Sensation Seeking, Sexual Curiosity and Testosterone in Inmates

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Key Words
Sensation seeking • Testosterone • Sex hormone-binding globulin • Curiosity about sexual events

Abstract
The relationships between sensation seeking, curiosity about sex, and total and free testosterone in inmates were investigated. The role of other hormones such as luteinizing hormone (LH), follicle-stimulating hormone (FSH), and sex hormone-binding globulin (SHBG) in these relationships was also analyzed. Previous analysis allowed the deletion of extreme hormone values affecting the distribution of the variables. In spite of obtaining a high mean for SHBG, relationships between hormones were appropriate. It was observed that higher values of SHBG produce an increment in total testosterone, but not in free testosterone. Positive relationships between total testosterone and the Disinhibition scale of the Sensation Seeking Scale Form V were replicated, although they were affected by SHBG. Significant relationships between total and free testosterone and curiosity about sex were also found. LH and FSH did not influence these patterns of relations. It was suggested that relationships between SHBG and sensation seeking in inmates could be mediated by items referring to alcohol and drugs. The high levels of SHBG observed in the sample reinforced this suggestion. In spite of the role of SHBG, subjects who were desinhibited and concerned about sex presented higher concentrations of total and free testosterone. The results support Zuckerman’s sensation seeking theory.

Introduction
In the last 30 years, different studies have suggested the existence of a relationship between the personality trait of sensation seeking and sex hormones, basically testosterone (see the review by Roberti [1]). Daitzman [2], Daitzman et al. [3] and Daitzman and Zuckerman [4] were the first to relate sensation seeking to androgens and estrogens, using different versions of the Sensation Seeking Scale (SSS) [5, 6]. Later on, Bogaert and Fisher [7], Galligani et al. [8], and recently Aluja and Torrubia [9] have also reported positive relationships between sensation seeking and testosterone. However, other authors did not find any relationship between the SSS and testosterone [10]. On the other hand, positive relationships between sensation seeking-related traits and testosterone were also obtained in delinquent and normal samples with scales similar to the SSS, such as the Monotony Avoidance Scale...
from the Karolinska Scales [11, 12], or the Novelty Seeking Scale from Cloninger’s Temperament and Character Inventory [13, 14].

In these studies, hormonal levels obtained from blood or saliva samples were correlated with personality measures, or compared between extreme groups considering the trait of sensation seeking. In the studies reviewed, it was observed that determination of total testosterone (TT) is the most frequently used parameter. TT is bound to its transport protein, the sex hormone-binding globulin (SHBG). Unbound testosterone is the free testosterone (FT) fraction and represents around 2% of TT. FT is the only part which is biologically active and can be obtained directly from saliva. However, if obtained from blood, SHBG (and albumin) are also needed to calculate FT [15], because in blood testosterone is only represented as bound to albumin and globulin. To date, few studies involving the trait of sensation seeking have used the free fraction of testosterone obtained in blood. Aluja and Torrubia [9] have suggested the need to control the role of the luteinizing hormone (LH), follicle-stimulating hormone (FSH), and SHBG when studying the relationship between testosterone and personality. LH and FSH can influence testosterone and sperm production in the testicles. SHBG transports testosterone in the blood, and an excessive production of it can affect the levels of bound testosterone [16, 17].

In healthy subjects, the control of LH, FSH and SHBG significantly improved the relationships between a sensation seeking factor [formed by the Experience Seeking (ES), Disinhibition (Dis) and Boredom Susceptibility (BS) scales of the SSS Form V (SSS-V)] and testosterone [9]. In subjects with hepatic disorders (i.e. alcoholics), increases in serum LH and specially SHBG levels have been found [18–20]. SHBG is produced in the liver and is related to biochemical indicators of liver injury, such as the aspartate aminotransferase, alanine aminotransferase, and $\gamma$-glutamyl transferase. Inmates usually present higher levels in these measures due to the ongoing intake of toxic substances. Inmates are expected to have higher levels of SHBG than the general population, and it has indeed been found to be associated with antisocial behavior [19]. It should be noted that since SHBG binds to testosterone in blood, a high concentration of this substance could explain high levels of TT in these samples [21]. Although SHBG is necessary to measure the free fraction of testosterone, the latter is independent of SHBG concentration levels in blood [17].

The Dis scale of the SSS-V contains items about drugs, alcohol, and sex. Brook et al. [22] found the Dis scale to be related to the intake of alcohol in young and adult samples. Zuckerman and Little [23] also reported a high correlation between the Dis scale and watching X-rated erotic movies for both sexes. Correlations between the Dis and the Curiosity about Sexual Events (CASE) scales were 0.58 and 0.48 ($p < 0.001$) for men and women, respectively. It should be noted that both the Dis and CASE scales contain items about sex. The Dis scale revealed the highest correlation with TT as compared to the other subscales of the SSS [4, 24]. Laferla et al. [25] found that the magnitude of LH response was positively correlated with the subjective evaluation of sexual arousal. The FSH showed results in the same direction. Exposure to sex stimuli activates specific areas of the frontal cortex in men relating highly processed sensory information to motivational states, and activates the left anterior cingulate cortex, a paralimbic area that controls autonomic and neuroendocrine functions. Activation of some of these areas was positively correlated with plasma testosterone levels [26].

The aim of the present study was to explore the relationships between the trait of sensation seeking, CASE, and sex hormones in a sample of inmates, following Zuckerman’s [24] sensation seeking theory. The role of LH, FSH, and SHBG in these relationships between testosterone and psychological measures was also investigated.

Method

Sample

The participants in this study were 93 inmates. Four cases with abnormal hormone values (see results) were eliminated from the study. The analyses were thus conducted on 89 subjects. Most of them were serving sentences for different crimes, such as rape, murder, or robbery. The rest were awaiting trial. The age range was 19–46 years (mean $\pm$ SEM 27.69 $\pm$ 5.71). All measures were anonymously collected. Inmates did not receive any financial reward for participating in the study. This study was approved by the corresponding ethical committee.

Personality Measures

The SSS-V has 40 items and includes the subscales Thrill and Adventure Seeking (TAS), ES, Dis, BS, and a total sensation seeking score. The psychometric properties of the Spanish version are very similar to those observed in the English-speaking countries [6, 27–29].

The question about the attitudes towards the media and sports included two curiosity scales: Curiosity about Morbid Events and CASE, but only CASE was used in the current study. This scale is composed of 10 true-false response items and measures attitudes toward pornography, reactions to portrayals of sex in films, pictures and literature, and interest in witnessing sexual acts of others in real life. The CASE scale shows a good internal reliability and convergent validity in terms of correlations with reported sex film attendance.
Table 1. Descriptive statistics of the psychometric and hormone variables

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAS</td>
<td>89</td>
<td>5.75</td>
<td>2.70</td>
<td>0</td>
<td>9</td>
<td>-0.67</td>
<td>-0.76</td>
<td>0.83</td>
</tr>
<tr>
<td>ES</td>
<td>89</td>
<td>6.34</td>
<td>2.15</td>
<td>0</td>
<td>10</td>
<td>-0.09</td>
<td>-0.35</td>
<td>0.58</td>
</tr>
<tr>
<td>Dis</td>
<td>89</td>
<td>5.12</td>
<td>2.61</td>
<td>0</td>
<td>10</td>
<td>-0.00</td>
<td>-0.77</td>
<td>0.77</td>
</tr>
<tr>
<td>BS</td>
<td>89</td>
<td>4.55</td>
<td>2.24</td>
<td>0</td>
<td>9</td>
<td>0.13</td>
<td>-0.62</td>
<td>0.60</td>
</tr>
<tr>
<td>SSS</td>
<td>89</td>
<td>21.76</td>
<td>7.34</td>
<td>0</td>
<td>36</td>
<td>-0.37</td>
<td>-0.01</td>
<td>0.87</td>
</tr>
<tr>
<td>CASE</td>
<td>89</td>
<td>4.84</td>
<td>2.72</td>
<td>0</td>
<td>10</td>
<td>-0.08</td>
<td>-0.91</td>
<td>0.75</td>
</tr>
<tr>
<td>LH</td>
<td>89</td>
<td>8.018</td>
<td>2.611</td>
<td>1</td>
<td>15</td>
<td>-0.77</td>
<td>1.82</td>
<td>–</td>
</tr>
<tr>
<td>FSH</td>
<td>89</td>
<td>5.065</td>
<td>2.073</td>
<td>1.5</td>
<td>12</td>
<td>0.85</td>
<td>0.94</td>
<td>–</td>
</tr>
<tr>
<td>SHBG</td>
<td>89</td>
<td>41.11</td>
<td>12.96</td>
<td>20</td>
<td>77</td>
<td>0.39</td>
<td>-0.64</td>
<td>–</td>
</tr>
<tr>
<td>TT</td>
<td>89</td>
<td>760.28</td>
<td>258.73</td>
<td>157</td>
<td>1,415</td>
<td>0.29</td>
<td>-0.08</td>
<td>–</td>
</tr>
<tr>
<td>FT</td>
<td>89</td>
<td>15.48</td>
<td>5.62</td>
<td>2.70</td>
<td>30.10</td>
<td>0.54</td>
<td>0.36</td>
<td>–</td>
</tr>
<tr>
<td>BT</td>
<td>89</td>
<td>360.05</td>
<td>136.21</td>
<td>25</td>
<td>706</td>
<td>0.38</td>
<td>0.41</td>
<td>–</td>
</tr>
<tr>
<td>Age</td>
<td>89</td>
<td>27.69</td>
<td>5.70</td>
<td>19</td>
<td>46</td>
<td>1.19</td>
<td>1.52</td>
<td>–</td>
</tr>
</tbody>
</table>

These results were satisfactorily replicated in a Spanish sample by Aluja and Torrubia [30]. CASE correlated strongly with SSS, particularly with the Dis scale in both males and females. Furthermore, this scale shows a significant correlation with Eysenck’s [23] psychoticism trait.

**Assay Procedures**

Blood samples were drawn three times (10 ml × 3) from the antecubital vein at intervals of 20 min between 8.00 and 9.00 a.m., in order to minimize the pulsatile effects on hormone levels. They were then pooled and transferred to heparinized tubes and centrifuged. Supernatant plasma was withdrawn and stored in a freezer (–20°C) before proceeding with each determination. These samples were radioimmunoassayed for LH, FSH, TT (assays obtained from Immunootech, Marseille, France), and SHBG, and were measured using the immunoradiometric assay method (Farmos Diagnostica, Oulunsalo, Finland).

FT and bioavailable testosterone (BT) were calculated according to TT values assuming an albumin concentration of 43 g/l [31]. Both measures were equivalent, but in this study they are presented conjointly to facilitate the comparison with other studies that report values of FT or BT. We used a calculator developed at the Hormonology Department, University Hospital of Ghent, Belgium by Dr. Fiers or Prof. Kaufman (http://www.issam.ch/freetesto.htm). Note that in men, the use of both FT and BT is more appropriate than the free androgen index (100 TT/SHBG), especially when the SHBG values are high [31, 32].

**Procedure and Statistical Analysis**

After the subjects had completed the questionnaires individually, they handed them to one of the researchers covered in an envelope. Blood sampling was carried out the following morning. Descriptive parameters of the personality and hormone variables were computed. The alpha index of reliability was only calculated for the personality measures. Pearson correlations were computed between hormones and controlled by Spearman’s rank correlations. Partial correlations controlling for age between personality and hormones were computed. Furthermore, the nonparametric Mann-Whitney U test was used to compare hormone levels in two extreme groups. Subjects with scores one standard deviation above or below the mean on the Dis and CASE scales were selected for the high and low groups, respectively.

**Results**

**Descriptive Values**

Table 1 shows the descriptive values (means, standard deviations, range, skewness and kurtosis) of psychometric and hormone variables. The ratio of kurtosis can be used as a normality test. Normality is usually rejected if the ratio is less than –2 or greater than +2. A skewness value higher than ±1 indicates a distribution that departs significantly from normality [33]. Note that almost all skewness and kurtosis values are inside the ±1 range. Values shown in table 1 were obtained after 4 subjects had been excluded from the study. These participants had abnormally high values regarding the normal distribution of LH (2 subjects), FSH (1), and TT (1). Note that before these subjects were removed, skewness and kurtosis of these variables were higher than 2. Alpha coefficients of the psychological measures are also shown in table 1. Values oscillated between 0.58 and 0.79 for the SSS-V. The CASE scale reached an alpha of 0.75.

**Correlation Analyses between Hormones**

As a prerequisite for discussing relationships between hormones and personality, correlations were computed between hormones. As expected, SHBG was strongly correlated with TT (0.54; p < 0.001), but not with FT and BT. TT also showed high correlations with FT and BT (0.88
Sensation Seeking, Sexual Curiosity and Testosterone in Inmates

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Fig. 1. Means of hormone values (t score) for high and low (± 1 SD) Dis and CASE groups and Mann-Whitney U comparisons.

Table 2. Zero-order correlations between age and SSS, and partial correlations controlling for age between SSS, CASE and hormones

<table>
<thead>
<tr>
<th></th>
<th>TAS</th>
<th>ES</th>
<th>Dis</th>
<th>BS</th>
<th>SSS</th>
<th>CASE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>−0.06</td>
<td>−0.13</td>
<td>−0.19</td>
<td>−0.06</td>
<td>−0.11</td>
<td>−0.08</td>
</tr>
<tr>
<td>LH</td>
<td>−0.11</td>
<td>−0.10</td>
<td>0.02</td>
<td>0.05</td>
<td>−0.05</td>
<td>−0.07</td>
</tr>
<tr>
<td>FSH</td>
<td>0.10</td>
<td>−0.07</td>
<td>0.09</td>
<td>0.03</td>
<td>0.06</td>
<td>0.12</td>
</tr>
<tr>
<td>SHBG</td>
<td>0.17</td>
<td>0.27*</td>
<td>0.30**</td>
<td>0.12</td>
<td>0.29**</td>
<td>0.08</td>
</tr>
<tr>
<td>TT</td>
<td>0.15</td>
<td>0.16</td>
<td>0.24*</td>
<td>0.03</td>
<td>0.20</td>
<td>0.24*</td>
</tr>
<tr>
<td>FT</td>
<td>0.08</td>
<td>0.04</td>
<td>0.13</td>
<td>−0.02</td>
<td>0.08</td>
<td>0.24*</td>
</tr>
<tr>
<td>BT</td>
<td>0.06</td>
<td>0.03</td>
<td>0.11</td>
<td>−0.01</td>
<td>0.07</td>
<td>0.22*</td>
</tr>
</tbody>
</table>

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

and 0.87, respectively; p < 0.001). FT correlated with BT (0.98; p < 0.001), and age correlated with SHBG (0.28; p < 0.01). The results obtained by Spearman’s correlations were quite similar, with the exception of the correlation between LH and FSH, which reached a statistically significant value (0.23; p < 0.05).

Correlation Analyses between Hormones and Personality

Table 2 shows correlations between age and SSS, and partial correlations, controlling for age, between SSS, CASE and hormones. The results indicate that SHBG correlated with ES (0.27; p < 0.01), Dis (0.30; p < 0.01) and SSS (0.29; p < 0.01). TT also revealed a significant correlation with Dis, and CASE (0.24 and 0.24; p < 0.05). FT and BT were not correlated with SSS, but showed significant correlations with CASE (0.24 and 0.22; p < 0.05). After controlling for LH and FSH, these correlations improved slightly, but remained nonsignificant. Partial correlations, controlling for SHBG, between TT and ES, Dis and SSS were also nonsignificant. This finding suggests that the relationships between TT and sensation seeking are mediated by SHBG. However, the correlations of TT, FT and BT with CASE, controlling for SHBG, remained the same.

Hormone Levels in Dis and CASE Extreme Group Subjects

Two groups of high and low scorers were created for the Dis and CASE scales. Subjects with scores one standard deviation above or below the mean were located in the corresponding groups. Plasma values of hormones were converted into t scores (mean ± SD 50 ± 10) in order to compare mean differences. The nonparametric Mann-Whitney U test for two independent samples was conducted. High scorers on Dis (n = 17) obtained higher mean scores on SHBG (p < 0.01) and TT (p < 0.02) (fig. 1). Figure 1 also shows the U test between 33 high scorers and 22 low scorers on CASE. Subjects scoring high on CASE also obtained a higher mean score on TT, FT,
and BT. It turned out that controlling for age did not have much effect on the correlational analysis, since it was not correlated with the personality scales in this sample and can therefore be ignored in this group comparison.

**Discussion**

The present study investigated the relationships between sex hormones and sensation seeking in inmates according to Zuckerman’s theoretical framework [24]. Most of the studies on this topic did not control for the effect of LH and FSH on testosterone or analyze the role of SHBG and the active FT. This procedure is advisable since the inmate population presents a high risk of having liver damage, which would affect hormone concentrations and especially SHBG [18, 19].

The relationships found between SHBG, testosterone, and FT are quite similar to those reported by Stålenheim et al. [19] in alcoholic inmates. This kind of sample is more prone to present hepatic damage due to the ongoing intake of toxic substances (e.g. alcohol, drugs). This characteristic produces an increase in SHBG levels. Note that in the present study SHBG is higher than in healthy subjects, and similar to the value reported by Vilalta et al. [18] in alcoholics. The same pattern emerges for TT, although FT is lower due to the role of SHBG [9, 18]. It should be mentioned that FT, and not TT, is the active fraction of testosterone. Besides, TT increases with SHBG. Therefore, TT does not reflect the activity of the hypothalamic-pituitary-gonadal axis. This is why it is necessary to consider FT.

High correlations were found between SHBG and the Dis and ES scales. Also TT correlated with Dis. Three items of this scale (11, 23, and 39) and 2 of the ES scale (10 and 14) explicitly refer to alcohol or drugs. Others also suggest their presence (i.e. I like ‘wild’ uninhibited parties). Positive relationships between TT, Dis, and ES seem to be linked to SHBG, since controlling for this hormone lowered the correlations to a nonsignificant value. This effect does not arise with regard to CASE, since SHBG is not related to CASE. However, in spite of the influence of SHBG on TT, it is observed that more disinhibited subjects and those curious about sex events have higher levels of TT and FT. On the other hand, controlling for LH and FSH does not alter the correlations between hormones and psychometric measures substantially. A last point is that FT does not correlate with Dis. This fact suggests that FT could represent a state measure, whereas TT could be more linked to the stable component of the sensation seeking trait.

In conclusion, our results replicate previous findings about positive relationships between sensation seeking and testosterone [2–4, 7, 8]. Also, inmates have higher levels of SHBG and TT than normal healthy samples, probably due to hepatic disorders produced by a history of alcohol and drugs abuse. Thus, SHBG and TT are related to sensation seeking, especially to the Dis scale, probably mediated by the items about alcohol and drugs. A relationship between CASE and TT and FT has also been found, but this link is not influenced by SHBG. When SHBG levels were high, bound testosterone also tended to be higher and, therefore, the level of FT fell. Nevertheless, TT and FT were substantially related, both being higher in the high groups of Dis and CASE. This pattern of results supports Zuckerman’s [24] theory.

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