The near win effect on observing behaviour in simulated slot-machine gambling: the role of conditioned reinforcement

By

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#### Abstract

Slot machines are a remarkably popular mode of gambling even though they are programmed to make a profit by paying out less money than is put in. One common feature of slot machines, which may increase the likelihood of persistent gambling in the face of this monetary loss, is the near win. This study's aim was to investigate the conditioned reinforcing properties of near wins using an observing response procedure in the context of a simulated slot machine. In an observing response procedure, participants can use an observing button to produce a stimulus correlated with the availability of reinforcement (S+) or a stimulus correlated with no reinforcement or less reinforcement (S-). The percentage of observing responses made for each stimulus is thought to reflect the reinforcing efficacy of the reinforcer correlated with each stimulus. Experiment 1 successfully tested the procedure with an obvious reinforcer - wins - and found consistently more observing for the S+. In Experiment 2 and 3 the S+ was correlated with near wins, and in Experiment 2 only those with slot-machine experience had consistently more observing for the S+. Experiment 3 increased the probability of wins to enhance the reinforcing efficacy of near wins, but failed to find consistently more observing for the S+, regardless of slot machine or scratchie card experience. These results indicated that near wins are not conditioned reinforcers. However, participants tended to bet more following near wins than losses, which suggested that near wins may instead function as discriminative stimuli.

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# The near win effect on observing behaviour in simulated slot-machine gambling: the role of conditioned reinforcement

In New Zealand, approximately 2.5% of adults are considered problem or moderaterisk gamblers (Abbott, Bellringer, Garrett, & Mundy-McPherson, 2014), and the mode of gambling most often associated with problem gambling is slot machines (Beaudoin & Cox, 1999; Breen & Zimmerman, 2002; Chóliz, 2010; Ministry of Health, n.d). Slot machines are readily accessible in pubs, clubs, casinos, and, increasingly, online (Jacques et al., 2016). For these reasons, it is important to better understand the driving forces behind slot-machine gambling.

A combination of factors are thought to influence the development of problem slotmachine gambling. These are the structural features, such as pay-outs, spin outcomes, and the audio and visual effects, of the slot-machine games and the underlying Pavlovian and operant processes through which these features influence play (Dowling, Smith, & Thomas, 2005; Griffiths, 1993; Meyer, Fiebig, Häfeli, & Mörsen, 2011).

#### The Near Win Effect

A near win is an event that appears similar or close to an actual win, but is a loss. In slot-machine gambling, if all of the symbols on the pay line must match for a win, a near win occurs when all the symbols, aligned along the pay line, are identical except for one. Many researchers have shown the effect of near wins on people's behaviour to be similar to the effect of wins (e.g. Belisle & Dixon, 2015; Chase & Clark, 2010; Clark, Crooks, Clarke, Aitken, & Dunn, 2012; Côté, Caron, Aubert, Desrochers, & Ladouceur, 2003; Daugherty & Maclin, 2007; Dixon et al., 2011; Dixon & Schreiber, 2004; Dymond et al., 2014; Ghezzi, Wilson, & Porter, 2006; Habib & Dixon, 2010; Kassinove & Schare, 2001), which suggests that near wins could have reinforcing properties similar to those of wins. Given that the

monetary outcome of a near win is the same as a clear loss, loss of the original wager, this is a somewhat puzzling phenomena and is often described as the 'near win effect'.

The effect of near wins is evident in physiological, behavioural responses, and perceptions and beliefs about near wins. Gambling studies have found evidence that near wins are more physiologically arousing than other losses (Clark et al., 2012; Dixon et al., 2011), activate similar brain regions to wins(Clark, Lawrence, Astley-Jones, & Gray, 2009; Dymond et al., 2014), increase response latencies as the near win becomes increasingly similar looking to a win (Belisle & Dixon 2015), increase persistence of gambling behaviour (Côté et al., 2003; Daugherty & Maclin, 2007; Ghezzi et al., 2006; Kassinove & Schare, 2001), and will be described by gamblers as more similar to wins than clear losses (Dixon & Schreiber, 2004). Two possible explanations for why near wins have these effects in slotmachine gambling are: (1) near wins, in non-gambling contexts, serve as discriminative stimuli and through generalization also have effects in the gambling context, and (2) near wins are conditioned reinforcers that maintain responding.

Near Wins as Discriminative Stimuli. A discriminative stimulus indicates the availability of reinforcement, should a particular behaviour be performed. In many different contexts, nears wins, that is, stimuli that resemble those present when a goal *is* achieved - indicate that persistence will increase the likelihood of a win in the future. For example, in sports, second place (or 'nearly wining') often indicates that the player's performance was almost good enough to win and with perseverance the likelihood of getting first place next time is greater. In slot-machine gambling, there is no such relationship between a near wins and wins. Slot-machine outcomes are independent, which means that the presentation of one outcome does not change the probability of another outcome type occurring on the next spin. However, the understanding of near wins, in non-gambling contexts, could be generalised to near wins in slot-machine gambling. Consequently, a near win in the slot-machine context

could also serve as a discriminative stimulus to continue gambling, because this is how near wins have functioned in the past. Alternatively, some researchers have also argued that the near win effect occurs when near wins are established as conditioned reinforcers (e.g. Daly et al., 2014; Kassinove & Schare, 2001).

Near Wins as Conditioned Reinforcers. Reinforcement is a process that increases the likelihood that the behaviour that led to reinforcement will reoccur (Skinner, 1953). There are two types of reinforcers: unconditioned and conditioned. Unconditioned reinforcers are innate (e.g. food and water), while conditioned reinforcers (e.g. money) acquire reinforcing properties via a period of learning or past experience. It is through this second mechanism, conditioned reinforcement, that near wins are thought to acquire reinforcing properties (Daly et al., 2014; Kassinove & Schare, 2001). There are at least two potential ways that near wins could become established as conditioned reinforcers, these are: Pavlovian generalisation and Pavlovian conditioning.

*Pavlovian generalisation*. Generalisation is when the effect of conditioning is transferred from one stimulus to another similar stimulus. For example, if a person becomes frightened at the sound of gun fire this response could be transferred to the sound of a car backfiring. Delfabbro and Winefield (1999) and Peters, Hunt and Harper (2010) suggest that, if wins are reinforcing, this type of transference could also occur from wins to near wins in slot machines because the two types of stimuli are visually very similar. That is, in a typical slot machine, the reels stop spinning in a sequential manner, from left to right. A near win will look increasingly like a win up until the final reel comes to a complete stop, revealing the loss. Belisle and Dixon (2015) observed a generalisation gradient showing shorter response latencies for clear losses and longer latencies for stimuli that looked increasingly more similar to wins – that is, as the number of matching symbols in the sequence increased, so did response latencies. It is this sequential order of events in a win sequence that is also ideal for

establishing near wins as conditioned reinforcers through Pavlovian conditioning (Daly et al., 2014; Witts, Ghezzi, & Manson, 2015).

*Pavlovian conditioning.* Pavlovian conditioning is the process by which a previously neutral stimulus gains reinforcing properties after repeated pairings with an unconditioned or previously conditioned reinforcer. For Pavlovian conditioning to occur, there must be a contingency between the reinforcer and neutral stimulus and typically the neutral stimulus precedes the unconditioned reinforcer. In slot-machine gambling, the symbols in each spin outcome are typically revealed in a sequential left-to-right order. This sequence of events means that for every win a near win precedes it, right before the final symbol is revealed. As this arrangement of wins and near wins is an ideal setup for establishing near wins as conditioned reinforcers (Daly et al., 2014), those with slot-machine experience would be more likely to exhibit a conditioned reinforcement effect of near wins.

#### Measuring the effect of Near Wins on gambling

There are several measures by which the reinforcing efficacy of near wins have been investigated. These include response latency, persistence and preference tests. However, studies using these measures have produced inconsistent results regarding the effects of near wins on gambling.

**Response Latency.** Response latency is the time between the spin outcome and the next response. It is often reported that reinforcing outcomes will produce longer latencies than other outcomes (Belisle & Dixon, 2015; Daly et al., 2014; Delfabbro & Winefield, 1999; Peters et al., 2010; Schreiber & Dixon, 2001 in gambling studies; Felton & Lyon, 1966; Ferster & Skinner, 1957 in non-gambling studies). In a study that measured response latencies in real slot machines, it was found that latencies were longer following wins than losses (Delfabbro & Winefield, 1999). Similar results have also been found in a rat model of

gambling (Peters et al., 2010). These findings are consistent with the notion of *post-reinforcement pause*, which has been demonstrated in animal models of reinforcement schedules (Felton & Lyon, 1966), including variable ratio schedules which resemble the arrangement of wins on slot machines (Ferster & Skinner, 1957), and in slot-machine gambling where response latencies following wins increased systematically as the magnitude of the wins increased (Delfabbro & Winefield, 1999). If response latency reflects the efficacy of a reinforcer, and near wins are reinforcing, response latencies for near wins should be longer than those for clear losses. Studies that have investigated response latency following near wins have found mixed results.

Dixon and Schreiber (2004) evaluated response latencies following near wins, wins and losses in a commercial slot machine and did not find a consistent effect of near wins. Spin outcomes were presented in the typical left-to-right sequence and near wins in this study were defined as any outcome with two matching symbols and one different symbol aligned along the pay line (e.g. xxo, xox. oxx). However, the effect of the near win type conducive for Pavlovian conditioning (xxo) was not distinguished from the other possible near win types. This could have resulted in response latencies that reflected the frequency of each near win type and would account for the failure to find a consistent effect of near wins on response latency.

Other studies have found that near win response latencies following near wins are longer than clear losses, but not longer than response latencies following wins (Daly et al., 2014 in humans; Peters et al., 2010 in rats). Studies have also observed response latencies that were the shorter following near wins compared to win and clear losses (Dixon, MacLaren, Jarick, Fugelsang, & Harrigan, 2013; Luo, Wang & Qu, 2011). In a more recent study, Belisle and Dixon (2015) found that participants showed longer response latencies after near wins than wins. These results suggest either that near wins are reinforcing in some conditions and not in others, or that response latency reflects more than just the reinforcing properties of near wins. In either case, response latencies alone are not sufficient in the study of near wins and further research is required.

**Persistence.** Persistence of responding (also known as resistance to extinction) is another measure used to study the reinforcing properties of near wins, but has also produced mixed findings. Typically, a persistence study is done in two phases. In the first phase, the participant is exposed to a combination of near wins, wins and clear losses. In the second extinction phase, near wins, wins, or both are removed and the participant is told they may stop gambling whenever they like. The number of responses the participant makes in this second phase is thought to reflect the reinforcing value of the outcomes they were exposed to in the initial phase. Daugherty and Maclin (2007) found that the greatest level of persistent occurred when 45% of outcomes in the exposure phase were near wins compared to 15% and 30%. However, Kassinove and Schare (2001) found that 30% of near wins was ideal (the percentage that had the largest effect on responding) compared to 15% and 45%. If near wins are conditioned reinforcers, then, a greater percentage of near wins should results in more persistent gambling behaviour (as found by Daugherty & Maclin, 2007), and not a u-shaped effect (as found by Kassinove & Schare, 2001).

However, the different ideal percentages of near wins may be a result of the different percentages of *wins* that accompanied the near wins, which suggests that near wins gain reinforcing properties via Pavlovian conditioning. If near wins become conditioned reinforcers through the conditioned stimulus (near win) – unconditioned stimulus (win) pairings, every win is a conditioning trial and every near win is an extinction trial. This means that if there are too many near wins compared to wins in the first phase, the extinction effects of the near wins may weaken the conditioned reinforcing effect. This may have been the case in Kassinove and Schare (2001) where the ideal percentage of near wins was 30%,

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but the percentage of wins in the exposure phase was only 10%. In Daugherty and Maclin (2007), the ideal percentage of near wins was 45%, but the percentage of wins in the exposure phase was 30%, much higher than in Kassinove and Schare (2001). Thus, it is possible that differences in the rates of wins arranged accounts for some of the differences in the effects of NWs observed in previous studies.

Another explanation for the different ideal percentages of near wins in persistence studies could be found in the extinction phase itself. When wins are removed, in the extinction phase, the pairing between near wins and wins no longer occurs which may weaken the reinforcing value of near wins (Witts et al., 2015). This means that persistence might not reflect the true value of near wins as conditioned reinforcers. Instead, persistence might reflect a combination of how much reinforcing efficacy near wins have gained during the exposure phase and how much extinction has occurred during the second phase. This issue makes it difficult to get a clear measure of how effective near wins are as a reinforcer using the persistence measure.

**Preference**. Preference is another measure of conditioned reinforcement that has been used in the study of near wins. In a typical preferences test participants first play on multiple slot machines that have different ratios of spin outcomes. In a second phase, participants may choose which slot machines to gamble on. The amount that each slot machine is played on is thought to reflect the reinforcing properties of the outcomes presented on each machine in the first phase.

Preference studies have also shown an inconsistent effect of near wins in slot-machine gambling, but previous studies have lacked experimental control. It has been found that participants prefer to gamble on slot machines with near wins rather than slot machines without them Giroux and Ladouceur (2006), and Gyozo and Kormendi (2012) found more preference for slot machines with 30% near wins compared to slot machines with fewer.

These results are consistent with the idea of near wins being reinforcers. However, Maclin, Dixon, Dougherty, and Small (2007) found no change in preference for slot machines with more near wins.

The lack of preference for slot machines with more near wins could reflect a lack of experimental control in the preference measure. In preference studies, participants experience a feedback loop between their preferred slot machine and how much they are exposed to that slot machine. That is, exposure to each slot machine is not controlled, instead exposure (and actual wins obtained because of the ratio schedule used) varies as a result of the participant's preference. A measure of conditioned reinforcement is required that controls the level of exposure and hence reinforcers obtained from each alternative as a more direct measure of reinforcer efficacy. The observing response procedure provides such a measure (Shahan, 2002b; Williams, 1994).

The Observing Response Procedure. A standard observing response procedure is able to overcome some of the issues identified in preference and persistence tests. That is, responding in an observing procedure does not increase exposure to a preferred schedule of reinforcement, and the observing response procedure allows the investigation of conditioned reinforcement in a set of unchanging conditions that does not require an extinction condition (Shahan, 2002b).

*Observing response*, a term coined by Wyckoff (1952), describes a behaviour that produces stimuli that signal the availability of reinforcement – discriminative stimuli. In a standard procedure, unconditioned reinforcement, or already-established reinforcement, is provided on a mixed schedule of reinforcement (two or more schedules of reinforcement that alternate in the *absence* of any discriminative stimuli). In an observing response procedure, one type of responding will produce unconditioned reinforcement (e.g. food), and an observing response will briefly produce a discriminative stimulus that signals which

component is active, and thus the rate of reinforcement. This transforms the mixed schedule into a multiple schedule of reinforcement (two or more schedules of reinforcement that alternate in the presence of discriminative stimuli; Wyckoff, 1952).

A key feature of the observing response procedure is that an observing response does not increase the likelihood of unconditioned reinforcement. That is, observing behaviour is not maintained by the unconditioned reinforcer. Instead, observing is maintained by the conditioned reinforcing properties of the discriminative stimuli (Fantino & Silberberg, 2010). Consequently, the rate of observing responses should reflect the reinforcing efficacy of the stimuli they produce (Wyckoff, 1952). For example, in a mixed schedule of VI and EXT components, observing behaviour should be greater for the stimulus associated with the VI stimulus (S+) compared to the stimulus associated with the EXT component (S-). However, there has been disagreement in the literature about how the discriminative stimuli maintain observing. These conflicting theories, that explain how observing response contingent stimuli maintain observing behaviour, are known as the *conditioned reinforcement hypothesis* and the *information hypothesis* (also known as the uncertainty-reduction hypothesis).

The conditioned reinforcement hypothesis is that observing behaviour is maintained by a correlation between the discriminative stimulus and the reinforcer (Fantino & Silberberg, 2010). Alternatively, the information hypothesis is that discriminative stimuli are reinforcing because they provide information about the availability of reinforcement (Lieberman, Cathro, Nichol, & Watson, 1997; Shahan & Podlesnik, 2005). The information hypothesis argues that information – good or bad – will maintain observing behaviour (Lieberman et al., 1997). For example, when a stimulus is correlated positively with reinforcement it signals that reinforcement is available (i.e. 'good news'). Likewise, if the stimulus is correlated negatively with reinforcement then this is 'bad news' for the observer. When a stimulus is uncorrelated with reinforcement this could, similarly, be considered 'no *news*'. If information is responsible for maintaining observing behaviour then observing should occur equally for good news and bad news, and less for no news. However, Fantino and Silberberg (2010) have shown that good news and bad news do not maintain observing behaviour equally, and numerous studies have shown that observing behaviour is maintained by the conditioned reinforcing properties of the discriminative stimuli they produce (e.g. Fantino & Silberberg, 2010; Shiels, Hawk, Richards, & Colder, 2007; Shahan, 2002b).

Fantino and Silberberg (2010), in a series of experiments, investigated how good news, bad news and no news differentially maintain observing behaviour in humans. In a mixed schedule with a standard observing response procedure, participants could respond on two buttons that were assigned to good, bad or no news. Responses on the good-news box produced a stimulus that was correlated with reinforcement when that schedule was in operation. Likewise, responses on bad-news button produced a stimulus that was negatively correlated with reinforcement, and responses on a no-news button could produce a stimulus that was not related to either component in the mixed schedule. Fantino and Silberberg (2010) found that, when the buttons were assigned to good and bad news, participants responded more on the good-news button. When the choice was between bad news and no news, participants responded more on the no-news button. Greater observing for good news and no news -or no information - favours the conditioned-reinforcement account of observing behaviour (c.f. Lieberman et al., 1997; Shahan & Podlesnik, 2005).

There is still some evidence that information can be reinforcing, but only when it is useful information. Participants, in Case, Ploog, and Fantino (1990), played a version of a Star Trek game in which the participant could shoot Klingons. The "bad news" stimulus indicated that no Klingons were available. When the bad news indicated that no Klingons were available and that no other activities could be done in this time, the information could not be *utilized* in the game and participants observed more for the no news stimulus. However, when the bad news indicated that no Klingons were available and that other activities could be done, the bad news was useful and it was preferred to no news. These findings suggest that observing can be maintained by useful discriminative stimuli. Therefore, in order to determine whether an observing stimulus is a conditioned reinforcer, the observing procedure must not provide information that could be utilised, or this variable should be carefully controlled across the mixed schedule components.

In summary, the observing response procedure has a lot of potential for investigating whether near wins affect gambling behaviour because they are conditioned reinforcers. However, the observing procedure has yet to be successfully adapted for the study of near wins in slot-machine gambling.

Witts et al. (2015) used a variation of the observing response procedure with three *concurrently* available slot-machine components and *simultaneous* observing. In an initial exposure phase, participants gambled on each of the three slot machines to learn that each slot machine was different in terms of reinforcement probability, and the discriminative stimulus associated with each machine. In this phase, all three slot machines had the same rate of wins, and the near win rate varied. After each spin, in both phases, the slot-machine components would rearrange themselves in a random order. In the observing phase, the discriminative stimuli were removed and a single observing button became available. In this phase, wins were removed (extinction) from each slot machine, but the rate of near wins on each machine remained identical to those in the exposure phase. The observing button, when pressed, revealed all three discriminative stimuli for one spin. After every spin the discriminative stimuli were removed and the components were rearranged, so that the participants did not know the location of each slot machine. In this study, participants were split into a *no cost* condition, where observing responses were free, and a *cost* condition, where observing responses each cost three credits. Witts et al. (2015) did not find any effect

of near wins on observing responses in either the cost or no cost conditions and concluded that near wins were not reinforcing.

The design of the simultaneous observing procedure, in Witts et al. (2015), did not utilise the observing procedure to its full effect. This procedure had a single observing response button that revealed all three discriminative stimuli simultaneously, and observing rates were compared *between* those who had no cost associated with observing and those who had to pay three credits to make an observing response. In a typical observing procedure, one observing button will reveal a discriminative stimulus one at a time and only when the corresponding component is active (e.g. Shahan, 2002a, 2002b, in rats; Tomanari, 2004; Tomanari et al., 2007, in humans), or multiple observing buttons are provided which are each assigned to one component and only reveal the correlated stimulus when the corresponding component is active (e.g. Case et al., 1990; Fantino & Case, 1983; Fantino & Silberberg, 2010; Perone & Kaminski, 1992; Shiels et al., 2007). This standard design allows for a systematic measure of the effect of independent variables within-subject (Shahan 2002b), and, used effectively, could be advantageous in the study of near wins. Moreover, a welldeveloped observing procedure could also be used to identify procedural variables that may contribute to the varying effects of win rates.

Furthermore, the Witts et al. (2015) observing procedure incorporated the issue identified in persistence studies as a means of investigating near wins in simulated slotmachine gambling. In this study wins were removed in the observing phase. As in the extinction phase of persistence studies, the Pavlovian association between wins and near wins could have been weakened, accounting for the low rate of observing and failure to find a conditioned reinforcement effect of near wins. The use of a standard observing procedure does not require an extinction phase to measure conditioned reinforcement. Finally, the observing response procedure used in Witts et al. (2015) failed to measure differential observing behaviour (greater observing for one stimulus over the other) and, therefore, also the conditioned reinforcing properties of near wins. A key feature of the standard observing response procedure is that observing should not increase the availability of reinforcement. In Witts et al. (2015), the slot-machine components were concurrently available and an observing response revealed *all three* discriminative stimuli simultaneously. This meant that an observing response allowed the component with the most reinforcement to be identified and bet on, thus increasing the likelihood of reinforcement. Therefore, the behaviour being measured was not observing behaviour and this study does not further our understanding of near wins as conditioned reinforcers.

In another study, the standard observing procedure was also adapted to measure observing behaviour for spin outcome stimuli, this time by Schienle (2014). In an initial phase, participants gambled on a single slot-machine component with equal number of wins and near wins. In the observing phase, participants were divided into one of four conditions where the 100 spins in the phase differed in the ratio of wins and near wins. These were: (1) 50 win/50 near wins (0 losses), (2) 25 win/25 near win (50 losses), (3) 50 win/25 near win (25 losses), and (4) 25 win/50 near win (25 losses). In the observing phase for each condition, the last reel for wins, near wins, and complete losses was curtained and an observing response could reveal them. In this phase, there was sometimes a cost of two credits to make an observing response, otherwise observing was free. Even though the final reel was curtained in this phase, the outcome of each spin was still identifiable by the combination of symbols not curtained and whether the participant's credit went up or down. In this context therefore, observing responses did not yield information about the outcome. Schienle (2014) found that, regardless of the cost, in all four conditions more observing responses were made

for near wins than either wins or complete losses. Schienle (2014) argued that this result suggested that near wins were conditioned reinforcers.

However, in an observing response procedure, observing responses are argued to be maintained by conditioned reinforcement. In the procedure Schienle (2014) developed, the conditioned reinforcers were the different outcome stimuli, and Schienle (2014) found that participants observed for near wins more than actual wins. This suggests either that wins are less reinforcing than near wins, or that this procedure did not measure conditioned reinforcement. Research, that more closely resembles the standard observing response procedure in a simulated slot machine, is still required to understand the role of near wins in slot-machine gambling.

Research using an observing response procedure that is in keeping with the standard observing procedure, described in the literature, is required in order to establish whether: (1) the standard observing response procedure can be effective in the investigation of near wins as conditioned reinforcers, and (2) whether near wins are conditioned reinforcers.

#### Purpose

The current study developed an observing response procedure in a simulated slot machine that more closely resembled the standard observing procedure to investigate the reinforcing efficacy of near wins. The aim of Experiment 1 was to develop an effective observing response procedure in the context of a simulated slot machine that could be sued to investigate conditioned reinforcement. For this, a procedure with multiple observing buttons was used, as this has been more successful in previous human observing studies (e.g. Case et al., 1990; Fantino & Case, 1983; Fantino & Silberberg, 2010; Perone & Kaminski, 1992; Shiels et al., 2007), and two slot-machine components that were presented sequentially, rather than concurrently. Wins, a less disputed reinforcer, were available on one of these components and correlated with the S+. There were no wins on the other component. In the exposure phase and observing phase, the rate of wins and near wins remained constant. A greater observing response percentage for the discriminative stimulus associated with a machine with wins, would indicate that the observing procedure captured the reinforcing properties of wins.

#### **EXPERIMENT 1**

The purpose of this experiment was to develop an observing response procedure suitable for the investigation of conditioned reinforcement in a simulated slot machine. The working assumption was that wins are reinforcing – having been conditioned at some point in the participants' history- as has been shown in previous research (e.g. Delfabbro & Winefield, 1999; Witts et al., 2015). If the observing procedure used in the simulated slot machine is suitable then participants should exhibit a greater observing percentage for the stimulus associated with the slot machine providing wins (S+) compared to the stimulus not associated with wins (S-; see Fantino & Silberberg, 2010 the conditioned reinforcement hypothesis).

#### Method

#### **Participants**

Participants were 20 students who were enrolled in a first year psychology course at Victoria University of Wellington and earned course credit for their participation. Participants completed the South Oaks Gambling Screen (SOGS; Lesieur & Blume, 1987), this is a 20item self-report standardized measure of problem gambling risk (see Appendix I). One participant (participant 610) scored within the problematic range on the SOGS. All participants were provided with contact information for local problem gambling support services.

#### **Apparatus and Setting**

This experiment was conducted in an internal room with four Dell computers in cubicles. The computers had 17 inch monitors, 1680 x 1050 screen resolution, a keyboard, mouse and headphones. The simulated slot machines and embedded experimental task were constructed by the author using Visual Basic Express 2013.

**Slot-machine Simulation**. I created a slot-machine simulation was created based on a tropical beach theme. The background colouring and text printed down the right side of the display could be varied to produce a "sunset" slot machine and "midday" slot machine (see Figure 1), and served as the discriminative stimuli in the experiment. In the foreground of the slot machine, there were five slot-machine reels, three textboxes and three buttons. The textboxes displayed the total amount of credit cumulated over play time, as well as the total bet amount, and total win amount of the most recent spin. The buttons were labelled: "Bet Min", "Spin", and "Bet Max". Figure 1 shows the exact layout of these features. Importantly, the bet buttons were equidistant to the left and right of the spin button. The central placement of the spin buttons was informed by Gunnarsson, Rowsey and Dixon (2015) who found that response effort influenced wager sizes.

*Reels*. The slot-machine task was a computerised version of a mechanical slot machine with a row of five spinning reels each with thirteen fruit symbols. Each column was 152 x 567 pixels. A window in the front revealed three symbols from each reel (see Figure 1). Thus, when the reels were stationary, participants saw a 3 x 5 matrix of symbols where the three rows were betting lines and the five columns were the visible position of the reels. Participants could only bet on the middle line, and the symbols on each reel were arranged uniquely, so that a matching combination of symbols could not occur above or below the middle betting line

*Betting*. Participants could place a bet of either \$1 or \$5 using one of the two bet buttons before each spin. Bet amounts were displayed before each spin and the bet amount was deducted from the participant's total credit. When a bet was placed both bet buttons became disabled until the spin response was made and the spin cycle was completed, after which the bet buttons were enabled and another bet could be made.



*Figure 1.* Screenshot images of the discriminative stimuli associated with either the RR 3.3 or EXT components in the multiple schedule of reinforcement in the exposure phase. Each panel filled the whole screen when that slot machine was active. The top panel displays the sunset themed slot-machine component stimuli and one of the possible combinations of symbols that made up a near win. The bottom panel displays the midday themed slot-machine component stimuli and one of the possible combinations of symbols that made up a near win.

*Spin cycles.* A spin cycle was from the moment a spin button response was made until the final reel had come to a stop, which lasted 3400 ms. The spin and bet buttons were disabled during each spin cycle until the reels had stopped, after which the bet buttons were enabled and the spin button remained disabled until the next bet amount was selected. The five reels had different spin durations, so that the reels stopped in a sequential manner, from left to right. The spin duration for each reel was as follows: 2000 ms, 2350 ms, 2700 ms, the 3050 ms, and 3400 ms.

Spin Outcomes. Every spin response resulted in one of three possible outcomes: a win, near win, or complete loss. A win consisted of five matching symbols along the middle line (see Figure 1, bottom image), and the delivery of either \$5 or \$25 depending on the bet size. When a win occurred the font of the background text and the text displaying the total amount won flashed multiple colours and a winning sound was presented. The visual and auditory stimuli associated with a win lasted until the participant made their next bet, the active slot machine changed, or when an experimental phase came to an end. This ensured that stimuli associated with wins were never associated with an extinction trial (near wins or losses). A near win consisted of four matching symbols along the middle row with a matching fifth symbols on the top row of the fifth reel (see Figure 1, top image). A complete loss consisted of five different symbols along the middle row (see Figure 2). If the spin outcome was a near win or complete loss the participant did not receive any credit and the 'total win' text box remained at zero. There were no auditory stimuli associated with either a near win or complete loss. The combination of symbols that made up each iteration of each outcome type was pre-determined, so that this was identical for each participant. The probability of each of these outcome types was varied.

*Sound*. Sound effects were used during the course of the slot-machine task to emulate the experience of playing on an electronic slot machine. Different sound effects,



*Figure 2*. Screenshot image of how the RR 3.3 or EXT components appeared in the mixed schedule of reinforcement in the observing phase. One of the possible combinations of symbols that made up a complete loss is displayed along the middle pay line.

typical of EGM games, were used for button clicks, spinning reels, reels coming to a stop, and wins.

*Observing response buttons.* The slot-machine simulation included two additional buttons labelled 'Am I playing on sunset?' and 'Am I playing on midday?' (these labels were pilot tested and this particular phrasing was easily understood by participants), that could be made visible and active or remain inactive and unseen. When visible these button were positioned directly below the first and fifth reel, next to bet min and max buttons in (see Figure 2). Responses on the observing buttons could reveal the corresponding background stimulus (see below) if that component was in effect.

### Procedure

Participants completed an informed consent form on their computer before the session began. At end of the session, participants were given a written and verbal debrief in which the purpose of the research was explained. Sessions lasted no more than one hour and consisted of three phases: an exposure phase, observing phase and a questionnaire phase. This procedure was approved by the Victoria University of Wellington Human Ethics Committee.

**Exposure phase**. Before this phase began, participants read the following instructions on the screen:

"You are about to play a slot-machine gambling task.

There are two slot machines in this task that have different background themes: Sunset and Midday. Each slot machine has a different arrangement of spin outcomes. The computer will switch between these two slot machines.

You will have \$500 to bet with. To place a bet use the 'Bet Min' or 'Bet Max' button and then press 'Spin'. If you get a winning sequence, the size of the win will be five times the original bet (e.g. 1 bet = 5 win).

Please play on each slot machine as if you were playing for real money.

When you are ready to begin paying press the 'Start' button below."

Participants were then given verbal instructions that reiterated the written instructions on their screen. If a participant asked a question the researcher reiterated the instruction above.

Participants were then exposed to the slot-machine simulation and wins were delivered according to a MULT RR 3.3 EXT schedule with the components signalled by the slot-machine background. The component (RR 3.3 or EXT) presented first and the discriminative stimulus (midday or sunset) correlated with each component was counter balanced across participants (see Appendix II for a summary of counterbalancing). In both components there was also a 0.10 probability that a near win would occur. Table 1 provides a summary of the probabilities for all spin outcome types.

#### Table 1

Programmed probabilities for spin outcomes in each component of the multiple and mixed schedules of reinforcement in Experiment 1.

	Multiple and Mixed Schedule Components		
Spin outcome	RR 3.3	EXT	
Win	.30	.00	
Near Win	.10	.10	
Loss	.60	.90	

The two components were scheduled to alternate every 60 s until the participant had completed 12 minutes of the exposure phase. However, the phase and component could not end or change during a spin cycle and a 500 ms buffer period. This allowed every spin outcome to be viewed, and meant that the duration of each EXT and RR 3.3 component iteration lasted between 60 s and 63.90 s. The length of components and regular alternations was informed by previous human observing research (Case, et al., 1990; Fantino & Case, 1983; Shiels et al., 2007). Regular alternations also allowed participants to keep track of which component was active without using the observing buttons. This meant that participants were less likely to respond for information about the active component and observing behaviour was a more direct measure of conditioned reinforcement.

**Observing Phase.** In this phase the multiple schedule was changed to a mixed RR 3.3 EXT schedule with an observing response procedure. This was achieved within the slot-machine simulation by having the stimuli associated with the components masked by a transparent grey filter (see Figure 2) and the addition of the observing response buttons.

Before this phase began, participants read the following instructions on their screen: "In the first phase you finished with \$[remaining credit]. Good effort.

*In the next phase:* 

- (1) The background colour of the 'Midday and 'Sunset' slot machines will be hidden by a grey filter.
- (2) You will continue to play on the 'Midday' and 'Sunset' slot machines and they will continue to alternate, but you will not be able to see them change over.
- (3) You can use the buttons in the left and right corners to reveal which slot machine you are playing on in that moment.

These buttons may not work every time you press them. Sometimes these buttons will reveal the slot-machine background and sometimes they will have no effect at all.

Please wait for instructions before continuing"

Participants were then given verbal instructions that reiterated what they had read on their screen. It was then explained how the new buttons did not switch them between the two slot machines, instead the new buttons could be used to reveal which slot machine they were playing on. This instruction was included because some pilot participants incorrectly believed that clicking the observing button allowed them to switch to the other component. The two components alternated as in the exposure phase until the participant had completed 30 minutes of the observing phase.

*Observing response.* An observing response could be made by clicking either of the observing buttons. Responses to an observing button were reinforced if the component associated with that observing button was currently in effect, *and* the requirements of an independent VI 30 s schedule were met. The left or right position of the S+ and S- observing buttons were counter balanced across participants (see Appendix II for a summary of

counterbalancing). Reinforced observing responses produced either the S+ (background stimuli for the RR component) or S- (background stimuli for the EXT component) for a 15s interval or until the next component change, whichever occurred first. During this observing interval, both observing buttons were darkened and disabled so that no further observing responses could be made until the end of the interval. This reinforcement arrangement meant that some observing responses were unreinforced either because the schedule VI time had not elapsed or because the observing button responded on did not match the current component, thus the absence of any discriminative stimulus following an observing response was not informative.

**Questionnaire phase.** After completing the slot-machine task participants answered a 10item questionnaire about the task they had just completed (see Appendix III for Exit Survey questions). This questionnaire measured the participants' understanding of specific features of the task and the task in general. Participants also completed the SOGS questionnaire in this phase - the 20-item self-report screen for problem gambling risk. One of these items was used to identify participants who had experience with slot machines and those that had no experience with slot machines. This item asked participants to indicate the types of gambling they had participated in over their life time. Possible responses for each type of gambling were 'Not at all', 'Less than once a week', and 'Once a week or more'.

#### **Results and Discussion**

#### **Observing Response**

To evaluate the reinforcing efficacy of wins, the percentages of observing responses made for the S+ were calculated. Figure 3 shows the percentage of observing responses allocated to the S+ for each participant. The percentages of observing responses were calculated as the individual's total number of observing responses for the S+, divided by the total number of observing responses for the S+ and S-. Observing was considered differential if the participant had a greater observing percentage for either the S+ or S-. The percentage of observing responses made to the S+ button varied considerably across participants (43.86% to 78.05%). As can be seen from Figure 3, 18 out of 20 participants observed more for the S+ than the S-. Only two participants observed more for the S- than the S+ (603 and 609). These results are evidence of reinforcing properties of the discriminative stimuli that signal the availability of reinforcement (Fantino & Silberberg, 2010; Shahan, 2002b; Shiels et al., 2007). Based on this, this slot-machine task and observing procedure could also be an effective measure of near wins as conditioned reinforcers in the slot-machine gambling context.

The total number of S+ responses across the 30-minute observing phase was on average greater for the S+ (M = 47.90, SD = 50.22) than for the S- (M = 34.05, SD = 35.02). While a large majority of participants allocated more observing responses to the S+, there was substantial variation in the total number of observing responses made. For the S+, observing responses ranged from 2 to 188, while, for the S-, observing responses ranged from 1 to 130. The standard deviations also indicate considerable variability in observing responses, a result that is consistent with the human observing literature (e.g. Fantino & Case,

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*Figure 3.* Participants' percentage of the total observing responses made for the S+ in Experiment 1. Bars above the x-axis indicate a greater percentage of observing responses made for the S+, and bars below the x-axis indicates a greater percentage of observing response made for the S-.

1983; Shiels et al., 2007). For example, Fantino and Case (1983) found that students made more observing responses for a light correlated with points, which were exchangeable for money, compared to a stimulus correlated with extinction. However, the number of observing responses made for the S+ ranged from 30 to 6870 responses, and for the S- ranged from 0 to 5580 responses. Little research has been done to better understand individual variability in human observing responses; however, there is some evidence that observing is correlated with other measures of sensitivity to reward (Shiels et al., 2007). An understanding of this individual variability in sensitivity to the reinforcing effects of gambling-related stimuli could reveal why some people develop gambling problems.

A time course analysis of observing responses was conducted to evaluate whether the exposure phase was adequate for conditioning of the S+ and S- or whether differential

responding for the S+ only emerged later in the observing phase. Figure 4 displays each participant's mean observing response rate for the S+ and S- across three consecutive blocks in the observing phase. Each block was five minutes long and consisted of five iterations of the RR 3.3 or EXT components. The mean observing response rates for the S+ and S- were calculated as the block's total number of observing responses divided by the total amount of time that the observing buttons were active for in that block (if an observing response produced the S+ or S- both observing buttons became inactive for the duration of that observing interval). Given the variability in the absolute number of observing responses noted above, participants' means were partially normalised by dividing the rate for each block by the participant's mean rate of observing for the entire observing phase. Figure 4 shows that 15 out of 20 participants responded more for the S+ during the first block of the observing phase, five participants responded equally on the S+ and S- (601, 605, 616, 617, and 619), and none of the participants responded more for the S- in this first block. These results suggest that the 12 minute exposure phase was adequate for conditioning of the S+ and S- because differential observing was exhibited from the beginning of the observing phase for most participants.

A time course analysis of observing responses also helped to assess whether observing behaviour was affected by the length of the task. Figure 4 shows consistent differential observing behaviour across the observing phase. In the second block, 14 out of 20 participants responded more for the S+ than the S-, four responded equally for the S+ and S-(609, 611, 614, and 616), and two participants responded more for the S- (601 and 603. In the third block, 14 out of 20 participants responded more for the S+ than the S-, two responded equally for the S+ and S- (603 and 614), and four participants responded more for the S-(609, 617, 618, and 620). In addition, Figure 4 shows no consistent downward or upward trend in the rate of observing behaviour as the observing phase progressed. While some



Figure 4. Participants' mean observing response rate for the S+ and S- across three consecutive blocks of the observing phase. Each block represents five iterations each of the RR 3.3 or EXT components, making each block five minutes long in total. Response rates have been partially normalised by dividing the rate for each block by the participant's mean rate of observing for the entire observing phase.

participants did respond more for the S- in later blocks of the observing phase, most participants observed more for the S+ throughout the observing phase. These findings indicate that the length of the observing phase was sufficient for the evaluation of reinforcement in this context and that the length of the task did not consistently affect participants' observing behaviour.

#### **Additional Analysis**

**Response Latency.** In order to evaluate the effect of the three spin outcomes (wins, near wins and losses) and the effect of both components on response latency, the response latency was recorded following every spin in the exposure and observing phases. Response latency was measured as the length of time between the presentation of a spin outcome and the next spin response.

*Outcome Response Latency.* To investigate the effect of win, near win and losses on response latency, the median response latency following each outcome type was calculated for each participant. To minimise the influence of the occasional very short or very long latencies the median rather than mean was used as a measure of central tendency. These are displayed in Figure 5. Each participant showed the same pattern of response latencies: the response latency following wins was the longest, followed by near wins, and losses had the shortest response latency. The group's mean of the median latencies was also calculated and reflected the same pattern seen for each individual. The mean of the median latencies was greatest following wins (M = 1882.38 ms, SD = 683.79), followed by near wins (M = 1082.13 ms, SD = 215.91), and shortest following complete losses (M = 758.03 ms, SD = 226.70).

Longer response latencies following wins than losses is consistent with the interpretation that longer response latencies are post reinforcement pause (Daly et al., 2014;



*Figure 5*. Participants' median response latencies following wins, losses and near wins in the exposure and observing phases.
Delfabbro & Winefield, 1999; Dillen & Dixon, 2008; Peters et al., 2010). Likewise, near wins consistently produced a longer latency than complete losses, also observed in Daly et al. (2014) with humans, and Peters et al. (2010) with rats. These results suggest that near wins are more reinforcing than complete losses, but not as reinforcing as wins.

This pattern of longer response latencies following wins and near wins may indicate that these stimuli are reinforcers- that is, these increased response latencies might be postreinforcement pauses. One possible alternative explanation for the consistent difference in response latency following each outcome type is that different outcomes take different durations to identify due to the sequential presentation of the symbols. Losses are identifiable after the second symbol is presented, and wins and near wins are only distinguishable after the last symbol is presented; perhaps outcomes (wins and near wins) that take longer to identify produce longer response latencies. This explanation does not, in fact, account for the entire current pattern of results, however. Differences in the time required to identify outcomes could explain why loss latencies are shorter than both wins and near win, but it does not account for the difference between wins and near wins because both outcomes are revealed at the same time. In addition, Macaskill, Hunt, Tan, and Harper (in prep) found that when slot-machine symbols were revealed simultaneously, rather than sequentially, the same pattern of differences in response latency are wins, near wins and losses. These findings suggest that differences in response latency can be viewed as a post-reinforcement pause.

*Across Component Response Latency*. To investigate whether participants' spin behaviour was sensitive to the RR 3.3 and EXT multiple schedule components, the median response latencies following losses were compared between components in the exposure phase. Figure 6 displays each participant's median response latency following losses during six blocks of RR 3.3 and EXT components. Each block represents one third of RR 3.3 or EXT components in either the exposure or observing phase. In the exposure phase (Blocks 1



*Figure 6.* Participants' median response latencies following losses across the exposure (blocks 1-3) and observing phases (blocks 4-6). One block represents one third of R 3.3 or EXT components in the exposure or observing components. Note that participant 607 and 610 have a different y-axis for easy comparison of latencies between components.

to 3), each block was two minutes long and consisted of two iterations of RR 3.3 or EXT components. In the exposure phase, 16 out of 20 participants had longer response latencies - a slower spin response rate - in at least two blocks of the exposure-phase RR 3.3 components (see Figure 6). Figure 7 shows the group's mean median response latencies for losses in each component, and across each third of the exposure phase, and shows that as a group, participants were slower to make spin responses after loses in the RR 3.3 component than in the EXT component. The small, but consistent difference in responding between the RR 3.3 and EXT component in the exposure phase indicates that the participants' behaviour was sensitive to the multiple schedule components on both the individual and group level. That is, participants behaved differently depending on whether they were in the RR 3.3 or EXT component during the exposure phase when the S+ and S- were present all the time. Figure 6 also shows a general reduction is response latency across the session. This is evident for many individuals and on the group level (Figure 7), and may reflect a tendency for participants to habituate to the different outcome stimuli.

Whether or not participants also behaved differently on the two components in the observing phase would also indicate whether participants knew which component they were on even when the S+ and S- were not always present. This information would indicate whether participants' observing behaviour was maintained by information about the active component or the conditioned reinforcing value of the S+. As discussed, there are two explanations for what maintains observing behaviour: the information hypothesis, and conditioned reinforcement hypothesis. The information hypothesis posits that observing is maintained by information about the availability of reinforcement (Lieberman et al., 1997), while the conditioned reinforcement hypothesis argues that observing is maintained by the conditioned reinforcement hypothesis argues that observing is maintained by the conditioned reinforcement hypothesis argues that observing is maintained by the conditioned reinforcement hypothesis argues that observing is maintained by the conditioned reinforcement hypothesis argues that observing is maintained by the conditioned reinforcement hypothesis argues that observing is maintained by the conditioned reinforcement hypothesis argues that observing is maintained by the conditioned reinforcement hypothesis argues that observing is maintained by the



*Figure 7*. Mean of participants' median response latencies following losses across the exposure (blocks 1-3) and observing phases (blocks 4-6). One block represents one third of R 3.3 or EXT components in the exposure or observing components.

maintained by the conditioned reinforcing value of the S+, response latencies following losses should also be different in the observing phase. This would show that participants were able to keep track of the active component in the observing phase. If participants kept track of the active component they would be unlikely to observe for information they already had, and this would suggest that when they did observing it was maintained by the reinforcing value of the S+.

To assess whether participants observed for information about the active component, or instead observing was maintained by the conditioned reinforcer, the median response latencies following losses were also compared between components in the observing phase (see blocks 4-6 on Figures 6 and 7). Blocks four to six, in Figure 6, represent the median response latency in the observing phase. Each block was five minutes long and consisted of five iterations of RR 3.3 or EXT components. Figure 6 shows that, during the observing phase, all participants responded more slowly in the three blocks of the RR 3.3 components

compared to EXT. Figure 7 shows the group's mean median response latencies for losses in each component type, and across each third of the observing phase, and shows that as a group, participants were slower to make spins after losses in the RR 3.3 component than in the EXT component. The small, but consistent difference in responding between the RR 3.3 and EXT component in the observing phase indicates that the participants' behaviour was sensitive to the mixed schedule components on both the individual and group level. That is, participants behaved differently depending on whether they were in the RR 3.3 or EXT component during the observing phase when the S+ and S- were not always present. This suggests that participants did not observe for information.

However, it was possible that this effect was driven by the response latencies during periods when the component stimuli were present, after an effective observing response. Therefore, median response latency was calculated following losses for when the S+ and S-were present and absent. Figure 8 displays the median response latencies for S+ present (solid) and absent (stripes) periods for RR 3.3 (left) EXT (right) components. Figure 8 shows that, for 16 out of 20 participants, median latencies were longer in S + *present* periods compared to S- *present* periods, and that 19 out of 20 participants had longer response latencies in S+ *absent* periods than both S- *absent* and *present* periods. This finding is also reflected in the groups' mean of the median response latencies following losses, which were longer during S+ absent (M = 968.75 ms, SD = 275.00) and S+ present periods (M = 1064.63 ms, SD = 840.87) compared to S- absent periods (M = 713.50, SD = 236.28) S- present periods (M = 618.53 ms, SD = 215.12). Longer latencies for spin responses during the RR 3.3 component when the S+ was absent, compared to both periods of EXT, indicates that participants could keep track of the active component even in the absence of any discriminative stimuli. This means that participants were unlikely to be checking what



*Figure 8*. Median response latencies following losses during periods of the observing phase when S+ and S- were present (PR; solid) and absent (AB; stripy). Note that participant 603 and 616 have a different y-axis for easy comparison of latencies between present and absent periods.

component was active with an observing response, instead observing behaviour probably reflected the reinforcing properties of wins.

**Return-to-player.** Return-to-player (RTP) in real world slot machines is the average percentage of the player's wager that is returned to them. This percentage is always programmed as less than 100%, and the remaining credit is profit for the gambling venue. Slot machines approximate the programmed RTP over the long term, however, in the short term players may experience profits or losses that differ from the programmed RTP. Similarly, in the current study the rich slot machine was programmed to produce wins following 30% of trials in the RR 3.3 component, but the participants' experience RTP varied as a function of the number of spins played and the amount of credit bet per spin.

To assess how the experienced RTPs in the exposure phase affected observing behaviour, a correlation between the experienced RTP and the percentage of observing for



*Figure 9*. Total observing percentage for the S+ plotted against the RTP percentage for each participant. Each dot represents one participant. Note that both axes start above zero.

the S+ was conducted. The experienced RTP was calculated for each participant (see Appendix IV). This was calculated as the total credits won divided by the total amount bet in the RR 3.3 component in the exposure phase, multiplied by 100 (Note that the RTP for the EXT component was always 0%). There was a significant positive correlation between experienced RTP and observing percentage for the S+ (r(18) = .474, p = .04). Figure 9 displays observing percentages for the S+ plotted against the RTP percentages, and a visual analysis indicates a weak linear relationship between these variables. This result indicates that differential observing of the S+ varied as a function of the size of the RTP percentage. That is, the reinforcing efficacy of the S+ tended to be greater for those who had an overall greater RTP. This is consistent with the idea that the S+ was a conditioned reinforcer through its association with wins. In this case, the S+ could also become a stronger reinforcer for those who experience a greater amount won. Future research could manipulate RTP more systematically to investigate this further.

How much the current study's experienced RTPs in the exposure phase differed from real world slot machines was also assessed. The mean RTP for the RR 3.3 component was 160% (*SD* = 30%) and the standard deviation indicates some variability in the experienced RTPs across participants. The RTP in this experiment was higher than real world programmed RTPs, but not necessarily higher than real world experienced RTPs over short periods. Moreover, many online slot machines will have an RTP greater than 100%, which is reduced as soon as the gambler begins betting real money (Sévigny, Cloutier, Pelletier, & Ladouceur, 2005). Based on this, the external validity of this task was somewhat compromised but the current study's RTPs were not unrealistic of potential RTP percentages that could be obtained over a short period it remains a satisfactory model.

**Task understanding.** Exit survey responses to the items : "1. I understood what to do in this task", "5. The 'Am I playing on...?' buttons showed me the background of the active

slot machine.", "6. I used the 'Am I playing on...?' buttons to decide how much to bet.", and "8. I used the "Am I playing on...?' buttons to switch to another slot machine." were analysed in order to evaluate participants' understanding of the slot-machine task or identify any misconceptions about the task that were common in the piloting stage of this research. Participants were selected either "Agree", "Disagree", or "I don't know" in response to each of these items. Most participants selected "agree" for items one, five and six, and selected "Disagree" for item eight, which indicates that the majority of participants understood what to do in this task, the two slot-machine components were different, and what the observing buttons did (see Appendix V for graphs). Responses to the remaining questions were used primarily in the development and piloting stage of this study. Exit survey results suggest that the written and verbal instructions given were sufficient, and the observing responses were likely to reflect the reinforcing properties of wins, rather than any misconceptions participants had about the purpose of the observing response buttons.

# Conclusion

Response latencies following losses in the RR 3.3 and EXT components during the observing phase indicated that participants did not use the observing buttons for information, which suggests that this observing procedure directly measured the effect of conditioned reinforcement. The greater observing percentages for the S+ indicated that wins have a reinforcing effect. Moreover, response latencies following outcomes indicate that near wins are more reinforcing than losses, but not as reinforcing as wins. Based on these findings, the current observing procedure, in the context of the simulated slot-machine task, is an effective measure of conditioned reinforcement, therefore, it was used to assess the effects of near wins in Experiment 2.

### **EXPERIMENT 2**

Experiment 2 investigated the reinforcing efficacy of near wins in a simulated slot machine using the task developed in Experiment 1. Experiment 1 found that participants' observing behaviour was sensitive to the reinforcing properties of wins, therefore if differential observing is found for the stimulus associated with the slot machine with near wins (S+) this would suggest that near wins have reinforcing properties similar to wins in the simulated slot-machine context.

## Method

## **Participants**

Participants were 40 people, twenty of whom were students enrolled in a first year psychology course at Victoria University of Wellington and earned course credit for their participation (participant 701-720). The remaining twenty participants were recruited from the Victoria University of Wellington community and received a movie ticket voucher for their participation (participant 721-740). Two participants (participant 714 and 738) scored within the problematic range on the SOGS. All participants were provided with contact information for local problem gambling support services.

### **Apparatus and Setting**

This experiment was conducted in the same location, with the same equipment, and an identical slot-machine simulation as in Experiment 1.

# Procedure

The procedure for this experiment was exactly as described in Experiment 1, except for the following change: near wins varied according to a MULT RR 3.3 EXT schedule, and, in both components there was also a 0.10 probability that a win would occur. Table 2 summarises the probability of all spin outcome types in Experiment 2.

### Table 2

Programmed probabilities for spin outcomes in each component of the multiple and mixed schedules of reinforcement in Experiment 2.

	Multiple and Mixed Schedule Components		
Spin outcome	RR 3.3	EXT	
Win	.10	.10	
Near Win	.30	.00	
Loss	.60	.90	

# **Results and Discussion**

## **Observing Response**

To evaluate the reinforcing efficacy of near wins, the percentage of observing responses made to the button revealing the S+ (the background associated with the component that had near wins) was calculated. Figure 10 shows the percentage of observing responses allocated to the S+ for each participant. The percentage of observing responses were calculated as the individual's total number of observing responses for the S+, in the observing phases, divided by the total number of observing responses for the S+ and S-. Observing was considered differential if the participant had a greater observing percentage for either the S+ or S-. The percentage of observing responses made to the S+ button varied considerably across participants (0% to 100%). As can be seen in Figure 10, 35 out of 40 participants exhibited differential observing behaviour. Twenty-two out of 40 participants observed more for the S+ than the S-, but 13 participants observed more for the S- than the



*Figure 10.* Participants' percentage of the total observing responses made for the S+ in Experiment 2. Bars above the x-axis indicate a greater percentage of observing responses made for the S+, and bars below the x-axis indicate a greater percentage of observing response made for the S-. Bars on the left represent participants who had slot-machine experience, bar on the right represent those who had no slot-machine experience. Note, participant 714 observed equally for the S+ and S-, otherwise no bar indicates that the participant did not make any observing responses.

S+. One participant observed equally for the S+ and S- (714), and four participants did not observe at all (701, 720, 726 and 736).

The total number of S+ responses across the 30-minute observing phase was on average greater for the S+ (M = 32.40, SD = 35.85) than for the S- (M = 28.20, SD = 30.97). While more than half of participants allocated more observing responses to the S+, there was substantial variation in the total number of observing responses made across participants. For the S+, observing responses ranged from zero to 127 responses, and for the S-, observing responses ranged from zero to 129 responses. The standard deviations also indicate considerable variability in observing responses, a result that is consistent with Experiment 1 and the human observing literature (e.g. Fantino & Case, 1983; Shiels et al., 2007).

The differential percentages of observing is evidence that participants did have a preference for one machine over another. However, differential observing for the S+ was not consistent across participants, which suggests a variable other than the independent variable (percentage of wins) may have influenced the effect of near wins on observing.

One such possibility is that participants' slot-machine experience may have affected the reinforcing efficacy of near wins, and consequently the reinforcing efficacy of the S+. Those with slot-machine experience may have already learnt the association between near wins and wins through Pavlovian conditioning, while for those with no experience, the exposure phase may not have been sufficient to learn this association. To evaluate how the reinforcing efficacy of near wins varied as a function of slot-machine experience, the percentage of observing responses made for the S+ was compared between participants who had slot-machine experience and those who had no slot-machine experience (see Figure 10). Figure 10 shows the percentage of observing responses allocated to the S+ for each individual with experience (left hand section of the figure) and no-experience (right hand section of the figure). Slot-machine experience was determined by how the participant had responded on the SOGS item about the slot-machine gambling in their life time. Participants who responded 'Not at all' were categorised as having no experience, and those who answered 'Less than once a week' (n = 9) or 'Once a week or more' (n = 0) were categorised as having experience.

Figure 10 shows that those with slot-machine experience exhibited greater differential observing for the S+, while those with no experience tended to show more differential observing for the S- or smaller differential observing for the S+. Nine out of the 12 participants with experience showed differential observing behaviour for the S+, and three observed more for the S-. In contrast, 13 out of 28 participants with no experience, showed greater differential observing for the S+, one participant observed equally for the S+ and S- (714), two participants did not observe (701 and 720), and 11 showed differential observing for the S-. This result is consistent with neurobehavioral research that found a greater near win effect in pathological (Dymond et al., 2014; Habib & Dixon, 2010) and regular (Chase & Clark, 2010) slot-machine gamblers, compared to non-pathological and non-regular gamblers. These findings provide tentative evidence that near wins are conditioned reinforcers for people with experience with slot machines. Furthermore, these results support the idea that near wins gain their reinforcing properties through Pavlovian conditioning between win and near wins in the slot-machine gambling context.

A time course analysis of observing responses was conducted to evaluate whether observing behaviour exhibited by participants was consistent across the course of the observing phase. Figure 11 displays each participant's mean observing response rate for the S+ and S- across three consecutive blocks in the observing phase. Given the variability in the absolute number of observing responses noted above, participants' means were partially normalised by dividing the rate for each block by the participant's mean rate of observing for the entire observing phase. This allowed patterns in observing rates to be easily compared



*Figure 11.* Participants' mean observing response rate for the S+ and S- across three consecutive blocks of the observing phase. Each block represents five iterations each of the RR 3.3 or EXT components, making each block five minutes long in total. Response rates have been partially normalised by dividing the rate for each block by the participant's mean rate of observing for the entire observing phase. Note that participant 728 has a different y-axis to allow for easy comparison between the rate of observing for the S+ and S-.

across participant. Each block was five minutes long and consisted of five iterations of the RR 3.3 or EXT components. The mean observing response rates for the S+ and S- were calculated as the block's total number of observing responses divided by the total amount of time that the observing buttons were active for in that block. Differential observing behaviour for the S+ was considered consistent if more responses were made for the S+ in at least two, out of the three, blocks of the observing phase. Figure 11 shows that in the observing phase, 17 out of 22 participants, who displayed differential observing percentages for the S+, displayed consistent differential observing for the S+ across the observing phase. Six out of the nine participants with experience, and who displayed differential observing for the S+ (702, 709,711, 717, 721, 722, 723, 728, and 731), displayed consistent differential observing for the S+ across the observing phase (702, 717, 721, 722, 723 and 731). These results suggest that when a participant exhibited differential observing for the S+ across the observing phase as a whole this behaviour was relatively consistent and that session totals were not driven by sporadic observing that was not consistent across the course of the observing phase.

## **Additional Analysis**

**Outcome Response Latency.** To investigate the effect of win, near win and losses on response latency, the median response latency following each outcome type was calculated for each participant. These are displayed in Figure 12. Thirty-nine out of 40 participants showed the same pattern of response latencies as in Experiment 1: the response latency following wins was the longest, followed by near wins, and losses had the shortest response latency (only participant 713 had a longer median response latency following losses compared to near wins, but not longer than wins). The group's mean of the median latencies was also calculated and reflected the same pattern seen for the majority of individuals. The mean of the median latencies was greatest following wins (M = 2654.08 ms, SD = 1323.25),



Figure 12. Participants' median response latencies following wins, near wins, and losses in both the exposure and observing phases.

followed by near wins (M = 1086.79 ms, SD = 346.21), and shortest following complete losses (M = 839.14 ms, SD = 358.50).

Longer response latencies following wins than losses is consistent with the interpretation that longer response latencies are post reinforcement pauses (Daly et al., 2014; Delfabbro & Winefield, 1999; Dillen & Dixon, 2008; Peters et al., 2010). This finding was also seen in Experiment 1. Near wins also consistently produced a longer latency than complete losses. This was also observed in Experiment 1, and Daly et al. (2014) with humans, and Peters et al. (2010) with rats. Longer response latencies following near wins than complete losses suggest that near wins are more reinforcing than complete losses, but not as reinforcing as wins.

Across Component Response Latency. To investigate whether participants' spin behaviour was sensitive to the RR 3.3 for near wins and EXT multiple schedule components, the median response latencies following losses were compared between components in the exposure phase (refer to the Experiment 1 analysis). Figure 13 shows that in the exposure phase, that 30 out of 40 participants had longer response latencies - a slower spin response rate – in the RR 3.3 component than in the EXT component in at least two blocks. Figure 14 shows the group's mean median response latencies for losses in each component type, and across each third of the exposure phase, and shows that as a group, participants were slower to make spin responses in the RR 3.3 component than in the EXT component. The small, but consistent difference in responding between the RR 3.3 and EXT component in the exposure phase indicates that the participants' behaviour was sensitive to the multiple schedule components on both the individual and group level. That is, participants behaved differently depending on whether there were near wins in a component or not. Also visible in Figure 13 is that there tends to be a reduction is response latency across the session. This is evident



*Figure 13.* Participants' median response latencies following losses across the exposure (blocks 1-3) and observing phases (blocks 4-6). One block represents one third of R 3.3 or EXT components in the exposure or observing components. Note that participant 705, 732, 735 and 738 have a different y-axis for easy comparison of latencies between components.

in for many individuals an on the group level (Figure 14). This may reflect a tendency for participants to habituate to the different outcome stimuli. These results are identical to those found in Experiment 1, for wins, and suggests that the effect of near wins in the component on spin responses following losses is similar to that of wins.



*Figure 14.* Mean of participants' median response latencies following losses across the exposure (blocks 1-3) and observing phases (blocks 4-6). One block represents one third of R 3.3 or EXT components in the exposure or observing components.

To check whether participants knew which component was active even when the S+ and S- were not always present, response latencies following losses in the observing phases were also assessed (see blocks 4-6 on Figures 13 and 14). This information would indicate whether participants' observing behaviour was maintained by information or not. Blocks four to six, in Figure 13, represent the median response latency in the observing phase (refer to Experiment 1 analysis). Figure 13 shows that, during the observing phase, 39 out of 40 participants responded slower following losses in at least two of the three blocks of the RR 3.3 components compared to EXT. The small, but consistent difference in responding between the RR 3.3 and EXT component in the observing phase indicates that the.



*Figure 15.* Participants' median response latencies following losses during periods of the observing phase when S+ and S- were present (PR; solid) and absent (AB; stripy). Note that participant 713 and 739 have a different y-axis for easy comparison of latencies between present and absent periods. No bar for stimulus present periods indicates that the participant did not make an observing response which produced that stimulus or did not make spin responses during stimulus present periods.

participants' behaviour was sensitive to the mixed schedule components on both the individual and group level. The median response latencies were also calculated following losses for when the discriminative stimuli were present and absent. Figure 15 shows that, for 25 out of 40 participants, median latencies were longer in S + *present* periods compared to S-*present* periods. More important, 38 out of 40 participants had longer response latencies in S+ *absent* periods than S- *absent* periods. This finding is also reflected in the groups' mean of the median response latencies following losses, which were longer during S+ absent (M = 950.99 ms, SD = 362.57) periods than S- absent periods (M = 800.81 ms, SD = 365.40). Longer latencies for spin responses during S+ absent periods compared S- absent periods indicates that the percentage of near wins participants identified was sufficient for them to identify the active component with reasonable accuracy. This means that participants were unlikely to use the observing buttons for information about the active component

**Task understanding.** Exit survey responses to the items : "1. I understood what to do in this task", "5. The 'Am I playing on...?' buttons showed me the background of the active slot machine.", "6. I used the 'Am I playing on...?' buttons to decide how much to bet.", and "8. I used the "Am I playing on...?' buttons to switch to another slot machine." were analysed in order to evaluate the participants' understanding of the slot-machine task or identify any misconceptions about the task that were common in the piloting stage of this research. Participants were selected either "Agree", "Disagree", or "I don't know" in response to each of these items. Most participants selected "agree" for items one, five and six, and selected "Disagree" for item eight, which indicates that the majority of participants understood what to do in this task, the two slot-machine components were different, and what the observing buttons did (see Appendix VI for graphs). The remaining questions were used primarily in the development and piloting stage of this study. This finding suggests that observing behaviour was not the result of any misconception or misunderstandings about the task.

## Conclusion

Based on the results of Experiment 1, which found a consistent effect of wins on the percentage of observing behaviour for the S+, the finding in this study that only some participants observed more for the S+ while others observed more for S- suggests that near wins are not universally reinforcers. However, those with slot-machine experience tended to observe more consistently for the S+, which suggests that slot-machine experience may moderate any conditioned reinforcement effect of near wins. These results are consistent with the strong and plausible explanation that near wins become conditioned reinforcers via the association between near wins and wins learned through slot-machine experience. However, all but one participant had longer response latencies after near wins compared to losses which can be interpreted as indicating that near wins have some conditioned reinforcement effect, even in those participants with no slot-machine experience. The response latencies after losses were longer in the component that had near wins just as they were longer in the component that had wins in Experiment 1 also suggesting a similar effect of near wins and wins. That these measures of the reinforcing effects of near wins do not agree may indicate that the response latencies following spin outcomes are confounded with a variable unrelated to the reinforcing properties of the outcomes. With respect to the latency following near wins compared with latencies following losses the time available to decide on the next bet amount may be a confound. This will be discussed more in-depth the general discussion.

The failure to find a consistently higher percentage of observing for the S+ may be explained by the low rate of wins in the current experiment. As discussed earlier, if Pavlovian conditioning is the process by which near wins become conditioned reinforcers then every win is a conditioning trial, and every near win is an extinction trial. In the RR 3.3 component of the current experiment, the programmed percentage of wins was 10% and the percentage of near wins was 30%. This percentages of wins, compared to near wins, may not have been

sufficient to strengthen the conditioned reinforcing effect of near wins, whilst negating the extinction effect of the near wins. However, the contingency between near wins and wins was high as there were never a win trial that was not preceded by a near win. This means that even though more near wins may result in weaker conditioning, conditioning should still occur with enough trials. This could explain why those with experience showed a consistent near win effect, but those without slot-machine experience did not show such a consistent effect. Additionally, real-world slot machines have higher rates of wins than arranged by the current procedure which may also have contributed to the effect of near wins in experienced gamblers. Based on this argument, a greater percentage of wins would be expected to produce a more consistent near win effect on observing responses even in participants with no slot machine experience.

#### **EXPERIMENT 3**

Experiment 3 was a partial replication of Experiment 2 that increased the programmed probability of wins, had a more detailed assessment of near win experience that included not only slot machine experience, but also scratchie card experience, and had a shorter observing phase to accommodate the longer questionnaire phase. The purpose of these questions was to establish a more sensitive measure of each participant's past exposure to near win stimuli in slot machines and scratchies. Near win stimuli are prevalent in scratchie card gambling and are very similar to those seen in slot machines (Stange, Graydon, & Dixon, 2015), it was also thought, based on the small number of participants in the previous experiment with slotmachine experience, that scratchie experience would be more common. If the participants recruited had a range of gambling experience, this more detailed measure would allow a more detailed exploration of the effect of experience found in Experiment 2 in more detail.

If near wins have reinforcing properties, as suggested by the findings in Experiment 2, and these are obtained via their Pavlovian association with wins then increasing the rate of the primary reinforcement should enhance the reinforcing efficacy of near wins (Shahan, 2002a; Shahan, Magee & Dobberstein, 2003). Moreover, this change was informed by near win persistence studies that tend to show that a higher win percentage produces a higher ideal near win percentage (see Table 3). Table 3 shows that some studies that used higher percentages of wins found a higher ideal percentage of near wins for persistence behaviour in slot machine gambling.

# Table 3

Summary of persistence studies on near wins and the corresponding win and near win percentages that produced ideal responding.

Authors	Win percentage	I	Near Win	Percentag	ges	Ideal Near Win Percentage
Ghezzi, Wilson, Porter, (2006)	40 %	0 %	33 %	66 %	100 %	66 %
Ghezzi et al., (2006)	40 %	0 %	33 %	66 %	100 %	None
Daugherty and MacLin (2007)	30 %	0 %	15 %	30 %	45 %	45 %
Côté et al., (2003)	18.75 % (0% control)	0 %	25 %	-	-	25 %
Strickland and Grote (1967)	10 %	5%	25 %	-	-	25 %
Kassinove and Schare (2001)	10 %	15 %	30 %	45 %	-	30 %
Ghezzi et al., (2006)	10 %	0 %	33 %	66 %	100 %	Mixed

*Note*. From "Simultaneously Observing Concurrently-Available Schedules as a Means to Study the Near Miss Event in Simulated Slot Machine Gambling " by B. Witts, P Ghezzi, M. Manson 2015, *The Psychological Record*, 14(3), p. 62.

### Method

# **Participants**

Participants were 21 people recruited from the Victoria University of Wellington community who received a movie ticket voucher for their participation. None of the participants scored within the problematic range on the SOGS. All participants were provided with contact information for local problem gambling support services.

### **Apparatus and Setting**

This experiment was conducted in the same location, with the same equipment, and an identical slot-machine simulation as in Experiment 1 to 2.

# Procedure

The procedure for this experiment was exactly as described in Experiment 2, except for the following changes:

(1) In both components there was now a 0.30 probability that a win would occur. The probability of near wins remained the same as in Experiment 2. Table 4 provides a summary of the programmed probability of all spin outcome types for Experiment 3.

(2) In the observing phase, the two mixed schedule components alternated as in the two previous experiments, but this phase lasted until the participant had completed 20 minutes of the observing phase.

(3) In the questionnaire phase, participants answered four additional questions from the Canadian Problem Gambling Index that had been revised for a New Zealand Audience (CPGI; see Appendix VII) before completing the SOGS.

### Table 4

Programmed probabilities for spin outcomes in each component of the multiple and mixed schedules of reinforcement in Experiment 3.

	Multiple and Mixed Schedule Components		
Spin outcome	RR 3.3	EXT	
Win	.30	.30	
Near Win	.30	.00	
Loss	.40	.70	

# **Results and Discussion**

## **Observing Response**

To evaluate the reinforcing efficacy of near wins, the percentage of observing responses made to the button revealing the S+ was calculated. Figure 16 shows the percentage of observing responses, calculated as in in Experiment 1 and 2, that were allocated to the S+ for each participant. The percentage of observing responses made to the S+ button varied considerably across participants (0% to 100%). As can be seen in Figure 16, three participants did not observe at all and of the remainder 10 observed more for S+, six for S- and two showed no differential observing. Differential observing was thus less consistent than in the previous experiment. Moreover, fewer than half of the participants exhibited differential observing for the S+, which suggests that more wins did not increase the value of near wins as a conditioned reinforcer.

In the previous experiment there was evidence that participants' slot-machine experience may moderate the reinforcing efficacy of near wins, and consequently the



*Figure 16.* Participants' percentage of the total observing responses made for the S+ in Experiment 3. Bars above the x-axis indicate a greater percentage of observing responses made for the S+, and bars below the x-axis indicate a greater percentage of observing response made for the S-. Bars on the left represent participants who had slot-machine experience, bar on the right represent those who had no slot-machine experience. Note, participant 909 and 921 observed equally for the S+ and S-, otherwise no bar indicates that the participant did not make any observing responses.

reinforcing efficacy of the S+. To evaluate how the reinforcing efficacy of near wins varied as a function of slot-machine experience in the current experiment, the percentage of observing responses made for the S+ was compared between participants who had experience with slot machines and/ or scratchie cards. Slot-machine and scratchie experience was determined by how the participant had responded on the CPGI questionnaire about their experience with various modes of gambling. Due to the limited gambling experience of participants in this experiment, participants who responded anything greater than zero for questions on the CPGI about time or money spent on slot machines or scratchies, or frequency of slot machines or scratchies use were categorised as having experience. Figure 16 shows the percentage of observing responses allocated to the S+ for each individual with experience (left-hand side of the figure) and with no experience (right-hand side of the figure). A visual analysis of Figure 16 indicates that those with slot-machine or scratchie experience did not exhibit greater differential observing for the S+. In fact, those with no experience tended to show more differential observing for the S+. This result is inconsistent with the results from Experiment 2 and neurobehavioral research which has found that those that have spent more time gambling exhibit a greater near win effect (Chase & Clark, 2010; Dymond et al., 2014; Habib & Dixon, 2010), and suggests that near wins are not conditioned reinforcers for this group of participants in this procedure.

The total number of S+ responses across the 20-minute observing phase was on average very similar for the S+ (M = 22.62, SD = 21.28) and for the S- (M = 22.24, SD = 23.34). Fewer than half of participants allocated more observing responses to the S+, but there was substantial variation in the actual number of observing responses made, across participants. For the S+, observing responses ranged from zero to 78 responses, and for the S-, observing responses ranged from zero to 90 responses. The standard deviations indicate considerable variability in observing responses, a result that is consistent with Experiments 1 and 2, and the human observing literature (e.g. Fantino & Case, 1983; Shiels et al., 2007).

A time course analysis of observing responses was conducted to evaluate whether observing behaviour exhibited by the participants was consistent across the course of the observing phase. This analysis showed that differential observing was not systematically changed throughout the observing phase, a result also found in Experiment 2 (see Appendix VIII). These results suggest that when a participant exhibited differential observing for the S+ or S- this behaviour was somewhat consistent across the course of the observing phase.

In this experiment, the probability of wins was increased to enhance the conditioned reinforcing effect of near wins, and negate the extinction effect that may occur in each near win trial. However, this manipulation did not increase the observing percentages for the S+. It is possible that the failure to find consistent differential observing for the S+ was an artefact of an increase in competition between observing behaviour and behaviour related to the primary reinforcer (i.e. spin and bet responses). Shahan (2002a) investigated the effect of rate and magnitude of primary reinforcement on observing behaviour of rats and found that observing behaviour decreased as with the rate and magnitude of the primary reinforcer. However, when the response requirement for the primary reinforcer was removed from the observing response procedure, and there was no competition, observing behaviour increased. This finding suggests that behaviour related to the primary reinforcer can compete with observing behaviour, compromising observing behaviour and the measurement of the value of the conditioned reinforcer. If competition was present in the current experiment then the previous experiment.

To evaluate whether observing behaviour differed in Experiment 3, compared to Experiment 2, as a result of increased wins, the median of the mean observing rates in the RR 3.3 and EXT components were compared between experiments. Figure 17 displays the group's median of the mean observing response rates for the S+ and S- across three consecutive blocks in the observing phase for Experiment 2 and across the two consecutive blocks of the observing phase in Experiment 3. A visual analysis of Figure 17 indicates that there were no notable differences between observing response rates for the S+ and S- in Experiment 3 compared to Experiment 2. For experiment 2, the median of mean observing response rates was greater for the and for the S+ than the S, but this effect was primarily driven by the participants with slot machine experience. These findings indicate that there was not an effect of competition, as a result of the increased number of wins, on observing



*Figure 17.* Medians of participants' mean observing response rates for the S+ (black line) and S- (grey line) across the consecutive blocks of the observing phases in Experiment 2 (First blocks 1 to 3), and Experiment 3 (Second blocks 1 and 2). Each block represents five iterations each of the RR 3.3 or EXT components, making each block five minutes long in total.

behaviour. Moreover, in the current study's slot-machine task, every time the spin button was clicked the spin and bet buttons became inactive for the duration of the spin cycle. This meant that there was very limited time during the task where competition could occur. Based on this and the similar observing rates in Experiment 2 and 3 it is unlikely that competition was a factor in this experiment and, therefore, the percentage of observing responses is likely to reflect the conditioned reinforcing value of near wins.

## **Additional Analysis**

Outcome Response Latency. To investigate the effect of win, near win and losses on response latency, the median response latency following each outcome type was calculated for each participant. These are displayed in Figure 18. Seventeen out of 21 participants showed the same pattern of response latencies as in Experiment 1 and 2: the response latency following wins was the longest, followed by near wins, and losses had the shortest response latency. The longest median response latency for participant 904 was following near wins, then wins, and losses had the shortest median response latency. The longest median response latencies for participants 902 and 913 were following wins, then losses, and the shortest median response latency were following near wins. The group's mean of the median latencies was also calculated and reflected the same pattern exhibited by most participants: the mean of the median latencies was greatest following wins (M = 1742.71 ms, SD = 765.43), followed by near wins (M = 1054.71 ms, SD = 367.48), and shortest following complete losses (M =925.52 ms, SD = 322.05). These findings were similar to those in Experiment 1 and 2, and previous gambling research using response latency (Daly et al., 2014; Delfabbro and Winefield, 1999; Dillen and Dixon, 2008; Peters et al., 2010). One interpretation of these results is that near wins are more reinforcing than complete losses, but not as reinforcing as wins.



Spin Outcome Types (Wins/Near Wins/Losses)



Across Component Response Latency. To investigate whether participants' spin behaviour was sensitive to the RR 3.3 and EXT multiple schedule components, the median response latency following losses were compared between components in the exposure phase (refer to Experiment 2 analysis). Figure 19 shows that all participants had longer response latencies - a slower spin response rate - in at least two blocks of the exposure-phase RR 3.3 components. Figure 20 displays the group's mean median response latencies for losses in each component type, and across each third of the exposure phase. These result are identical to that found in Experiment 1 for wins, and Experiment 2 for near wins, and indicate that the participants' behaviour was sensitive to the multiple schedule components on both the individual and group level.

To check whether participants knew which component was active even when the S+ and S- were not always present, response latencies following losses in the observing phases were also assessed (see blocks 4 and 5 on Figures 19 and 20). This analysis would indicate whether participants' observing behaviour was maintained by information.

Blocks four and five, in Figure 19, represent the median response latency in the observing phase (refer to Experiment 1 analysis). Figure 19 shows that, during the observing phase, 20 out of 21 participants responded more slowly in both blocks of the RR 3.3 components compared to EXT, and only participant 905 responded more slowly in both blocks of EXT components compared to RR 3.3. The consistent difference in responding between the RR 3.3 and EXT component in the observing phase indicates that the participants' behaviour was sensitive to the mixed schedule components on both the individual and group level and suggests that participants did not observe for information.

However, it was possible that this effect was driven by the response latencies during periods when the component stimuli were present. Therefore, median response latencies were calculated following losses for when the discriminative stimuli were present and absent in the



*Figure 19.* Participants' median response latencies following losses across the exposure (blocks 1-3) and observing phases (blocks 4-6). One block represents one third of R 3.3 or EXT components in the exposure or observing components. Note that participant 907, 910 and 916 have a different y-axis for easy comparison of latencies between components.


*Figure 20*. Mean of participants' median response latencies following losses across the exposure (Blocks 1 to 3) and observing phases (Blocks 4 and 5). One block represents one third of R 3.3 or EXT components in the exposure or observing components.

observing phase (refer to Experiment 1 analysis). Figure 21 shows that, for 9 out of 21 participants, median latencies were longer in S + *present* periods compared to S- *present* periods, and 20 out of 21 participants had longer response latencies in S+ *absent* periods than S- *absent* periods. This finding is also reflected in the groups' mean of the median response latencies following losses, which were longer during S+ absent (M = 1097.50 ms, SD = 460.39) periods than S- absent periods (M = 887.67 ms, SD = 382.90). Longer latencies for spin responses during S+ absent periods compared S- absent periods indicate that participants' spin responding was sensitive to the active component in the absence of any discriminative stimuli. This means that participants were unlikely to use the observing buttons for information about the active component.



*Figure 21*. Participants' median response latencies following losses during periods of the observing phase when S+ and S- were present (PR; solid) and absent (AB; stripy). No bar for stimulus present periods indicates that the participant did not make an observing response which produced that stimulus or did not make spin responses during stimulus present periods.

**Task understanding.** Exit survey responses to the items : "1. I understood what to do in this task", "5. The 'Am I playing on...?' buttons showed me the background of the active slot machine.", "6. I used the 'Am I playing on...?' buttons to decide how much to bet.", and "8. I used the "Am I playing on...?' buttons to switch to another slot machine." were analysed in order to evaluate the participants' understanding of the slot-machine task or identify any misconceptions about the task that were common in the piloting stage of this research. Participants were selected either "Agree", "Disagree", or "I don't know" in response to each of these items. Most participants selected "agree" for items one, five and six, and selected "Disagree" for item eight, which indicates that the majority of participants understood what to do in this task, the two slot-machine components were different, and what the observing buttons did (see Appendix IX for graphs). The remaining questions were used primarily in the development and piloting stage of this study. This finding suggests that observing behaviour was not the result of any misconception or misunderstandings about the task.

## Conclusion

In this experiment the ratio of wins to near wins was increased to investigate whether this would enhance the conditioned reinforcing effect of near wins. However, no consistent conditioned reinforcement effect of near wins was found. Based on the results of Experiment 1, in which those with slot-machine experience showed a consistently a greater percentage of observing for the S+, slot-machine and scratchie card experience was expected to increase the effect of near wins. However, those with slot-machine and scratchie card experience did not show a more consistent effect of near wins. This finding suggests that there may be another extraneous uncontrolled variable that moderates the conditioned reinforcing effect of near wins, or that near wins are not conditioned reinforcers, but, instead, near wins may function as discriminative stimuli.

#### SECONDARY ANALYSIS

The consistent result in Experiments 1, 2 and 3 was differential observing for the S+ or S-. In Experiments 2 and 3, participants did not tend to respond equally for the S+ and S-, which would have strongly suggested no effect of near wins on observing behaviour, nor did participants have consistently greater percentages of observing for the S+, which would have been strong evidence that near wins are conditioned reinforcers. Rather, participants had greater percentages of observing for one stimulus or the other. Differential observing could be evidence of participants' idiosyncratic preference for one machine over another, or evidence of another uncontrolled extraneous variable. Alternatively, if participants' observing behaviour was sensitive to near wins, but near wins are not conditioned reinforcers, they may instead function as discriminative stimuli. The following analyses explored other possible variables as an explanation for the results in Experiments 2 and 3, and also assessed near wins as possible discriminative stimuli.

#### Win percentage and Return-to-Player

In the current study's experiments, the percentage of win and subsequently the return-to-player (RTP) percentages were not controlled and varied across components and participants. The percentages of wins were programmed to be identical on each machine in Experiment 2 and 3. In Experiment 2 this percentage was 10% and in Experiment 2 each slot machine was programmed to have 30% wins. However, the experienced win percentages varied as a function of the number of spins played. Likewise, the experienced RTPs varied as a function of the number of spins played and the amount of credit bet per spin. See Appendix X and XI for participants' individual win percentages and RTPs on the RR 3.3 and EXT components.

To evaluate the effect of the experienced win percentage on observing behaviour the percentages of observing for the S+ were evaluated for participants who had a greater win percentage on the RR 3.3 near win component. If win percentage contributed to differential observing, then these participants would have observed more for the S+. Table 5 shows the mean observing percentage for the S+ for these participants and the percentage of these participants who observed more for the S+. This table shows that fewer than half of these participants exhibited a greater percentage of observing for the S+, which indicates that a greater win percentage on the RR 3.3 component is unlikely to have driven observing behaviour. This result is consistent with past research on win percentage, which has shown that participants are sensitive to win percentage differences when the percentages are very low (e.g. 2% and 10%; Dixon, MacLin, & Daugherty, 2006), but less able to discriminate when the win percentages are much higher (e.g. 20% and 40%; Coates & Blaszczynski, 2013). These results suggest that participants' observing behaviour was not sensitive to the small differences in experienced RTP between the RR 3.3 and EXT components.

To evaluate the effect of the experienced win percentage and RTP on observing behaviour the percentages of observing for the S+ was evaluated for participants who had a greater RTP on the RR 3.3 near win component. Table 5 shows the mean observing percentage for the S+ for these participants and the percentage of participants who observed more for the S+. These results show that mean observing percentage for the S+ was close to 50% but that more than half of these participants exhibited a greater percentage of observing for the S+, which indicates that a greater RTP on the RR 3.3 component may have impacted observing behaviour.

#### Table 5

The mean observing percentages for the S+ in Experiments 2 and 3, and the percentage of participants in Experiments 2 and 3 who observed more for the S+.

RR 3.3 component	Mean percentage of	Percentage of participants who
properties	observing for the S+	observed more for the S+
Greater RTP	50.68%	61.54%
Greater percentage of wins	45.75%	46.67%
First component	48.06%	53.13%
Sunset theme	45.65%	46.88%
S+ button on right side	49.07%	46.88%

Note. Percentages markedly over 50% indicate a potential response bias.

To evaluate more closely how the observing behaviour for the S+ varied as a function of RTP, the percentage of observing responses made for the S+ was compared between participants who had a greater RTP on the RR 3.3, compared to EXT, and those who had an equal or smaller RTP on the RR3.3 compared to EXT (see Figure 22). Figure 22 shows the percentage of observing responses allocated to the S+ for each individual in the greater RTP group compared to the equal or smaller group. A visual analysis of Figure 22 indicates that 24 out of 39 participants in the greater RTP group showed differential observing behaviour for the S+, and 13 observed more for the S-. In contrast, in the equal or smaller RTP group, eight out of 21 participants showed differential observing for the S+, one participant observed equally for the S+ and S- (714), and 11 out of 21 participants showed differential observing



*Figure 22.* Participants' percentage of the total observing responses made for the S+ in Experiment 2 and 3. Bars above the x-axis indicate a greater percentage of observing responses made for the S+, and bars below the x-axis indicate a greater percentage of observing response made for the S-. Bars on the left represent participants who had a greater RTP on the RR 3.3 component than the EXT component, and bars on the right represent those who a smaller RTP on the RR 3.3 component than the EXT components. No bar indicates that the participant did not make any observing responses. Note, the exception being participant 714 who observed equally for the S+ and S-

for the S-. Figure 22 shows that those with a greater RTP exhibit more differential observing for the S+, while those in the equal or smaller RTP group tended to show more differential observing for the S-. This finding suggests a possible interaction between the effect of near wins and RTP on percentage of observing for the S+. These results are inconsistent with the literature that has shown that different RTP percentages have no effect on betting behaviour (Brandt & Pietras, 2008; Weatherly & Brandt 2004), persistence of gambling behaviour (Weatherly & Brandt, 2004), response latencies (Schreiber & Dixon, 2001) or preference (Haw, 2008). There is some evidence that that participants can be sensitive to varying RTPs, but one study showed that participants preferred slot machines with a higher RTP (Coates & Blaszczynski, 2013), and another study discovered that participants preferred slot machines with a lower RTP (Coates & Blaszczynski, 2014). More research is required to fully understand the effect of RTP on gambling behaviour. In the current study RTP was not controlled as this is consistent with how slot machines function in the real world and important for the ecological validity of this study. However, future research could investigate the effect of RTP and near wins on observing behaviour by varying the RTP more systematically.

#### Counterbalancing

In the current study's experiments, properties of the RR 3.3 component were counter balanced across participants. These included whether participants were exposed to the RR 3.3 component first, the theme of the RR 3.3 component, and the location of the observing button for the RR 3.3 components S+. To evaluate the effect of the counter balancing conditions on observing behaviour the percentages of observing for the S+ was evaluated for participants who experienced each of these conditions. Table 5 shows the mean observing percentage for the S+ for these participants and the percentage of participants who observed more for the S+. These results show that mean observing percentage for the S+ did not vary systematically with these variations. These findings indicate that none of the factors that were counter balanced in this study influenced observing behaviour

#### **Bet Amount Following Near Wins**

The results from Experiment 2 and 3 suggest that near wins may not be conditioned reinforcers, therefore near wins may function as discriminative stimuli instead. A discriminative stimulus provides information about the availability of reinforcement and can influence the likelihood of different behavioural responses. As already discussed, in many non-gambling contexts, nears wins indicate that reinforcement is likely to occur in the future with perseverance. This idea could be generalised to near wins in slot-machine gambling, even though slot-machine outcomes are independent. To show that near wins functioned as discriminative stimuli in the current study participant must have been more likely to choose one behaviour over another based on the presence or absence of the stimuli. In the current study, the only choices available were to spin or not and the amount to bet (one credit or five credits). If participants bet more following near wins, this would indicate that they expected a win to follow and that near wins were treated as discriminative stimuli.

To assess whether participants were more likely to place a higher bet following near wins, the mean of participants' bet amount following the different outcome types was calculated. The mean bet for each participant was calculated as the total amount bet following each outcome, divided by the number of times that outcome occurred. This was calculated for wins, near wins, and losses for each participant in Experiments 2 and 3. The mean of these mean bets was greater following wins (M = 2.76, SD = 1.15) and near wins (M = 2.76, SD = 1.10) compared to losses wins (M = 2.50, SD = 1.01). This pattern of bet amounts following each outcome was relatively consistent, 68.85% of participants in Experiment 2 and 3 bet more following near wins than losses. In all experiments the only bet options were for one and five credits. Larger mean of mean bets following near win and wins, compared to losses,

suggests that participants were more likely to bet five credits after seeing these outcomes. This finding is evidence that near wins may have functioned as discriminative stimuli in the current study.

#### **General Discussion**

The current study investigated the conditioned reinforcing efficacy of near wins in slot-machine gambling. Previous research measuring persistence had found different ideal percentages of near wins (e.g. Daugherty & Maclin, 2007; Kassinove & Schare, 2001), which suggests that near wins may gain conditioned reinforcing properties via the Pavlovian near win - win pairing that occurs within every win sequence. However, previous measures of near wins, such as preference and persistence, had some procedural issues that made them inappropriate for investigation of near wins in slot machines. Likewise, previous studies using variations of the observing response procedure were methodologically flawed, and found conflicting results (i.e. Schienle, 2014; Witts et al., 2015). The current study developed an observing response procedure that more closely resembled the standard design in order to overcome some of these issues and measure the reinforcing efficacy of near wins in a simulated slot machine.

#### **Summary of results**

Experiment 1 tested the observing response procedure as a measure of conditioned reinforcement with a more obvious conditioned reinforcer – wins (pelfabbro & Winefield, 1999; Witts et al., 2015). Almost every participant in this experiment exhibited a greater percentage of observing for the background associated with wins. Experiment 2 applied this procedure to near wins and found less consistent differential observing for the S+, now associated with near wins. However, differential observing for the S+ was more consistent for those who had already been exposed to near wins in slot-machine gambling. Experiment 3

attempted to enhance the effect of near wins by increasing the programmed percentage of wins. The definition of near win experience was also broadened to include not only those with slot-machine experience, but also those with scratchie card gambling experience. Participants in this experiment did not observe more consistently for S+ and near win experience did not seem to have an effect. These finding suggest that near wins are not conditioned reinforcers because they do not produce a consistent, replicable effect on observing responses.

While this study did not find consistent differential observing for the S+, participants did consistently observe more for either the S+ or the S-. This was evidence that participants had a preference for one machine over another. While, this finding may have been a result of idiosyncratic preference for the appearance of one of the machines, extraneous and uncontrolled variables were assessed as possible explanations for participants' observing behaviour. RTP emerged as a possible variable that may have interacted with the presence of near wins to contribute to greater observing for one machine over another. More than half of the participants with a greater RTP on the RR 3.3 component had a greater percentage of observing for the S+. Evidence was also found that near wins may have functioned as discriminative stimuli, rather than conditioned reinforcers. It was found that the bet amounts following near wins was larger compared to losses, and this pattern of bet amounts was true for most participants in Experiment 2 and 3. A larger bet following near wins indicates that participants expected a win to follow near wins. This suggests that near wins functioned as discriminative stimuli.

The results from this study's main dependent variable, observing percentages, indicate that near wins are not conditioned reinforcers. However, the results from the other measure of conditioned reinforcement, response latency, indicated otherwise. Response latency is the time between the spin outcome and the next response, and it is often reported that reinforcing

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outcomes will produce longer latencies than other outcomes (Daly et al., 2014; Delfabbro & Winefield, 1999; Peters et al., 2010). For most participants, in all three experiments, response latencies were consistently the longest following wins, then near wins, and the shortest following losses. If response latency reflects the efficacy of a reinforcer, then near wins were more reinforcing than losses, but not as reinforcing as wins. This finding is consistent with previous research that also found response latencies were longer following near wins than losses (Daly et al., 2014; Peters et al., 2010); however, there is also research that has found response latencies are shorter following near wins compared to other outcomes (Dixon et al., 2013; Luo et al., 2011). The conflicting observing response and response latency results in the current study may, in fact, indicate that response latency length in the current procedure reflected factors other than the reinforcing efficacy of the previous outcome.

The response latency measure may not only reflect post reinforcement pause after wins and near wins, but also the time it took to decide on the next bet amount, based on the previous outcome. In the current study, response latency was measured as the time between the previous spin outcome and the next *bet* button response. In all three experiments, participants could bet using one of two different bet amount buttons. Participants did switch between these buttons, and the mean bet amount analysis revealed that the previous outcome did influence how much participants were likely to bet in the following trial. Therefore, the longer response latency following near wins, compared to losses, would include the time participants took to make the decision about the next bet and switch between bet amounts.

Whether or not the current study's response latency measure reflected conditioned reinforcement or also incorporated the extra time it took to make the bet could be resolved in a future study using a single bet button. This would remove the extra time required to first decide on a bet amount, based on the preceding spin outcome, and move the mouse to the new bet amount button if the decision was made to switch. This way response latency would be a more direct measure of conditioned reinforcement. If response latencies following near wins remain longer than losses this would be stronger evidence of a conditioned reinforcement effect of near wins. However, if response latencies following near wins were found to be more similar to losses this would strongly support the idea that near wins are not conditioned reinforcers, but instead discriminative stimuli.

#### Near Wins as Discriminative Stimuli

Discriminative stimuli indicate the availability of reinforcement, should a particular behaviour be performed. For instance, in the sports example described earlier, nearly wining could indicate to the player that perseverance will likely lead to actually winning in the future. In this example, the player has two options: to persevere or to not persevere. If the player perseveres reinforcement is likely, so the player is more likely to choose this behaviour. In slot machine gambling, near wins may have this same effect on behaviour, through a generalisation like process. That is, a near win may indicate to the gambler that a win is coming up because of their experience with near win type stimuli in other contexts where they are discriminative stimuli. Because slot machine outcomes in this simulation and in real world games are independent this overgeneralisation is an example of the Gambler's Fallacy – the belief that independent outcomes are actually dependent (Barron & Leider, 2009).

The current study found a discriminative effect of near wins on bet amount. Participants generally bet more following near wins than following losses. A discriminative effect of near wins has been found in previous research. In a yet-to-be published study, conducted in the same lab as the author, evidence was found of a discriminative effect of 'offline near wins' (Macaskill, 2015). Offline near wins are winning sequences that occur above or below the pay line, and result in a monetary loss – similar to the near win type focused on in the current study. This research found that participants were more likely to gamble on the slot-machine line that had recently presented an offline near win (Macaskill, 2015). In addition, participants were also likely to bet more on the lines that previously presented an offline near win (Macaskill, 2015). This research concluded that, while slot-machine spins are independent and offline near wins do not signal the likelihood of future wins, near win stimuli may still have a discriminative effect on gamblers (Macaskill, 2015).

Similarly, Tan, Macaskill, Harper, and Hunt (2015), in a study that investigated the verbal processes that underlie the effect of near wins on gamblers, also found evidence that near wins function as discriminative stimuli. In this study different relationships between different slot machine outcomes and the words 'win', 'almost', and 'loss' were trained. One finding was that the derived relationship between loss outcomes and the word 'almost' was less easily acquired than the derived relationship between near wins and the word 'almost'. This indicated that participants may have already held the false belief that near wins were an almost win, generalised from the belief about near wins in non-gambling contexts.

Near wins as discriminative stimuli may also account for the near win effect seen in persistence and preference studies. In persistence studies, participants are typically exposed to a combination of near wins, wins, and clear losses in an exposure phase, followed by an extinction phase. The number of responses the participant makes in this second phase is thought to reflect the reinforcing value of the outcomes they were initially exposed to. However, this may instead reflect the discriminative effect of the outcomes they were exposed to. Actual discriminative stimuli indicate the availability of reinforcement and increase the likelihood of a particular behaviour being performed. Côté et al. (2003), Daugherty and Maclin, (2007), Ghezzi et al. (2006), and Kassinove and Schare (2001) found that participants are more likely to continue responding in persistence tests when they had been exposed to near wins. And Giroux and Ladouceur (2006) and Gyozo and Kormendi (2012) found that participants prefer to gamble on slot machines with near wins. These results would also be expected if near wins are incorrectly perceived as discriminative stimuli signalling increased probability of reinforcement.

The current study's result, and previous research, suggest that near wins may have a discriminative effect, however as a person becomes more experienced in slot-machine gambling the function of near wins may transform into one of conditioned reinforcement. This is theoretically plausible as experience of near wins, in this context, where near wins do not signal wins, should weaken their control as discriminative stimuli. However, increased gambling could lead to increased exposure to near-win win pairing that occurs within all wins and would strengthen near wins as conditioned reinforcers. Participants did not consistently observe more for the S+. This was especially evident in those with no slot-machine experience in Experiment 2. This may suggest that the discriminative function of the near win is limited to those with little previous exposure to them. In contrast, previous neurobehavioral research that found a greater near win effect in pathological (Dymond et al., 2014; Habib & Dixon, 2010) and regular slot-machine gamblers (Chase & Clark, 2010) compared to non-pathological and non-regular. The different near win effects for those with more experience suggest that the function of near wins is not fixed; rather, the function of near wins may evolve over time to one of conditioned reinforcement.

Whether near wins function differently depending on the individual's history with slot machines could be resolved by replicating the current study in a sample with varying degrees of slot-machine gambling experience. This should include those with no experience and those further down the problem gambling spectrum. If problem gamblers observe more consistently for the S+ and those with no experience observe the least consistently for the S+, this would be evidence of an evolving effect of near wins.

#### **Near wins and Gambling Interventions**

If the function of near wins changes with experience, interventions for gambling behaviour should correspond to their function. When near wins function as discriminative stimuli for inexperienced gamblers interventions should focus on undermining false beliefs about slot machine gambling events signalling future winning events. Messages should emphasise that these gambling events are independent and that "persistence" does not pay off. For more experienced gamblers, for whom near wins may function as conditioned reinforcers, Pavlovian based interventions may be more appropriate. If near wins gain reinforcing properties via the pairing of near wins and wins in every win sequence, then exposing these gamblers to win sequences that do not always incorporate a near win stimulus will weaken contingency between wins and near wins and in turn weaken the reinforcing efficacy of near wins. This could be achieved by having slot machines only present spin outcome symbols simultaneously, rather than sequentially, effectively removing the Pavlovian pairing between near wins and wins. Research already conducted, in the author's lab, has found evidence that simultaneous presentation of slot machine outcomes may reduce the reinforcing efficacy of near wins. In one experiment, Macaskill et al. (in prep) found that when slot-machine symbols were revealed simultaneously response latencies following near wins were initially longer than losses, but by the second half of the session were no longer different to response latencies following losses. This finding suggested that near wins lost their reinforcing efficacy as the session progressed and participants were exposed to wins that were no longer preceded by near wins.

Current Australian and New Zealand Gaming Machine National Standards already require that slot machines do not "improperly indicate a near miss" (Ministry of Business, 2010, p. 48). Therefore, there is no reason that these standards could not also regulate the presentation of slot machine outcomes. Doing so could reduce persistence of slot machine gambling.

### Conclusion

The aim of the current study was to develop an appropriate observing response procedure in which to investigate the conditioned reinforcing properties of near wins. Results in Experiment 1 indicated that the procedure developed was an effective measure of reinforcement for wins. When this observing procedure was applied to near wins the results suggested that near wins did not have conditioned reinforcing properties, but instead near wins may have a discriminative effect. That is, those with minimal slot-machine experience may be more prone to the erroneous Gambler's fallacy and treat near wins as indicative of a future win, even though slot-machine outcomes are entirely independent and it is possible to never experience a winning outcome. However, the sample in this study had little slotmachine experience and previous research has shown an effect of near wins in more experienced slot-machine gamblers. Therefore, near wins may still have conditioned reinforcing properties in an experienced population. Controlling for slot-machine experience or applying this observing response procedure to a more experienced sample is an important next step in the investigation of near wins as conditioned reinforcers.

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## **Appendix I: South Oaks Gambling Screen**

1. Please indicate which of the following types of gambling you have done in your lifetime. For each type, mark one answer: "**Not at All**," "Less than Once a Week", or "Once a Week or More."

Please Check one answer for each statement:	NOT AT ALL	Less than once a week	Once a week or more
a. Played cards for money.			
b. Bet on horses, dogs, or other animals (at OTB, the track, or with a bookie).			
c. Bet on sports (parlay cards, with bookie, at Jai Alai.			
d. Played dice games, including craps, over and under or other dice games.			
e. Went to casinos (legal or otherwise).			
f. Played the numbers or bet on lotteries.			
g. Played bingo.			
h. Played the stock and/or commodities market.			
i. Played slot machines, poker machines, or other gambling machines.		-	
j. Bowled, shot pool, played golf, or some other game of skill for money.			
k. Played "instant kiwi" or other "scratchies"			
1. Some form of gambling not listed above (please specify):			

2. What is the largest amount of money you have ever gambled with on any <u>one-day</u>?

Never Gambled	More than \$100.00 up to \$1,000
\$ 1.00 or less	More than \$1,000 up to \$10,000
More than \$1.00 up to \$10.00	More than \$10,000
More than \$10.00 up to 100.00	

3. Check which of the following people in your life has (or had) a gambling problem.

\_\_\_\_\_Father

\_\_\_\_\_ Mother

\_\_\_\_\_ My child(ren)

\_\_\_\_\_ A Friend or someone important in my life

4. When you gamble, how often do you go back another day to win back money you have lost?

\_\_\_\_\_ Another relative

Never	Most of the time
Some of the time (less than half	Every time that I lose
of time I lose).	

5. Have you ever claimed to be winning money gambling, but weren't really? In fact you lost?

\_\_\_\_\_ Never \_\_\_\_\_ Yes, less than half the time I lost

Yes, most of the time

6. Do you feel you have ever had a problem with betting or money gambling?

No Yes Yes, in the past, but not now.

7. Did you ever gamble more than you intended to?

\_\_\_\_\_Yes \_\_\_\_No

8. Have people criticized your betting or told you that you had a problem, regardless of whether or not you thought it was true?

\_\_\_\_\_Yes \_\_\_\_No

9. Have you ever felt guilty about the way you gamble, or what happens when you gamble?

\_\_\_\_\_Yes \_\_\_\_No

10. Have you ever felt like you would like to stop betting money on gambling, but did not think that you could?

Yes No

11. Have you ever hidden betting slips, lottery tickets, gambling money, IOUs, or other signs of betting or gambling from your spouse, children or other important people in your life?

\_\_\_\_\_Yes \_\_\_\_No

12. Have you ever argued with people you live with over how you handle money?

\_\_\_\_\_Yes \_\_\_\_No

13. (If you answered "yes": to question 12) Have money arguments ever centered on your gambling?

\_\_\_\_\_Yes \_\_\_\_No

14. Have you ever borrowed from someone and not paid them back as a result of your gambling?

\_\_\_\_\_Yes \_\_\_\_No

15. Have you ever lost time from work (or school) due to betting money or gambling?

\_\_\_\_\_Yes \_\_\_\_\_No

16. If you borrowed money to gamble or to pay gambling debts, who or where did you borrow from (check "Yes" or "No" for each):

a. From household money	Yes	No
b. From your spouse/partner	Yes	No
c. From relatives or in-laws	Yes	No
d. From banks, loan companies, or credit unions	Yes	No
e. From credit cards	Yes	No
f. From loan sharks	Yes	No
g. You cashed in stocks, bonds or other securities	Yes	No
h. You sold personal or family property	Yes	No
i. You borrowed on your checking accounts (passed bad	Yes	No
checks)		
j. You have (had) a credit line with a bookie	Yes	No
k. You have (had) a credit line with a casino	Yes	No

	Variables counterbalanced					Experiment Number		
Counterbalancing Conditions	First Component	S+ Theme	- S-	Position of S+	1	2	3	
	component meme		Button		n			
LMR	RR 3.3	Midday	Sunset	Right	3	5	2	
LML	EXT	Sunset	Midday	Left	3	5	2	
LSR	RR 3.3	Sunset	Midday	Left	3	5	3	
LSL	EXT	Midday	Sunset	Right	3	5	2	
RMR	RR 3.3	Midday	Sunset	Left	2	5	3	
RML	EXT	Sunset	Midday	Right	2	5	3	
RSR	RR 3.3	Sunset	Midday	Right	2	5	3	
RSL	EXT	Midday	Sunset	Left	2	5	3	

# Appendix II: Summary of Counterbalancing Conditions

# Appendix III: Exit Survey

Please answer whether you 'Agree' or 'Disagree', with each of the following statements. Answer each question to the best of your ability.	Disagree	I don't know	Agree
1. I understood what to do in this task.			
2. I won frequently on both slot machines.			
3. I preferred to use the 'Am I playing on Midday?' button over the 'Am I playing on Sunset?' button			
4. I preferred to use the 'Am I playing on Sunset?' button over the 'Am I playing on Midday?' button.			
5. The 'Am I playing on?' buttons showed me the background of the active slot machine.			
6. I used the 'Am I playing on?' buttons to decide how much to bet.			
7. I used the 'Am I playing on?' buttons to increase the likelihood of a winning sequence occurring.			
8. I used the "Am I playing on?' buttons to switch to another slot machine.			
9. The "Am I playing on?' buttons did not alter the likelihood of a win occurring.			
10. I had more winning outcomes (5/5 matching symbols) on slot machine	Sunset	I don't know	Midday

	Return-to-Player		Rate of Rein	nforcement
Participant ID	RR 3.3	EXT	RR 3.3	EXT
601	124%	0%	26%	0%
602	158%	0%	30%	0%
603	147%	0%	29%	0%
604	215%	0%	38%	0%
605	183%	0%	29%	0%
606	231%	0%	37%	0%
607	201%	0%	32%	0%
608	173%	0%	32%	0%
609	122%	0%	21%	0%
610	129%	0%	24%	0%
611	129%	0%	25%	0%
612	179%	0%	29%	0%
613	159%	0%	30%	0%
614	151%	0%	32%	0%
615	140%	0%	28%	0%
616	201%	0%	40%	0%
617	111%	0%	29%	0%
618	138%	0%	30%	0%
619	161%	8%	38%	1%
620	141%	0%	32%	0%

*Note*. Due to a programming error the observed percentage of wins and RTP for participant 619 during the EXT component was greater than 0. The RTP for each participant in each component was calculated as the total credit won in the component divided by the total amount bet in that component, in the exposure phase, multiplied by 100.



*Figure A*. The percentage of participants in Experiment 1 who selected the different possible responses for each survey question.



*Figure B*. The percentage of participants in Experiment 2 who

selected the different possible responses for each survey question.

# Appendix VII: Revised Canadian Problem Gambling Index Questions

Please answer some questions about activities you may participate in.

1. In the past 12 months	Daily	2 to 6 times/week	About once/week	2-3 times/month	About once/month	Between 6-11 times/year	Between 1-5 times/year	Never
a. how often did you bet or spend money on lottery tickets like Lotto ?								
b. how often did you buy daily lottery tickets like Play 3, Bullseye, or Keno?								
c. how often did you buy instant win or scratch tickets like Instant Kiwi?								
d. how often did you bet or spend money on electronic gaming machines like coin slot machines or VLT's.								
e. how often did you bet or spend money on slot machines type games online?								

2. How many	Enter number of MINUTES	more than 8 hours	Don't know
a. minutes do you normally spend each time you buy lottery tickets like Lotto?			
b. minutes do you normally spend each time you buy daily lottery tickets like Play 3, Bullseye, or Keno?			
c. minutes do you normally spend each time you buy instant win or scratch tickets like Instant Kiwi?			
d. hours or minutes do you normally spend each time you play electronic gaming machines coin slot machines or VLT's?			
e. hours or minutes do you normally spend each time you play free online slot machines type games?			
f. hours or minutes do you normally spend each time you play online slot machines type games for money?			
3. In a typical month, how much money, not including winnings, do you spend on	Enter number of dollars	Don't know	
--	-------------------------	------------	
a. lottery tickets like Lotto?			
b. daily lottery tickets like Play 3, Bullseye or Keno ?			
c. Instant win or scratch tickets like Instant Kiwi?			
d. coin slot machines or VLT's?			
e. slot machines type games online?			

4. In the past 12 months, what is the largest amount of money you ever spent on	Enter number of dollars	Don't know
a. lottery tickets like Lotto in any one day?		
b. daily lottery tickets like Play 3, Bullseye or Keno in any one day?		
c. Instant win or scratch tickets like Instant Kiwi in any one day?		
d. coin slot machines or VLT's in any one day?		
e. slot machines type games online in any one day?		

## Appendix VIII: Experiment 3 Time Course Analysis of Participants' Mean Observing Response Rate for the S+ and S-

Figure D displays each participant's mean observing response rate for the S+ and Sacross three consecutive blocks in the observing phase. Each block was five minutes long and consisted of five iterations of the RR 3.3 or EXT components. The mean observing response rates for the S+ and S- were calculated as the block's total number of observing responses divided by the total amount of time that the observing buttons were active for in that block. Differential observing behaviour for the S+ was considered consistent if it was greater for the S+ in both blocks of the observing phase. A visual analysis of Figure D indicates that only six out of the 10 participants who had a greater percentage of observing for the S+ displayed consistent differential observing for the S+ (902, 905, 910, 911, 917 and 920). Out of the two participants with experience that displayed a greater percentage of observing for the S+, only participant 910 had consistent differential observing for the S+.



Blocks of Mixed Schedule Components

Figure D. Experiment 3 participants' mean observing response rate for the S+ and S- across two consecutive blocks of the observing phase. Each block represents five iterations each of the RR 3.3 or EXT components, making each block five minutes long in total. Response rates have been partially normalised by dividing the rate for each block by the participant's mean rate of observing for the entire observing phase.



*Figure C*. The percentage of participants in Experiment 3 who selected the different possible responses for each survey question.

Return-to-Player		Rate of Reinforcemen	
3.3	EXT	RR 3.3	EXT
%	45%	11%	10%
%	30%	11%	10%
%	54%	11%	11%
%	59%	10%	10%
%	49%	10%	11%
%	86%	9%	12%
%	64%	3%	12%
%	64%	12%	12%

Appendix X: Experiment 2

Participant ID	RR 3.3	EXT	RR 3.3	EXT
701	66%	45%	11%	10%
702	38%	30%	11%	10%
703	47%	54%	11%	11%
704	66%	59%	10%	10%
705	63%	49%	10%	11%
706	70%	86%	9%	12%
707	31%	64%	3%	12%
708	51%	64%	12%	12%
709	64%	23%	13%	7%
710	64%	22%	12%	6%
711	69%	41%	12%	8%
712	51%	45%	12%	10%
713	50%	67%	8%	13%
714	29%	66%	6%	13%
715	65%	59%	11%	15%
716	92%	44%	12%	13%
717	27%	34%	7%	6%
718	42%	64%	6%	13%
719	45%	9%	12%	4%
720	48%	24%	10%	6%
721	41%	24%	8%	11%
722	54%	38%	14%	8%
723	96%	58%	22%	13%
724	55%	67%	11%	13%
725	34%	20%	7%	7%
726	142%	77%	17%	13%
727	44%	35%	11%	6%
728	40%	66%	7%	16%

729	98%	42%	16%	8%
730	115%	42%	15%	10%
731	61%	54%	12%	13%
732	63%	45%	12%	9%
733	49%	47%	12%	10%
734	34%	45%	9%	15%
735	91%	34%	11%	9%
736	30%	41%	10%	14%
737	82%	24%	19%	7%
738	43%	41%	7%	9%
739	80%	15%	14%	8%
740	59%	18%	11%	7%

*Note.* The RTP for each participant in each component was calculated as the total credit won in the component divided by the total amount bet in that component, in the exposure phase,

multiplied by 100

	Return-to-Player		Rate of Reinforcement	
Participant ID	RR 3.3	EXT	RR 3.3	EXT
901	42%	30%	39%	23%
902	86%	114%	27%	28%
903	113%	121%	36%	39%
904	93%	99%	26%	31%
905	89%	45%	21%	35%
906	187%	167%	37%	35%
907	71%	69%	38%	43%
908	46%	68%	28%	33%
909	56%	67%	33%	27%
910	123%	111%	31%	40%
911	80%	49%	32%	16%
912	66%	76%	34%	31%
913	83%	75%	31%	24%
914	69%	47%	37%	34%
915	51%	79%	24%	28%
916	48%	56%	29%	33%
917	48%	42%	35%	35%
918	83%	52%	37%	25%
919	72%	70%	40%	33%
920	59%	88%	33%	39%
921	34%	39%	26%	30%

Appendix XI: Experiment 3 Participants' Win and Return-to-Player Percentages

*Note.* The RTP for each participant in each component was calculated as the total credit won in the component divided by the total amount bet in that component, in the exposure phase, multiplied by 100.