[Analysis of Gambling Behavior](https://repository.stcloudstate.edu/agb)

Volume 9 Article 2

2015

Habituation and Brief-Stimulus Presentations in Near-Equivalent Simulated Slot Machine Arrangements as a Means to Study Persistence and Preference

Benjamin N. Witts
St. Cloud State University, benjamin.witts@gmail.com

Marie Erickson
St. Cloud State University

Karisan Samu
St. Cloud State University

Analysis of Gambling Behavior 2015, **9**, 5-17 Number 1 (Summer, 2015)

Habituation and Brief-Stimulus Presentations in Near-Equivalent Simulated Slot Machine Arrangements as a Means to Study Persistence and Preference

Benjamin N. Witts, Marie Erickson, & Karisan Samu
St. Cloud State University

Preference and persistence in slot machine play are not yet fully understood. Two areas of research that might help discover variables related to preference and persistence are habituation and delay-reduction. Habituation research might account for persistence in considering how repetitive, differential, and novel stimulus presentations influence responding to slot machines. Delay reduction theory asserts that preference should be given to any machine that, in some form, signals a delay to a win. We investigated preference and persistence via habituation and delay-reduction with near-equivalent slot machine arrangements across two experiments. Results showed that repetitive stimulus presentations led to shorter persistence compared to a slot machine that produced differential stimulus presentations and that preference was given to a machine with fewer schedule-correlated brief stimulus presentations, both conforming to predictions from their respective literatures. This paper demonstrates how one machine preparation can test for multiple hypotheses and sets the stage for habituation and delay-reduction gambling research.
Keywords: slot machine, sensitization, habituation, delay reduction, translational research

---

The last several decades have seen an increase in the number of peer-reviewed behavior-analytic gambling publications (Witts, 2013). This rise in publication frequency is fortunate on many fronts. First, behavioral approaches to gambling research will influence how practitioners help treatment-seeking problem gamblers (e.g., Costello & Fuqua, 2012; Dixon & Wilson, 2014). Second, behavioral conceptualizations of gambling phenomena are parsimonious and align with a natural science of behavior (e.g., Dymond & Roche, 2010; Weatherly & Dixon, 2007). Third, gambling research might be instrumental in sustaining basic laboratory research on complex human behavior (cf. Kantor, 1970). These three benefits can be merged through translational research efforts (see Dube, 2013) that connect basic research to the applied domain (e.g., Dymond & Roche, 2010; Nastally, Dixon, & Jackson, 2010) and vice-versa. In doing so, we might gain more mainstream relevance in addressing the cognitive aspects of a complex human activity and find greater prominence among our non-behavioral gambling research colleagues (see also Fantino, 2008a).

To set up preliminary work in translational research, we created a single slot machine simulation that could test multiple phenomena from basic research that would interest the applied worker. We set out to answer two questions; What keeps a gambler on a slot machine, and What leads a gambler to select one slot machine over another? To help answer our questions, we settled on two experiments that addressed 1) habituation to reinforcement (i.e., wins) and 2) the potential role of delay reduction in varying small win

Address all correspondence to:
Benjamin N. Witts
EB-B210
St. Cloud State University
720th Avenue
St. Cloud, MN 56301-4498
Email: benjamin.witts@gmail.com

presentations in relation to larger jackpots. While we used the same apparatus in both experiments, the experimental preparations differed (see below). Before presenting our findings, exploring the perceived relevance of these two areas of basic research to gambling is warranted.

Habituation

Habituation is a decrease in responding to repeated stimulus presentations that is not related to a) sensory adaptation or b) motor fatigue (Rankin et al., 2009). Its counterpart, sensitization, is an increase in responding to repeated stimulus presentations early in the presentation sequence (McSweeney & Murphy, 2009). Other factors disrupt the habituation process, including presenting different stimuli (dishabituation) and altering the stimulus (stimulus specificity) (McSweeney, 2004; Murphy, McSweeney, Smith, & McComas, 2003). While habituation and sensitization have been the subject of respondent analyses, more recent conceptualizations show that these phenomena are present in operant behavior.

In their review, McSweeney and Murphy (2009) contended that responding to sensory characteristics present during reinforcement consumption are altered after repeated exposure to those characteristics, and this alteration varies as a function of other stimulus presentations. Murphy et al. (2003) identified several factors that influence habituation to reinforcement presentations (see Murphy et al., 2003, Table 1). Understanding the influence these variables have on habituation to reinforcement accounts for a broad range of topics, including behavioral contrast, extinction, and the termination of responding (Murphy et al., 2003). This latter concern, habituation as it relates to the termination of responding, stands to better our understanding of why gamblers opt to end their session in the casino or in laboratory research (e.g., Daugherty & MacLin, 2007; Ghezzi, Wilson, & Porter, 2006; Kassinove & Schare, 2001). Slot machine research using termination as its dependent variables is referred to as persistence research.

Persistence research in slot machine gambling makes use of a two-phase experimental design. In the first phase, participants are required to gamble for a pre-determined number of spins. During the second phase, participants may end their play at any point. The second phase might keep all parameters equivalent, or the machine might differ on rate of wins, near miss presentations, and losses. Why some participants persist more than others across different conditions has been attributed to the particular stimulus of interest without considering the rate of other stimulus presentations. For example, Kassinove and Schare (2001) compared persistence between three machines; 15%, 30%, and 45% near miss presentation machines. In a three-reel slot machine, a near miss is had when two of the three reels produce a matching symbol on the payline, though in Kassinove and Schare's experiment a near miss consisted of three out of four matching reels. All machines produced an average of 5 small wins and, for half of the participants, a big win on the 8th spin of a 50-spin sequence. Responding past the 50th spin produced no further near misses or wins. Results showed that the 30% near miss machine sustained gambling longer than the 15% and 45% machines regardless of big win presence or absence[1]. Kassinove and Schare concluded that it was the near miss presentation rate that was responsible for the sustained play.

While we might conclude, as other have, that the near miss was responsible for persistence of play, we should also take care in acknowledging the rates of other stimulus presentations. For example, if we consider

[1] This finding, that near miss presentations that do not lie on the ends of a distribution range (e.g., 0%, 100% presentation rate) can sustain gambling, is not unique (see Witts et al., 2015, Table 1)

win rate to be the variable of interest, Kassinove and Schare's (2001) participants might have habituated faster to wins when near misses were rare (e.g., dishabituation did not occur) or when near misses were frequent (e.g., stimulus exposure, habituation of dishabituation), and similar analyses can be made to losses. Consider that in the big-win-absent group the 30% condition saw 10% wins, 30% near misses, and 60% losses, which could be an argument for dishabituation for each of these variables. A salient outcome, like a win or near miss, might habituate quickly after being presented on 45% of opportunities, even against a possible dishabituation effect from loss presentations. Each stimulus outcome (wins, losses, near misses) stands to produce its own habituation effect, and this effect can be attenuated or enhanced by the presentation rate of the other variables.

One way to account for concerns of stimulus presentation rates in slot machine gambling is to create slot machines that differ only on stimulus characteristics. By keeping rates of outcomes consistent, any habituation effect is relegated to the outcome's presentation, and is not confounded by its rate. Future research should continue to include stimulus presentation rate, but a cleaner initial habituation account is had with a simplified approach based only on stimulus characteristics. For example, winning outcomes occur on the same spins, but differ in their presentation. Other factors, like win size, are held constant. Such a simplified approach is adopted for the current study, and is explored in more detail below.

Delay Reduction Theory

Delay reduction theory (DRT) is concerned with understanding the formation and maintenance of stimuli that function as conditioned reinforcement. Proponents of DRT state that those stimuli that are more highly-correlated with a delay in reduction to primary reinforcement (or first-order conditioned reinforcement) will better serve as conditioned reinforcement (e.g., Fantino, 2008b; Fantino & Romanowich, 2007). While various methods by which one can assess conditioned reinforcement effects exist (e.g., new response method, resistance to extinction), DRT researchers have successfully made use of concurrent chain schedules in their analyses. DRT researchers have noted that preference for one chain schedule, rather than rate of responding, is the determining factor in identifying conditioned reinforcement effects (e.g., Fantino, 2008b; Fantino & Romanowich, 2007).

Concurrent chain schedules involve two separate operanda with which the organism may interact. Each operandum differs on some aspect(s), such as the schedule(s) in effect, topographical aspects of schedule-correlated stimuli, and so forth. For example, a rat may have two response levers from which to allocate responses, with a fixed-ratio 5 (FR 5) schedule of food reinforcement for one, and an FR 10 for the other. Prior to first responding to one of the levers (the choice phase or initial link), a small panel above each lever is illuminated white. Upon selection, the panel is illuminated red (left lever, FR 10) or blue (right, FR 5), and the other lever's panel light is inoperative until the rat completes the current schedule (terminal link), at which point the schedules reset and the panel again turns white. Preference should be clear with greater allocation toward the FR 5 lever, and we can test for conditioned reinforcement effects of the blue light correlated with this side through a variety of means. In other words, the blue light is more highly correlated with a reduction in the time until reinforcement, and is thus more reinforcing than the red light.

While slot machine research that reproduces traditional DRT studies in which schedule-correlated stimuli are constantly present is possible (e.g., Gollub, 1958 as cited in Fantino, 2008b), limitations on the current apparatus prevent such investigations. Namely, the apparatus presented one unchanging background stimulus, thus making it impossible to alternate constantly-available schedule-correlated stimuli in a chain schedule fashion. Instead, gambling researchers might make use of brief stimulus presentations as opposed to constant presentations of schedule-correlated stimuli. Researchers interested in DRT have noted that use of superimposed schedules of brief stimulus presentations of putative conditioned reinforcement result in greater response production in the terminal link (cf. Williams, 1994). But, such brief stimulus presentations do not lead to greater preference for that choice when compared to a chain schedule with a nonexistent rate of brief stimulus presentations or a comparable rate of uncorrelated brief stimulus presentations (see Fantino, 2008b and Fantino and Romanowich, 2007 for reviews). We are, however, unaware of any research in which brief stimulus presentations of putative conditioned reinforcement are superimposed in a discrete trial procedure, such as one would find in slot machine gambling. Equal brief presentations of stimuli correlated and uncorrelated with primary (or larger magnitude) reinforcement across concurrent schedules using discrete trial arrangements should result in preference for the option with fewer presentations of correlated stimuli. There are two brief stimulus presentations that are arguably salient enough[2] to warrant their use for studies in simulated slot machine research; near miss events and small wins.

With respect to near misses, results are mixed as to how schedule effects alter preference and persistence (cf. Witts, Ghezzi, & Manson, 2014), and topographical arrangements are likely to produce differential responding (Ghezzi, Wilson, & Porter, 2006). Specifically, it is unclear if the near miss event functions as conditioned reinforcement, in what form putative reinforcement effects are best achieved (cf. Ghezzi et al. 2006 for several near miss forms), and if any such effects are idiosyncratic. Thus, the near miss as a brief stimulus presentation is likely to produce difficult-to-interpret results. It is in this light that the small wins seem most amenable to investigating DRT in simulated slot machine gambling.

However, smaller wins might serve as conditioned reinforcement independent of any correlated reduction in delay to the jackpot. Thus, we cannot compare concurrent schedules with superimposed brief stimulus presentations to a machine that lacks such presentations without also being forced to alter the rate and magnitude of each small win to maintain equivalence of outcomes between machines. Thus, slot machine researchers interested in creating equivalent machines in terms of reinforcement rate and magnitude (i.e., jackpot) must keep conditioned reinforcement rates equal. So, what must change between brief stimulus presentations is the topography of the winning outcome. Specifically, small win arrangements can be topographically alike or distinct as one progresses through the schedule requirements.

Regarding practical concerns, understanding DRT's role in slot machine gambling might help to shed light upon issues of persistence and preference. Specifically, we might suspect that slot machines with high rates of non-full-loss events (e.g., near misses, losses disguised as wins, small and moderate wins, some bonus games) might inadvertently produce some large-win or jackpot-correlated stimulus which, if presented routinely in the absence of the large win, would elevate responding within the session but lead to the avoidance of that machine on subsequent visits. For example, a machine that uses scatter symbols to trigger a bonus round might find that near miss presentations of the required symbols (e.g., 2 of 3) produce more gambling

[2] Subtler arrangements like particular loss topographies, lights, or sounds might not be noticed by participants, particularly when conducting relatively brief research studies

(e.g., persistence, risk) after having contacted the bonus round earlier during play. In other words, having all three symbols scattered on the screen triggers a bonus round, and having two symbols was predictive of the third. Thus, on future spins, seeing two scatter symbols might produce a change in responding. However, future gambling sessions would likely see the gambler opting for a different machine. Given this rationale, slot machine characteristics might be better viewed as accomplishing one of two goals; a) getting a player to stay at the machine longer or b) getting players to return to the machine on future visits. Of course, any machine that accomplishes both goals would be of particular interest and concern to the interventionist.

Thus, we created the following apparatus to test two hypotheses: 1) consistent with habituation and sensitization research, repeated presentation of the same stimulus outcome should result in shorter play as compared to presenting varying outcomes and 2) under these arrangements preference should be given to the simulated slot machine that produced superimposed brief stimulus presentations uncorrelated with the larger magnitude win compared to a machine with equal brief presentations of a stimulus correlated with the larger magnitude win.

EXPERIMENT 1: HABITUATION

METHOD

Participants and Settings

Eight undergraduate volunteers (7 female and 1 male; *M* age = 26.63, *SD* = 6.30) from community psychology classes at a mid-sized Midwestern university participated. No participant endorsed a history of problem gambling. An institutional review board approved all parameters of the study.

A dedicated research space approximately 6.5 m by 2.6 m served as the session room. The room was divided into two partitions; a participant area (approximately 5 m by 2.6 m) and an observation area behind a tall storage cabinet, placing the researcher out of sight from the participant. The participant area contained two long (1.21 m and 1.05 m) tables, each supporting one computer monitor and equipped with one chair. Adjacent to the storage cabinet divider was a rolling cart with a large widescreen television blocking from the participants' view two external monitors displaying duplicate screens from the monitors in the participant area.

Apparatus

We created two simulated slot machines using AllJ Slots 2.2 (v.2.2.287). Both simulations used a three-reel setup with virtual reel strips consisting of cherry, orange, liberty bell, "BAR", 7, triple 7s, plum, and jackpot symbols set against a black background. The single 7 symbol appeared twice in the virtual reel strip. Slot machine simulations were presented on a Dell 20 E2014T touch screen monitor, and the keyboard, mouse, and speakers were placed behind the screen to prevent participants from interacting with these other devices. Speakers were set at a constant volume between participants.

Slot machine simulations were set to force players to bet 3 credits per spin, and each participant was provided 50 credits with which to wager. A 30-credit Jackpot was set on an FR 15. Three smaller 6-credit wins were semi-randomly determined using a random number generator function in Microsoft Excel on a superimposed extended-variable ratio 5 (VR 5) schedule. Once determined, the VR 5 was held constant across all 15-spin cycles such that the 4^{th}, 9^{th}, and 14^{th} spin produced a small win. The only restriction in the random assignment was that a small win needed to occur on spin 14 (see Experiment 2 for rationale) and that no small win could occur on spin 15 (the dedicated jackpot spin). Losing spin arrangements were predetermined and repeated with each 15-spin sequence.

Once a jackpot was triggered, the 15-spin sequence repeated.

The habituation machine presented the same winning outcome (i.e., three cherries) for each small win, accompanied by the same winning sound. A different winning sound played during jackpot spin. Ambient casino noise played through the computer's speakers, and was set at a volume of "2" via the AllJ Slots control panel (volume available from 0 to 10).

The stimulus specificity (SS) machine—so called as stimulus specificity refers to changes in the stimulus, here the small win—produced different small wins each with its own winning sound. The first small win consisted of three liberty bells, the second three bars, and the third three oranges. Jackpot outcomes were identical to the habituation machine. The ambient casino noise was set at a volume of "7" in the control panel.

Procedure

Participation occurred across two consecutive days. On the first day, participants played either the habituation machine (n = 4) or the SS machine (n = 4). Participants were seated at the left table in the participant area where their monitor was turned off and were instructed to turn off all electronic devices and remove any time-keeping pieces. Participants read and signed an informed consent document and completed a demographics survey that also assessed for any reported history of problem gambling. Next, the researcher read a script stating that the participant's goal was to earn as many credits as possible by playing as long as s/he wished. The script also included instructions on how to play the machine. The researcher then turned on the participant's monitor, informed the participant to announce to the researcher when s/he felt as though s/he had won enough, and then retreated behind the cabinet until the participant announced his/her completion. On the second day of participation, participants played the machine not played on the first day and were not asked to complete any forms from the first day. Participants completed an exit survey after the second day was finished.

Interobserver Agreement

The researcher recorded the number of spins on the AllJ Slots spin count recorder in the administration control panel (hidden to the participant) before and after each session and compared this number to the number of spins the researcher recorded from viewing the observation monitor. There were no differences in recorded spin counts between the two recording methods.

RESULTS AND DISCUSSION

Table 1 displays study parameters for each participant (i.e., machine order) and individual results (i.e., number of spins per machine). Figure 1 presents a visual display of each participant's percentage change in the number of spins from the first to the second day. Participants 7546, 5829, 1133, and 7611 each played the SS machine on the first day and the habituation machine on the second. The percentage difference in the number of spins for each participant from the first to the second day, respectively, are: 65.57% decrease, 47.83% increase, and a 0.00% change for the last two participants. Participants 2322, 4711, 2929, and 1213 each played the habituation machine on the first day and the SS machine on the second. The percentage difference in the number of spins for each participant from the first to the second day, respectively, are: 72.13% increase, 37.50% increase, 113.33% increase, and 31.82% increase.

An exit survey assessed machine preference and any strategies used during participation. Four participants stated they preferred the SS machine because there appeared to be more winnings and there were a variety ways to win. Four participants stated they preferred the habituation machine because "there was

			Number of Spins		
Participant	Day 1	Day 2	Stimulus Specificity (SS)	Habituation (H)	Greater Persistence
7546	SS	H	305	105	SS
7611	SS	H	15	15	Neither
5829	SS	H	23	34	H
1133	SS	H	15	15	Neither
2322	H	SS	105	61	SS
1213	H	SS	29	22	SS
4711	H	SS	165	120	SS
2929	H	SS	32	15	SS

Table 1. Study parameters and results for each participant in Experiment 1.

less chaotic noise," and "it seemed like you win more," but two of these four participants actually played the SS machine more (i.e., number of spins). One participant made a comment during play on the habituation machine, "this game was like watching paint dry." Participants did not endorse any strategies.

The average number of spins was larger on the SS machine. Thus, results from Experiment 1 support the hypothesis that repeated presentations of visual and auditory stimuli on a simulated slot machine might be involved in a decrease in persistent play, while novel stimulus presentations might have the opposite effect.

While participants who first interacted with the habituation machine played more trials on the second day, participants who first interacted with the SS machine produced mixed results upon their return. These results are surprising as we expected a general decrease in persistence from the first to the second day, with perhaps a smaller change in the habituation to SS condition. That fact that second day participation resulted in greater persistence in the SS machine further supports the hypothesis that presenting novel stimuli might increase persistence in slot machine gambling, though spontaneous recovery—recovering responsiveness to a previously-habituated stimulus, even if partially—might be involved (cf. McSweeney & Murphy, 2009).

The preparation used in Experiment 1 might be of use in addressing what properties of the win (or other stimulus presentations) are most influential in habituation. For example, McSweeney and Murphy (2009) argued that different species might attend to different sensory aspects of the same reinforcement. By creating simulated slot machines whose wins differed on one win characteristic, we might better understand what aspects are most influential, even if idiosyncratically, to the slot machine gambler. For example, the habituation machine used in this study might be compared to an equivalent machine that produces differential music on subsequent wins, or one in which music is constant but win arrangement changes. As statistical differences in slot machine gambling research can be inconsistent with single-subject analyses (e.g., Witts, et al., 2015), we suggest the use of within-subject analyses.

However, there were several limitations that should be addressed. This experiment's sample population was small and homogeneous (all were undergraduate students from the same university, seven out of eight were women, and most were from similar socioeconomic backgrounds). Small sample sizes are not necessarily limitations, though given the new avenue of research being explored, they may be here. For example, additional participants might have continued to yield similar response patterns or they might have offered up new patterns to explore in future research. Future studies should recruit more participants from diverse populations to determine if different backgrounds influence persistence in play under these experimental arrangements.

Participants only received extra course credit for participating. As there was no monetary incentives and course credit was not contingent upon responding, external validity might be a concern. Specifically, research has found alterations in play between monetary and non-monetary incentives (e.g., Brandt, Sztykiel, & Pietras, 2013; Peterson & Weatherly, 2011; Weatherly & Meier, 2007).

Further, our simulated slot machine used an FR 15 schedule of reinforcement for the jackpot win with a superimposed extended-VR 5 schedule of reinforcement for the smaller wins, which does not emulate the actual random ratio schedule of reinforcement used in casino slot machines. However, we used these reinforcement schedules to ensure consistency between machines to limit any confounding variables that could have influenced persistence with a varied payout rate within and between machines. Future research should determine if persistence differs with repeated or novel presentations of visual and auditory stimuli when using a random ratio schedule of reinforcement.

Additionally, FR schedules add potential difficulties in interpreting results. For example, a participant who plays quickly under FR schedules would contact more wins than would a slower player in the same time. Such changes in reinforcement rate are directly linked to changes in habituation rate (cf. McSweeney & Murphy, 2014). An alternative schedule, like a variable interval (VI) schedule, might help protect against such effects. As we failed to record response timings, we are unable to document if such patterns were present in the current study. However, an alternative apparatus might need to be constructed to support time-based schedules, and doing so might not mimic gambling under more naturalistic conditions. Pursuing translational research might first require that the gambling researcher construct experiments based more closely on the basic literature. Doing so might better orient the researcher to the variables of interest prior to building more representative models from which to conduct research.

Finally, we note that our labels for the simulated slot machines are not necessarily accurate. The habituation machine might only be so in comparison to its alternative in this study, as some other arrangement in which all losses and win types are held constant might make our habituation machine a SS machine. We make no claims to what, if any, aspects of the SS machine are involved in response maintenance. For example, greater persistence seen in the SS machine might be due to dishabituation effects from differential win presentations, stimulus specificity given differential win arrangements, or from fewer repeated presentations of each win outcome which might have either sensitization effects or prevent habituation from occurring (cf. McSweeney, 2004; Murphy et al., 2003). Future efforts will need to find creative means of investigating these potential sensitization and dishabituation effects with the inherent restrictions present in slot machine research (e.g., difficulties in free operant responding), though for our purposes we will keep with the title *stimulus specificity machine*.

EXPERIMENT 2: DELAY REDUCTION THEORY

METHOD

Participants and Setting

Eight female undergraduates (*M* age = 24.50, *SD* = 4.31) from community psychology classes at a mid-sized Midwestern university participated. No participant endorsed a history of problem gambling. An institutional review board approved all parameters of the study.

The setting was identical to Experiment 1 except for the following change: both tables in the participant area had a working touchscreen monitor with which to interact.

Apparatus

The apparatus was identical to that used in Experiment 1. However, for Experiment 2, the habituation machine is referred to as the *same small win (SSW)* machine, and the SS machine as the *different small win (DSW)* machine, referring to the type of small win presented.

Procedure

Participants were seated at either the right or left computer monitor, which either hosted the DSW or SSW machine (see Table 2). Participants read and signed an informed consent document and completed a demographics survey that also assessed for self-reported histories of problem gambling. Participants were then read a script describing the study's design, which consisted of playing four 15-spin sequences alternated across the two machines to ensure familiarity with both machines.

Following these 60 spins, participants moved to a chair mid-way between the two monitors but on the opposite wall and asked to select between the two machines. Being seated in this manner set the occasion for the choice phase (initial link) in the now concurrent-schedules procedure in which identical FR 15 (jackpot) and superimposed extended-VR 5 schedules of brief stimulus presentation were available. This forced-choice condition repeated twice more, thus forcing a preference between the two machines. Once all seven 15-spin sequences were finished, the participants completed the exit survey.

RESULTS AND DISCUSSION

Table 2 shows individual choices during each of the three forced-choice points. We defined preference as at least two choice point allocations to the same machine. Five of the eight participants preferred the DSW machine over the SSW machine.

Results from Experiment 2 offers initial support for the DRT's account of the role rate of (putative) conditioned reinforcement plays in preference. Specifically, a concurrent-schedule arrangement did not result in responses being allocated to the schedule with greater numbers of stimuli correlated with the jackpot. However, additional details were lacking that would add greater credibility to these results.

There were no assessments related to whether the initial win on the SSW machine served as conditioned reinforcement (i.e., CS+) or if it might have functioned as conditioned inhibition (i.e., CS-) that signaled the absence of reinforcement. It is possible that not enough trials were run to develop the appropriate conditioned stimulus effects, or to differentiate it from general conditioned reinforcement effects as the presentation is itself likely reinforcing (i.e., it is a win). This latter concern, that of the stimulus presentation potentially having independent conditioned reinforcement effects, proves important in untangling these and future results using similar preparations (cf. segmented schedules, e.g., Alessandri, Molet, & Fanitno, 2010).

Participant	Starting Location	Machine Location		Choice 1	Choice 2	Choice 3	Preference
		SSW	DSW				
4647	Right	Left	Right	SSW	SSW	DSW	SSW (2/3)
1113	Left	Left	Right	DSW	SSW	SSW	SSW (2/3)
1159	Right	Left	Right	SSW	SSW	SSW	SSW (3/3)
4567	Left	Left	Right	DSW	DSW	DSW	DSW (3/3)
5439	Left	Right	Left	SSW	DSW	DSW	DSW (2/3)
0101	Right	Right	Left	DSW	SSW	DSW	DSW (2/3)
6409	Left	Right	Left	DSW	DSW	DSW	DSW (3/3)
2015	Right	Right	Left	DSW	DSW	DSW	DSW (3/3)

Table 2. Study parameters and results during the three free choice points. Machine preference includes parenthetical data on how many of the three free choice points were allocated to the preferred machine.

Seven of the eight participants endorsed a preference for the DSW machine on the exit survey. Consistent with reports from four of the participants in Experiment 1, participants stated they felt as though the DSW machine produced more wins. While their conclusions were inaccurate, it is not surprising that greater perceived wins might influence preference. For example, in Experiment 1 in Witts, et al. (2014), participants allocated more responding to a simulated slot machine that produced a win on 67% of spins as opposed to 33% and 0% (cf. Weatherly & Brandt, 2004; Weatherly, Thompson, Hodny, & Meier, 2009). Any perceived inequality between machines might explain the results from the current experiment, and such perceptions might have served as a rule during play (cf. Weatherly & Dixon, 2007; however, it is unknown if any rule was actually in place before the exit survey).

The question of why participants perceived more wins on the DSW machine needs attention. Consistent with Experiment 1 in this manuscript, habituation might have accounted for the perceived inequality in the number of wins on each machine (see McSweeny & Murphy, 2009). The DSW machine's wins, though equivalent in the number produced to the SSW machine, were perhaps more salient. A simple alteration in small win arrangements could address this concern. For example, an FR 50 and a superimposed extended VR 5 schedule could be in effect in which the SSW machine produces the same small win outcome on 5 trials alternated consecutively with unique small wins (total small wins = 10). A DSW machine would produce 9 wins uncorrelated with the jackpot and 1 win (spin 49) that is.

Finally, a small sample size (cf. Experiment 1 discussion), participant characteristics, and study parameters might have limited these results. For example, participants were all female undergraduate students playing for extra course credit. Perhaps additional monetary incentives (e.g., Brandt, et al., 2013; Peterson & Weatherly, 2011; Weatherly & Meier, 2007) could have altered the study's outcome, though this is unlikely given the exit survey results.

GENERAL DISCUSSION

We set out to build a single apparatus that could test multiple hypotheses from different research topics. We narrowed our investigation to habituation effects (habituation and stimulus specificity) and the role of brief stimulus presentations in terms of the DRT. While refinements are needed to better articulate these results, we remain confident we have succeeded in our efforts, and we base this conclusion on two observations. First, both experiments produced results consistent with their respective literatures. Second, we created both experiments such that greater persistence (Experiment 1) and preference (Experiment 2) should be given to the same machine, and our results confirmed this.

Each experiment in this paper opens several new avenues in gambling research. In terms of habituation, the role of repeated wins, near miss event presentations, and full loss presentations might need to factor in habituation effects when preparing the apparatus. For example, near miss presentations might have dishabituating effects with respect to other outcomes, like wins or losses. Contextual factors might also be of interest in terms of dishabituation to machine and outcome characteristics, such as with a neighboring machine winning a jackpot in which bells are rung and celebratory music is played or with other interruptions like a waitperson coming by to offer complimentary drinks.

That being said, habituation effects might best be seen in between- and within-session changes during play, which is absent from the current behavioral slot machine literature, favoring aggregate data from each session instead. For example, McSweeney and Murphy (2014) noted that within-session changes should be measured in absolute terms, which could be accomplished by having participants play across multiple time-restricted sessions on particular win arrangements. Other metrics might need to be identified with which to detect subtle differences in play, such as latency, force (pressure placed on the slot machine button), or bet size of each gamble. Alternatively, the slot machine could be built such that spinning is the result of satisfying some reinforcement schedule, like requiring a spin button to be pressed on a variable interval or ratio schedule.

A DRT approach to slot machine gambling might help in investigating persistence versus preference in machine selection. For example, DRT would predict that increased play (e.g., number of spins, bet size) during a session can be produced by introducing additional stimuli uncorrelated with a reduction in the delay to reinforcement, but that preference would be given to a similar machine in which those additional stimulus presentations are absent. For instance, two machines are equivalent except that one machine has near miss presentations unrelated to wins; while near misses might produce more responding on that machine, given the opportunity to choose the player would opt for the machine that does not produce near miss events.

Gambling research that considers habituation and/or DRT will set a new research agenda that has far-reaching implications in terms of casino gambling behavior. We have outlined several areas for future research in each respective discussion section that might help the gambling researcher better orient to slot machine research within these topics. We have yet to identify just what gets a gambler to gravitate toward one machine, and what keep him or her there. Discovering the variables that relate to preference and persistence in slot machines might even help the behavioral gambling research find a voice in policy research as it pertains to variables believed to be involved in problematic slot machine gambling, such as the near miss event.

REFERENCES

Alessandri, J., Molet, M., & Fantino, E. (2010). Preference for a segmented schedule using a brief S+ stimulus correlated with a great delay reduction in humans. *Behavioural Processes, 85*, 72-76.

Brandt, A. E., Sztykiel, H., & Pietras, C. J. (2013). Laboratory simulated gambling: Risk varies across participant-stake procedure. *The Journal of General Psychology, 140*, 130-143.

Costello, M. S., & Fuqua, R. W. (2012). A brief behavioral intervention of harm reduction for online poker players. *Analysis of Gambling Behavior, 6*, 57-66.

Daugherty, D., & MacLin, O. H. (2007). Perceptions of luck: Near win and near loss experiences. *Analysis of Gambling Behavior, 1*, 123-132.

Dixon, M. R., & Wilson, A. N. (2014). *Acceptance and commitment therapy for pathological gamblers*. Shawnee Scientific Press LLC.

Dube, W. V. (2013). Translational research in behavior analysis. In G. J. Madden (Ed.) *APA handbook of behavior analysis: Vol. 1*. Washington, DC: American Psychological Association.

Dymond, S., & Roche, B. (2010). The impact of derived relational responding on gambling behavior. *Analysis of Gambling Behavior, 4,* 38-53.

Fantino, E. (2008a). Behavior analysis: Thriving, but how about its future? *Journal of the Experimental Analysis of Behavior, 89*, 125-127.

Fantino, E. (2008b). Choice, conditioned reinforcement, and the Prius effect. *The Behavior Analyst, 31*, 95-111.

Fantino, E., & Romanowich, P. (2007). The effect of conditioned reinforcement rate on choice: A review. *Journal of the Experimental* Analysis *of Behavior, 87*, 409-421.

Ghezzi, P. M., Wilson, G. R., & Porter, J. C. K. (2006). The near-miss effect in simulated slot machine play. In P. M. Ghezzi, C. A. Lyons, M. R. Dixon, and G. R. Wilson (Eds.) *Gambling: Behavior theory, research, and application* (pp. 155-170). Reno, NV: Context Press.

Kassinove, J. I., & Schare, M. L. (2001). Effects of the "Near Miss" and the "Big Win" on persistence at slot machine gambling. *Psychology of Addictive Behaviors, 15*, 155-158.

Kantor, J. R. (1970). An analysis of the experimental analysis of behavior (TEAB). *Journal of the Experimental Analysis of Behavior, 13*, 101-108.

McSweeney, F. K. (2004). Dynamic changes in reinforcer effectiveness: Satiation and habituation have different implications for theory and practice. *The Behavior Analyst, 27*, 171-188.

McSweeney, F. K., & Murphy, E. S. (2009). Sensitization and habitation regulate reinforcer effectiveness. *Neurobiology of Learning and Memory, 92*, 189-198.

McSweeney, F. K., & Murphy, E. S. (2014). Characteristics, theories, and implications of dynamic changes in reinforcer effectiveness. In F. K. McSweeney and E. S. Murphy (Eds.) *The Wiley-Blackwell handbook of operant and classical conditioning* (pp. 339-368). Oxford, UK: Wiley.

Murphy, E. S., McSweeney, F. K., Smith, R. G., & McComas, J. J. (2003). Dynamic changes in reinforcer effectiveness: Theoretical, methodological, and practical implications for applied research. *Journal of Applied Behavior Analysis, 36*, 421-438.

Nastally, B. L., Dixon, M. R., & Jackson, J. W. (2010). Manipulating slot machine preference in problem gamblers through contextual control. *Journal of Applied Behavior Analysis, 43*, 125-129.

Peterson, J. M., & Weatherly, J. N. (2011). Comparing three strategies of motivating gambling behavior in the laboratory environment. *Analysis of Gambling Behavior, 5*, 28-34.

Rankin, C. H., Abrams, T., Barry, R. J., Bhatnagar, S., Clayton, D. F., Colombo, J., Coppola, G., … Thompson, R. F. (2009). Habituation revisited: An updated and revised description of the behavioral characteristics of habituation. *Neurobiology of Learning and Memory, 92*, 135-138.

Weatherly, J. N., & Brandt, A. E. (2004). Participants' sensitivity to percentage payback and credit value when playing a slot machine simulation. *Behavior and Social Issues, 13,* 33-50.

Weatherly, J.N., & Dixon, M. R. (2007). Toward an integrative behavioral model of gambling. *Analysis of Gambling Behavior, 1*, 4-18.

Weatherly, J. N., & Meier, E. (2007). Studying gambling experimentally: The value of money. *Analysis of Gambling Behavior, 1*, 133-140.

Weatherly, J. N., Thompson, B. J., Hodny, M., & Meier, E. (2009). Choice behavior of nonpathological women playing concurrently available slot machines: Effect of changes in payback percentages. *Journal of Applied Behavior Analysis, 42*, 895-900.

Williams, B. A. (1994). Conditioned reinforcement: Experimental and theoretical issues. *Journal of the Experimental Analysis of Behavior, 17*, 261-285.

Witts, B. N. (2013). Cumulative frequencies of behavior analytic journal publications related to human research on gambling. *Analysis of Gambling Behavior, 7*, 59-65.

Witts, B. N., Ghezzi, P. M., & Manson, M. (2015). Simultaneously observing concurrently available schedules as a means to study the near miss event in simulated slot machine gambling. *The Psychological Record, 65*, 115-129.

Action Editor: **Jeffrey N. Weatherly**