Slot Machines: Pursuing Responsible Gaming Practices for Virtual Reels and Near Misses

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Abstract Since 1983, slot machines in North America have used a computer and virtual reels to determine the odds. Since at least 1988, a technique called clustering has been used to create a high number of near misses, failures that are close to wins. The result is that what the player sees does not represent the underlying probabilities and randomness, and this misrepresented outcome will have some effect on the player's perceptions of the game, which may lead directly to classical and operant conditioning, the frustration effect, the perception of early wins, illusion of control, biased evaluation of outcomes, entrapment, and irrational thinking. We use transcripts of Nevada hearings to show that the initial proponents understood that virtual reels and near misses may have a detrimental psychological effect on the player. We conclude by suggesting that jurisdictions should consider the historical facts and research presented in this paper when pursuing responsible gaming practices for slot machines.

For over two decades, slot machine manufacturers have been using a computer and virtual reels to control the game outcome, while the physical reels in the payline window are simply used to display the results to the player. Transcripts from the Nevada State Gaming Control Board (1983) show that at the time the virtual reels were approved, the Board had heard concerns from the two largest slot machine manufacturers. They argued that virtual reels: (a) misrepresent the outcome for the player and (b) create near misses, failures that appear close to a win. An analysis of the transcript shows that the proponent of virtual reels did not disagree that virtual reels misrepresent the outcome of the game, but stressed the benefit that the use of virtual reels allows for larger jackpots. A Board member correctly explained that virtual reels in and of themselves do not create a high number of near misses.

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In the transcripts of hearings 6 years later (Nevada Gaming Commission 1988a, b, 1989a, b, c), statements were made to the Nevada Gaming Commission by representatives from the slot machine manufacturers, in which they acknowledged that they did create near misses above and below the payline and it was implied, incorrectly and contrary to the 1983 Nevada Gaming Control Board transcripts, that these near misses were a known side effect of using virtual reels.

In this paper, we use transcripts from 1983 and 1988/1989 to help trace the history of virtual reels and near misses. We then address the common misunderstanding that an inherent side effect of using virtual reels is that the outcome will have a disproportionate number of high-paying symbols just above and just below the payline. We follow this by reviewing the problem gambling literature and showing that misrepresented game outcomes may contribute to problem gambling and, as the outcome influences the player's perceptions, may lead to irrational thinking. We conclude by suggesting that the information presented in this paper is useful to jurisdictions for informing public policy regarding gaming and, specifically, the regulation of electronic gaming machines (EGMs).

The Design of Virtual Reels and Near Misses

Filing of the Telnaes Patent (1982–1984)

In 1984, Inge Telnaes (1984) was granted a patent; its significance was described in 2004 by Wilson, an employee of the slot machine manufacturer IGT, as follows: "[the Telnaes patent] revolutionized the slot machine industry just as much as Charles Fey did when he invented the slot machine in the first place" (Wilson 2004a). Bally, a large slot machine manufacturer, originally owned the patent, but several years later it was acquired by IGT, which licensed it to others (Nestor 2007).

The "Background of the Invention" section of the Telnaes patent referred to the limitations of traditional mechanical and electromechanical slot machines. Specifically, it pointed out that they restricted the number of possible outcomes to the number of physical stop positions on the reels. On a mechanical 3-reel slot machine, in which each reel has 22 stops, at least one jackpot has to be rewarded in every 10,648 plays ($22 \times 22 \times 22$ equals 10,648). In the patent, Telnaes explains that with his technique, the results are controlled by a computer and the physical reels are simply used to display the results: "In this invention the physical reels are only used as a display of the random number generated results and are not the game itself as in standard slot machines." According to Telnaes, use of the patent enables slot machine game designers "to make a machine that is perceived to present greater chances of payoff than it actually has within the legal limitations that games of chance must operate."

The use of random numbers and virtual reels is the basis of the Telnaes patent, and has been documented in various places including Harrigan (2007a, b), Turner and Horbay (2004), Wilson (2004a, b, c, d, e, f), and Locke (2001). Table 1 provides an overview of how the virtual reels work. A random number is generated between one and the number of stops on the virtual reel (64 in the example in Table 1). The true odds are determined by the virtual reel. Table 1 shows that the true odds of the high-paying 'Double 7' are 2 out of 64 (3.1%) since the Double 7 is on the two virtual stops 20 and 56. The virtual reel is then mapped to the physical reel on the slot machine; it is the physical reel that shows the result to the player. The Double 7 occurs 2 out of 22 times (9.1%) on the physical reel, in positions 7 and 19.

As shown in Table 2, the odds of a jackpot on two virtual reel slot machine games that are currently in use in Ontario are 1 in 46,656 and 1 in 114,131 (Ontario Lottery and Gaming Corp. 2007a, b), which is much higher than the maximum of 1 in 10, 648 that can be

Table 1 Virtual Reel Mapping

Virtual Stop No.	Physical Stop No.	Physical Reel Symbol
1–3	1	Double Bar
4–5	2	Blank
6	3	Single 7
7–8	4	Blank
9–15	5	Double Bar
16–19	6	Blank
20	7	Double 7
21–24	8	Blank
25–27	9	Triple Bar
28–29	10	Blank
30	11	Single 7
31–32	12	Blank
33–38	13	Single Bar
29–40	14	Blank
41	15	Single 7
42–43	16	Blank
44–51	17	Single Bar
52–55	18	Blank
56	19	Double 7
57–60	20	Blank
61–63	21	Triple Bar
64	22	Blank

Example from Reel 1 of the game described by Wilson (2004c, p.20)

achieved using 22-stop physical reels to determine the odds. Table 2 also includes data from five PAR Sheets which are publicly available, but we do not know if these games are in use in any jurisdictions. The odds of a jackpot in these five games are: 1 in 93,312; 1 in 262,144; 1 in 8,192; 1 in 1,048,576; and 1 in 15,503,906. However, as shown in Table 2, the jackpots are not necessarily large. The maximum jackpot is only available for four of the seven games in Table 2 and, for a one coin wager, they all have a jackpot of 1,000 credits or less. A jackpot of 1,000 credits can easily be given out in a game in which there are only 10,648 possible outcomes.

Table 2 Jackpots on Seven Slot Machine Games

	Virtual Reels	No. of Jackpots	True Odds of a Jackpot	Jackpot Amount
Ontario PAR Sheets				
1) Double Diamond Deluxe	72-72-72	8	1 in 46,656	800/1,600/2,500
2) Phantom of the Opera	256-256-256	147	1 in 141,113	1,000/2,000/5,000
Other PAR Sheets				
1) Locke (2001)	72-72-72	4	1 in 93,312	1,000
2) Watts (2007)	64-64-64	1	1 in 262,144	1,000
3) IGT (2005)	32-32-32	4	1 in 8,192	N/A
4) IGT (2005)	64-64-64-64	16	1 in 1,048,576	N/A
5) IGT (2005)	45-35-35-25-45	4	1 in 15,503,906	N/A

Nevada Rules to Accept Virtual Reels: 1983

In 1983, the Nevada State Gaming Control Board unanimously approved virtual reels on slot machines after conducting hearings to consider a request for "New/Games Devices (Request for Approval) Device: Virtual Reel Slot Machine" that was brought before them by a company called Elsinore (Nevada State Gaming Control Board 1983).

At the time, Elsinore had already been conducting a trial in which they had 44 nickel slot machines installed at the Four Queens for several months, and all of the virtual reels on all of the installed slot machines had 88 virtual stops. The slot machines were all manufactured by a company called Summit. Bob Maxey, President of Elsinore, said "I ordered forty-four machines to be installed at the Four Queens in Las Vegas where they have been installed and been operating for some almost three months now" (Nevada State Gaming Control Board 1983, p. 5).

Bob Maxey explained that virtual reels allow for large jackpots: "For example, to offer a $2,500 jackpot, as we do on our nickel machines, to a customer that plays a nickel machine" (p. 12). He noted that video slots had already been allowing large virtual reels in video games: "In a video game, you can break up a game that is attractive to the customer, without limitations, the mathematical limitations that are associated with physical reels" (p. 12). He explained that virtual reels allow the manufacturer to provide more flexibility in addressing the customer's preferences: "Some customers like games that have a high intermediate play, that return lots of coins frequently. Some customers don't care about that. They want a very large jackpot. That's what they come to Nevada for. They want a chance to win a large jackpot. Well, you need to be able to address these various market elements" (p. 13).

The transcripts of the hearings show that representatives from Casino Electronics and Bally raised concerns regarding the virtual reels, and IGT raised concerns regarding the issue of whether the use of virtual reels generated a high number of near misses (which they called phantom symbols).

Virtual Reels: Concerns by Casino Electronics and Bally

Colin Foster from Casino Electronics opposed virtual reel slots. He acknowledged that virtual reels do allow for larger jackpots but opposed the ethics of using virtual reel slots, even claiming that he should have his money back because he was cheated. He explained, "My mother-in-law, who is from Australia and was visiting just recently, was in the Four Queens with my wife and myself looking at the machines and said, which machine should she play. I said, 'Play the one with the $2500 jackpot. They made a mistake on that machine.' I said, 'You can't give away a $2500 jackpot. See if you can win that.' I think you owe us our money back. I am a sophisticated player. I didn't know they had cheated on the machine" (p. 35–36). Foster went on to offer other concerns, such as that the approval of virtual reels would open a "Pandora's Box" for such ideas as virtual dice.

Mr. Hyte read a letter from Alan Maiss, President of Bally Distributing of Nevada, that raised the concern that virtual reels would be misleading to the player (p.39):

Although electronically speaking, there is probably nothing at all wrong with this procedure in terms of the machine being random and maintaining a theoretical percentage, we do take the position that it could be argued that from a visual standpoint, it is misleading to the slot machine player.

If an electro-mechanical slot machine having twenty symbols on each of its respective mechanical reels were to be electronically controlled as if it had 80 symbols, the player would not visually be able to see that. One of the reasons reel spinning slot

machines have been so successful throughout their history is that players can visually see during the course of several handle pulls, all of the symbols on all of the reels as they spin and can psychologically perceive that there are actual combinations that should eventually show up over the course of time.

It would appear to us that if a mechanical reel on a slot machine possesses four sevens and it is electronically playing as if there were one seven, the player is being visually misled.

After reading the letter, Mr. Hyte also provided the following information from Mr. Maiss, which was not in the letter (p. 41):

He's also asked me to make an additional comment that is not in this letter, and that is if this concept is approved, Bally will design and perhaps market or will market the concept, if the market demands.

Near Misses: Concerns Raised by IGT

Ray Pike was legal counsel for IGT and added "comments from IGT" that were specific to near misses above and below the payline (Mr. Pike used the term "Phantom Symbols" rather than "Near Misses") (p. 41–44):

It is a good idea and people from IGT have talked about it as well. But we have a problem with it ... the comment we have is that we are afraid there is a deception involved with this kind of machine. ...

But to the extent that there is a picture of a jackpot appearing four times as often as it actually is seen by the computer, either above or below, it is that inducement almost, and that may account for the success of the play perhaps of these machines. To the extent that the inducement is a phantom symbol, I think it is false advertising.

Mr. Pike was assured that the Summit machines did not present winning symbols disproportionately above or below the payline. When asked if IGT would potentially create slot machines with virtual reels, Mr. Pike said they would produce Phantom Symbols above and below the payline if that were allowed (p. 53):

Well, the only comment I would make is if the concept of allowing symbols that would not otherwise have appeared on an eighty-eight reel, that concept, such that you allow phantom jackpot symbols, tantalizing, be portrayed above and below the payline, certainly we would like to be able to do that because I think that is a competitive advantage that can recreate without interrupting the random selection process of the payline, and we would certainly want to offer that.

The transcripts do not specifically show how each of the three Commissioners would vote or why they would vote the way they did. In various places in the transcripts, the Commissioners do provide some comments. For example, near the end of the transcript, and just before the Commissioners voted, we see that Commissioner Hyte seemed to be in agreement with Bob Maxey regarding the virtual reels, as Commissioner Hyte stated (p. 79):

There has been some discussion here about the process of deception. There may be a perception problem, not necessarily a deception problem.

Today we have heard testimony that indicates that this device by using the cluster concept is able to represent to its player not only which symbols were won, but also

the symbols in relation to that above and below it using the cluster concept [i.e. using the virtual reel].

So that if a player were to analyze the symbols above and below the payline, he will be able to see a proper proportionate amount of fruit and jackpot to some degree that would be available if he were playing a regular twenty-two stop machine.

I am comforted in this concept, in this approach, because it minimizes the perception problem, if at all there is one.

Commissioner Hyte then goes on to explain that video machines have a "great degree of perception problem" and implies that the perception problems with slot machine virtual reels are no worse than they are with video machines. He introduces his explanation as follows (p. 80):

I am going to present some testimony at this point in time that will show that there are other devices that have been approved and are out on the market that have a great degree of perception problem, and they are the video machines.

Then after a lengthy discussion about the design and operation of a 256-stop video machine, Commissioner Hyte concludes by saying (p. 87–88):

What I am trying to do is put this in perspective. When we talk about deception, when we talk about perception, on the particular device we are speaking of today [i.e. virtual reel slot machines], it is much less, if it's there at all, much less than other devices that are out in the field.

So, it's important that we understand when we approve this device that we are not going into a concept that is going to create problems that have been expressed [by the other manufacturers], some of which have been expressed here today, that don't already exist in this industry.

As I said earlier, there is only one game in Nevada where the player doesn't know what his odds are. There isn't an establishment that would agree with posting those odds on that slot machine because you are going to take away the mystery, the excitement and entertainment and risk of playing those machines.

I am not a proponent of labeling machines and telling the customer what the payouts are, what the holds are, the number of stops, as long as we can control it in the approval process by regulation.

I feel good about this machine. I am going to vote in favor of it. I think the concept is an exciting one.

Nevada Gaming Commission Hearings: 1988/1989

In 1988/1989 the Nevada Gaming Commission dealt with an issue regarding Universal Distributing. Universal's slot machine games were programmed to determine whether the outcome was a win or a loss. If it were a loss, it would select from a table to determine what loss would be displayed and would frequently show high-paying symbols on the payline in non-winning combinations. As a result of these hearings, Universal's use of a 'secondary decision' to create near misses on the payline was ruled unacceptable and Universal was required to retrofit all of their machines. For details on the Universal issue see Burbank

(2000), Harrigan (2007a), and the transcripts of the hearings (Nevada Gaming Commission 1988a, b, 1989a, b, c).

The hearings revealed that rather than using a secondary decision, North American slot machine manufacturers were using the 'clustering' technique to create near misses above and below the payline. The technique was described by Ed Allen, head of Nevada's Gaming Lab, as follows (as cited in Burbank 2000, p. 118):

> Slots made by companies other than Universal, Allen testified, did 'cluster' blanks above and below jackpot symbols on reel strips, such as placing most of the 12 blanks on a reel above and below a 7 symbol. The practice was done on the disproportionate slots, using software capable of assigning 32 software stops on a reel with 22 physical symbols. That way, players would normally see a 7 or another jackpot symbol above and below the payline more often in a losing game—a near miss. However, again, Allen said, the individual reel stops on those machines were nonetheless chosen at random, and a jackpot symbol would not appear any more or less often than a blank or any other symbol.

Although Allen had explained that clustering causes the near misses above and below the payline, the transcripts indicate that there still appeared to be a general consensus that virtual reels in and of themselves cause near misses. For example, Ellen Whittmore, the lawyer for the Board, acknowledged that North American manufacturers created near misses above and below the payline and claimed that such a practice is "an acceptable deviation from the criteria because the reason why they had to do that was initially in order to increase the probability of a jackpot" (Nevada Gaming Commission 1989b, p. 280).

Commissioner Lewis acknowledged the existence of near misses in 1989 as follows (as cited in Burbank 2000, p. 122):

> Commissioner Lewis said it was true that the near-miss concept was present "in a multitude of gaming devices in one form or another, and we have them in, according to what our lab folks have told us today, in nearly every machine that's on the floor of every casino in the state of Nevada, and it's an accepted process as far as slot machines are concerned .... And I would hope that we would not tinker with that. I think the systems that we have had works."

Clustering

Fig. 1 uses a section of an actual 72-stop virtual reel (Locke 2001) to show how clustering works. The physical reel has 22 stops, half of which are blank, and TD is the highest paying symbol. The TD in virtual stop 29 has five blanks above it (virtual stops 24–28) and five blanks below it (virtual stops 30–34). This practice of putting blanks adjacent to a high-paying symbol is called clustering, and is explained as follows:

- Each stop on the virtual reel will occur on the payline 1 time out of 72. Thus, each of the five blanks in positions 24–28 will occur on the payline one time out of 72 for a total of five times. Because the 5 blanks 24–28 are adjacent to the TD, it means that that the TD in position 29 will be just below the payline five times out of 72.
- The TD in position 29 will occur on the payline one time out of 72.
- The five blanks in positions 30–34 will each occur on the payline one time out of 72 for a total of five times. Because the five blanks 30–34 are adjacent to the TD, it means that that the TD in position 29 will be just above the payline five times out of 72.
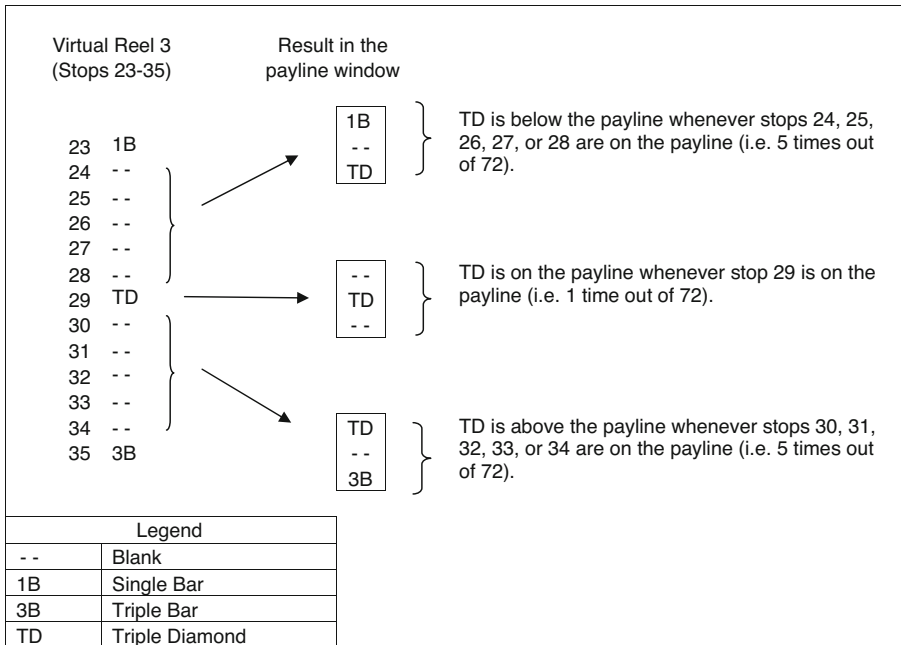
Fig. 1 Clustering: an example from Reel 3 of the game described by Locke (2001, p. 7)

Thus, in this example, the use of clustering results in a near miss in which the TD in virtual stop 29 occurs on the payline once, above the payline five times, and below the payline five times. This is sometimes referred to by the gaming industry as an 'award symbol ratio' of 5 (Harrigan 2007a).

As shown in this section, it is the use of virtual reels and clustering, with blanks adjacent to the high paying symbols, that causes the near misses above and below the payline. Slot machine games could be created without clustering by having a requirement that on the virtual reel there be one blank, and only one blank, adjacent to each paying symbol.

The Regulations

Nevada

After the Universal case, the Regulations of the Nevada Gaming Commission and State Gaming Control Board were rewritten to ban the type of secondary decision that was used by Universal to create near misses. The new regulations state: "The gaming device must not make a variable secondary decision which affects the result shown to the player" (Nevada Gaming Commission 2006, section 14.040(3)). The Nevada Regulations, however, do not ban, or even mention, virtual reels or near misses caused by clustering.

Ontario

Jurisdictions that are newer to legalized gambling, such as Ontario, with its 23,000 slot machines, tend to follow Nevada's lead. Ontario's "Electronic Gaming Equipment Minimum Technical Standards—Draft" (a) bans near misses that are created by secondary decisions

(sections 20.4.1), (b) allows virtual reels (section 14.3.12) and (c) allows near misses above and below the payline (section 20.4.2 a) (Alcohol and Gaming Commission of Ontario 2007). The near miss clause states: "For single line games, jackpot symbols may not appear in their entirety more than 12 times, on average, adjacent to the payline, for every time they appear on the payline" (Alcohol and Gaming Commission of Ontario 2007, p. 42).

Australia and New Zealand

In contrast, the Australian and New Zealand Gaming Machine National Standards (Australia and New Zealand 2007) do ban near misses: "3.9.57a. The display of the result of a game outcome must not be misleading or deceptive to the player (e.g. must not improperly indicate a near-miss)."

Problem Gambling

The Slot Machine is Not the Game Itself

Some casino games, such as slot machine games and roulette, are purely games of chance; others, such as blackjack, involve a combination of skill and chance. As shown diagrammatically in Fig. 2, in games of chance such as roulette, the probabilities and randomness are clearly visible to the player. However, in slot machine games that use virtual reels, the physical reels do not represent the underlying probabilities and randomness, as was clearly stated by the originator of the concept of virtual reels when he said that the slot machine is "not the game itself" (Telnaes 1984). Fig. 2 shows the slot machine player's view, in which the player sees the result that has been determined by the virtual reels and the random number generator; the player cannot see the underlying nature of the probabilities and randomness of the game. If the outcome contains a near miss, that near miss may have occurred by chance based on the layout of the virtual reels, which are hidden from the player, or it may have occurred because of clustering. In either case, the physical reels, which the player can see, are not used in determining the result; rather, they are simply used to display the results. The fact that the physical reels on the slot machine game misrepresent the underlying probabilities and randomness has implications for problem gambling, as the player's perceptions will be influenced by the game outcome.

Griffiths (1993, 1994, 1995, 1999) and Parke and Griffiths (2004, 2006) have written extensively about the structural characteristics of EGMs, and have shown that there are many EGM structural characteristics that may have an influence on problem gambling. In this paper, we focus solely on the potential ramifications for problem gambling that are caused by the fact that the slot machine game outcome is determined by the virtual reels and clustering, whereas the player's perceptions will be influenced by the physical reels, which are simply used to display the game outcome. In this section, we review problem gambling literature that relates to the structural characteristics of the games, and discuss the implications of the fact that slot machines misrepresent the game outcome using virtual reels and clustering.

Sociocognitive Theory of Gambling Involvement

Walker's Sociocognitive Theory of Gambling Involvement (Ladouceur and Walker 1996; Walker 1992) "is based on the premise that gambling is maintained by irrational thinking" (Walker 1992, p. 139). This irrational thinking is (p. 147):
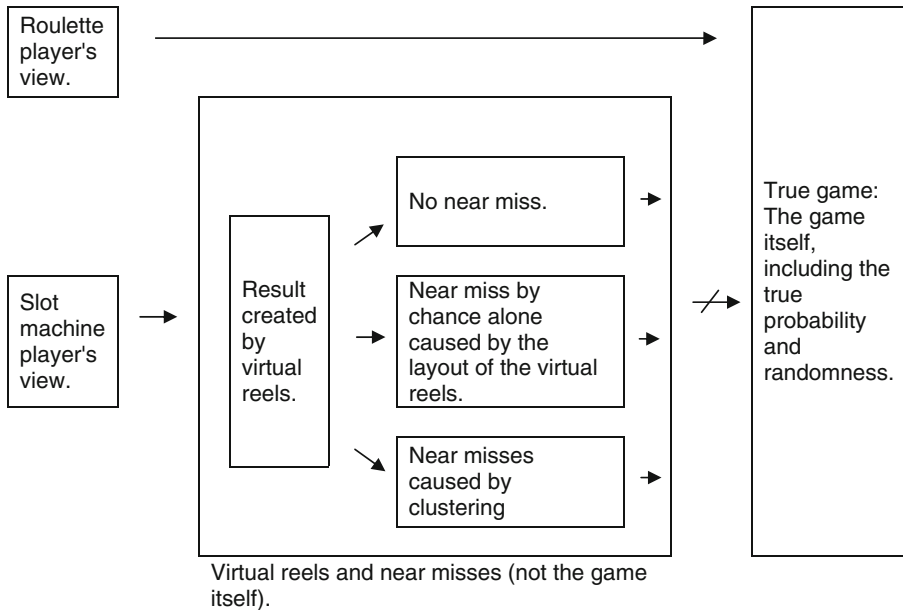
Fig. 2 Player's view of the game: roulette versus slots

characterized by three well-known social psychological processes: (1) the illusion of control—that there is more skill in the game than is objectively the case; (2) a biased evaluation of outcomes—the wins are evidence of ability whereas the losses are discounted as evidence of failure; and (3) entrapment—an escalating commitment to a decision strategy that has already failed.

Illusion of Control

Walker says that one contributing factor to the illusion of control may be near misses. He gives the following lottery ticket example (p. 141):

> Imagine that the winning number in a lottery was 865304 and consider how you would feel if your ticket was variously 361204, 965304, or 865305 (Kahneman and Tversky 1982). Objectively, all three tickets are equally failures, but undoubtedly the third number would cause the most pain.

North American slot machine games use virtual reels and clustering to create a high number of near misses and, according to Walker's model, these near misses will be a factor in maintaining irrational thinking.

Empirical studies have been conducted on a different type of near misses, and the results may shed some light on near misses caused by clustering. These near miss studies looked at cases where there was a winning symbol on the first two reels and a non-winning symbol on the third reel. Studies by Strictland and Grote (1967) showed that near misses lead to "significantly longer playing times," although in a similar study, Reid (1986) did not find longer playing times. In an experiment using actual Video Lottery Terminals (VLTs), Cote et al.(2003) found that near misses increased playing time. Kassinove and Schare (2001) showed that "The present results support the effect of the near miss on gambling

persistence" (p. 157). Dixon and Schreiber (2004) conducted empirical testing of near misses with participants using an actual slot machine, and found that all subjects rated near misses as closer to a win than to a total loss (i.e., a total loss was a loss that did not have a near miss). They concluded in their discussion note that "Our current data lend an initial empirical foundation to Skinner's theoretical comment that almost hitting the jack pot increases the probability that the individual will play the machine" (p. 344).

Ghezzi et al.(2006) performed a series of three experiments using slot machine simulation software and concluded that "The results of the three studies reported here suggest that the near-miss is either terribly elusive or overstated as a means of prolonging slot machine play" (p. 168). However, as noted by Ghezzi, Wilson and Porter, their experiments had several design features that may have affected the outcome, for example: (a) the participants played for points rather than for money and (b) on the first two experiments the participants won 40% of the time, which is much higher than the percentage of wins on a slot machine; analyzing near misses in a reinforcement schedule with such a high number of wins may not reflect the outcome that would be obtained if a smaller number of wins were used.

The empirical study of Chantal and Vallerand (1996) of roulette showed similar results, with a near miss frequency of 30% increasing persistence of play, while near miss frequencies of 0 and 45% did not differ from one another.

Walker cites Langer (1975), who defined illusion of control as "an expectancy of personal success probability inappropriately higher than the objective probability would warrant" (p. 311) and contrasted this with skill, in which "there is a causal link between behavior and outcome" (p. 311). Langer conducted six experiments which introduced the perception of skill factors into chance events to determine whether people would attribute the outcome of the random event to the perceived skill factor. For example, two versions of an experiment were conducted in which actual raffle tickets were sold with half of the purchasers being able to choose their ticket and half not being able to choose their ticket (choice was the skill factor). Later, the subjects were asked to sell back their ticket or trade it for a ticket in a different raffle that had better odds. People who were able to choose their tickets valued their tickets as being worth significantly more than those people who did not get to choose their ticket, although both groups clearly understood that the outcome of the raffles was random. The results of Langer's studies suggest that any slot machine structural characteristics that give the perception of skill, such as the choice to pull the handle or push the "spin" button, may give the player an illusion of control and contribute to problem gambling. Although Walker and Langer both use the term "illusion of control", Langer's focus on player choices is not directly related to virtual reels and clustering, as virtual reels and clustering do not give the player choices.

Biased Evaluation of Outcomes

In discussing the biased evaluation of outcomes, Walker presents an example in which two basketball teams play and Team A is behind by one point with one second remaining in the game. Team A has to make a very easy shot to win the game but they miss the shot and thus lose the game. Walker cites a study (Gilovich 1983, as cited in Walker 1992, p. 142) that shows that in betting on sports, sports betters for whom betting is a big part of their lives will see this as a fluke loss, and those who originally bet on Team A would pick Team A in a rematch.

Near misses have been referred to as the "Aww Shucks" principle, with players having reactions such as "Aww Shucks. Just missed it. One more spin and I'll get it" (Locke 2001,

p. 6). Although this similarity has not been researched directly, it may be that the psychological effect of a near miss and a "fluke loss" are similar.

Frustration theory (Amsel 1958) may offer an explanation as to why an individual would pick Team A in a rematch in Walker's example above. Amsel described Frustration Theory as follows (p. 43):

> The frustration theory of persistence emerged out of a series of experiments, beginning in the early 1950s, which seemed to demonstrate that frustrative nonreward (nonreward in the presence of anticipated reward) can be regarded as influencing behavior in several ways. First of all, frustrative nonreward appears to have an invigorating or potentiating effect on any behavior that immediately follows it, the so-called frustration effect (FE).

The Frustration Effect has been empirically tested with animals and, in reviewing these experiments, Amsel refers to studies that may offer insight into why the near miss by Team A would be predicted to have an effect on the player: "The closer to the goal a response is blocked, the greater are the energizing effects of primary (and perhaps also secondary) frustrations" (p. 45).

Entrapment

Entrapment refers to "a decision making process whereby individuals escalate the commitment to a previously chosen, though failing, course of action in order to justify or 'make good on' prior investments" (Brockner and Rubin 1985, p. 5, as cited in Walker 1992, p. 144). Walker (1992) comments that "All gambling is entrapment, provided that you believe that, with persistence, you will win" (p. 146). The "just world" hypothesis of Langer (1975) is a possible explanation for why individuals may continue to play even when their current play is unsuccessful. According to Langer, there is a body of research to support the hypothesis that people believe that "good things happen to people who do good things" (p. 312). EGM players who feel they "do good things" in their lives may have heightened expectations that they will win at a chance event such as playing a lottery or EGM. As Langer says, "It eliminates the necessity for concern and worry over the possibility that aversive events may occur by chance at any time" (p. 312). This hypothesis has not been explored relative to EGM players, but it does seem to offer an explanation as to why an individual player would continue to play a slot machine with full knowledge that the slot machine is random. Blaszczynski et al. (2001) conducted a study to examine the efficacy of modifying EGMs. Their focus group feedback included the following: "It was consistently stated that near win combinations caused gamblers to continue playing in the expectation that a win is imminent." One participant explained the effects of near misses as follows: "...makes you want to press the button and continue...you live in hope because you got close and you want to keep trying. You get to learn the pattern and just need to get it right" (p. 86). This implies that near misses caused by virtual reels and clustering would lead to persistence of play and are thus a form of entrapment.

In discussing the core beliefs of the regular gambler, Walker notes that that early wins are often cited as being correlated with problem gambling (Custer and Milt 1985). The near misses caused by virtual reels and clustering may be perceived by the gambler as a positive contributing factor during his/her early experience because "A near miss could produce some of the excitement of a win, i.e., secondary reinforcement. Therefore, the player is not constantly losing but constantly nearly winning" (Parke and Griffiths 2004, p. 407).

The Pathways Model of Problem and Pathological Gambling

The Pathways Model of Problem and Pathological Gambling (Blaszczynski 2000; Blaszczynski and Nower 2002; Nower and Blaszczynski 2004) shows that all gamblers, regardless of their pathway into gambling, go through certain "common processes" including "classical and operant conditioning" which may lead to "increasing participation and the development of habitual patterns of gambling, and cognitive processes resulting in faulty beliefs related to personal skill and probability of winning." The model goes on to say that "Operant conditioning occurs when intermittent wins delivered on a variable ratio produce states of arousal often described as equivalent to a 'drug-induced high,' while with repeated pairings, this arousal is also classically conditioned to stimuli associated with the gambling environment" (Blaszczynski and Nower 2002, p. 491). According to the Pathways Model, the player's beliefs related to personal skill and probability of winning will be influenced by the game outcome and, with slot machine games, that outcome does not truly represent information regarding the probabilities and randomness of the game. Therefore, the player's beliefs will be influenced by the misrepresented game outcomes.

As far back as 1953, Skinner had suggested that slot machines have an optimal schedule of reinforcements, with wins frequent enough to keep the gambler playing and yet not so frequent that the gaming venue loses money. He elaborated on the potential effects of near misses as follows (Skinner 1953, p. 397):

> Gambling devices make an effective use of conditional reinforcers which are set up by pairing certain stimuli with the economic reinforcers which occasionally appear. For example, the standard slot machine reinforces the player when certain arrangements of three pictures appear in a window on the front of the machine. By paying off very generously—with the jack pot—for "three bars," the device eventually makes two bars plus any other figure strongly reinforcing. "Almost hitting the jack pot" increases the probability that the individual will play the machine, although this reinforcer costs the owner of the device nothing.

Reid (1986) agrees with Skinner regarding the applicability of the behaviorist model to slot machines, and suggests that a moderate number of near misses would be optimal: "To increase the proportion of near miss trials in relation to wins seems likely in the long term to be self-defeating, like calling 'Wolf'" (p. 36). Parke and Griffiths (2004, p. 410) agree that a moderate number of near misses may have the most effect. In their review of the near miss literature, they say: "It is probably the case that near misses only work up to a point" and "repeated exposure to near miss stimuli will reduce their value as signals that success is on the way" (2004, p. 410).

Policy Implications and Conclusion

The "Reno Model" is a science-based framework for responsible gambling (Blaszczynski et al. 2004) that calls for key stakeholders to work together internationally in an effort to reduce the harm of gambling. Two of its recommendations include that key stakeholders will "use scientific research to guide the development of public policies" and "collaboratively identify short and long-term priorities thereby establishing an action plan to address these priorities within a recognized time frame" (p. 307).

In this paper we used transcripts from the 1983 Nevada hearings to show that when virtual reels were approved for use in slot machines in North America, the Nevada State Gaming Control Board heard concerns about the potential detrimental psychological effects on the player of the misrepresented outcome. However, these concerns were outweighed by the fact that virtual reels allow for larger jackpots. We used the transcripts of the 1988/1989 Nevada hearings to show that the Nevada Gaming Commission was aware by this time that North American slot machine manufacturers used virtual reels and a technique called clustering to create a high number of near misses. Our review of the problem gambling research shows that misrepresented game outcomes, such as those caused by virtual reels and clustering, will have some effect on the player's perceptions of the game, which may lead directly to: classical and operant conditioning, the frustration effect, the perception of early wins, illusion of control, biased evaluation of outcomes, entrapment, and irrational thinking.

We conclude by suggesting that, in line with the Reno Model, stakeholders in North America who are involved in efforts to reduce the harm of gambling should consider the issue of the misrepresented game outcomes caused by virtual reels and clustering as a priority. This should be addressed with an action plan and within a recognized timeframe. The transcripts of the Nevada hearings show that virtual reels and clustering have been acceptable for over two decades, but given that the research shows that the misrepresented game outcomes raise many concerns for problem gambling, the stakeholder should consider whether virtual reels and clustering should be acceptable in North American slot machines today.

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