Full of Sound and Fury, Signifying Something:
The Impact of Autonomic Arousal on EGM Gambling

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Abstract

An experiment was conducted to observe the influence of autonomic arousal on subsequent gambling behavior. Thirty-seven male and 32 female regular Electronic Gaming Machine (EGM) players were recruited through newspaper advertisements. Participants were randomly assigned to either: 1) a control condition, or 2) an experimental condition that introduced a loud white-noise event (80 db) at fixed 120 sec intervals throughout the 5-minute EGM gambling session. Galvanic Skin Response (GSR) measurements showed that the manipulation was successful in elevating autonomic arousal. The results showed differences in behavioral response to the manipulation based on prior experience with gambling problems. Persons with many gambling problems had lower average bet-sizes in the white-noise condition compared to the control, while those with few or no problems had higher average bet-sizes. The results suggest that arousal may provide different signals to gamblers with few versus many problems. Gamblers with many problems may interpret their arousal as a sign that they will soon lose money, while gamblers with few or no problems may associate feelings of arousal exclusively with winning.

Key Words:

Gambling

Pathological Gambling

Physiological Arousal

Sensation Seeking

Affect

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From a behavioral perspective gambling, like any other behavior, is maintained by the outcome or consequence of that behavior. If the consequence is positive, or reinforcing, then the contingent behavior becomes more likely to occur again (Baum, W. M., 1994). Limited research within the behavioral psychology field goes some way to support the idea that environmental contingencies act to maintain gambling behaviors including such elements as: relative payoff-rates, cues, and alternative sources of reinforcement (Dickerson, M. & Baron, E., 2000; Weatherly, J. N. & Brandt, A. E., 2004). However, while the potential negative consequences of gambling behavior have been well documented (Freidenberg, B. M., Blanchard, E. B., Wulfert, E., & Malta, L. S., 2002), the exact nature of what reinforces and maintains general gambling behaviors is less clear.

One area of continuing interest is the role of physiological arousal (or excitement) as a source of reinforcement for gambling behaviors (Brown, R. I., 1986; Rockloff, M. J. & Dyer, V., 2006). Researchers have suggested that the "high" or aroused state that follows the act of gambling (regardless of whether a win is achieved or not) may act to maintain gambling behaviors in those who regularly gamble (Freidenberg, B. M. et al., 2002; Sharpe, L., 2004). This "high" is theorized to promote not only recreational gambling, but may also facilitate the development of more problematic gambling behaviors (Wulfert, E., Roland, B. D., Hartley, J., Wang, N., & Franco, C., 2005). Physiological arousal in high-

frequency gamblers (regardless of whether they meet the criteria for problem or pathological gambling) has been shown following imagined participation in gambling, mere-exposure to cues regularly associated with gambling, in naturalistic and experimental settings, and across a range of gambling activities (Anderson, G. & Brown, R. I., 1984; Coventry, K. & Constable, B., 1999; Sharpe, L., 2004); again suggesting that arousal plays a pivotal role in reinforcing and maintaining gambling behaviors. However, in past studies, arousal has been demonstrated to be a consequence of gambling; or imagined gambling; but has not explicitly been shown to directly influence gambling behavior.

In a recent review of the literature examining the role of arousal in the maintenance of gambling behaviors, Wulfert, Roland, Hartley, Wang and Franco (2005) suggested three factors that may mediate a gamblers experience of arousal, and therefore potentially alter patterns of excitement and subsequent gambling behavior. The first of these is the individual's prior history of gambling; however the exact effect of this history (i.e., to promote higher or lower levels of arousal) is unclear with disparate results extant in the literature. Wulfert et al. suggest that this inconsistency in experimental findings indicate that prior involvement alone is not sufficient to explain the arousal that occurs with gambling. The second factor is that of winning and the monetary outcome of that winning. While money has been shown to be a powerful, generalized reinforcer for behaviors other than gambling; and various researchers have shown that those who win show higher arousal levels than those who lose (Coventry, K. R. & Hudson, J., 2001); other studies have shown that arousal occurs regardless of

whether an individual wins or loses (especially among pathological gamblers, (Sharpe, L., 2004)). Again this suggests that, while winning may play a role in arousal levels, arousal is not solely dependent on winning. However, it also suggests that any research into aspects of the environment that maintain gambling related behavior needs to ensure that participants play for real money – i.e., if the financial outcome of winning is related to arousal levels as is suggested in some findings, then researchers should mimic this aspect of the "real" environment. The perceived need to make a gambling situation "real" has limited experimental investigation into what maintains gambling behavior (Weatherly, J. N. & Brandt, A. E., 2004).

The final factor mentioned by Wulfert et al., in their review of the literature is that of "intrinsic" excitement. That is, they suggest that gambling activities may simply be intrinsically reinforcing with monetary outcomes being a secondary consideration. According to these authors, the contradictory results of the research examined highlights the need for further enquiry into the role of arousal in maintaining gambling behavior.

Our interest in conducting the present study was to directly observe the influence of experimentally induced arousal on gambling behavior. This is a critical link in the suggested cycle of gambling that leads to arousal; and arousal that maintains behavior.

Arousal is often manipulated experimentally by using the so-called Startle Paradigm. Essentially, this involves an aversive noise - generally white noise at 80db or louder (e.g., Gooding, D. C., Davidson, R. J., Putnam, K. M., & Tallent,

K. A., 2002) - that is played to a participant without prior warning. The magnitude of the startle response or arousal has been shown to be affected by a range of variables such as, sensory modality; strength of stimulus (i.e., volume) and psychological state. For example, arousal is said to be less if the startle probe is in a different modality to the task (Vrana, S. R., Spence, E. L., & Lang, P. J., 1988). Researchers looking at the effects of changes in phasic arousal (i.e., temporary changes due to presentation of short-term stimuli as in the startle paradigm) on attention and memory suggest that not only does attention narrow during times of arousal, but that general awareness of other options is restricted due to attentional filtering (Tracy, J. I., Mohamed, F., Faro, S., Tiver, R., Pinus, A., Bloomer, A. P., & Harvan, J., 2000). Cahill and Alkine (2002) also suggested that autonomic arousal may affect the way in which memory of the events that triggered the arousal are encoded. Both of these processes may have an implication in the development of gambling behaviors resulting from arousal.

Arousal is generally measured using physiological reactions that are not under the conscious control of the participant. Arguably one of the most common and useful measures of physiological arousal is skin conductivity, also known as the Galvanic Skin Response (GSR, Groeppel-Klein, A., 2005). Skin conductivity changes depending on the amount of perspiration within the epidermis, with increases in arousal level shown as changes in GSR.

Aims of the Present Study. The aim of the current experiment was to manipulate arousal to explore its influence on Electronic Gaming Machine (EGM) related behavior. As illustrated in our literature review, there is a host of evidence

that gambling creates arousal. At present; however, there is no work directly addresses whether arousal can in-turn facilitate gambling behavior. Other authors have suggested that arousal might be linked to gambling in a cycle that maintains behavior, but have offered no specific evidence of this proposition. This study will use a Startle Paradigm (cf., Gooding, D. C. et al., 2002) to experimentally induce arousal in some participants to observe its effect on gambling behavior. As in our past work (Rockloff, M. J. & Dyer, V., in press), we employ the concept of gambling intensity for analyzing the results. Gambling intensity is operationally defined as any marker or trace of behavior which would tend to contribute to gambling losses over long-run play. EGMs, as well as most other forms of gambling, have a negative expected return from each dollar bet. As such, larger average bet-sizes, smaller final payouts and faster speeds in gambling all tend to indicate greater losses from long-run play. In short, our hypotheses for the study are that the arousal induced by the white-noise event should intensify gambling behavior compared to a control condition on these measures. In addition, the white noise should lead to greater intensification of gambling among persons with many (as opposed to few) gambling problems.

Methods

Participants. Sixty-nine subjects, 37 males and 32 females, were recruited using flyers in a daily newspaper in Rockhampton, Australia. Recruitment criteria included persons 18+ years in age who self-reported regular EGM gambling, but excluded 11 persons who suffered from heart conditions. Persons who completed the study ranged in age from 18 to 76 years with an average of 47.8

years ($SD = 17.7$). Participants were categorized into the following groups based on the 9-item scoreable portion of the Canadian Problem Gambling Index (Ferris, J. & Wynne, H., 2001): a) 13 (18.8%) no problems, b) 18 (26.1%) low risk, c) 27 (39.1%) moderate risk, and d) 11 (15.9%) problem gamblers. The cultural identities of subjects included: 61 (88.4%) Australian; 3 (4.3%) German; 2 (2.9%) English; 2 (2.9%) New Zealand; and 1 (1.4%) Irish.

Apparatus. The experiment utilized a traditional 3-reel EGM simulated on a laptop computer. The EGM was programmed to payoff at random intervals, but on average at intervals of 120 seconds (or 2 minutes). To achieve this interval, each second the computer would calculate if the next spin would be a "win" with a 1/120 probability. Players could place bets of 1, 10 or 25 cents on each trial, with payoffs equaling 10 times the amount bet. Credits were presented in cents, with an initial bankroll of \$20 (or 2,000 cents) presented on the screen at the start of play.

The experimenter was blind to condition, with the EGM program randomly assigning participants to either the white-noise or control conditions. In the white-noise condition, a 2-second 80 db(A) white noise event, as calibrated with a Radio Shack Sound-Level Meter, was programmed at fixed intervals of every 120 seconds for the fixed 5-minute duration of the gambling session. Both the white-noise and the control conditions had typical EGM noises associated with the spinning of the reels and winning bells. To avoid any overlap between the winning bells and the white-noise event, any random selected wins that were initially selected to occur within 3 seconds either side of the start of the white-

noise event were delayed until a minimum of 2 seconds after the termination of the white-noise.

Galvanic Skin Response (GSR) was recorded using a ProComp+ unit and Biograph Software for data processing. The unit was clipped to subjects using a finger sensor.

Design and Procedure. Participants were greeted in a waiting room for scheduled appointments, and were given \$20 as compensation for their arrival. Subjects first filled-out a basic demographics questionnaire and informed consent, and then were asked if they would be willing to gamble with their \$20 compensation. All 69 participants agreed to gamble with their \$20 payment. Participants were led from the waiting room into the experimental room containing the simulated EGM. Furthermore, participants were told that they would play the machine until told the experiment was over, and that they would keep any amount remaining on the machine. Participants were not initially told how long the task would last. Furthermore, they were informed that they "may" hear a loud noise during the course of the study, and that this was "normal". Immediately prior to the start of the gambling-task, the \$20 compensation was retrieved from the subject to reinforce their perception that they were gambling with their own money. The subjects were measured on Galvanic Skin Response (GSR) while playing the EGM for 5-minutes. A second questionnaire at the end of the 5-minute gambling session contained the 9-item scoreable portion of the Canadian Problem Gambling Index (CPGI, Ferris, J. & Wynne, H., 2001).

Results

Manipulation Check. To ensure that the startle-response of the white-noise event was sufficient to raise autonomic arousal, measurements of Galvanic Skin Response (GSR) were recorded for the entire 5-minute gambling session. As a manipulation check, two mean scores were computed for the time periods of: a) 60-120 sec (baseline), and b) 120-180 sec (post-event). In the white-noise condition, the first white-noise event takes place at 120 sec, or in-between the two aforementioned 1-minute time periods. Change in GSR arousal was calculated by subtracting the mean GSR of the 60-120 sec baseline period from the mean of the 120-180 sec post-event period. An independent samples t-test showed a highly significant difference in the mean GSR changes between the white-noise condition ($M = 0.26 \mu\text{m}$) and the control ($M = -0.15 \mu\text{m}$), $t(66) = 3.25$, $p < .01$. As predicted there was a significant positive change in GSR in the white-noise condition, but no positive change for the control.

Average Bet-Size. A 2x2x2 ANOVA was calculated with Average Bet-Size as the dependent variable and Noise-Condition, Gender and CPGI-Severity as independent variables. For the purposes of this calculation, CPGI gambling severity was dichotomized into two categories based on a median split: 1) No- and Low-risk Gambling Problems ($n = 31$), and 2) Moderate- and High-risk Gambling Problems ($n = 38$). As shown in *Figure 1*, this model revealed a significant interaction between Condition and CPGI-Severity, $F(1,61) = 5.36$, $p = .02$, $\eta^2 = .08$. Persons with more gambling problems had lower Average Bet-sizes in the white-noise condition compared to the control. In contrast, people

with few gambling problems had dramatically higher Average Bet-sizes under the white-noise condition. No other main effects or interactions proved significant, $p > .05$.

Figure 1. Average Bet-Size by Condition and Dichotomized CPGI Problem-Gambling Classification.

Average Final Payouts. A 2x2x2 ANOVA was calculated with Average Final Payouts as the dependent variable and Condition, Gender and CPGI-Severity as independent variables. No significant main effects or interaction were found, $p > .05$.

Speed of Betting. A 2x2x2 ANOVA was calculated with Time per Trial (sec) as the dependent variable and Noise-Condition, Gender and CPGI-Severity

as independent variables. As shown in *Figure 2*, there was a significant interaction between Condition and CPGI-Severity on the Speed of Betting (or Time per Trial). Persons with no or few gambling problems were dramatically slower in the pace of their betting under the white-noise condition compared to the control. In contrast, for people with moderate to severe gambling problems there was little difference in the speed of betting between the white-noise condition and the control. Figure 2 also shows a significant main-effect for Condition, $F(1,61) = 6.83$, $p = .01$, $\eta^2 = .07$. On average, betting was slower overall in the white-noise condition compared to the control. Lastly, Figure 2 shows a significant main effect for CPGI Severity, $F(1,61) = 9.31$, $p < .01$, $\eta^2 = .10$. On average, people who had more gambling problems were faster in their betting than those participants with few gambling problems.

Figure 2. Speed-of-Betting by Condition and Dichotomized CPGI Problem-Gambling Classification.

Finally, the model also revealed an interaction between Gender and Condition affecting the Speed of Betting, $F(1,61) = 4.67$, $p = .04$, $\eta^2 = .05$ (see Figure 3). When compared to the control, the white-noise condition slowed the speed of betting for male participants to a greater degree than females. No other main effects or interactions in the model proved significant, $p > .05$.

Figure 3. Speed-of-Betting by Condition and Gender.

For the preceding analyses, it is important to note that no functional relationship existed in the experiment between Bet-size and the Speed of betting (or Time-per-trial). The experimental session was limited to 5 minutes for each participant; and by design all participants ended the study with a positive bankroll remaining (min = \$3.25, max = \$30.34). Therefore, participants were not restricted by funds-available in either how much or how quickly they could bet. Likewise, no significant correlation was found between Bet-size and Speed of betting for participants with either a high or low number of gambling problems ($r(29) = -.03, p = .86$ and $r(36) = -.20, p = .23$, respectively).

Discussion

Our original hypothesis was that the white-noise condition, by heightening physiological arousal, would intensify gambling behavior compared to the control condition. Additionally, we expected that this intensification due to arousal would be more pronounced for persons with more gambling problems. However, the results provided a more complicated picture than the one depicted by these predictions.

The manipulation check using the GSR measurement revealed that the white-noise event was successful in raising the autonomic arousal of participants. The consequences of this arousal on behavior were starkly different between persons with either few or many gambling problems, as measured by the Canadian Problem Gambling Index (CPGI).

As predicted, the Average bet-size of persons with relatively few gambling problems was larger in response to the arousal by the white-noise compared with the control (see Figure 1). However, the reverse was true for participants with many gambling problems. People with moderate-risk or problem-gambling CPGI scores tended to have smaller-sized bets in the presence of white-noise induced arousal.

Related results were obtained by Sharpe (2004), who found that social gamblers become more aroused (as measured by GSR) in response to imagining situations in which they had won at gambling compared to imagining losses. In contrast, problem gamblers were equally aroused by imagining wins or losses. Sharpe's (2004) research provides a possible explanation for the current

findings. Our results suggest that gamblers with few problems may have associated their feelings of arousal exclusively with winning, and thus they made larger bets to take advantage of their presumed luck. In contrast, participants with more problems may associate arousal with losing, and thus made smaller bets accordingly.

Final payouts showed no significant main-effect differences between the white-noise and control conditions. The lack of significant differences; however, is consistent with the findings on average bet-size. Persons with few gambling problems raised their average wagers in response to the arousal, while participants with many gambling problems decreased their bet-sizes. The net result across both sets of subjects was no significant difference in final payouts between the two conditions. There were also no significant interactions in the model. The lack of results for final payouts; however, may be a consequence of the noisiness of the measure. Unsurprisingly, the ultimate performance of individuals in the game was highly dependent on chance.

The speed at which participants played the game was influenced by the Condition, Gender and CPGI severity. Rather than quickening the pace of gambling as predicted, the white-noise induced arousal generally slowed the speed of betting. This slow-down under arousal was most evident for people with few gambling problems (see Figure 2), and male participants (see Figure 3). In contrast, there was little arousal induced changes in speed of betting for either persons with many gambling problems (see Figure 2) or female participants (see Figure 3).

The findings in this study suggest arousal may serve as a cue to gamblers that convey different information to people with few versus many gambling problems. Gamblers with few problems associate arousal with the euphoria of winning, while gamblers with many problems are more likely to associate arousal with losing. The betting behavior of gamblers in this experiment is at least consistent with this explanation. Less clear; however, is the practical significance of the slower pace of gambling under conditions of arousal. This slow-down is most pronounced for males, and those with fewer gambling problems. It is possible that it takes more cognitive effort and time to decide to make large bets (a risk-taking activity), rather than to make small bets (a risk-mitigating activity). Another possible explanation is that people with fewer gambling problems put more cognitive effort into the choices about their behavior in general.

In summary, this study demonstrated that autonomic arousal has a strong influence on gambling behavior. The sample size was modest ($N = 69$) and thus the exploration of some potential effects, such as gender-differences for gambling-intensity, may have been hampered by the power of the study. It is also important to recognize that the white-noise event is only one of many possible methods for inducing arousal, and it is difficult to determine what meta-cognitive effects this manipulation may have had on players. However, this is the first study that links arousal directly to changes in gambling behavior, rather than showing arousal as simply the consequence of behavior. Exploring the possible existence of a reinforcing cycle of arousal and behavior will be an important topic for future study.

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