Sensation Seeking and Hormones in Men and Women: Exploring the Link

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Risky behaviors (e.g., binge drinking, drunk driving, risky sex) are increasing among U.S. college students, and the personality trait of sensation seeking provides a potential link between such norm-breaking behaviors and biological processes. We examined the relationship between sensation-seeking behaviors and two hormones, testosterone and cortisol, in male and female college students. Hormone levels were hypothesized to contribute to the variability of individual scores on Zuckerman’s Sensation-Seeking Scale. As expected, males scored higher on the scale than females, but the data failed to support the generally accepted positive relationship between testosterone and sensation seeking for either sex. Instead, our results support the existence of a significant inverse relationship between cortisol and sensation seeking in men, but not in women, even after adjustment for testosterone levels and age. Our study contributes to the current literature by (a) supporting the association between risky behavior and a hormone other than testosterone, (b) being the first to examine the association between cortisol and sensation seeking in women, and (c) identifying a possible effect of gender on the association between hormones and sensation-seeking behaviors. Gendered social norms and expectations are likely to be partly responsible for this effect. Theory-guided interdisciplinary research is needed to improve understanding of the biological influences on human behavior, and special attention must be paid to social context, women’s perceptions of their expected behavior, and gendered socialization regarding norm-breaking or risky behaviors, which may obscure biological links to female behavior.

Key Words: college population; cortisol; risk behavior; sensation seeking; testosterone.

Recent data confirm the rising incidence of norm-breaking behavior among U.S. college students. The rates of binge drinking, multiple sexual partners, incidence of sexually transmitted diseases, drug use, and drunk driving have increased in recent years (Bell, Wechsler, and Johnston, 1997; Wechsler, Dowdall, Maenner, Gledhill-Hoyt, and Lee, 1998; Duncan, Donnelly, Nicholson, and White, 1999; Centers for Disease Control and Prevention, 2000; Wechsler, Lee, Kuo, and Lee, 2000). This phenomenon has been studied from social, psychological, and economic perspectives (Oetting, Deffenbacher, and Donnermeyer, 1998; Deery and Fildes, 1999), but biosocial explanations are scarce. The personality trait of sensation seeking, defined as pursuing and taking risks in order to experience a variety of new sensations (Zuckerman, 1979; McCourt, Gurrera, and Cutter, 1993), provides a link between deviant or norm-breaking behavior and biological processes. Deviant behavior can be considered a reflection of sensation-seeking tendencies (Newcomb and McGee, 1991; Oetting et al., 1998; Deery and Fildes, 1999), which, in turn, have been associated with men’s testosterone levels (e.g., by Daitzman, Zuckerman, Sammelwitz, and Ganjam, 1978; Daitzman and Zuckerman, 1980; Bogaert and Fisher, 1995; Gerra, Avanzini, Zaimovic, Sartori, Bocchi, Timpano, Zambelli, Delsignore, Gardini, Talarico, and Brambilla, 1999; see Wang, Mason, Charney, Yehuda, Sherry, and Southwick, 1997 for an exception) and cortisol levels (Netter, Henning, and Roed, 1996; Wang et al., 1997). For example, studies on a large sample of male veterans (n = 4179) have found positive associations between testosterone and risk behaviors such as gambling, alcohol use, and multiple sexual partners (Dabbs and Morris, 1990; Mazur, 1995).
Another biological link to sensation seeking, not explored here, is the role of the neurotransmitters dopamine (Zuckerman, 1994; Netter et al., 1996; Ruegg, Gilmore, Ekstrom, Corrigan, Knight, Tancer, Leatherman, Carson, and Golden, 1997; Gerra, Zaimovic, Timpano, Zambelli, Delsignore, and Brambilla, 2000) and serotonin (Zuckerman, 1994; Netter et al., 1996).

In a comprehensive review of all aspects of sensation seeking, Zuckerman (1994) pointed out that, as early as 1973, the trait of sensation seeking was linked to both delinquency and creativity in different individuals (Farley, 1973, 1981, as cited by Zuckerman, 1994). In simple terms, Farley postulated that individuals from lower socioeconomic classes do not have access to the same outlets for prosocial and antisocial tendencies, implying that the environment provides the outlet for the sensation seeking, be it prosocial or antisocial (Farley, 1973, 1981, as cited by Zuckerman, 1994). Brook, Whiteman, Cohen, Shapiro, and Balka (1995) found that sensation seeking, among other personality traits, predicted alcohol use among adolescents and young adults.

The purpose of our study is to examine the relationship between two hormones, testosterone and cortisol, and sensation-seeking behaviors in men and women. We build upon previous studies mentioned above that have examined the link between these hormones and sensation-seeking measures. The participants in our study, students at a state university from similar socioeconomic backgrounds, share a common social context and environment. The relative lack of positive outlets for sensation seeking on a college campus located in a medium-sized city is likely to contribute to the high rates of alcohol and drug use, multiple sexual partners, and high incidence of sexually transmitted diseases found on many U.S. college campuses.

The first study to report a link between testosterone and sensation seeking (Daitzman et al., 1978) used an earlier version of Zuckerman’s (1979) Sensation-Seeking Scale (SSS-V) that consisted of four subscales: Thrill and Adventure Seeking (TAS), Disinhibition (DIS), Experience Seeking (ES), and Boredom Susceptibility (BS). A review of past research indicates that testosterone and sensation seeking in both men and women.

The predominantly white non-Hispanic sample consisted of 68 males (mean age 22.01 ± 0.53 SEM)
and 75 females (mean age 22.37 ± 0.59 SEM). All participants were students at a large university in a medium-sized city in northern Florida and were recruited from various classes on campus. Participation was voluntary and unremunerated. To be eligible, students had (a) to be currently enrolled at the university, (b) to agree to fill out a paper-and-pencil questionnaire, and (c) to provide a saliva sample. Because we have no information on those who refused to participate (5% of those approached) we ignore whether participants differ from nonparticipants. Given the small percentage of refusals, however, we believe the possible bias introduced would be negligible.

**Measures**

To measure our variable of interest, sensation seeking, we used the SSS-V developed by Zuckerman (1979), which has proven validity and reliability. The SSS-V consists of 40 questions divided into four subscales. The TAS subscale measures subjects’ motivation for engaging in sports or activities involving some physical danger or risk, such as mountain climbing, sky diving, or high-speed driving. The DIS subscale measures the desire for uninhibited behavior in social situations, like drinking, partying, or seeking variety in sexual partners. The ES subscale measures the desire to seek new experiences through unconventional friends and travel. Finally, the BS subscale measures aversion to repetition of any kind. Scoring ranges from 0 to 10 on each subscale, for a range of 0 to 40 on the complete SSS-V. All are measured at the interval level.

To measure our two main putative hormonal predictors, testosterone and cortisol, we collected a saliva sample at approximately 12:00 noon from each subject. Participants were instructed to chew a piece of Wrigley’s Extra sugar-free gum and to spit into a small vial until 25 ml of saliva had accumulated. Within a few hours, the saliva was frozen at −84°C in a laboratory located on campus until it was ready for assay (for a complete description of the procedure and for reliability and validity measures, see Soler, Vinayak, and Quadagno, 2000). Commercially available solid-phase 125I radioimmunoassay kits from Diagnostic Products Corp. (Coat-A-Count Total Testosterone kit and Coat-A-Count Cortisol kit) were used to assay the free testosterone (ng/dl) and cortisol (μg/dl) in the saliva samples.

The antibody-coated tubes are specific for testosterone and cortisol, respectively, and show minimal cross-reactivity to other steroids. Specifically, the Coat-A-Count Total Testosterone kit has minimal cross-reactivity to other androgens, estrogens, and adrenal steroids, and the Coat-A-Count Cortisol kit is highly specific for cortisol (Diagnostic Products product specifications). The lower limit of sensitivity of the testosterone assay was 2.0 ng/dl; that for cortisol was 0.14 μg/dl.

A 200-μl sample of saliva was used for duplicate analysis for both testosterone and cortisol. The interassay coefficients of variation for the low- and high-testosterone controls across five assays were 1.08 and 3.61%, respectively, and the intraassay coefficient was 3.38%. The interassay coefficients for the low- and high-cortisol controls across five assays were 0.83 and 5.76%, respectively, and the intraassay coefficient was 2.70%.

Age was collected in an open-ended question format and included in the analyses ungrouped. In terms of socioeconomic status, because all participants were students at an institution whose student body lacks substantial heterogeneity of family socioeconomic background, we assume that the sample is quite homogeneous. Data-collection limitations did not allow us to control for other theoretically relevant psychosocial variables such as social and religious values or attitudes toward risk and sensation-seeking behaviors. These and other social factors are very likely to influence these behaviors and/or mediate the relationship between hormones and sensation seeking. The purpose of this study, however, was simply to examine the contribution of the two hormones to the variability in sensation-seeking behaviors in an income-, education-, and age-homogeneous sample. The lack of psychosocial controls is therefore unlikely to bias the results.

**Statistical Analyses**

We used group t tests to compare hormone levels and scale scores in both men and women. We also used this technique to compare the hormone levels of individuals scoring in the upper 20% on the scales with those of subjects scoring in the bottom 20%. We tested all differences for males and females separately, both for total SSS-V score and for subscale scores. To examine the association between hormone levels and sensation-seeking behaviors, we used Spearman correlations rather than the more commonly used Pearson correlations so as to reduce biases from the non-normality of the distributions tested. Because of the changes in testosterone level with age, we performed partial correlations controlling for age, although,
given the homogeneity of the sample in terms of age, the change in the coefficients was very small. Here we report the results of the partial correlations. Finally, we tested the independent effects of testosterone and cortisol on sensation-seeking scores with ordinary least-squares regression. We performed all analyses using the Statistical Package for the Social Science (SPSS, 10th edition).

RESULTS

Sex Differences

As expected, male participants’ testosterone levels (±SEM) were significantly higher than females’ (14.79 ± 0.55 ng/dl versus 3.18 ± 0.16 ng/dl), whereas men and women showed similar cortisol levels (0.47 ± 0.04 µl/dl versus 0.51 ± 0.05 µl/dl). Comparisons of our sample’s values with those reported in previous studies of college populations confirm the validity of our measures (Bogaert and Fisher, 1995; Dabbs, Campbell, Gladue, Midgley, Navarro, Rad, Susman, Swinkels, and Worthman, 1995; Vedhara, Hyde, Gilchrist, Tytherleigh, and Plummer, 2000).

Table 1 contains the results of the SSS-V scale (Zuckerman, 1979). Male participants scored significantly higher than females on the total SSS-V score, as well as on three of the subscales: BS, ES, and TAS. Again, we compared these results with those of other studies to test the validity of our sensation-seeking measures. Our values, both means and standard deviations, for both men and women, are almost identical to those reported for male and female college students in the United States by Zuckerman (1994).

Hormones and Sensation Seeking in Men

Testosterone. Spearman correlations controlling for age showed that male testosterone values were not associated with either the total SSS-V score or those on any of the subscales (Table 2). Comparisons, for the total SSS-V scale and each of the subscales, of testosterone levels of participants scoring in the upper 20% with those of participants scoring in the lower 20% again yielded no significant differences (data not shown).

Cortisol. In contrast, males’ cortisol levels were negatively associated with sensation-seeking behavior (Table 2). Spearman correlation coefficients between hormone levels and total SSS-V scores and scores on the BS, DIS, and ES subscales were negative and statistically significant (P < 0.05). Group comparisons (t test) between men scoring in the upper and lower 20% on the sensation-seeking scales confirmed this inverse relationship for four of the scales (total SSS-V, BS, DIS, and ES; data not shown). Finally, multivariate regression analyses (Table 3) confirmed the negative effect of cortisol on the total SSS-V score, BS, and DIS (P < 0.01), but not ES or TAS, net of testosterone levels. No interaction between the two hormone variables was found. The adjusted R² shows the amount of variability of the scores explained by the model.

### TABLE 1
Total SSS-V and Subscale Mean Scores (±SEM) for Men and Women and T Test Results

<table>
<thead>
<tr>
<th></th>
<th>Total score</th>
<th>BS</th>
<th>DIS</th>
<th>ES</th>
<th>TAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men (n = 68)</td>
<td>21.2 ± 0.75</td>
<td>3.5 ± 0.25</td>
<td>5.1 ± 0.34</td>
<td>5.0 ± 0.24</td>
<td>7.9 ± 0.28</td>
</tr>
<tr>
<td>Women (n = 75)</td>
<td>18.1 ± 0.78</td>
<td>2.9 ± 0.23</td>
<td>4.4 ± 0.32</td>
<td>4.4 ± 0.23</td>
<td>6.5 ± 0.34</td>
</tr>
<tr>
<td>t</td>
<td>2.85**</td>
<td>1.94*</td>
<td>1.53</td>
<td>1.88*</td>
<td>3.11***</td>
</tr>
</tbody>
</table>

Note. BS, Boredom Susceptibility; DIS, Disinhibition; ES, Experience Seeking; TAS, Thrill and Adventure Seeking.

* P < 0.05.
** P < 0.01.
*** P < 0.001.

### TABLE 2
Spearman Correlations between SSS-V Subscales and Each Hormone, by Sex

<table>
<thead>
<tr>
<th></th>
<th>Testosterone</th>
<th>Cortisol</th>
<th>Testosterone</th>
<th>Cortisol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>0.063</td>
<td>−0.240*</td>
<td>0.091</td>
<td>0.045</td>
</tr>
<tr>
<td>Women</td>
<td>0.012</td>
<td>−0.271**</td>
<td>0.018</td>
<td>−0.061</td>
</tr>
<tr>
<td>BS</td>
<td>−0.073</td>
<td>−0.234*</td>
<td>−0.036</td>
<td>−0.015</td>
</tr>
<tr>
<td>DIS</td>
<td>−0.054</td>
<td>−0.162</td>
<td>0.131</td>
<td>0.006</td>
</tr>
<tr>
<td>ES</td>
<td>0.034</td>
<td>−0.289*</td>
<td>0.074</td>
<td>−0.041</td>
</tr>
</tbody>
</table>

Note. BS, Boredom Susceptibility; DIS, Disinhibition; ES, Experience Seeking; TAS, Thrill and Adventure Seeking.

* P < 0.05.
** P < 0.01.
Hormones and Sensation Seeking in Women

Female participants’ testosterone and cortisol levels were not significantly correlated with total sensation-seeking scores or scores on any of the subscales (Table 2). In addition, those scoring in the upper and lower 20% of the SSS-V or its subscales did not differ in hormone levels (data not shown). Multivariate regression analyses confirmed these findings (Table 3).

DISCUSSION

Our results confirm those of earlier studies (Zuckerman, Eysenck, and Eysenck, 1978; Zuckerman, 1994, 1996) and support our first hypothesis: male participants in our study reported significantly and substantially higher levels of sensation-seeking behaviors than did female participants on the total SSS-V and three of its subscales (BS, ES, and TAS).

Our results failed to support our second hypothesis, i.e., existence of a positive relationship between testosterone levels and sensation-seeking behaviors. For both men and women, the relationship was weak and failed to reach significance. The first study to demonstrate a link between elevated testosterone values and sensation seeking in men, that by Daitzman et al. (1978), showed an association only between the DIS subscale and the hormone. No associations with other subscales or total score were found. We find no relationship between elevated testosterone and DIS or between testosterone and any of the other three subscales or total score. In a second study, Daitzman and Zuckerman (1980) compared the testosterone values of males who scored in the upper and lower 20% on the DIS subscale. High-testosterone males were found to be in the upper 20% and lower-testosterone males in the lower 20% on this subscale. In contrast, male participants in our study scoring in the upper and lower 20% of the four sensation-seeking subscales scales and total score did not differ in testosterone levels.

In the case of females, the lack of relationship between testosterone and sensation seeking behaviors in our data confirms the findings of Daitzman et al. (1978), the only other study to include female subjects. The Daitzman et al. (1978) study included only seven women.

Other studies exploring the relationship between testosterone and sensation seeking have reported conflicting results. No relationship between total score and testosterone was reported by Daitzman et al. (1978), Daitzman and Zuckerman (1980), or Wang et al. (1997), but Bogaert and Fisher (1995) and Gerra et al. (1999) did find a significant association between the hormone and total score; they did not find the positive association between testosterone and DIS subscore re-

### TABLE 3

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>BS</th>
<th>DIS</th>
<th>ES</th>
<th>TAS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$b$</td>
<td>$SE$</td>
<td>$b$</td>
<td>$SE$</td>
<td>$b$</td>
</tr>
<tr>
<td><strong>Men</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Testosterone</td>
<td>0.20</td>
<td>0.16</td>
<td>0.07</td>
<td>0.06</td>
<td>0.06</td>
</tr>
<tr>
<td>Cortisol</td>
<td>−5.53</td>
<td>2.05</td>
<td>−1.93</td>
<td>0.70</td>
<td>−2.35</td>
</tr>
<tr>
<td>Age</td>
<td>0.15</td>
<td>0.17</td>
<td>−0.02</td>
<td>0.06</td>
<td>−0.00</td>
</tr>
<tr>
<td>Constant</td>
<td>17.63</td>
<td>4.61</td>
<td>3.95</td>
<td>1.57</td>
<td>5.43</td>
</tr>
<tr>
<td>Adj. $R^2$</td>
<td>0.08</td>
<td>0.07</td>
<td>0.05</td>
<td>0.04</td>
<td>−0.02</td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Testosterone</td>
<td>0.49</td>
<td>0.57</td>
<td>0.21</td>
<td>0.17</td>
<td>0.06</td>
</tr>
<tr>
<td>Cortisol</td>
<td>−1.41</td>
<td>1.92</td>
<td>0.11</td>
<td>0.55</td>
<td>−0.85</td>
</tr>
<tr>
<td>Age</td>
<td>−0.05</td>
<td>0.16</td>
<td>0.04</td>
<td>0.05</td>
<td>−0.04</td>
</tr>
<tr>
<td>Constant</td>
<td>18.43</td>
<td>4.25</td>
<td>1.19</td>
<td>1.22</td>
<td>5.52</td>
</tr>
<tr>
<td>Adj. $R^2$</td>
<td>−0.02</td>
<td>−0.01</td>
<td>−0.02</td>
<td>0.04</td>
<td>−0.04</td>
</tr>
</tbody>
</table>

* $P < 0.05$.
** $P < 0.01$.
*** $P < 0.001$. 

Rosenblitt et al.
ported by Daitzman et al. (1978) and Daitzman and Zuckerman (1980).

Many confounding variables complicate the interpretation of differences between the results of these studies. The sample sizes ranged from 27 (Wang et al., 1997) to 215 (Bogaert and Fisher, 1995), and the males ranged in age from 17–20 years (Daitzman and Zuckerman, 1980) to 19–60 years (Gerra et al., 1999). The Gerra et al. study recruited Italian potential blood donors, Wang et al. used American army veterans, and the remaining studies used American college students. Gerra et al. (1999) and Wang et al. (1997) used the Cloninger Tridimensional Personality Scale, which contains a novelty-seeking component, whereas the other studies used Zuckerman’s (1979) sensation-seeking scale. Any or all of these factors may have contributed to the contradictions evident in the results.

Finally, our data provide partial support for our third hypothesis. Males with lower cortisol levels scored higher on the SSS-V total score and the BS, DIS, and ES subscales. These findings support and extend those of past research (Zuckerman, 1994; Netter et al., 1996; Wang et al., 1997). Among females, however, we found no relationship between cortisol and sensation-seeking measures.

Our findings suggest that the sensation-seeking behaviors of college-age males, but not females, are associated with a hormone other than testosterone. Not surprisingly, the association is moderate, as cortisol levels accounted for less than 8% of the variability in the SSS-V scores in males before T and age were controlled for (Table 3). Many sensation-seeking behaviors, because they are performed within social groups, are of course influenced by group dynamics, norms, and expectations (i.e., “college culture”), which are difficult to measure. Nevertheless, the relationship between cortisol and sensation seeking in males deserves further study. Clearly, an association exists between low cortisol values and sensation seeking in males, but causation cannot yet be argued. The stress or “rush” resulting from sensation-seeking behaviors may affect cortisol levels, or a third factor (or factors) such as low physiological responses to stress might influence both variables.

Interestingly, cortisol levels were not associated with any aspect of sensation seeking in females. This finding suggests a gender difference in the relationship between hormones and sensation-seeking tendencies. Future studies should investigate this effect; normative context may influence women’s sensation-seeking tendencies more than men’s because both societal and peer expectations for the two sexes differ.

As a result, attitudes toward these behaviors may also differ by gender. For example, Zuckerman (1978, 1994) proposed that men value risk taking or sensation seeking significantly more than do women. A large literature deals with gender differences in socialization. The dominant theme is that women are socialized to “repress,” whereas men are socialized to “express” (for reviews see Block, 1983; Rury, 1987; Bussey and Bandura, 1999; Udry, 2000). Thus, although some behavioral gender differences are influenced by biological factors, many of the gender dimorphic stereotyped behaviors and roles seen in men and women are also influenced by sociocultural factors (Beall and Sternberg, 1993; Epstein, 1997; Bussey and Bandura, 1999). These cultural factors may explain the difference we found between males and females in the association of cortisol levels with sensation seeking.

Our study has certain limitations. First, by design, the sample is not representative of all men and women, nor is it representative of college-age students overall in the United States or Florida. Second, our data set did not include some sociodemographic information and relevant psychosocial factors that might have contributed to explaining variability in sensation-seeking behaviors or hormone levels. Because our goal was to examine the association between the two hormones and sensation-seeking scores rather than to explain the maximum variability in the scores, the simplicity of the multivariate models is not an important limitation.) Finally, the sample’s homogeneity in age, education, social status, normative context, and life stage may have contributed to the weakness of the relationships between the biological and behavioral variables under study.

Theory-based interdisciplinary research would greatly improve our understanding of biological influences on human behavior. Because of the strong influence of social environment on norm-breaking or risky behavior, psychosocial factors should be given special attention. Specifically, introducing controls for gendered socialization and expectations in terms of risky behaviors is likely to uncover more accurate associations between biological variables and women’s sensation-seeking behavior.

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