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Male gamblers have significantly greater salivary cortisol before and after betting on a horse race, than do female gamblers

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Abstract

Prevalence rates of gambling are influenced by gender. Among normative populations, hypothalamic-pituitary-adrenal (HPA) axis response to stress is affected by gender. However, pathological, compared to recreational, gamblers demonstrate perturbations in HPA activation in response to gambling stimuli. We examined whether there were gender differences in HPA response to gambling in a naturalistic setting among horse-race bettors and scratch-off lottery bettors. Salivary cortisol was collected from horse-race gamblers (n=32) and scratch-off lottery ticket players (n=39) before and after (0, 10, or 20 minutes) betting on a horse race at an off-track betting establishment. Salivary cortisol levels were significantly higher among men than among women, both prior to and following, betting on a horse race. Among women, but not men, there was a decline in salivary cortisol across time in scratch-off bettors, whereas women horse-race bettors maintained consistent low concentrations of salivary cortisol at every time point sampled. Together these data suggest that engaging in gambling may have different effects on stress responses of men, compared to women. Whether these gender differences in HPA activation contribute to gender-related differences in gambling behavior is the subject of ongoing investigation.

Keywords

Addiction; Gender Differences; Hypothalamic-Pituitary-Adrenal Axis; Gambling; Recreational Gambling; Pathological Gambling

1. Introduction

1.1. Gender Differences in Gambling

Gambling, a common form of entertainment, is gaining popularity with widespread access and/or legalization. The lifetime prevalence of pathological gambling is between 0.4% and 3.4% [1] and “problem gamblers”, those at risk for developing a pathological form of gambling,

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represent ~3% of the adult population [2]. Gambling, like other addictions, is associated with financial, legal, interpersonal, and physical and mental health problems [3–15]. Understanding neurobiological factors, such as gender, associated with recreational, problem and/or pathological gambling, may provide insight into vulnerabilities to development of addiction. Prevalence rates of gambling are higher among men, compared to women [16–17]. Although men are typically younger at the onset of gambling, among women there is often a shorter duration between onset of gambling and report of a gambling problem [18–20]. Thus, gender differences may have important implications for etiology and/or treatment of gambling, often referred to as a “behavioral addiction” [21].

1.2. The HPA axis and gambling

Excitement is one explanation that individuals often give for engaging in gambling. Increases in heart rate (HR) occur during and after gambling [22–26]. The hypothalamic-pituitary-adrenal (HPA) axis is implicated in autonomic activation and underlies circulatory release of stress hormones [27], such as cortisol, which occur with acute psychological and/or physical stressors [28–31]. Increases in cortisol are a robust indicator of HPA arousal to stimuli with negative valence, arousing, and/or rewarding stimuli [32–45], including pharmacological addiction [36–38]. HPA arousal is also associated with endogenous opioid release, which may underlie some of the reinforcing effects of cortisol and/or CRH manipulation in animal models [39,40] and may have implications for gambling and other addictive processes [41–47]. Thus, cortisol response, as a proxy measure for HPA activation, to gambling is of interest.

1.3. Cortisol among pathological gamblers

Investigations of HPA arousal among gamblers report contradictory results perhaps due to perturbations among pathological gamblers, which most studies have not taken into account [48–50]. For example, we recently explored gender differences in HPA arousal among pathological gamblers in a laboratory setting. Men and women pathological gamblers had a hypoactive salivary cortisol response to gambling cues compared to recreational gamblers; an effect that was greater among women than men [51]. Thus, hypo-arousal of the HPA axis may be associated with gambling pathology and gender differences in these factors may be important.

1.3. Cortisol and casino gambling

Few studies have empirically investigated the effect of gambling on cortisol secretions in a native gambling environment. Among aboriginal natives, urinary cortisol levels were significantly higher when individuals were tested soon after partaking in large-stakes card gambling, but controls were lacking [52]. In a field study with male casino blackjack players, salivary cortisol increased in response to gambling, compared to controls, and remained elevated after play [24]. Among male blackjack gamblers, blood cortisol levels were increased among both problem and recreational gamblers in response to gambling compared to a control condition [53]. These findings suggest that casino gambling can activate the HPA axis and secretion of cortisol. However, gender differences in the native gambling environment, when pathology is a risk but has not been established, is not known and is of interest.

We investigated gender differences in gambling-specific reactivity by measuring the cortisol responses among experienced gamblers (exclusive horse race bettors and exclusive scratch-off lottery players) in response to betting on a horse race. We hypothesized that experienced horse-race gamblers would have greater cortisol responses following betting on a horse race than would scratch-off lottery players, and that men would have greater cortisol secretion than would women.

2. Materials and methods

All procedures were approved by the Institutional Review Board of the University at Albany, State University of New York.

2.1. Participants

Recreational gamblers were recruited via flyers and newspaper advertisements in the Capital District of Albany New York and underwent a telephone screen to determine eligibility. Eligible participants were 18 years of age or older, who reported gambling at least two times per week, had not received treatment for a gambling-related problem within the past year, and were required to affirm that their gambling did not currently generate problems for which help was required.

Participants included 39 scratch-off lottery players (21 males and 18 females) and 32 horse race gamblers (21 males and 11 females) who were high-frequency recreational gamblers that had gambled at least twice a week during the past year ($M = 3.8$ days/week, $SD = 2.1$), with an average of 14.9 years of gambling experience ($SD = 11.5$). Participants had a mean age of 41.9 years ($SD = 13.5$); approximately one third each of the sample were never married, married, or separated/divorced/widowed. Most worked fulltime (56%), part-time (13%) or attended an educational setting (11%); 20% were retired, disabled, or unemployed. Their yearly income was low, with 49% earning \$25,000 or less, 35% earning between \$25,001 and \$50,000, and 16% earning more than \$50,000. Eighty percent identified themselves as Caucasian, 11% were African American, 6% Latinos, and 3% "other."

2.2. Overview of procedures

Eligible participants were met at a local Off-Track Betting (OTB) establishment for individual 60-minute sessions. Appointments were scheduled between 2:00 pm and 7:00 pm to control for diurnal fluctuations in cortisol levels, and all participants were asked to abstain from eating and drinking (except for water) or smoking for one hour prior to their scheduled appointment. Once at the OTB, participants provided informed consent and then completed a packet of questionnaires presented in counterbalanced order in addition to partaking in the gambling paradigm. At study completion (approximately 60 minutes from beginning to end), temporally distanced from the gambling paradigm and separate from any wager-related monetary win, participants received a total honorarium of \$50 for the time and effort expended during participation: \$15 for completing the questionnaires, and \$35 for completing the cue exposure procedure. All participants who started the study completed all phases of the protocol.

2.3. Questionnaires

Participants provided basic demographic information and pertinent gambling-related information. Information regarding hormone replacement therapy, oral contraception use, and cigarette smoking history was obtained to aid in the interpretation of cortisol analyses. Two standardized gambling measures were also incorporated into the questionnaire packet.

The South Oaks Gambling Screen (SOGS) [54] is a 20-item self-report measure based on the DSM-III criteria [55] for pathological gambling. It yields a score between 0 and 20: identifying social gamblers (scores of 0–2), potential problem gamblers (scores of 3 or 4), and probable pathological gamblers (scores of 5 or higher). The SOGS is a widely used screening instrument in clinical, non-clinical, and epidemiological studies and has well-established psychometric properties including high internal consistency and sufficient 1-month test-retest reliability [54].

The NORC DSM Screen (NODS) [16] is a 17-item instrument that assesses severity of gambling behavior based on the 10 DSM-IV [56] criteria for pathological gambling. It yields a total score between 0 and 10 and identifies “at risk” (scores of 1 or 2), “problem gamblers” (scores of 3 or 4), and “pathological gamblers” (scores of 5 to 10) [16]. The NODS has established psychometric properties including adequate internal consistency and strong test-retest reliability [16,57].

2.4. Demographics Based Upon Responses to Questionnaires

The two groups did not differ in gender composition, race, relationship status, education, gambling frequency, NODS or SOGS scores. Horse race gamblers were, on average, older than the scratch-off lottery players [mean age = 45.75, $SD = 11.91$ vs. 38.69, $SD = 13.99$; $F(1, 69) = 5.10, p = .03$] and had more gambling experience than did the scratch-off lottery players [years gambled = 19.93, $SD = 11.89$ vs. 10.21, $SD = 9.11$; $F(1, 69) = 11.89, p = .001$]. Reported income was significantly higher among horse race bettors (over \$35,000 per year) than scratch-off lottery players (\$15,000 per year) [$\chi^2 = 11.88, p = .04$].

2.5. Gambling paradigm

Participants chose a horse race and placed a straight bet to win on a horse of their choosing, using their own money. All races from which participants could choose were approximately 2 minutes in duration. Wagers were limited to either \$2 or \$5 to control for variations in betting amounts. While these wagers may not be typical of pathological gamblers, they represent a more standard straight wager that one would expect a recreational gambler to place. Participants sat quietly for a 10-min baseline, then watched the race, followed by a 20-minute return to baseline period.

2.6. Collection and measurement of salivary cortisol

Saliva samples were collected using commercially available “Salimetrics Oral Swabs” (Salimetrics, LLC, State College, PA). In keeping with recommended collection procedures, participants were instructed to place the oral swab in their mouths between the lower gum and cheek until it became saturated, or for approximately 2 minutes [58]. Saliva was collected from each participant at 4 time points: at the end of the baseline period (10 minutes prior to the race), at the end of the race, and 10 and 20 min after completion of the race. As such, samplings were spaced approximately 10 minutes apart.

Samples were stored at -20°C until they were analyzed using commercially available cortisol enzyme immunoassay kits (Salimetrics, LLC, State College, PA) [84–85]. Briefly, samples were thawed slowly on ice and centrifuged at $1500 \times g$ for 15 minutes to draw saliva out of oral swabs. Samples were pipetted into 96-well microtitre plates pre-coated with cortisol antibodies. After known (standards) and unknown (samples) concentrations of cortisol were added to well plates, cortisol bound to horseradish peroxidase was added to each well. Following mixing (500 rpm), well plates were washed four times with detergent buffer. Well plates were reacted by addition of tetramethylbenzidine. Optical density (450 nm) was determined via an ELx800 universal microplate reader (BioTek Instruments, Inc., Winooski, VT). The standard curve ($0 - 3 \mu\text{g/dl}$) and all saliva samples were run in duplicate. High and low cortisol controls were utilized to correct for multiple plate comparisons. Intra- and inter-plate co-efficient of variances were both 0.01. This method has been used previously as a valid and reliable approach to detect and measure cortisol among healthy children, adolescents, and adults of both sexes [59–63]. The typical range for salivary cortisol detected using these methods is between 0 (below the limit of detection) and $0.359 \mu\text{g/dl}$ according to manufacturer instructions (Salimetrics, LLC, State College, PA).

2.7. Data analyses

Data analyses were conducted using Statistical Package for the Social Sciences (SPSS, Inc., Chicago, IL). A three-way mixed-design ANOVA was employed to determine whether the cortisol levels of horse race bettors would be greater than those of scratch-off lottery players and whether these levels vary depending on gender. For the analysis, Group (scratch-off lottery players and horse race bettors) and Gender (men and women) served as the between-subjects factors, with Time (collection at baseline, end of race, 10 minutes post-race, and 20 minutes post-race) serving as the within-subjects repeated-measures factor. Alpha level for significance was $p < 0.05$.

One male horse race bettor was eliminated because of extreme cortisol levels across all measures; all other participants demonstrated cortisol levels within the normal range for all time points with variation across time. Additionally, evaluations of assumptions of normality and homogeneity of variance were satisfactory for the dependent variable cortisol. As Mauchly's Test of Sphericity reached significance ($p = .001$), Greenhouse-Geisser corrections were employed.

3. Results

Gender had a significant effect on cortisol levels [$F(1, 66) = 9.05, p = 0.004$; partial $\eta^2 = 0.121$]. Overall, men had higher cortisol responses than did women. This gender effect was significant at baseline [$t(68) = 1.98, p = .05$], at the end of the race [$t(68) = 2.23, p = .03$], at 10-minutes post-race [$t(68) = 3.39, p = .001$], and at 20-minutes post-race, [$t(68) = 2.81, p = .007$]. See Figure 1.

4. Discussion

Consistent with our hypothesis, a gender effect was observed with men demonstrating higher cortisol levels than women. This overall gender difference was observed at all time points including baseline levels, suggesting that HPA axis response in men and women is different both prior to, and after engaging in, horse race betting. Specifically, it may imply differences in anticipatory arousal at baseline, with men demonstrating greater basal cortisol in anticipation of gambling behavior than women. This finding is similar to that of a prior study [64] in which men demonstrated increased cortisol in anticipation of a psychological stressor. Interestingly, women tended to show a decline in salivary cortisol secretion, an effect that was also consistent with previous findings [64]. These data indicate that engaging in gambling may have different effects on stress responses in men and women.

Contrary to our hypothesis, cortisol reactivity did not appear to be cue-specific as there were no overall significant differences in cortisol levels between preferred horse race bettors and preferred scratch-off lottery players following betting on a horse race. While men demonstrated higher cortisol levels at every time point compared to the means of women horse race bettors and scratch-off gamblers, it was observed that the latter group of women had cortisol levels commensurate to those of men both at baseline and immediately following the race. Women horse-race gamblers did not demonstrate the same initial cortisol response to the horse race. One interpretation of these data is that horse-race gambling women may demonstrate a hypoactive HPA response to engaging in horse-race gambling compared to men or women scratch-off bettors. We have previously found that pathological gamblers demonstrate hypoactive HPA response to gambling stimuli [51]. It is also notable that men, irrespective of preferred mode of gambling, demonstrated high consistent salivary cortisol concentrations. Cortisol is reinforcing in animal models [39,40] and therefore may underlie some of the reinforcing effects reported with gambling. This may also underlie, in part, the greater incidence of pathological gambling as an addiction among men [16,17]. Taken together, these

data support the notion that engaging in gambling is accompanied by changes in HPA arousal and that there are gender differences in this response.

The observed gender effect supports previous investigations examining gender differences in human cortisol responding. Studies with healthy human participants reveal that men experience greater HPA-axis activity than do women in various laboratory stressors including examination stress, pain, cognitive tasks, and public speaking [64–68]. Gender differences have also been observed in pathological gamblers following exposure to gambling cues in a laboratory setting with a non-significant trend towards men having higher cortisol levels than women [51]. The present study adds to the existing literature by demonstrating significant gender differences in HPA axis activity both prior to and following engagement in gambling within a natural environment.

Although we did observe an apparent interaction between gender and preferred mode of gambling, with $p = 0.12$ it did not reach statistical significance. While this was somewhat disappointing, these data remain informative regarding the potential effects that preference for gambling medium may imply in terms of HPA-responding. Future investigations should aim to elucidate more divergent groups of male and female gamblers on HPA response to a variety of gambling stimuli.

4.1. Limitations

Although representing an important first attempt at examining gambling-specific reactivity within a real gambling environment, the present investigation had some limitations. First, given that the present investigation focused on baseline and overall HPA response to a horse race, the study did not take into account the possible mediating effects of winning/losing within a real gambling environment, as winning and losing has previously been shown to influence other physiological responses to gambling [25–26]. While the investigation was designed to specifically look at reactivity to gambling regardless of monetary wins, gambling-specific stress responses may have been influenced by instances of winning or losing. Future studies should therefore systematically investigate the occurrence of wins and losses and their potential influence on gambling-specific responding. Moreover, the recompense provided to all participants may have enabled everyone to come out a winner and thereby have reduced the capacity for HPA reactivity.

Second, the research design, while allowing for increased external validity, may have compromised internal validity. Findings from the present field investigation may have been influenced by uncontrollable factors (e.g., inability to control outcomes of horse race, number of patrons in the betting establishment, lighting and temperature differences between betting establishments); these variables become difficult to control in designs allowing for more external validity. Despite these limitations, it should be emphasized that the present findings represent research conducted in a naturalistic environment with a high potential for real-world application.

Third, the present study lacks a true “baseline” measure of cortisol responding. While the baseline measure for cortisol was obtained after participants became acclimated to the OTB and this method of collection resembled methods used in other studies, it is possible that environmental cues within the OTB influenced baseline cortisol levels. However, we have previously observed that salivary levels of cortisol are enhanced from true baseline following exposure to gambling cues [51]. Additionally, the lack of a non-gambling comparison group clearly limits the scope and interpretation of the findings. Given the naturalistic design, we chose to include two distinct groups of gamblers: those who solely prefer horse-race betting and those who solely prefer scratch-off lottery tickets. This effort was intended to capture two divergent groups of gamblers in an attempt to explore potential mode-specific cortisol

response. Future studies should take these methodological considerations into account by obtaining a baseline in cortisol level in a non-gambling context and including a non-gambling comparison group in the design.

Finally, cortisol was measured across only one gambling activity. To understand fully if HPA response is gambling-specific, and to further elucidate the observed gender effect therein, future research should be conducted across a range of gambling activities. Moreover, research suggests that alpha-amylase and testosterone [59–63] are also sensitive to stress exposure. Therefore, additional measures of HPA-axis activity should be included in future studies to glean a better understanding of the effects of gambling behavior on neuroendocrine responses.

4.2. Clinical implications and future directions

The present study empirically tested gambling-specific cortisol reactivity and compared male and female gamblers who gambled in a real-world environment. As such, it represents an important step towards increasing our knowledge of reactivity to gambling-related cues, with the results holding important clinical implications.

A combination of negative health factors and increased HR during gambling may contribute to increased health problems and risk for cardiovascular difficulties [69]. Although research suggests cortisol increases can be adaptive by enabling individuals to cope with proximal challenges [70], substantial research has highlighted the relationship between chronic HPA activation and negative emotional outcomes such as depression, anxiety, and fatigue [71,72]. Poor health outcomes such as diabetes, obesity, coronary heart disease, and high blood pressure, are also related to chronic stress [73,74]. Moreover, research in people and animal models demonstrates that exposure to stress is associated with drug craving and drug relapse [37]. Studies such as the present investigation represent a vital first step in attempting to understand the effects of gambling on health and well-being.

As cortisol research in response to gambling is in its infancy, it remains unclear if gambling represents a true “stressor” in the same sense as the laboratory stressors currently utilized in other studies investigating cortisol stress response with human participants [64–68]. Future studies of cortisol response in gamblers will need to fully explore gambling as a stressful event for the results of such studies to be fully understood in the larger context and may want to focus on potential correlations between cortisol response and years gambled, gambling frequency, or gambling severity. Future studies may also want to consider examining gambling-specific cortisol reactivity between different populations of gamblers (social gamblers vs. pathological gamblers), comparing reactivity in two different gambling environments (analogue vs. real) within the same study, and measuring reactivity across a variety of gambling activities (strategic vs. non-strategic). Additionally, considering the apparent gender differences in stress reactions to gambling, gender should be included in any future investigations of cortisol responding. The combined findings from these and other studies may yield a more comprehensive understanding of both social and problematic gambling and may add to the field by contributing to the development of more effective treatments for gambling.

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Figure 1.

Salivary cortisol (mean $\pm$ SEM) for men and women by gambling group. * indicates significant difference, $p < 0.05$.