

Near Misses in Slot Machine Gambling Developed Through Generalization of Total Wins

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Abstract The purpose of the present study was to evaluate the development of the near miss effect in slot machine gambling as a product of stimulus generalization from total wins. The study was conducted across two experiments. Twelve college students participated in the first experiment, which demonstrated that greater post-reinforcement pauses followed losing outcomes that were formally similar to total wins, relative to losing outcomes that were formally dissimilar [$F(5, 7) = 5.24, p = .025$] along a generalization gradient ($R^2 = .96$). Additionally, 11 out of 12 participants showed greater response latencies following near-misses than following total wins. Thirteen college students participated in the second experiment, which demonstrated that symbols that more saliently indicated a loss resulted in lower response latencies than functionally equivalent but visually dissimilar losing symbols [$F(3, 10) = 15.50, p = .01$]. A generalization gradient was observed across winning symbols ($R^2 = .98$), and an inverse of the gradient observed across winning symbols was observed across symbols that were the least formally similar ($R^2 = .69$). The present study replicates and extends previous research on near misses in slot machine gambling, and provides discussion around the clinical utility of such findings on the prevention of problem gambling.

Keywords Near misses · Gambling · Generalization · Discrimination · Slot machine

Introduction

Slot machine gambling has been considered as potentially the most addictive form of gambling behavior (Abbott 2001; Schull 2012). The addictive nature of slot-machine play may be a product of how the specific features of slot machine games interact with the

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illusory gambling cognitions of gamblers, as well as the reinforcement-based learning that occurs during play (Schull 2012; Potenza 2014). One such feature that has garnered considerable scientific attention is the near-miss effect, which has been shown to contribute to the resiliency and pervasiveness of slot machine gambling (ex., Kassinove and Schare 2001; MacLin et al. 2007). Near-misses occur when losses appear close to wins due to the formal proximity of the reel array to a total win (Reid 1986). For example, if three of the same symbol on the line results in a total win on a three reel slot machine, a near miss occurs when two of the same symbol appear on the line and no win occurs. Although near misses are conceptually equivalent to total losses because they are never paired with credit or monetary rewards, near misses are paradoxical because they appear to operate as reinforcers similar to total wins (e.g., Dixon and Schreiber 2004; Kassinove and Schare 2001). Kassinove and Schare (2001) demonstrated that near misses interspersed within play at an appropriate density increase the persistence of slot machine play when wins no longer occur. Cote et al. (2003) replicated these results by demonstrating that near-misses also effect gambling persistence on video lottery terminals. Casinos have capitalized on the near miss phenomenon by introducing near misses at a greater density than would be predicted by chance alone (Griffiths 1991; Reid 1986), and neurophysiological evidence suggests that near misses are particularly salient for problem gamblers when compared to non-problem gamblers (Habib and Dixon 2010).

Understanding how the near-miss effect is developed across all relevant levels of analysis may contribute to preventative intervention aimed at decreasing the impact of near-misses on the development of problem gambling. Attempts at understanding the development of the near-miss effect have largely been centered at the neurological and cognitive levels of analysis (Foxall and Sigurdsson 2012). At the neurological level, near miss outcomes during slot machine play have been shown to result temporary changes in the central nervous system similar to those observed following winning outcomes (e.g., Clark et al. 2009; Habib and Dixon 2010). Habib and Dixon (2010) demonstrated that near-misses result in changes in the left midbrain near the substantia nigra and the ventral tegmental area. Clark et al. (2009) demonstrated that near misses activate the ventral striatum and the anterior insula. Also, Clark et al. (2011) demonstrated that near-misses result in increased electrodermal activity and heart rate analogous to increases that occur during a win. At the cognitive level, the near-miss effect has been shown to involve several cognitive distortions, including the belief that near-miss are closer to wins (Dixon and Schreiber 2004), the illusion of control (Langer 1975; Clark et al. 2011), distorted thought patterns (Ladouceur and Walker 1996; Clark 2010), the belief that wins are somehow closer in temporal proximity following near-misses (Griffiths 1991; Parke and Griffiths 2004), and trait gambling cognitions (Billieux et al. 2012). Although examination of the near-miss effect at these levels of analysis is imperative for a complete understanding of the phenomenon, examination at the behavioral level could better inform understanding and treatment of problem gambling.

Skinner (1953) proposed that slot machine gambling is maintained by variable ratios of reinforcement, and suggested that almost hitting the jackpot may also contribute to prolonged slot machine play. More recently, researchers have suggested that primary and secondary reinforcement schedules, as well as temporal and spatial positioning of reel symbols, contribute to the development of the near miss effect (e.g. Hoon et al. 2008). Although such studies demonstrate the ubiquity of the reinforcing value of near misses, they do not allude to how near misses obtain their reinforcing value. Few studies have been conducted that experimentally analyze how structural characteristics effect slot machine play from a behavioral perspective (Peters et al. 2010), but one response pattern that has

been used as a dependent variable in several studies is response latencies (e.g., Schreiber and Dixon 2001; Dixon and Schreiber 2002). Response latencies have been used as an indicator of post-reinforcement pauses, or the time between a reinforcing event and the emission of the next behavior to obtain the next reinforcer. Post-reinforcement pauses have been demonstrated in several animal models of variable-ratio schedules of reinforcement (Felton and Lyon 1966), and research conducted in simulated gambling tasks suggest that response latencies systematically increase with increased magnitudes of wins during slot machine play (Delfabbro and Winefield 1999). Dixon and Schreiber (2004) further suggest that near misses also result in greater response latencies, resembling the response latencies that traditionally follow total wins. Dixon and Schreiber (2004) suggest that the near miss effect may be verbally constructed, whereby two of the same symbol on the line are intuitively more similar to wins than are total losses. Although specific verbal behaviors have been shown to correspond with near misses, there is insufficient evidence to suggest that co-occurring verbal behaviors causally relate to the near miss effect. Another potential explanation of the near miss effect is that the reinforcing value of total wins generalizes to near misses based on the formal similarity of the reel array. Two of the same symbol on a three reel array is formally similar to a total win, and therefore obtains the reinforcing function of total wins. From a respondent perspective, the closer in formal proximity that a stimulus is to one that elicits a respondent response, the more likely the stimulus is to elicit the same response (Bouton 1993). From an operant perspective, it would follow that events that are similar in formal proximity to reinforcing events may come to acquire reinforcing functions.

Therefore, the purpose of the present study was to examine the development of the near miss effect as generalizing from total wins based on the formal similarity of the reel array. The study was conducted across two experiments. The first experiment was conducted to determine if reel arrays would acquire reinforcing value based on their formal similarity to reel arrays that accompany total wins. A first prediction was that response latencies following near-misses would be greater than response latencies following total losses, indicating a greater reinforcing value. A second prediction was, if the near-miss effect is a product of generalization based on formal similarity, then a generalization gradient would emerge as the reel array became increasingly dissimilar from a winning array. A third prediction was that participants would subjectively rate near-misses as closer to wins than they would total losses, and that these ratings would form a gradient similar to that stated in the second prediction. The second experiment was conducted to determine if symbols that were never paired with a win would also obtain reinforcing value based on their formal similarity to winning symbols. A first prediction was that a generalization gradient like that hypothesized in “[Experiment 1](#)” section would emerge based on the number of winning symbols in the reel array. A second prediction was that the reel array with all symbols that were formally similar to the winning symbols would produce greater response latencies than a reel array with all symbols that were formally dissimilar. A third prediction was that an inverse gradient to that described in the first prediction would be observed for symbols that were the most formally dissimilar, where the greatest response latency would be observed when the fewest dissimilar symbols appeared in the reel array. The current study replicates previous research providing a demonstration of the near miss effect, and extends these findings by exploring its development in terms of stimulus generalization, and discusses potential implications to preventative practice in terms of stimulus discrimination.

Experiment 1

Method

Participants

Twelve graduate students, ranging in age from 25 to 34 (3 males, 9 females) participated in “[Experiment 1](#)” section. The participants received extra credit and a probabilistic chance of winning \$50.00 USD based on their gambling credits at the conclusion of the experiment. Each of the participants completed the South Oaks Gambling Screening (SOGS) questionnaire prior to the study. The SOGS is a reliable and valid assessment tool used to detect potential problem gamblers (Lesieur and Blume 1987). The SOGS assesses gambling behavior on a 20-point scale, where scores above five indicate a potential problem gambler. Each of the participants indicated that they had some experience gambling prior to the study, however at the time of the study, none of the participants were problem gamblers according to their SOGS scores. As in the study conducted by Dixon and Schreiber (2004), problem gamblers were not included in the study due to the potential risk that playing the simulated slot machine game could potentially results in relapse symptoms. In addition, the contribution of near-misses to the persistence of slot machine play of non-problem gamblers has been well documented in the literature (e.g., Dixon and Schreiber 2002; Schreiber and Dixon 2001).

Setting and Materials

The participants completed the study in their homes using a simulated slot machine program designed on Microsoft Visual Studio 2013. The interface of the slot machine program is displayed in Fig. 1. A simulated slot-machine program was used because previous research has suggested that computerized slot-machines can effectively demonstrate relationships between gambling stimuli and gambling behavior, while allowing the researcher to experimentally manipulate game variables (MacLin et al. 1999; MacLin and

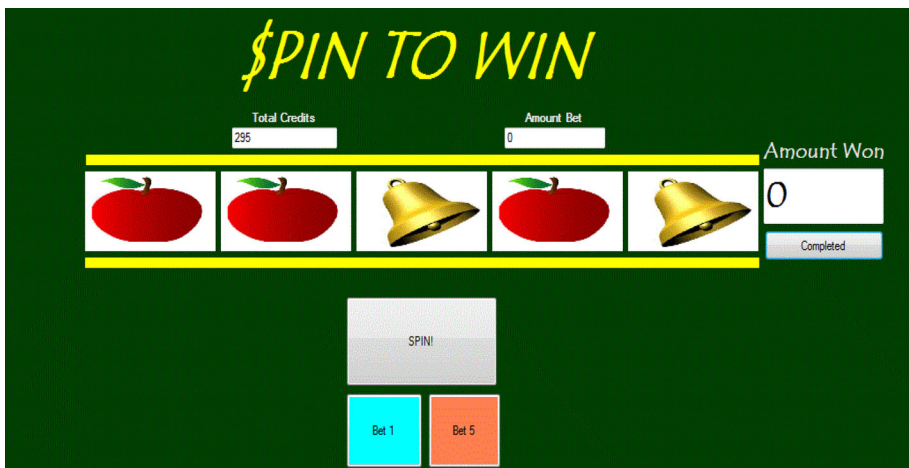


Fig. 1 User interface of the simulated slot machine program in “[Experiment 1](#)” section

Dixon 2004). To access the slot-machine program, the participants retrieved the program through a Dropbox folder and installed the contents onto their home computer. For a detailed description of how to design slot machine programs on Microsoft Visual Basic, see Dixon and MacLin (2003).

The simulated slot machine in the present study included five reels, the participants total credits, the amount that the participants bet, the amount that the participants won, two bet allocation buttons (1 credit and 5 credits), and a spin button. There were two symbols that could appear on the reels, apples (S+) and bells (S–), and no other symbols appeared in the game. In the present setup, only five S+ on the line resulted in a payout of ten times the amount bet. The program automatically recorded the trial number, the position of each of the reels, the amount of credits bet, the amount of credits won, the current amount of credits, and the response latency of each trial. Response latency was defined as the time from when the reels stopped spinning to the participants placing their next bet. Outcomes were preprogrammed into the game for two reasons. The first was to ensure that each possible outcome type occurred an equal number of times throughout the game. The second was to ensure that each of the participants underwent the same experiment, including the presentation order of winning, losing, and near miss outcomes. The specific order of the outcomes was decided using a random number generator, and entered into the computer program prior to the study.

Procedure

The program began by having the participants complete the SOGS survey. Following the completion of the survey, the participants were presented with the following instructions:

All of your points at the end of the game will be entered into a draw for \$50.00. The more points you have, the better chance you have of winning. You will begin the game by pressing the ‘continue’ button located at the bottom of the screen. The game will consist of 40 spins. You may either bet 1 credit or 5 credits on each spin, and you will begin the game with 300 credits. Good luck.

After reading the instructions, the participants clicked continue and began the game. The slot-machine program consisted of forty spins, and the order in which the symbols appeared on the line throughout the game was held constant across participants. This was done to control for idiosyncratic schedule effects across participants (Harrigan and Dixon 2010). The specific reel combination order was randomly selected using a random number generator, and random-ratio 5 (RR5) schedule of reinforcement was used. Each of the participants completed all trials.

The game began by having the participants bet either 1 credit or 5 credits and pressing the spin button. The reels spun for 2.34 s and displayed a combination of S+ and S–. If 5 S+ appeared on the line, then the participants won 10 times the amount bet. No other combination of reel symbols resulted in a win. A text box then was displayed below the reel array asking the participants how close their spin was to a win. The independent variable was the number of S+ on the line, as apples were the only symbol that was ever paired with a credit reward. The dependent variables were response latency as an indication the post reinforcement pause and perceived closeness to a win. Response latency was measured as the time from when the reels stopped spinning to the participant placing a bet. All methods and procedures used in both recruitment and implementation of the present experiment were approved by the Southern Illinois University—Carbondale Human Subjects’ Committee.

Results

The results from “Experiment 1” section are summarized in Figs. 2, 3, and 4. Figure 2 shows each participants’ mean response latency following total losses, near misses, and total wins. The mean response latency was calculated by finding the sum of the response latencies following each outcome type, divided by the number of trials associated with each outcome type, multiplied by 100. Total losses occurred when zero apples (S+) and five bells (S-) appeared on the line, near misses occurred when four apples (S+) and one bell (S-) appeared on the line, and total wins occurred when five apples (S+) and zero bells (S-) appeared on the line. In line with the first prediction, the data suggest that 11 of the 12 participants demonstrated greater response latencies following near-misses than following total losses. The data also suggest that 9 of the 12 participants demonstrated greater response latencies following total wins than total losses, and 0 of the participants showed the greatest response latency following total losses compared to the remaining outcome types. Figure 3 shows the mean response latency aggregated across participants, based on the number of apples (S+) that appeared on the line. Conceptually, as fewer apples (S+) appeared on the line, the reel array became increasingly formally dissimilar to that which was paired with a total win (i.e., 5 S+). The data support the previous literature suggesting that total wins resulted in the highest response latency ($M = 4.88$, $SD = 1.40$), and near-misses resulted in greater response latencies ($M = 4.76$, $SD = 1.17$) than total losses ($M = 3.86$, $SD = 1.16$). A Repeated Measures ANOVA was conducted to determine if there were differences in response latencies across the levels of S+’s on the line. The obtained data yielded significance [$F(5, 7) = 5.24$, $p = .025$]. An LSD post hoc analysis yielded pairwise comparisons across groups of S+ on the line. The obtained data yielded significant differences between total wins (5 S+) and 2 ($p = .003$), 1 ($p = .01$), and 0 ($p = .004$) S+ on the line. There were no significant differences between total wins and 4 ($p = .314$) and 3 ($p = .087$) S+ on the line. Figure 4 shows a cubic curve function fit to the mean latency aggregated across participants. The cubic function provided a strong fit for the generalization gradient ($R^2 = .91$). The nature of the cubic function is such that

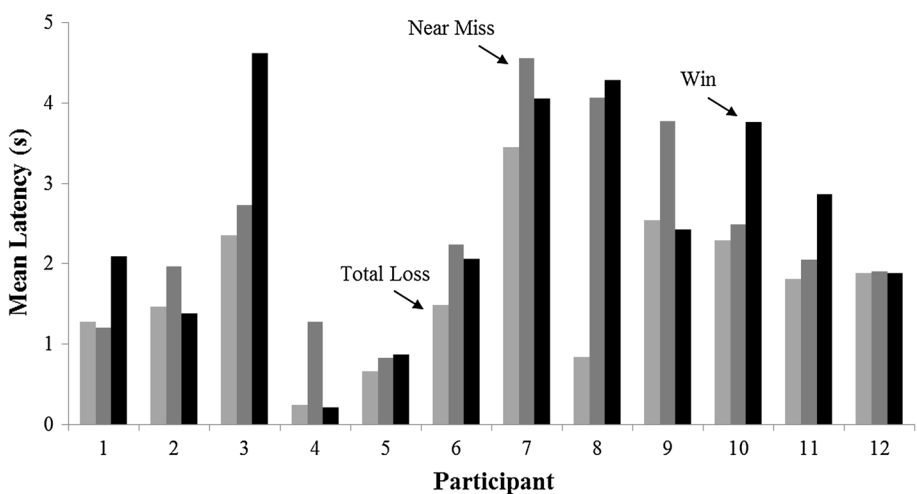


Fig. 2 The mean response latency across total loss (0 S+, 5 S-), near miss (4 S+, 1 S-), and total win (5 S+, 0 S-) trial types for each participant

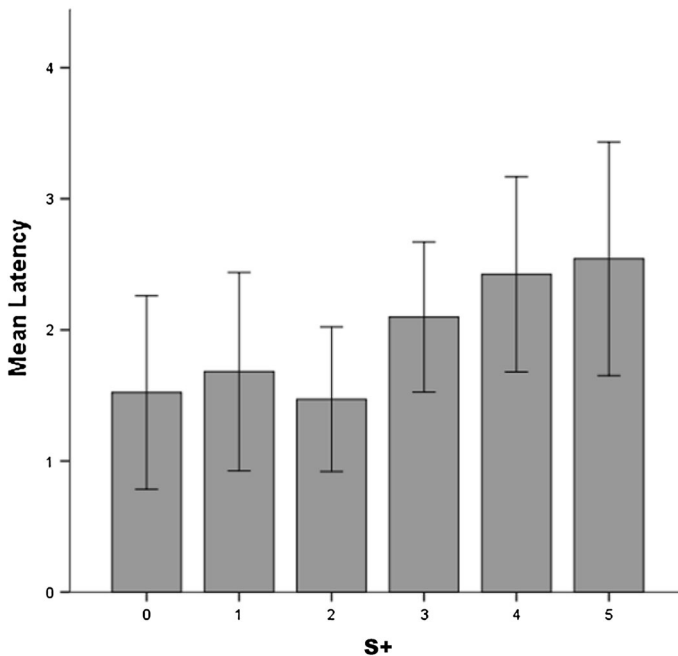


Fig. 3 Mean latency aggregated across participants, across the number of apples (S+) on the line. Error bars represent 95 % confidence intervals

around 3 S+ on the line, there is a steady increase in response latency toward a maximum response latency when 5 S+ appeared on the line. Figure 5 shows the median closeness to a win rating across the number of S+ on the line. No differences were observed across win ratings as a function of varying the reel arrays [$F(5, 7) = 1.09, p = .44$]. Because there were no significant differences in subjective closeness to a win across S+ on the line, no further analyses were conducted.

Discussion

The results from “[Experiment 1](#)” section replicate the results from previous literature that near misses may be more reinforcing than total losses, despite never being paired with credit reward. Dixon et al. (2012) presented data suggesting that the near miss effect was observable via skin conductance analyses but not through post-reinforcement pauses. The present data, however, show that near misses did result in longer post-reinforcement pauses, which is in line with the results shown by Dixon and Schreiber (2004). The present data failed to replicate Dixon and Schreiber’s (2004) demonstration of the near miss effect through estimated closeness to a win, but the procedure used in the present study was different from the procedure used in previous research. Specifically, the participants were required to rank each spin on the computer rather than on a tangible document, which by decreasing the effort required to rate each spin may have also encouraged careless responding. Although such an explanation does not appear in the present data, median closeness to a win rankings do suggest that the participants did not rate total wins as any closer to a win than total losses, suggesting an error in the experimental design or apparatus rather than results that run contra the previous literature on subjective ratings of closeness to a win.

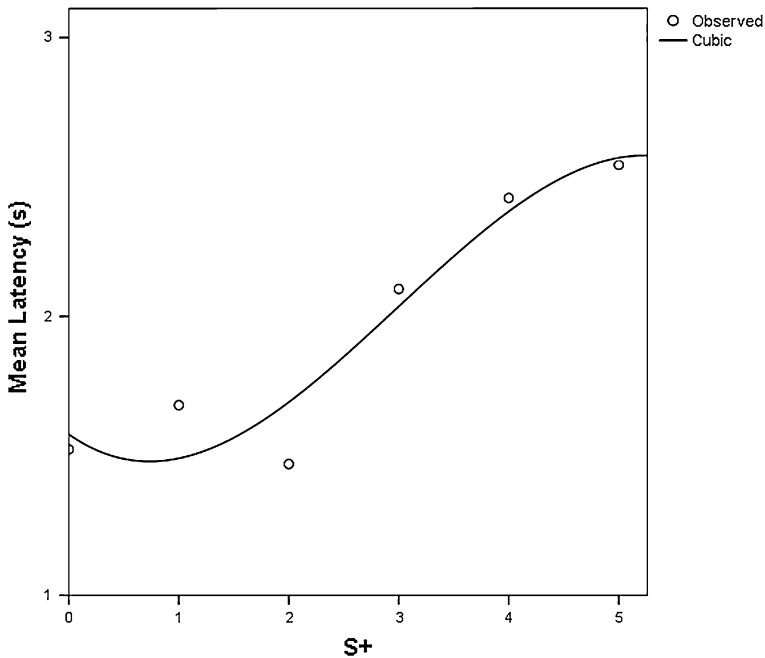


Fig. 4 Mean latency aggregated across participants. *Open circles* represent the mean latency (s) across the number of apples (S+) on the line. The *fit line* represent a cubic curve function fit to the mean aggregated latency across participants

The results from “[Experiment 1](#)” section extend previous research in two ways. First, the near-miss effect was replicated on a five reel slot machine, where previous research had primarily demonstrated the occurrence of the near-miss effect on a three reel slot machine. The use of a five reel slot machine allowed for a comparison of near-misses that were formally similar (i.e., 4 S+, 1 S–), rather than other forms of near misses that may have been conceptually more similar (i.e., 0 S+, 5 S–). Second, the present arrangement allowed for the demonstration of a generalization gradient across the number of S+ on the line. A generalization gradient is typical when evaluating progressively more dissimilar stimuli, and suggest that stimulus generalization may have occurred. As 5 S+ on the line signaled a total win, the reinforcing effect of 4 and 3 S+ on the line appears to have generalized reinforcing value shown through higher response latencies than total losses. There was no significant difference in the response latencies associated with 3 S+ and 4 S+ on the line compared to total wins, however there was a significant difference between total wins and 2 S+, 1 S+, and 0 S+. This corresponds with the cubic function fit to the mean latencies aggregated across participants. Although an exponential or Gaussian function has typically shown a strong fit in studies of stimulus generalization (see Ghirlanda and Enquist 2003), the cubic function likely provided a strong fit for the data in “[Experiment 1](#)” section due to a lack of generalization from total wins to 2 S+ , 1 S+ , and 0 S+ on the line. The cubic function further supports the generalization of the winning reel array to 4 S+ and 3 S+ on the line. Although the data support the generalization of total wins to near misses, an alternative hypothesis could equally explain the results obtained in “[Experiment 1](#)” section. The results could be explained through a negative reinforcement paradigm (Hineline 1977), whereby total losses create an aversive condition that motivates participants to more rapidly progress

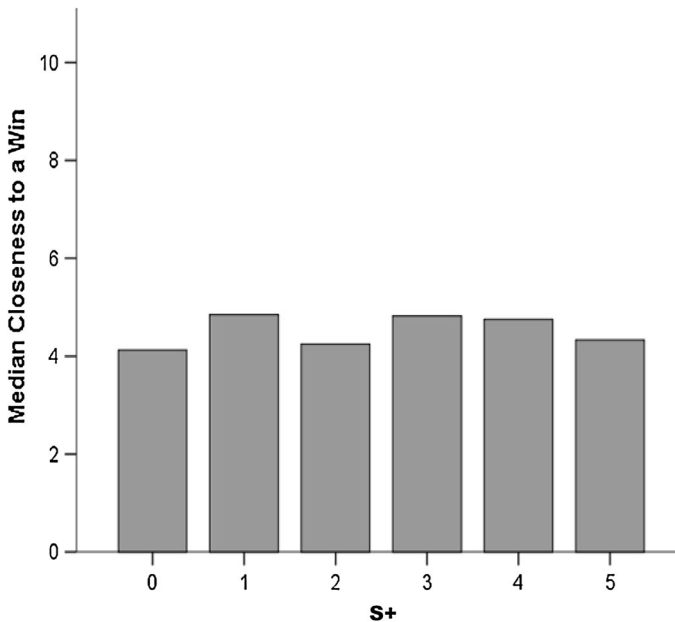


Fig. 5 Median closeness to a win ratings aggregated across participants, across the number of apples (S+) on the *line*

to the next spin. Because only two reel symbols were used, 5 S–'s on the line would suggest a total loss, and a gradient would equally exist from 0 SR–'s through 2 SR–'s as the inverse of the results shown in Fig. 3. Therefore, a second experiment was conducted to determine if using two different symbols as S– would produce differential effects on response latency, despite the fact that both of the S– symbols are functionally equivalent, as each indicate a loss. Differential effects across S– symbols would suggest that the formal differences between the symbols yield differences in participant responding. As such, one of the symbols was formally more similar to the winning symbol. If an inverse gradient was observed across the number of formally dissimilar S– symbols, this would lend support to the negative reinforcement paradigm explaining the results in “[Experiment 1](#)” section. An inverse gradient across different symbols would suggest that, not only do the effects of total wins generalize from S+, but the effects of total losses may also generalize from S–. Failure to produce an inverse gradient across S– would suggest that stimulus generalization from S+ may be an independent process, and the formal similarity of S–'s has minimal effect on the development of the near miss effect.

Experiment 2

Method

Participants

Thirteen undergraduate students (2 males, 11 females), who were enrolled in an on-campus staff training course, participated in the second experiment. The participants were recruited

by the authors of the study, and also received extra credit and a probabilistic chance to win \$50.00 USD based on their gambling credits at the end of the study. Each of the participants completed the South Oaks Gambling Screening (SOGS) questionnaire prior to the study. Each of the participants indicated that they had some experience gambling prior to the study, however at the time of the study, none of the participants were problem gamblers according to their SOGS scores. As in “[Experiment 1](#)” section, problem gamblers were not included in the study due to ethical considerations and a precedent of using non-problem gamblers in studies on the specific nature of the near-miss effect.

Setting and Materials

The participants completed the study in a 10' × 4' room on campus using a simulated slot machine program similar to the program used in “[Experiment 1](#)” section of the present study. The participants played the game on a 13" HP Pavillion laptop computer. The user interface of the simulated slot machine is displayed in Fig. 4. The slot machine included three reels; the participants' total credits, the amount that the participants bet, the amount that the participants won, two bet allocation buttons (1 credit and 3 credits), and a spin button. Unlike in “[Experiment 1](#)” section, there were three symbols that could appear on the reels—apples (S+), bells (S–a), and blanks (S–b). Like in “[Experiment 1](#)” section, only all S+ on the line resulted in a win, and all other combinations resulted in a loss. The slot machine program automatically recorded the trial number, the position of each of the reels, the amount of credits bet, the amount of credits won, the current amount of credits, and the response latency as an indicator of the post reinforcement pause. Again, response latency was defined as the time from when the reels stopped spinning to the participant placing a bet. As well, outcomes were programmed into the study in the same manner as that presented in “[Experiment 1](#)” section.

Procedure

The program began by having the participants complete the SOGS survey. Following the completion of the survey, the participants read instructions that were identical to the instructions in “[Experiment 1](#)” section, except that the game consisted of fifty spins. Again, the order in which the symbols appeared on the line throughout the game was held constant across participants. This was done to hold the order constant for all of the participants to control for the sequence of the reel combinations as a source of variability. The specific reel combination order was randomly selected using a random number generator. Each of the participants completed all trials.

The game began by having the participant place a bet—either 1 credit or 3 credits. Once they placed the bet, they pressed the spin button. The reels spun for 1.4 s and displayed a combination of apples, bells, and/or blanks. If 3 S+ appeared on the reel array, the participants won 10 times the amount bet. Again, no other combination of symbols within the reel array resulted in a win, even if all of the reel symbols were either S–a or S–b. The independent variables were the number of S+'s and S–'s on the line. Only response latency was used as a dependent variable because perceived closeness to a win failed to yield significant results in “[Experiment 1](#)” section. All methods and procedures used in both recruitment and implementation of the present experiment were approved by the Southern Illinois University—Carbondale Human Subjects' Committee.

Results

The results from “[Experiment 2](#)” section are summarized in Figs. 6, 7, 8, 9, 10 and 11. Figure 6 shows the mean response latency across the number of apples (S+) on the line. The results replicate the results from “[Experiment 1](#)” section, as the greatest response latency was associated with total wins ($M = 4.61$, $SD = .82$), and a gradient occurred as fewer S+ appeared on the line. The results from a Repeated Measures ANOVA suggested that the differences across the number of S+ on the line were significant [$F(3, 10) = 14.47$, $p = .01$], and an LSD post hoc analysis suggested that there was a significant difference between total wins and total losses ($p = .039$). Figure 7 shows an exponential curve function fit to the mean latency aggregated across participants. The exponential function provided a strong fit for the generalization gradient ($R^2 = .98$). The exponential curve showed an increasing trend toward a maximum latency when 3 S+ appeared on the line. Figure 8 shows the mean response latency across the number of bells (S–a) on the line. There appeared to be no relationship between the number of SR-b on the line, and the results from a Repeated Measures ANOVA suggested that the differences across the number of S–’s was not significant [$F(3, 10) = .07$, $p = .97$]. Figure 9 shows an exponential curve function fit to the mean latency aggregated across participants. The exponential function provided a weaker fit for the data than that provided in the previous analyses ($R^2 = .60$). The exponential curve showed a stable trend across S–a on the line. Figure 10 shows the mean response latency across the number of blanks (S–b) on the line. The results suggest that the greatest mean response latency was associated with 1 S–b on the line ($M = 4.58$, $SD = .74$), and the lowest mean response latency was associated with 3 S–b on the line ($M = 3.55$, $SD = .78$). Visual analysis of the data suggest an inverse gradient, whereby a greater number of S–b on the line result in lower response latencies. The results of a Repeated Measures ANOVA suggested that the differences between the number of SR-b on the line was statistically significant [$F(3, 10) = 15.50$, $p = .01$], and



Fig. 6 User interface of the simulated slot machine program in “[Experiment 2](#)” section

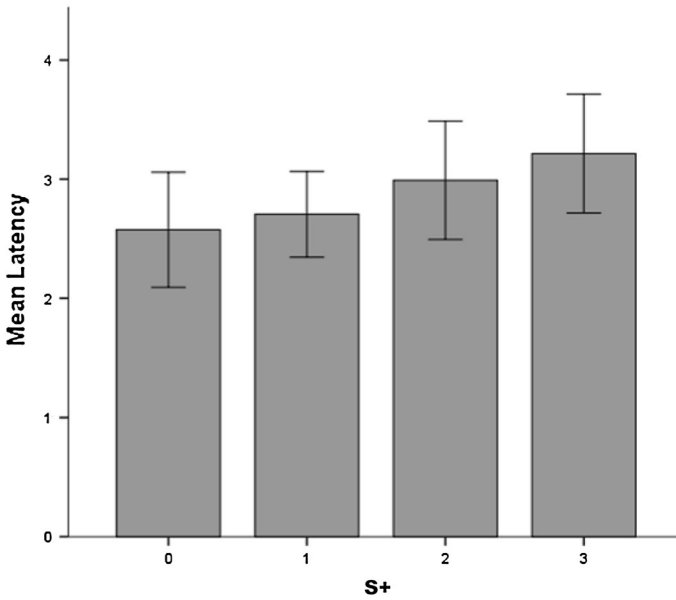


Fig. 7 Mean latency aggregated across participants, across the number of apples (S+) on the line. Error bars represent 95 % confidence intervals

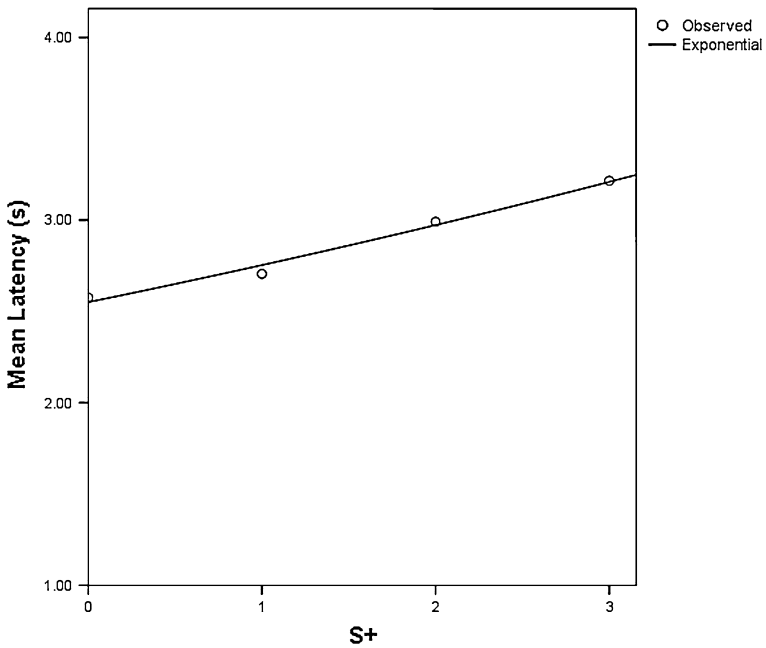


Fig. 8 Mean latency aggregated across participants. Open circles represent the mean latency (s) across the number of apples (S+) on the line. The fit line represents an exponential curve function fit to the mean aggregated latency across participants

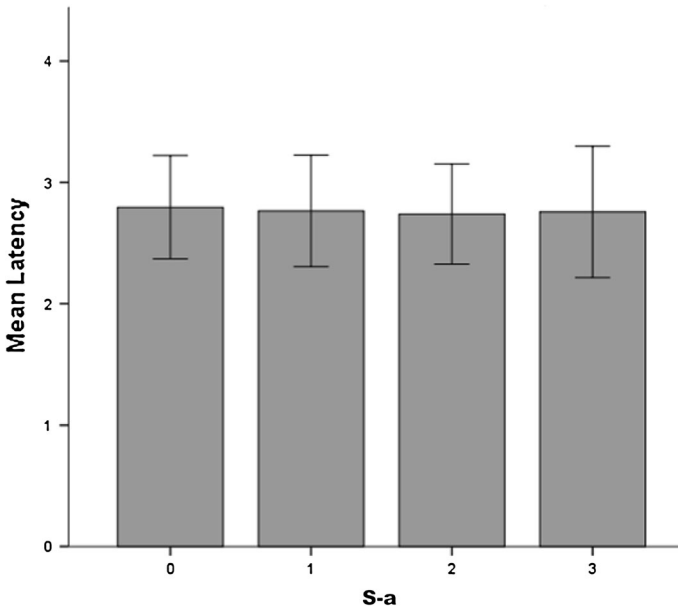


Fig. 9 Mean latency aggregated across participants, across the number of bells (S-a) on the line. Error bars represent 95 % confidence intervals

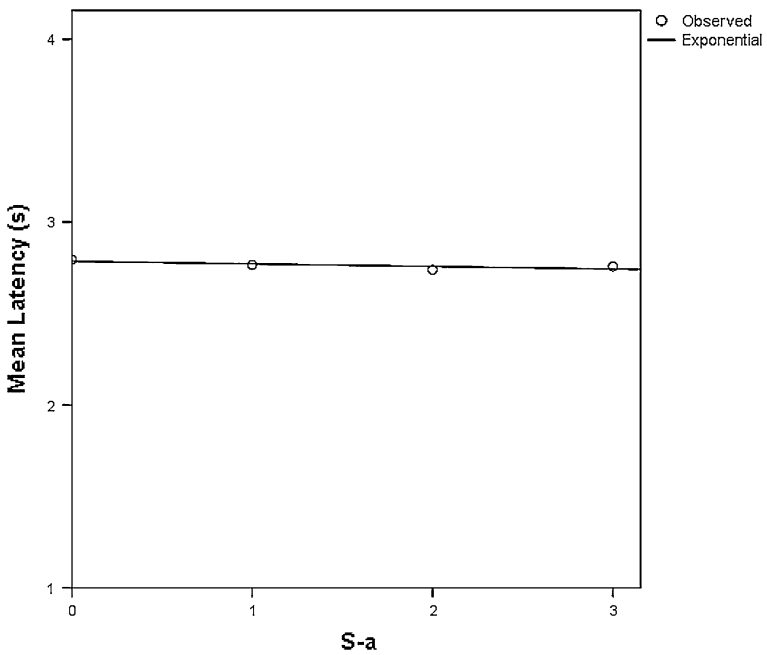


Fig. 10 Mean latency aggregated across participants. Open circles represent the mean latency (s) across the number of bells (S-a) on the line. The fit line represents an exponential curve function fit to the mean aggregated latency across participants

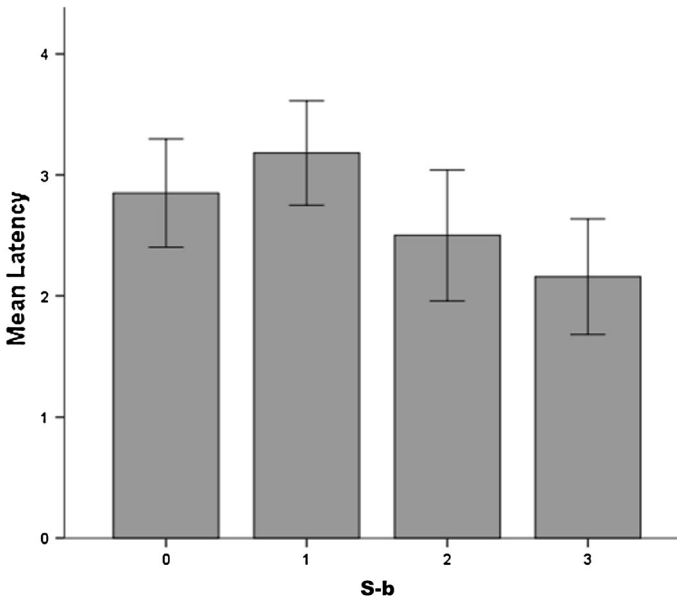


Fig. 11 Mean latency aggregated across participants, across the number of blanks (S+) on the line. Error bars represent 95 % confidence intervals

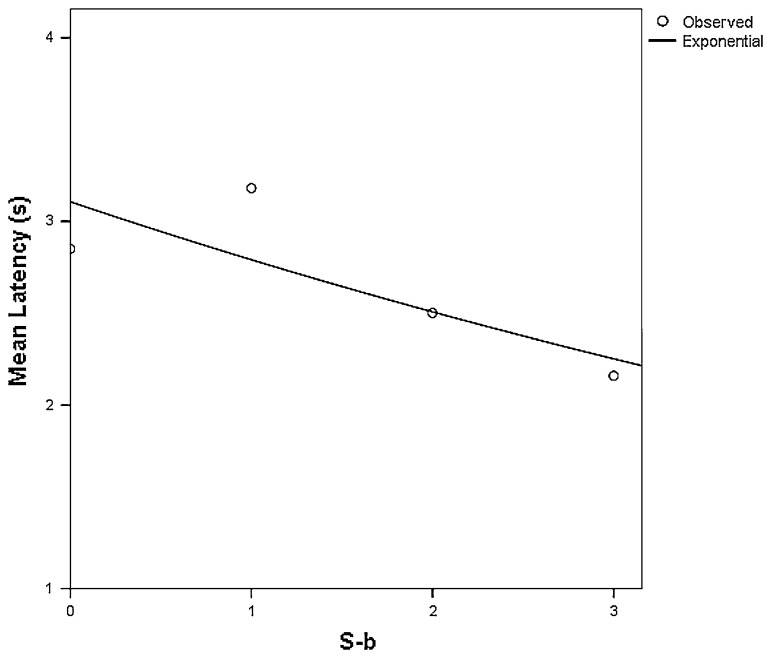


Fig. 12 Mean latency aggregated across participants. Open circles represent the mean latency (s) across the number of blanks (S–b) on the line. The fit line represents an exponential curve function fit to the mean aggregated latency across participants

an LSD post hoc analysis suggested that total wins was a difference between 3 S–b on the line and 0 S–b ($p = .03$) on the line. Figure 11 shows an exponential curve function fit to the mean latency aggregated across participants. The exponential function provided a weaker fit than that for S+ on the line ($R^2 = .69$), similar to the fit provided S–a on the line. The exponential curve showed the inverse trend associated with S+, as the latency appeared to gradually decrease with successive S–b on the line (Fig. 12).

Discussion

The results of “Experiment 2” section replicate the results of “Experiment 1” section by demonstrating a generalization gradient across the number of SR+ on the line. Like in “Experiment 1” section, the post reinforcement pause was lower the further that the reel array deviated from a total win. Unlike in “Experiment 1” section, an exponential curve function was fit to the data, which is more typically found in the behavioral generalization literature (Ghirlanda and Enquist 2003). To determine whether this gradient resulted from the generalization of total wins, or if this gradient resulted from the generalization of total losses, 2 S– symbols were used (i.e., bells and blanks) were used. In “Experiment 2” section, no gradient was observed across the number of S–a on the line, however, an inverse of the generalization gradient observed across S+ was observed across S–b. S–a and S–b are functionally equivalent as neither has been paired with a win and both equally signal a loss. Despite being functionally equivalent, the two symbols had different effects on the participants’ mean responding. The only difference between S–a and S–b are their formal properties (i.e. bells and blanks), and this differentially affected the participants’ responding. One explanation of these results may be that S–a are more formally similar to S+ than are S–b, as S–a contains an object and background similar to S+. Because of the greater degree of formal dissimilarity between S–b and S+, S–b may have more saliently indicated a loss and resulted in the effect predicted by Himeline (1977). The inverse gradient observed across S–b support the negative reinforcement paradigm as an explanation for the observed results.

General Discussion

The results from the present study replicate previous literature suggesting that the near miss effect is detectable through response latencies, and extends upon previous literature by suggesting that the near miss effect may result from the generalization of total wins and the visual saliency of losing reel arrays. The combined effects of the reinforcing nature of wins and the aversive nature of losses appear to culminate in a gradient that may explain the development of the near miss effect in slot machine gambling from a behavioral perspective. Several explanations exist alluding to events happening within the organism, such as the verbal construction of near-misses (Dixon and Schreiber 2004), and the present data may explain the environmental factors that may result in the verbal behaviors that have been shown to accompany near-misses.

The erroneous belief that near-misses are closer to wins than are total losses may be the result of stimulus generalization, and the results presented here could have specific implications in terms of reducing the effects of near-misses on the development of problem gambling. Because stimulus generalization appears to have an effect on the development of the near-miss effect, approaches aimed at promoting stimulus discrimination may have the

inverse effect. In behavioral terms, stimulus discrimination is the opposite of stimulus generalization. In stimulus generalization, stimuli that are formally similar may come to elicit equal or near equal responses. The present data suggest that the formal similarity of near-misses come to elicit near-equal response latencies when compared to total wins, relative to total losses. Stimulus discrimination, on the other hand, occurs when a participant responds differentially to stimuli despite potential formal similarities. In the case of preventing the development of the near-miss effect, interventions aimed at encouraging participants to discriminate between wins and near-misses may have great utility in the prevention of problem gambling. Kassinove and Schare (2001) demonstrated that when the prevalence of near misses are too dense, they lose their effectiveness. In light of the present data, repeatedly pairing near-misses with the absence of credit reward may result in the participant discriminating between near misses and total wins. Another approach may involve using the verbal behaviors that accompany near misses to encourage gamblers to appropriately discriminate between near misses and wins. Indeed, research conducted by Nastally and Dixon (2012) has shown that a single session of acceptance and commitment therapy (ACT) was sufficient to reduce participants' subjective ratings of the closeness of near-misses to total wins. ACT and other therapeutic approaches grounded in mindfulness encourage participants to attend to the immediate contingencies in their environment rather than all of the cognitions and language surrounding the events. The effects observed in the study conducted by Nastally and Dixon (2012), when considered alongside the results of the present study, suggest that a general approach grounded in mindfulness may be sufficient to encourage discrimination of near-misses from total wins.

Despite the results, the present study had several limitations. First, graduate and undergraduate students who did not have a history of problem gambling participated in the study. Data from Habib and Dixon (2010) suggest that near misses have stronger effects on problem gamblers than non-problem gamblers based on corresponding neurological changes. Although significant findings were observed with students, the applicability of these findings with pathological gamblers must be assessed. A second limitation is the contrived nature of the simulated slot machine task. Only two symbols were used in “[Experiment 1](#)” section and only three symbols were used in “[Experiment 2](#)” section. The purpose of the present study was to experimentally isolate reel arrays in terms of their reinforcing value, and the setup of the present study accomplished this aim at the risk of reducing the external validity of the present results. Future research could expand upon the results of the present study in several ways. First, future research could evaluate the interactive effects of near-misses and language. The correspondence between verbal behavior and the near miss effect is well documented; however, the correspondence between generalization, verbal behavior, and categorization of near misses as losses and wins could better inform the prevention and treatment of problem gambling. Studies have reported that individuals are more likely to rate near-misses as closer to total wins than losses, which demonstrates how language may interact with the generalization of reinforcement effect from wins to near misses. The degree to which teaching individuals to discriminate between near misses and wins reduces the persistent nature of slot machine play, however, has not been experimentally examined. Another avenue for future research may be to examine how mindfulness, or the ability to separate language from the contingencies present in the immediate environment, relates to the development of problem gambling. If mindfulness based approaches improve participants' abilities to discriminate between near-misses and total wins, and the near miss effect is related to problem gambling, then it may follow that mindfulness more generally could prevent some aspects of the development of problem gambling.

In summary, problem gambling is an epidemic, and there are numerous variables that contribute to its development. The near miss effect is one of those factors, and the present data suggest that generalization from total wins may contribute to its effect. As we scientifically move towards a more refined understanding of the events that encourage problem gambling, we may begin to move towards a more parsimonious prevention and treatment of this socially valid issue.

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