Discriminative and Reinforcing Effects of the Near Miss in Simulated Slot Machine Play

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Abstract

The near miss in slot machine gambling may be described as two of three winning symbols aligning on the pay line and usually is responded to as a form of feedback for the individual who is participating in various types of games. For gambling, the near miss does not actually provide such feedback, and, therefore, it is thought that a near miss may contribute to prolonging play. Behavior analytic research has been interested in this supposed phenomenon for some time and has looked to explore the proposed conditioned reinforcing effects of the near miss using the S-S and S-R hypotheses (Hendry, 1969). Experiment 1 examined the reinforcing effects of a near miss that has been paired with a win to facilitate acquisition of conditioned reinforcing properties and unpaired with a win (instead, paired with a loss) to simulate extinction conditions with a six-component counterbalanced reversal design. Experiment 2 examined the discriminative effects on betting behavior when a near-miss is paired and unpaired with a win. Frequency and total time measures suggest that in neither experiment did the near miss come to function as a conditioned reinforcer. Average response latency measures in Experiment 1 showed clear delineation between win outcomes in comparison to near-miss and full loss outcomes. Further, for some participants in Experiment 2, a higher percentage of betting occurred following a near miss outcome in the explicitly paired conditions. The implications of these data, limitations of the experimental preparation, and areas for future research will be discussed.
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The number of people who regularly gamble in the United States and abroad has increased dramatically over the past two decades (United States Commercial Casino Revenues, 2016). The impetus is widely attributed to the rise in legalized gambling throughout the United States in the 1990s (United States Commercial Casino Revenues, 2016). The number of people who experience problems controlling their level of play is at a record high as well and so, too, is number of prevention and treatment programs available to help people cope with the personal and social consequences of problem and pathological gambling (Dixon, Whiting, Gunnarsson, Daar, & Rowsey, 2015).

The volume of research on gambling has grown as well. Why people start gambling, how they develop preferences and beliefs about certain games and what leads some but not others to become pathological gamblers are among the most often asked research questions. As expected, the answers differ on the basis of the theory of gambling a researcher favors. There is no shortage of options, which range from orthodox psychoanalytic theory to operant learning theory (Ghezzi, Wilson, & Porter, 2006). The present research is based on operant learning theory (Pierce & Cheney, 2013).

The most popular game among casino gamblers, the slot machine, is also the game favored by behavior analytic researchers who, after Skinner (1953), regard the machine as a prototype operant research environment: a repeatable, relatively homogeneous response, a contingent, nearly immediate consequence, and a well-established and insatiable motive, winning money. This collection of variables leads naturally to this central question for behavior analysts: How is an individual’s slot machine play affected by the prevailing contingencies of reinforcement?
The present research is given to how slot machine play is affected by a type of loss known as a “near miss.” The working assumption is that “nearly winning” can increase the frequency or duration of play and that the process by which this occurs is conditioned reinforcement. What this means in theory and how the near miss is researched in the human operant gambling laboratory is discussed in the following section.

**Theory and Research on the Near Miss**

Questions regarding the conditioned reinforcement properties of the near miss are posed within the context of a general theory of conditioned reinforcement (e.g., Hendry, 1969). The near miss, in this context, is viewed in one of two ways. One view starts with the observation that a formal relationship exists between a winning display (e.g., three identical symbols along a horizontal payline of a three-reel slot machine) and a losing display that “nearly misses” a win (e.g., two winning symbols on the payline on the first and second but not on the third reel). The similarity in the form of a winning display to a losing display, in this view, is how a near miss becomes a conditioned reinforcer. Hendry called this the “S-S hypothesis” of conditioned reinforcement, “to emphasize the operation (stimulus pairing) that is held to be crucial for the establishment of conditioned reinforcement” (p. 12). The “pairing” in the case of near miss is achieved on the basis of the similarity it shares with the form of a win.

The second view of the near miss centers on what Hendry (1969) called the “discriminative stimulus hypothesis” of conditioned reinforcement. A near miss, in this view, must first become a discriminative stimulus for a win before it can function as a conditioned reinforcer. Hendry (1969) termed this the “S-R hypothesis” to emphasize
that, “a reinforced response has to occur in the presence of the stimulus to make the stimulus a conditioned reinforcer” (p. 13).

The difference between the two hypotheses is that the S-R hypothesis maintains that a stimulus must gain discriminative control over a response before it acquires a conditioned reinforcing function, whereas the S-S hypothesis states that a stimulus becomes a conditioned reinforcer by being paired with an established reinforcer. This pairing is achieved in near miss research by relating the form of a win (the established reinforcer) to the form of a near miss (the putative conditioned reinforcer).

We turn first to the S-S hypothesis and near miss research and, following that, to near miss research and the S-R hypothesis.

**The S-S hypothesis and near miss research.** Skinner’s views on the near miss are consistent with the S-S hypothesis. “By paying off very generously—with the jackpot—for three bars,” wrote Skinner, “the device eventually makes two bars plus any other figure strongly reinforcing” (1953, p.397). This point of view has dominated near miss research for decades.

A test of the S-S hypothesis starts by assembling a putative conditioned reinforcer from parts of an established reinforcer. Putting the same two bars on a single payline from a winning display of three bars along the same payline, for example, and then testing for the effects of the two bars is standard practice. Importantly, three winning symbols do not simply occur on the payline, they occur in succession on the payline, from left to right, one after the other. Assembling a conditioned reinforcer, then, involves slightly altering a winning display by placing combinations of winning symbols and
successions of winning symbols on, above and below a payline and then testing for the conditioned reinforcing properties of the various displays.

There are two ways to test for a near miss effect, traditional and nontraditional. The traditional test identifies a conditioned reinforcer by an increase in the frequency or duration of the response(s) on which the reinforcer is contingent. A near miss effect, on this view, is identified when the frequency or duration of slot machine play increases over time as a consequence of producing a given display.

The nontraditional test relies on rating scales to identify a near miss effect. A study by Dixon and Schreiber (2004) represents the approach. Participants were asked to rate on a scale of 1-10 how near in appearance they thought a given loss was to a win. The consensus was that a display of winning symbols landing in succession on the first and second reels and the second and third reels along a horizontal payline of a three-reel slot machine appeared closer to a win than symbols which fell in succession on the first and third reels along a payline. The former display constitutes a near miss effect but not the latter display, which is regarded simply as a loss.

The nontraditional approach is further represented in a study by Habib & Dixon (2010). A group of 22 pathological and non-pathological gamblers viewed various displays and rated each one on the basis of how close it appeared to a winning display. The results both confirmed the finding reported by Dixon and Schreiber (2004) for non-pathological gamblers and extended it to pathological gamblers.

Habib and Dixon (2010) also took measures of brain activity while the gamblers, lying on their backs inside an fMRI scanner, viewed and rated the various displays through a mirror attached to the inside of a head coil. Habib and Dixon discovered that a
winning and a near miss display activated the same regions of the brain, but only in the brains of the pathological gamblers. The brains of non-pathological gamblers, in contrast, were unresponsive to a near miss display.

The main difference between the traditional and nontraditional tests is that the nontraditional test uses subjective ratings and measures of brain activity to identify a near miss effect. The traditional approach identifies a near miss effect when the frequency or duration of play increases over time as a result of the contingency in place between playing the game and the consequences of playing it. “The effect of conditioned reinforcement,” wrote Autor, “is measured by the increment in responding,”(1969, p. 127). This traditional approach contrasts sharply with the nontraditional approach, and, yet, they co-exist in the literature as a “near miss effect.” The present research takes the traditional approach to testing for the near miss effect.

The traditional approach to testing for the near miss effect is represented in an early study by Strickland and Grote (1967). Using a three-reel simulated slot machine, these researchers found that certain successions of the same winning symbols along a payline produced longer playing times compared to other successions. A winning symbol that appeared in succession on the payline of the first and then the second reel of the machine produced longer play, whereas a display of winning symbols in succession on the second and the third reel and the first and third reels produced shorter play.

A series of studies by Ghezzi and his colleagues (Ghezzi, Wilson & Porter, 2006; see also Côté, Caron, Aubery, Desrochers, & Ladouceur, 2003) have since confirmed the play-prolonging effects of a near miss first reported by Strickland and Grote (1967). This near miss effect, obtained with traditional methods and metrics, is consistent with the
near miss effect described by Dixon and Schreiber (2004) and Habib and Dixon (2010) in their nontraditional approach with people who rate a display as a near miss in terms of how close it appears to a winning display. The relevance of that “near miss” to the conditioned reinforcing effects of a “near miss” observed under game playing conditions is that the display rated most highly as a near miss would presumably function as a strong conditioned reinforcer. What the data show is just the opposite: the near miss is a weak conditioned reinforcer.

A study by Ghezzi et al. (2006, Experiment 3) makes this point. High, moderate and low densities of six different forms of near miss displays were compared to a condition in which no near misses were ever displayed. The 120 college students who played a machine spent as much time playing when no near misses were displayed than they did when the near misses were displayed, regardless of their appearance and the density at which they were presented. The data led Ghezzi and his colleagues conclude that the near miss, as a conditioned reinforcer, “is either terribly elusive or grossly overstated as a means of prolonging slot machine play” (2006, p. 168).

This conclusion is limited to one traditional test of the conditioned reinforcement functions of a near miss, however. There are other tests and measures, most notably the observing procedure and the choice procedure. In the observing procedure (Wyckoff, 1952), the strength of a conditioned reinforcer is assessed by the number of responses a participant makes which produce a stimulus correlated with reinforcement (a win) and/or extinction (a loss). In near miss research, an increase in observing a given display with a near miss feature more frequently than some other display(s) without a near miss feature is taken as evidence of conditioned reinforcement. In the choice procedure (Fantino,
1969b), a participant selects one option from at least two options. If the individual selects the first more often than the second, a conditioned reinforcing function is identified for the first relative to the second option. Choosing to play a slot machine with the largest number of near miss displays, for instance, would be considered evidence for a conditioned reinforcement effect.

Witts, Ghezzi & Manson (2015) utilized an observing procedure in which a participant could make a response that revealed whether or not a loss was a near miss. The prediction was that if a near miss is a conditioned reinforcer, observing responses that produced a near miss display more often would increase in frequency compared to observing responses that produced a near miss display less often or never at all. Only a modest amount of observing was seen across a wide range of more-to-less frequent near miss displays. In the light of these data, Witts and his colleagues concluded that the near miss in slot machine play is, in their words, an “inconsequential stimulus.”

In an unpublished study by Schienle and Ghezzi (2014), participants could reveal the display of symbols at the end of a winning, losing or near miss trial at no point cost. Participants observed the near miss displays slightly more often than the ordinary loss displays, and winning displays were seldom observed. When the cost of an observing response was a single point, however, observing dropped to near-zero levels across all three displays, a win, a loss, and a near miss. The findings are consistent with the results reported by Witts et al. (2015) and support the conclusion that the conditioned reinforcing effects of the near miss are nonexistent.

Studies by MacLin, Dixon, Daugherty and Small (2007) and Gyozo and Kormendi (2012) used a choice procedure with participants who played on several
different slot machines, each with its own low, moderate and high density of near miss displays. When given a choice between concurrently available machines, participants in the MacLin et al. study showed a modest preference for the machine with a higher density of near miss displays. Participants in the Gyozo and Kormendi study, likewise, showed a greater preference for higher densities of miss displays. When they were asked to distinguish between the various densities of near miss outcomes, which ranged from 0% to 45% of the total number of losses, participants in the Gyozo and Kormendi study reported that there were no differences. “A near miss,” according to Gyozo and Kormendi, “is hard to perceive but its effect is mediated unconsciously” (p. 110).

The conditioned reinforcement properties of the near miss can be summarized as follows. Slot machine play is only slightly prolonged by the contingent presentation of a near miss display, and very little observing behavior occurs when the consequence is a near miss display. A relatively dense schedule of near miss displays tends to be selected over comparably leaner schedules, yet those who select the dense schedule are unable to distinguish between it and lower density schedules, including a control schedule with no near miss displays. Research from the nontraditional approach shows only that people rate a near miss as close to a win. The assumption that a near miss, in turn, will function as a conditioned reinforcer is not well supported.

It seems reasonable to conclude that a near miss display is a weak conditioned reinforcer and that the “near miss effect” is trivial. A second conclusion is that the S-S hypothesis of how a near miss becomes a conditioned reinforcer could be mistaken. We elaborate on this conclusion in the next section on the S-R hypothesis of conditioned reinforcement.
The S-R hypothesis and near miss research. The S-R hypothesis maintains that a stimulus must first acquire a discriminative function over a response before it acquires a conditioned reinforcing function (Hendry 1969). The newer version of this hypothesis is Fantino’s Delay Reduction Theory (DRT) of conditioned reinforcement (Fantino, 1977; Fantino & Romanowich, 2007; O’Daly, & Fantino, 2003). “A stimulus associated with a smaller average interval until reinforcement,” according to Fantino, “should have a greater conditioned reinforcing strength than a stimulus associated with a larger average interval until reinforcement,” (1997, p 314). In other words, a stimulus will become a conditioned reinforcer once it becomes discriminative for a relatively short delay in time to an established reinforcer. The acquisition of discriminative stimulus control and, in turn, the development of conditioned reinforcement is relative, then, to how close in time the stimulus is to a reinforcer. When this time is short, the stimulus is more likely to acquire these functions than when it is comparably long.

In slot machine play, a display that always precedes a short delay to a win on the very next play should serve both a discriminative and reinforcing function. As a discriminative stimulus, the display should function as an occasion to play; after all, the very next play is a relatively short delay to a guaranteed win. As a conditioned reinforcer, the display should function as a consequence that increases the frequency or duration of play over time.

DRT makes an additional prediction involving the function of a display that always precedes a short delay to a loss on the next play. The display should function as both a conditioned punisher and as a discriminative stimulus for a relatively short delay to an established punisher. As a conditioned punisher, play that produces the display
should decrease in frequency or duration over time. As a discriminative stimulus, play in
the presence of the display should be unlikely; after all, the very next play is a relatively
short delay to a guaranteed loss.

There are no published studies on the near miss effect from a DRT point of view. The present study sought to fill this gap by determining the discriminative and
conditioned reinforcing and punishing functions of two types of displays, one that always
precedes a short delay to a win, and one that always precedes a short delay to a loss. A
third display was a control condition whereby the relation between it and wins and losses
was random.

Experiment 1

Methods

Participants and setting. Ten undergraduate students enrolled at the University
of Nevada, Reno (UNR) were recruited for participation. The SONA online recruitment
software provided by UNR was used for this purpose. Sessions were conducted at the
UNR library in reserved study rooms. Each room contains a desk or table, laptop, and
chair.

The South Oaks Gambling Screen (SOGS; Lesieur & Blume, 1987) was
administered to all prospective participants prior to the start of the study. The SOGS is a
self- report measure that is routinely used to identify individuals as non-gamblers,
probable gamblers, or pathological gamblers. A score above 4 on the 20-item
questionnaire indicates a strong possibility of an individual developing a gambling
problem. Participants who received a score at or above 4 were excluded from the study.
Participants who scored at or below 3 on the SOGS were read instructions (see Appendix A) for navigating the experiment, and upon completion were given an Exit Survey (see Appendix B) at the end of the study. A $25 gift card was awarded at random to one participant in a blind draw at the conclusion of the study.

**Apparatus.** A laptop computer equipped with simulated slot machine software program was used. The software allowed the experimenter to change various components of the program, including (a) number of trials played, (b) type of images on reel strips, (c) total amount of credits available, (d) reel spin speed; (e) sound effects for various outcomes, (f) starting and stopping positions of reels, (g) total number of credits won on each spin, (h) kinds of exposed or hidden features, (i) background colors (j) betting trials. The characteristics of the program that were used in the current study are described below.

**Reel strip symbols.** A 109 x 179-pixel reel strip displaying traditional cherry symbols was used. Reel symbols were displayed in a 3X3 matrix with an 8-section reel strip.

**Reel spin durations.** The software program allowed for the control of the duration of reel spin times at increments of 1.25 seconds. For this study, the software displayed 3 reels simultaneously. The inter-spin interval was 2 seconds.

**Sound effects.** The software program was equipped with professionally developed, studio-quality sound effects. For this study, two types of sound effects were used. The first sound effect occurred on all winning spins. The effects included an increased tempo. The second sound effect occurred on all near-miss and full misses and included a decreased tempo.
Procedure. Each participant started play with 200 credits. The cost to play was fixed at two credits. There were three possible outcomes: 1) a win, 2) a near miss, and 3) a full miss. A win occurred when three matching symbols fell in succession on the horizontal pay line. A winning outcome paid out four credits. A near miss occurred when the first two symbols stopped on the pay line, and the third stopped above the pay line (cf. Ghezzi et al., 2006). A full miss occurred when one symbol fell above or below the payline on one of the three reels. As losing outcomes, neither a near miss nor a full miss paid out any credits.

Participants were given pre-play instructions to read silently while the experimenter read them aloud (see Appendix A). The instructions informed the participant that their goal was to earn as many credits as possible, that they could play in a condition for as long or as little as they wished, and that they could move from one condition to the next by pressing the “Exit” button. There were three conditions: Random Control, Discriminative Win, and Discriminative Loss.

Random control (RC). Each participant began the study in the RC condition. In this condition, all three possible outcomes of a spin (near miss, winning, or a full loss) were randomly distributed. There were 100 RC trials programed to produce (a) 33 winning outcomes, (b) 33 near miss outcomes, and (c) 34 full miss outcomes. The background color for this condition was white.

Discriminative win (DW). When a near miss occurred in this condition, the very next spin was a winning outcome, without exception. The 100 DW trials were programed to produce (a) 33 winning outcomes, (b) 33 near miss outcomes, and (c) 34 full miss outcomes. The background color for this condition was blue.
**Discriminative loss (DL).** When a near miss occurred in this condition, the very next spin was a full miss, without exception. The 100 DL trials were programmed to produce (a) 34 winning outcomes, (b) 33 near miss outcomes, and (c) 33 full miss outcomes. The background color for this condition was yellow.

**Data inclusion criterion.** The data for participants who played less than ten percent (10 trials) of the total trials in any one condition were excluded from the study. This was to ensure that the participant interacted with the contingencies in each condition before electing to end the condition.

**Experimental Design**

A reversal design was used (Johnston & Pennypacker, 2009). The sequence of conditions for each participant was RC-DW-DL-DW-DL-DW (i.e., ABCBCB).

Measures of conditioned reinforcement included the frequency of individual play and the duration of individual play. Individual response latency measures, defined as the time elapsed between the outcome of a spin and the next spin of the reels, were also taken.

**Results**

Figures 1-10 show the frequency of play for each participant in Experiment 1. A visual inspection of each figure shows little individual change from one condition to another. Figure 11 shows the aggregate of the individual frequency of play data across conditions, while Figure 12 shows the aggregate of the individual frequency of play data for the three conditions combined. No differences were noted in these aggregate data sets by visual inspection. A one-way ANOVA was conducted on the data shown in Figure 12. The test indicated that there is no statistically significant difference in the frequency
of play between the RC, DW, and DL conditions (F = 2.42, p = 0.098) (See Table 1 for Select Statistics).

Figures 13-22 show the total amount of time each participant spent playing across conditions in Experiment 1. Each figure shows little individual variation from one condition to the next condition. Figure 23, which contains the aggregate of the individual play durations for the three conditions, and Figure 24, which contain the aggregate of the individual play durations for the three conditions combined, both show no visually significant differences between conditions. A one-way ANOVA indicated, further, that there is no statistically significant difference in total time played in the RC, DW, and DL conditions (F = .63, p = 0.536).

Figures 25-34 show the response latency data for each participant across conditions in Experiment 1. This measure, which marks the time between the outcome of a spin and the next bet, was consistently greater for all participants after a win compared to after a full loss and a near miss, which did not differ. Figure 35 shows the difference in the aggregate of individual latencies for the three conditions, while Figure 36 shows the difference across the three conditions combined. The differences shown in those figures, according to a post-hoc matched sample t-tests with Bonferroni adjustments, indicated that the differences in the average response latencies were statistically significant (t= 18.69, p < .00001). A matched sample t-test revealed that the average response latencies were greatest only after a win; the differences between a full loss and a near win were insignificant (t = .51, p = .61).

As to the Exit Survey (see Appendix B), all 10 participants reported noticing a pattern between winning and losing outcomes. Four of the 10 participants indicated that a
losing spin came right before a winning spin, and three of the 10 participants reported that a losing spin came right after a losing spin. The remaining three reported a mix of the patterns reported by the seven other participants. With respect to background color change, seven of the 10 participants reported seeing the background change color.

**Discussion**

The purpose of Experiment 1 was to test the discriminative and conditioned reinforcing and punishing functions of a formal near miss display under each of these three conditions: (1) the (DW) display always precedes a short delay to a win, (2) the (DL) display always precedes a short delay to a loss, and (3) the (RC) display is random with respect to (1) and (2). According to DRT, the DW arrangement will function as both a conditioned reinforcer and a discriminative stimulus. The DL display, in contrast will function as both a discriminative stimulus and a conditioned punisher, whereas the RC display, according to DRT, should not function as either a discriminative stimulus or a conditioned reinforcer or punisher but rather as a neutral stimulus.

No individual or group differences were seen in the frequency of play or in the duration of play across the three conditions. Given a DW display as a consequence of play, for example, individuals played no more or less frequently compared to a DL and a RC display. The fact that every DW display was followed by a win – and that every DL display was followed by a loss – was evidently insufficient to establish a formal near miss display as a discriminative stimulus and, in turn, a conditioned reinforcer or a conditioned punisher.

The finding that response latencies were consistently longer for all participants after a win only is consistent with the results of a study by Dixon and Schreiber (2004).
What these researchers found was that response latencies were much longer after a winning outcome compared to either a near miss or a full miss. One interpretation of this finding is that as with any reinforcer delivered on an intermittent schedule, a winning play will engender a post-reinforcement pause (see Felton & Lyon, 1966). Schedules of conditioned reinforcement, according to research conducted by Marr and Zeiler (1971), also typically produce post-reinforcement pausing. That this was not the case after a near miss outcome in the present study, and this adds further support to the argument against a conditioned reinforcement near miss effect in slot machine play.

The results of the Exit Survey suggested that the DW, DL and RC contingencies were not in control of the participant’s slot machine play. Some said that wins followed losses, that losses followed wins and that wins and losses were unrelated. Seven of the 10 participants noted that the screen changed color periodically yet not one participant related this change to a change in how the displays related to wins and losses.

Experiment 2 was designed both to pursue these observations empirically and to replicate the first experiment.

**Experiment 2**

The purpose of Experiment 2 was to determine whether a participant would bet a larger amount (4 credits as opposed to 2) in the presence of the DW display compared to the DL and RC displays. Given that the DW display was discriminative for a win, the prediction was that participants in this condition would bet larger in the presence of a DW display. Conversely, given that the DL display was discriminative for a loss, the prediction was that participants in this condition would not bet larger in the presence of a DL display. As in Experiment 1, the RC condition served as a control.
Method

Participants and setting. Seven undergraduate students enrolled at the University of Nevada, Reno (UNR) were recruited for participation. The SONA online recruitment software provided by UNR was used for this purpose. Sessions were conducted at the UNR library in reserved study rooms. Each room contains a desk or table, laptop, and chair.

The South Oaks Gambling Screen (SOGS; Lesieur & Blume, 1987) was administered to all prospective participants prior to the start of the study. Participants who scored at or below 3 on the SOGS were read instructions (see Appendix C) for navigating the experiment and were asked to complete an Exit Survey (see Appendix D) at the end of the study.

Apparatus

The same laptop computer equipped with simulated slot machine software program that was used in Experiment 1 was used in Experiment 2. The reel strip symbols, the reel spin durations and the sound effects were also unchanged from the first experiment. What changed in Experiment 1 was the opportunity to place a bet. The software program was configured to activate two keys on the computer keyboard, a “Maximum Bet” key and a “Minimum Bet” key. Pressing the Maximum Bet key placed a 4 credit bet on the next spin, while pressing the “Minimum Bet key placed a 2 credit bet (the cost of play) on the next spin.

Procedure

Aside from allowing participants to place a minimum or maximum bet in the presence of a display, the procedure in Experiment 2 was identical to Experiment 1 in
every respect. This included the instructions given to the participants, the three
conditions of the experiment (DW, DL, and RC), the colors associated with the
conditions, and the data inclusion criteria.

Experimental Design

A reversal design was used (Johnston & Pennypacker, 2009). The sequence of
conditions for Experiment 2 (RC-DW-DL-DW-DL-DW) was the same as it was in the
first experiment. Measures were taken on the individual frequency of play, the individual
duration of play, and the number of times a maximum and a minimum bet was placed.

Results

Figures 37-43 show the frequency of play for each participant in Experiment 2. A
visual inspection of the individual data reveals very little differences between and within
conditions. Both Figure 44, which shows the aggregate data across conditions, and
Figure 45, which shows the aggregate data for each condition combined, show no
differences on this measure. A one-way ANOVA confirmed that there was no
statistically significant difference in the frequency of play across the DW, DL, and RC
conditions (F = .27, p = 0.764) (See Table 2 for Select Statistics).

Figures 46-52 show the individual duration of play for each participant in
Experiment 2. There are no clear or consistent differences in play duration within or
across the seven participants throughout the study. The aggregate data shown in Figures
53 and 54 supports the same conclusion. A one-way ANOVA revealed that there were
no statistically significant differences in play duration for the DW, DL, and RC
conditions (F = .88, p = 0.423).
Figures 55-61 show the percentage of times each participant made a maximum bet within and across each condition. (Recall that the display in the DW condition always preceded a win and that the display in the DL condition always preceded a full loss.) Of the seven participants, Participant S0930 (Figure 56) was alone in consistently placing a maximum bet in the presence of the DW display. Excluding the first DW condition, Participant S1107 (Figure 61) placed a maximum bet mostly in the presence of the second and third replication of the DW display. Participant S1001 (Figure 57) also placed a maximum bet in the presence of the DW display, but only in the initial and second replication of the DW display but not the third. The remaining five participants bet inconsistently from one condition to the next. The aggregated data (Figures 62 and 63) suggests that the percentage of maximum bets made in the presence of any one of the three displays was roughly the same. A matched sample t-test with Bonferroni adjustments revealed that the percentages of maximum bets placed after a win were statistically different from bets placed after near-miss outcomes \( t= 3.65, p < .0008 \) and between bets placed after a win and after loss outcomes \( t= 3.11, p < .004 \). In addition, a matched sample t-test indicated that percentages of maximum bets placed after a near miss were not found to be statistically different from after loss \( t= .11, p= .97 \).

Figures 65-71 show the individual percentages of bets made which aligned with the prevailing contingencies. That is, in the presence of the DW display, betting should be maximum, whereas in the presence of the DL display, betting should be minimum. The first 10 trials (spins) of play were excluded from each condition, this as a means of removing any “warm-up” effects which may have interfered with control by the prevailing contingencies.
With regards to the DW contingency, one participant never bet in alignment with the DW contingency (see Figure 64), while some participant’s responding fluctuated across the three DW conditions (Figures 67, 68, 70). Percentages across three participants increased over the three experiences playing in the DW conditions (Figures 65, 67, and 69) while the data for the remaining three participants show a decrease from one condition to the next (Figures 66, 68, and 70).

The DL condition data reveal that for all participants, maximum bets were placed in alignment with the programmed contingencies a far higher percentage of the time than in the discriminative win conditions. Percentages across four participants increased over the two experiences playing in the discriminative loss conditions (Figures 64, 68, 69, and 70), while the data for the remaining three participants show a decrease from one condition to the next (Figures 65, 66, and 67).

The Exit Survey (see Appendix D) showed that only 57% of participants reported noticing that a losing spin came right before a winning spin while the remaining 43% did not notice a relationship between outcomes. With respect to background color change, only 14% of participants report they saw the background color change and they reported preferring the game associated with the blue background. Questions pertaining to betting indicated that 43% of participants reported preferring to bet in the RC condition while the remaining 57% preferred several conditions. All preferred DW conditions, with only one participant reporting a preference for an DL condition.

**Discussion**

The purpose of Experiment 2 was to test the extent to which participants would bet a larger amount than the cost to play (4 credits as opposed to 2) when a winning spin
is always preceded by a near miss, therefore, testing for any discriminative properties. Frequency and total time data from Experiment 2 yielded similar results as Experiment 1. Neither of the data sets suggest that the near-miss may have functioned as a conditioned reinforcer given no indication of prolonged play in DW conditions or higher response rates. Even though this was found to be the case, in the exit survey for Experiment 2, participants reported betting the most in DW conditions but could not identify why that was the case in the written commentary portion.

The data reflecting percentages of maximum bets following an outcome shed light on the original prediction that participants in the discriminative win condition would place a maximum bet after every near miss outcome and the regular cost to play for win and full loss outcomes. Results suggest that only three participants engaged in more bet placing behavior after a near-miss in the DW conditions than after winning and losing outcomes. The other four participants did not show the same type of responding. These outcomes reflect that participants were insensitive to the contingencies that were presented and, therefore, did not bet in the optimal way to maximize their opportunities to earn a higher total of credits.

Given that the percentage of maximum bets placed after a particular outcome data showed that three participants bet more following a near-miss, further analysis of the probability that the near miss had a discriminative function helps to illustrate whether participants were randomly betting on near-misses or if betting aligned with the DW contingency. For example, these data will account for the differences between a participant A who, when presented with the 8 spin outcomes: [near-miss, win, loss, loss, near-miss, win, near-miss, win], bets on the italicized outcomes [near-miss, win, loss,
loss, near-miss, win, near-miss, win] from participant B who may have placed maximum bets in this pattern: [near-miss, win, loss, loss, near-miss, win, near-miss, win]. Overall, participants A and B may have a similar percentage, but responded in a different pattern. Data collected on probability of discriminative function shows that, while one participant never followed the pattern, the other six participant’s data reflected an increase of betting in alignment, or a decrease of betting in alignment across the sequentially ordered DW and DL conditions, respectively.

The results of the DL conditions depict higher percentages than the DW conditions, this may be due to there being more opportunities for participants to behave with respect to the programmed contingency. As stated previously, in order for a maximum bet to be included in the percentage, the participant must have placed a maximum bet on a near-miss and not on the following win. For the DL condition, the percentage may have been higher because maximum bets aligned with the program contingencies were considered maximum bets placed after a winning or after a full loss outcome, therefore twice the opportunities. In addition, more contingency aligned betting may have been observed in the DL condition because there was more discriminative control exerted over responding than the DW condition.

**General Discussion**

This study leaves behavior analysts in an interesting state of affairs as far as the how S-S hypothesis and the S-R hypothesis can be applied as ways to study the near miss. First, let’s reassess the S-S hypothesis. One finding of this study was that discriminability may not have been effectively established because, across conditions, participant’s data did not show higher frequencies of play or total time played in the DW
conditions as compared to the DL conditions. In laymen’s terms, the participant may not have been able to distinguish between the near miss that was programmed to become a discriminative stimulus for a win and the other outcomes presented. This may have been the case because of the formal similarity between the outcomes (win, near miss, and full loss). In addition, the exit survey results showed that a large percentage of participants reported that they did not notice a background color change between conditions, and, therefore, it did not function as information that signaled a change in contingencies. Research in this area suggests that salience (the extent to which stimuli stand out from the background) and disparity (the extent to which one stimulus differs from another) of the stimuli may have an impact on the ability for discriminability to be established between stimuli or conditions (Dinsmoor, 1995b). One way to test the effects of this in future studies would be to make the symbols for each outcome slightly different from each other. It may also be beneficial to make the background color more salient or program for a signal that is more salient for a change in conditions.

The implications for the S-R hypothesis from the results of this study speak even louder volumes about the near miss functioning as a conditioned reinforcer, even when there are explicitly taught contingencies. While the results of the data collected can be analyzed individually, there are broader behavioral interpretations that need to be considered. First, the DRT approach seemed to have small effects with respect to establishing a conditioned reinforcer.

While, in this study, it did not seem to contribute to the near-miss acquiring conditioned reinforcing properties, this may be attributed to the difference between the near-miss and win delay not being significantly shorter than the one between a loss and a win. If the
delay between a loss and a win were larger, for example, the salience of the distinction between the two outcomes may have been enough to shape and control responding. In this way, Fantino’s delay reduction theory should not be disregarded for future near-miss research and future studies should further manipulate the delay to reinforcement that the near-miss can predict.

Second, in the DW condition the probability of a near miss preceding a win is 1.0, and in the DL condition the probability of a near miss preceding a loss is 1.0. These conditions would seem prime for establishing discriminated responding. For discrimination to occur, the participant must have been attending to the explicit pairing of the near miss with either a loss or a win. In these experiments, however, discrimination was not observed and this would suggest that the participants were not attending to what outcomes came before or after a near miss. Dinsmoor (1995a) suggests that for discrimination to occur, the participant must be attending to stimuli. Attending is most probable when the stimulus predicts access to reinforcement. The assumption with regards to these experiments, then, is that there was no functional reinforcer and that may be responsible for the variability across data.

Third, the failure of the programmed contingencies in each condition to control responding may also be considered a stimulus control issue. Stimulus control may not have been established due to a lack of exposure to the programmed contingencies if a participant did not play for a long duration of time. The time that participants played across all conditions varied between 41 seconds to 8 minutes in Experiment 1, and 1 minute and 13 seconds to 3 minutes and 30 seconds in Experiment 2. This would suggest that there may be a difference in frequency of play for participants who played for longer
times as compared to those who played for less time, and, therefore, stimulus control in the latter circumstance may not have been established and yielded mixed results. A post-hoc comparison conducted in both experiments suggested that the two participants in Experiment 1 who played and spun the most, and, therefore, contacted the most near miss and win pairings (S533), and the participant with the least amount of spins and pairings (S890), respectively, did not differ significantly with respect to frequency of play or average response latencies. In addition, the same results were found when comparing the participant who spun the most and experienced the most pairings of the near miss and win in Experiment two (S1104) and the least (S1107) with respect to frequency of play, maximum bets placed following a particular outcome, or probability of discriminative function. This comparison is important because it suggests that procedural issues may not have been to blame for the near miss not acquiring a discriminative function.

Finally, future research may consider combing Experiment 1 and Experiment 2 to simulate a teaching or pre-exposure phase followed by a learning phase to assess how responding may be impacted. This may more closely simulate actual gambling circumstances where people may watch another gambler before partaking. Further, anecdotally, many of the participants in these two studies indicated that they “knew” something about gambling that impacted the way they responded. For example, some participants reported that they were attempting to catch on to whatever pattern was present while others reported that gambling always resorts in loss and therefore, they bet less. It would be ill-advised to completely remove the verbal component of human responding, even with the most contrived of circumstances. Given that humans tend to produce self-rules that may or may not be accurate toward any given activity, future
research may align with a similar slot-machine paradigm with the addition of a confederate commenting on ‘figuring out the pattern’ or ‘proclaiming how many credit’s they’ve earned.’ In addition, future research could manipulate the delay between a near-miss and social reinforcement by a confederate to determine if a near-miss may acquire conditioned reinforcing properties more quickly as opposed to a winning outcome.

The overall conclusion that can be drawn from this research is that even in a circumstance where a near miss was formally similar to a win, and it always predicted a short delay to a win, data suggest those circumstances may have been inefficient for establishing it as a conditioned reinforcer or punished. Therefore, the near miss effect should be regarded differently in future gambling research.
References


### Table 1

*Select Statistics for Experiment 1*

<table>
<thead>
<tr>
<th>Condition(s)</th>
<th>Mean</th>
<th>Min</th>
<th>Max</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RC</td>
<td>14.86</td>
<td>8.8</td>
<td>21.1</td>
<td>3.4</td>
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<tr>
<td>DW</td>
<td>17.82</td>
<td>8.1</td>
<td>35.2</td>
<td>4.4</td>
</tr>
<tr>
<td>DL</td>
<td>16.48</td>
<td>10.1</td>
<td>21.4</td>
<td>2.85</td>
</tr>
<tr>
<td><strong>Total Time</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RC</td>
<td>136.4</td>
<td>41</td>
<td>375</td>
<td>95.98</td>
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<tr>
<td>DW</td>
<td>151</td>
<td>46</td>
<td>357</td>
<td>79.69</td>
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<tr>
<td>DL</td>
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<td>46</td>
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<td>126.9</td>
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<td><strong>Response Latencies</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Win</td>
<td>3.64</td>
<td>2.5</td>
<td>6.86</td>
<td>0.79</td>
</tr>
<tr>
<td>Near Miss</td>
<td>1.27</td>
<td>0.3</td>
<td>3.6</td>
<td>0.72</td>
</tr>
<tr>
<td>Loss</td>
<td>1.21</td>
<td>0.4</td>
<td>3.6</td>
<td>0.68</td>
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</table>

*Note.* One-way ANOVA results for Frequency and Total Time analyses are in the Results section of Experiment 1. Matched samples t-test results for Avg. Response Latencies are in the Results section of Experiment 1.

### Table 2

*Select Statistics for Experiment 2*

<table>
<thead>
<tr>
<th>Condition</th>
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<th>Min</th>
<th>Max</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RC</td>
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<td>DL</td>
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<td>10.2</td>
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<td><strong>Total Time</strong></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>RC</td>
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<td>DL</td>
<td>106.64</td>
<td>64</td>
<td>324</td>
<td>78.56</td>
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<tr>
<td><strong>% Max Bets Placed</strong></td>
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<td></td>
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</tr>
<tr>
<td>Win</td>
<td>27.2</td>
<td>0</td>
<td>78</td>
<td>22.23</td>
</tr>
<tr>
<td>Near Miss</td>
<td>39.29</td>
<td>0</td>
<td>92</td>
<td>22.31</td>
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<td>Loss</td>
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<td>0</td>
<td>100</td>
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<td><strong>Prob. Disc. Function</strong></td>
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<tr>
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<td>DL</td>
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</table>

*Note.* One-way ANOVA results for Frequency and Total Time analyses are in the Results section of Experiment 2. Matched samples t-test results for Maximum Bets Placed are in the Results section of Experiment 1.
Figure 1

![Graph S307]

Figure 2

![Graph S420]

Figure 3

![Graph S890]
Figure 4

S852

Sequence of Conditions

0  10  20  30  40

Frequency of Play (spins/min)

Figure 5

S533

Sequence of Conditions

0  10  20  30  40

Frequency of Play (spins/min)

Figure 6

S488

Sequence of Conditions

0  10  20  30  40
Figure 7

![Frequency of Play (spins/min)]

Figure 8

![Frequency of Play (spins/min)]

Figure 9

![Frequency of Play (spins/min)]
Figure 10

S910

Figure 11

Aggregate

Figure 12

Nested Aggregate
Figure 13

S307

Figure 14

S420

Figure 15

S890
Figure 20

Figure 21

Figure 22
Figure 29

Figure 30

Figure 31
Figure 32

Figure 33

Figure 34
Figure 35

Figure 36

Figure 37
Figure 47

Figure 48

Figure 49
Figure 53

Figure 54

Figure 55
Figure 56

Figure 57

Figure 58
Figure 59

Figure 60

Figure 61
Figure 62

Figure 63

Figure 64
Figure 65

Figure 66

Figure 67
**Figure 68**

![Probability of Discriminative Function S1005](image)

**Figure 69**

![Probability of Discriminative Function S1006](image)

**Figure 70**

![Probability of Discriminative Function S1104](image)
Figure 70

Probability of Discriminative Function
S1107

Percentage

Sequence of Conditions

Figure 71

Probability of Discriminative Function
Aggregate

Percentage

Sequence of Conditions
Appendix A
Instructions: Experiment 1

Welcome to this on study on slot machine gambling! You have signed up to participate for roughly 30-60 min, as you know, so please keep that commitment in mind as you play the game.

You will be playing a computer simulation of a three-reel slot machine, just like one you would play at a casino. This slot machine accepts credits, not money, but in every other respect the game operates the same way as a casino slot machine. And just like playing in a casino where your aim is to win money, your objective in playing this game is to win credits. Treat credits as money, in other words, and play to win as many credits as you possibly can.

Do you have any questions?

You will start play with 200 credits.
The cost of play is always 2 credits for one spin of the reels.
A win always pays out 4 credits.
A loss always forfeits the cost of play, i.e., 2 credits

Do you have any questions?

How to start play/ continue to play: Press the Spin button
How to stop play: Press the Exit button

You may play the slot machine for as long as you like. Once you press “Exit” the game you are playing will end, the screen will return to the home page, and you will select the next version of the game. To do this, select “Add”, click on the next game, and press “Ok.” Once you have done that, highlight the next game from the list, and press “Run Condition.” You may play this version as long as you like, too. If you decide to stop playing this version, press the “Exit” key. The order of games you will play is: H, P, S, C, J, and A.

Do you have any questions?

Keep in mind that your aim in this study is to play to win as many credits as you possibly can. Keep in mind, too, that if you don’t pay attention to what happens while you play, the study will be longer than if you do pay attention and play the game to win. So, pay close attention to what is happening and play to win as many credits as you possibly can.

Do you have any questions?
You may begin play the moment I shut the door. I’ll be right outside the door if you need me. When you decide to stop playing, please open the door and we’ll finalize your participation.
Appendix B

Exit Survey- Experiment 1

Instructions: Please circle all answers that apply.

1. Did you notice a relationship while you were playing between winning spins and losing spins?
   a. Yes. Sometimes a losing spin came right before a winning spin.
   b. Yes. Sometimes a losing spin came right after a losing spin.
   c. No. There was no relationship between winning and losing spins.

2. Did you notice the background color of the game changed now and then?
   a. Yes
   b. No

3. If you noticed that the background color of the game changed, which game did you prefer to play?
   a. The game with the white color background
   b. The game with the blue color background
   c. The game with the yellow color background

4. How interesting was playing this game to you (circle one)?

   1---------------------------------- 3 ---------------------------------- 5
   very interesting      moderately interesting      not at all interesting

5. Any comments?
Appendix C

Instructions- Experiment 2

Welcome to this on study on slot machine gambling! You have signed up to participate for roughly 30-60 min, as you know, so please keep that commitment in mind as you play the game.

You will be playing a computer simulation of a three-reel slot machine, just like one you would play at a casino. This slot machine accepts credits, not money, but in every other respect the game operates the same way as a casino slot machine. And just like playing in a casino where your aim is to win money, your objective in playing this game is to win credits. Treat credits as money, in other words, and play to win as many credits as you possibly can.

Do you have any questions?

You will start play with 200 credits.
The cost of play is always 2 credits for one spin of the reels.
You can wager either the minimum bet (2) or the maximum bet (4).
A win always pays out 4 credits.
A loss always forfeits the cost of play, i.e., 2 credits

Do you have any questions?

How to start play/ continue to play: Press the Spin button
How to bet: Press Minimum Bet (Cost of play-2) or Maximum Bet (4)
How to stop play: Press the Exit button

You may play the slot machine for as long as you like. Once you press “Exit” the game you are playing will end, the screen will return to the home page, and you will select the next version of the game. To do this, select “Add,” click on the next game, and press “Ok.” Once you have done that, highlight the next game from the list, and press “Run Condition.” You may play this version as long as you like, too. If you decide to stop playing this version, press the “Exit” key. The order of games you will play is: G, T, U, R, D, and L.

Do you have any questions?

Keep in mind that your aim in this study is to play to win as many credits as you possibly can. Keep in mind, too, that if you don’t pay attention to what happens while you play, the study will be longer than if you do pay attention and play the game to win. So, pay close attention to what is happening and play to win as many credits as you possibly can.
Do you have any questions?

You may begin play the moment I shut the door. I’ll be right outside the door if you need me. When you decide to stop playing, please open the door and we’ll finalize your participation.
Appendix D
Exit Survey

Instructions: Please circle all answers that apply.

1. Did you notice a relationship while playing between winning spins and losing spins?
   a. Yes. Sometimes a losing spin came right before a winning spin.
   b. Yes. Sometimes a losing spin came right after a losing spin.
   c. No. There was no relationship between winning and losing spins.

2. Did you notice the background color of the game changed now and then?
   a. Yes
   b. No

3. If you noticed that the background color of the game changed, which game did you prefer?
   a. The game with the white color background
   b. The game with the blue color background
   c. The game with the yellow color background

4. How interesting was playing this game to you (circle one)?
   1---------------------------------- 3 ---------------------------------- 5
   very interesting  moderately interesting  not at all interesting

5. Which game(s) did you bet the most in?
   a. Game G (1st)
   b. Game T (2nd)
   c. Game U (3rd)
   d. Game R (4th)
   e. Game D (5th)
   f. Game L (6th)

6. Why did you bet the most in the game(s) that you circled?

7. Any comments?