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ORIGINAL PAPER

Using Sound to Unmask Losses Disguised as Wins in Multiline Slot Machines

Mike J. Dixon · Karen Collins · Kevin A. Harrigan · Candice Graydon · Jonathan A. Fugelsang

Abstract Losses disguised as wins (LDWs) are slot machine outcomes where participants bet on multiple lines and win back less than their wager. Despite losing money, the machine celebrates these outcomes with reinforcing sights and sounds. Here, we sought to show that psychophysically and psychologically, participants treat LDWs as wins, but that we could expose LDWs as losses by using negative sounds as feedback. 157 participants were allocated into one of three conditions: a standard sound condition where LDWs, despite being losses, are paired with winning sights and sounds; a silent condition, where LDWs are paired with silence; and a negative sound condition where LDWs and regular losses are both followed by a negative sound. After viewing a paytable, participants conducted 300 spins on a slot machine simulator while heart rate deceleration (HRD) and skin conductance responses (SCRs) were monitored. Participants were then shown 20 different spin outcomes including LDWs and asked whether they had won or lost on that outcome. Participants then estimated on how many spins (out of 300) they won more than they wagered. SCRs were similar for losses and LDWs (both smaller than actual wins). HRD, however, was steeper for both wins and LDWs, compared to losses. In the standard condition, a majority of participants (mis)categorized LDWs as wins, and significantly overestimated the number of times they actually won. In the negative sound condition, this pattern was reversed; most participants correctly categorized LDWs as losses, and they gave high-fidelity win estimates. We conclude that participants both think and physiologically react to LDWs as though they are wins, a miscategorization that misleads them to think that they are winning more often than they actually are. Sound can be used to effectively prevent this misconception and unmask the disguise of LDWs.

Keywords Slot machines · Losses disguised as wins · Skin conductance responses · Heart rate deceleration · Sounds · Categorization

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Introduction

A particularly intriguing aspect of modern multiline electronic gaming machines involves the capability of participants to bet on more than one line at a time. Consider, for example, a participant who bets 10 cents on each of nine lines, for a total wager of 90 cents per spin. When they spin and lose their entire wager, the machine goes into a state of quiet in both the visual and auditory domain. When they spin and win more than their wager (e.g., they wager 90 cents and win $1.80), they receive both visual and auditory feedback—the winning symbols animate and are joined by a line that indicates which of the nine played lines contained the symbols that led to the win. A rolling sound, akin to coins falling, "counts up" the win, culminating in a celebratory winning song. Thus, there is a stark contrast between winning outcomes filled with celebratory feedback, and losing outcomes characterized by a state of quiet. On a substantial proportion of spins, participants will spin and the reels will stop with a winning combination on one of the lines. These "wins", however, pay back less than the spin wager (e.g., the participant bets 10 cents per line on each of nine lines, and wins 40 cents on one of the lines). Despite the fact that the participant loses money on this spin, (50 cents in the example above) the machine highlights the win with animated symbols, and celebratory songs. In our lab we have referred to these outcomes as *losses disguised as wins* or LDWs (Dixon et al. 2010; Jensen et al. 2012; Harrigan et al. 2012). LDWs are a ubiquitous feature of electronic gaming machines in North America, and in other parts of the world (e.g., Pokies in Australia).

Researchers have used both skin conductance responses (Dixon et al. 2010, 2011; Lole et al. 2011; Clark et al. 2011) and phasic heart rate changes (Dixon et al. 2010, 2011; Clark et al. 2011) to measure the responses of participants as they played slot machines. In Dixon et al. (2011), we showed that heart rate temporarily decelerates following a win, whereas following a loss no deceleration was noted. In a separate study (Dixon et al. 2010), we showed that the skin conductance responses to LDWs were more similar to those of wins than to losses. Despite the fact that participants lost money on these spins, these outcomes appeared to be more arousing than regular losses where no credits were gained. Jensen et al. (2012) demonstrated that novice participants who were exposed to LDWs miscategorized these outcomes as wins. Furthermore, if participants are asked to estimate on how many spins they won more than they wagered during a playing session they just completed, participants tend to markedly overestimate the number of wins, likely because they either misinterpret LDWs as wins, or because they conflate LDWs and wins in memory (Dixon et al. 2013).

Sound is an important factor in the categorization of losses, wins and LDWs. Winning sounds are certainly carefully constructed to be "happy" sounds, and losing is usually silent. Large wins in slot machines are characterized by a "rolling sound", with the length of the win tied to the length of the music. Winning sounds are carefully constructed to be heard over the gameplay of other participants to draw attention to the machine and to raise the self-esteem of the participant, who then becomes the centre of attention on the slot machine/casino/bar floor (Griffiths and Parke 2005). It is significant, in other words, that losses disguised as wins are auditorially much more similar to wins, than they are to (silent) losses. Dixon et al. (2013) had participants play 200 spins on a multi-line slots simulator with the sound on, and a further 200 spins with the sound off. When asked to estimate how many times they won more than they wagered, players overestimated the number of wins in both the sound-on and sound-off conditions. Crucially, however, their overestimations were significantly exacerbated in the sound-on condition. Furthermore, the majority of players preferred the game with sounds and rated this game as more arousing than the game without sounds.

Not all sounds in the game domain are positive, however. Many video games have losing sounds for negative events—such as getting a puzzle answer wrong in the *Professor Layton* games (a series of popular Nintendo video puzzle games), or having the character die in most popular games—as in *Pac-Man*'s death or "game over" sounds. Negative iconic sounds tend to be lower in pitch, "fatter" in timbre, shorter in duration and descending in melodic contour (Collins and Tagg 2001). These negative sounds stand in contrast to the sounds played following winning (and LDW) outcomes on most slot machines. If the auditory information given to the participant is that LDWs are wins, rather than losses, and participants thus mistakenly categorize LDWs as wins, we hypothesized that we could possibly counter this effect by having negative sounds accompany both LDWs and regular losses. Such pairings, we assumed, would increase the similarity between LDWs and losses, and decrease the similarity between LDWs and wins. Given our previous finding that participants fail to physiologically distinguish between wins and LDWs, we predicted that if participants treat LDWs as losses, then the psychophysical responses to losses and LDWs would be equivalent; participants when shown an LDW would categorize it as a loss as opposed to a win, and the propensity to overestimate the number of wins within a playing session would be reduced.

We attempted to unmask the disguise of LDWs in two different ways. In a "silent" condition, we removed all reinforcing sounds from the LDWs. These outcomes would still visually celebrate the win with a line joining the "winning" symbols, but no winning jingle would play on LDWs. In a "negative sound" condition we paired both losses and LDWs with a distinct losing sound. Our overarching goal was to use negative sounds to allow participants to easily tell whether they won or lost money on a given spin. Our hope was that we could do so without impacting the player's enjoyment of the game. To measure enjoyment, we used the Game Experiences Questionnaire (IJsselsteijn et al. 2008), which assess both positive and negative affect during game play (along with other game experiences). We also supplemented the GEQ with items concerning their subjective arousal during game play and whether they found the game pleasurable.

Our most general prediction was that we could use psychophysical indices (SCRs, and HRD) to show that despite losing money on both outcomes participants would treat LDWs differently than regular losses (losses would lead to small SCRs and little HRD, whereas LDWs would trigger larger SCRs and HRD). Our more specific prediction was that for participants who played the standard games (where LDWs are accompanied by winning sounds) the difference between the SCRs and the HRD for LDWs and losses would be very pronounced (losses leading to minimal effects, LDWs leading to much larger effects). For participants who played games where LDWs were accompanied by negative sounds or silence, the SCRs and HRD elicited by LDWs would be more similar to the SCRs and HRDs for losses (both losses and LDWs would lead to minimal psychophysical responses). For the categorization task we predicted that when shown an example of a standard LDW (accompanied by winning sounds) participants would (mis)label this outcome as a win. When shown an LDW accompanied by silence or a negative sound, they would correctly label the LDW as a loss. We predicted that when asked to estimate how many times (out of 300 spins) they won more than they wagered, participants playing the standard game would overestimate the number of wins, but participants playing the silent or negative sound games would give more high-fidelity estimates.

Table 1 Demographic information for the three randomly assigned groups

Condition	No. of participants	Gender (female)	Mean age	PGSI
Standard	53	40	21.23	0.32
Silence	52	38	20.88	0.16
Negative	52	42	20.98	0.04

One participant in the standard condition declined to give their age or gender

Methods

Participants

A total of 157 students (36 males) from the University of Waterloo participated in the experiment. Participants' average age was 21.03 years of age. Participants were screened for potential gambling problems using the Problem Gambling Severity Index (PGSI) of the Canadian Problem Gambling Index (Ferris and Wynne 2001). The PGSI scores ranged from 0 to 4. There were four participants who scored in the moderate risk range (3 scored 3 on the PGSI, one scored 4). The majority of participants were characterized as novice slots players ($n = 153$), the other four participants indicated playing slots less than 12 times a year. Participants were randomly assigned to the standard sound, silent, or negative sound condition. The demographic information for each group are shown in Table 1.

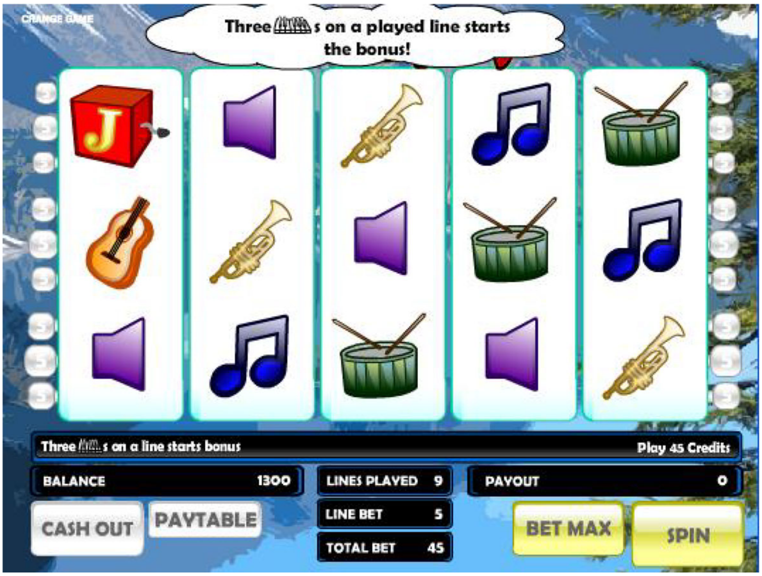
Apparatus

Physiological Measurements

Skin conductance changes and heart rate changes were measured using an eight channel, AD instruments Powerlab (model 8/30). The Powerlab system amplified the ECG signal from disposable electrodes—two attached below each clavicle and one above the left hip (ground). Skin conductance levels were recorded using non-gelled electrodes attached to the upper phalanges of the middle and index fingers of the left hand. The simulator sent an event marker to the Powerlab indicating the type of outcome (win, LDW, or loss). The marker was sent as soon as the fifth reel stopped spinning (i.e., as soon as the outcome was known to the participant). Using these markers enabled us to time-lock simulator events (commencement of feedback on wins and losses) to participants' changes in heart rates and skin conductance levels.

Slot Machine Simulator (Game Planit Interactive Corp)

A nine-line, realistic simulator was used rather than an existing slot machine because it allowed for several levels of customization and control beyond what could be achieved using a commercial slot machine. This game had a visual and sonic musical instrument theme. The simulator had counters that showed: the number of lines played, the amount bet per line, and the total bet per spin (see Fig. 1). As in commercially available slot machines, during multiline play, the amount of credits that the participant gained on that spin was shown upon outcome delivery; for regular losses the "payout" counter showed 0, for LDWs and wins the payout counter sequentially flashed rising digits culminating in the amount of credits won on that spin.



Three s on a played line starts the bonus!

Three s on a line starts bonus

Play 45 Credits

BALANCE 1300

LINES PLAYED 9

PAYOUT 0

LINE BET 5

TOTAL BET 45

Fig. 1 Our musical instrument themed slot machine simulator called ‘Magic Melody’

Questionnaires

The Canadian Problem Gambling Index (CPGI) (Ferris and Wynne 2001) was used to assess demographic information, (age and gender) and the types of gambling participants engaged in (slots, cards, etc.). The frequency of slot machine play was assessed using the CPGI question that asked participants to indicate, “In the past 12 months how often did you bet or spend money on slot machines in a casino?” The nine-item Problem Gambling Severity Index (PGSI) component of the CPGI was used to assess gambling severity.

The *Game Experience Questionnaire* (GEQ) (IJsselsteijn et al. 2008) was designed to assess seven components of game play. We used the streamlined 14 item in-game version of the GEQ. In the 14-item version, there are two items that assess positive affect “I felt good” and “I felt content”, and two questions that assess negative affect “I felt bored” and “I found it tiresome” After each item participants are given “Not at all”, “Slightly”, “Moderately”, “Fairly”, “Extremely” as response options. For the positive and negative affect questions these categorical responses were converted to a scale ranging from 0 to 4, and the total component score was based on the average of the two questions tapping into that particular component. We supplemented the GEQ with items that polled their arousal during game play, and how pleasant they found the game (using the same response options as the GEQ). A range of other questionnaires were administered for purposes peripheral to the current study.

Negative Sound Characteristics

The negative sound was designed to be similar to existing negative sounds from game shows or video games. Our negative sound consisted of a tone of approximately 1.5 s in length, which rapidly descended in frequency from about 131 Hz (C3 in musical terms) to about 69 Hz (C#2). The sound was heavy in harmonics (overtones), giving the tone a "fat", "fuzzy" sound. There was no noticeable change in amplitude over time. For further discussion of what constitutes negative sounds in music, see Collins and Tagg (2001).

Procedures

Participants were recruited through a psychology participant pool, and tested in the University of Waterloo Gambling Research Lab. Participants participated for course credit, and for the potential to win money while playing a slot machine. Participants read an information synopsis of the study and informed consent was obtained. After giving consent, participants filled out the gambling involvement section of the CPGI, then the PGSI (and other questionnaires not used in this study). Participants were informed that the slot machine would be loaded with $15.00 and that they could keep their winnings. All participants ended their slots play with $12.10 cents, which they were allowed to keep. The possibility of winning extra funds was used to combat the artificiality of the laboratory environment experience (see Anderson and Brown 1984).

Upon agreeing to participate in the study, participants were randomly assigned to one of the three experimental conditions (standard game, silence following LDWs, or negative sounds following LDWs and losses). Participants then played their 300 spins on the simulator which delivered outcomes according to the condition to which the participant was assigned.

Prior to play participants were shown that $15.00 was loaded into the machine. They were shown the paytable indicating the various symbols and how much they paid. One credit was worth one cent. They were then asked to play nine lines and wager 1 cent per line for a total spin bet of 9 cents. In total, they wagered 2,700 credits (9 credits × 300 spins). The simulator paid out a total of 2,410 credits for a payback percentage of 89.26 % (comparable to the payback percentages used in slot machines in Ontario). Table 2 shows the number of credits gained, the resulting net gain (or loss) and the frequency of occurrence over the 300 spins of six different bins of outcomes grouped according to how many credits were gained on a given spin. This table shows that full losses were the most frequent outcome (216), with LDWs (42) and wins (42) occuring equally frequently.

After the 300-spin block, participants filled out the GEQ and GEQ-like arousal and pleasantness questions. Next they played 20 extra spins. After each spin, the participants were asked whether they won or lost on that spin. The outcome delivery on these twenty spins depended on the condition the participant was assigned to (e.g., a participant assigned to the Standard Sounds condition, was exposed to the "winning" jingles on LDWs, whereas a participant in the Negative Sounds condition would be exposed to the "losing" sound on LDWs and losses). The 20 spins in the categorization block ("was it a win or loss") consisted of 14 losses, 3 wins and 3 LDWs (occurring on spin 2, 6 and 17). Finally,

Table 2 Distribution of outcomes and their frequency of occurrence

	Losses	LDWs		Wins		
Credits gained	0	2–4	5–8	10–17	18–50	51–199
Net result (credits—bet of 9)	Loss of 9	Loss of 5–7	Loss of 1–4	Win of 1–8	Win of 9–41	Win of 42–190
Number of spins	216	21	21	12	13	17

participants were asked to estimate on how many spins (out of 300) they won more than they wagered.

Results

Skin conductance responses (SCRs) were calculated for regular losses, 2–4 credits, 5–8 credits, 10–17 credits, 18–50 credits, and 51–199 credits. The first spin (a loss) and the last spin (a 2-credit LDW) were not analyzed. For the other 298 spins the SCRs were calculated by first defining a 3 s window that occurred 1 s after outcome delivery (the final reel stopping). To calculate the SCR, the skin conductance level at the beginning of the window was subtracted from the peak skin conductance level within the window. To reduce the potential skew of SCRs, a square root transformation was applied to these difference scores (Dawson et al. 2000).

Of the 157 participants, 5 could not be analyzed due to technical problems and 4 persons decided to withdraw half way through the playing session. This left a total of 51 participants in the Standard Sounds condition, 47 in the Silence condition and 50 in the Negative Sounds condition. For 12 participants, between 1 and 5 spins were lost due to technical problems. For all other participants the SCRs were calculated for all 298 spins. For each participant, six mean SCRs were calculated based on the outlier-free averages of that participant's SCR amplitudes for each of the outcome bins shown in Table 2. Since the number of observations within each outcome were very different (e.g., there were 216 losses, but only 12 wins from 10 to 17 credits) prior to calculating the means, outliers were eliminated using the procedures of Van Selst and Jolicoeur (1994), which uses a sliding criterion based on the number of observations in the particular cell. On average, this procedure led to 4 % of the data being rejected as outliers.

Skin conductance responses (SCRs) were analyzed using a mixed model analysis of variance with Outcome (losses, 2–4 credits, 5–8 credits, 10–17 credits, 18–50 credits, 51–199 credits) as the repeated variable and Condition (Standard Sounds, Silence, Negative Sounds) as the between-subjects variable. For all analyses of variance conducted, where Mauchly's test of Sphericity was found to be significant, a Greenhouse–Geisser correction was applied prior to calculating the probability values. This analysis revealed a main effect of Outcome, $F(5, 725) = 12.64$, $p < .001$. However, there was no main effect of Condition, $F(2, 145) = 0.743$, n.s., nor was the predicted Condition by Outcome interaction significant, $F(10, 725) = 1.02$, n.s.

Figure 2 shows the main effect of outcome. As can be seen in Fig. 2, SCRs are essentially identical for losses and both bins of LDWs, and rise with increasing win size. Post hoc comparisons (using Fisher's LSD test) showed no differences between losses and the two LDW bins. Wins of between 10 and 17 credits triggered significantly larger SCRs than losses, LDWs of 2–4, and 5–8 credits.

Heart Rate Deceleration

Heart rate deceleration (HRD) was measured using inter-beat intervals, which refers to the temporal distance (in ms) between R-waves of consecutive heartbeats. The pre-outcome IBI was the temporal distance between the two heartbeats just prior to outcome delivery. The next IBI was designated as the IBI during which the outcome was delivered (i.e., the last reel stopped between these two heartbeats). The post-outcome IBIs were separated into four bins: IBI 1 comprised the temporal distance between the first and second heart beats

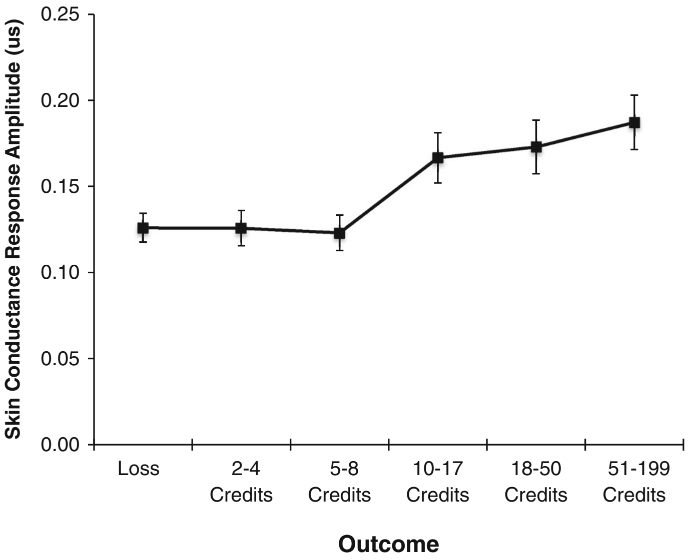


Fig. 2 Skin conductance response amplitudes for different outcomes (collapsed across condition)

following outcome delivery; IBI 2 comprised the distance between beats 2 and 3 post-outcome; IBI 3 comprised the distance between beats 3 and 4; and IBI 4, the distance between beats 4 and 5. Heart beat trains were scanned and filtered to minimize artefacts typically due to movements. As noted above, four participants dropped out prior to completing the playing session, and a further 11 could not be analyzed because the ECG signals were too noisy (optimal filtering still led to hundreds of artefacts), or other technical problems prevented us from analyzing the data. For the remaining 142 participants, R-waves were labelled, and the pre-outcome IBIs, the IBI during which the outcome was delivered, and 4 post-outcome IBIs were analyzed. Prior to calculating averages for each person, the IBIs were submitted to the Van Selst and Jolicoeur (1994) observation-dependent outlier elimination procedure. This ensured that any artefacts not detected by the scanning protocol were removed prior to the main analysis.

The outlier-free data was analyzed using a 3 × 6 × 6 mixed-model ANOVA with Condition (Standard Sounds, Silence, Negative Sounds) as the between subjects factor and Outcome (losses, 2–4 credits, 5–8 credits, 10–17 credits, 18–50 credits, 51–199 credits), and IBI (pre-outcome IBI, outcome IBI, post IBI1, post IBI2, post IBI3, post IBI4) as the repeated factors.

This analysis revealed a main effect of Outcome, $F(5, 700) = 13.41$, $p < .001$, a main effect of IBI, $F(5, 700) = 100.87$, $p < .001$, and an Outcome by IBI interaction, $F(25, 3500) = 6.69$, $p < .001$. The IBI by Condition interaction was not significant, $F(10, 700) = 0.37$, n.s., nor was the predicted Outcome by IBI by Condition interaction, $F(25, 3500) = 1.14$, n.s.

The Outcome by IBI interaction, depicted in Fig. 3, shows a more pronounced heart rate deceleration for all credit gains relative to losses indicating that participants treated LDWs differently than losses.

Due to the theoretical importance of contrasting losses to LDWs, this data was re-analyzed using a 3 Condition (Standard Sound, Silence, Negative Sound) by 3 Outcome

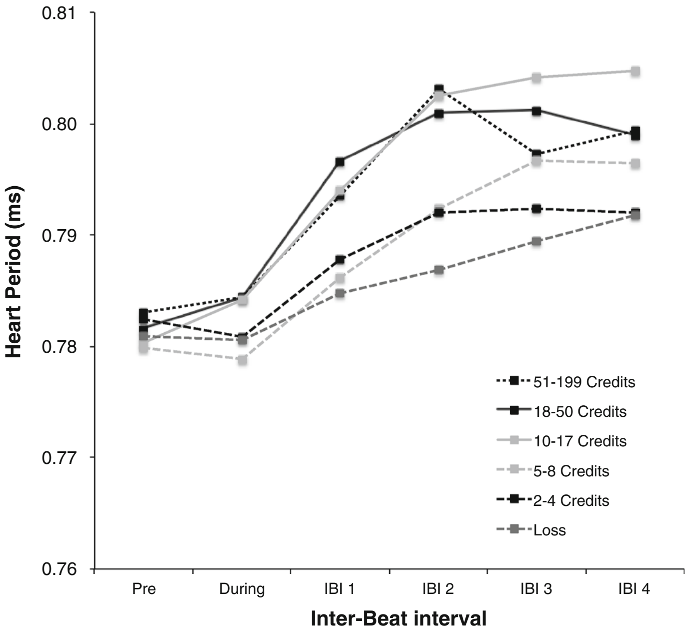


Fig. 3 Average heart period for each outcome across the six key inter-beat intervals

(losses, 2–4 credits, 5–8 credits) by 6 IBI ANOVA. Once again, Condition was not involved in any main effects or interactions. There was a main effect of Outcome, $F(2, 280) = 3.11$, $p = .046$, a main effect of IBI, $F(5, 700) = 85.60$, $p < .001$, and an outcome by IBI interaction, $F(10, 1{,}400) = 7.23$, $p < .001$.

In order to statistically verify that LDWs had steeper HRD than regular losses, we conducted simple main effects analysis for Outcome at each IBI. For the pre-outcome, the IBI during which the outcome was delivered and the first post outcome IBI there were no significant differences among the heart periods for losses, credit gains of 2–4, or 5–8. At post-outcome IBI 2 there was a simple main effect of Outcome, $F(2, 280) = 7.03$, $p = .001$. Post-hoc analyses (using Fisher's LSD test) revealed that the heart periods for 2–4 credits, and 5–8 credits were both longer than for losses (loss vs. 2–4, $p = .001$, loss vs. 5–8, $p = .002$). By IBI 3, there was again a simple main effect of Outcome, $F(2, 280)$, 12.10, $p <$ 001. Post-hoc analyses revealed that the heart periods for 2–4 credits, and 5–8 credits were both longer than for losses (loss vs. 2–4, $p = .022$, loss vs. 5–8, $p < .001$). By IBI 4, there was a significant main effect of Outcome $F(2, 280) = 5.80$, $p = .003$. Post-hoc analyses revealed no significant differences between losses and 2–4 credits, but there remained a significant difference between losses and 5–8 credits ($p = .001$).

For the GEQ as well as the GEQ-like items on arousal and pleasantness, we conducted four separate univariate ANOVAs with Condition as the independent variable to assess whether there were any differences in: positive affect, negative affect, arousal or pleasantness between the standard, silent, negative sound games. All games triggered similar affective responses (all F values associated with Condition were <1.0).

In the categorization task participants were shown different outcomes and asked to indicate whether they were wins or losses (LDWs were shown on the 2nd, 6th, and 17th spins). Figure 4 shows the percentage of participants that were able to correctly categorize

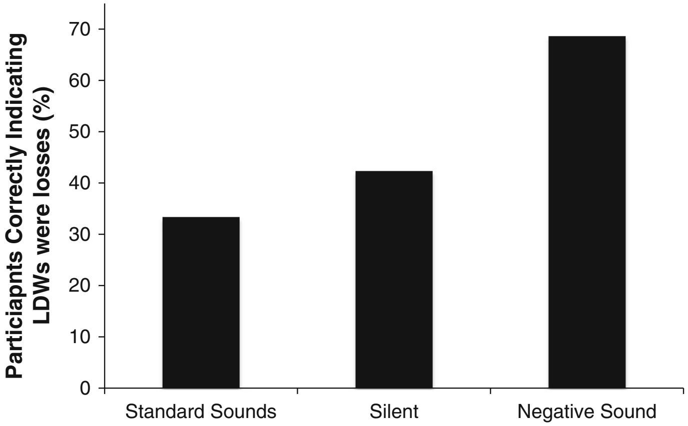


Fig. 4 The percentage of participants in each condition who correctly categorized an LDW as a loss. Categorizations were only calculated for the last LDW presentation (spin 17 in the 20-spin categorization block)

LDWs as losses on spin 17. (Only the last LDW spin was analyzed here as a conservative measure, since it gave participants the potential to learn that LDWs were actually losses with repeated exposure). As can be seen in Fig. 4, in the Standard Sounds condition, only a minority of participants (33.3 %) realized that they lost money on LDWs,—the vast majority (66.6 %) were taken in by the disguise. In the Silent condition, 42.3 % of the participants realized that LDWs were losses. Chi squared analyses revealed no significant differences between the Standard Sounds, and Silent condition X^2 (1, $n = 103$) = 0.88, n.s. In the Negative Sound condition, the percentage of participants who correctly categorized LDWs as losses rose to 68.6 % (right hand of Fig. 4). The participants in this Negative Sound condition were significantly better at categorizing LDWs as losses than those in the standard condition X^2 (1, $n = 102$) = 12.71, $p < .01$, and those in the silent condition X^2 (1, $n = 103$) = 7.22, $p < .01$.

Following the categorization block, participants were asked to estimate the number of spins on which they won more than they wagered in their block of 300 experimental spins. Recall that regardless of which condition participants were assigned to, there were 42 actual wins within the 300-spin session (along with 42 LDWs). For this analysis, 52 participants in the Standard Sounds condition, 48 participants in the Silent condition, and 50 participants in the Negative Sound condition completed both the playing session and gave win estimates.

The win estimates are shown in Fig. 5. As can be seen by looking at the leftmost bar in Fig. 5, participants in the Standard Game condition overestimated the number of wins to which they were exposed (mean win estimation of = 68.4). This translates to an LDW overestimation effect of 26.4 (68.4 − 42 actual wins). Those in the Silent condition showed a reduction in their win estimates (mean = 57.7) and consequently a reduced LDW overestimation effect (mean = 15.7). Those in the Negative Sound condition showed relatively high-fidelity win estimates (mean = 47.9), and a virtual elimination of the LDW overestimation effect (mean LDW overestimation = 5.9).

These win estimates were analyzed using a one-way analysis of variance. This analysis revealed a marginal main effect of condition, $F(2, 147) = 2.961$, $p = .055$, whereby the standard and silent conditions did not differ from one another in their win estimates (as

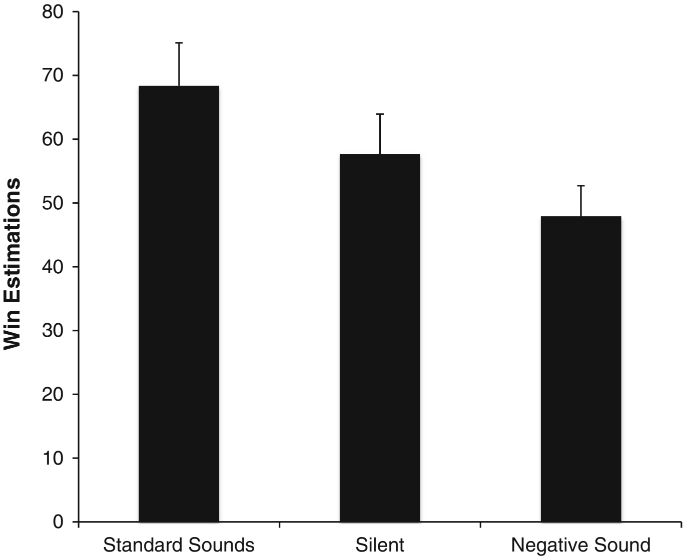


Fig. 5 The average win estimates for each of the three experimental groups. Participants were asked to estimate how many spins (out of 300) on which they won more than they wagered

indexed by Fisher's LSD tests), but those in the negative sound condition gave significantly lower win estimates than those in the standard condition ($p = .016$).

Lastly, we conducted one-sample t tests on the estimation data to see if the estimates given were significantly different from the actual number of wins (42). For the Standard Sounds condition, participants' average win estimate of 68.4 was significantly higher than the actual number of wins $t(51) = 3.91$, $p < .001$. For the Silent condition, their win estimate of 57.69 was also significantly higher than the actual number of wins $t(47) = 2.512, p = .015$. However, for the negative sound condition, their win estimate of 47.9 was not significantly different from the actual number of wins $t(49) = 1.27$, n.s.

Discussion

One overarching goal was to show using psychophysical responses that players do indeed treat LDWs differently than losses. This goal was achieved using HRD. We were unable to show, however, that negative sounds impacted the psychophysical responses to these outcomes. When we analyzed the *psychological* responses to LDWs, all of our a priori hypotheses were confirmed. We showed that players exposed to standard LDWs miscategorised these outcomes as wins, and overestimated the number of times they won more than they wagered during game play. Crucially, we showed that by adding negative sounds to both LDWs and losses, players were better able to correctly categorize LDWs as losing outcomes and were also able to give more high-fidelity win estimates when reflecting back on a slots playing session.

Previously, we have hypothesized that losses disguised as wins were a key feature of multi-line slot machines that accounted for their popularity. In these outcomes, participants lose money, yet the machine celebrates these outcomes as though they were actual wins. In this previous study, we (Dixon et al. 2010) recorded both skin conductance responses and heart rate deceleration as participants played a commercially available machine. In that study, we found that LDWs triggered significantly larger SCRs than losses, (and that the SCRs for LDWs and wins were of similar magnitude). In that study, we showed that HRD for wins was greater than for either LDWs or losses, which did not differ. In the current study, we showed that SCRs did not differentiate between losses and LDWs, but HRD clearly did. Participants showed significantly greater HRD for LDWs compared to regular losses. The HRD data in the present study fulfill one of the goals of this study—namely to use psychophysical indices to show that slots players treat LDWs differently than losses.

One limitation of this study is our failure to replicate the findings of our own lab, and others (Wilkes et al. 2009) that SCRs are higher for LDWs than regular losses. However, there were a number of key differences between our previous work and the current study. Here, we used a realistic stimulator in which the number of wins, losses and LDWs were carefully controlled. In the Dixon et al. (2010) study we used a commercially available slot machine identical to the ones participants would play in Ontario, and therefore the outcomes were randomly selected by the slot machine. In addition, in our 2010 study we used SCR response magnitudes, whereas in the current study we used response amplitudes. Importantly in each study we showed that psychophysically players treat LDWs differently than regular losses (using SCRs in the 2010 study, and HRD in the current study).

We believe that LDWs are treated differently from losses because at least some participants miscategorize LDWs as wins, rather than as losses. Support for this contention comes from the current study's categorization task where we explicitly asked participants to label whether LDWs were wins or losses. Here, we showed that in the Standard Sounds condition, most participants were taken in by the disguise—only a minority of participants correctly indicated that LDWs were in fact losing outcomes. A key goal of this study was showing that by having negative sounds accompany both LDWs and regular losses, we were able to counteract the disguise. When negative sounds were paired with both LDWs and losses, only a minority of participants were still fooled by the disguise, whereas the majority of participants now realized that LDWs were in fact losses. This pattern of results shows that sound is a highly effective means of helping participants to disambiguate whether LDWs are winning or losing outcomes. It also takes out of play a potential misinterpretation of the data in the Standard Sounds condition. One might argue that these participants categorized LDWs as wins simply because, even though they knew they lost money, they still called them wins because they "won" something back. If this were true, the percentage of people who labelled LDWs as wins should not have been influenced by the negative sounds since these participants too "won" something back. The dramatic reduction in the percentage of people who were fooled by the reinforcing sights and sounds on LDWs in the Negative Sound condition suggests that participants playing the standard games truly do think they won when they actually lost money.

Support for the hypothesis that participants are actually misinterpreting at least some LDWs as wins also comes from the win-overestimation data. Recall that we explicitly asked participants to recall the number of times they won "more than they wagered". As predicted, in the Standard Sounds condition, participants gave win estimates that were significantly higher than their actual number of wins. In the Negative Sound condition, participants were able to accurately estimate the number of actual wins they encountered during the slots session. Thus, we have shown here that sound can effectively unmask the disguise in LDWs. By encouraging participants to group LDWs with losses, the overestimation effect is virtually eliminated.

Having negative sounds accompany both regular losses and LDWs is a practical way of getting participants to recognize that LDWs are outcomes where they lose money. Although one might think that having all of these negative sounds might impact the excitement and enjoyment of the game, we showed no evidence for this. Participants' subjective ratings of arousal/excitement, pleasantness, and positive affect were no lower in the Negative Sound condition than in the Standard condition. As a caveat, future studies might compare such subjective reactions to standard games and games with negative sounds using more powerful repeated measures designs to ensure that there are no subtle differences between standard and negative games in terms of these affective components of game experience.

This study examined winning sounds in a single slot machine in a laboratory setting. In a casino, the ambient soundscape environment does not just play winning sounds when participants are winning: but also when participants are losing (experiencing LDWs). Importantly, the influence of hearing other participants winning, and the perception that more winning is occurring very often may markedly contribute to the betting patterns of slots patrons. Indeed Rockloff et al. (2011) have shown that players increased the speed of their bets, persisted longer and lost more money when hearing the winning sounds of others compared to when playing alone. If LDWs, in addition to regular wins, can be heard repeatedly on the casino floor, the slot machines are giving the impression that wins are occurring far more often than they are in actuality. In addition to manipulating the participant on a slot machine, the LDW sounds may be manipulating all participants in the casino who may believe that others are winning when they, in fact, are not.

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