Hormones and Behavior 58 (2010) 820–826

Contents lists available at ScienceDirect

Hormones and Behavior

journal homepage: www.elsevier.com/locate/yhbeh

Testosterone and partnering are linked via relationship status for women and 'relationship orientation' for men

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ARTICLE INFO

Article history:
Received 3 May 2010
Revised 9 August 2010
Accepted 11 August 2010
Available online 18 August 2010

Keywords:
Pair bonding
Relationships
Gender
Sex
Testosterone

ABSTRACT

Cross-cultural evidence links pair bonding and testosterone (T). We investigated what factors account for this link, how casual relationships are implicated, and whether gender/sex moderates these patterns in a North American sample. We gathered saliva samples for radioimmunoassay of T and self-report data on background, health, and social/relational variables from 115 women and 120 men to test our predictions, most of which were supported. Our results show that singles have higher T than long-term (LT) partnered individuals, and that casual relationships without serious romantic commitment are more like singlehood for men and LT relationships for women–in terms of T. We were also able to demonstrate what factors mediate the association between partnering and T: in women, frequency of partnered sexual activity mediated the effect in men, interest in more/new partners mediated the effect. This supported our prediction of relationship status interpretations in women, but relationship orientation in men. Results replicated past findings that neither sexual desire nor extrapair sexuality underlie the T-partnering link. We were able to rule out a large number of viable alternative explanations ranging from the lifestyle (e.g., sleep) to the social (e.g., social support). Our data thus demonstrate pattern and mediators for the development of T-pair bonding associations, and emphasize the importance of neither under- nor overstating the importance of gender/sex in research about the evolution of intimacy.

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Introduction

Partnering and testosterone (T) are linked in men (van Anders and Gray, 2007; van Anders, 2009) with singles having higher T than monoamorously partnered men (Gray et al., 2004b; Gray and Campbell, 2009; van Anders and Watson, 2006a). However, being partnered per se is not tied to lower T as both polyamorous men in North America (van Anders et al., 2007b) and polygamous men in non-Western locales (Gray et al., 2007) have higher T than their monoamorously partnered counterparts, and similar or higher T than single men. Results point to effects among men partnered with women, but not same-gender partnered men (van Anders and Watson, 2006a). As such, it appears that men who are partnered with one woman, i.e., heterosexually uni-pair bonded, have lower T. A major gap remains, however, since no studies have systematically examined T in casual relationships. Polyamory and polygamy differ from casual relationships in that the former involves long-term (LT) structured romantic/emotional commitments while casual relationships do not. In contrast, these are all similar in that they all involve the possibility of new/multiple partners.

Group differences in T by relationship status in men have been found cross-culturally and replicated independently among multiple labs, indicating a robust effect. In contrast, few studies have addressed how partnering and T may be linked in women, and therefore, the pattern of findings is less consistent though indicative of an underlying effect. Monoamorously partnered women have lower T than single women (van Anders and Watson, 2006a) especially if they are same-city rather than long-distance partnered (van Anders and Watson, 2007), and polyamorous women have higher T than both single and LT partnered women (van Anders et al., 2007b). Sexual orientation appears to be an inconsistent moderator in women (van Anders and Watson, 2006a; van Anders et al., 2007b), although means are repeatedly in the expected directions regardless of sexual orientation. As such, monoamorously partnered women tend to have lower T than single women, who have lower T than polyamorously partnered women—but again, no research has examined casual relationships and the overall effect is still unclear in women.

The critical question of what underlies the T-partnering link is unanswered, although researchers have attempted to examine what might account for the low T-pair bonding link in men. Relational activities, like time spent with partners, might be expected to account for the lower T, but findings strongly indicate that this is not the case (Gray et al., 2004a). Pointing to the same conclusion, van Anders et al. (van Anders and Watson, 2007) found that men in long-distance and

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doi:10.1016/j.yhbeh.2010.08.005

same-city relationships had similar T, and lower T than single men, which could not be the case if daily interactions with partners were an explanatory factor. McIntyre et al. (2006) examined whether sociosexual orientation inventory (SOI) scores and interest in extrapair sexual opportunities accounted for the effect, but found mixed effects. They sometimes failed to replicate the established group difference in T by relationship status, and sometimes found effects only in paired men or sexually experienced single men—there was no clear-cut evidence that SOI accounts for the observed differences in T. Further, van Anders et al. (2007b) found that SOI and T were not significantly correlated and that SOI did not account for any of the group differences in T and partnering in women or men. Similarly, van Anders et al. (2007b) found that sexual desire also did not account for the group differences in T for men or women. Accordingly, there is still no explanation for why T and partnering are linked in men, and there are similarly no data for women.

Directionality of effect – i.e. whether T predicts partnering or partnering changes T – has not been conclusively demonstrated in women or men, but data are suggestive though interpretations are controversial (van Anders and Gray, 2007). Lower T in men predicted subsequently entering LT relationships in a small preliminary sample, and T did not change in response to entering an LT relationship (van Anders and Watson, 2006a). A much larger and longer longitudinal study also found that men with lower T were more likely to have married and less likely to have divorced (Booth and Dabbs, 1993; Mazur and Michalek, 1998). And, as noted above, van Anders and Watson (2007) found that men in same-city and long-distance relationships had similar T, which could not be the case if many types of daily relational behaviors were the root of the group differences in T. Finally, we found that polyamorous men with multiple partners had similar levels of T to polyamorous men who at time of testing did not have multiple partners, suggesting that interest in multiple partners influenced T rather than presence of multiple partners (van Anders et al., 2007b). Many social behaviors do affect T (Gleason et al., 2009; Roney et al., 2007; van Anders and Watson, 2006b), and there is evidence of state effects on T of changes in relationships, but these are transient and do not account for the group differences in T: divorce leads to transient increases in T in men (Mazur and Michalek, 1998) and entering a relationship transiently changes T in women and men (Marazziti and Canale, 2004). In both studies, T reverted to previous levels after a duration. Given this pattern of findings in men, evidence more strongly points to a long-term effect of T on entering relationships (van Anders and Gray, 2007), and we have predicted that the group differences in T in men are actually due to 'relationship orientation' (propensity to enter long-term or other kinds of relationships) rather than relationship status (current status as partnered or not). Specifically, we have predicted that interest in new and/or more partners is the factor that underlies the group differences in T and partnering in men based on a collection of evidence, including the T trade-off framework, in which higher T is linked to competitive behaviors, including more sexual encounters within or outside relationships, and more interest in new partners, while lower T is linked to bond-maintenance behaviors including nurturance (van Anders and Watson, 2007; van Anders et al., 2007b; van Anders, 2009).

There is less evidence pointing to either directional interpretation in women given fewer extant studies, but physical partner presence has been linked with lower T in women (van Anders and Watson, 2007), which is suggestive of T being linked to relationship status in women rather than relationship orientation. In one longitudinal study with a small sample of women, we found that T appeared to predict entering an LT relationship rather than changing in response to it. However, we found that polyamorous women who had multiple partners had higher T than polyamorous women who were not multiply partnered at the time (van Anders et al., 2007b), suggesting that number of partners, rather than interest in partners, influenced T. Although data are mixed, we have argued they point more strongly to a prediction that T and partnering in women is linked via relationship status (van Anders and Watson, 2007; van Anders et al., 2007b). Specifically, we have predicted that frequency of masturbation underlies the group difference in T and partnering in women (van Anders and Watson, 2007; van Anders et al., 2007b) based in part on evidence of links between high T and masturbation frequency (van Anders et al., 2007a).

Our first major aim in this study was to examine how T and partnering were associated when considering casual relationships. We expected (1a) to replicate past findings of higher T in single men compared to long-term partnered men and to clarify whether this pattern exists for women. We predicted (1b) casually partnered individuals would have higher T than single individuals, and that (1c) casually partnered individuals would have higher T than LT partnered individuals. Our second major aim was to examine why T and partnering are related, by examining a large variety of factors that might account for differences in T. In men, we predicted that (2a) factors related to relationship orientation (propensity to enter long-term or other kinds of relationships) would account for the group differences in T; and (2b) interest in new partners, specifically, would be the key variable (van Anders and Watson, 2007). Unlike McIntyre et al. (2006), we did not predict that extrapair sexual interest or SOI would be the key variable, but instead a more general interest in finding new and/or more partners. In women, we predicted that (2c) factors related to relationship status would account for the group differences in T and (2d) that frequency of masturbation would be key (van Anders and Watson, 2007).

Methods

Participants

Participants ($N = 235$) were 115 women (mean age = 21.96 yrs, SD = 6.6) and 120 men (mean age = 22.93 yrs, SD = 8.3) recruited from the undergraduate psychology pool and the larger community through posters and online advertisements, and compensated with course credit or $10. The majority ($n = 203$) were students, but many ($n = 80$) were employed in diverse occupations. All but two participants had graduated from high school, and the majority ($n = 225$) had some college or other advanced training. Participants self-identified their race/ethnicity, which we categorized such that we had the following responses: 22 African American/Black, 1 American Indian, 56 Asian, 5 Hispanic/Latino/a, 14 Bi/Multiracial, and 135 White/Caucasian participants. Participants were diverse by religion. Most participants had spent the majority of their lives in the United States, although 10% had lived in the United States for 10 years or less. Participants self-identified their sexual orientation, and the majority were classifiable as heterosexual ($n = 181$).

Participants self-identified their relationship status by selecting from preset options of single, dating (not including committed relationships), committed relationship, separated/divorced, widowed, and/or other, terms we defined for participants. We defined 'dating' as a casual relationship with another person that may be sexual and is 'romantic,' but not committed, with examples of going to the movies or dinner. We defined 'committed relationship' as a relationship that is romantic and usually sexual, involving a commitment by each person to be together as relationship partners for some time, with examples of boy/girlfriends, going out, long-term relationships, marriage, cohabiting, and common-law. Participants indicated the number of partners and also indicated the type of relationship if they selected 'committed relationship.' Based on these responses and past studies (van Anders and Watson, 2006a; van Anders and Watson, 2007; van Anders et al., 2007b, 2009), we categorized relationship type as: single = not linked to anyone; casually partnered = having one or more noncommitted (dating) partners; or long-term (LT) partnered = in a committed relationship. We thus had 108 single participants (50 women, 58 men), 50 casually partnered participants (26 women, 24 men), and 77 LT partnered participants (39 women, 38 men).

Materials

Questionnaires

Participants completed a background questionnaire with items about demographics to characterize the sample, height and weight to calculate BMI (body mass index, a measure of weight adjusted for height), and possible confounds with hormone measures. The questionnaire also contained items about relationships and sexuality, including participants' frequency of masturbation during the previous week and frequency of partnered sexual activity (defined as passionate kissing or touching, oral sex, vaginal sex, anal sex, etc.) on a Likert-type scale from 0 = none to 6 = 2 or more times per day.

We asked participants to report on their interest in and enjoyment of sexual encounters, dating encounters, and flirting experiences using 7-point Likert-type scales for responses ranging from 1 = not at all to 7 = very much. We defined, with examples provided: sexual encounters as sexual interactions with another person that do not include a longer-term connection; dating as a casual relationship you have with another person that may be sexual and is 'romantic' (that is, you 'like' or are interested in the other person) and flirting as verbal and/or physical interactions that have some degree of potential romantic/sexual playfulness and/or interest. For dating desires, we summed participants' responses to 18 questions: how much they would like (or would have liked) to date, initiate a dating relationship, or have someone else initiate a dating relationship with them for the future month, year, and upcoming lifetime as well as the past month, year, and already passed lifetime. Similarly, for sexual encounter desires, we summed participants' responses to the same 18 questions, modified for sexual encounters. We had an overlapping but also divergent set of questions for flirting desires, given the multidimensional nature of flirting—we summed participants' responses to 15 questions: how much they would like to initiate or be receptive to flirting given committed relationships in the future; how much they would like to flirt, initiate flirting, or be flirted with for the past month, year, and already passed lifetime; their enjoyment of flirting, initiating flirting, and being flirted with; and their comfort letting people know of their attraction. For future cheating desires, we asked participants to report on their preference to have additional sexual encounters with people other than their committed relationship partner if it were possible, the likelihood of being sexually/romantically involved with another attractive person interested in them without their partner's consent, and the likelihood of initiating a sexual/romantic involvement with another attractive person who was interested in them without their partners' consent. The scales had very high internal consistency, e.g., Cronbach's α was .946 for dating desires. Not surprisingly, scale items resolved into factors representing the temporal aspects (e.g., past vs. future) and agentic/receptivity themes (e.g., be asked out vs. ask someone out); however, the extremely high internal consistency as well as high a correlation between past and future dating desires, $r(222) = .72$, $p < .001$, supports using the scales as unitary measures.

Participants also completed other questionnaires to assess various social, psychological, and health parameters: the General Well-Being (GWB) Schedule (Fazio, 1977), which results in subscales of positive well-being, self control, vitality, anxiety, depression, and general health (Brook et al., 1979); the Godin Leisure-Time Questionnaire, which measures exercise and physical recreation (Godin and Shephard, 1997); the Perceived Stress Scale (PSS) (Cohen et al., 1983), for which we used the shorter 10-item version (Cohen and Williamson, 1988); the Positive and Negative Affect Schedule (PANAS) (Watson et al., 1988), which results in positive and negative subscales; the Rosenberg Self-Esteem Scale (Rosenberg, 1965); the Sexual Body Image Self-Consciousness (BISC) Scale (Wiederman, 2000), which was completed only by participants who had ever been sexually active with a partner; the Sexual Desire Inventory (SDI) (Spector et al., 1996), which results in total, solitary, and dyadic desire scores; and the UCLA Loneliness Scale, Version 3 (Russell, 1996).

Saliva samples

Participants provided unstimulated saliva samples by spitting into 17-mL polystyrene tubes after rinsing their mouths with water; samples were frozen until assay. T was assayed in one batch by radioimmunoassay at the Core Assay Facility, University of Michigan, using a commercially available kit from Siemens. The intra-assay coefficient of variation was 3.33%. Samples were assayed in duplicate, and samples with coefficients of variation greater than 15% between the duplicates were re-run. Eight women had T values below the sensitivity level of the assay (4 pg/mL), so their data were not used in analyses.

Salivary T measurements present both advantages and disadvantages when compared to blood samples. Saliva collection is less invasive, less likely to trigger stress responses associated with venipuncture, and poses less (if any) of a biohazard. Saliva sampling is newer than serum sampling, but is widely used in biobehavioral research. Salivary assays are well-established and validated; salivary T correlates well with free serum T (Granger et al., 2004; Khan-Dawood et al., 1984; Magrini et al., 1986; Swinkels et al., 1988) and total serum T (Granger et al., 2004; Shirtcliff et al., 2002). However, salivary T measurements may underestimate the strength of T-behavior relationships in women, so larger samples of women should be used in order to alleviate this concern (Granger et al., 2004; Shirtcliff et al., 2002). Salivary steroid levels reflect the portion of hormone that is "bioavailable"; i.e., the portion that is unbound or weakly bound to albumin or sex hormone-binding globulin (SHBG) and available to bind with receptors (Quissell, 1993).

Procedure

Thus study was approved by the university's institutional review board. Participants were tested between 12:00 and 19:00 h to avoid the high levels and rapid decline in T associated with waking and/or the morning (Axelsson et al., 2005; Khan-Dawood et al., 1984). Participants were tested from February to September. Women were tested in all phases of their menstrual cycles; although small fluctuations in T occur across the cycle, cycle phase does not need to be controlled for in research involving T unless menstrual phase is specifically of interest (Dabbs and de La Rue, 1991; van Anders and Watson, 2006a; van Anders et al., 2007a, 2009).

Participants were asked to refrain from eating, drinking, smoking, brushing their teeth, or chewing gum for 1 hour before testing. During a laboratory session, participants completed an informed consent and provided a saliva sample while completing a questionnaire packet.

Analyses

Two women and two men had T values over 3 SD from the mean for their gender/sex and were excluded from analyses. Participants using hormonal medications/supplements or with hormone-altering health conditions were also excluded. Women of all sexual orientations were retained in the analyses since previous research (van Anders, 2009) showed the effect to be nonspecific to orientation. Men who self-identified as gay or bisexual were excluded since previous research (van Anders and Watson, 2006a) showed the effect to be specific to heterosexual men. Age covaries with both T (Burger et al., 2000; Feldman et al., 2002) and partnering status, as does nicotine use (Chivers and Bailey, 2005; Diamond, 2003); however, only nicotine use was a meaningful covariate for women (nicotine, $F[1,76] = 6.37$, $p = .014$; age, $F[1,76] = 1.71$, $p = .196$), and neither were significant covariates in our sample for men (age, $F[1,69] = 1.38$, $p = .244$; nicotine use, $F[1,68] = .02$, $p = .883$). Because T differs so

strongly by gender/sex, we conducted our analyses separately as is typical (van Anders and Watson, 2007; van Anders et al., 2007b).

Results

We conducted analyses with SPSS 17.0. First, we examined whether T differed by partnering status using analyses of covariance (ANCOVAs) with T as the dependent variable, partnering status as the independent variable, and the covariate as appropriate. Next, we conducted ANOVAs to see which variables differed by partnering status, using $p<.10$ to increase the likelihood of falsifying our hypotheses that relationship status and not other underlying variables account for the differences in T. We then entered any variables that met this criterion back into the ANCOVA and concluded that those that decreased the effect from statistical significance to nontrend accounted for at least part of the variance of the effect. Finally, we entered any factors that met this last criterion into a forwards regression to see which were the strongest predictors of T.

Women

A univariate ANCOVA with nicotine use as the covariate showed a significant effect of partnering status on T, $F(2,76)=3.19$, $p=.047$. Single women had significantly higher T than women in casual relationships ($p=.025$) and a trend for higher T than women in LT relationships ($p=.075$). There was no significant difference between women in LT and casual relationships ($p=.527$). See Fig. 1.

There were no significant differences or trends (all p's $>.10$) by partnering status for date of sampling, BMI, alcohol use, caffeine consumption, diet (e.g., protein intake), exercise, most sleep habits, perceived social stress, PANAS-positive, GWB, loneliness, self-esteem, sexual desire, or sexual orientation.

There were significant or nearly so differences by partnering status for parental status, $F(2,86)=3.08$, $p=.051$, income, $F(2,66)=4.88$, $p=.011$, time of sampling, $F(2,87)=3.11$, $p=.050$, PANAS-negative, $F(2,86)=2.65$, $p=.076$, typical weekday bedtime, $F(2,86)=2.95$, $p=.058$, and body image self-consciousness, $F(2,64)=3.43$, $p=.038$. Including these as covariates did not reduce the effect of partnering status on T to a nontrend.

There were significant or nearly so differences by partnering status for overall flirting desires, $F(2,82)=4.47$, $p=.014$, overall dating desires, $F(2,81)=10.78$, $p<.001$, overall sexual encounter desires, $F(2,85)=5.90$, $p=.004$, and future cheating desires, $F(2,87)=3.00$, $p=.055$. Including these as covariates did not reduce the effect of partnering status on T to a non-trend, except that overall dating desires (see Fig. 2) did, $F(2,69)=1.87$, $p=.161$.

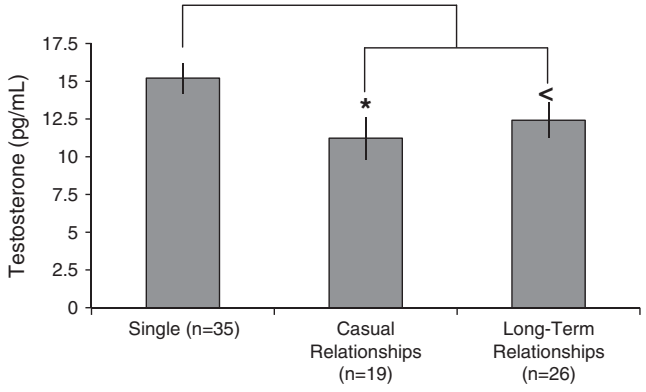

Fig. 1. Testosterone levels by relationship type in women. 'Casual' indicates casually partnered; '*' indicates a significant difference at $p<.05$; '<' indicates a statistical trend at $p<.075$.

There was a significant or nearly so difference by partnering status for frequency of partnered sexual activity (see Fig. 3), $F(2,87)=29.58$, $p<.001$, and masturbation frequency (see Fig. 4), $F(2,85)=2.96$, $p=.057$. When entered into a covariate, frequency of masturbation decreased the effect of partnering status on T, $F(2,73)=1.76$, $p=.180$, as did frequency of partnered sexual activity, $F(2,75)=1.62$, $p=.204$. We also examined sexual orientation though it did not differ significantly by partnering status, because it has been a moderator of the partnering-T link in women in the past. However, it did not change the pattern of findings in these data.

We conducted a forward entry regression to see how strongly each variable (partnering status, nicotine use, overall dating desires, masturbation frequency, and frequency of partnered sexual activity) predicted T levels in women. The regression described 14% of the variance, $R^2_{adj}=.13$, and was significant, $F(1,71)=11.99$, $p=.001$. Of the five variables, only frequency of partnered sexual activity, $t(71)=-3.46$, $p=.001$, was a significant predictor of T, though there was a trend for nicotine use, $t(71)=1.89$, $p=.063$. T was not significantly correlated with overall dating desires, *partial* $r(71)=-.05$, $p=.701$, or masturbation frequency, *partial* $r(75)=.19$, $p=.102$. T was significantly negatively correlated with frequency of partnered sexual activity, *partial* $r(77)=-.34$, $p=.002$. Within partnering type, T was significantly negatively correlated with frequency of partnered sexual activity T for casually partnered individuals, *partial* $r(16)=-.54$, $p=.020$, but nonsignificantly in singles and LT partnered individuals likely due to the small n's for within-group correlations.

Men

A univariate ANOVA showed a significant effect of partnering status on T, $F(2,70)=4.18$, $p=.019$. Single men ($p=.020$) and men in casual relationships ($p=.010$) had significantly higher T than men in LT relationships, and there was no significant difference between single men and men in casual relationships ($p=.507$). See Fig. 5.

There were no significant differences by partnering status for time of sampling, BMI, parental status, alcohol use, caffeine consumption, diet (e.g., protein intake), exercise, income, typical weekend wake-up, typical weekday bedtime, time to sleep last night, waking time this morning, perceived social stress, PANAS-negative or -positive, GWB, loneliness, self-esteem, body image self-consciousness, sexual desire, future cheating desires, or frequency of masturbation.

There was a significant difference in testing date, $F(2,70)=5.43$, $p=.006$, and sleep by partnering status for typical weekday wake-up, $F(2,69)=3.76$, $p=.028$, typical weekend bedtime, $F(2,68)=5.34$, $p=.007$, and hours slept last night, $F(2,69)=3.52$, $p=.035$, but

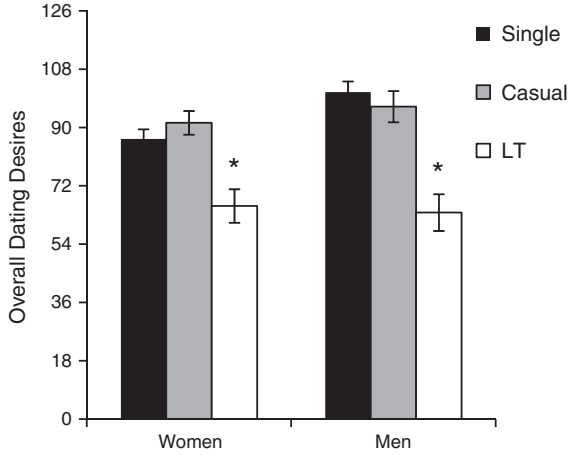

Fig. 2. Overall dating desires by partnering status in women and men. 'Casual' indicates casually partnered; 'LT' indicates long-term partnered; '*' indicates a significantly different value from other within-gender/sex means at $p<.001$.

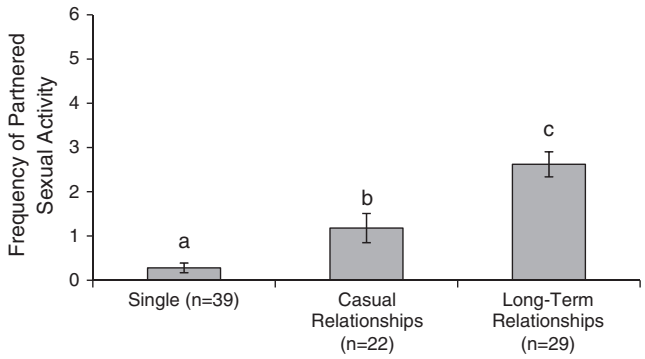

Fig. 3. Frequency of partnered sexual activity on a Likert-type scale by partnering status in women. '0' = none; '1' = 1/mo; '2' = '2-3 times/mo'; '3' = '1/wk'; '4' = 2-4 times/wk; '5' = '1/day'; '6' = '2+ times/day'; 'Casual' indicates casually partnered; differing letter superscripts indicate significant differences at $p < .01$.

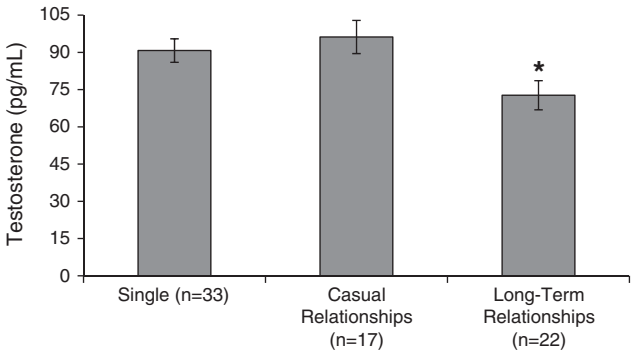

Fig. 5. Testosterone levels by relationship type in men. 'Casual' indicates casually partnered; '*' indicates a significant difference at $p < .05$.

including these as covariates did not change the pattern of results. There was a significant difference by partnering status in frequency of sexual activity, $F(2,70) = 11.67$, $p < .001$, but accounting for this did not change the pattern of results.

There were also significant differences by partnering status in overall dating desires, $F(2,66) = 20.61$, $p < .001$, overall flirting desires, $F(2,68) = 5.62$, $p = .006$, and overall sexual encounter desires, $F(2,70) = 3.38$, $p = .040$. Including overall flirting desires and overall sexual encounter desires had no effect on the pattern of results. However, including overall dating desires (see Fig. 2) as a covariate eliminated the effect, $F(2,65) = 1.31$, $p = .276$.

We conducted a forward entry regression to see how strongly each variable (partnering status, overall dating desires) predicted T levels in men. The regression described 9% of the variance, $R^2_{adj} = .07$, and was significant, $F(1,67) = 6.47$, $p = .013$. Of the two variables, only overall dating desires, $t(67) = 2.54$, $p = .013$, was a significant predictor of T. Overall dating desires were significantly correlated with T across all men, $r(67) = .30$, $p = .013$, and positively correlated in each partnering type, although nonsignificantly, likely due to the small n's for within-group correlations.

Discussion

Results from our study are the first to clearly point to similar overarching associations between T and partnering across gender/sex, with patterns and mediators that differ markedly by gender/sex. We examined how partnering and T were linked among single, casually partnered, and long-term (LT) partnered men and women and what factors accounted for these group differences in T. Our results replicated past findings and confirmed expectation 1a that LT partnered men had lower T than single men. We also found clear evidence supporting 1a in women for the first time; i.e., LT partnered women had lower T than single women, and sexual orientation did not moderate this effect. Our results did not confirm prediction 1b: casually partnered individuals did not have higher T than single individuals. However, prediction 1c led to interesting and novel findings. Here, we predicted that casually partnered individuals would have higher T than LT partnered individuals, and this was confirmed—for men. In contrast, women who were casually or LT partnered displayed similar T levels, and both groups of partnered women had lower T than single women. These results are the first to show differences in T between single, casually partnered, and LT partnered women and men, and also therefore the first to show that casual relationships without serious romantic commitment are more like singlehood for men and LT relationships for women in terms of T.

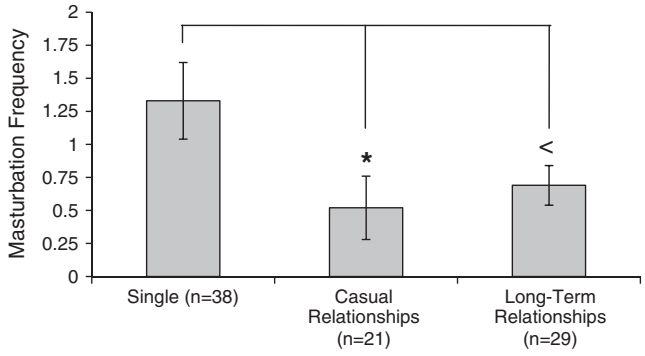

Fig. 4. Frequency of masturbation in the previous week in women. 'Casual' indicates casually partnered; '*' indicates a significant difference at $p < .05$; '<' indicates a trend towards a statistical difference at $p < .055$.

Our results are also the first to explain the proximate mediators of the link between partnering and T in women and men, and our predictions were based on theoretical considerations derived from the Challenge Hypothesis (Wingfield et al., 1990), T trade-offs (van Anders and Watson, 2006b), and empirical data from our and others' labs. Analyses confirmed predictions 2a and 2c that T would be related to relationship orientation (propensity to enter long-term or other kinds of relationships) in men and relationship status in women (current status as partnered or not). Further, findings confirmed our prediction 2b that interest in new partners and not interest in extrapair sexual encounters/cheating would be the key explanatory variable for men. Results partially confirmed our prediction 2d that masturbation frequency would be the key explanatory variable for women, as masturbation frequency accounted for a significant portion of the variance between T and partnering. However, frequency of partnered sexual activity was instead the key explanatory variable as it was a significant predictor of T over masturbation frequency. As such, although our results replicate associations between T and masturbation frequency we have found before in women (van Anders et al., 2007a) perhaps based on more relaxing/peaceful orgasm experiences (van Anders and Dunn, 2009), they indicate that partnered sexual activity is more important to understanding T-partnering links. These results indicate that state variables may mediate the T-partnering link for women, while trait variables may mediate the link for men, and strongly point to T being linked to relationship status in women and relationship orientation in men. While our findings cannot demonstrate the directionality of these mediators, they are in line with our predictions and further longitudinal studies are needed to definitely determine causality.

Our set of predictions were made a priori (van Anders and Watson, 2007; van Anders et al., 2007b; van Anders, 2009) and were largely supported so that we were able to show how sexual frequency for women and interest in new partners for men mediate the T-partnering link. Importantly, we were also able to falsify many viable alternative explanations as our results showed that state variables did

not account for the effect in men, and trait variables did not account for it in women. We are thus in a position to affirm that a variety of variables, including life habits (e.g., sleep, eating, recreation), social/relational (e.g., social support), psychological (e.g., mood, self-esteem, body image), and health (e.g., general well-being), do not mediate the robust association between T and partnering. Our predictions and findings are in line with the T trade-off theoretical framework that we have discussed and contrasted with other extant theoretical positions (van Anders and Gray, 2007; van Anders and Watson, 2007; van Anders et al., 2007b; van Anders, 2009; van Anders and Watson, 2006a,b). In this framework, we have posited that high T is linked to competitive situations (including sexual experiences), and low T to bond maintenance contexts. As such, we have predicted that higher T should be linked to a competitive-type relationship orientation, i.e., a propensity to enter shorter-term relationships, or more competitive relationship statuses, i.e., relationships characterized by more jealousy, sexual encounters, etc. This theoretical framework, however, makes no predictions of gender/sex-differentiated effects in trait vs. state ways, and these predictions were instead drawn from interpreting patterns in the empirical literature.

Research on T and partnering provides a model for thinking about gender/sex in ways that neither undermine nor overstate its importance. Our results clearly show that T and partnering are linked in both supra-gender/sex and gender/sex-specific ways. Monoamorously partnered women and men have lower T than their single counterparts. However, gender/sex is important for considering patterns and mechanisms in (at least) two ways: firstly, casually partnered men have T that is more similar to single men, while casually partnered women have T that is more similar to LT partnered women; secondly, frequency of sexual activity accounted for the effect in women, while interest in new/more partners accounted for the effect in men, supporting our predictions that T is related to relationship orientation in men but relationship status in women. Other lines of research suggest that women's sexuality is more fluid than men's is in several contexts; for example, women show more flexibility in sexual orientation (Diamond, 2003), and their sexual arousal is stimulated by a broader array of cues than men's (Chivers and Bailey, 2005). Our findings, in some ways, converge with these data as the pattern of associations between T and partnering is more dependent on state cues in women than in men, which suggests a greater capacity for fluctuation in T levels over time, and perhaps heightened sensitivity of T to state cues, for women. Our research thus points to the value of incorporating women and men into physiological research about the evolution of intimacy more broadly, and T and pair bonding more specifically, to understand effects that are not specific to one gender/sex and those that are.

We also confirmed past research (van Anders et al., 2007b) that showed that neither sexual desire nor interest in extrapair sexuality/SOI scores underlie the T-partnering link. Why would interest in new partners but not interest in sexual encounters, extrapair sexuality, or SOI scores themselves mediate the link in men, especially since higher T has been linked both with a higher number of sexual partners (Bogaert and Fisher, 1995; Cashdan, 1995; van Anders et al., 2007b) and more extramarital sex (Booth and Dabbs, 1993)? We have theorized that higher T should be linked with a competitive-type relationship orientation (i.e. propensity to enter shorter-term relationships) under the T trade-off framework (van Anders et al., 2007b; van Anders and Watson, 2006b) and should therefore be linked with a higher likelihood of attempting to find or interest in new partners specifically. Sexual encounters can occur within or outside of a pair bond, and it may be that comparably few individuals in contemporary Western societies look for solely sexual encounters (e.g., with a sex worker) rather than encounters that involve at least some nonsexual social contact (e.g., via dating). As such, sexual-only encounters are conceptually less likely to be a mediator of the link between relationship orientation and T in men and more likely to be folded into the more meaningful variable of interest in new partners; our results support this contention empirically.

We sampled participants at one time, which may underestimate the strength of the effect. Methodological investigations show high stability for T over time (Dabbs, 1990) and more participants are recommended over more samples. Accordingly, our employment of single sampling should not have interfered with our pattern of significant findings, although it is possible mediators that did not reach significance might be meaningful with more samples or more participants—however, the strength and primacy of the key explanatory variables would be unaltered (i.e., frequency of partnered sexual activity in women and interest in new partners for men). Although the study contained a large sample, our participants were young on average (i.e., in their early 20s) with a resulting shorter average relationship lengths than an older sample would yield. One interpretation of the robust and clear effects we found is therefore that an even older sample might yield even stronger effects as LT relationships would be even longer and trait variables might have had a longer time to develop and become entrenched.

Considerations of state vs. trait variables are relevant, since we define dating desires as a trait variable because it represents an attitude, and partnered sexual activity as a state variable because it represents a discrete event, even though having a dating desire could be a discrete event and frequency of partnered sexual activity could be a trait. Indeed, engaging in a state behavior over a long period of time (e.g., 30 years) might reasonably be considered a trait variable. As such, it remains to be seen whether interest in new partners mediates men's T as a trait variable because of state effects, i.e., repeatedly considering new partners might lead to pulsatile increases in T that result in ostensible trait differences. And only longitudinal research can determine how trait-like the variable of dating desires actually is, or whether it changes over time. Certainly, dating desires should be responsive to relational context to some degree, such that a 'trait' level of dating desires might change markedly upon commitment. Similarly, it remains to be seen whether frequency of sexual activity during early stages of relationships still mediates the association between T and partnering during later life stages even if frequency of activity has declined (although frequency does not, of course, always decline). There is something of a paradox in the larger pattern of findings on T and sexuality in women, in that we have previously demonstrated that engaging in sexual activity increases T in women (van Anders et al., 2007a), but we found in the present paper that frequency of sexual activity is negatively correlated with T. That frequency of partnered sexual activity accounted for the partnering-T link in women might be due to a converse interpretation, i.e., abstinence; times spent abstaining from sexual activity have been linked to increased T (Exton et al., 2001). In general, future research will help us understand if is more accurate to describe the link between T and relationship status in women as due to behavioral, rather than 'state,' mediators, and the link between T and relationship orientation in men as due to attitudinal, rather than 'trait,' mediators.

Past studies have demonstrated that partnering and T are linked in men (Gray and Campbell, 2009; van Anders, 2009) and, to a lesser extent, women (van Anders, 2009). Our data, however, are among the first to show mediator and pattern and to emphasize the importance of gender/sex in this field. Our findings also provide avenues for future research. Are cues to relationship status in women and relationship orientation in men associated with T in non-Western cultures? How does relationship orientation develop, and how stable is it? How does the response to relationship status cues parallel fluidity in response to intimate stimuli? Findings from the present study suggest that evolutionary species-wide assumptions based on male-only samples are premature, that considerations of mediators are likely to be promising, and add to a growing body of literature on comparative pair bonding physiology.

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