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Cover Page Footnote

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This study investigated the effect of changes in prize volatility and presence or absence of an anticipatory stimulus signally reward on verbal ratings, playing behaviour, and biometric responses in casual and frequent electronic gaming machine (EGM) players. Biometric measurements of 129 participants were recorded while they played an actual EGM with money provided by the experimenters. However, only the data from 95 participants were analysed. Participants were first connected to biometric sensors to record their heart rate and galvanic skin responses, and completed a demographic questionnaire. All participants then played an EGM game for 10 minutes. After playing the EGM game, they either played the same EGM game or a different EGM game for another 10 minutes in accord with their experimental condition. The second game was characterized by one of four conditions, (a) low volatility, absence of anticipatory stimulus, (b) low volatility, presence of anticipatory stimulus, (c) high volatility, absence of anticipatory stimulus, and (d) high volatility, presence of anticipatory stimulus. After 20 minutes of EGM play, participants completed the Canadian Problem Gambling Index (CPGI; Ferris & Wynne, 2001). Statistical results revealed that the volatility condition had a significant effect on how quickly a player would bet. That is, players bet later in conditions with higher volatility. Furthermore, frequent players bet later than casual players. There was a significant interaction between volatility and player type, but the anticipatory stimulus condition was not found to have a significant effect on playing behaviour.

Keywords: Video lottery terminal gambling, Volatility, Anticipatory stimulus present or absent

Maintaining a healthy lifestyle includes entertainment. This often involves choosing to play games characterized by uncertain outcomes. In Canada and elsewhere, gambling is a popular recreational activity (i.e., the Addiction and Mental Health Research Laboratory in the province of Alberta; http://www.knowmo.ca) reports that in Canada, more than two thirds of adults gamble at least occasionally. Furthermore, playing electronic gaming machines (EGMs), typically known in various countries as video lottery terminals (VLTs), slots, fruit machines, poker machines (pokies), fixed odds betting terminals (e.g., virtual roulette) is a highly popular, world-wide gambling activity (Griffiths, 1994). For example, in Canada, Azmier (2001) reported that there were approximately 40,000 EGMs. Furthermore, the government of the province of Nova Scotia, Canada, reported that in 2006 and 2007, approximately 54.3% of the government's net gambling revenues came from VLT gambling and 17.9% came from casinos. However, only a relatively small number of these gamblers may be classified as problem gamblers, according to a report by Focal Research (1998) to the Department of Health in Nova Scotia:

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> "Problem VL Gamblers account for approximately 4% of all those who played EGMs in the last year, yet contribute approximately 53% of net revenue for video lottery gambling in Nova Scotia. On average, these players each spend approximately $9,706.56 on an annual basis and, collectively, contribute approximately $62 million in VL revenue to the province; …" (p. 14)

Therefore, for most players, EGMs are played for entertainment and with no significant negative consequences. However, for a relatively small portion of EGM players, the consequences have led to devastating financial ruin, psychiatric problems, and suicide. This has impacted not only individuals but also their families and their communities (Afifi, Cox, Martens, Sareen, & Enns, 2010; Bureau du coroner du Québec, 2004; Jacobs et al., 1989; Lorenz, 1987). Therefore, the gambling industry experiences conflicting goals. One goal of companies, provincial governments, and corporations is to make a profit by providing a service or product that the Canadian gambling population desires. The other goal is to minimize any harm to players who are not responsible gamblers. For the gambling industry, to encourage more players to gamble responsibly while discouraging players to gamble excessively is a daunting challenge. In order to address this challenge, this research investigated specific structural features of EGMs that may be preferred by the general population, but do not have a significant detrimental impact on problem gamblers.

Situational characteristics, including advertisements and the placement of EGMs in gambling venues, and structural characteristics, including near-wins, the use of intermittent reinforcement schedules, and its high-speed nature allows its users repeatedly to obtain immediate gratification, thus contributing to a player's state of pathological gambling (Parke & Griffiths, 2006). For example, near-wins could actually result in a level of excitement comparable to an actual win for some EGM players. Therefore, near-wins can be a powerful influence to continue gambling despite not winning any money at all. Furthermore, receiving frequent small prizes at irregular intervals increases the perception of winning more prizes. In addition, animated images on EGM screens keep the player's attention, multiple lines of play with a variety of bet-sizes add to the complexity of the game and in turn increase the challenge of winning, and EGM sounds of bells and whistles convinces others that if they continue to play, that they also could win.

The effect of EGM features on playing behaviour can vary greatly. Delfabbro and Winefield (1999) video-recorded the gambling behaviour of 21 occasional and 18 regular gamblers who played electronic poker machines using their own money in a gambling venue in Adelaide, Australia. Larger wins were found to disrupt response rates giving rise to larger post-reinforcement pauses. However, smaller rewards were found to maintain running response rates (based on the total time elapsed between reinforcements excluding post-reinforcement pauses, divided by total number of responses) rather than increase them, which had been reported in previous research by Dickerson et al. (1992).

Loba et al. (2002) recruited 60 regular VLT players, 29 who were "probable pathological gamblers" according to the South Oaks Gambling Screen (SOGS; Lesieur & Blume, 1987), to play spinning reels games or a video-poker game on two commercially available VLTs for a total of 80 minutes in the gambling laboratory. Each player was provided with $50 as compensation to play the games and also could use his/her own money. Game parameter variations involved a manipulation of two structural characteristics (Griffiths, 1993), (a) increased speed of play, sound off, and (b) decreased speed of play, sound on. Decreasing speed of play and turning off the sound were found to lower ratings of enjoyment, excitement, and tension reduction more for pathological than for non-pathological gamblers.

In a landmark study by Sharpe et al. (2005), behavioural patterns of play were observed in 779 EGM problem and non-problem gamblers who used their own money in clubs and hotels in New South Wales, Australia. Seven of the standard-configuration one-cent Aristocrat Leisure Technologies 'Pirates' machines were designated as control machines with a maximum bet size of $10, wager cycle speed of 3.5 seconds, and maximum denomination acceptance note size of $100. In addition, seven machines were modified with respect to all possible combinations of maximum bet size ($1), wager cycle speed of five seconds, and maximum denomination note size acceptance of $20. With respect to bet size, players spent more time playing, and placed more individual bets, using control machines with a $10 maximum bet size than using the modified machine with a $1 maximum bet size. However, with respect to wager cycle speed or maximum denomination note size, no significant differences were found. Furthermore, more probable problem gamblers than non-problem gamblers bet amounts greater than $20 per wager. However, no differences were found between probable problem and non-problem gamblers with respect to length of wager cycle.

Most recently, graduate student participants who were mainly non-pathological gamblers, played video slot machines for course credits or $10 gift cards and were found to play a significantly greater number of spins while betting on one line rather than five lines (Dixon et al., 2012). Slower rate of play found on five lines was suggested by the authors to result from a greater post-reinforcement pause associated with an increased number of winning outcomes during a five-line condition, or because participants spend more time analysing the outcome of a five-line spin as opposed to a one-line spin.

There is a substantial amount of empirical evidence that regular gamblers experience increases in heart rate or physiological arousal during gambling (Raylu & Oei, 2002). Sharpe (2004) found that problem gamblers had higher levels of skin conductance or arousal than non-problem gamblers, both when imagining a winning scenario of poker-machine play, and when imagining a losing scenario. Dixon et al. (2010) found, with non-problem gamblers who were given $200 to play with on a Lobster Mania slot machine, that their heart-rate deceleration orientating responses were greatest for more perceptually exciting real wins than for losses and "loses disguised as wins." Furthermore, players were found to be equally aroused (i.e., skin conductance response amplitude) following wins or "losses disguised as wins" than following losses. Meyer et al. (2004) reported increases in heart rate, cortisol, and norepinephrine levels in both problem and non-gamblers when playing blackjack for their own money in a casino. Furthermore, consistent with the findings of Sharpe (2004), problem gamblers had significantly higher norepinephrine, heart rate, and dopamine levels than non-problem gamblers. Overall, these findings suggest that although both problem and non-problem gamblers have similar physiological responses to gambling, the response by problem gamblers is more intense than the response by non-problem gamblers.

Decreases in heart rate variability (HRV) have been generally associated with greater emotional arousal. For example, HRV has been found to decrease under conditions of acute time pressure and emotional strain (Nickel & Nachreiner, 2003) and elevated state anxiety due to focused attention (Jönsson, 2007). It has also shown to be less in individuals reporting a greater frequency and duration of daily worry (Brosschot, Van Dijk, & Thayer, 2007). However, to the best of our knowledge, no research has been reported in the gambling literature using HRV as a measure of arousal.

Relatively little research has been reported in the gambling literature involving gamblers playing actual EGM machines for monetary reward. The current study investigated the effects of differences in EGM features on wager size, playing speed, heart rate (HR), HRV, and galvanic skin responses (GSRs) in both frequent and casual gamblers playing actual EGM machines with their own money in a setting in Canada. Specifically, the effect of altering two EGM structural features was examined in four conditions, (a) low volatility, absence of anticipatory stimulus, (b) low volatility, presence of anticipatory stimulus, (c) high volatility, absence of anticipatory stimulus, and (d) high volatility, presence of anticipatory stimulus. Volatility pertains to the variability in the amount and frequency of prizes. The anticipatory stimulus condition was operationally defined in terms of the presence or absence of a distinctive sound signalling the occurrence of a bonus round. Firstly, we hypothesized that both higher volatility and presence of a stimulus signaling a bonus round would result in increased wager size, playing speed, HR (decreased HRV), and GSR. Secondly, we hypothesized that frequent gamblers would evidence greater changes than casual gamblers with respect to these dependent variables. However, it should be noted that because of the fact that the sample of physiological data was incomplete, only an exploratory analysis of these data was undertaken.

METHOD

Participants

A total of 129 EGM casual or frequent players who were at least 19 years old were recruited to take part in this study, using advertisements posted on Kijiji. Of the 129 participants who were recruited, 119 participants completed the study. Furthermore, the data for 24 participants were omitted due to incomplete or faulty measurements. Data from the remaining 95 participants were analysed. The recruitment or screening form included an informed consent page describing the purpose and procedures of the study, and questions regarding their frequency of playing EGMs, their history of spending on EGMs, their age, and their comfort level with respect to being recorded while playing on an EMG. There were 59 causal players and 36 frequent players, while 50 participants were male and 45 were female. The youngest participant was 19 years old and the oldest was 66. The mean age was 43 years.

Measures and Materials

Demographic Questionnaire. This brief questionnaire obtained information about the participant’s age, gender, frequency and duration of playing EGMs.

Canadian Problem Gambling Index (CPGI; Ferris & Wynne, 2001). The CPGI assesses gambling behaviors and gambling severity (scoring: non-problem: 0; low risk: 1–2; moderate risk: 3–7; problem: 8 or above). The CPGI was modified by reducing the total number of questions from 12 to nine. However, the total number of scored questions (nine) remained the same. Also, one rating label was changed, from “most of the time” to “often” and slight changes were made in the wording of questions. The CPGI has adequate internal consistency (Cronbach α = 0.84), test-retest reliability (r = 0.78), and validity (Ferris & Wynne, 2001).

Electronic Gaming Machines

The two EGMs used in this study each EGM had a five reel x nine line game with an Ancient Egypt theme using 11 different images. The conventional information displayed on the screen included the amount bet on each spin, the amount won on each spin, and the amount of money left to play with. There were four versions of the same game in accord with a 2 x 2 design involving two independent variables, each with two levels: low volatility (LV) with anticipatory stimulus absent (SA), low volatility (LV) with anticipatory stimulus present (SP), high volatility (HV) with anticipatory stimulus absent (SA), and high volatility (HV) with anticipatory stimulus present (SP). Dependent variables were wager size, playing speed, HR, and GSR. Assuming a medium effect size, the sample size of 95 participants was viewed as being appropriately large.

The volatility condition was a function of prize value, prize frequency, and overall payout. Based on an estimation of the results of 1,000,000 games, there was a mean payout of 92.55% for the LV games and a mean payout of 92.60% for the HV games (i.e., a difference of only 0.05%). Actual calculations for the lower and upper bounds of these payouts showed a slightly wider range for the HV games than for the LV games. That is, for the HV games, the payout was 92.60% (+/- 6.30), and for the LV games, 92.55% (+/- 4.86). There were three ways of winning: main, scatter, and bonus. For the main round, the HV was programmed to have a higher payout than LV by 5.53%, and for the scatter round, a higher payout than LV by 2.06%. However, for the bonus round, the HV was programmed to have a lower payout than LV by 7.06%.

For the stimulus anticipation condition, SP involved hearing a distinctive "clunk, clunk" sound whenever the first reel stopped on a bonus symbol. Secondly, if the second reel then stopped on a second bonus symbol, there would be another distinctive "clunk, clunk" sound. In addition, the subsequent reels were made to look brighter while the other reels were shaded, and a whirling sound occurred while the remaining reels were spinning. Thirdly, if a third reel stopped on a bonus symbol, there was then a fast ding-ding-ding sound (like the start of horse race), which signaled the start of a bonus round. On the other hand, SA involved an absence of these distinctive sounds signaling reward.

With the exception of volatility and anticipation manipulations, the features of the two EGMs remained the same. EGMs were programmed to record wager, outcome, type of win, and the real time of every event. Otherwise, the EGMs utilized sounds and visual stimuli in a manner common to EGMs in general.

Physiological Monitors

The physiological monitoring devices and accompanying software consisted of Nexus-10 and BioTrace+ software, obtained from Stens Corporation (http://www.stens-biofeedback.com/). The NX-BVP1C-(BVP) Finger Sensor was placed on a participant's fingertip to monitor the relative blood flow in the finger with infrared light. The BioTrace+ software used the pulse signal to compute HR. In turn, HR was used to calculate HRV. The NX-GSR1D GSR Sensor used two finger sensors to record the fingertips' electrical conductance with a resolution up to 1/10000 micro-siemens.

Procedure

The entire study took place in a large room in a building in downtown Moncton, New Brunswick, Canada in which there were two EGM machines. When participants arrived, they completed the research consent form, and they were then randomly assigned to one of the four conditions. Participants were then connected to biometric sensors on three fingers tips of their inactive hand to record their GSR and HR. They then completed a demographic questionnaire. Participants then played a SA, LV, EGM game for 10 minutes in order to provide practice in playing an EGM machine in this setting. Each participant was given five $20 bills to insert into the EGM. After 10 minutes of playing the same game, there was a slight interruption, and a new game appeared on the EGM corresponding to one of the four game conditions, which they could play for 10 minutes. If at any time during the 20 minutes of playing time they no longer had any money to play with, they were given another $100 to insert into the EGM.

After 20 minutes of EGM play, participants completed a modified form of the CPGI. They were then disconnected from the biometric sensors, and were paid their winnings (up to a limit of $100) that exceeded the amount of money provided by the experimenters for the participants to play the EGMs. Finally, they were thanked for their time and effort, and given $60 for compensation for their participation in the study.

RESULTS

The mean CPGI score was 5.3 with a range from 0 to 24. The CPGI mean for casual players was 3.5 (SD = 4.2) and for frequent players, 6.4 (SD = 5.8). The means were significantly different, $F(1, 92) = 6.19$, $p = .015$.

Betting Latency

With respect to the second 10-minute playing session, an analysis of variance (ANOVA) of the 2 (LV, HV) x 2 (SA, SP) x 2 (casual, frequent player type) results revealed significant differences in the betting latency (BL) as measured by total playing time (TPT) minus total bonus time (TBT), divided by number of spins played (NSP). Thus, BL = (TPT-TBT)/NSP appears to be equivalent to the "running response time" measure used by Delfabbro and Winefield (1999).

There was a significant difference in BL between casual and frequent players during the second 10-minute playing session, $F(1, 95) = 5.76$, $p = .018$. On the average, casual players bet sooner (M = 4.7 sec., SD = 0.81) than frequent players, (M = 5.1 sec., SD = 1.13; see Figure 1). There was also a significant difference in BL between LV and HV conditions, $F(1, 95) = 4.15$, $p = .045$. On the average, LV participants bet sooner (M = 4.7 sec., SD = 0.90) than HV participants, (M = 4.9 sec., SD = 1.00; see Figure 1).

There was also a significant interaction in BL between volatility and player type, $F(1, 95) = 4.24$, $p = .042$ (see Figure 1). That is, the effect of volatility on BL was different for frequent players than for casual players. This significant interaction mainly resulted from frequent players betting later than casual players in the HV condition than in the LV condition. Lastly, there was no significant difference in BL between the SA and SP conditions and none of the other interactions were found to be significant.

Wager Size

There were no significant differences in the amount wagered in the second 10-minute playing session for any condition (i.e., volatility, anticipatory stimulus present or absent, or player type).

Spin and Bonus Dollars Actually Won

There was a significant difference in the mean amount of spins dollars actually won in the second playing session only in the volatility condition, $F(1, 111) = 4.51$, $p = .036$. HV participants won more spin dollars (M = $90.97, SD = $41.62) than LV participants (M = $75.93, SD = $32.80). These findings are in accord with the fact that HV

Figure 1. A significant interaction occurred in betting latency between volatility and player type.

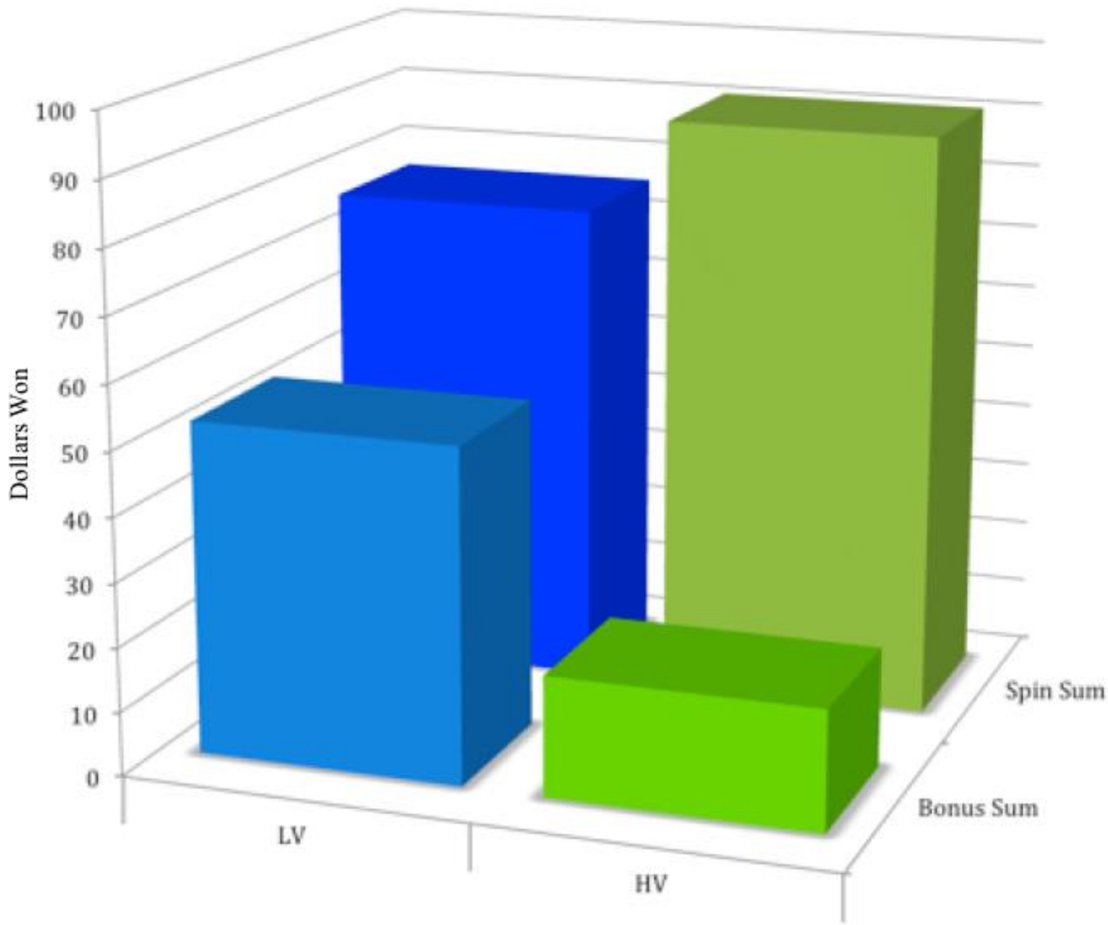
was programmed to have a higher payout than LV for main and scatter rounds. There was also a significant difference in the mean amount of bonus dollars actually won in the second playing session only in the volatility condition, $F(1, 111) = 18.01$, $p < .001$. LV participants won more bonus dollars (M = \$51.96, SD = \$54.53) than HV participants (M = \$18.79, SD = \$23.23). This was consistent with the fact that the bonus rounds had been programmed to have a higher payout associated with the LV condition than with the HV condition as noted earlier. The mean sum of dollars won for spins and bonuses is plotted in Figure 2.

An exploratory 2 (LV, HV) x 2 (SA, SP) x 2 (casual player type, frequent player type) ANOVA of the physiological data was completed on only 35 participants. Overall, although no significant differences were found, $F(1, 27) = 3.63$, $p = .067$, HRV was found to be marginally less in the HV condition ($M = 0.02$, $SD = 0.01$) than in the LV condition ($M = 0.06$, $SD = 0.10$). No other conditions or interactions were found to be significant.

DISCUSSION

In this study, CPGI scores of casual players were significantly less than those of frequent players. However, both kinds of players were in the moderate risk gambler category with casual players being at the lower end of the range and frequent players being at the higher end. Furthermore, the programming of the HV condition to have a greater payout on main and scatter rounds was consistent with the finding that the actual payout was higher for the HV condition than for the LV condition. Likewise, the

Figure 2. Mean sums of dollars won on spins and bonuses, in both low and high volatility conditions.



programming of the HV condition to have a lower payout than the LV condition on bonus rounds was consistent with the finding that the actual payout amount was lower for the HV condition than for the LV condition. At the same time, it should be noted that, in this study, it was initially predicted that both the programming and actual outcomes of main, scatter rounds, and bonus rounds would be greater in the HV condition than in the LV condition. This was only true for main and scatter rounds and not the bonus rounds.

Changing the features of a prize did make a difference in how quickly the players made each bet. As mentioned above, it is important to also note the finding of a significant interaction in BL between volatility and player type. When observing Figure 1, it is obvious that this interaction is the result of frequent players in the HV condition playing more slowly than everyone else. This result may be because frequent players are affected more than casual players by the differences in bonus wins, which surprisingly in this study turned out to be smaller and less numerous in the HV condition than in the LV condition, rather than the differences in spin wins. This explanation would be in accord with the research literature (e.g., Custer, 1984; Griffiths, 1995; Weatherly et al., 2004) where problem gamblers have been reported to be more vulnerable to larger wins than non-problem gamblers regarding the development and maintenance of problem gambling. That is, conversely in this study, frequent gamblers took greater time to respond in accord with their being fewer larger rewards associated with bonus rounds, which may have increased the latency to bet on the next spin.

There were no significant differences in how much players bet on spins with respect to prize-volatility, anticipatory stimulus present or absent, and player type. Possibly, choosing the amount to wager is a more conscious activity than just pressing the button for the next spin. If so, then a player might be more likely to retain their preconceived rule of how much to wager on a spin, in contrast to varying the intensity of pressing a play button in accord with their current emotional state. Furthermore, given that money was initially provided by the experimenters to players, and more money was provided if needed, players may not have been as sensitive to amount wagered as they might have been if they were using only their own money.

Lastly, although incomplete, the tentative findings of the HRV data suggested that the value of HRV was less in the HV prize condition than in the LV prize condition for both casual and frequent players. Lower HRV suggests that players may be experiencing an elevated state of anxiety (Jönsson, 2007) due to a more focused attention in anticipating the next win. This finding would be consistent with those of Meyer et al. (2004) who reported increases in heart rate, cortisol and norepinephrine levels in both problem and non-problem gamblers when playing blackjack for their own money in a casino.

Limitations

This study had a number of limitations. Although participants were randomly assigned to conditions, they were not randomly selected from the gambling population. Rather, they were recruited by a commercial recruiting agency to take part in the study with the prospect of monetary reimbursement. Secondly, as noted above, although casual players differed significantly from frequent players in their CPGI scores, strictly speaking, frequent players were not problem gamblers, with less than a score of 8.0 on the CPGI, and casual players were not low risk or no risk gamblers with more than a CPGI score of 2.0. Consequently, conclusions regarding the findings of this study pertaining to differences between problem and non-problem gamblers have to be qualified with respect to their relevance to responsible gaming practices. Thirdly, although participants gambled with real money, the funds were provided by the experimenter with a final payout limit of $100. Fourthly, actual playing time was relatively short — only 10 minutes. Playing for a much longer time would have provided a more valid sample of playing data regarding the EGM gambling population, which had acquired their gambling addiction over a lifetime of gambling. Lastly, analysis of the physiological data involving only 35 participants was undertaken only on an exploratory basis. That is, the study was underpowered to detect small and medium effect sizes in the physiological domain.

The findings of this study suggest that it is possible to program changes in payout reinforcement for main, scatter, and bonus rounds in commercial EGM machines, in spite of the fact that wins and the amount paid by the EGM machine occur on a random basis and participants do not have exactly the same experience while playing the EGMs in this study. This may be the first study involving participants playing EGM machines operating at an otherwise random basis, which reported a consonance between prior programming of reinforcement payout and actual payout outcomes. Such a novel finding underscores the potential for other gambling researchers to use a similar methodology in their investigations of EGM behaviour.

Furthermore, the findings of this study indicate that altering prize size and frequency of winning of prizes will affect how much time a player takes between spins, but not how much he or she will wager on each spin. In particular, frequent players (mean CPGI = 6.4, *SD* = 5.8) were found to bet slower than casual players (mean CPGI = 3.5, *SD* = 4.2), especially when bonus round prizes were relatively small and infrequent. Therefore, with respect to responsible gaming practices, the findings of this study suggest that the gaming industry should place greater emphasis on the development of game features pertaining to spins rather than bonus rounds. Such an emphasis might well result in the development and marketing of game features that promote VLT playing by casual players while having relatively little effect on playing by frequent players.

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