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Losses disguised as wins in modern multi-line video slot machines

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ABSTRACT

Aims Players can wager on multiple lines of modern slot machines. When they spin and fail to gain any credits, the machine goes into a state of relative quiet. By contrast, when they spin and win, these spins are accompanied by reinforcing sights and sounds. Such reinforcement also occurs when the amount won is *less* than the spin wager. We sought to show that these 'losses disguised as wins', or LDWs, would be as arousing as wins, and more arousing than regular losses. **Measurement and participants** We measured skin conductance response (SCR) amplitudes and heart-rate changes following wins, LDWs and losses for 40 novices playing a multi-line slot machine. **Findings** SCR amplitudes were similar for wins and LDWs—both were significantly larger than for regular losses. **Conclusions** For novice players, the reinforcing sights and sounds of the slot machine triggered arousal on wins, where the number of credits gained was greater than the spin wager, but also on 'losses disguised as wins' where the amount 'won' was less than the spin wager. Despite the fact that players lost money on these spins, these outcomes were more arousing than regular losses where no credits were gained. Although these findings involve novice players, the heightened arousal associated with these losses may have implications for the development of problem gambling, as arousal has been viewed as a key reinforcer in gambling behaviour.

Keywords Arousal, gambling, heart-rate deceleration, skin conductance, slot machines.

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INTRODUCTION

The modern video slot machine is a far cry from the familiar, three-reel, one-armed bandit. In the traditional three-reel slot machine, one puts coins into the slot machine and hopes that the winning symbols will fall on the pay line that falls across the three reels. Hence what you wager, and what you win or lose, are relatively easy to monitor. In modern video slots there are up to five video reels, a myriad of flashing lights and symbols, flashing messages and high-fidelity audio that plays certain songs during spins and other songs during wins. Rather than being limited to wagering on a single line, players can wager on multiple pay lines on every spin, and indeed flashing messages advise the player to do so—'for maximum action play all 15 lines!'. Amid this William Jamesian blooming, buzzing, confusion patterns emerge for the gambler. When players lose, the machine goes into a state of 'quiet' in both the visual and auditory domain. When players win, certain symbols flash and the symbols responsible for the win become joined by a coloured line indicating on which of the played lines the win occurred. Higher-paying symbols have unique sounds that the slot machine plays, and credit gains are all accompanied by the repeated chiming sound as the machine 'counts up' how much you gained on that spin. In video slots games in which the player bets on many lines, however, the majority of these 'wins' are actually less than the spin wager. That is, despite the flashing symbols, despite seeing the outlining of the symbols that led to the 'win' and despite hearing the chiming sound as the machine counts up your winnings, if you subtract the total that you wagered on the spin from the total that you 'won' on that spin the value is negative (i.e. you lost!). We refer to these outcomes as 'losses disguised as wins'.

An analysis of the design documents for multi-line games reveals that losses disguised as wins (LDWs) can occur relatively frequently, with the frequency rising as

Table 1 Using the 259 440 000 possible outcomes of Lobstermania, Table 1 shows the percentage of spins on which there is a regular win (amount gained ≥ wager), losses disguised as wins (LDWs) (amount gained < wager) or loss (gains of zero) as a function of the number of lines wagered. On some spins the regular win or LDW includes gains on multiple lines. For example, the player wagering on two lines may have regular wins on both lines.

Lines wagered	*Regular wins*	*LDWs*	*Losses*
1	5.1%	0.0%	94.9%
2	8.6%	0.0%	91.4%
3	8.1%	3.8%	88.1%
4	10.0%	4.9%	85.0%
5	11.9%	6.0%	82.1%
6	8.7%	10.7%	80.6%
7	10.0%	10.9%	79.1%
8	11.1%	12.4%	76.5%
9	12.2%	13.7%	74.1%
10	13.3%	13.8%	72.9%
11	11.1%	17.1%	71.8%
12	12.1%	17.3%	70.7%
13	12.9%	17.6%	69.5%
14	13.9%	17.7%	68.4%
15	14.2%	18.4%	67.4%

more and more lines are played. This is important when one considers that on some gambling machines one can wager on as many as 100 lines per spin. Wagering on multiple lines is like playing multiple games at once. Through the Freedom of Information Act we obtained the design documents for a game called Lucky Larry's Lobstermania. We analysed all 259 440 000 possible Lobstermania outcomes for players playing from one to 15 lines—the maximum in this game. Table 1 shows the percentage of spins that result in wins, LDWs and regular losses. This table shows that when few lines are played, few LDWs occur. Importantly, when 15 lines are played, the LDWs actually outnumber the wins.

Our central question of interest is how novice players would react physiologically to LDWs. We predicted that the similar sights and sounds that accompany both wins and LDWs would cause players to react physiologically to LDWs as though they were wins. We chose to monitor participants' psychophysiological reactivity to wins, LDWs and regular losses as opposed to their self-reports because of the strong link between gambling, arousal and slot machines that are designed to maximize this arousal. Although our ultimate interest is in the development of problem gambling, in this experiment we tested novice players. We reasoned that more seasoned gamblers might have developed conditioned autonomic responses to the winning sights and sounds of slot machines such as Lobstermania before they entered the laboratory. Given the laws of conditioning this could bias the results unduly in the predicted direction. A more conservative approach would be to see if novice players who had no opportunity to develop such conditioned responses would show equivalent arousal responses to wins and LDWs.

Lobstermania is a typical modern video slot machine. It has five reels with three visible symbols per reel (see Fig. 1). Players can wager on up to 15 different pay lines on any given spin. The first three lines are the horizontal rows in Fig. 1 and the remaining 12 are various zigzag lines traversing the 15 visible symbols. Any three consecutive identical symbols (starting from the left) on any of these lines would result in what the machine calls a 'win'.

This version of Lobstermania is a '5-cent game', which means one credit equals 5 cents. The leftmost box near the bottom ($841.45) shows the player's running total. The box to the right shows the value of each credit ($0.05). The 'lines' box shows the number of lines on which the player has wagered (15 in this example). The 'bet' box shows the number of credits wagered on each line (five credits, or 25 cents in this example). The 'total bet' box (75 credits, or $3.75) is the wager per spin and is calculated as the number of lines (15) multiplied by the 'bet' per line (five credits). The box labelled 'win' shows that the gambler 'won' 25 credits on that spin. Hence Fig. 1 shows a LDW in which the gambler lost 50 credits, or $2.50.

Although LDWs are obviously losses, the myriad of sights and sounds that occur during slots play may serve to camouflage this fact. In Lobstermania, when the spin button is pressed the spin wager is subtracted from the running total, and animated reels begin 'spinning'. As the reels spin the machine plays excerpts from the song 'Rock Lobster' by the B52s. On losing spins, the reels stop and the machine goes into a state of quiet, awaiting the next spin. This state of quiet is markedly different from the feedback associated with 'winning' spins, where a line joins the winning symbols and indicates on which line the winning symbols occurred (the three clams in Fig. 1). If one wins on more than one line, initially all the winning symbols are outlined followed by the sequential flashing of one winning line after another. At the same time, the digits in the 'win' box count up the win. The higher-paying symbols play specific sounds (the lighthouse plays the sound of a foghorn, etc.). Following these sounds, one hears a chiming sound (in game parlance a 'rolling sound') accompanying the counting-up of the win. For larger wins, the rolling sounds merge into a bouncy fetching winning song whose length is tied to the size of the win. For LDWs, as the payout is smaller, the rolling sound duration and the time it takes the digits in the 'win' box to count up is shorter. Also, one is more likely to hear the unique sounds of the higher-paying symbols and see more symbols outlined following wins

Figure 1 Video display of Lucky Larry's Lobstermania showing a loss disguised as a win

than following LDWs. For both wins and LDWs, however, the nature of the feedback is categorically similar; one *always* sees 'winning' symbols outlined, one *always* sees digits counting up in the 'win box' and one *always* hears the rolling sound as the win is counted up. Regular losses, by contrast, are categorically different from wins and LDWs in that no positive feedback occurs. It is this categorical similarity between wins and LDWs that led us to predict similar arousal responses for these outcomes.

Arousal has long been recognized as a rewarding property of playing slot machines [1]. Indeed, Brown [2] cites arousal as the major reinforcer of regular gambling behaviour. During slot machine play our heart rate (HR) may increase and our palms begin to sweat, elevating our skin conductance level (SCL). These bodily reactions indicate how arousing gambling can be for players with gambling problems [3]. Arousal patterns may depend upon wins and losses. Researchers [4,5] have documented substantial heart-rate increases for players who won playing slots, compared to negligible changes for those who lost. In all these studies, researchers measured tonic psychophysiological arousal—changes measured over 2 or 3 minutes' duration. In real slot machine play, gamblers spin about once every 3–6 seconds and either lose or win on each spin. Researchers have yet to show phasic, event-related psychophysical changes accompanying winning spins, and compare these changes to losing spins. More importantly, by measuring phasic responses, we can directly compare reactions to wins, losses and LDWs.

Event-related phasic heart-rate changes are measured typically by comparing the inter-beat intervals (IBIs) prior to a stimulus presentation to the IBIs following the stimulus presentation. Heart-rate deceleration follows exposure to infrequent stimuli. This response has been interpreted as an orientating response [6]. Researchers [7,8] have suggested that such heart-rate deceleration is related to the 'intake' of environmental stimuli. Because wins and LDWs are infrequent, they should be accompanied by an orientating response. Because visual and auditory events are tied to the size of the win we predicted that heart-rate deceleration would be largest for a real win, next largest for an LDW and smallest for a loss.

Event-related skin conductance responses (SCRs) are related directly to the sympathetic nervous system activity that leads to arousal [9]. When brain areas process stimuli that have emotional significance, SCRs are elicited [10]. Skin conductance increases directly with reports of increasing arousal [11]. Based on the contrast between the visual and auditory 'quiet' following a losing spin, with the myriad of visual and auditory reinforcers following either a win or an LDW, we predicted that gamblers' SCRs would be larger for wins and LDWs than for losses.

METHODS

Participants

Forty-six students were recruited from the University of Waterloo (29 females). Ages ranged from 19 to 30 years. Participants were free from any gambling problems; Canadian Problem Gambling Index (CPGI) scores were all either 0 ($n = 40$) or 1 ($n = 6$) out of a possible 27. Participants were recruited from a pool of undergraduates. Novice status was verified based on answering 'zero' to the CPGI question: 'In the past 12 months, how often did you bet or spend money on slot machines in a casino?'.

Apparatus

IBIs and SCRs were acquired using an eight-channel, ADinstruments Powerlab (model 8/30; Powerlab, Colorado Springs, CO, USA). The Powerlab system amplified the signal from three reusable clamp-on electrodes (with gel added) that were attached to the left and right biceps, and the left wrist (ground). SCRs were recorded using non-gelled electrodes attached to the upper phalanges of the left middle and index fingers. The wiring of a Lobstermania machine was altered so that we could time-lock machine events (commencement of feedback) to participants' IBIs and SCRs.

Procedure

After obtaining consent, participants were fitted with the SCR and heart-rate electrodes and given a tutorial on Lobstermania. Participants were instructed to ('max bet') wager on 15 lines, with five credits per line, for a total wager of 75 credits per spin. They were instructed that each credit was worth 5 cents, so their spin wager would be \$3.75. Having participants use the 'max bet' ensured a high percentage of LDWs (because they were wagering on 15 lines), and ensured that wagers were held constant to equate bet sizes across participants and conditions. Participants were told that to gain credits they needed to gain three or more of the same symbols (going from left to right) on any of the 15 lines. They were shown the total bet box, and told that the 'win' box displayed the amount gained per spin, in credits. It was emphasized that this amount was in credits and not dollars. They were also told that they could see their running total, in dollars, in the leftmost box.

Participants were given \$200 dollars to insert into the machine and told that they would be paid \$10 for participating, but could win up to an additional \$20 depending on how well they did on the slot machine during their two 15-minute sessions. They were told to keep their left hand still and to move their right hand only as required to push the 'max bet' spin button. When the machine is waiting for a player to spin, a 'repeat bet' button flashes on and off. Participants were told to spin and wait 'three flashes' (about 6 seconds) after the outcome before spinning again. Participants played for 15 minutes followed by a break followed by a further 15 minutes of play. They were then debriefed and paid.

RESULTS

Players spun on average 138.2 times (range = 106–181). On average players won on 15.6% of spins (range = 7.5–21.1%), had LDWs on 17.1% of spins (range = 11.5–24%) and lost on 67.3% of their spins (range = 60–74%). Entries into the 'bonus' mode were not analysed.

Inter-beat intervals

Of the 46 participants, six had to be removed because of difficulties in signal acquisition and one because of excessive movements. A low-pass filter was applied to the

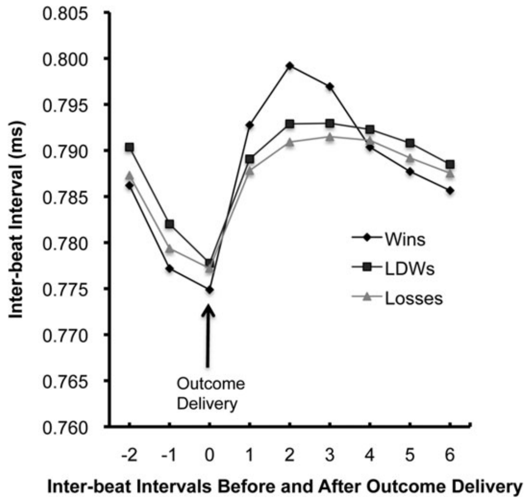

Figure 2 Mean inter-beat intervals (IBIs) before (–2, –1) at the beginning of outcome delivery (IBI 0) and during outcome evaluation (IBIs 1–6). LDWs: losses disguised as wins

heart-beat trains of the remaining participants to remove clusters of movement artefacts, then artefacts were detected using the default settings of the Heart Rate Variability module of Chart version 7.0, an ADinstruments analysis program. Statistically defined artefacts were removed, and missing R-waves replaced using interpolation. R-waves were then labelled and inter-beat intervals were calculated.

For every participant, slightly different numbers of wins, LDWs and losses occurred. For each win, LDW and loss, nine IBIs were analysed: two while the reels were spinning (IBIs −2 and −1 in Fig. 2); one while the outcome delivery was initiated (the outcome delivery arrow in Fig. 2) and six as the outcomes unfolded. For every participant these values were averaged to yield nine IBIs for wins, nine IBIs for LDWs and nine IBIs for losses. Prior to calculating these averages, the raw IBIs were subjected to an outlier removal procedure advocated by Van Selst & Jolicoeur [12] in which the criterion for removal was weighted by the number of observations (this was necessary because regular losses far outnumbered either wins or LDWs). Figure 2 shows the (outlier free) average IBIs for the 39 participants' wins, LDWs and losses. An IBI [9] by condition (wins, LDWs, losses) analysis of variance (ANOVA) revealed a significant interaction between IBI and condition $F_{(16,\ 608)} = 2.739$, $P < 0.02$, $\eta^2 = 0.067$, with a Greenhouse–Geisser correction for sphericity. Simple main effects of condition calculated at each IBI revealed a significant effect of condition only at IBI 2, $F_{(2,\ 76)} = 6.409$, $P < 0.01$ $\eta^2 = 0.144$. Figure 2 shows that heart-rate deceleration was greatest shortly after seeing and hearing the sights and sounds of a real win, relative to either LDWs or losses.

Skin conductance responses

Of the 46 participants, six had to be removed (one because of excessive movement, one because of a skin problem that precluded recording, four because they had no meaningful SCRs in one of the outcome conditions). For the remaining 40 participants individual SCR amplitudes were calculated following each win, each LDW and each loss. Amplitudes were calculated using a 3-second window, beginning 1 second after the spin outcome delivery. SCR amplitudes were the difference between the SCR value at the beginning of the window, and the maximum SCR value within the window. Following Dawson *et al.* [10], only meaningful SCRs were analysed (predefined as being ≥0.045 microsiemens).

The SCRs of each individual's wins, LDWs and losses were subjected to the observation-weighted outlier trimming procedure [12]. Following trimming, for each participant average SCR amplitudes were calculated for wins, LDWs and losses (each participant had three SCR values). As recommended by Dawson *et al.* [10], a square root transformation was applied to the SCR data to reduce the skewness of the SCR distribution. Figure 3 shows the average SCRs for wins, LDWs and losses for the 40 participants. An ANOVA showed a main effect of wins, LDWs and losses on SCRs $F_{(2,\ 78)} = 3.31$, $P < 0.05$, $\eta^2 = 0.078$. *Post-hoc* analyses showed that although wins and LDWs were not significantly different from one another, both had significantly higher SCRs than losses (both P-values <0.04). One participant was an outlier in all three conditions—removing this participant only strengthened the results $F_{(2,\ 76)} = 4.71$, $P < 0.02$, $\eta^2 = 0.11$ (*post-hoc* P-values < 0.02).

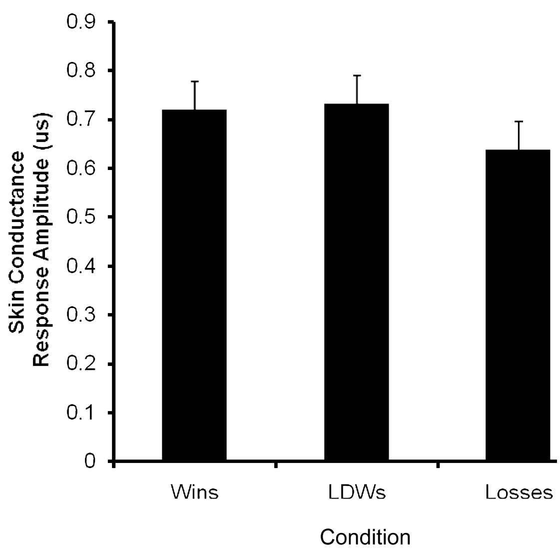

Figure 3 Mean skin conductance response amplitudes (square root of skin conductance response) as a function of wins, losses disguised as wins (LDWs) and losses (bars represent 95% confidence intervals for repeated measures designs)

DISCUSSION

In terms of ecological validity, although participants played an actual slot machine, they were given money to gamble with. This is clearly not the same as gambling with their own money and is an ethically unavoidable limitation of this study. Despite this drawback, participants still displayed different psychophysical reactions to wins, LDWs and losses.

Orientating responses and their accompanying heart-rate decelerations are elicited by infrequent stimuli. In slots games such as Lobstermania, losses are the most frequent outcome (67.3% of all outcomes in our version). By contrast, wins (15.5%) and LDWs (17.1%) were relatively infrequent. One might expect, therefore, that both wins and LDWs would have shown greater heart-rate decelerations than losses. This was not the case—only the real wins showed preferential heart-rate deceleration. Orientating responses have been linked to the intake of perceptual stimuli. For real wins the number of perceptual events is greater than for LDWs in both the visual and auditory domain. On average, more symbols become outlined on real wins than on LDWs. Finally, one is far more likely to hear the infrequent, unique sounds of the higher-paying symbols when they experience a real win than an LDW. Because more visual events followed wins than LDWs, and more unique sounds followed wins than LDWs, it makes sense that real wins led to the greatest heart-rate deceleration.

SCRs are triggered by the sympathetic nervous system and are correlated highly with subjective reports of arousal [11]. Our results show that gamblers become *equivalently* aroused following a win or an LDW, but were less aroused following a loss. Participants' SCRs appear to be sensitive to the absence of positive reinforcement following losses, compared to the plethora of flashing sights and rolling sounds that accompany credit gains on wins and LDWs. In terms of participants' somatic, sympathetically mediated responses, LDWs are treated as a win rather than a loss.

Somatic markers indexed by SCRs have been implicated in complex decision-making [13]. In the context of slot machines and LDWs, we suggest that if it looks and sounds like a win, it will feel somatically like a win and if it feels like a win, it will be interpreted as a win. Thus, the somatic responses to LDWs may make it hard for gamblers to realize that they are in fact losses.

According to Schull [14], game designers are aware of the potential impact of LDWs on players. In an excerpt from interviews with game designers she cites ' "The perception", Randy Adams of Anchor Gaming told me, "is that you're winning all the time, when you're really not— you're putting 25 in and winning 15 back, 45 in and 30 back, over and over". Nathan Leland of Silicon Gaming put it this way: "Positive reinforcement hides loss" '.

Playing multiple lines essentially amalgamates multiple bets into a single event. It takes (on average) far fewer spins to encounter reinforcement when playing multiple lines than a single line [15]. As shown in Table 1, when playing multiple lines many of these reinforcements occur following LDWs and thus these reinforcements are one way to ensure that 'positive reinforcement hides loss' [14].

CONCLUSIONS

Gambling researchers [4,5] have shown that winning at gambling is more arousing than losing, and that problem gamblers show higher arousal than non-problem gamblers. Brown [2] suggests that arousal is the most important reinforcer in frequent gambling behaviour. Because LDWs are as arousing as wins, it follows that games with a high proportion of LDWs will be more arousing than traditional games. If arousal is the key reinforcer in high-frequency gambling, and LDWs are as arousing as real wins, it suggests that games with many LDWs may be the game of choice for problem gamblers, as they provide more of the reinforcement that they crave. At this stage, as we only tested novice gamblers, the link between LDWs and problem gambling is based upon argument rather than data. That said, all problem gamblers were novices at one time, and the pattern of arousal reactions of novices to real wins, losses and LDWs suggests that despite being losses, LDWs engender the reinforcing arousal that is a key factor in the development of problem gambling.

Game designers indicate that they use positive reinforcement to hide loss [14]. One way that positive reinforcement may hide loss is through arousal—equally arousing outcomes (wins and LDWs) may be lumped mistakenly into the same category. Importantly, even when one recognizes that LDWs are really just a loss in disguise, if arousal itself is what is positively reinforcing one may still find slots games with LDWs more enjoyable (if one is a non-problem gambler), or potentially more addictive if one is a problem gambler. In the sage words of an elderly gentleman who learned the hard way about the allure of LDWs, 'I eventually realized that if I kept on winning, I was going to go broke'. This study provides the first objective evidence that the arousal generated by LDWs is equivalent to the arousal generated by wins, and highlights one means by which positive reinforcement may potentially hide loss from the gambler who plays multi-line slots.

Declarations of interest

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References

1. Raylu N., Oei T. P. S. Pathological gambling: a comprehensive review. *Clin Psychol Rev* 2002; **22**: 1009–2061.
2. Brown R. I. F. Arousal and sensation-seeking components of gambling and gambling addictions. *Int J Addict* 1986; **21**: 1001–16.
3. Anderson G., Brown R. I. F. Real and laboratory gambling, sensation seeking and arousal. *Br J Psychol* 1984; **75**: 401–10.
4. Coventry K. R., Hudson J. Gender differences, physiological arousal and the role of winning in fruit machine gamblers. *Addiction* 2001; **96**: 871–9.
5. Moodie C., Finnigan F. A comparison of the autonomic arousal of frequent, infrequent and non-gamblers while playing fruit machines. *Addiction* 2005; **100**: 51–9.
6. Vand der Molen M. W., Bashore T. R., Halliday R., Callaway E. Chrono-psychophysiology: mental chronometry augmented with psychophysiological time markers. In: Jennings J. R., Coles M. G. H., editors. *Handbook of Cognitive Psychopyhysiology: Central and Autonomic Nervous System Approaches*. Chichester, UK: Wiley; 1991, p. 9–178.
7. Lacey B., Lacey J. I. Cognitive modulation of time-dependent primary bradycardia. *Psychophysiology* 1980; **29**: 369–83.
8. Andreassi J. L. *Psychophysiology: Human Behaviour and Physical Response*, 4th edn. London: Lawrence Erlbaum Associates; 2000.
9. Wallin B. G. Sympathetic nerve activity underlying electrodermal and cardiovascular reaction in man. *Psychophysiology* 1981; **18**: 470–6.
10. Dawson M. E., Schell A. M., Filion D. L. The electrodermal system. In: Cacioppo J. T., Tassinary L. G., Berntson G. G., editors. *Handbook of Psychophysiology*, 2nd edn. New York, NY: Cambridge University Press; 2000, p. 200–23.
11. Lang P. J., Greenwald M. K., Bradley M. M., Hamm A. O. Looking at pictures: affective, visceral, and behavioural reactions. *Psychophysiology* 1993; **30**: 261–173.
12. Van Selst M., Jolicoeur P. A solution to the effect of sample size on outlier elimination. *Q J Exp Psychol A* 1994; **47**: 631–50.
13. Bechara A., Damásio A. R., Damásio H., Anderson S. W. Insensitivity to future consequences following damage to human prefrontal cortex. *Cognition* 1994; **50**: 7–15.
14. Schull N. D. Digital gambling: the coincidence of desire and design. *Ann Am Acad Pol Soc Sci* 2005; **597**: 65–81.
15. Haw J. Random-ratio schedules of reinforcement: the role of early wins and unreinforced trials. *J Gambl Stud* 2008; **21**: 56–67.

