Game Sound Technology and Player Interaction:
Concepts and Developments

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Chapter 1
Sound in Electronic Gambling Machines:
A Review of the Literature and its Relevance to Game Sound

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ABSTRACT

A much neglected area of research into game sound (and computer games in general) is the use of sound in the games on electronic gambling machines (EGMs). EGMs have many similarities with commercial computer games, particularly arcade games. Drawing on research in film, television, computer games, advertising, and gambling, this chapter introduces EGM sound and provides an introduction into the literature on gambling sound in general, including discussions of the casino environment, the slot machine EGM, and the physiological responses to sound in EGMs. Throughout the article, we address how the study of EGM sound may be relevant to the practice and theory of computer game audio.

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INTRODUCTION

A much neglected area of research into computer game sound is the use of sound in electronic gambling machines (EGMs; also known as slot machines, video slots and video fruit machines). To put the influence of EGMs into perspective, the computer game industry in the United States contributes approximately $8 billion in sales each year to the country's GDP (Seeking Alpha 2008). The slot industry, on the other hand, generates approximately $1 billion *a day* in wagers in the United States alone (Rivlin, 2004). Moreover, this amount is increasing as slot machines grow in popularity and are increasingly found outside of designated casinos. In 1980, an average of 45% of the gaming floor of a Nevada casino was devoted to slots, whereas today this number is at least 77%, with machines generating more than twice the combined revenue of all other types of games (Schull, 2005). Although they are also increasing in complexity (see below), slot machines are attractive to players because they require little or no training or previous experience, they are quick and easy to play and, perhaps most importantly, they elicit a number of sights and sounds that make them striking and exciting on the casino floor.

EGMs have many similarities with commercial computer games, particularly arcade games. In fact, many of the early video arcade game companies also had a long prior history manufacturing slot machines, including Bally and the Williams Manufacturing Company. As such, many of the creators and designers of slot machines today have also worked for computer game companies. In fact, much of the sound design and music of slots is still outsourced to game sound designers and composers, such as George "The Fat Man" Sanger (composer of *7th Guest*, *Wing Commander*, and others).

Furthermore, until the 1990s slot machines had fairly standard mechanical or electro-mechanical reels and parts. Today, however, with the digitization of slot machines there are now considerably more structural components to slot machine gameplay. Many of these structural components have been adapted from computer games, such as cut scenes, bonus rounds and specialist plays. And while the arm of the "one-armed bandit" remains on many slot machines, more commonly players use simple rectangular or round blinking buttons very similar to those of many arcade games.

There are also, of course, some notable differences between computer games and electronic gambling machines. Historically, the vast majority of EGMs have been exclusively installed in casinos, where the usual age for entry is 21, thus effectively excluding young people from gameplay. However, this is changing as the companies attempt to capture a younger audience and the machines proliferate in non-gambling environments (Rivlin, 2004). Today, EGMs can be found in bars, restaurants, arcades, hotel lobbies, and entertainment and sporting venues. There are also, of course, virtual slot machines online, and these represent a significantly growing proportion of slot income. Research has further shown that casinos and gaming companies are seeking to target women, particularly those over 55 as its main demographic, although as the venues change, the target market is becoming younger.

Electronic gambling machines today are also much faster to play than their mechanical and electronic ancestors. Now, the average player initiates a new game every 6 seconds (Harrigan & Dixon, 2009a, p. 83), playing up to 600 games per hour, and there are even artificially intelligent machines that adapt to the speed of the player—when they start slowing down, the machine will slow down with them, but work to build them back up after a little break. Many games aim for "immersion" (what might be best described in terms of Csíkszentmihályi's concept of "flow", characterized by concentration on the task at hand, a sense of control, merging of awareness and action, temporal distortion and a loss of self-consciousness—see Csíkszentmihályi, 1990). It is, however, often possible to jam the button

with a piece of card, and let the machine play on its own for even faster results. Most machines also include a "Bet Max" function, a one-button mechanism that simultaneously allows players to wager the maximum allowable amount and to spin the reels—a function that encourages both faster wagering and continuous, rapid gameplay requiring a minimum of attention from distracted players.[1] Thus, a "nickel slot" can mean wagers of up to about $4 per bet, although these are typically displayed in "credits" of 25-cent allotments so the illusion is that the player is betting less.

The biggest distinction between slot machines and computer games is, of course, the aspect of financial risk added to gameplay, which adds a potential new level of psychological, cognitive, and emotional involvement in the game (we say potential because these distinctions are as yet unexplored in the research). The win-loss component of electronic gambling games is more complicated than it at first appears, with "losses disguised as wins", and "near-misses" (see below). These are carefully doled out according to a reward schedule, based on scientific research about how long we will play before needing a win to keep motivated (see Brown, 1986). Reward schedules have also been built into computer games, particularly hunter-gatherer type games in which the player must spend considerable time roaming lands and collecting objects.[2] Some psychologists suggest that the reward schedule combined with the rapidity of the gameplay is similar in character to the effect of amphetamines, stimulating the on-off cycle that repeatedly energizes and de-energizes the brain. This link is supported by functional magnetic resonance imaging studies revealing that brain scans of active gamblers and active cocaine users reveal similar patterns of neurocircuitry (Crockford, Goodyear, Edwards, Quickfall, & el-Guebaly, 2005). It has been suggested that there are many different motivations for gambling, with a distinct dichotomy between arousal/action seekers and those who seek escape/dissociation. In other words, slot machine games are designed to simultaneously satisfy different needs of different players.

In this chapter, we will introduce the literature of EGMs and related phenomena to the reader with a specific focus on the use of sound. A brief introduction to the structural components of gameplay is followed by an examination of existing studies on the sonic elements of casinos and gambling and an exploration of how this knowledge might apply to computer games.

STRUCTURAL COMPONENTS OF EGM GAMES

A slot machine essentially involves three or more reels (in today's EGMs, these are often computer-generated digital simulations, rather than actual mechanical parts). Touch-screen machines typically do not have handles, but rather the reels are spun by the player pressing a button (the one-armed bandit style pull-lever handle still exists on most slot machines, but is not often used). When the reels stop spinning, three or more icons (often up to five) will line up on the payline for a win, but other combinations of icons can also lead to a win (diagonal lines, and so on), with the amount won relating inversely to the probability of the symbol coming up on the payline (Turner & Horbay, 2004). Payouts vary by country/state/province and by initial betting amount, ranging from about 80 to 95%—in other words, a fairly significant number of plays result in some form of a "win" (see below for information about these "wins"). The amount bet on a win can vary also—the player can, for instance, be playing a "nickel slot" but can end up betting several dollars on a single play by betting on a larger number of potential payout lines. Moreover, with EGMs, the number of payout lines also varies. For example, *Lucky Larry's Lobstermania* made by IGT, has five reels and 15 possible paylines. The maximum wager is 75 credits ($3.75), while the top prize is 50,000 credits ($2,500). There are also two different bonus

rounds available depending on the version of the game: a Great Lobster Escape, and a Buoy Bonus round in which additional payouts are guaranteed but the amount of payout varies.[3] In these bonus rounds, the player is asked to select from a variety of options, giving the player the illusion of control and the perception of skill. The use of a stopping device, for instance, in which the players can stop the spinning of the reels voluntarily, increases the perception that the stopping is not random but that there is some form of skill involved: By having that control, there is an increased probability of success, thus making the game more attractive to the player (Ladouceur & Sévigny, 2005).

Indeed, slot machines today can feature a library of game variations, in order to increase what the industry calls "time on device" (Schull, 2005, p. 67). Some features of EGMs (and particularly bonus rounds) such as nudge and stop buttons, give the illusion of control to the player—an important component but one that the gaming industry has referred to as being an "idiot skill" (Parke & Griffiths, 2006, p. 154). This perhaps calls to mind the "button-mashing" skill of the early arcade game beat'em-up genre.[4] David Surman (2007) notes that Capcom's 1987 arcade hit *Street Fighter,* for instance, was released with a touch-sensitive hydraulic button system in which the increase of the player's pressure on the button related to the power of the player's character's kicking and punching, thus encouraging players to bang and smash on the buttons. He states: "This 'innovation' led to many machines being rendered defunct by over-zealous players smashing the control system. The cacophony of these large red buttons being bashed would come to signify the arcades which stocked a number of these first *Street Fighter* units" (pp. 208-209). When the player has an increased perception of control, they are more likely to engage with the game, play for longer, and spend more money.

Bonus or built-in "secret" functions (often a cancel button, slow-down or hints—these are typically not actually secret but often not immediately apparent) also increase the illusion of control. The bonus elements of gameplay are sometimes hinted at by the sound (as in *The Simpsons* EGM, in which Krusty the Clown says "Here's a clue for ya, Jack"). A simple bonus or increased skill component leads to an increased psychological involvement on the part of the player and, it is suggested, has a "significant effect on habitual gambling" (Parke & Griffiths, 2006, p. 176). The use of these functions helps to keep players interested in that they hope that they will learn the "secrets" of the machine and thus be able to demonstrate their skill through winning as well as increase their winnings. Of course, similar bonus rounds and "Easter Eggs" are often built into computer games to reward the regular player who has taken the time to find them—thus upping the player's credibility amongst other gamers. Usually superfluous to gameplay, Easter Eggs are nevertheless viewed as rewards for the time spent on the device (see Oguro, 2009). But even beyond the world of Easter Eggs, players develop skills beyond the initial simple skills required to technically play a game, notes Surman (2007):

While a player new to videogames explores the pleasures of the gameworld with the clumsy curiosity of a toddler, as one becomes a more sophisticated gamer other pleasure registers come into play, which are concerned with a literacy of sorts in which one is sensitive to the codes and conventions of the gameworld, and the panoramic experience of worldliness reduces to a hunt for the telltale graphical or acoustic 'feedback loops', confirming success in play. Still higher, as the core gameplay becomes exhausted, players end up centring on the reflexive undoing of the gameworld; pushing it to its limits, exploring and exploiting glitches, ticks, aberrations in the system. (p. 205)

This description fits closely with Csíkszentmihályi's (1990) ideas of the requirements for flow (immersion), where a careful balance between difficulty and skill is required to continually en-

gage a player in an activity. As the skill increases, so must the difficulty, or the player will become bored. If the skill required is too difficult for the novice, the player will likewise lose interest.

Equally important to the psychology of the player are the built-in gambling machine concepts of the "near miss" and the "loss disguised as a win". A near miss is a failure that was close to a win—such as two matching icons arriving on the payline followed by a third reel whose icon sits just off the pay-line. Slot machine manufacturers use this concept to create a statistically unrealistically high number of near misses (Harrigan, 2009), which convinces the player that they are close to winning, and therefore leads to significantly longer playing times (Parke & Griffiths, 2006). Described gambling researchers Jonathan Parke and Mark Griffiths (2006):

At a behaviourist level, a near miss may have the same kind of conditioning effect on behaviour as a success. At a cognitive level, a near miss could produce some of the excitement of a win, that is, cognitive conditioning through secondary reinforcement. Therefore, the player is not constantly losing but constantly nearly winning. (p. 163)

A loss disguised as a win, on the other hand, is a play in which the player "wins" but receives a payout amount of money less than that of the amount wagered, hence actually losing on the wager despite being convinced (sonically) that they have, in fact, won. So for example, a gambler might wager $2 on a play and win $1.50 back. S/he is actually losing 50 cents, but is given the reinforcement cues (see below) of a win.

An important contributing factor to all of these illusions that increases playing time and increases money lost is sound. A small number of previous studies of sound in slot machines have shown that sound influences a gambler's impression or perception of the machine, including the quality of the machine (the fidelity of the sound is a primary reason for selecting one EGM over another), helping to create a sense of familiarity, branding or distinguishing the machine, and creating the illusion of winning, since players may only hear winning sounds (Griffiths & Parke, 2005). Furthermore, Dibben (2001) argues that, for listeners, the reception of music and sounds are not only embedded in the material and physical dimensions of hearing but are also, and critically, grounded in social and cultural knowledge and awareness, based on "listeners' needs and occupations" (p. 183). This idea—that response to music and sounds can be influenced by culture and personal experience—has self-evident relevance for a study focusing on the role of sound in relation to individuals immersed in gambling environments and/or those at risk for addictive gambling behavior. We will first cover the environment in which the slot machines are commonly found and then focus on the machines themselves.

CASINO SOUND: ENVIRONMENTAL FACTORS

The sound of electronic gambling machines in the context of a casino can play a significant role in the perception of the games. Background music in the casinos or bars changes throughout the day, with pop music played in daytime, and relaxing music in the evenings (Dixon, Trigg, & Griffiths, 2007). The noise and music gives the impression of an exciting and fun environment and, critically, that winning is more common than losing. In fact, Anderson and Brown (1984), in a comparison of response to gambling in a laboratory and a casino setting, found that in the casino, the player's heart rate increases considerably. Moreover, increased exposure to the casino setting in problem gamblers leads to an increased arousal response. They note that "[t]he constant repetition of major changes in autonomic or other kinds of arousal associated in time and place with various forms of gambling activity is likely to have a powerful classical or

Pavlovian conditioning effect on gambling behavior" (p. 400).

There has been considerable research into environmental sounds and its impact on consumer behavior in regards to advertising and retail. Servicescapes—that is, the soundscape and landscape of the service environment—have been one recent area of focus in advertising and marketing research. A pleasant ambience, it is felt, is key to a pleasurable shopping experience. Congruency in ambience between the brand, sounds scent, and other aspects of the store are vital to a positive consumer experience (see Mattilaa & Wirtz, 2001). Companies like the now-defunct Muzak have, of course, built businesses on this idea. Alvin Collis, VP of strategy and brand for Muzak, outlines the concept of the servicescape:

I walked into a store and understood: this is just like a movie. The company has built a set, and they've hired actors and given them costumes and taught them their lines, and every day they open their doors and say, 'Let's put on a show.' It was retail theatre. And I realized then that Muzak's business wasn't really about selling music. It was about selling emotion—about finding the soundtrack that would make this store or that restaurant feel like something, rather than being just an intellectual proposition. (see Owen, 2006)

Certainly, statistics seem to back-up Muzak's ideas, with some studies suggesting that young people spend 36% more time in a shop when music is being played, that if Muzak is played in a supermarket, it will increase the percentage of customers making a purchase there by 17%, and so on (KSK Productions, n.d). Generally speaking, consumers spend longer in environments when there is some form of background music as long as the volume is low and uncomplex (Garlin & Owen, 2006, p. 761). Music tempo changes can alter the length of time a shopper spends as well as the amount of money. Not only this, but music can also influence the perceived amount of time spent. Young people under 25 perceived that they had spent longer in an "easy listening" store condition, while older shoppers perceived that they had spent longer in a Top 40 store condition. Familiar music led to the impression that they were shopping longer (Yalch & Spangenberg, 2000). Muzak's website described of its music concept (what it terms "audio architecture"):

Its power lies in its subtlety. It bypasses the resistance of the mind and targets the receptiveness of the heart. When people are made to feel good in, say, a store, they feel good about that store. They like it. Remember it. Go back to it. Audio Architecture builds a bridge to loyalty. (Muzak Corporation, n.d)

Music is, of course, not the only element of environmental sound that plays into the overall ambience. Sound effects, such as in Discovery Channel's stores with sound zones, or a Canadian supermarket close to one of the authors, Sobey's, which has chirping birds and frogs in the produce aisle, can also create an overall atmosphere. Both sound effects and music can help to quickly identify a brand for consumers without prior experience of that brand. Music can cue the shopper as to the intended market, and a poor choice of music can clash with the values of the brand (Beverland, Lim, Morrison, & Terziovski 2006).

Griffiths and Parke (2005) draw on a theoretical model by Condry and Scheibe (1989) regarding persuasion in advertising and adopt this model for slot machine sound. They suggest that there are stages in the persuasion process that involves a person committing to the machine. This begins with exposure (they must be exposed to the machine and that might be in a bar) and leads to attention (in which sound plays a particularly important role to draw attention in a noisy atmosphere). From there, comprehension and yielding takes place—a familiar musical theme helps draw the player in, believing the machine is socially acceptable because the sound is likable and familiar. Finally,

the retention and decision-to-gamble stages occur. In other words, sound is used to draw people in, make them feel comfortable, and convince them to play. The authors hypothesize that the background sounds and music might increase confidence of the players, increase arousal, help to relax the player, help the player to disregard previous losses, and induce a romantic state leading them to believe that they may win.

One study into the effect of background music on virtual roulette found that the speed of betting was influenced by the tempo of the music, with faster music leading to faster betting. Another suggests that there are two main types of casino design: a playground design (spacious, with warm colors, vegetation, and moving water) and a low-ceiling, crowded and compact area. This study found that music increased perceived at-risk gambling intentions in the playground casino design while decreasing the intentions in the other gambling design. In the presence of just ambient sounds, however, this finding was reversed (Marmurek, Finlay, Kanetkar, & Londerville 2007). What is certain is that the flashing lights, the room lighting, the carpeting, and visual design of the space, the conflicting smells of food, perfume and alcohol, and in particular the use of loud sounds serves to at once create feelings of excitement and luxury as well as serving to distract the player by increasing cognitive load (the efforts involved in processing multi-modal information and use of working memory) (see Hirsch, 1995; Kranes, 1995; Skea, 1995). Multiple conflicting stimuli and calls on attention leading to this increased cognitive load causes people to process information using guessing, stereotyping, and automatic response to stimuli rather than reasoned and rational response and introspection.[5] This depends, somewhat, on the type of music involved, as well as the personal perception of the individual involved (Carter, Wilson, Lawsom, & Bulik, 1995; McCraty, Barrios, Atkinson, & Tomasino 1998; Wolfson & Case, 2000).

Some slot machines, however, employ noise cancellation technology to remove any "destructive interference" that may distract a player from the flow of gameplay, to increase immersion (Schull, 2005, p. 67). An Australian study found conflicting reviews of background ambience, with some players getting distracted, and others reporting excitement: "You can go either way when you hear somebody else going, you can get all hyped up and think, gee their machine's going I could also have it, or it could go the opposite, why isn't my machine paying. It has a double affect" versus, "The minute I hear the 'ching, chong China man', I quickly run around to see"… Two participants noted that the music made them "anxious" and "desperate" as they believed that everyone else around them was winning something, when they were not" (Livingstone, Woolley, Zazryn, Bakacs, & Shami, 2008, p. 103).

Computer games today are rarely consumed in an arcade environment whose music and sound can be manipulated, but the use of non-diegetic music in games as well as the use of ambience could be adjusted to take into consideration some of the results of these studies. For instance, altering the perception of time through the use of changing tempos or generating feelings of excitement with carefully timed sound effects in the ambient world may help to engage the player. There are also implications here relating to games that require further research. In particular, how does the fact that players can substitute their own music in Xbox360 games influence their perception of gameplay? How does the use of familiar music impact the player's perception of unfamiliar games? These questions are outside the scope of this chapter, but clearly have important consequences in regards to player engagement with and enjoyment of a game. Of course, more easily manipulated than the environmental space in which gameplay takes place, is the use of sound in the games themselves.

SOUND IN EGMS

The earliest slot machines, such as the Mills Liberty Bell of 1907, included a ringing bell with a winning combination, a concept that is still present in most slots today. Playwright Noël Coward noted that sound was a key part of the experience in Las Vegas: "The sound is fascinating . . . the noise of the fruit machines, the clink of silver dollars, quarters, nickels" (in Ferrari & Ives, 2005). As in the contemporary nickelodeons, sound's most important early role was its hailing function, attracting attention to the machines (Lastra, 2000, p. 98). Sound in EGMs has advanced alongside the technological changes introduced into the machines in the last few decades. EGMs are now using computer-generated graphics, popular music, and high-fidelity sampled sound rather than relying on mechanical ball-bearings, bells or basic square-wave synthesizer chips.

Today, sound effects in EGMs are used for a variety of feedback and reward systems. Up until about the early 1990s, slot machines featured about 15 ''sound events'', whereas they now average about 400 and are often carefully researched to manipulate the player (Rivlin, 2004, p. 4). Sound designer George Sanger described that sound is created "by committee" and that the committee "always want it to be more exciting" with little consideration for a dynamic range in the excitement portrayed (Personal communication, October 15 2009, Austin, TX). This includes sound effects of coins falling even though many slot machines neither accept nor pay out coins anymore. Notes Bill Hecht, an audio engineer for IGT, "We basically mixed several recordings of quarters falling on a metal tray and then fattened up the sound with the sound of falling dollars" (Rivlin, 2004, p. 3). Moreover, these false coin sounds can portray wins much larger than the actual win.

Unpredictable sounds in particular help to capture and maintain our attention (Glass & Singer, 1972). There has even been a recent patent to randomize winning sound effects in order to increase the perception that the sound is more real than it is in actuality and to reduce the recognition that it is merely careful programming at play. The patent describes:

In the conventional slot machine… the sound effects generated from the speaker are based on only one kind of sound effect pattern. For example, when a big bonus game occurs, a fanfare indicating the occurrence of the big bonus game is sounded, and so forth. Meanwhile, with a slot machine in which a special game has once occurred, the player typically keeps playing games while expecting special games to further occur. In this case, if the sound effects (winning sounds) identical to those at the first occurrence of the special game are generated upon the second or later occurrence, the pleasure of gaming may not fully be enjoyed. (Tsukahara, 2002, p. 1)

Slot machines use pseudo-random number generators carefully programmed to elicit the right reward schedule, however, and there is no real skill involved, only manipulations of perception. Recent research findings that music can increase success rate, for instance, are fallacious because it is simply not possible. Yamada (2009) for example proposes that:

Results indicated that the no-music condition showed the best rate of success. Moreover, a "mixed" musical excerpt added "unpleasantness" to the game and, in turn, resulted in a negative effect on the success rate. Increasing the speed increased the "potency" of the game, but did not affect the success rate, systematically. In the second experiment, we used the two excerpts performed in various registers and with various timbres as musical stimuli. (p.1)

It is unclear if Yamada custom-designed the games that were tested or if the test was for illusion of success and perceptions of gameplay rather than *actual* success, and neither is it clear

if the game involved was a custom-built game for the purposes of the study (we could find no references to the game in Google), and so Yamada's findings remain dubious at best. However, what Yamada's work does show is that it is highly likely that music plays an important role in increasing the *illusion* of success.

Of course, winning sounds are particularly important to the popularity and attraction of the machines and losing sounds are rarely heard. When losing sounds are used in some machines, they are intentionally employed to antagonize the player, creating a short-term sense of frustration that, it has been suggested, prolongs the play period in what has been called "acoustic frustration":

Antagonistic sounds invoke frustration and disappointment. For example, on The Simpsons fruit machine, Mr. Smithers smugly informs Homer Simpson that, "You're fired", or Chief Wiggam says, "You're going away for a long time". At present, we can only speculate about the consequences of such sound effects. In line with hypotheses supporting frustration theory and cognitive regret… this might make the fruit machine more inducing." (Parke & Griffiths, 2006, p. 171)

This idea of acoustic frustration could be adapted and utilized by computer games more effectively than is currently seen. For instance, commentary on gameplay (see below) is common in some types of games but absent in most computer games. Sound effects and music could play a commentary effect without using dialogue as well.

The types of sounds used are particularly important to their affective power. Pulsating sounds that increase in pitch or speed (vibrato and tremolo) have been shown to help to increase tension and verbal reinforcements (both negative and positive) are used to goad the player on with a sensation known as *perceived urgency* (see Edworthy, Loxley, & Dennis, 1991; Haas & Edworthy,1996). The deeper a player gets into a game, the louder and quicker the music usually becomes. High pitched sounds—very common to slot machines—are also very useful in attracting our attention as they perceptually appear closer to us. Notes Millicent Cooley (1998): "Advertisers use this principle when they pump television commercials full of high frequency audio that makes characters sound as if they are intruding into viewers' homes." The types of sounds used in EGMs are also carefully chosen according to Western cultural likes and dislikes. As one study of pleasing sounds found, chimes are particularly highly rated: "Our highest rated sounds generally related to escapism (e.g., fantasy chimes, birds singing) and pleasure (children laughing)" (Effrat, Chan, Fogg, & Kong, 2004, p. 64).

Large wins in slot machines are characterized by a "rolling sound" with the length of the win tied to the length of the music cue. Winning sounds are often carefully constructed to be heard over the gameplay of other players to draw attention to the machine and to raise the self-esteem of the player, who then becomes the center of attention on the slot machine/casino/bar floor (Griffiths & Parke, 2005, p. 7). Often, this music contains high pitched, major mode songs with lots of chimes and money sounds. Higher pitch also has a tendency to increase the perception of urgency, with that increase in perceived urgency corresponding to an increase in pitch, but it also helps to cut through the ambient noise of a busy casino (Haas & Edworthy, 1996).

There are several implications here for computer game sound. First is the reinforcement role of both encouraging and antagonistic sound. Sonic rewards are under-utilized in games and the idea of a reward schedule, while it *has* been used in computer games, is likewise unusual. To tie the two together—to have a system of sonic rewards at anticipated specific timings in the game—can help to keep a player interested for longer. Losing sounds, as discussed above, are perhaps the equivalent of player health decreases or death in a computer game. It is quite common for computer

games marketed to children to sonically represent the player's character's death as a not particularly negative event. This may in fact even be silence upon the character or game's end (the equivalent of not hearing a losing sound in a slot machine), a fun "raspberry", a game show-like losing sound (as in *Rocky and Bullwinkle* on the Nintendo Entertainment System (NES)), or a cheery "try again" music (as in the *Jetsons* or *Flintstones* game-over music for the NES). On the other hand, in more adult-oriented games, the player's death can be a much more negative event with serious funeral dirges. It may be worthwhile for sound designers to explore the possibility of including both more losing-type sounds in other places within the game, in order to increase the acoustic frustration the player feels, thus enhancing the impact of winning sounds and increase emotional engagement.

Psychological studies have shown that frustrative non-rewards are considerably motivating. In simple terms, "failing to fulfill a goal produces frustration which (according to the theory) strengthens ongoing behavior", leading to cognitive regret, encouraging persistent play in the desire to relieve the regret (Griffiths, 1990; see also Amsel, 1962). Note King, Delfabbro, & Griffiths (2009):

Video games have also become longer and more complex, making a punishment like permanent character death an unappealing feature, particularly for a less committed, casual playing audience. Common forms of punishment in games include having to restart a level, failing an objective, or losing resources of some kind, like items, XP or points. (p. 10)

It is possible, therefore, to improve the sound of losing tied to these lesser events, in order to tap into the acoustic frustration effect seen in slot machines. While we typically hear sounds tied to these events in current games, a stronger sense of loss (and thus, upon winning, reward) may improve player involvement.

Likewise, the concepts of near misses and losses disguised as wins are elements popular in slot machines but rarely—if ever—heard in computer game sound. One might imagine, for instance, a "mini-game" within a larger game in which the player is sonically teased with *almost* winning a bonus round or is given the impression that they have won more points than they actually have within that bonus round. This would probably, of course, only be useful for certain types of games aimed at certain types of players. One can imagine this effect in a Wii casual game designed for all ages, for instance, but less so for a big budget first-person shooter title on the Xbox360.

Slots, Familiarity and Brands

Important to feelings of player comfort and emotional connection to the machine is the role of branding EGMs by using well-known intellectual property. Popular songs are often used to attract a player to the machine and to cause players to feel more comfortable and familiar with that machine. Similarly, sound can play a role in branding by certain companies which create distinctive winning sounds in an effort to have their sounds heard over the din of the casino. Indeed, branded EGMs are becoming both more commonplace and more popular in casino environments. Whereas once producers of popular culture sought to remain apart from the perceived negative connotations associated with the gambling industry, today films like *Top Gun*, and *Star Wars*, television game shows like *Jeopardy!, Deal or No Deal* and *The Price Is Right*, and musical acts like Elvis Presley, the Village People and Kenny Rogers all have branded EGMs (Dretzka, 2004). Familiarity with a television show, film, person, place, musical act or sport can, for instance, entice players to the machine because it may "represent something that is special to the gambler… Players may find it more enjoyable because they can easily interact with the recognizable images and music they

experience" (Griffiths & Parke, 2005, p. 5). As Dretzka (2004) observed:

Seemingly overnight, casinos actually began sounding different. Instead of clanging bells, mechanical clicks and clacks, and jackpot alarms, the soundtrack was more of an electronic gurgle and hum, with bursts of 'This is Jeopardy!', Wheel of Fortune!' and snippets of rock songs. A generation of Americans raised in front of their television sets ate it up.

Moreover, familiarity and repetition of musical themes has been shown to have a positive influence on our liking of the music (see Bradley, 1971).

Verbal reinforcement with known characters (as well as, to a lesser degree, unknown characters) also takes place, as seen above, with familiar characters telling people that they are "cool" or "a genius". Parke and Griffiths (2006) note that verbal reinforcement that increases play is designed to raise self-esteem, give hints and guidance, and even provide friendship or company (p. 171). An unexplored area of research is the relationship between verbal reinforcement and the anthropomorphizing of slot machines. Describes Langer (1975), with regard to such anthropomorphism: **"**Gamblers imbue artifacts such as dice, roulette wheels, and slot machines with character, calling out bets as though these random (or uncontrollable) generators have a memory or can be influenced" (see also Gaboury & Ladouceur, 1989; Toneatto, Blitz-Miller, Calderwood, Dragonetti, & Tsanos, 1997). It is very likely that sound plays a considerable role in the anthropomorphizing of slot machines—particularly in those cases where the machines "talk" to the player, but also in the mere fact that they are sonically responsive to our input.

In reference to the game show computer game *You Don't Know Jack*, Millicent Cooley (1998) notes that the player:

Will be aggressively challenged to prove that you know jack (anything at all), and you know this, again, because of the dialog and swaggering, aggressive tone of the host. The machine is in charge and you, the player, are not; the game is quick-paced, there is a sense that you will be rushed along and should try to keep up and prove that you do, in fact, know jack. You feel this pressure because the voice of the host rushes you to sign in, taunting you impatiently at every step. (p. 8)

It is possible that a similar process is at work with slot machines—that is to say, the taunting will increase the speed with which the player plays, antagonizing the player to the point where the player loses focus on what truly matters (that is, the loss of their money).

In reference to sonic branding, Jackson (2003) suggests that the voice heard links to the perceived personality (including perceived behavior and perceived appearance) of the speaker and, therefore, of the brand (p. 135), and it is equally likely that a similar effect is seen in the perceived personality of the machine. It has been said that 38% of the effect we have on other people can be attributed to our voice, with only 7% to the actual words we've spoken (the rest being body language) (Westermann, 2008, p. 153). In a study into voice and brand, UK Telecom provider Orange identified a series of attributes that define the sound of a voice: rhythm (emphasis is placed on what is said); pitch (high versus low), melody (rhythm and pitch together; pace (speed), tone (overall musical quality); intonation (what is said relating to how it is said), energy; clarity; muscular tension; resonance pause, breath; commitment, and volume (Westermann, 2008, p. 153). Each of these attributes work together to impact our perceptions of what is being said. Particularly notable is the impact that the voice (and what it says) can have on our perceptions of what we are seeing and/or experiencing. Several studies have shown how the voice influences our perception of video sports performances. In a study of sports commentary, Bryant, Brown, Comisky, & Zillmann, (1982) discovered that our enjoyment of watching sports

is largely tied to the dramatic embellishments provided by the commentary of the sportscasters. However, it is not only our enjoyment but also the ways that we interpret what we are seeing that is influenced by commentary. In one study, it was found that commentary affected the perception of aggression of the players in an ice hockey match. (Comisky, Bryant, & Zillmann, 1977). Not only this, but the more aggressive commentary was also perceived as more enjoyable. Other similar studies have reached similar conclusions in commentary in a tennis match, (Bryant, Brown, Comisky, & Zillmann, 1982), a soccer game (Beentjes, Van Oordt, & Van Der Voort, 2002) and a basketball game (Sullivan, 1992). This influence of commentary on perception is likely to play an equally important role in slot machines as well as computer games, although this remains another area of game sound largely unexplored. Sports games in particular make use of commentary although it is also very common to find commentary in games that imitates television game shows. It is possible, therefore, that the addition of a narrative of events in some games may impact the player's perception of their gameplay, as well as their enjoyment of the game, although the technique is clearly under-utilized.

Another trait discussed above that is highly popular in slot machines but less common in computer games is the use of familiarity and branding tied to the machines. Not only do the games themselves have distinctive sounds, but each company has its own overarching style and aesthetic that can be quickly learned upon spending time on the casino floor. The coin sounds from an IGT slot machine, for instance, sound different from those generated by a Bally machine. While this acoustic branding is particularly relevant in an environment where machines are competing for attention, the relevance of creating a distinctive sound and branding franchise games or episodic games remains in other environments also. Some computer games have, of course, employed this technique—the *Super Mario Bros* series, for instance, has maintained a distinctive aesthetic through countless incarnations, platforms, and technological improvements. However, there are many games that still do not attempt to capitalize on this ability to entice experienced players to a new version of the game with the creation a distinct, recognizable sound.[6]

RESPONSES TO EGM SOUND

The response of players to slot machine sounds is diverse, representing the different needs and desires of the players. For many, music and sound signify success, as one study has found: "I like it when it's going long [the music], because you know you're winning plenty of money. When they're short, I don't like them…" (Livingstone et al., 2008, p. 103). Other players—those which by their comments appear to be more regular gamblers—dislike the sounds, the study found: "sounds are too loud and attract attention. If someone lets the feature music go on and on they are not serious—the problem gamblers hate hearing it go on and on—and it draws attention to you" (Livingstone et al., 2008, p. 103). A few other participants also reported pressing "collect" straight after a win specifically to stop the music from playing. While some players found the sounds of others winning exciting, others felt that it gave them the impression that "everyone is winning but you" (Livingstone et al., 2008, p. 103). One study regarding sound's presence (as on or off) showed that players strongly preferred sound to be on (Delfabbro, Fazlon, & Ingram, 2005). Response to sound, therefore, can vary from player to player, but some typical responses can be summarized.

Studies of the physiological response to sound (typically industrial noise, but also including music, speech, and other sounds) have found that sounds can contribute to increases in blood pressure and, most importantly, impair performance on a vigilance task (Smith & Morris

1997). Wolfson and Case (2000) studied heart rate response to manipulation of loudness of sound in a computer game, finding that louder sounds led to increased heart rate, and discussed the impact that physiological arousal has on our attention levels. They note:

People performing a task when minimally aroused are more likely to be slow, indifferent, and spread their attention across a wide range of stimuli. When highly aroused, people tend to be faster but less accurate, and they focus mainly on the most salient aspects of a task. Thus both high and low levels of arousal can have detrimental effects on performance. (Wolfson & Case, 2000, p. 185)

Physiological responses to stimuli can be tested using a variety of measures, including (but not limited to) electroencephalograms (EEGs), facial electromyography, heart rate, pupil dilation and electrodermal response. Galvanic skin response (GSR), one component of electrodermal response, also known as skin conductance response or sweat response, is an affordable and efficient measurement of simple changes in arousal levels—one of the reasons why it is the main component of a polygraph device. Essentially, GSR measures the electrical conductivity of the skin, which changes in resistance due to psychological states. (See Nacke & Grimshaw, 2011 for the use of such measures when assessing psychophysiological responses to computer game sound.)

Studies using GSR on subjects while being exposed to music date back to at least the 1940s (for example, Dreher, 1947; Traxel & Wrede, 1959) but are highly contradictory due to the conditions in which the studies took place. Sound and music has a known influence on listener's arousal and anxiety levels, but this depends on many factors including the degree of musical knowledge, the tempo of the music, the familiarity with the music, preference for the music, and recent exposure to that music. Smith and Morris (1976) found that stimulating music increased worry and anxiety, although they tested their student subjects during an examination. Rohner and Miller (1980) found that music had no influence on anxiety levels. Pitzen and Rauscher (1998) and Hirokawa (2004), on the other hand, more recently found that stimulating music increased energy and relaxation (increasing GSR but not heart rate).

Although there are many studies about music in isolation and its physiological effect on listeners, there has been much less research on music's impact on GSR while taking into consideration the interaction between sound and visual image (for example, Thayer & Levenson, 1983). Perceptual studies (non-physiologically based research) from the field of advertising suggest that image and sound, when used congruently (that is, for instance, when both have a similar message), tend to amplify each other (for instance, Bolivar, Cohen, & Fentress, 1994; Bullerjahn & Güldenring, 1994; Iwamiya, 1994). There have also been studies into the physiological effects of gambling, which have shown that pupils may dilate, heart rate may increase, and skin conductance levels increase (raising the GSR). Collectively, these are known as arousal levels, and it is the arousal inducing properties of slot machines that are affected by winning and losing, with increased arousal levels for wins (such as Coventry & Constable, 1999; Coventry & Hudson, 2001; Sharpe, 2004). Additionally, a number of studies, for instance, research by Dickerson and Adcock (1987), have questioned whether there is a connection between physiological responses to gambling and wider psychological issues governing perceptions of such elements as gambling environment, luck, and mood. These studies suggest there is some evidence to support both psychological and physiological responses to gambling behaviors are fuelled in part by a player's illusion of control (for example, Alloy, Abraham, & Viscusi, 1981).

In more recent research into computer games and the computer gaming environment, Hébert, Béland, & Dionne-Fournelle (2005) have discovered that, "for the first time…auditory input

contributes significantly to the stress response found during video game playing" (pp. 2371-2372). This research suggests that physiological responses to music in computer games may be linked in part to genre, noting generally that the more aggressive and rapid the music, the more elevated physiological stress levels become.

A recent pilot study into the sounds and sights of losses disguised as wins was undertaken with 16 participants by the University of Waterloo's Problem Gambling Research Group. Each participant played *Lucky Larry's Lobstermania* for 45 minutes while being tested for their arousal levels using GSR. Participants wore a GSR recording device on their fingers while they played, with the output from the GSR being tied to two wires which output when the player pressed the play button and whether or not the play resulted in a win, loss disguised as a win (where payout is less than spin wager) or a regular loss (that is, losses without reinforcing sounds of a win). As might be expected, the highest GSR rating—indicating the highest arousal level—was found with wins, with the lowest rating with regular losses. What is particularly interesting, however, is that losses disguised as wins were much closer physiologically to wins, than to losses. In other words, hearing the *sounds* of winning, even though the player has lost money, is enough to trick the mind/body into believing that the player is winning (Dixon, Harrigan, Sandhu, Collins, & Fugelsang, forthcoming).

In the case of losses disguised as wins, these games play on the idea of synchresis. Film theorist Michel Chion (1994) defines synchresis as "the forging of an immediate and necessary relationship between something one sees and something one hears," combining the ideas of *synchronism* (simultaneous events) with *synthesis* (p.5). Essentially, sound changes our perception of the image that we see and, despite there being an opposing relationship between sound and image, we view images as connected to sound when they are played concurrently, with the sound dominating our response. With losses disguised as wins, the numbers displayed on the machine tell us that we are losing (in other words, we "won" 50 cents, but our total credits and cash have been reduced since the last play) but the *sound* tells us that we are winning. In a sense, the sound overrules our eyes and leads the emotional (and physiological) response to the event. This phenomenon illustrates the importance of sound to our overall perception of audio-visual media, and demonstrates one under-utilized way that sound is used in computer games. Far from merely reinforcing image, sound can have a much more complex relationship with what is occurring on screen. We might use a "winning cue" sound for instance in a battle scene to trick the player into thinking that the evil "big boss" enemy is dead, only to have them return to life. Or, we might use sound into tricking the player into thinking drinking that bottle of potion was a beneficial event, only to later reveal that it was not.

CONCLUSION

The intent of this article has been to explore a comparatively understudied area of computer game sound, chiefly that of the role of music and sound in electronic gambling machines (EGMs). We explored the structural components of EGMs and EGM games, tracing the development of technical advances that have led to progressively more enhanced audio interfaces over the past two decades. Central to this discussion is the interrelationship between EGM technology, sound and human behavioral psychology. Research has shown that standard EGM gameplay concepts like, for instance, the "near miss" and "losses disguised as wins", coupled with enhanced sound prompts and triggers can encourage both more rapid and longer gameplay.

A second correlated point in this study has been our consideration of EGM sound within the wider soundscape of a casino/bar/gaming environment.

An interesting area of research as yet unexplored is determining whether gambling behavior is affected when EGM sounds commingle with, and compete against, external sources of music, sounds, and noise. Further, it would be interesting to explore whether a correlation exists between the concurrent use of image and sound in EGMs. Specifically, to determine if EGM sound and video individually and together amplify and/or reinforce the notion of a loss disguised as a win or, conversely, if EGM sound and visuals instead worked to distract and divert gamblers' attention away from the machine, and by extension, from the act of gambling. Early research does indicate that sound does, in fact, reinforce the idea of winning even when the player is losing. There have been no studies to explore the impact that a similar sonic process has in computer games, but this is an interesting area for future exploration.

A particularly important concept that can be taken from slot machines is the idea of customization. Slot machines, as shown, have two basic markets that they cater to: arousal/action seekers, and those who seek escape/dissociation. It may be suggested that computer games have a similar audience, although this simple way of dividing players is perhaps inadequate. What does remain, however, is the concept that players have different needs for gameplay. And while some players enjoy the sounds of slot machines and the casino environment, others clearly would prefer the ability to turn down—or turn off—sound altogether. computer games, of course, have long recognized this and offered the ability to turn sound on, off, and later adjust volumes of individual elements (ambience/sound effects/dialogue/music). More recently, the option for players to insert their own preferred music into a game has furthered the ability to customize game sound. Further, some games have "boredom switches" that drop the volume levels automatically after a player has become "stuck" at a particular stage in the game. However, it might also be possible to adjust sound based on the player's skill level and ability—with more frequent frustration sounds being used as the player advances, for example, and greater sonic encouragement at the start of a game. Different sounds may be used when the game is being played as a one-player or in multi-player mode.

Recently, with the creation of physiologically aware gaming devices such as the Wii Vitality Sensor, it has become possible to adjust in real-time based on the player's physiological response. We believe that this area of computer gaming—what we might call "player aware" games—will become an important future area for research. In particular, it is possible to both craft sound to manipulate the player based on their physiological response, as well as to respond based on their physiological response. It might be possible, in other words, for games to "read" our emotional and physiological state and adjust music to keep us interested, to guide us to another state, or to enhance an existing state. Sound clearly plays an important role in the perception of gaming, and will continue to grow in importance as computer games search for ever-increasing ways to keep players interested.

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KEY TERMS AND DEFINITIONS

Acoustic Frustration: The use of sound to antagonize a player, creating a short-term sense of frustration that, it has been suggested, prolongs the play period.

Electronic Gambling Machines: EGMs, also known as slot machines, video slots, or video fruit machines are digital, electronic slot machines. They tend to be much faster than electric or mechanical slots, with an increased number of play options and bonuses.

Galvanic Skin Response: GSR: one component of electrodermal response, also known as skin conductance response or sweat response, is an affordable and efficient measurement of simple changes in arousal levels—one of the reasons why it is the main component of a polygraph device. Essentially, GSR measures the electrical conductivity of the skin, which changes in resistance due to psychological states.

Losses Disguised as Wins: A play in which the player "wins" but receives a payout amount of money less than that of the amount wagered, hence actually losing on the wager despite being convinced (sonically) that they have, in fact, won.

Near Miss: A failure that was close to a win—such as two matching icons arriving on the payline followed by a third reel whose icon sits just off the pay-line. Slot machine manufacturers use this concept to create a statistically unrealistically high number of near misses (Harrigan 2009), which convinces the player that they are close to win-

ning, and therefore leads to significantly longer playing times (Parke & Griffiths, 2006).

Reward Schedule: A schedule of pay-off or rewards tied to timings or game actions, resulting in a series of emotional peaks and valleys to keep a player interested in a game.

Rolling Sound: The music or sound effects that are played when a player wins a round on a slot machine. The length of the sound (its roll) is tied to the amount of the win, with longer sounds rolling for longer times.

ENDNOTES

1 It is a common practice for many avid slot machine gamers to play multiple, adjacent machines simultaneously. Further, activities like drinking, smoking and interaction with other gamblers and passersby may also take gamers' attention away from the machines.

2 For instance, a reward schedule is built into *Too Human*. Personal conversation, Denis Dyack of Silicon Knights, St. Catherines, Ontario, 2008. See Hopson, 2001.

3 There are different versions of the game available, including a "progressive slot" with varying jackpots, a 25-line slot with a max bet of 1,250 credits and a payout of 500,000 credits.

4 Thanks to the anonymous reviewer of the chapter for this idea.

5 Commission on Behavioral and Social Sciences and Education Committee on the Social and Economic Impact of Pathological Gambling. (1999). Committee on Law and Justice. Commission on Behavioral and