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Psychophysiological and Subjective Arousal during Gambling in Pathological and Non-Pathological Video Lottery Gamblers

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Abstract

Two groups of video lottery gamblers (pathological n = 30, and non-pathological n = 34) were compared while they participated in gambling and gambling related tasks using subjective ratings of excitement, electromyographic activity (EMG), skin conductance level (SCL), and heart rate (HR). Both groups experienced significant increases on all physiological measures from baseline to gambling task, and both groups experienced significant increases in EMG and SCL when thinking about personally relevant wins and increases in SCL and HR when thinking about personally relevant losses. Pathological gamblers reported greater subjective feelings of excitement than non-pathological gamblers when gambling, resting, and thinking about winning, however subjective reports of excitement were not correlated with physiological measures. Preference for stimulating situations did not differ between groups but was significantly negatively correlated with baseline levels of HR and EMG. It was concluded that the pathological and non-pathological gamblers might perceive their responses to gambling and gambling related situations differently since although the groups experienced similar levels of increased physiological response the pathological gamblers reported greater levels of subjective excitement.

Psychophysiological and Subjective Arousal during Gambling in Pathological and Non-Pathological Video Lottery Gamblers

The behaviours involved in gambling can vary widely among individuals, depending on the form of gambling they choose. There is a great deal of difference between playing poker and betting on the outcome of a football game. As Dickerson states, 'It has been argued that to assume the same psychological models will explain impaired control in all forms of gambling is not only naïve but runs the risk of not fully explaining the significant differences between different forms to develop a far richer and more informative vein of research' (1993, p. 243). While it has been argued that attempts to understand gambling behaviour that do not include consideration of biological, psychological, and sociological elements are inadequate (Griffiths and Delfabbro, 2002), it remains useful to critically examine elements of existing theories of gambling behaviour in relation to particular forms of gambling. Machine gambling, which includes the use of slot machines and video poker and video lottery terminals, is very popular and has become widely available in many countries and is, therefore, an area of particular interest.

The increased physiological arousal that results from the excitement of taking risks is a component of many explanations of gambling behaviour – the heart beats faster, muscles tense and palms grow damp. Brown has suggested 'some form of arousal or excitement is a major and possibly the major reinforcer of gambling behaviour for the regular gambler' (1986, p.1001). This study examined whether video lottery gamblers' measured levels of physiological arousal and their subjective reports of arousal in laboratory gambling and gambling related situations support two theoretical models of gambling behaviour: Jacobs' General Theory of Addictions (1986) and Sharpe and Tarrier's (1993) cognitive behavioural model of gambling problems.

Jacobs' General Theory of Addictions (1986) suggests that individuals who experience chronically hypo or hypertensive underlying states of physiological arousal and who have experienced deep feelings of inadequacy or rejection in childhood or adolescence are at highest risk of developing addictive behaviour, including gambling problems. Sharpe and Tarrier (1993) propose a mechanism through which various factors including classical and operant conditioning, cognitions, environment, and physiological arousal contribute to the development of problem gambling. They suggest that gambling behaviour is reinforced by financial rewards and increased autonomic arousal, e.g. increased skin conductance, heart rate and electrodermal activity, which the gambler interprets as excitement. Problem gamblers are proposed to differ from high frequency social gamblers in terms of the level of arousal experienced in response to stimuli associated with gambling activities (Sharpe, Tarrier, Schotte and Spence, 1995). They suggest that problem gambling behaviour may result when gamblers lack the coping skills to deal with the

elevated levels of autonomic arousal produced by gambling and gambling related stimuli.

Previous research on arousal in gambling has often been based on gamblers' self reports. A summary of previous self report studies (Griffiths, 1993, p.366) cited studies by Wray and Dickerson (1981) which found that 70% of Gamblers Anonymous members surveyed reported feeling very excited or tense during gambling; Dickerson and Adcock (1987) which found persistent video poker players significantly more excited than low frequency players; Dickerson, Hinchy and Fabre (1987) which found persistent off-course bettors reported being significantly more excited than less persistent bettors; and Griffiths, (1990, 1991) which found that among fruit machine players, pathological gamblers reported being significantly more excited than non-pathological gamblers during play. Gupta and Derevensky (1998) found that adolescent problem and pathological gamblers were more likely to report dissociative experiences when gambling than occasional adolescent gamblers, and that adolescent gamblers were more likely to prefer stimulating situations than non-gamblers. In addition, Diskin and Hodgins (1999; 2000) found that problem video lottery gamblers reported more dissociative experiences when gambling than occasional video lottery gamblers.

Studies of physiological response to machine gambling situations using measures of heart rate have reported inconsistent results. Leary and Dickerson (1985) and Dickerson (1993) found evidence of increased heart rate during video poker play in both regular and occasional players, with significantly greater increases for regular players. Coloumbe, Ladouceur, Desharnais and Jobin (1992) found increased heart rates in both regular and occasional video poker players during video poker play but did not find differences between the groups. Griffiths (1993) reported that the heart rates of regular and nonregular fruit machine players increased similarly from baseline during play, but that regular players' heart rates decreased immediately afterward, while nonregular players' heart rates did not. He argued this could indicate that regular gamblers develop tolerance to the arousal experienced when playing, which may result in longer playing periods or increased wagers in order to maintain arousal levels. Coventry and Constable (1999) measured heart rates in a group of 32 high and low frequency female fruit machine players in a natural gambling environment. Significant increases in heart rate during and after gambling were found only for participants who won during the recorded session.

Studies in which physiological responses have been measured in response to gambling related cues include Sharpe et al. (1995) and Blanchard, Wulfert, Freidenberg and Malta (2000). Sharpe et al. (1995) measured skin conductance (SCL), heart rate (HR), electromyographic activity (EMG) and subjective ratings of excitement in problem, high, and low frequency video poker players exposed to gambling related cues. When participants watched a videotape of video poker with and without distraction, problem players experienced significantly increased levels of SCL compared to low and high frequency players. Similarly, when watching a poker machine video and a horserace video, only problem gamblers experienced

significant increases in SCL. There was a significant interaction for ratings of excitement, with social gamblers reporting greater excitement when watching horse racing than problem gamblers. All participants experienced increased heart rates when talking about personally relevant wins compared to a neutral task (reciting the alphabet). While SCL levels increased for all participants when talking about winning, the problem gamblers experienced a greater increase than the high and low frequency gamblers. There was also a significant main effect for subjective ratings of excitement, with all participants reporting feeling more excited when talking about winning. Blanchard et al. (2000) measured heart rate, blood pressure and skin resistance in seven male problem gamblers and matched non-gambling controls while doing mental arithmetic, listening to personally meaningful fear audiotapes and listening to personally meaningful gambling audiotapes. The gamblers showed increased heart rate responses to the gambling audiotapes compared to the control participants.

The objective of the current study was to measure both subjective and physiological responses of video lottery gamblers to gambling and gambling related tasks. A community sample of current video lottery gamblers who were not attempting to quit gambling at the time of participation was recruited through newspaper advertisements. Three measures of arousal (heart rate [HR], skin conductance [SCL] and electromyographic activity [EMG]) were recorded while participants rested, gambled for money on a video lottery terminal (VLT) in a laboratory situation, thought about personally relevant VLT wins and losses and did a neutral (non-gambling) task. Participants were asked to rate feelings of excitement/tension while performing the experimental tasks.

Hypotheses

I. Based on Jacobs' General Theory of Addiction (1986), which holds that problem gamblers are either hyper aroused or hypo aroused, it was hypothesized that pathological and non-pathological gamblers' physiological states would differ when resting and when performing a non-gambling neutral task.

II. Based on Sharpe and Tarrier's cognitive behavioural model (1993), it was hypothesized that physiological arousal would increase in both groups when gambling on the VLT. It was hypothesized that pathological gamblers would experience higher levels of arousal than non-pathological gamblers.

III. Based on the Sharpe and et al. (1995) study, it was hypothesized that members of both groups would experience changes in levels of physiological arousal when thinking about personally relevant VLT wins, with pathological gamblers experiencing greater changes in physiological arousal than non-pathological gamblers.

IV. Based on the Sharpe et al. (1995) study, it was hypothesized that both groups would experience changes in levels of physiological arousal when thinking about personally relevant VLT losses, with pathological gamblers experiencing greater changes in physiological arousal than non-pathological gamblers.

Exploratory Issues

The data was analyzed to explore whether the groups differed on subjective reports of excitement during the various experimental tasks, and whether correlations could be found between subjective reports of excitement and physiological measures of excitement.

Comparisons were also made between pathological and non-pathological gamblers' preferences for more or less stimulating situations and their self reported feelings of dissociation during gambling. We also examined whether preference for stimulation was related to baseline measures of physiological arousal.

Method

Participants and recruitment

A community sample of active VLT players was recruited using newspaper advertisements. The advertisements offered people who were presently playing VLTs (and who were not attempting to quit) the opportunity to win from zero to fifty dollars while participating in a research study. A total of 66 participants were recruited over a period of six months. There were 37 male and 29 female volunteers over this period, ranging in age from 20 to 75. Two participants were dropped from the analysis – a female participant who was currently dependent on both alcohol and cocaine and who had an extremely high resting heart rate, and a male participant who was suffering from an untreated psychotic disorder. Since we wished our sample to be as representative as possible we did not employ further exclusionary criteria.

Instruments

Pathological gambling criteria questionnaire (Stinchfield, 2002) a 19-item questionnaire developed by Stinchfield and Winters which incorporates DSM-IV diagnostic criteria for pathological gambling disorder. A score of 5 or more criteria endorsed indicates a diagnosis of pathological gambling disorder.

South Oaks Gambling Screen (SOGS; Lesieur and Blume, 1987) - a 20- item self-report questionnaire used to screen normal and clinical populations for pathological gambling. A score of 5 or greater on the SOGS is indicative of probable pathological gambling.

Structured Clinical Interview for the DSM-IV (SCID-I/NP; First, Spitzer, Gibbon and Williams, 1997). The SCID is a structured interview that enquires about the frequency and intensity of symptoms and provides a diagnosis. The Psychoactive Substance Use module, the Current Major Depressive Episode and Past Major Depressive Episode modules, and the Current Manic Episode and Past Manic Episode modules were used.

Brief Symptom Inventory (BSI; Derogatis and Melisaratos, 1983) - a 56-item self-report instrument that addresses psychiatric symptoms that may have been experienced in the preceding seven days. Scores obtained on the Global Severity Index (GSI), which is an indicator of an individual's general level of distress and on the Anxiety subscale were analyzed for the purposes of this study.

Dissociative Questionnaire, (Jacobs, 1986) The original questionnaire included four questions designed to access common dissociative feelings among addicts. An additional question regarding losing track of time when gambling was added and based on previous studies (Diskin and Hodgins, 1999; Gupta and Derevensky, 1998;Wynne Resources, 1998) the questions were modified to reflect feelings during video lottery play. Questions were scored from 0 for 'never' to 4 for 'all the time'. For this study Cronbach's alpha across the five questions was .78.

Arousal Scale (Gupta and Derevensky, 1998). Four forced choice questions suggested by Jacobs that require the participant to state a preference for more or less stimulating activities. Answers are scored 1 for the less stimulating activity and 2 for the more stimulating activity. Cronbach's alpha across the four questions was .69 for this study.

Perception of excitement self-report checklist - measured subjective feelings of excitement with a list of each of the experimental tasks using a scale from 0-10 to indicate the level of perceived excitement/tension experienced by the participant.

Physiological Measurements

Heart rate (HR) was measured with a photoplethysmographic sensor using an LED photodetector with a light source and light sensor placed on the pad of the index finger of the non-dominant hand.

Skin conductance level (SCL) was measured using self-adhesive 1cm silver silver chloride electrodes placed on the thenar and hypothenar eminences of the palm.

Electromyographic activity (EMG) was measured using 3 silver silver chloride electrodes attached to the forehead approximately 1 inch above the eyebrows, with the ground electrode in the centre of the forehead.

Apparatus

1) Video lottery terminal (model VLC) set in demonstration mode. The machine was supplied by the Alberta Gaming and Lotteries Commission and is identical to those in use in the province. Credits were entered using the touch screen rather than by inserting money into the terminal.
2) Procomp+ biofeedback system with heart rate/blood volume sensor, EMG sensors and skin conductance sensors, using a Biograph software data recording and analysis

program with an IBM 1.66 Pentium PC.

Procedure

Interviews and gambling tasks took place in the same room. A curtain concealed the video lottery terminal during the interviews and the initial baseline period.

(i) After informed consent had been obtained, participants answered the demographic questions, and were administered the SCID modules, the DSM-IV based gambling screen, the SOGS, a semi structured interview on gambling behaviour, the BSI, and questionnaires on dissociative feelings while gambling and preference for stimulation.

(ii) Physiological sensors were attached as described above, the lights in the room were dimmed, and participants were asked to rest quietly. The first baseline measurement was taken for a period of 3 minutes during which participants were asked to close their eyes and visualize a relaxing situation. (The same instructions were given for all subsequent baseline periods).

(iii) Participants were then moved to the VLT. They were reminded that a $25.00 credit had been entered and were asked to play their choice of VLT game for a minimum 4-minute period. They were told they could stop playing any time after 4 minutes until a maximum time of 10 minutes had passed and that any credits remaining at the end of play would be reimbursed to a maximum value of $50.00.

(iv) After the gambling session they were asked to relax again for a 3-minute baseline period.

(v) After the baseline, half the participants were asked to spend two minutes visualizing the personally relevant win they had described in the semi-structured interview. They were then asked to relax again for another baseline reading. The other participants were asked to visualize the personally relevant loss they had described earlier and then to relax for a baseline reading.

(vi) A non-gambling neutral task was then performed in which participants wrote the alphabet on a whiteboard for a period of 2 minutes, followed by a 2-minute baseline relaxation period.

(vii) After the baseline, those participants who had been asked to visualize a personally relevant winning situation were asked to spend two minutes visualizing the personally relevant VLT loss they had described earlier, while those who had been asked to think of a loss were asked to think of the personally relevant win they had described earlier.

(viii) A baseline relaxation period of 2 minutes followed.

(ix) Sensors were removed and participants completed an excitement/tension questionnaire, were debriefed and reimbursed. Information about available treatment was given if requested.

Results

Participants

Participants (N = 64) were classified into groups based on the number of DSM-IV diagnostic criteria for pathological gambling disorder met. The Pathological Gambling group (PG) n = 30 endorsed 5 or more DSM-IV criteria (M = 7). The Non-pathological group (NPG) endorsed 4 or fewer criteria (M = 1). The groups did not differ on mean age or gender. The mean age of the PG group was 42, while the mean age of the NPG group was 40. There were 19 male and 15 female participants in the NPG group and 17 male and 13 female participants in the PG group.

The groups differed significantly on both measures of problem gambling (SOGS and DSM), anxiety, overall distress, frequency of play and number of cigarettes smoked daily. Results are displayed in Table 1.

Table 2 displays the distribution of SCID-based psychiatric and substance abuse disorders for the groups. The groups differed in past alcohol dependence, with the PG group having a significantly greater number of occurrences than the NPG group. Several of the participants reported being treated for schizophrenia and schizoaffective disorders. An analysis of the data was done with these participants removed (N = 58). No differences were found in the results; therefore the participants were retained in the final analysis.

Data Analysis

Given the exploratory nature of the study, the error rate for each hypothesis was set at .10 (Cohen, 1992). Separate 2 x 2 analyses of variance were conducted for each of the three physiological measures (EMG, SCL, and heart rate) with one between subjects factor (Group) and one repeated measure (Times 1 and 2). Since three indices of physiological arousal were examined for each hypothesis, a Bonferroni adjustment was used. The alpha level related to each physiological measure was set at .10/3 = .033 for each hypothesis, so that the total error rate for each hypothesis was maintained at .10.

Hypothesis I

The first hypothesis, that levels of physiological arousal for the PG and NPG groups would differ at rest (baseline) and during a non gambling neutral task, was not supported.

Mean EMG, SCL and HR readings were compared using independent t-tests for the first 30 seconds of the first baseline, the entire first baseline period (3 minutes), the first 30 seconds of the neutral task, and the entire neutral task period (2 minutes). No significant between group differences were found. It was noted that the pathological gamblers' heart rates were consistently non-significantly higher than the non-pathological gamblers' heart rates across these tasks.

Hypothesis II

The second hypothesis stated that all participants would experience increased levels of physiological arousal when gambling, with pathological gamblers experiencing greater levels of arousal than non-pathological gamblers.

The hypothesis received partial support. All participants experienced increased levels of arousal when gambling. Separate univariate repeated measures analyses of variance were performed for each physiological parameter. A significant effect for Task was found for each of the physiological parameters – that is HR, SCL, and EMG increased significantly from the last 30 seconds of the preceding baseline to the first 30 seconds of the gambling task. Significant results were also found when the last 30 seconds of the preceding baseline were compared with the gambling session at 90-120 seconds. (Means and F values are displayed in Table 3). No significant Group x Task interactions were found at an alpha level of .033 – pathological gamblers' levels of arousal during the first 2 minutes of the gambling task did not differ significantly from non-pathological gamblers. The Group by Task interaction for heart rate, F (1,62) = 4.56, p < .036, approached significance in the first 30 second period. This result was not found at 90-120 seconds.

Hypothesis III

The third hypothesis stated that all participants would experience changes in arousal when thinking about personally relevant wins with pathological gamblers experiencing greater changes in arousal.

Both groups of participants experienced significant increases in SCL and EMG when thinking about personally relevant wins. Separate univariate repeated measures analyses of variance were performed for each physiological parameter using the last 30 seconds of the preceding baseline and the first 30 seconds of the thinking about winning task. Results are displayed in Table 4. Task order and number of credits won in the preceding gambling session were not found to significantly affect the analysis. A significant main effect of Task was found for EMG, F (1,60) = 11.35, p <. 001 and for SCL, F (1,60) = 5.18, p. = .029, when participants were asked to think about personally relevant VLT wins. However, no significant Group x Task interactions were found, that is, there were no significant between group differences when participants were asked to think about personally relevant wins.

Hypothesis IV

The fourth hypothesis stated that all participants would experience changes in arousal when thinking about personally relevant losses with pathological gamblers experiencing greater changes in arousal.

Both groups of participants experienced significant increases in SCL and HR when thinking about personally relevant losses. Separate univariate repeated measures analyses of variance were performed for each physiological parameter, using the last 30 seconds of the preceding baseline and the first 30 seconds of the thinking about

losing task. Task order and number of credits won in the gambling session were not found to significantly affect the analysis. Significant increases in SCL, F (1,60) = 4.95, p <.033 and HR, F (1,60) = 5.69, p < .033, were found when participants were asked to think about personally relevant losses. Results are displayed in Table 4. No significant Group by task interactions were found - there was no significant between group differences when participants were asked to think about personally relevant losses.

Subjective ratings of excitement and physiological measures

Group differences were found on several questions from the Perception of Excitement checklist. Pathological gamblers reported higher levels of excitement than non-pathological gamblers on all questions, with significantly higher levels of reported excitement/tension when resting (baseline), t (60) = 2.88, p= .005, when playing the VLT, t (61) = 2.73, p < .01, and when thinking about winning, t (61) = 2.85, p < .01. No correlations were found between self-reported perceptions of excitement and physiological measurements for the relevant periods. Correlations are displayed in Table 5. Self reported excitement scores for baselines were not statistically significantly correlated with EMG, SCL or HR for any of the baseline scores. Excitement scores for playing the VLT were not correlated with physiological measures during the VLT session, and excitement scores for thinking about winning were not correlated with physiological measures when thinking about winning.

Dissociative questions, preference for stimulation

Pathological gamblers reported higher levels of dissociative-like experiences when gambling. The mean overall score for the PG group on the dissociative questions was 7.97(SD = 3.6) while the mean score for the NPG group was 3.18 (SD = 2.2), t (62) = 6.48, p <. 001. As well, scores for each of the individual dissociative questions were significantly higher for the PGs than the NPGs.

No difference in preference for stimulation (Arousal scale scores) was found between the groups. The mean for the PG group was 6.51(SD =1.4) and the mean for the NPG group was 6.81(SD = 1.3), t (59) = .851, p = .398.

Pearson correlations (N =61) were examined between total Arousal scores and physiological measures of arousal. A greater preference for stimulation (reflected in higher Arousal scores) was correlated with lower baseline heart rate scores and some lower baseline EMG readings. Arousal scores were negatively correlated with heart rate at the first 30 seconds of all baselines (baseline 1 r = -0.35, p <. 05; baseline 2 r = -0.31, p < .05; baseline 3 r = -0.30, p < .05; baseline 4 r = -0.282, p < .05; baseline 5 r = -0.35, p < .005; baseline 6 r = -0.306, p < .019). Arousal scores were negatively correlated with baseline EMG for baseline 3 r = -0.37, p < .05, and baseline 5 r = -0.36, p < .05.

Discussion

Both pathological and non-pathological gamblers experienced increases in physiological arousal when thinking about significant personal wins and losses. Visualizing personally relevant VLT wins or losses resulted in increased physiological arousal while participants were sitting quietly with their eyes shut in a darkened room. This finding would appear to support the suggestion that gambling related cognitions can produce physiological arousal in the absence of gambling.

All the gamblers in the study experienced similar levels of physiological arousal during the various experimental conditions. The pathological gamblers in this study did, however, display a non-significantly higher mean heart rate in all situations, similar to that found by Sharpe et al. (1995). This may be due to lifestyle issues, since the pathological gamblers reported smoking more heavily than the non-pathological gamblers. It is also possible that the higher mean heart rate may be due to the higher levels of distress reported by the pathological gamblers, or to the greater feelings of anxiety reported by this group.

Pathological gamblers reported feeling higher levels of excitement than non-pathological gamblers when performing the same activities. They reported feeling more excited when resting, when thinking about winning and when playing the VLT. Self reported levels of excitement were not correlated with increased levels on the physiological parameters measured. These higher levels of perceived excitement suggest that the pathological gamblers may have experienced the gambling related experimental condition differently than the non-pathological gamblers. The pathological gamblers in the study also reported more dissociative experiences than the non-pathological gamblers when VLT gambling. They were more likely to report trance-like feelings, feelings of taking on another identity when gambling, and ‘losing track of time’ when gambling. These results are similar to those found in other studies (Gupta and Derevensky, 1998; Diskin and Hodgins, 1999, 2000). It would appear from these responses that the pathological gamblers in the sample perceive the VLT gambling experience differently as compared to the non-pathological gamblers.

Sharpe and Tarrier (1993) have suggested that lack of coping skills in dealing with increased arousal resulting from gambling related cues or cognitions might lead to problem gambling. It may be that problem gamblers are more sensitive to increases in physiological arousal than non-pathological gamblers. This greater sensitivity to changes in their physiological state could explain differences in how pathological gamblers perceive the gambling experience. However, the pathological gamblers in this sample also reported being more excited/tense than the non-pathological gamblers when they were resting. It may be that for the pathological gamblers, simply being in a gambling related situation produced feelings of excitement/tension that were not related to physiological arousal.

Preference for stimulation (arousal scores) did not differ between the problem and non-problem gambling groups. However, higher preference for stimulating situations was significantly negatively correlated with baseline heart rate for all six baseline measurements and was also negatively correlated with baseline EMG levels at two baselines. This is an interesting result because it may provide empirical support for the suggestion that some people who have lower baseline levels of arousal (hypo aroused unipolar resting states, Jacobs, 1988) prefer stimulating situations. This finding does not support the contention that lower baseline levels of arousal are associated with gambling problems. It could be argued that the gamblers in this sample who had lower baseline heart rates and lower EMG levels did not have the negative childhood experiences which the General Theory of Addiction would suggest are also necessary for the development of gambling problems. Unfortunately, no information about the participants' early experiences or feelings of inadequacy or rejection was gathered in this study. It should be noted, as well, that the preference for stimulation scale is brief and not well validated.

Limitations of the study and suggestions for future research

A $25.00 credit was piloted when the study was being designed, and appeared to be sufficient to allow participants to gamble for at least 4 minutes. In practice this was not always the case and several gamblers used up their credits before 4 minutes had passed, allowing analyses to be performed for only the first 2 minutes of the gambling situation. Between group comparisons were made for this limited time period so the results of the present study relate only to the beginning of the gambling session. Significant differences in physiological arousal between pathological and non-pathological gamblers may have become apparent if a longer time period had been used.

Since the study took place in a laboratory situation, other cues that could have affected levels of arousal, such as the presence of other gamblers, the ambiance of the gambling situation, and access to alcohol and tobacco were not included. It is difficult to speculate on the effect of these cues – if they increase the familiarity of the situation they may serve to decrease physiological responsiveness and feelings of excitement for some individuals, or they may act to increase these responses. This study is currently being replicated. Physiological and subjective responses to gambling are being measured both in a casino/lounge situation with gamblers who are staking their own money and in a laboratory situation.

The physiological measures used were more extensive than those used in other studies of machine gambling and were able to detect increased levels of physiological arousal in the experimental tasks. However, it is possible that the instruments used were not sensitive enough to measure subtle differences between the responses of pathological and non-pathological gamblers.

The findings from this study suggest that pathological and non-pathological gamblers have similar levels of physiological arousal when they initiate a gambling

session. A logical next step would be to ask gamblers to play for an extended period of time. Many problem gamblers report VLT sessions lasting 6-8 hours (Smoliak, 1997). Given the resources required, it would not be possible to use a large sample of gamblers, but it would be useful to undertake detailed study of a few extended gambling sessions, particularly in a natural environment.

In order to explore the possibility that pathological and non-pathological gamblers perceive the gambling experience differently, a study could be developed incorporating a 'thinking aloud' component similar to that used by Coulombe et al. (1992). Instead of concentrating on erroneous cognitions, however, participants could be asked to describe their feelings of excitement and/or dissociation while asked to think about relevant gambling situations and when gambling in vivo.

Conclusions

The most interesting results of the study involve the similarities between the pathological and non-pathological gamblers' physiological responses. Both groups experienced increases in measured levels of physiological arousal when gambling and when thinking about personally relevant wins and losses. This similarity did not extend to self-reported feelings of excitement/tension when resting, gambling, and thinking about winning, where pathological gamblers reported more subjective feelings of excitement than non-pathological gamblers.

These differing self reports offer some support for Sharpe and Tarrier's (1993) suggestion that problem gamblers lack suitable coping mechanisms to deal with the increased physiological arousal they experience when gambling (and therefore experience greater subjective feelings of excitement/tension in gambling related situations). These results also support the suggestion that all gamblers exposed to gambling related cues (in this case thoughts of personally relevant wins and losses) experience increased physiological arousal.

The study may also offer some support for Jacobs' (1986) General Theory of Addictions, since it appeared that gamblers in the study who preferred more stimulating situations had lower baseline levels of arousal. This preference for more stimulating situations was not, however, associated with problem gambling behaviour, perhaps because the other requirements of the General Theory were not met.

Exploring how various theoretical understandings of problem gambling apply to different types of gambling behaviour may be helpful in the development of more inclusive theories of gambling. Machine gambling is only one of many forms of gambling that warrant further research in order to develop a clearer understanding of problem gambling behaviour.

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Table 1
Group Means for Pathological and Non-pathological Gamblers

	Non-Pathological		Pathological		t (62)	p
	Mean	S.D.	Mean	S.D.		
Age	40.03	14.2	41.93	10.4	.601	.547
DSM criteria	1.00	1.07	7.37	1.5	19.35	< .001
SOGS score	2.76	2.2	9.77	3.4	9.97	< .001
Gambling frequency/year	53.85	50.5	117.1	59.1	4.62	< .001
Anxiety	.4	.5	1.09	.81	3.84	< .001
GSI	.39	.36	1.04	.62	5.14	< .001
Cigarettes daily	11	12	24	12	4.32	< .001

Note. SOGS = South Oaks Gambling Screen score; GSI = Global Severity Index of the Brief Symptom Inventory.

Table 2
Number of Pathological and Non-Pathological Gamblers who received DSM-IV Diagnoses

	Non-pathological (n =34)	Pathological (n = 30)	$\chi^2(1)$	Fishers exact 2 sided
Current MDE[a]	3	6	1.647	.285
Past MDE	10	13	1.342	.301
Current alcohol abuse	2	1	.232	1.00
Past alcohol abuse	1	4	2.39	.177
Current alcohol dependence	1	1	.008	.928
Past alcohol dependence	4	11	5.508	.036
Current substance abuse	1	1	.008	1.00
Past substance abuse	3	4	.333	.697
Current substance dependence	2	3	.375	.540
Schizoaffective disorder	1	1	.000	1.00
Schizophrenia	2	2	.000	1.00

Note. [a]MDE = Major Depressive Episode

Table 3
ANOVAs for Preceding Baseline and Gambling Task

	Non-pathological				Pathological				F (1,62)	p
	Baseline		VLT start		Baseline		VLT start			
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.		
EMG	9.0	4.5	13.66	6.0	10.6	6.5	15.76	10.3	24.8	<.001*
SCL	9.95	6.9	13.89	6.5	10.71	6.3	14.47	6.3	102.8	<.001*
HR	73.06	12.0	77.55	12.4	77.95	10.5	79.79	10.3	26.15	<.001*
	Baseline		VLT 1.5-2 min		Baseline		VLT 1.5-2 min			
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.		
EMG	9.0	4.5	12.05	5.3	10.6	6.5	14.37	7.3	17.2	<.001*
SCL	9.95	6.9	13.67	6.2	10.71	6.3	13.94	6.1	93.0	<.001*
HR	73.06	12.0	76.91	12.7	77.95	10.5	81.34	11.5	37.2	<.001*

* significant at adjusted alpha p<=.033
Note: ANOVAs = analyses of variance; EMG = electromyographic activity; SCL= skin conductance level; HR = heart rate, VLT = video lottery terminal.

Table 4
ANOVAs for Preceding Baselines and 'Think Win' and 'Think Lose' Tasks

	Non-pathological				Pathological				F (1,60)	p
	Baseline		Think win		Baseline		Think win			
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.		
EMG	7.45	2.6	8.19	2.8	7.70	3.4	9.21	4.8	11.35	.001*
SCL	12.69	6.3	12.88	6.7	12.64	6.0	13.27	6.0	5.18	.029*
HR	73.70	12.3	77.39	11.5	74.86	11.3	76.87	10.47	.380	.540
	Baseline		Think lose		Baseline		Think lose			
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.		
EMG	7.43	2.6	7.95	2.9	7.73	3.2	9.65	6.8	4.316	.042
SCL	12.12	5.9	12.73	6.4	12.73	6.1	12.96	6.1	4.948	.030*
HR	72.00	12.0	73.65	11.6	77.07	11.8	77.77	11.3	5.692	.020*

*significant at adjusted alpha $p<=.033$

Note: ANOVAs = analyses of variance; EMG = electromyographic activity; SCL = skin conductance level; HR = heart rate

Table 5
Pearson Correlations between Self-Reported Excitement and Relevant Variables

When I was…I felt….excited/tense	Resting	Thinking about wins	Thinking about losing	Doing neutral task	Playing the VLT
DSM criteria endorsed	.34**	.35**	.16	.20	.32*
Global Severity Index (BSI)	.38**	.35**	.04	.18	.22
ANX (anxiety subscale score BSI)	.32*	.26*	.10	.06	.15
Self identification as problem gambler	.36**	.19	-.03	.11	.25*
Arousal score	-.18	.01	.08	.09	-.05
Baseline EMG (last 30 s)	.12				
Baseline SCL (last 30 s)	.002				
Baseline HR (last 30 s)	.11				
Think win – preceding baseline EMG		.11			
Think win – preceding baseline SCL		.02			
Think win- preceding baseline HR		.09			
Think lose – preceding baseline EMG			-.04		
Think lose- preceding baseline SCL			.04		
Think lose-preceding baseline HR			.05		
Neutral task – preceding baseline EMG				-.02	
Neutral task – preceding baseline SCL				-.02	
Neutral task – preceding baseline HR				.002	
VLT start – neutral task EMG					.20
VLT start – neutral task SCL					.12
VLT start – neutral task HR					.23

Note. DSM = number of DSM-IV criteria endorsed; GSI = Global Severity Index Score on the Brief Symptom Inventory (BSI); ANX. = Score on the Anxiety subscale of the BSI; Self ID = Affirmative answer to SOGS question 20 “Do you feel you have a problem with betting money or gambling?”; Arousal = total score on Arousal questions; SCL= skin conductance level; EMG= electromyographic activity, HR= heart rate; Base 1 = mean for last 30 seconds of first baseline period,;TW-base = mean of first 30 seconds of thinking about winning minus mean of last 30 seconds of preceding baseline; TL-base = mean of first 30 seconds of thinking about winning minus mean of last 30 seconds of preceding baseline; NT-base = mean of first 30 seconds of neutral task minus mean of last 30 seconds of preceding baseline; VLTS-NTS = mean of first 30 seconds of VLT play minus mean of first 30 seconds of neutral task

*p <.05. **p<.01