J Gambl Stud (2010) 26:159–174
DOI 10.1007/s10899-009-9154-8

ORIGINAL PAPER

Government Sanctioned "Tight" and "Loose" Slot Machines: How Having Multiple Versions of the Same Slot Machine Game May Impact Problem Gambling

Kevin A. Harrigan · Mike Dixon

Published online: 16 September 2009

Abstract In Ontario, Canada, the regulator approves identical looking slot machine games with different payback percentages. We gained access to the design documents (called PAR Sheets) used to program these different versions of the same slots game and ran Gambler's Ruin simulations of 2,000 first-time players who each arrived with a $100 bankroll and played either the 85 or 98% version of the same game until broke. Simulations revealed that the typical (median) player's experience did not differ significantly between versions. However the payback percentage affected the experience of players in the upper tails of the distributions with those in the 98% version having dramatically more total spins, winning spins, entries into the "bonus mode", and "hand pays" (a win of $125 or more on a given spin). Most importantly, the number of simulated players who had a maximum peak balance in excess of $1,000 rose tenfold—from 5 in the 85% version to 54 in the 98% version. The results are discussed in terms of the Pathways Model of Problem and Pathological Gambling especially in terms of behavioural conditioning, cognitive beliefs, and early big wins. It may well be that those machines that are on the surface the "fairest" to the gambler, actually pose the most risk for ensuing gambling problems.

Keywords Gaming regulations · Problem gambling · Slot machines · Video slots · PAR sheets · Structural characteristics

Slot machine manufacturers typically create multiple versions of the same slot machine game with the major distinguishing characteristic being the payback percentage. Payback percentages are the percentage of wagers that on average the gambler gets back—a

K. A. Harrigan (✉)
Canadian Centre for Arts and Technology, University of Waterloo,
200 University Avenue West, Waterloo, ON N2L 3G1, Canada
e-mail: kevinh@uwaterloo.ca
URL: http://problemgambling.uwaterloo.ca/

M. Dixon
Psychology Department, University of Waterloo, 200 University Avenue West, Waterloo,
ON N2L 3G1, Canada
e-mail: mjdixon@uwaterloo.ca

machine with a 98% payback percentage returns 98 cents of every dollar wagered, with a profit or "hold" of 2 cents for the house. Payback percentages typically vary from a low of 85% to a high of 98% (with the Casinos keeping 15–2% of wagers, respectively). All versions of the game look identical to the player. The regulators in any given gaming jurisdictions may approve one or more versions of the game that meet their jurisdictional regulations or standards. Once the regulator in a jurisdiction has approved a game, any approved versions can then be installed on slot machines in that jurisdiction. In addition, any time after a version of a game has been installed on a slot machine in the jurisdiction, slot machine technicians can change the version of the game that is played on that slot machine with a different approved version.

Through the Freedom of Information and Protection of Privacy Act (FIPPA), we have received design documents for a number of slot machine games. These design documents are referred to as PAR (Probability Accounting Report) sheets. Our PAR sheets are for slot machine games approved in Ontario, Canada—Ontario typically approves seven or eight versions of the same game with payback percentages that vary from 85 to 98%.

In this paper we contrast the 85 and 98% versions of "Lucky Larry's Lobstermania" (hereafter referred to as Lobstermania) that are approved for use in Ontario, Canada. We wrote a computer program to simulate 1,000 players on each version in a Gambler's Ruin scenario whereby the novice player arrived with $100 bankroll and played until broke. The simulation provided us with the number of spins, winning spins, bonus mode entries, hand pays, jackpots, and the maximum or peak balance achieved by the 2,000 players. We defined a "big win" as a session in which the player accrues a peak balance in excess of $1,000 on their $100 bankroll. Results of our simulation show that the average (i.e., median) players on both the 85 and 98% versions had similar experiences but that those in the upper tail of the distribution had experiences that varied dramatically between the two versions. In the 98% version, those in the upper tail had many more total spins, winning spins, bonus mode entries, and hand pays. The peak balance was greater than $1,000 for five simulated players in the 85% version and rose tenfold to 54 simulated players in the 98% version. We conclude that the higher payback machines, which seem on the surface fairer to the player, are in fact more of a concern for problem gambling. The results are discussed in terms of the Pathways Model of Problem and Pathological Gambling especially in terms of the "common processes" of behavioural conditioning, cognitive beliefs, and early big wins.

Literature Review

The Pathways Model of Problem and Pathological Gambling (Blaszczynski 2000; Blaszczynski and Nower 2002) is a conceptual framework that that defines three major pathways culminating in pathological gambling (a) behaviorally conditioned problem gamblers, (b) emotionally vulnerable problem gamblers and (c) antisocial, impulsivity problem gamblers. The model states that the "starting block" to all three pathways is accessibility and access to gaming and that in all three pathways behavior conditioning brings rise to cognitive processes that result in faulty beliefs related to personal skill and probability of winning. This paper focuses on the effect of the game's payback percentage on behaviorally conditioning using the simulated scenario of 2,000 novice gamblers who are playing for the first time in a new gambling venue that has recently opened in their area.

The premise that accessibility and access act as a starting block is supported by research that shows that individuals who have easy access to gambling have higher rates of problem gambling (Abbott and Volberg 1996; Volberg 1996; Grun and McKeigue 2000). In Turner et al.'s (2006) study, 58% of problem gamblers and sub-clinical problem gamblers said that a gaming venue opened near their place of residence just before gambling became a problem for them.

With regard to the behavioral conditioning and cognitive processes, Blaszczynski and Nower (2002, p. 491) state:

> As the frequency of gambling progresses, strong biased and distorted cognitive schemas appear. These schemas shape beliefs surrounding attribution, personal skill and control over outcome, biased evaluations, erroneous perceptions, superstitious thinking and probability theory (see Griffiths 1995; Ladouceur and Walker 1996 for a comprehensive review of these processes). The potency and pervasiveness of distorted and irrational cognitive belief structures strengthen with increasing levels of involvement in gambling (Griffiths 1990, 1995).

Turner et al. (2006) showed that having an early big win is correlated with problematic gambling and that the median amount that gamblers considered a big win was $1,000. Often the big win occurred the very first time the gambler gambled seriously. Interestingly, gamblers who had an early big win often did not leave that first gambling session with the money they had won as Turner et al. did not show a correlation between whether problem gamblers won, lost, or broke even on their first gambling experience. These findings by Turner et al. align nicely with our Gambler's Ruin scenario of 2,000 first-time gamblers in which we defined a peak balance of $1,000 on an initial bankroll of $100 as a big win and in our simulation the gamblers continued to gamble after they had reached the $1,000 threshold.

The gamblers who have a big win in their first gambling experience and continue to gamble have increased levels of gambling involvement in that they have many more spins than gamblers who did not experience a big win. This suggests that it is not only the big win in and of itself that correlates with problematic gambling but rather the behavioural conditioning associated with the increased number of spins may partly explain why players who have an early big win, and continue to gamble in the session in which they have the big win, later developing gambling problems.

Early big wins as a predictor of gambling problems is supported by Walker's Cognitive Theory of Gambling Involvement; Walker (1992) says that "The necessary ingredient to convert an occasional gambler to one that accepts the challenge of gambling is a belief in one's ability to succeed and concerning this belief, we can predict that one contributing factor will be early success" which "can foster the belief that you have the resources to beat the system and win at gambling" (p. 136–137).

Walker's statement is supported by the fact that problem gamblers often retrospectively report having early big wins. Greene (1982) wrote that after treating approximately 400 people, the staff of the Johns Hopkins University Compulsive Gambling Centre said that pathological gamblers often have early wins "Pathological gamblers usually experience a 'big win'—a racetrack, casino, or lottery win, which, in their eyes, is of such mammoth proportion that it makes a lasting impression on them." (p. 51). Custer (1984) and Custer and Milt (1985) reported that many problem gamblers in treatment indicated that they had had a substantial early win: "it is generally those who win early and consistently in their gambling career who become the compulsive gambler" (Custer and Milt 1985, p. 100). Moran (1970) stated that "In one analysis of 50 pathological gamblers, 20 out of 50 reported that they had a large win early in their gambling career" (as cited in Walker 1992, p. 137).

The Queensland household gambling survey (Queensland 2002, p. 20) found “In terms of early experiences, a majority (71%) of the Problem Gambling group and more than half of Moderate Risk groups recall a big win when they first started to gamble.” In the British Columbia Problem Gambling Prevalence Study (Ministry of Public Safety and Solicitor General 2003) of 2,134 respondents, early wins were reported by 21% of non-problem gamblers ($n = 1757$), 37% of at risk gamblers ($n = 266$), 45% of moderate problem gamblers ($n = 199$), and 91% of severe problem gamblers ($n = 11$). Livingston and Woolley’s (2008, p. 11–12) focus groups and interviews with 64 problem gamblers highlighted the importance of the wins early in the gambler’s experience “Big wins were also valued, but featured most often in discussion in relation to the first big win the individual had experienced.”

Wexler (2002) provides a personal insight into the effects of early wins. He describes how a win of $54 in 1951 was a key event that led him down the path to becoming a pathological gambler. He said:

> As a young kid growing up, I always felt that everyone was better than me. The only time I felt okay about myself was after I had a win, whether it was marbles or baseball cards or pennies. Then, at 14, I went to the racetrack for the first time; it was Memorial Day 1951, Roosevelt Raceway. At the time, I made 50 cents an hour after school, working 15–20 h a week. That night at Roosevelt Raceway I had my first big win and walked out of the track with $54. Looking back today, I think it was that night that changed my life. Even though I had only won $54, it was about five weeks’ salary to me. After that night, I believed I could be a winner from gambling, and eventually, become a millionaire. I can still recall that high feeling walking out of the racetrack that night.

The empirical studies of early wins have focused on laboratory experiments where the participants were presented with various conditions for a very short period of time. The results of these studies are mixed. Langer and Roth (1975) asked 90 subjects to predict the outcome of 30 flips of a coin; the experiment was controlled so that all subjects had 15 heads and 15 tails. The sequence of wins varied, with one-third having most wins early in the sequence, one-third having the wins randomly occurring in the sequence, and one-third having losses near the beginning. In the task, it was made clear to the subjects that the outcome was determined by chance; yet, the results showed that the group with the early wins attributed their results more to skill than did the other groups. Coventry and Norman (1998) found similar results to Langer and Roth in a computer generated task called the “turtle task” where 54 participants predicted which turtle would win in 32 separate trials. Ladouceur and Mayrand (1984) also conducted similar studies and their results showed that “Primacy effects were observed with those having frequent initial wins estimate their amount of personal control as higher than do those beginning with few wins” (p. 49).

Kassinove and Schare (2001) conducted an experiment with 180 undergraduate psychology students as participants. Participants played a simulated slot machine for 50 trials that contained wins and non-wins, followed by 50 trials in which no wins occurred (i.e., extinction). One group was exposed to a big win of $10 on trial eight and the results showed no difference in persistence of play for the “big win” group versus the “no big win” group. Weatherly et al.’s (2004) study, involving 33 college students, did not support the early wins effect as they found that participants who experienced a slot machine win on the first play quit playing the simulator earlier than subjects who experienced a big win on the fifth play.

The Process of Creating, Approving, and Deploying Multiple Versions of the Same Game

Creating: How Slot Machine Manufacturers Create Multiple Versions of the Same Game

For the PAR Sheets that we have obtained through FIPPA, the multiple versions are always created by manipulation of the number of each type of symbol on the virtual reels, while leaving the total number of symbols per reel unaltered. For example, on all versions of Lobstermania there are 47 symbols on reel 1, 46 on reel 2, 48 on reel 3, 50 on reel 4, and 50 on reel 5 (which we denote as 47-46-48-50-50). The higher paying versions have fewer occurrences of the lower paying symbols and more occurrences of the higher paying symbols. All versions have the same number of occurrences of the highest paying "jackpot" symbol (2-2-1-4-2), the bonus mode symbol (2-5-6-0-0), and the scatter symbol (2-2-2-2-2) (See Harrigan and Dixon (2009) for more technical details on how the multiple versions are created).

Approving: How Multiple Versions of the Same Game are Regulated

Each jurisdiction may approve one or more versions of a game. Gaming in Ontario is governed by the Gaming Control Act (Ontario Gaming Control Act 1992). The Alcohol and Gaming Commission of Ontario (AGCO) sets the standards for slot machines in Ontario as described in the AGCO's Electronic Gaming Equipment Minimum Technical Standards (AGCO 2007). The minimum payback percentage is regulated by the standards which state that "the gaming equipment must have a minimum theoretical payout percentage of 85 (85.000) % for each wager available on the game" (AGCO 2007, 20.1.2, p. 46). Importantly, although there is a stated lower limit on payback percentages, the Ontario standards do not preclude having multiple versions of the same game that employ different payback percentages.

The Ontario Gaming Control Act states that the rules of play for all games must be made available to the public. A key exception to this regulation involves slot machine games—"the operator of a gaming premises shall, on request, provide a player with a description of the rules of play of any game of chance offered for play at the gaming premises, except for games played on slot machines" (Ontario Gaming Control Act 1992, 30(6), p. 10). Despite this regulatory exemption, many of the rules of play *are* displayed on slot machine games in Ontario. For example, in Lobstermania there are multiple "Help" screens that explain how to play the game and list all winning combinations and their associated winning amounts. Key pieces of information that are missing from these descriptions are the odds of winning each prize and the payback percentage of the machine. The clause from the Ontario Gaming Control Act cited above, means that the operator is under no obligation to provide this key information to the player.

Deploying: Setting and Changing the Payback Percentage for a Game

As noted earlier, after a slot machine has been deployed, slot technicians can change the payback percentage by either a hardware chip change or by a software reconfiguration. At our university, we have a research laboratory in which we have four slot machines, and their accompanying technical manuals, that we use for conducting empirical research.

These slot machines are identical to the type employed in Ontario gaming facilities. One is a Bally ProSlot 6000 running "Blazing 7s," two are IGT S2000 with the games "Wild Thing" and "Triple Stars" while the fourth is a more modern video slot IGT Game King containing the game "Lucky Larry's Lobstermania." In all of these machines, the version of the game can be changed by a slot machine technician who has access to the machine's configuration menu and one or more of the necessary computer chips.

PAR Sheet Information

Freedom of Information

Through FIPPA in Ontario we received the lists of the approved versions of four games. In our request, we only asked for PAR Sheets for the versions that are in use in our local casino, Grand River Raceway, and thus we did not receive the PAR Sheets for all approved versions:

- There are nine approved versions of Money Storm with payback percentages of 85, 87.5, 90, 92.5, 94, 95, 96.2, 97 and 98%.
- There are eight approved versions of The Phantom of the Opera with payback percentages of 85, 87.5, 90, 92.5, 94, 95, 97.4, and 98%.
- There is one approved version of Double Diamond Deluxe with a payback percentage of 92.6%.
- There are nine approved versions of Lucky Larry's Lobstermania with payback percentages of 85, 87.5, 90, 92.5, 94, 95, 96.2, 97 and 98% versions. We received the PAR Sheets for the 85, 87.5, 90, 92.5, 94, 95, 96.2% versions and were able to determine the PAR Sheet information for the 97 and 98% versions, using the versions of Lobstermania in our lab.

In this paper we will focus exclusively on Lobstermania as a representative game that has multiple versions and for which we have the complete PAR Sheet information.

Characteristics Common to All Versions of Lobstermania

All approved versions of Lobstermania have the following characteristics in common:

- Five reels
- 47/46/48/50/50 symbols per reel yielding 259,440,000 possible outcomes
- Jackpot that is won once, on average, in 8,107,500 spins
- Bonus mode that is entered once, on average, every 1,730 plays per line
- Average amount won in bonus mode of 331× the initiating line wager
- In our local casino, a minimum wager of $0.05 per line (although this can be changed to $0.01, $0.25, or $1.00 via a software configuration on the machine in our lab)
- Maximum wager per line of 5× the minimum wager, and thus a maximum wager of $0.25 per line in our local casino
- 15 lines that can be played at once
- Maximum wager per spin of $3.75 ($0.25 × 15) in our local casino
- Scatter wins
- In our local casino, hand-pays if the amount of a winning spin is $125 or greater

- Hit Frequency—approximately 5% when playing only one line (This is the Hit Frequency as reported in the PAR Sheets. When wagering on all 15 lines, the player wins something on approximately one-third of the spins.)
- Jackpot size of 10,000× the initiating line wager (i.e., a maximum of 50,000 credits, which is $2,500)
- A visible "Pay Table" on the glass panel, which shows the winning combinations and the amount paid for each.

Gambler's Ruin Scenario: Analysis of All 259,440,000 Possible Outcomes

To determine the differences between the 85.0 and 98.0% versions of Lobstermania we analyzed the PAR Sheets and wrote a computer program to analyze all 259,440,000 possible outcomes. To highlight the differences we considered a Gambler's Ruin scenario whereby the player arrives with $100 and makes maximum wagers on each spin (i.e., $3.75) until broke. Our results are shown in Table 1 and are described as follows.

Number of Spins and Duration of Play

The number of spins that the player can expect, on average, for a given bankroll varies significantly between versions and can be calculated based on the average loss per spin (i.e., the hold). The hold for the 85% version is 15%, and for the 98.0% version is 2.0%. Thus in the 85% version the player loses 56.25 cents per spin ($3.75 × 15% = 56.25 cents) while in the 98.0% version the loss is 7.5 cents per spin ($3.75 × 2.0% = 7.5 cents). Thus, on average $100 will generate 178 spins on the 85% version (100/0.5625 = 178) and 1,333 spins on the 98.0% version (100/0.075 = 1,333).

We estimated the duration of play, in hours, based on the player making a spin every 6 s. The duration is calculated as the estimated number of spins times six, which gives the total estimated duration in seconds, divided by 3,600 (which is the number of seconds in an hour). For example, on the 85% version, the number of spins is 178 and the duration in hours is 0.3 h (178 times six divided by 3,600 equals 0.30).

Number of Winning Spins

We counted "winning spins" as any spin in which the game outcome included one or more individual wins (for example, a game outcome that contains two line wins and a scatter win is counted as one "winning spin"). Note that the total number of individual wins can be

Table 1 Results of analysis of all 259,440,000 possible outcomes in Lobstermania

	Payback percentage	
	85.0%	98.0%
Expected # of spins	178	1,333
Estimated hours	0.30	2.22
Expected # of winning spins	56	435
Expected # of bonus mode entries	1.54	11.56
Expected # of hand-pays	0.38	4.56
Expected # of jackpots	0.0003	0.0025

Gambler's Ruin scenario whereby the player arrives with $100 and always makes the maximum wager of $3.75 until broke calculated from the PAR Sheet but to determine the number of "winning spins" we needed to analyze all 259,440,000 possible outcomes. As shown in Table 1, the results are that when making the maximum wager, approximately one-third of all spins are "winning spins" (56 of 178 for the 85% version which is 31.3% and 435 of 1,333 for the 98% version which is 32.6%).

Number of Times Entering Bonus Mode

In all versions of Lobstermania, out of the total possible combinations of 259,440,000, there are 150,000 winning combinations that initiate the "bonus mode". In Lobstermania when the three lobster symbols appear on reels one, two, and three of a played line, the lobster symbols change to "pick me" symbols signalling the entrance into the bonus mode. After the gambler selects one of the "pick me" symbols, the graphics change to a different virtual environment. Instead of reels, the screen shows a fishing boat with a number of buoys. The player is asked by an animated fisherman to select a subset of these buoys which when selected reveal prizes. Throughout the awarding of the prizes the animated fisherman "interacts" with the gambler commenting on the size of the win for each buoy (e.g., "that was a big one"). After all prizes are revealed, a screen appears showing the total amount won (i.e., credited to the players account). All wins are multiplied by the wager on the initiating line (in our scenario wins are multiplied by five as we wagered 25 cents per line on a 5 cent game). The game then automatically returns to the standard game mode.

From the PAR sheets we calculated that players enter the bonus mode, on average, once in every 1,730 plays per line wagered (259,440,000/150,000 = 1,730). A gambler wagering on all 15 lines (as in our Gambler's Ruin scenario) enters the bonus mode, on average, once in every 115 spins (1,730/15 = 115). Hence, in our gamblers ruin scenario on average a gambler playing the 85% version would enter the bonus mode 1.5 times (178/115 = 1.5), whereas a gambler playing the 98% version would enter the bonus mode 11.6 times (1,333/115 = 11.6) before they lose all of their money.

Hand-Pays

In our local casino, players playing Lobstermania receive a hand-pay when a winning amount on a spin is $125 or more. Our analysis of all possible outcomes shows that in the 85% version the percentage of wins that are hand-pays is 0.68% while in the 98% version the percentage is 1.05%. In our gamblers ruin scenario, the gambler playing the 85% machine would only have a 38% probability of encountering a hand-pay during a single gambling session (56 × 0.68% equals 38.0%). The experience of the gambler playing the 98% version is markedly different. With an average of 435 winning spins, before the player exhausts their bankroll, and a hand-pay on 1.05% of all wins, the gambler playing this machine would, on average, encounter 4–5 hand-pays per session (435 × 1.05% equals 4.6).

Jackpots

Table 1 shows the expected number of jackpots in Lobstermania. When playing one line the jackpot occurs once in every 8,107,500 plays. Playing all 15 lines means that the chances are one in 540,500 spins (8,107,500/15 equals 540,500). In our Gambler's Ruin scenario the player gets on average 178 (85% version) or 1,333 spins (98% version) and thus any individual gambler would not be expected to hit the jackpot during a given session as the expected number of jackpots is 0.0003% for the 85% version and 0.0025 for the 98% version (178/540,500 equals 0.0003 while 1,333/540,500 equals 0.0025).

Positively Skewed Data

Table 1 shows that the mean values of winning spins, bonus mode entries, hand-pays and jackpots are all higher for the 98% version. These means are therefore one way of documenting the influence of differing payback percentages for the same game. One must, however, keep in mind that these means will be influenced by a small number of players who happen to win a lot. Being up by a lot will elevate the number of spins, winning spins, bonus mode entries, and hand-pays for those players and consequently affect the means for these variables. Thus, although these means are accurate population level statistics, because the distributions of these variables are positively skewed (and highly influenced by those in the upper tails of the distributions), it could be argued that they do not capture the average gambler's experience. To better capture the average gambler's experience with different versions of the same game requires a different empirical strategy.

Gambler's Ruin Scenario: Simulation of 1,000 Players

Using the information in the PAR sheets we wrote a computer program to simulate 1,000 single gambling sessions conforming to our Gambler's Ruin scenario of a player arriving with a $100 bankroll and playing maximum wager until broke on each of the 85 and 98% versions of Lobstermania. Our program recorded data on spins, winning spins, bonuses, hand-pays, and jackpots. This data is reported in Table 2. As can be seen by comparing Tables 1 and 2, the means of our simulations (with a sample size of 1,000 for each version)

Table 2 Count of the number spins, winning spins, bonuses, hand-pays, and jackpots in the simulation of 2,000 sessions of the Gambler's Ruin

All simulated players

	Payback percentage			
	85.0%		98.0%	
	n = 1000		n = 1000	
	Mean	Median	Mean	Median
# of Spins	186	81	1,184	101
Estimated hours	0.31	0.14	1.97	0.17
# of winning spins	58	26	386	32
# of bonuses	1.6	0	10.3	0
# of hand-pays	0.4	0	4.1	0
# of jackpots	0.000	0	0.002	0
Peak balance	$188	$128	$314	$145
Payback %	85.4	66.5	97.7	72.9

are quite close to the population values from our analysis shown in Table 1. Table 2 shows that the mean number of spins is much higher in the 98% version and subsequently the mean number of winning spins, bonuses, and hand-pays is much higher. We can also see that nobody in the 85% version won the jackpot while two did in the 98.0% version. By simulating 1,000 players for each version we were able to calculate median values for winning spins, bonuses, hand-pays, and jackpots. Since the median is far less affected by extreme values than the mean, these median values provide a better approximation of what a gambler can expect on a typical gambling session. Two key points are relevant, using the median we see that the number of spins, winning spins, and bonus mode entries as we move from the 85% payback machines to the 98% machines are not markedly different. Indeed in this sample of 2,000 people, the number of winning spins for the 98% version (32) was only six greater than the number of winning spins for the 85% version (26). Similarly for bonus mode entries, and hand pays, the median values are identical for the 85 and 98% versions. Thus, even though machines have markedly different payback percentages, these median values indicate that the typical experience of playing these machines is quite similar. The second point is the payback percentage experienced by the typical player when using the median as opposed to the mean is far lower than the average payback percentage for that machine. As shown in the bottom row of Table 2, the mean payback percentages of our simulated sample map nicely on to the payback percentages of the machines (not surprising given our large samples). However, when we look at the payback percentage experienced by the typical player as indexed by the median, these percentages are far lower than the mean. Although the payback percentages of the machines are 85 and 98%, the *typical* experience of the players playing these machines is far worse at 67 and 73%.

We have defined a big win as a session in which the player accrues a peak balance in excess of $1,000 on their $100 bankroll (i.e., ten times the initial bankroll). Although in our gamblers ruin scenario the players play until they lose their entire bankroll those whose peak balances were in excess of $1,000 would leave having experienced being “up” by a vast amount. Consider the scenario when a brand new casino opens in a market without other casinos in the nearby vicinity. We sought to assess the likelihood of experiencing a “big win” among the two different cohorts of 1,000 new gamblers playing the 85.0 and 98.0% versions.

Table 3 shows the same Gambler’s Ruin simulation results as Table 2 but Table 3 breaks the results down by those simulated players who had a peak balance less than $1,000 and greater than $1,000. Table 3 shows that those with peak balances less than $1,000 had gambling sessions that were quite short with both the mean and median estimated time gambling being less than one half hour in both versions. The mean and median total spins, winning spins, bonuses, hand-pays and jackpots were all low or zero. This contrasts sharply with the small number of players who had a peak balance greater than $1,000. There were five players in the 85% version with a balance greater than $1,000 and this increased tenfold to 54 in the 98% version. In this group the simulated players in the 98% version had much higher values across the board. In the 98% version the mean and median estimated playing time were 28.5 and 11.2 h, respectively. Clearly these players had a gambling experience that provided much more behavioural reinforcement than any of the other players.

Table 4 shows a frequency distribution across different peak balance amounts. As an example, our simulations revealed that 501 out of 1,000 gamblers had peak winnings ranging between $100 and $199 for the 85% machine, and 432 out of 1,000 gamblers had peak winning ranging between $100 and $199 for the 98% machine. In the 85% game there

Table 3 Simulation of 2,000 sessions of the Gambler's Ruin broken down by those with a peak balance ≤$1,000 and those with a peak balance >$1,000

	Peak balance ≤$1,000				Peak balance >$1,000			
	Payback percentage				Payback percentage			
	85.0%		98.0%		85.0%		98.0%	
	$n = 995$		$n = 946$		$n = 5$		$n = 54$	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
# of Spins	175	80	275	93	2,347	2,110	17,104	6,712
Estimated hours	0.29	0.13	0.46	0.16	3.91	3.52	28.51	11.19
# of winning spins	55	25	89	29	736	643	5592	2169
# of bonuses	1.5	0.0	2.2	0.0	22.8	28.0	152.9	66.0
# of hand-pays	0.4	0.0	0.8	0.0	7.4	8.0	63.6	25.5
# of jackpots	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00
Peak balance	$183	$127	$214	$136	$1,078	$1,083	$2,080	$1,449
Payback %	62.2	66.0	66.3	71.1	98.7	98.7	99.6	99.6

Table 4 Distribution of the peak balance in the simulation of 2,000 simulated sessions of the Gambler's Ruin scenario whereby the player arrives with $100 and always makes the maximum wager of $3.75 until broke

Peak Balance		Payback Percentage	
Low	High	85.0%	98.0%
$100	$100	217	197
$100	$200	501	432
$200	$300	154	128
$300	$400	52	69
$400	$500	37	42
$500	$1,000	34	78
$1,000	$1,500	5	29
$1,500	$2,000	0	5
$2,000	$3,000	0	11
$3,000	$4,000	0	5
$4,000	$5,000	0	1
$5,000	$10,000	0	3
Total		1,000	1,000

Double or Nothing	
282	85.0%
371	98.0%

Big Wins (> $1,000)	
5	85.0%
54	98.0%

were only five gamblers who had peak balances above $1,000 and all five were less than $1,500. For the 1,000 simulated gamblers playing the 98% machine by contrast, there was more than a tenfold increase to 54 gamblers whose peak balance was greater than $1,000 (29 gamblers had peak balances between $1,000 and $1,499; five gamblers had peak amounts between $1,500 and $2,000, 11 gamblers were between, $2,000 and $2,999, five gamblers were between $3,000 and $3,999, one was between $4,000 and $4,999, and three were above $5,000). In considering a peak balance of over $1,000 as a big win, one can see the dramatic influence of the machines payback percentages.

Implications for Problem Gambling

Early Big Wins and Behavioural Reinforcement

We feel that the most significant result from our simulation is with respect to early big wins. This relatively high incidence of peak amounts greater than $1,000 in the 98% game is important given the relationship between early big wins in a gamblers career, and the tendency to develop gambling problems. Assuming these sessions were for new gamblers, and that winning over $1,000 on a $100 bankroll would be considered an early "big win" clear differences emerge between the potential of the 85 and 98% machines to create problem gamblers. Of the 1,000 people playing the 98% machine, 54 would experience big wins compared to five playing the 85% machine. Given the relationship between early big wins and problem gambling, it is ironic that the machines that are at face value "fairer" to the gambler (i.e., pay back a greater percentage to the gambler), may ultimately create more problem gamblers because of the propensity to expose novice gamblers to these early "big wins." As noted earlier, it may not be the big win in and of itself that gives rise to problematic gambling but the fact that those who have a big win do not leave with their winnings but rather gamble more and are thus exposed to much more behavioural reinforcement.

Typical Payback Percentage and Information Based Treatment Strategies

When conveying information about the typical experience gamblers can expect when playing a slot machine, it is more realistic to use median values than mean values to convey to the gambler what they will typically encounter. As shown in Table 2 their typical experience will entail getting a payback percentage of 66.5% on the 85% game and 72.9% on the 98% game. The median values may be of crucial importance in information based treatment strategies related to problem gambling.

Multiple Versions of the Same Game and the Gambler's System

As the median experience for many players on the different versions of Lobstermania will be similar, the infrequent player will probably not be able to tell the difference between the versions. Our conclusion is similar to Turner and Horbay's (2004) who stated "as a result of the volatility, it is impossible for players to determine the payback from any short gambling episode" (p. 35). However, heavy gamblers who play often and watch others play often may over time determine that one version of Lobstermania pays out more than another version. If so, the fact that two identical looking slot machines can have different payback percentages may feed into a gambler's elaborate (but ultimately doomed-to-fail) "system" that they use to "beat the odds." Some recurring themes among gamblers' systems pertain to the notion that that there are "loose" machines, "lucky" blackjack tables, and "good" days to gamble etc. Part of the gambler's system involves being able to discern these loose from tight machines; lucky from unlucky tables; and good from bad days to gamble. By having identical machines with different payback percentages, the machine manufacturers are creating a scenario where a small subset of rules within an otherwise erroneous "system" are actually true. That is, thanks to the manufacturers there really are loose (98% payback) and tight (85% payback) slot machines. If one aspect of the gambler's system is found through repeated experience to be true, it is likely that the gambler will put faith in *all* facets of their overarching system. This would make the gambler's system quite resilient to information-based intervention strategies that attempt to teach the problem gambler that their system is indeed doomed to fail.

Playing Time as an Indicator of a "Good" or "Bad" Gambling Session

Subjective reports indicate that problem gamblers use play times to differentiate a good session from a bad one. For example, based on interviews with gamblers who were "in contact" with a treatment agency, Livingtone and Woolley (2008) concluded that "the measure of value for money was very frequently the first and foremost consideration, directly conceptualized as the time on device that a given amount of money should typically purchase" and that "almost all our qualitative participants reported that finalizing a gambling session usually occurred because funds with which to gamble had been exhausted" (p. 12).

In our Gambler's Ruin scenario all players go broke, but a subset of the players (54 in our simulation) who play the highest payback machine have a dramatically increased amount of playing time compared with all other players. The mean number of playing hours for these 54 players is 28.5 while the median is 11.2. We considered our 2,000 simulated players to be novices and as such these 54 novice players received much more value for their money (measured as time on device for a given amount) on their first gambling experience than the other 1,946 simulated players.

Bonus Mode Wins: Behavioural Reinforcement and Illusion of Control

From the perspective of problem gambling the bonus mode is of significant interest. It is an environment within the game characterized by positive reinforcement, but is infrequently entered. Although always positively reinforcing, the payoffs are variable. Thus the bonus mode when considered within the context of the slot machine game is encountered within a random ratio reinforcement schedule which is inserted within the random ratio reinforcement schedule of regular wins in standard game play (see Haw (2008) for a discussion of random ratio reinforcement versus variable ratio reinforcement in slot machines). Thus games like Lobstermania provide *multiple* random ratio reinforcement schedules—one for regular wins, and one for bonus modes. Although to our knowledge no research has been conducted on the addictive properties of these overlayed or interleaved reinforcement schedules, common sense dictates that they could well exacerbate problem gambling. Namely if gamblers are sensitive to one random ratio reinforcement schedule, they would be sensitive to another overlaid/interleaved random ratio reinforcement schedule, and might even be drawn to games that give them overlaid as opposed to single random ratio reinforcement schedules. Also, as previously mentioned, many problem gamblers have elaborate systems that they employ to "beat the odds." One can reasonably speculate that by having environments within slot machines where players are asked to select certain symbols (in this case buoys), and not others, this may feed into these systems by fostering the self attribute of perceived gambling "skill." This combination of overlaid random ratio reinforcement schedules, and interactions that foster the illusion of control over the gambling situation make it reasonable to surmise that the 98% machines may in fact be more addictive than the 85% machines.

Hand-Pays: Behavioural Reinforcement and Social Reinforcement

Playing higher payback machines also dramatically increases the number of times a small subset of players will get a hand-pay. Like the bonus mode, hand-pays are of specific interest to problem gambling. Like the bonus mode, they are accompanied by a very salient context that differs from normal game play. During a hand-pay, the normal game mode ceases, a siren sounds, a flashing light atop the machine rotates and continues rotating until the attendant arrives. As though this were not reinforcing enough, our observations at actual casinos indicate that during this period, other players often will congratulate the winner of the hand-pay. For problem gamblers this type of social reinforcement can further substantiate the self attribution of being a "skilled" gambler. Since this situation occurs far more often in the 98% game, one can again surmise that the machines with higher payback percentages would be more reinforcing, and hence possibly more attractive to problem gamblers than the 85% machines.

Double or Bust Scenario: A Potential Responsible Gambling Strategy

Our scenario and analysis is based on the Gambler's Ruin scenario in which the gambler arrives with a bankroll of $100 and plays maximum wager until broke. From Table 4 we can consider the impact of the different version under different scenarios. For example, in looking at our Table 4 of peak balances we considered the scenario of a gambler who arrives with $100 bankroll and makes maximum wagers until the bankroll is double or depleted, which we termed the "double or bust" scenario. From Table 4, we see that in the 85% version 282 of the simulated players reached the $200 plateau and would have quit once they doubled their money. Importantly in the 98% version the number of gamblers who doubled their money is much higher at 371 in our simulation. In general, our scenario shows that gamblers who follow the "double or bust" scenario do have a reasonable probability of doubling their money (28.2 and 37.1%). Thus, as entertainment the double or bust strategy can be viewed as an entertainment strategy whereby the chances of doubling are reasonable but the majority will lose their $100. Importantly, from a problem gambling perspective, those with the double or bust strategy will have quit playing much earlier than those in the Gambler's Ruin scenario and are less likely to encounter aspects of the game such as "big wins" that are known to be related to problem gambling. As such, the double or bust scenario can be viewed as a responsible gambling strategy.

Multiple Versions of the Same Game and Treatment

One implication of the fact that jurisdictions have multiple versions of the same game is for treatment. As discussed above, over time heavy gamblers may be able to determine that one version of a game pays more than another version of the same game. Until now, treatment providers may have viewed these as the gambler's cognitive distortion. With the knowledge that there are multiple approved versions of the same game, the treatment provider may be able to more fully and correctly explain to the gambler that different versions of the same game do exist but that in all versions there is a house advantage and thus all versions will realize profits from players over time.

Multiple Versions of the Same Game and Public Policy

Our final implication regarding multiple versions of the same game is for public policy. Williams and Wood (2004) have shown that slot machines are the most addictive form of gambling in Ontario with 60% of slot machine revenue being derived from moderate and severe problem gamblers. Based on the concerns that we have raised in this paper regarding multiple versions of the same game, we feel that jurisdictions should consider approving only games with a certain payback percentage such as 85%, or perhaps a small range such as from 85.0 to 87.0%. This would mean that there would be no "hot" or "cold" games in the jurisdiction and it would avoid any problem gambling concerns that may be associated with having multiple versions of the same game. Furthermore, we suggest that jurisdictions should regulate a lower payback percentage (such as 85%) rather than a higher one (such as 98%) as the higher payback machines appear to be more addictive.

References

Abbott, M. W., & Volberg, R. (1996). The New Zealand national survey of problem and pathological gambling. *Journal of Gambling Studies, 12*, 43–160.

AGCO. (2007). *Alcohol and gaming commission of Ontario: Electronic gaming equipment minimum technical standards*. http://www.agco.on.ca/.

Blaszczynski, A. (2000). Pathways to pathological gambling: Identifying typologies, eGambling. *The Electronic Journal of Gambling Issues, 1*, 1–14.

Blaszczynski, A., & Nower, L. (2002). A pathways model of problem and pathological gambling. *Addiction, 97*(5), 487–499. May.

Coventry, K., & Norman, A. (1998). Arousal, erroneous verbalizations and the illusion of control during a computer-generated gambling task. *British Journal of Psychology, 89*, 629–645.

Custer, R. L. (1984). Profile of the pathological gambler. *Journal of Clinical Psychiatry, 45*(2), 35–38.

Custer, R. L., & Milt, H. (1985). *When luck runs out*. New York: Facts on File.

Greene, J. (1982). The gambling trap. *Psychology Today, 16*, 50–55.

Griffiths, M. (1990). The cognitive psychology of gambling. *Journal of Gambling Studies, 6*, 31–42.

Griffiths, M. (1995). *Adolescent gambling*. London and New York: Routledge.

Grun, L., & McKeigue, P. (2000). Prevalence of excessive gambling before and after introduction of a national lottery in the United Kingdom: Another example of the single distribution theory. *Addiction, 95*, 959–966.

Harrigan, K., & Dixon, M. (2009). PAR Sheets, probabilities, and slot machine play: Implications for problem and non-problem gambling. *Journal of Gambling Issues, 23*, 81–110.

Haw, J. (2008). Random-ratio schedules of reinforcement: The role of early wins and unreinforced trials. *Journal of Gambling Issues, 21*, 56–67.

Kassinove, J., & Schare, M. (2001). Effects of the "near miss" and the "big win" at persistence in slot machine gambling. *Psychology of Addictive Behaviors, 15*(2), 155–158.

Ladouceur, R., & Mayrand, M. (1984). Evaluation of the illusion of control: Type of feedback, outcome sequence, and number of trials among regular and occasional gamblers. *The Journal of Psychology, 117*, 34–46.

Ladouceur, R., & Walker, M. (1996). A cognitive perspective on gambling. In P. Salkovskis (Ed.), *Trends in cognitive and behavioral therapies* (pp. 89–120). New York: Wiley.

Langer, E., & Roth, J. (1975). Heads I win, tails it's chance: The illusion of control as a function of the sequence of outcomes in a purely chance task. *Journal of Personality and Social Psychology, 32*(6), 951–955.

Livingtone, C., & Woolley, R. (2008). *The relevance and role of gaming machine games and game features on the play of problem gamblers*. Report for the independent gaming authority South Australia. Retrieved February 22, 2008, from http://www.iga.sa.gov.au/pdf/0801/Final%20report.Print.Feb08.pdf.

Ministry of Public Safety and Solicitor General. (2003). *British Columbia problem gambling prevalence study*. Final Report, March. Retrieved May 19, 2007, from http://www.bcresponsiblegambling.ca/responsible/bcprobgambstudy.pdf.

Moran, E. (1970). Gambling as a form of dependence. *British Journal of Addiction, 64*, 419–428.

Ontario Gaming Control Act. (1992). Ontario regulation 385/99. Amended to O. Reg. 478/01. Games of chance conducted and managed by the Ontario Lottery and Gaming Corporation. http://www.agco.on.ca/en/ft.features/ft4.acts.html. Accessed 21 December 2006.

Queensland Office of the Government Statistician & Queensland Gambling Policy Directorate. (2002). Queensland household gambling survey 2001 [electronic resource]: [Web site] Queensland Treasury: Brisbane http://nla.gov.au/nla.arc-51569.

Turner, N., & Horbay, R. (2004). How do slot machines and other electronic gambling machines really work? *Journal of Gambling Issues, 11*, 1–42.

Turner, N., Zangeneh, M., & Littman-Sharpe, N. (2006). The experience of gambling and its role in problem gambling. *International Gambling Studies, 6*(2), 237–266.

Volberg, R. (1996). *Gambling and problem gambling in New York: A ten year replication survey, 1986–96*. Report to the New York council on problem gambling. Roaring Springs, PA: Gemini Research.

Walker, M. (1992). *The psychology of gambling*. London: Pergamon Press.

Weatherly, J. N., Sauter, J. M., & King, B. M. (2004). The "big win" and resistance to extinction when gambling. *The Journal of Psychology, 138*, 495–504.

Wexler, A. (2002). First person account: Arnie Wexler's story. *Journal of Gambling Issues, 7*, 1–6.

Williams, R., & Wood, R. (2004). *Final report to the Ontario problem gambling research centre: The demographic sources of Ontario gaming revenue*. Retrieved February 26, 2008, from http://www.gamblingresearch.org.