only, and to further examine the topography of the near-miss in blackjack. By adding group play to the current study the investigators aimed to measure whether there would be a difference in self-ratings on near-miss scores between lone play and group play conditions.

METHOD

Participants and Setting
Sixteen college students (15 female and 1 male), with ages ranging from 18 to 45 ($M=23.8$, $SD=6.3$) participated in the study for extra course credit. All participants completed the South Oaks Gambling Scale (SOGS; Lesieur & Blume, 1987) to investigate whether they demonstrated tendencies towards pathological gambling. All scores indicated no evidence of pathological or problematic gambling and no participant was excluded from the study.

Sessions were conducted in two adjacent rooms in a university gambling laboratory. One room had a desk with a deck of cards and chips, a computer, and two chairs among other office materials such as computers and cabinets. The second room had a standard casino style blackjack table outfitted with cards, chips, four chairs and other gambling stimuli such as inactive slot machines, a roulette wheel, and a craps table. Approximately half of the individual sessions and half of the group sessions were conducted in either room to control for any differential effects of the setting.

Response Measurement and Interobserver Agreement
Following each hand of blackjack, participants recorded whether they won or lost, the score of the dealer, their own score, the score of the other player, and, their rating of closeness to a win. During gameplay participants were asked what their score was by the dealer, and were observed placing a
closeness to win rating on their data sheet. If they incorrectly stated their score the dealer corrected them and had them write the correct score down on the data sheet. If they did not rate their hand the dealer directed them to do so and observed them writing down their score. The closeness to win rating scale was the same as used by Dixon et al. (2009).

To ensure accuracy of observations, a second independent observer recorded player and dealer scores and win/loss outcomes on 50% of all hands played. Closeness to win ratings were copied by the experimenter and entered into a computer file after each session. A second experimenter independently entered the ratings for closeness to win ratings to assess the reliability. Reliability was calculated as the number of agreements divided by the number of agreements plus disagreements, multiplied by 100%. Reliability for closeness to win ratings was 100%, 100% for lone play condition scores, 100% for group play condition scores, and 100% for win and loss scores.

**Procedure**

After consenting to participate and completing the SOGS, participants then played blackjack in two different conditions. In the first condition, participants played 25 hands as the only player against the dealer (lone condition). The second condition required 25 additional hands of blackjack against the dealer, but alongside another participant or confederate (group condition). To control for possible sequence effects, participants were randomly assigned to the two possible condition sequences. Of the 16 participants in the study, nine started playing in the lone condition and proceeded to the group condition, and the remaining seven completed the conditions in reverse order.

After condition sequences were decided, the experimenter provided the following instructions:

"The game we are about to play is called blackjack and consists of trying to get a score of 21 to win. You will get 245 credits in chips that you will use to wager. Your aim is to end the game with more chips than you started with. We will start by dealing to you two cards and I (dealer) will also have two cards. Then you can look at your cards but you will only see one of my cards. When you look at your cards you will have to assess how good your hand is and place a bet. After you place the bet you can ask for another card or you can stay with the cards you got. You can ask for as many cards you need to win. You can make an additional bet if your hand improved from receiving another card. When you decide to stay I will flip over my second card and I will place cards down until I reach 17 or higher. If you win you will get the amount you bet, if I win you will lose that amount. You will not be allowed to double-down or split."

None of the participants indicated that they were advanced players at blackjack. All participants were allowed to play 3 to 5 practice hands without betting, to facilitate gameplay and to verify that they understood the rules. After practicing the experimenter gave the following instructions to participants starting in the lone play condition:

"We are going to play 25 hands and then another player is going to join us for another 25 hands. The only change that occurs when the other player joins us is that you have to write down his score as well. Any questions?"
Instruction for participants starting in the group play condition were:

“We are going to play 25 hands and then one of you is going to go with another experimenter to play another 25 hands against a dealer only. Any questions?”

If there were any questions made by the participants the experimenter answered them by referring to the relevant portion of the instructions. Whenever the experimenter observed the participants fail to record scores and/or rate the closeness to win, the dealer paused the game and prompted participants to complete their data collection.

RESULTS AND DISCUSSION
In the lone play condition participants lost on average 45% of all hands played, and in the group play condition they lost 63.5% of all hands played. This difference was significant $t(15) = -5.381, p < .001$. In the lone play condition, 4 out of 16 participants won more hands than they lost, and in the group play condition no participant won more hands than they lost. Pushes (not a win or a loss) accounted for 15% and 10.5% of all hands played in the lone play and group play conditions, respectively. Similar to Dixon et al. (2009), a “bust loss” occurred when a participant had a cumulative score of 22 or higher, and a “no-bust loss” was when the participant had a cumulative score of 20 or less, but his or her total was less than that of the dealer. The top and middle panel of Figure 1 display mean closeness to win ratings across all participants in the lone and group play conditions, respectively, of the player's hand from 21, dealer's distance from 21, (middle panel; group play) for non-bust losses only. The final panel of Figure 1 displays closeness to win ratings as a function of the difference of the other player's distance from 21.

A hierarchical regression analysis was carried out to assess predictors of closeness to win ratings (Tables 1 and 2). Two models were utilized, including distance of player’s, dealers, and other player’s hand from 21, as predictor variables in the first model. In the second model, distance between player’s, dealer, and other player’s hands were added to analysis. Distance was defined as the numerical distance from the player’s (i.e., 15) and dealer’s hand (i.e., 18). The general procedure was to test the distance from 21 of the player, dealer and other player first, then add distance between hands to assess their added contribution to the predictive variance.

Significant correlations of the variables are shown in Table 1 and regression coefficients in Table 2. The first prediction model was statistically significant, $F(3, 12) = 6.063, p = .009$, and accounted for approximately 60% of the variance of closeness to win ratings ($R^2 = .602$, Adjusted $R^2 = .503$). Closeness-to-win ratings were primarily predicted by participant distance from 21 and second player distance from 21, and not by dealer distance from 21. The second prediction model was not significant $F(5, 10) = 3.055, p = .063$. The second model analysis was conducted to replicate the findings of Dixon and colleges (2009) by using similar measures, that is distance from dealer’s hand. The results did not indicate that there was an added prediction value by these three variables.

In summary, the presence of another player influenced the participant’s closeness to win ratings but the dealer’s distance from 21 did not. The data displayed in the top and bottom panel of Figure 1 show a relationship in closeness to win rating as the difference between hand total and 21 increases for player and the other player respectively. Conversely, participants did not systematically differentiate ratings based on the difference between their total and the dealer’s
Figure 1. Closeness to win scores across comparisons. All three panels display mean closeness to win ratings in non-bust losses for lone play and group conditions.
Table 1. Correlations of the variables in the regression analysis \((N = 16)\)

<table>
<thead>
<tr>
<th></th>
<th>Closeness to win</th>
<th>Player difference from 21</th>
<th>Dealer difference from 21</th>
<th>Other player difference from 21</th>
<th>Player difference from dealer</th>
<th>Player difference from other player</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closeness to win</td>
<td>-</td>
<td>-.649**</td>
<td>.046</td>
<td>.647**</td>
<td>-.587**</td>
<td>-.040</td>
</tr>
<tr>
<td>Player difference from 21</td>
<td>-.106</td>
<td>-</td>
<td>-.456*</td>
<td>.642**</td>
<td></td>
<td>.179</td>
</tr>
<tr>
<td>Dealer difference from 21</td>
<td>-</td>
<td>.149</td>
<td>-</td>
<td>.414</td>
<td>-</td>
<td>-.218</td>
</tr>
<tr>
<td>Other player difference from 21</td>
<td>-</td>
<td>-</td>
<td>-.471*</td>
<td>-</td>
<td>.089</td>
<td></td>
</tr>
<tr>
<td>Player difference from dealer</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>.112</td>
</tr>
<tr>
<td>Player difference from other player</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 2. Regression coefficients from the regression models

<table>
<thead>
<tr>
<th></th>
<th>(b)</th>
<th>(SE\ b)</th>
<th>(\beta)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1 (Constant)</td>
<td>6.163</td>
<td>2.914</td>
<td>-0.454*</td>
</tr>
<tr>
<td>Player difference from 21</td>
<td>-1.382</td>
<td>.623</td>
<td>0.464*</td>
</tr>
<tr>
<td>Dealer difference from 21</td>
<td>-.443</td>
<td>.501</td>
<td>-0.163</td>
</tr>
<tr>
<td>Other player difference from 21</td>
<td>1.380</td>
<td>.613</td>
<td>0.464*</td>
</tr>
<tr>
<td>(Constant)</td>
<td>6.723</td>
<td>4.148</td>
<td>-0.419</td>
</tr>
<tr>
<td>Player difference from 21</td>
<td>-1.275</td>
<td>.971</td>
<td>-0.419</td>
</tr>
<tr>
<td>Dealer difference from 21</td>
<td>-.410</td>
<td>.758</td>
<td>-0.151</td>
</tr>
<tr>
<td>Other player difference from 21</td>
<td>1.375</td>
<td>.750</td>
<td>0.462</td>
</tr>
<tr>
<td>Player difference from dealer</td>
<td>-.084</td>
<td>.750</td>
<td>-0.042</td>
</tr>
<tr>
<td>Player difference from other player</td>
<td>-.186</td>
<td>.929</td>
<td>-0.043</td>
</tr>
</tbody>
</table>

*. \(p < 0.05\)

Overall, the results support the previous research on the blackjack near-miss in that an effect was observed for non-bust losses (Dixon et al., 2009) and extended those findings with the inclusion of an additional player at the table, which may more closely represent the social aspects of blackjack in a casino environment. Further, the authors included an analysis different from Dixon and colleges where they investigated distance between player and dealer total score and how that affected closeness to win ratings. The current study investigated the effects of player's and other player's hands from 21 and analyzed how this distance affected closeness to win ratings. Previous research observed differentiated ratings as a function of the difference between the dealer's total and the player's total (Dixon et al., 2009). Statistical analysis of the present re-
sults suggests that the difference to 21 may exert more control over closeness to win ratings, a similar result as that of Dixon (2010), who found ratings in roulette were controlled by numerical proximity between the number bet and the outcome. However, these measures are not always necessarily independent. For instance, on a non-bust loss, a hand with a value of 17 is relatively close to 21, but hands of this value will also closely approximate the dealer's total because the dealer must possess a value between 17 to 21 to win. Because the dealer is required to continue taking cards until s/he reaches a total of 17 in standard casino play, many non-bust losses will occur within a range close to 21 and close to the dealer's hand. Future research in this line may wish to systematically isolate each of these variables with rigged hands or computerization to more completely determine the influence of each comparison.

Along with random variation inherent in the game, the results are also limited due to uncontrolled winnings and the frequency of particular outcomes. In the current study, participants lost an average of almost 20% more hands in the group condition than in the lone condition. Also, near-misses have been reported to maintain game play by gamblers, specifically when playing slot-machines, if the near-misses are frequent, but may not maintain play when they are overly frequent (MacLin, Dixon, Daugherty, & Small, 2007). Again, future research may wish to control such variation or to further examine the influence of frequent losses or frequent wins on the near-miss effect. Other limitations were related to the sample and the game used. In the current study 15 out of the 16 participants were females and the Blackjack game used in the current study was not a common version of the game. It was an adapted version that was originally used by Dixon and colleagues (2009) where there were no doubles, no splits and instructions to the participants were kept the same. Due to the nature of the study being a replication, the authors decided to use a similar game for the purposes of replication and to facilitate comparison between the two studies. The results of the current study must also be interpreted with care because the researchers were unable to maintain equal gender participation. Future research on the near-miss effect across different games of chance may be valuable in determining the development of the effect and suggest more effective treatments for problem gamblers. In slot machines, for example, near-miss outcomes are formally similar to wins, so generalization may influence the effect. However, the present results and those of Dixon (2010) that showed numerical proximity influenced participants' ratings of outcomes in blackjack and roulette, respectively, suggest that other factors may be more relevant as visual similarity of winning outcomes is not necessary to produce higher closeness to win ratings in these games. As many games appear to have a unique arrangement that produces the near-miss effect, a further analysis of these arrangements in different games of chance may find common environmental characteristics or sources of control suggestive of underlying causes of the effect so that these variables can be directly targeted in treatment.

In sum, the current study replicated and extended a study by Dixon et al. (2009) and added implications to the body of literature on near-misses. By further investigating the characteristics of near-misses we take one step forward on the path to discover the complex controlling contingencies of gambling behavior, and by successfully replicating and extending previous research this path may become easier to follow by future researchers.
REFERENCES


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