Hostility-Aggressiveness, Sensation Seeking, and Sex Hormones in Men: Re-Exploring Their Relationship

Anton Aluja\textsuperscript{a} Rafael Torrubia\textsuperscript{b}

\textsuperscript{a}University of Leida, Lleida, and \textsuperscript{b}Autonomous University of Barcelona, Barcelona, Spain

**Key Words**
Luteinizing hormone • Aggressiveness • Testosterone • Sensation seeking • Sex hormone-binding globulin

**Abstract**
To evaluate the relationship between sex hormones and aggressiveness, hostility and sensation seeking we studied 30 healthy males. Using a standardised technique of radioimmunoassay, we obtained blood values of luteinizing hormone (LH), follicle-stimulating hormone (FSH), 17\beta-estradiol (E\textsubscript{2}), total testosterone (TT), sex hormone-binding globulin (SHBG) and the free androgen index (FAI). Personality was evaluated by the Buss-Durkee Hostility Inventory and the Sensation-Seeking Scale, form V. The results showed a lack of significant correlations between the measures of aggressiveness-hostility and hormones. Nevertheless, Spearman and Pearson correlations between Sensation Seeking and testosterone were positive and significant after controlling for age. Considerably higher correlations were obtained after controlling for LH and SHBG. A group of subjects with high scores in a factor made up of Experience Seeking, Disinhibition and Boredom Susceptibility obtained significantly higher scores on TT and FAI. Subjects with high scores in a factor made up of Assault, Indirect Aggression and Verbal Aggression obtained significantly higher scores in SHBG and TT. These findings support Zuckerman’s personality model for the sensation-seeking trait.

**Introduction**
Historically, self-reports and direct observations have dominated the assessment of the relationship between sex hormones and aggressiveness and hostility in humans. The Buss-Durkee Hostility Inventory (BDHI) is among the best-known self-report measures [1]. Working with a student sample, Persky et al. [2] found a high correlation between testosterone production rate, plasma testosterone levels, and self-reported measures of aggression and hostility derived from the BDHI. However, two studies using the same instrument yielded contradictory results [3, 4]. Using behavioural measures and criteria, Kreuz and Rose [5] and Ehrenkranz et al. [6] found that a group of inmates with a record of violent crimes showed higher testosterone levels than a group without a violent crime record. Rada [7] and Rada et al. [8] found that sexual assault criminals had higher levels of testosterone than non-sexual assault criminals. Bradford and McLean [9],...
however, did not find differences in testosterone levels between diverse groups of sexual assault criminals classified according to their level of violence. More recent studies considering total or free testosterone, either in blood or saliva, have shown a relationship between testosterone and aggressiveness-dominance in normal and criminal male and female samples [10–12]. Recently Gerra [13] found that subjects with higher scores on the BDHI had significantly higher basal testosterone levels and aggressive behaviour when compared to low BDHI scorers.

In the review by Archer [14], it was concluded that comparisons between high and low aggressiveness groups reveal higher testosterone levels in the more aggressive groups, despite the only low positive correlations between trait measures and testosterone. Overall, the author concludes that androgens might influence aggressive behaviour although they are only one of several influencing factors and not the determining one. Probably the opposite relationship (i.e. the environment and behaviour influencing hormone secretion) is the stronger of the two relationships.

Daitzman et al. [15] reported correlations between both testosterone and 17ß-estradiol and the Disinhibition (Dis) subscale of the Sensation-Seeking Scale (SSS) in men. In a second study, Daitzman and Zuckerman [16], selecting subjects on the basis of extreme Dis scores, confirmed the results obtained in the first study. Male subjects with higher scores on the Dis subscale of the SSS also had higher levels of plasma testosterone and 17ß-estradiol. Galligani et al. [17] have found that athletes with an intake of androgens show more disinhibition, extraversion and risk behaviours [see also 18], although other studies have found no relationship between sensation-seeking scales and testosterone [19]. Using the Novelty-Seeking scale from Cloninger’s Tridimensional Personality Questionnaire, a number of authors have reported positive relationships between androgens and this scale [20, 21]. Using the Monotony Avoidance scale from the Karolinska Scales of Personality in a sample of young delinquents, alcoholic subjects with high testosterone levels obtained elevated scores on this scale [22, 23].

For males, the luteinizing hormone (LH) is related to testosterone through the stimulation of the Leydig cells, while the follicle-stimulating hormone (FSH) is related to the initiation and maintenance of sperm production through the stimulation of the Sertoli cells [24]. Both hormones are related to testicular function, and testosterone and behaviour studies should control for the effect of these hormones since any abnormality in the production of LH and FSH can affect testosterone levels. There are many explanations for abnormalities in the LH and FSH levels, such as genetic predisposition, nutritional factors and toxic effects. In alcoholics, for instance, a significant increase in serum LH, FSH and sex hormone-binding globulin (SHBG) levels, and a decrease in the free androgen index (FAI) [25] have been found. The SHBG is produced in the liver and transports testosterone to the blood. It is possible that in alcoholics and heroin addicts, as well as in subjects with hepatic diseases, there is an increase in total testosterone due to the effect of SHBG [26]. Stålenheim et al. [27] found significant correlations between testosterone and SHBG in alcoholics, and both compounds correlated with the antisocial factor (factor II) of the Hare Psychopathy Checklist-Revised (PCL-R). Taken together, the aforementioned results suggest that in studies of trait and behaviour correlates of testosterone, results could be refined if hormone levels were controlled for LH, FSH and SHBG.

Summing up, enough evidence exists with regard to the relationships between gonadal axis activity and aggressive and sensation-seeking traits. Nevertheless, these studies do not consider the relationship between the two personality characteristics and sex hormone levels. Also, most published studies did not control for the mediating role of LH, FSH and SHBG. The major aim of the present study was to investigate the relationship between basal levels of testosterone – and their aromatization into estradiol –, aggressiveness-hostility (BDHI) and sensation seeking (SSS-V) in a sample of healthy volunteers in order to clarify the extent to which relationships were attributable to each one of these traits. The second aim was to ascertain if the relationships usually found between sex hormones and these personality traits were also observed after controlling for LH, FSH and SHBG.

Method

Sample
The sample consisted of 30 males who volunteered to participate in the study; they were recruited among hospital sanitary staff and final year undergraduate medical students. Age ranged between 21 and 40 years (mean age 27.9 ± 4.9 SEM). All measures were collected anonymously. Two questionnaires had missing data, so both were excluded from statistical analyses. Furthermore, SHBG measures from two participants were missing. Finally, one participant was also excluded because he had an abnormal FSH level (25 mU/ml).

Personality Measures
The Spanish version of the Sensation-Seeking Scale, form V [28] has 40 items and includes the subscales of Thrill and Adventure
In order to reduce the variables related to aggression and sensation seeking, a principal component analysis was carried out for the SSS-V and BDHI subscales together. Four factors were extracted using eigenvalues ≥ 1 as the extraction criterion. They account for 75.33% of the variance. The first factor was composed of Guilt, Sus, Res, Neg and Irr, the second factor of Ass, Ind and Ver, the third of BS, Dis and ES, and the fourth of TAS. The Neg and Irr subscales obtained high secondary loadings on factor II. Given that Neg and Irr had high loadings on two factors, and TAS is encapsulated in an independent factor with regard to ES, Dis and BS from the SSS-V, a second principal component analysis was performed excluding the Neg, Irr and TAS subscales. Three factors were obtained with an eigenvalue ≥ 1, accounting for 73.99% of the variance. The first factor grouped BS, Dis and ES, and was called Sensation-Seeking factor (SSF). The second factor was composed of Sus, Res and Guilt, and was named Hostility factor (HosF). The third factor was represented by Ass, Ind and Ver, i.e. a factor of Aggressiveness (AggF).

Table 1 shows Spearman’s correlations between personality factors and hormones, and partial correlations controlling for age, LH, FSH, and SHBG in different combinations. Age has no role in the observed correlations. However, when age and LH were controlled, correlations between TT and FAI with SSF increased (0.47 and 0.46; p<0.01), as did the correlation between TT and SSF when age and SHBG were controlled (0.45; p<0.05). It should be noted that no significant correlations were found between hormones and the AggF and HosF. The following partial correlations are also shown in Table 1: (a) hormones with SSF, controlling for AggF and age; (b) hormones with AggF, controlling for SSF and age, and (c) hormones with HosF, controlling for SSF and age. Note that correlations between TT and SSF do not improve substantially when the aggressiveness factor and age were controlled.

In a second step, two groups of high and low scorers were created for each personality factor. The criterion for selection was to obtain a percentile equal to or higher than 70 for the high group, or equal to or lower than 30 for the low group. Plasma determination of hormones was converted into T scores in order to compare mean differences (fig. 1). High scorers on AggF (n = 10) obtained mean scores significantly higher than low scorers (n = 8) on SHBG (p < 0.04) and TT (p < 0.03). Figure 1 also shows the U test between 9 high and 8 low scorers on SSF. Subjects scoring higher on SSF also obtained a higher mean on TT (p < 0.02), and on FAI (p < 0.03). No significant
Fig. 1. Mean hormone values (T scores) for high and low Aggressive factor (AggF): Ass + Ind + Ver for high and low Sensation-Seeking factor (SSF: ES + Dis + BS) groups, and Mann-Whitney U test comparisons. LH = Luteinizing hormone; FSH = follicle-stimulating hormone; SHBG = sex hormone-binding globulin; TT = total testosterone; FAI = free androgen index.

Table 1. Spearman’s rho (#) and partial correlations between personality factors and hormones (correlations including 17ß-estradiol were only calculated for the 17 cases with values >10 pg/ml)

<table>
<thead>
<tr>
<th>Sensation seeking factor</th>
<th>Aggressivity factor</th>
<th>Hostility factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>(#) Controlling for</td>
<td>(#) Controlling for</td>
<td>(#) Controlling for</td>
</tr>
<tr>
<td>SSF Age Age + LH Age + FSH Age + SHBG Age + AggF age</td>
<td>AggF Age Age + LF Age + FSH Age + SHBG Age + SSF + age</td>
<td>HosF Age Age + LF Age + FSH Age + SHBG Age + SSF Age + SSF + age</td>
</tr>
<tr>
<td>LH -0.05 -0.11 -0.11 -0.10 -0.13 -0.11 -0.03 0.10 0.06 0.10 0.10</td>
<td>-0.06 0.03 -0.04 0.02 -0.02 -0.03</td>
<td>-0.12 -0.23 -0.23 -0.13 -0.21 -0.23</td>
</tr>
<tr>
<td>FSH -0.04 -0.05 -0.05 -0.01 -0.21 -0.05 -0.23 -0.07 -0.17 -0.06 -0.07</td>
<td>-0.12 -0.23 -0.23 -0.13 -0.21 -0.23</td>
<td>-0.16 -0.27 -0.27 -0.20 -0.26 -0.28</td>
</tr>
<tr>
<td>E2 0.40 0.26 0.26 0.33 0.28 0.30 0.27 0.33 0.43 0.39 0.43 0.43</td>
<td>-0.29 -0.35 -0.36 -0.39 -0.35 -0.30 -0.34</td>
<td>0.00 -0.15 -0.16 -0.20 -0.04 -0.16 -0.16</td>
</tr>
<tr>
<td>SHBG -0.11 -0.10 -0.08 -0.08 -0.11 -0.09</td>
<td>0.28 0.22 0.20 0.27 0.21 0.22</td>
<td>0.14 0.18 0.16 0.17 0.20 0.20</td>
</tr>
<tr>
<td>TT 0.35 0.36 0.47** 0.36 0.45* 0.39* 0.38</td>
<td>0.33 0.28 0.26 0.27 0.21 0.30 0.30</td>
<td>0.12 -0.02 -0.01 -0.13 -0.01 -0.01</td>
</tr>
<tr>
<td>FAI 0.40* 0.40* 0.46** 0.42* 0.49* 0.41*</td>
<td>0.14 0.18 0.16 0.17 0.20 0.20</td>
<td>0.14 0.18 0.16 0.17 0.20 0.20</td>
</tr>
</tbody>
</table>

LH = Luteinizing hormone; FSH = follicle-stimulating hormone; E2 = 17ß-estradiol; SHBG = sex hormone-binding globulin; TT = total testosterone; FAI = free androgen index.
*p < 0.05; **p < 0.01.

difference was obtained for the Hostility factor. It turned out that partialling out age did not show much influence in the correlational analysis, and therefore can be neglected in this group comparison.

Discussion

The main results obtained in the current study were: (1) no significant relationship was found between either aggressiveness or hostility and gonadal hormones; nevertheless, analysis of extreme groups showed higher testosterone levels in highly aggressive subjects; (2) a positive relationship between testosterone and sensation seeking was found when using correlations and extreme group comparisons; (3) the above-mentioned correlations were substantially increased after controlling for LH and SHBG, and (4) correlations between SSF and TT or FAI did not change after controlling for SSF.

Some authors have suggested that age could be a confounding factor in studies linking the gonadal axis to behaviour since both aggression and TT decrease with age. It should be noted that most studies which obtain significant relationships between self-reported aggressive-
ness and personality have been performed with rather young subjects. Schalling et al. [32] attributed these results to the fact that aggressive behaviour is relatively rare in non-clinical adults, and also to the difficulty of using adequate instruments. In any case, our results suggest that when comparing hormone values between extreme AggF scorers, the most aggressive subjects obtain significantly higher mean values in SHBG and TT than the low aggressive ones, although not on the FAI. It is also noteworthy that age, LH, FSH and SHBG did not modulate the results obtained.

The correlational results between gonadal hormones and personality show a consistent relationship between a Sensation-Seeking factor (ES, Dis and BS) and total and free testosterone. Analyses of extreme groups also confirm these results. Estradiol also presents a relationship with the Sensation-Seeking factor, albeit this is not statistically significant. These results confirm previous evidence [15, 16, 18, 20]. As far as we know, no previous study has controlled the effect of the pituitary hormones, LH, FSH and of the binding globulin SHBG in the relationships between hormones and personality. In fact, our results indicate that controlling for both LH and SHBG reinforces the relationship between testosterone and SS. It means that the free fraction of testosterone is associated with sensation seeking because it is not mediated by higher release of LH, which would induce more testosterone, nor is it mediated by higher production of the SHBG. However, as opposed to sensation seeking, aggressiveness may be related to free as well as to bound testosterone and could also depend on LH production, since there was no change in correlations after partialling out LH and SHBG, which is a valuable finding for differentiating between sensation seeking and aggression. Our results suggest that the relationship between SSF and TT or FAI was not modulated by aggressiveness or hostility factors. This would suggest that, in normal samples, the personality variable associated with sex hormone levels is sensation seeking rather than aggressiveness or hostility.

The present results show different hormonal profile patterns for the extreme sensation-seeking and aggressive groups. While the high SS subjects present high levels of TT and FAI compared to the low SS, those subjects with high scores on aggressiveness show higher levels in SHBG and TT. Thus high SS and the most aggressive individuals would share high levels of TT, but would on the other hand differ in their SHBG and FAI profiles. Judging from the present results, SHBG could be a biological marker of aggressive behaviour but not of sensation seeking, whereas free testosterone could be more related to sensation seeking than to aggression in non-clinical healthy subjects.

This study simultaneously explores the relationship between hormones and aggressive personality traits and sensation seeking. One question that remains to be answered is what results would have been obtained if account had been taken of sensation seeking in studies in which a relationship between aggressive traits and testosterone has been observed. A possible explanation for most studies might include the notion of testosterone as a common mediator of the sensation-seeking trait and aggressive tendencies. Further specific studies would be required to test this hypothesis.

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