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RESEARCH REPORT

Gender differences, physiological arousal and the role of winning in fruit machine gamblers

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Abstract

Aims. *To examine gender differences in changes in physiological arousal as indexed by heart rate during fruit machine gambling while controlling for the confounding effect of movement and as a function of winning and losing, and to examine relationships between sensation-seeking, self-reported arousal during gambling, heart rate during gambling and loss of control of gambling behaviour.* **Sample, design and measurements.** *Heart rate and subjective arousal were recorded in a sample of 22 male and 20 female fruit machine players before, during and after the gambling process. At baseline measures were taken of sensation seeking, self-reported arousal during gambling and loss of control of gambling. A simulation of the behaviour used to operate fruit machines was used during baseline measurement.* **Findings.** *Significant increases in heart-rate over movement controlled baselines were observed within participants during gambling. However, for the losing group these differences were slight compared to the increases found when participants won during play. Furthermore, winning/losing was the only variable among a range of variables which was a significant predictor of heart-rate increase during play over a baseline control. Additionally HR levels of males and females behaved the same way in relation to the manipulations. Significant correlations between HR during play and the measures of both subjective arousal and sensation seeking were also present.* **Conclusions.** *Winning during gambling is essential in order to maintain increased HR levels over baseline after play. Subjective arousal and sensation seeking may be predictors of levels of arousal experienced during play.*

Introduction

The role of arousal as an explanation for gambling at both normal and problematic levels has received much attention, both theoretically and empirically, in the gambling literature. It has been established that increased levels of autonomic arousal (usually measured using heart-rate) are in evidence during play across a range of gambling forms including blackjack (Anderson & Brown, 1984), off-course horse racing (Coventry & Norman, 1997) and fruit machine play (Leary & Dickerson, 1985; Dickerson & Adcock, 1987; Griffiths, 1993a; Coventry & Constable, 1999). For example, in one of the first studies in this area Anderson & Brown (1984) found heart-rate (HR) increases of up to 58 beats per minute during blackjack play measured in the casino.

While significant increases in arousal during play are clearly present during gambling across a

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range of forms, the focus of research to date has been to compare the arousal levels experienced by gamblers at different levels of play. While these studies fail to show any meaningful differences between high and low frequency players in the levels of arousal experienced (see Coventry & Norman, 1997 for a review), there are other features of play which merit closer attention in relation to arousal levels experienced. The role of winning during play has recently received some attention in relation to arousal levels experienced. Coventry & Norman (1997) found that, in a sample of horse racing off-course bettors, gamblers who bet on horses that won had significantly higher HR levels in the last 30 seconds of a race than those who backed horses that lost the race. It should be noted, however, that the arousal levels for the gamblers who bet on horses that lost were none the less elevated over baseline controls during play. Therefore gambling for male gamblers in this study is arousing, even when their horses do not win.

In contrast, Coventry & Constable (1999) examined the HR levels of female gamblers during fruit machine play. Their study was motivated partly by a lack of examination of gender differences in arousal during gambling specifically, and a lack of research in gender differences in gambling generally (despite the fact that around one third of gamblers are female; Sommers, 1988; Volberg & Steadman, 1988). Indeed, Coventry & Constable found, in contrast to the findings of Coventry & Norman (1997), that heart rate levels in female fruit machine players increased during play over baseline controls *only* when the gambler experienced a win during play. Additionally, they found that gamblers who won had increased levels of arousal not only during play, but after play. They argue that this might suggest gender differences in arousal contrasting their findings with those of Coventry & Norman (1997). Indeed, Bruce & Johnson (1994) found that women are more likely to place low-risk bets than men in off-course betting offices, suggesting that there may be a relationship between arousal levels and levels of risk-taking behaviour. Further support for this link comes from the sensation seeking literature where women generally score lower than men.

A limitation of the Coventry & Constable study is that they did not compare men *and* women gambling in the same situation. Their gender differences argument rests on comparisons between their results and those found with men in different studies, and on other gambling forms. For this reason the present study aimed to compare arousal levels in men and women directly during fruit machine play when winning versus losing, while controlling carefully for possible confounding effects of movement during baseline measures missing in some earlier studies (see Coventry & Norman, 1997 for a review). In addition, given the view that gender differences in risk taking may be related to arousal levels, the study also examined sensation seeking and subjective arousal during play in order to assess possible gender differences on these dimensions.

Method

Participants

Sixty participants were approached inside a single amusement arcade in England to take part in the study, and 42 participants (70%) agreed to take part and completed the data collection. Twenty-two of these participants were male (mean age = 25 years, SD = 5.16, range 19–35) and twenty were female (mean age = 28 years, SD = 5.07, range 20–37).

Materials

A small ambulatory monitor (Cateye Heartbeat Counter PL-6000) was used to record HR at regular 5-second intervals before, during and after the gambling process. The monitor provided a beat-to-beat display recorded with the use of a photo-plethysmograph clipped to the participant's earlobe. Artefactual readings were indicated by a red error signal displayed by the monitor, and by a buzzer alerting the experimenter of this (quiet enough to be out of range of the gambler). These were calculated as those outside the upper and lower HR limits (usually the result of sudden movement or changes in light).

In addition to HR recordings, participants were given a questionnaire to complete consisting of:

(a) Questions concerning the frequency of gambling behaviour, the number of gambling forms participated in and the level of cash involvement in gambling as used previously by Coventry & Constable (1999).
(b) Questions relating to loss of control as used

previously (Dickerson, 1977, 1979, 1984; Dickerson et al., 1987; Kuley & Jacobs, 1987; Lesieur & Blume, 1987; Coventry & Norman, 1997, 1998; Coventry & Constable, 1999; DSM-IV, American Psychiatric Association, 1994). These questions were forced choice questions (with answers of yes/no), and consisted of the following items:

(i) Do you ever gamble longer than intended?
(ii) After losing money gambling, do you often return another day in order to get even?
(iii) Do you think you have a problem controlling your level of gambling?
(iv) Do you need to gamble with more and more money to achieve the desired excitement?
(v) Have you previously tried to stop gambling?
(vi) Have you ever become restless or irritable when attempting to cut down or stop gambling?
(vii) Have you ever denied losing money through gambling?
(viii) Do you gamble in order to escape from everyday life?
(ix) Do you relive past gambling experiences?
(x) Do you plan the next gambling venture?

(c) A question on chasing: "When you are behind or losing, how often do you attempt to chase your losses? In other words, how often do you start placing more bets, or larger bets once you've had a few losses? (*never, occasionally, usually or nearly always*).
(d) A four-item subscale from the State portion of the Speilberger State–Trait Anxiety Questionnaire (Speilberger, Gorsuch & Lushene, 1979) as used previously by Coventry & Brown (1993), Coventry & Constable (1999) and Dickerson and colleagues (Leary & Dickerson, 1985; Dickerson & Adcock, 1987; Dickerson, Hinchy & Fabre, 1987). This scale was used as a measure of subjective arousal, and has been found to correlate with other measures of subjective arousal during gambling (Coventry & Brown, 1993). Participants were asked to: "Imagine a situation where you are waiting for the wheels of a fruit machine to stop ... Please read each statement below and indicate how you usually feel when waiting for the wheels of the fruit machine to stop." The items used were *calm, tense, at ease*, and *over-excited.*
(e) The Sensation Seeking Scale (SSS) Form V (Zuckerman, 1979). This is a 40-item forced-choice questionnaire comprising of four subscales of 10 questions. These are the thrill and adventure-seeking scale, the disinhibition scale, the experience-seeking scale and the boredom susceptibility scale.

Procedure

Permission from the amusement arcade proprietors was received, and co-operation of the staff was secured prior to running the study. To ensure that a variety of customers were sampled, times of the day and days of the week were chosen systematically. Additionally the experimenter frequented the arcade for a few days prior to commencing the study to further heighten unobtrusiveness. Participants were never approached during play. Each participant was asked if he/she would mind having his/her HR monitored while playing the fruit machine. If participants agreed, the session began. All participants, provided they made no objection, were asked to gamble on a fruit machine chosen by the experimenter (a machine called "Red Alert", which had a 78% pay-out rate). Participants were required to use their own money and were instructed to behave as they normally would during the session. They were also instructed to refrain from smoking and drinking alcohol before and during recording. In addition, the experimenter was careful to select participants as far as possible who had not been smoking, drinking or playing immediately before being asked to participate. A baseline heart-rate for each participant was obtained (out of sight of the machine). The baseline involved monitoring HR for a period of 30 seconds while each participant pressed a button on a calculator (thus controlling for movement), as used previously by Coventry and colleagues (1997, 1999). This method was chosen to simulate motor activity during fruit machine play as closely as possible. The gambling session started when instructed after the baseline. The experimenter recorded HR readings at 5-second intervals during the gambling session, and the session itself lasted for 3 minutes. The experimenter stood a few feet behind the participant throughout the session, and no communi-

cation was made between experimenter and participant during the session. The fixed session time of 3 minutes was set so that HR levels were measured for the same period for every participant. Within this fixed session length the number of trials played by participants could, in theory vary, but given the regular spin rate of the machine it was expected that all participants would play around the same number of trials. The start of a trial was defined as the point when the button was pressed and the end of a trial as the point when the wheels came to rest, indicating a winning or losing line. Winning was operationally defined as the case when the wheels came to rest on a winning line. Other information such as amount of win was also noted. One minute after playing each participant's HR was recorded for a further 30 seconds at 5-second intervals. The questionnaire was then given out for completion while each participant was still in the presence of the experimenter.

Results

Overall 48% of participants ($N = 20$) stated that they played on fruit machines at least once a week. Of these, 26% ($N = 11$) were male and 21% were female ($N = 9$). Thirty-one per cent ($N = 13$) reported chasing (seven males and six females) and 7% ($N = 3$) admitted to having a problem controlling their level of gambling. Sixty-nine per cent ($N = 29$) reported gambling more than intended and 7% ($N = 3$) admitted to trying to stop unsuccessfully in the past. Overall the mean score (out of a possible 10) for the loss of control questions was 2.43 (SD = 2.10). Twenty-one per cent of participants ($N = 9$) scored over five or more on the loss of control questions, which is broadly equivalent to the score needed to be classified as a problem gambler on the SOGS and the DSM-IV. All those scoring over five on the loss of control questions reported playing fruit machines more than once a week (and indeed loss of control and frequency were highly correlated; $r = 0.65$, $p < 0.01$). The number of gambling forms participated in ranged from a single form to eight forms.

All 42 participants completed the State portion of the State–Trait Anxiety Questionnaire. The mean score was 9.10 (SD = 2.99, range 4–16). All participants also completed the Zuckerman Sensation Seeking Scale. The mean total score was 18.76 (SD = 8.08, range 1–33). The mean subscale scores were 5.98 for TAS (SD = 3.21, range = 0–10), 4.19 for ES (SD = 1.80, range 0–7), 5.19 for Dis (SD = 2.32, range = 0–8) and 3.55 for BS (SD = 2.93, range = 0–9).

t-tests were used to compare the scores of males and females on the SSS and subscales, the STAI, measures of loss of control and chasing, and the age of the samples. Means and standard deviations for the main measures by gender are displayed in Table 1.

The only significant gender differences found were for the number of forms participated in

Table 1. *Means (and standard deviations) by gender for the main measures*

Measure	Men	Women	Results of analyses comparing men and women
No. of forms participated in	3.95 (2.28)	2.75 (0.97)	$t(40) = 2.19$, $p < 0.05$
SSS total score	20.18 (7.16)	17.25 (8.93)	NS
TAS score	6.68 (3.23)	5.20 (3.09)	NS
ES score	4.82 (1.56)	3.50 (1.82)	$t(40) = 2.52$, $p < 0.05$
Dis score	5.32 (1.86)	5.05 (2.78)	NS
BS score	3.5 (2.79)	3.6 (3.15)	NS
Loss of control	2.32 (1.86)	2.55 (2.37)	NS
Chasing	2.09 (0.97)	2.00 (0.79)	NS
STAI	8.55 (2.79)	9.5 (2.86)	NS
HR baseline	72.09 (8.13)	71.80 (5.77)	NS
HR during play	89.59 (13.28)	85.30 (10.20)	NS
HR after play	77.77 (6.10)	74.70 (6.88)	NS

SSS = Sensation Seeking Scale, TAS = Thrill and Adventure Seeking subscale, ES = Experience Seeking subscale, Dis. = Disinhibition subscale, STAI = State Trait Anxiety Inventory questions, HR = heart rate, NS = non-significant.

Table 2. *Pearson product-moment correlations (two-tailed significance) between heart rate measurements and questionnaire measures*

Variable	SSS	No. of forms participated in	Chasing	STAI	HR baseline	HR during play	HR after play
No. of forms participated in	0.15						
Chasing	0.23	0.60**					
STAI	0.03	−0.13	0.11				
HR Baseline	−0.03	−0.22	−0.24	0.14			
HR during play	−0.09	0.14	0.18	0.32*	0.29		
HR after play	−0.21	0.08	−0.16	0.15	0.52**	0.52**	
Loss of control	0.33*	0.19	0.65**	0.23	−0.05	0.29	−0.03

*$p < 0.05$; **$p < 0.01$. HR = heart rate.

[$t(40) = 2.19$, $p < 0.05$], and for the score on the experience seeking subscale of the sensation seeking scale [$t(40) = 2.52$, $p < 0.05$]. On average, men participated in significantly more gambling forms (mean = 3.95) than women (mean = 2.75). Males also scored significantly higher (mean = 4.82) than women (mean = 3.50) on the ES scale.

On average 15 trials were played during the 3-minute gambling session by participants (SD = 3.20, range = 9–21). Twenty-four participants (13 men and 11 women) won at least one of these trials during play (defined as the case where the wheels on a trial came to rest on a winning combination of symbols; in all cases this was associated with a cash win). Of those who won, the amount won ranged from £2 to £10 on a single trial. At the end of the session the majority of those who won a trial were down at the end of the session. In order to check that the number of trials played was unlikely to influence further analysis, a two-way analysis of variance checked whether number of trials played differed as a function of gender and/or winning/losing. A two-way analysis of variance indeed revealed no effects of gender [$F(1, 22) = 0.28$, $p > 0.05$] or interaction between gender and winning/losing [$F(1, 22) = 1.81$, $p > 0.05$]. There was, however, a main effect of winning/losing [$F(1, 22) = 12.89$, $p < 0.01$]. Those who won played significantly less trials (mean = 14) than those who lost (mean = 16). Given that arousal is known to increase as a function of motor activity (e.g. Fahrenberg, Foerster & Wilmers, 1992), if winning/losing differences are a function of number of trials played alone one would expect people who win to have *lower* HRs during play that those who lose.

The data recorded for heart-rate allowed the calculation of average heart-rate scores before, during and after the gambling process. The mean heart rate for each individual during play was calculated using the HR readings recorded at 5-second intervals. Table 2 illustrates the relationship between arousal levels before, during and after gambling, subjective arousal, sensation seeking and questions relating to loss of control.

Significant correlations were found between loss of control and the SSS total score, between loss of control and chasing and between chasing and number of forms participated in. In addition, there was a significant correlation between the STAI and levels of arousal experienced during play.

The HRs of those who won were compared to those who lost (nine men and nine women) during the gambling process using a three-way analysis of covariance, using loss of control as a covariate. The between-subjects factors were gender and winning/losing, and the within-subjects factor was the period during the gambling process (three levels). The means and standard deviations for this analysis are displayed in Table 3.

The analysis revealed no main effects of winning versus losing [$F(1, 37) = 1.72$, $p > 0.05$] or of gender [$F1, 37) = 1.35$, $p > 0.05$]. There was, however, a main effect of period [$F(2, 76) = 56.76$, $p < 0.001$]. Follow-up analysis using Tukey (HSD) tests revealed that mean HR during play (mean = 86.72) was significantly higher than the mean HR both during the baseline (mean = 72.08) and after gambling (mean =

Table 3. *Means (and standard deviations) for heart rate data at different periods throughout the gambling process by gender and winning/losing*

	Winners		Losers	
	Men	Women	Men	Women
HR baseline	71.15 (8.07)	71.27 (7.07)	73.44 (8.50)	72.44 (3.97)
HR during play	93.92 (12.24)	89.64 (11.01)	83.33 (12.81)	80.00 (6.18)
HR after play	78.69 (5.99)	74.91 (8.64)	76.44 (6.37)	74.44 (1.80)

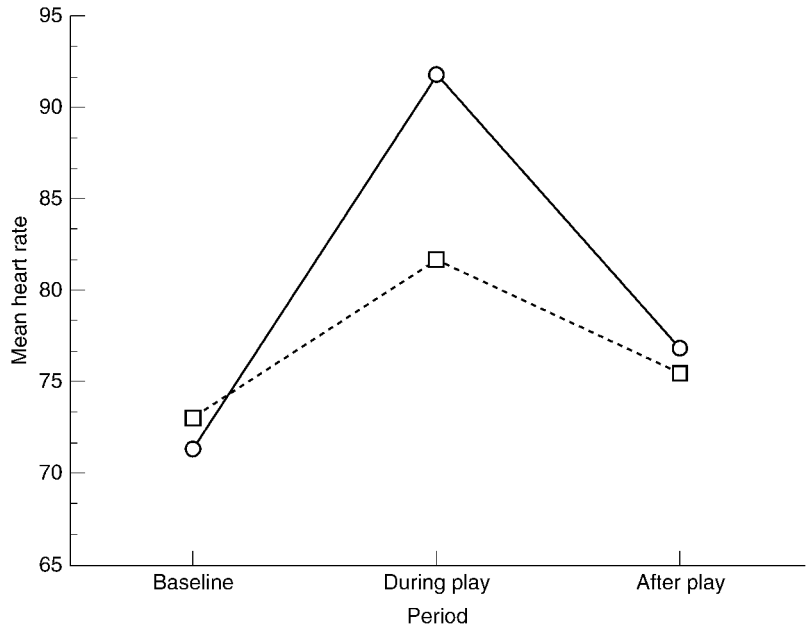

Figure 1. *Interaction between heart rate during gambling and winning/losing (○ gamblers who won; □ gamblers who lost).*

76.12). HR levels after gambling were also significantly higher than the baseline. There was also a significant interaction between winning/losing and period [$F(2, 76) = 9.36$, $p < 0.001$]. This interaction is displayed in Fig. 1.

Follow-up analysis using Tukey (HSD) tests revealed that the mean HR for the winning group was significantly higher than that of the losing group during gambling ($p < 0.001$). Additionally, all three periods differed significantly from one another in the winning group, but the only significant difference observed for the losing group was between the baseline and levels of arousal during play ($p < 0.05$). None of the other interactions approached significance.

Further analysis was undertaken to see if outcome (winning/losing), gender, loss of control or sensation seeking scores could predict the change in HR during gambling over the baseline control. Change in HR was calculated by subtracting the mean baseline level from the mean HR during play for each participant. A standard regression was performed where the dependent variable was the size of increase of HR over baseline and the predictors were gender, loss of control, sensation seeking scores (total SSS score) and winning/losing. The results of this analysis are displayed in Tables 4 and 5. As is shown clearly, only the outcome variable was a significant predictor of change in heart rate levels over baselines. None of the other variables were significant predictors of HR change.

Table 4. *Summary of regression analysis predicting change in HR level over baseline (N = 42)*

Variable	*B*	SE *B*	*β*	*t*(37)	*p*-level
SSS	−0.25	0.22	−0.17	−1.18	>0.05
Gender	−4.74	3.27	−0.20	−1.45	>0.05
Loss of control	1.64	0.86	0.29	1.91	>0.05
Outcome	−9.77	3.38	−0.41	−2.90	<0.01

R^2 adjusted = 0.27 ($p < 0.01$).

Table 5. *Inter-correlations between variables for regression analysis predicting change in HR level over baseline (N = 42).*

Variable	HR change	SSS	Gender	Loss of Control
SSS	−0.08			
Gender	−0.17	−0.18		
Loss of control	0.32*	0.33*	0.06	
Outcome	−0.50***	0.08	0.04	−0.25

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

Discussion

For the first time possible gender differences in autonomic arousal, particularly in relation to the effects of winning versus losing, were examined comparing a sample of female and male participants during fruit machine play. The study controlled for the possible confounding effects of movement observed in some previous studies (see Coventry & Norman, 1997 for a review). In addition, a number of other controls were in place. The ages of the male and female samples were almost identical and did not differ statistically from one another, and no differences between samples were observed with respect to a range of measures, including total scores on the SSS, loss of control and chasing. The only differences between samples were that the men on average took part in a greater number of types of gambling activities than women, and also scored higher than women on the ES. It can therefore be argued that the examination of possible gender differences in the study is uncontaminated by meaningful differences on other variables. It is also the case that a significant proportion of participants scored five or more on the loss of control items, which is comparable to the identification of those participants as problem gamblers in the SOGS and DSM-IV. Therefore it cannot be argued that the results in this study are a result of limited range of infrequent gamblers classified on relatively weak criteria (such as a binary frequency variable as used by Coventry & Constable, 1999). Rather, the gamblers in the present study cover a range of points on the gambling continuum from infrequent to problem gamblers (Dickerson, 1993).

To begin with heart rate levels during gambling, significant increases were observed during play overall, consistent with the direction of effects found previously (e.g. Dickerson & Adcock, 1987; Leary & Dickerson, 1987; Griffiths, 1993a; Coventry & Constable, 1999). HR during play increased on average by 15 beats per minute, and slightly elevated HR levels over baseline were found after play (average increase of 4 beats per minute). The results also showed significant differences in HR levels experienced by people who won during play versus those who lost. For those who won, HR levels were much higher than those of losers during play, and remained elevated over baselines afterwards. In contrast, HR levels of those who lost, although increased over baseline during play, were small in comparison and did not stay elevated after play. Furthermore, these results are all the more striking given that people who won played on average fewer trials than people who lost, and therefore would have experienced less of an arousal increase as a function of motor activity alone than those who lost.

Although arousal levels were observed during play, and were greater for winners versus losers, the study failed to find any gender differences in arousal as suggested by Coventry & Constable (1999). While the results for female gamblers who won are similar comparing the two studies, the present study also found arousal increases for women who lost whereas Coventry & Constable did not. There could be a number of reasons for this difference. First, the present study comprised a range of gamblers on the loss of control continuum, whereas the Coventry & Constable study tested gamblers predominantly at the infrequent levels of play end of the continuum. Additionally, the machine used in the present study has a wider range of sound and light effects than that used in the Coventry & Constable study, and therefore the stimulus characteristics of the machine may play a role in the levels of arousal experienced during play (as suggested by Griffiths, 1993b).

While the effects of winning versus losing are clearly important in the levels of autonomic arousal experienced during fruit machine play, the present study also sheds light on the relative importance of a range of variables as possible predictors of increases in arousal during play over baseline controls. The regression analysis revealed that winning versus losing was the only predictive variable of the levels of HR increase experienced. Given the range of scores on the loss of control questions, these results concur with the general lack of evidence for differential levels of arousal experienced during play found previously (Coventry & Norman, 1997; Coventry & Constable, 1999). However, it should be noted that this study is perhaps an improvement over previous studies in that there were gamblers in the present study who met the criteria for problematic gambling, and indeed the scores on the loss of control scale covered a range of points on the infrequent to problem gambler continuum.

Although the results are clear in relation to the importance of winning, the components of winning need to be further investigated. In the present study winning was operationally defined as the case when the reels came to rest on a winning combination, and in all cases participants won money with this combination. However, most of these participants lost the money by the end of the session. Therefore while it is clear that being up financially at the end of the session is not necessary to increase arousal levels compared to those who do not win, it is unclear whether being ahead for a number of trials during play is necessary. Increased arousal levels could be a function of monetary gain for short periods, a winning combination of symbols irrespective of monetary gain, or a combination of both variables. Furthermore, it may be the case that almost winning is enough to increase arousal levels (see Griffiths, 1999 for a discussion of this point). More studies need to be conducted that tease apart the relative importance of these factors.

While HR changes during gambling seem unlikely to offer a unitary explanation of differential levels of gambling behaviour, we acknowledge that heart rate can be regarded as a relatively crude measurement of objective arousal (see for example Sharpe *et al.*, 1995 for a discussion of this point). However, the sensitivity of the technique used needs to be balanced against the lack of realism of laboratory studies as demonstrated by Anderson & Brown (1984), and must also be tempered by the levels of obtrusiveness of measurement used in the field.

In relation to other variables measured in the study some interesting correlations were observed between sensation-seeking total score and loss of control, on one hand, and between HR during play and the STAI. The significant correlation between sensation-seeking total score and loss of control scores reopens the debate in relation to the explanatory role of sensation seeking as a predisposing route to loss of control (Coventry & Brown, 1993). The positive correlation between subjective arousal and level of arousal during gambling suggests some relationship between the two measures, but this relationship has failed to appear in some past studies (e.g. Coventry & Constable, 1999).

Overall, the findings suggest that events occurring within the gambling task are the best predictors of levels of autonomic arousal experienced during the task. This indicates that more detailed analysis of what happens within a task, and the interaction between the task characteristics and the gambler, are likely to be crucial in the understanding of arousal changes during the task. Indeed, as Coventry & Norman (1998) have noted, the possibility that continued participation on tasks may be a function of experience during the task alone, rather than any differences in arousal or personality, needs to be explored further.

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