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Does personality moderate the link between women's testosterone and relationship status? The role of extraversion and sensation seeking

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ABSTRACT

Research shows that testosterone (T) is lower among partnered women, but not for women with a more unrestricted sociosexuality. There are fundamental personality traits, which are indices of mating effort and might moderate the association between T and relationship status. Two such traits are extraversion (E) and sensation seeking (SS). The present study tests if E and SS moderate the association of women's T with relationship status and parental care. Seventy-three Portuguese women completed a short form of the NEO-FFI and the Sensation Seeking Scale (SSS-V). Salivary T was assayed using luminescence immunoassays. Being involved in a committed relationship was related to lower T for the total sample, and for the subgroups low in E and SS, but not for the subgroups high in E and SS. Parental care was related to lower T in the subgroup low in E, and marginally in the subgroup low in SS. In multivariate analyses, only relationship status predicted T in the total sample and in the subgroups low in E and SS. The results were not confounded by age and oral contraception. These results provide support for lower T being important for monogamous pair bonding rather than for being partnered *per se*.

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1. Introduction

Research reveals that men in committed relationships tend to have lower testosterone (T) than uncommitted men or men involved in multiple relationships (Alvergne, Faurie, & Raymond, 2009; Burnham et al., 2003; Gettler, McDade, Feranil, & Kuzawa, 2011; Gray, Kahlenberg, Barrett, Lipson, & Ellison, 2002; Gray et al., 2004; Hooper, Gangestad, Thompson, & Bryan, 2011; Pollet, van der Meij, Cobey, & Buunk, 2011; Sakaguchi, Oki, Nonma, & Hasegawa, 2006; van Anders & Goldey, 2010; van Anders, Hamilton, & Watson, 2007; van Anders & Watson, 2006, 2007). Moreover, lower T levels have been associated with better marital adjustment (Booth & Dabbs, 1993; Edelman, van Anders, Chopik, Goldey, & Wardecker, 2014; Gray et al., 2002). These findings have been interpreted as higher T levels favoring allocation of resources to mating effort, whereas lower T levels facilitate greater allocation of resources to pair bonding and parental care; a bidirectional

causal nexus is also plausible (Gettler et al., 2011; Mazur & Michalek, 1998), in which positive relationship and parental interactions may also lower T (van Anders, Goldey, & Kuo, 2011). This interpretation is consistent with several studies showing that fathers have lower T than non-fathers, independently of the latter being committed or not (Berg & Wynne-Edwards, 2001; Gettler et al., 2011; Gray, Yang, & Pope, 2006; Kuzawa, Gettler, Muller, McDade, & Feranil, 2009), and that T is inversely related to the amount of male parental investment (Alvergne et al., 2009; Gettler et al., 2011; Kuzawa et al., 2009; Muller, Marlowe, Bugumba, & Ellison, 2009).

A smaller number of studies in women have pointed in the same direction, but the results are more mixed. In a study done in the Philippines, mothers had lower T than non-mothers, and married women or women living with a partner had lower T than women who were unmarried or not living with a partner (Kuzawa, Gettler, Huang, & McDade, 2010). In a Norwegian study, mothers had lower T than non-mothers, but there was only a trend towards married women having lower T than their non-married counterparts (Barrett et al., 2013). In a series of North American studies, inconsistencies in studies with women continue to arise. In a study with heterosexual and homosexual women, being in a relationship was only related to lower T in the female homosexual group (van

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Anders & Watson, 2006). Although polyamorous women (committed to more than one partner) had higher levels of T than unpartnered or monogamous women, the two latter groups did not differ (van Anders et al., 2007). In a study with heterosexual couples, whereas men's T was inversely related to partner's satisfaction and commitment, the associations of women's T with their partners' satisfaction and commitment just approached significance in statistical analyses controlling for the interdependence of measures within couples (Edelstein et al., 2014). However, in the same study, zero-order correlations revealed that women's T was related to own and partner's satisfaction and commitment (Edelstein et al., 2014). Interestingly, another investigation showed that unpaired women had higher T than partnered women whose partner lived in the same city, but not than partnered women whose partner lived in a different city (van Anders & Watson, 2007). Because, in the same study, unpaired men were found to have higher T than partnered men, regardless of where their partner was living, the results were interpreted as relationship interactions being more relevant for lowering T in women than lower T predisposing women to enter monogamous long-term relationships. In the case of men, the opposite was proposed to be a more relevant factor in the link between T and partnerships, that is, lower T *a priori* might predispose men to establish monogamous long-term relationships (van Anders & Watson, 2007). This view was strengthened by findings that, whereas unpartnered and casually partnered men had higher T than long-term partnered men, unpartnered women had higher T than both casually partnered and long-term partnered women (albeit in the latter case, at trend level) (van Anders & Goldey, 2010). The findings appear to support that women's T is more likely to decrease with relationship interactions than is the case of men, who seem more prone to establish long-term partnerships, when their T is lower (van Anders & Goldey, 2010; van Anders & Watson, 2007). In a sample of elderly Americans, T was unrelated to marital or relationship status: however, remarriage was associated with T in men, but not in women.

Individual differences in sociosexual orientation vary from preferentially investing resources in one single partner and in a committed relationship (more restricted sociosexuality) to a marked willingness to engage in casual and uncommitted sex (more unrestricted sociosexuality). However, since it is possible that some persons are committed and at the same time predisposed to casual sex, it is plausible that more sociosexually unrestricted people enter committed relationships with higher T levels and/or their T levels do not diminish with relationship interactions or parental care. Thus, it is likely that for more sociosexually unrestricted persons, relationship commitment is not associated with lower T. Indeed, this prediction has been confirmed for both sexes. A study by Edelstein and colleagues used a revised version of the Sociosexual Orientation Inventory (SOI-R), which has three dimensions: desire to have casual sex, attitudes to casual sex, and actual past frequency of casual sex (Edelstein, Chopik, & Kean, 2011). This study found that the association between T and relationship status was moderated by desire for casual sex in men, and by actual frequency of casual sex in women (Edelstein et al., 2011). These findings might be due to women being able to find casual sexual partners with less difficulty than men, even if men can generally feel more desire for casual sex. Moreover, McIntyre and collaborators using the Sociosexual Orientation Inventory (SOI) found that more unrestricted sociosexuality was associated with T levels among partnered men, but not among unpartnered men (McIntyre et al., 2006). These results were interpreted as men in committed relationships, but who are interested in casual extra-pair sex, maintaining higher levels of T. (McIntyre et al., 2006).

However, it is still untested if fundamental personality traits in influential models of personality moderate the association between T and relationship status. Two such traits that can index

greater mating effort are extraversion (E) and sensation seeking (SS). An unrestricted sociosexual orientation is more likely among persons high in E and SS (Penke & Asendorpf, 2008; Schmidt & Shackelford, 2008), which are fundamental personality traits in widely studied models of personality (Costa & McCrae, 1992; Zuckerman, 2010). Both E and SS have been related to other indices of greater mating effort, such as greater lifetime number of sexual partners (Bancroft et al., 2004; Bogaert & Fisher, 1995; Nettle, 2005), lack of relationship exclusivity and mate poaching (Schmidt & Shackelford, 2008). Some research has also found positive correlations between T and both E and SS. (Aluja & Torrubia, 2004; Alvergne, Jokela, Faurie, & Lummaa, 2010; Campbell et al., 2010; Daitzman & Zuckerman, 1980; Daitzman, Zuckerman, Sammelwitz, & Ganjam, 1978; Guerra et al., 1999; Kerschbaum, Rueder, Weissshuhn, & Klimesch, 2006). Extraversion is weakly and inconsistently related to infidelity (Schmidt, 2004), but people more extraverted and more dissatisfied with their relationships are more likely to engage in extra-dyadic sex (Barta & Kiene, 2005). These findings suggest that in the case of committed extroverts, casual sex or extra-dyadic relationships might be more frequently attempted to initiate a new exclusive relationship than interest in casual sex *per se*. In contrast, more introverted people might be more resilient to relationship problems, in the sense that, when there are relationship problems, more introverted people will not be so prone to look for other partners. In this regard, there is less research on sensation seeking, but there is some evidence that it is related to infidelity (Lalasz & Weigel, 2011). Interestingly, T was found to be lower in fathers low in sensation seeking than in fathers high in sensation seeking, further suggesting that more sensation seeking fathers might engage in greater mating effort (Perini, Ditzen, Hengartner, & Ehlert, 2012).

Thus, the aim of the present study is to test the hypotheses that T levels are lower in women involved in committed relationships or providing parental care, but E and SS moderate these associations, in a way that it is hypothesized that lower T levels are related to being in a committed relationship or providing parental care in women low in E and SS, but not in women high in E and SS.

2. Methods

2.1. Participants

Seventy-three women participated in the study (age range: 18–38); 32 were unpaid community volunteers, and 41 were undergraduates who received course credits in exchange for their participation. Table 1 depicts sample characteristics. The study was done according to the Declaration of Helsinki; all participants gave informed consent; anonymity, confidentiality, and ability to discontinue participation at any time were assured. The undergraduate students were recruited from the psychology participant pool of the university, and provided their data in the psychology laboratory. The community volunteers were recruited among a variety of workers of a supermarket who volunteered for the study. They provided the saliva samples and completed the questionnaires in a quiet, undisturbed, place.

2.2. Personality and relationship measures

Extraversion was measured with the respective four-item subscale of the NEO-FFI-20 (Bertoquini & Ribeiro, 2006), a validated Portuguese short version of the NEO-PI-R (Costa & McCrae, 1995). In the present study, Cronbach's alpha for the extraversion subscale was .69. Sensation seeking was measured with a Portuguese version (Mendes & Queirós, 2005) of the Sensation Seeking Scale form V (SSS-V) (Zuckerman, Eysenck, & Eysenck, 1978). In

Table 1
Descriptive statistics.

	Mean (SD) or valid % (N)
Age (years)	25.69 (6.83)
Testosterone (pg/ml)	26.66 (21.45)
Committed	69.9 (51)
Cohabiting	35.6 (26)
Relationship duration (months)	55.27 (59.70)
Parental care	31.5 (23)
Oral contraceptive use	64.8 (46)
<i>Marital status</i>	
Single	84.9 (62)
Married	8.2 (6)
Divorced	6.8 (5)
<i>Profession</i>	
Student	56.2 (41)
Full-time worker	42.5 (31)
Unemployed	1.4 (1)
<i>Sexuality best described as</i>	
Only with opposite sex	87.3 (62)
Mostly with opposite sex	11.3 (8)
About equally with opposite and same sex	1.4 (1)

SD = standard deviation.

the present study, Cronbach's alpha for SSS-V was .83. Median splits were used to create groups low and high in E and SS.

Relationship status was assessed by asking participants if they were involved in a committed relationship with a sexual partner or not. Parental care was assessed by asking participants if they were mothers of children whom they were taking care of.

2.3. Hormonal assays

Each participant provided approximately 1 ml of saliva in a polypropylene tube. Saliva samples were conserved at -20° , centrifuged at 2245g during ten minutes, and assayed for T with luminescence immunoassays (LIAs) done with 50 μ l of saliva. Kits for the LIA were from IBL-International (Ref. RE62031). Intra-assay

and inter-assay coefficients of variation were 4.4 and 7.3, respectively.

2.4. Statistical analyses

Univariate analyses of variance were used to test if committed women had lower T than their uncommitted counterparts. Univariate analyses of variance were also used to test if women providing parental care had lower T than women not providing parental care. Because age and oral contraception are potential confounds, they were entered as covariates. The same analyses were repeated for the groups high and low in E, and high and low in SS, as divided by median splits. Although the use of median splits has been criticized on the basis that it reduces statistical power (Cohen, 1983), median splits are common in personality research of extraversion and sensation seeking, and several hypotheses about these traits have been confirmed using this methodology (Blumenthal, 2001; Helgason, Fredrikson, Dyaba, & Steineck, 1995; Jonah, Thiessen, & Au-Yeung, 2001; Stafford, Ng, Moore, & Bard, 2010; Wong, Bernardo, & Carducci, 1991). For more references, see Stafford et al. (2010).

To test potential independent associations of relationship status and parental care in predicting T, backward multiple regressions were used with T as dependent variable. The candidate predictors were relationship status, parental care, age, and oral contraceptive use. The regressions were done separately for the total sample, and for the groups high and low in E or SS.

3. Results

Tables 2 and 3 display the results of the ANOVAs for the total sample, and by subgroups of women high and low in E, and high and low in SS. The differences in the number of participants by subgroup is due to the proportions of women who are partnered or providing parental care being different from their counterparts according to personality. Nevertheless, χ^2 tests did not reveal significant differences. As displayed in Tables 2 and 3, partnered women had lower T levels. Among the group low in E, women with a committed partner had lower T than unpartnered women (see

Table 2

Univariate analyses of variance comparing basal testosterone levels (pg/ml) of partnered and unpartnered women (age and oral contraception are covariates).

	Partnered Estimated marginal mean (SE), N	Unpartnered Estimated marginal mean (SE), N	F	Partial eta squared
Total sample	22.48 (16.00), 51	37.75 (4.75), 22	7.09**	.097
Extroverted	25.08 (4.82), 25	39.63 (8.63), 9	2.13	–
Introverted	20.74 (3.78), 26	35.83 (5.48), 13	5.09*	.13
Higher sensation seeking	25.06 (2.75), 27	26.42 (4.79), 10	.06	–
Lower sensation seeking	20.08 (5.44), 24	46.91 (7.91), 12	7.71**	.20

SE = standard error.

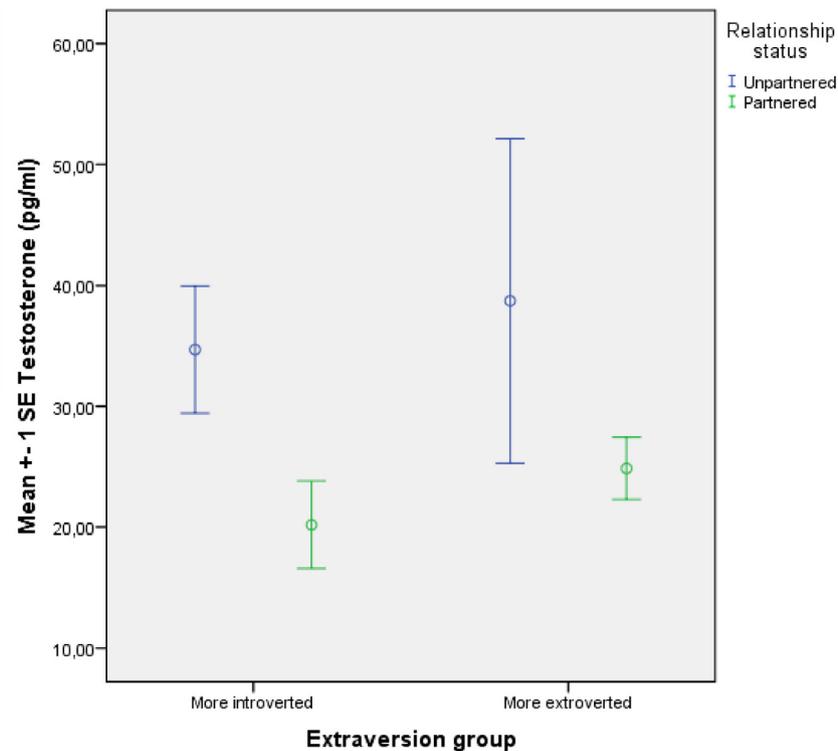
* $p < .05$.** $p \leq .01$.**Table 3**

Univariate analyses of variance comparing basal testosterone levels (pg/ml) of women with and without parental care (age and oral contraception are covariates).

	With parental care Estimated marginal mean (SE), N	Without parental care Estimated marginal mean (SE), N	F	Partial eta squared
Total sample	18.67 (5.74), 23	30.87 (3.50), 50	2.63	–
Extroverted	31.32 (10.31), 8	27.74 (5.26), 26	.08	–
Introverted	9.73 (6.80), 24	35.31 (4.78), 15	6.82 [†]	.17
Higher sensation seeking	28.28 (13.47), 8	24.63 (13.56), 29	.67	–
Lower sensation seeking	14.89 (8.66), 15	38.47 (6.93), 21	3.64 [†]	.11

SE = standard error.

* $p = .013$.† $p = .066$.



SE = standard error

Fig. 1. Basal T levels (pg/ml) of partnered and unpartnered women by extraversion group. SE = standard error.

Fig. 1), and women providing parental care had lower T than women not providing parental care. Among the group low in SS, women with a committed partner had lower T than unpaired women (see Fig. 2). Among the group low in SS, women with parental care had lower T, but the association was marginal. However, among the groups high in E and SS, T levels were unrelated to relationships status and parental care.

Partial eta squared values are reported for the significant or near-significant associations. Partial eta squared values are measures of effect size of ANOVAs and indicate the percentage of explained variance of the association; in that sense, they are equivalent to r^2 .

Table 4 depicts a series of backward multiple regressions with T as dependent variable, and relationship status, existence of parental care, oral contraceptive use, and age, as independent variables. For the total sample, only relationship status predicted T: partnered women had lower T levels. Similar results, but with larger effect sizes, were obtained among the groups low in E and SS (see Table 4). There were no significant predictors when the analyses were done for the groups high in E and SS.

4. Discussion

In a Portuguese female sample, it was confirmed that, for the total sample, partnered women have lower T than unpartnered women. These findings were not confounded by age and oral contraception, and are congruent with other studies (Barrett et al., 2013; Edelstein et al., 2014; Kuzawa et al., 2010; van Anders & Watson, 2007). The results of the present investigation appear to support the view that lower T is related to greater investment in pair bonding also in women. For the total sample, parental care was not associated with T.

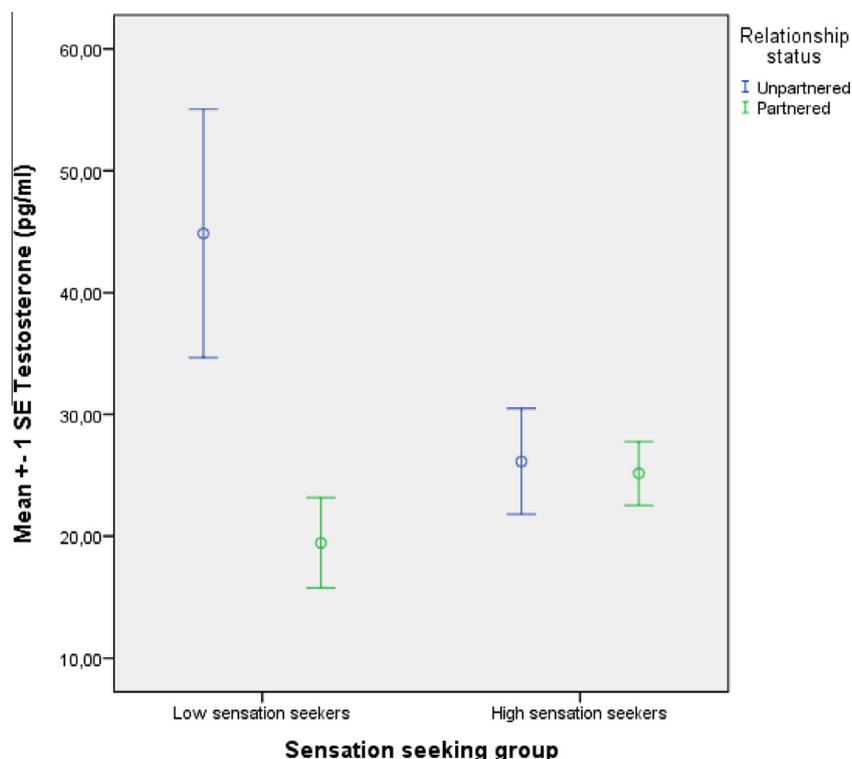
As predicted, both E and SS moderated the associations between T and relationship status, and between T and parental care. Only

for more introverted and less sensation seeking women, T was lower among those partnered or providing parental care (although the association of parental care with lower T among women low in SS was marginal). These findings are congruent with others demonstrating that fathers high in SS had higher T than fathers low in SS. In multivariate analyses (for total sample and subgroups), only relationship status predicted T, which indicates that the inverse associations of parental care with T among women lower in E and SS were due to these women generally being in a committed relationship. All results were not confounded by age and oral contraceptive use.

Given that both E and SS are related to greater lifetime number of sexual partners, among other indices of mating effort, the present findings are consistent with previous research, in both sexes, revealing that T is lower only among those partnered people who have a more restricted sociosexual orientation (Edelstein, Chopik, & Kean, 2011). Therefore, the findings suggest that persons higher in E and SS may be more prone to invest their resources in mating effort, even when they are involved in a committed relationship.

Limitations of the study include a relatively small convenience sample of younger women. Future studies should attempt replication in larger representative samples, including women of older age ranges. Given the cultural context of the participants, the possibility of commitment with more than one partner, known as polyamory, is expected to be negligible. However, times change, and persons and cultures change with them. Given that there are people who identify as polyamorous, future research might consider to control for this factor. Future studies might also distinguish between short-term and long-term committed relationships. We did not make this distinction, but the larger mean duration of the committed relationships indicates that they were generally long-term partnerships.

It has been suggested that, for women, the amount of intimate interactions in a relationship is more cause than effect of lower T, whereas the opposite causal direction is more likely for men: that



SE = standard error

Fig. 2. Basal T levels (pg/ml) of partnered and unpartnered women by sensation seeking group. SE = standard error.

Table 4

Backward multiple regressions predicting testosterone from relationship status, parental care, age, and oral contraception.

	Significant predictors	β	p	Adjusted R square	Standard error
Total sample	Relationship status	-.30	.011	.076	5.33
Extroverted	None	-	-	-	-
Introverted	Relationship status	-.35	.032	.099	6.51
Higher sensation seeking	None	-	-	-	-
Lower sensation seeking	Relationship status	-.44	.009	.17	9.13

Relationship status: 0 = not committed, 1 = committed.

is, those men with lower T appear to be more inclined to establish stable relationships, whereas for women relationship interactions may be more likely to lower T (van Anders & Goldey, 2010; van Anders & Watson, 2007). Future research might examine if E and SS moderate decreases in women's T caused by relationship interactions. If that is the case, it could explain the greater number of inconsistencies in the studies with women, because women involved in committed relationships, but not having enough interactions of adequate quality, might maintain higher T levels.

In sum, the present study shows that fundamental personality traits related to greater mating effort, such as E and SS, moderate the association between women's T and relationship status.

Conflict of interest

There are no conflicts of interest.

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