

Northumbria Research Link

Citation: Farrelly, Daniel, Owens, Rebecca, Elliott, Hannah, Walden, Hannah and Wetherell, Mark (2015) The effects of being in a "new relationship" on levels of testosterone in men. *Evolutionary Psychology : An international journal of evolutionary approaches to psychology and behavior*, 13 (1). pp. 250-61. ISSN 1474-7049

Published by: Evolutionary Psychology

URL: <http://dx.doi.org/10.1177/147470491501300116>
<<http://dx.doi.org/10.1177/147470491501300116>>

This version was downloaded from Northumbria Research Link:
<http://nrl.northumbria.ac.uk/21734/>

Northumbria University has developed Northumbria Research Link (NRL) to enable users to access the University's research output. Copyright © and moral rights for items on NRL are retained by the individual author(s) and/or other copyright owners. Single copies of full items can be reproduced, displayed or performed, and given to third parties in any format or medium for personal research or study, educational, or not-for-profit purposes without prior permission or charge, provided the authors, title and full bibliographic details are given, as well as a hyperlink and/or URL to the original metadata page. The content must not be changed in any way. Full items must not be sold commercially in any format or medium without formal permission of the copyright holder. The full policy is available online: <http://nrl.northumbria.ac.uk/policies.html>

This document may differ from the final, published version of the research and has been made available online in accordance with publisher policies. To read and/or cite from the published version of the research, please visit the publisher's website (a subscription may be required.)

www.northumbria.ac.uk/nrl



Original Article

The Effects of Being in a “New Relationship” on Levels of Testosterone in Men

Daniel Farrelly, Department of Psychology, University of Sunderland, Sunderland, UK; Institute of Health and Society, University of Worcester, Worcester, UK. Email: d.farrelly@worc.ac.uk (Corresponding author).

Rebecca Owens, Department of Psychology, University of Sunderland, Sunderland, UK.

Hannah R. Elliott, Institute of Genetic Medicine, Newcastle University, Newcastle, UK.

Hannah R. Walden, Biomedical and Biomolecular Research Centre, Northumbria University, Newcastle, UK.

Mark A. Wetherell, Department of Psychology, Northumbria University, Newcastle, UK.

Abstract: In light of previous research showing that different types of relationships affect levels of testosterone in men, this study examined whether categorizing relationship types according to relationship length can shed further light on variations in levels of testosterone. Salivary testosterone samples were obtained from a sample of men and details about their relationship status, sociosexual orientation, extra-pair sexual interest, and their perceptions of their relationships were recorded. Using a median split analysis, participants who indicated that they had been in their relationship for less than 12 months were categorized as being in “new relationships” and those in longer relationships being categorized as in long-term relationships. Results showed that levels of testosterone of single men and men in new relationships did not differ, but both had significantly greater levels of testosterone than men in long-term relationships. Differences in levels of testosterone were unrelated to sociosexual orientation and extra-pair sexual interest. These findings support the evolutionary explanation of levels of testosterone in men varying in accordance with their internal motivation to seek new potential mates.

Keywords: testosterone, relationships, competition, mating strategies, sociosexual orientation

Introduction

An intriguing area of recent research has highlighted the association between relationship status and/or mating strategies in men and their fluctuating levels of circulatory testosterone. Examples of this include the findings from multiple studies that pair-bonded men (who are either married or in long-term, committed relationships) have lower levels of testosterone than single men (Booth and Dabbs, 1993; Burnham et al., 2003; Gray, Chapman, et al., 2004; Gray, Kahlenberg, Barrett, Lipson, and Ellison, 2002; Mazur and Michalek, 1998; van Anders and Watson, 2006). Further findings suggest that fathers have lower levels of testosterone than non-fathers independently of relationship status, and that pair-bonded fathers demonstrate lower levels than pair-bonded non-fathers (e.g., Alvergne, Faurie, and Raymond, 2009; Gettler, McDade, Feranil, and Kuzawa, 2011; Jasienska, Jasienski, and Ellison, 2012; Kuzawa, Gettler, Muller, McDade, and Feranil, 2009; Muller, Marlowe, Bugumba, and Ellison, 2009; Perini, Ditzen, Fischbacher, and Ehlert, 2012).

There is a clear evolutionary explanation for this decrease in levels of testosterone in pair-bonded men and fathers. Testosterone plays an important role in men when they are seeking mating opportunities with women (van Anders, Hamilton, and Watson, 2007). However, a decrease in levels of testosterone in men when they are no longer seeking new relationships has clear adaptive benefits. A reduction in testosterone will facilitate men who have a reduced investment in mating effort (such as pair-bonded men and/or fathers) to subsequently increase their inclusive fitness by alternative means, such as relationship maintenance and caring for offspring (Gray et al., 2002; Wingfield, Hegner, Dufty, and Ball, 1990).

Recently, research has progressed from examining only external indicators of changes in men's life history characteristics (e.g., marriage, fatherhood) and explored subjective indicators of men's mating strategies. For example, measures such as sociosexual orientation and desire to engage in extra-pair sexual activity have also been shown to be positively associated with levels of testosterone in paired men (McIntyre et al., 2006). Similarly, only paired individuals with a more restricted sociosexuality had low testosterone levels, and paired men with a higher desire for uncommitted sexual activity had testosterone levels that were similar to those of single men (Edelstein, Chopik, and Kean, 2011). Also, men in polyamorous relationships (with multiple committed partners) have greater levels of testosterone than those in monogamous relationships (Gray, 2003). Again, this is commensurate with the suggested evolutionary explanation; these men, although pair-bonded, will still be psychologically motivated to seek new sexual encounters and/or additional sexual partners. In other words, they do not show the same hormonal response to external cues (such as marriage or fatherhood) as have men who are "honestly" committed to reduced mating effort. A similar perspective is that of van Anders and Goldey (2010), who found that although neither sexual desire or extra-pair sexuality mediated the link between pair-bonding and testosterone in men, an interest in new and/or more partners did. They suggest that this is because high testosterone is related to a "competitive-type relationship orientation" (van Anders et al., 2007) in men who have a greater propensity to enter new relationships.

Relationship type has also been assessed in relation to levels of testosterone, with a number of studies highlighting the differences between men in casual and committed relationships. For instance, van Anders and Goldey (2010) found that single men and men

who categorized themselves as “casually partnered” did not differ in levels of testosterone, but both had greater levels of testosterone than men who categorized themselves as “long-term partnered.” Again this would be predicted, as only when a man believes that their relationship is at the “committed” stage should they experience this adaptive decrease in testosterone. Prior to this stage, however, casually-paired men should still perceive that they are not at the “committed” stage of the relationship, and may also consider additional and/or new partners at this time. Therefore, this may explain the lack of a drop in testosterone observed in this partnered group.

One potential limitation of these findings with regards to relationship type is that it relies on self-categorization by participants (e.g., Burnham et al., 2003; Gray, Chapman, et al., 2004; Sakaguchi, Oki, Honma, and Hasegawa, 2006; van Anders and Goldey, 2010; van Anders et al., 2007; van Anders and Watson, 2006). Although this is important, as it should accurately reflect their subjective belief about the relationship (thus revealing their underlying psychological state with regards to their current motivation to seek new partners), it may not be wholly accurate. The categories available to participants are often quite broad (such as “in a relationship” versus “casually dating”). This may lead to the more nuanced influences that the precise stage of their relationship can have on levels of testosterone being missed. Furthermore, the influence of experimenter effects (and possibly social desirability) may affect how participants categorize their relationship to these external labels in a laboratory setting (for example, they may wish to show themselves in a more positive manner by indicating higher commitment and faithfulness to their current relationship than may actually be true).

It is therefore of interest for additional ways of measuring relationship status to be explored. As a result, the aim of the current study was to complement the existing research by investigating how the actual length of the relationship is also related to testosterone levels. This has the advantage of avoiding attaching broad labels to the relationship type a man is in, meaning it can be more precise than categories such as “casually dating.” In a similar vein to being in “casual relationships,” it was expected that men in “new relationships” would not have experienced the adaptive decrease in testosterone of men in longer relationships. This would be because men in new relationships remain motivated to seek further mating opportunities at this early stage, a status that may change should the permanence of the relationship become more established in the future. Other studies have taken relationship length into account, but only in terms of either excluding men in new relationships (e.g., Gray, Campbell, Marlowe, Lipson, and Ellison, 2004) or by only concentrating on changes in relationship status over a 6-month period (van Anders and Watson, 2006). Gray, Campbell, et al. (2004), however, did find a small sample of men in relationships of 6 months or less had higher testosterone levels than men in longer relationships. Therefore, it is now important to specifically address men in the early stages of relationships as a separate grouping in more depth and detail, and examine not only their levels of testosterone, but also other factors that may affect this, such as their perceptions of the relationship, sociosexual orientation, and extra-pair sexual interest.

It was predicted that long-term paired men would have lower levels of testosterone than both single men and men in new relationships, whereas there would be no difference in levels between men in these latter two relationship categories. It was also predicted that further indicators of relationship quality would vary between men in these different relationship categories; specifically, the ratings of their satisfaction with the relationship

and also the perception of the long-term future of the relationship would be lower for men in new relationships than men in longer relationships. We also conducted an analysis to examine if additional measures of sociosexual orientation and interest in extra-pair sexual activity affected how levels of testosterone vary between the different relationship types.

Materials and Methods

Participants

A total of 76 heterosexual male university students from the north east of England, aged between 18 and 39, took part in the experiment. These were mainly psychology undergraduates who responded to advertisements via the research participation scheme on-line booking system (www.sona-systems.com) and received course credit for participating. One participant was subsequently removed from the data analyses due to having abnormally high levels of circulatory testosterone (more than three standard deviations above/below the sample mean), resulting in 75 participants remaining (age $M \pm SD = 22.11 \pm 4.83$). This research was approved by the University ethics committee.

Procedure

Demographic details. Each participant's age was recorded, as well as the time (in hours) since they had last consumed food and alcohol. Further details were then obtained with regards to the participant's current relationship status (Married, Engaged, Cohabiting, Non-cohabiting relationship, Dating, Single, Divorced). If they indicated that they had a partner (i.e., not selected "Single"), they were asked how long they had been in that relationship (in months) and asked to respond on a 7-point Likert scale regarding how long-term or permanent they considered this relationship to be (1 = "Not at all," 7 = "Extremely permanent"), as well as how satisfied they were with their relationship overall (1 = "Not at all," 7 = "Extremely satisfied"). They were then asked how often they saw their partner each week ("Every day," "Every other day," "1-3 times a week," "Less than once a week") and the last time they saw them ("Today," "Yesterday," "Within the last five days," "More than a week ago"). Participants who had indicated that they were single were asked when their previous relationship had ended. The final two questions were taken from McIntyre et al. (2006) and examined participants' extra-pair sexual interest; the first asked if participants had ever engaged in sex with a partner other than a current partner while involved in a romantic relationship (they were asked to consider all partners, current and previous), and the second question asked if they would ever consider having an "affair" (defined here as sex with someone other than their main, current relationship partner) without their partner's knowledge. Both of these questions required either a "yes" or "no" response from participants.

Sociosexual Orientation Inventory. This was measured using the original 7-item Sociosexual Orientation Inventory (SOI) devised by Simpson and Gangestad (1991). This consists of a combination of open-item response items that assess aspects of participants' behaviors (e.g., How many different partners have you had sex (sexual intercourse) with in the past year?) and a 7-item Likert scale items that assess aspects of participants' attitudes (e.g., "I can imagine myself being comfortable and enjoying 'casual' sex with different partners."). Following Simpson and Gangestad (1991), the scores were standardized using z transformations, and the resulting Cronbach's alpha for this sample was $\alpha = .74$. Webster

and Bryan (2007) proposed a dual factor model of Simpson and Gangestad's (1991) SOI, which produces a significantly better fit than does the single factor of the original model. These two factors are classified as measuring sociosexual behaviors (SOI-behavior) and sociosexual attitudes (SOI-attitude). These factors were also calculated from the present sample because the dual factor model provides a more in-depth analysis of the role of SOI in terms of the research question being addressed here.

Saliva collection and assaying. To control for diurnal variability in testosterone (Dabbs, 1990), all participation was between 12:00 and 18:00 hours. Before providing saliva samples, participants were provided with Trident sugar-free chewing gum to stimulate saliva flow, after which they deposited saliva into a 2mL polypropylene collection tube. All saliva samples were immediately refrigerated and were stored at -20°C within 24 hours. Salivary levels of testosterone were analyzed in duplicate using enzyme-linked immunosorbent assays according to the manufacturer's instructions (Salimetrics, 2014). Intra and inter coefficients of variation were $\leq 10\%$.

Results

To examine the relationships between levels of testosterone and sociosexual orientation, Pearson's *r* correlations were conducted on levels of testosterone, age, scores for the two factors of SOI (SOI-behavior and SOI-attitude), and overall SOI score for all participants. No significant correlations were found between levels of testosterone and any SOI measure or age (see Table 1). These Pearson's *r* correlations were also conducted on paired men only ($n = 36$), as well as further correlations with additional indicators of relationship quality (see Table 2). Here there was found to be significant correlations between levels of testosterone and total SOI score as well as for SOI-behavior and SOI-attitude. There were no further significant correlations between levels of testosterone and any other indicators of relationship quality, including relationship length (see Figure 1).

Table 1. Inter-correlations between levels of testosterone, age and SOI measures for all participants

Variable	2	3	4	5
1. Levels of testosterone	.1	.2	.15	-.04
2. Total SOI score		.92**	.74**	.03
3. SOI-behavior			.67**	.03
4. SOI-attitude				.18
5. Age				

Note. ** $p < .01$

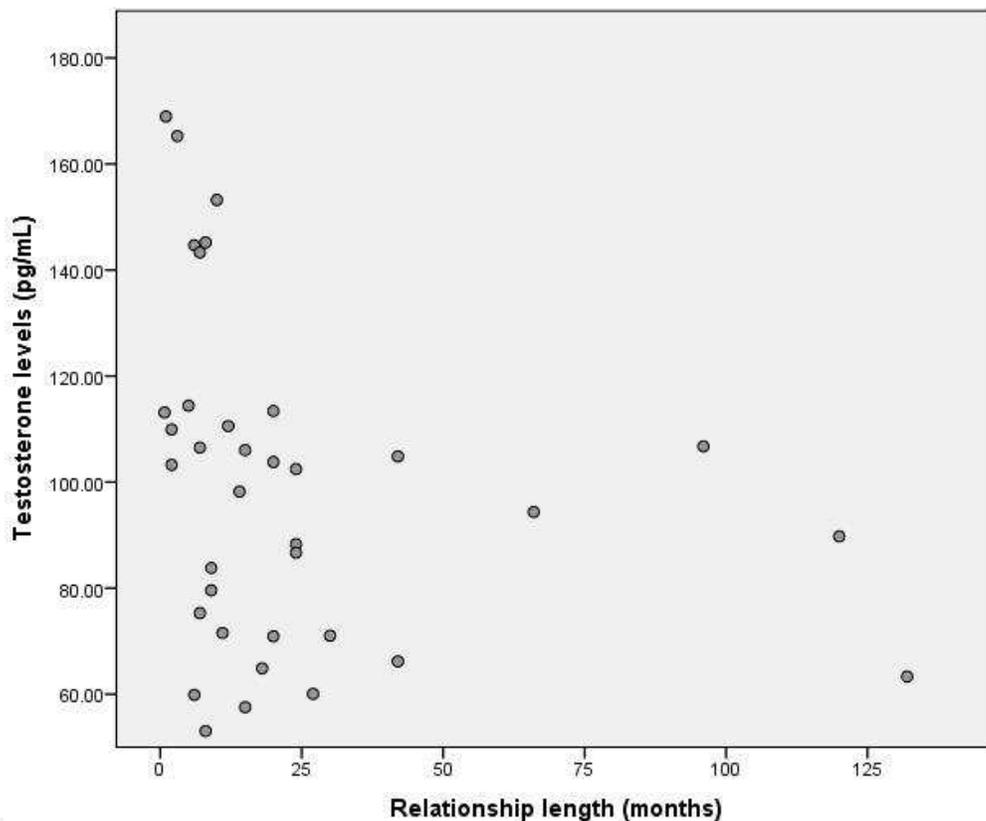
Testosterone and relationship length in men

Table 2. Inter-correlations between indicators of relationship quality and levels of testosterone and SOI measures for paired men

Variable	2	3	4	5	6	7	8	9
1. Levels of testosterone	.41*	.46*	.42*	-.27	-.26	-.08	-.04	.07
2. Total SOI score		.92	.75	-.12	-.02	-.13	.19	.2
3. SOI-behavior			.71	-.18	-.16	-.01	.23	.25
4. SOI-attitude				-.02	-.07	-.065	-.01	.1
5. Relationship length					.24	-.13	-.15	-.15
6. Long-term rating						.61**	-.37*	-.32
7. Relationship satisfaction							-.16	-.22
8. Amount of contact								.81**
9. Time since last contact								

Note. *p < .05 ** p < .01

Figure 1. Scatterplot of relationship length and testosterone levels for paired men



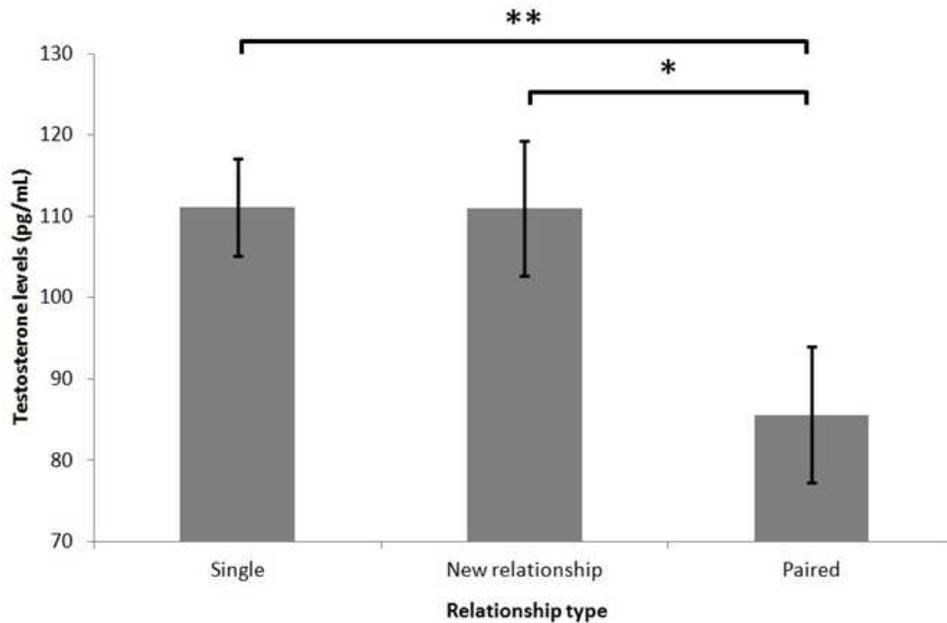
Participants who reported themselves as being in a relationship were separated by the length of their relationship via a median split, with those reporting relationship lengths of less than the median (12 months) being classified as being in a “new relationship.” Three further participants were removed from analysis at this stage due to providing incomplete information on relationship length. This produced a group of individuals in “new

relationships" ($n = 17$) and the remainder reporting relationship lengths of more than the median in long-term relationships ($n = 18$). Comparisons were made between these two groups of men for different indicators of relationship quality. Men in new relationships had been in their relationship for less time than men in long-term relationships, $t(16.23) = 3.98$, $p = .001$, $r = .7$, and also rated their relationship as being less long-term and/or permanent than did men in long-term relationships, $t(20.85) = 3.07$, $p = .006$, $r = .56$. However, there was no significant difference between these groups in their perceived satisfaction with the relationship, or in the amount of contact they had with their partner or the time since last contact with them (all t s < 0.95 , all p s $> .35$). It was also found that there was no significant difference between the ages of participants across the three relationship conditions, $F(1, 69) = 2.55$, $p = .086$, $\eta^2 = 0.07$, nor for total SOI score, $F(1, 69) = 1.62$, $p = .21$, $\eta^2 = 0.05$, SOI-behavior, $F(1, 69) = 2.98$, $p = .057$, $\eta^2 = 0.08$, or SOI-attitude, $F(1, 69) = 1.74$, $p = .18$, $\eta^2 = 0.05$. Finally, as fatherhood may have had a potentially confounding effect on these results, the above t -tests were also repeated with all fathers ($n = 6$) removed from the data set. This produced the same findings as above, suggesting no such confounding effect of fatherhood.

To identify whether levels of testosterone varied between the relationship categories, a univariate ANOVA was conducted, with levels of testosterone as the dependent variable and relationship status (single vs. new relationship vs. paired) as a between-subjects measure. However, beforehand, ANCOVAs were conducted to see if SOI measures (total score, SOI-behavior, and SOI-attitude) or age had significant effects on the results obtained. None of the covariates had significant effects, therefore justifying the use of the above ANOVA. There was a significant main effect of relationship status, $F(1, 69) = 3.4$, $p = .039$, $\eta^2 = .09$ (see Figure 2). Subsequent pairwise comparisons were conducted using LSD (due to differences between all categories being explicitly predicted in our hypotheses). It was revealed that paired men ($M \pm SD = 86.03 \pm 18.87$) had significantly lower levels of testosterone overall than single men ($M \pm SD = 110.77 \pm 39.73$, $p = .017$, $r = .37$) and men in new relationships ($M \pm SD = 111.23 \pm 37.13$, $p = .037$, $r = .39$). However, there was no difference in overall T levels between men in new relationships and single men ($p = .96$, $r < .01$). Again, the above analysis was conducted with fathers excluded, and the same findings were obtained.

To control for the potential influence of participants' extra-pair sexual interest, the original ANOVA was also repeated with participants' previous extra-pair sexual activity ("had engaged" vs "had never engaged") as an additional between-subjects measure. This had no significant main effect on levels of testosterone, $F(1, 69) = 1.9$, $p = .17$, $\eta^2 = .03$, nor did it have a significant interaction with relationship type, $F(2, 69) = 2.34$, $p = .11$, $\eta^2 = .07$. Similar results were obtained when participants' hypothesized likelihood of engaging in future extra-pair sexual activity ("I could imagine it" vs. "I would never") was included instead of actual activity in the original ANOVA as a between-subjects measure (main effect: $F[1, 69] = 0.34$, $p = .56$, $\eta^2 < .01$; interaction: $F[2, 69] = 0.26$, $p = .77$, $\eta^2 = .01$). Finally, the exclusion of fathers from the above analysis led to the same findings.

Figure 2. Mean (\pm SE) salivary levels of testosterone for participants in different relationship types



Discussion

These findings support the first study hypothesis, as long-term paired men had lower levels of testosterone than both single men and men in “new relationships.” Furthermore, there was no significant difference in the levels of testosterone between men in new relationships or single men. This suggests that future research examining the role of relationship status on testosterone levels in men should also take into account the potential impact of being in a new relationship. There was partial support for the second prediction as men in new relationships had lower ratings of the long-term prospects of their relationship compared to men in longer relationships. However there was no difference between these groups in terms of relationship satisfaction, nor other indicators of relationship quality. Also, neither sociosexual orientation measures (SOI-behavior and SOI-attitude) nor interest in extra-pair sexual activity had a significant influence on the difference in levels of testosterone between the different relationship categories, nor did they have a significant effect on levels of testosterone overall. However it is interesting to note that within paired men only, testosterone levels positively correlated with measures of sociosexual orientation, as was the case for McIntyre et al. (2006).

The similarity in levels of testosterone between men in new relationships and single men suggests that men in new relationships are still in a physiological state that aids competition with other men for access to potential mates. This may be due to the need to maintain and develop their new relationship and/or still being motivated to seek further mating opportunities. This is further supported from the perceptions of men in these new relationships, as they did not perceive their relationships as being as permanent as those in longer relationships. This suggests that the psychological change in motivation to compete (and with it, the subsequent drop in levels of testosterone) tends not to have occurred for

those in new relationships. Also the lack of a difference in terms of levels of contact with partners suggests that physical proximity is not the mechanism by which men in relationships experience lower levels of testosterone, as van Anders and Watson (2007) also found. Similarly the negative effect that age can have on testosterone levels (e.g., Harman, Metter, Tobin, Pearson, and Blackman, 2001) is also not responsible for these differences, as there was no significant difference between the ages of participants in the different relationship categories.

The finding of sociosexual orientation and extra-pair sexual interest having no further effect is perhaps surprising, considering previous research has found just that (Edelstein et al., 2011; McIntyre et al., 2006). This perhaps reflects that the internal psychological mechanism that mediates changes in the levels of testosterone in men in relationships is a complex one, and difficult to measure when using external indicators of “commitment” (be it marriage, fatherhood, or length and/or type of relationship). Indeed, it is perhaps debatable whether such a precise, definitive mechanism can ever be reliably measured, via either self-report or more objective measures. However, as research increases our understanding of the different factors involved, including the contribution of the present study in terms of “new relationships,” the picture is becoming clearer. Future research will no doubt cast further light on these factors, and also on novel ones.

However, an alternative explanation for these effects may be due to the direction of causality. In other words, it may be that men with higher baseline levels of testosterone are more likely to terminate their relationships before they become long-term due to their greater propensity to seek new partners (van Anders et al., 2007). This issue of cause and effect in the link between male mating strategy and testosterone levels is common to much research in this area and may only be fully resolved in future studies that utilize extensive longitudinal research. However, this issue is somewhat negated by the findings here of no significant difference between men in new relationships and those in longer term relationships in their perceived satisfaction with the relationship, and also the lack of significant effects of SOI and extra-pair interest measures on testosterone levels, and there being no significant differences between the three relationship conditions on SOI measures.

A potential limitation of this study is the median split of 12 months for “new relationships.” This is acknowledged, but should not undermine the findings as it has acted as a reliable comparison in our analysis. Furthermore, even though there was found to be significant differences between the different relationship types, no significant correlation was found between relationship length and levels of testosterone (however, it is worth noting from Figure 1 and the reported correlation size that this may be partly due to the sample size). Interestingly, the median of 12 months from this sample population coincidentally would also correspond to a major landmark that men may recognize (i.e., a full year in the relationship is often acknowledged by both partners and others as an anniversary and an important milestone). Although such landmarks are not part of our evolutionary history, it would perhaps be adaptive for a man’s internal perception and evaluation of their current relationship to be affected by external cues such as this (as is possibly also the case for marriage and fatherhood), either consciously or not. This is, of course, speculative, but worth reflecting on as part of the interpretation of these findings. A final consideration of these findings is that it has recently been shown, since the current study was executed, that saliva assays for testosterone are affected by the use of sugar-free

chewing gum (van Anders, 2010). This, therefore, should be borne in mind when interpreting these results, as with all previous research in this area that used such methods.

Future research may also explore the testosterone levels of women in new relationships, as recent studies on relationship status have shown similar effects to that of men (e.g., Barrett et al., 2013; Edelman et al., 2011; van Anders and Goldey, 2010). This would shed light on whether the observed effect here is the product of only male-specific evolution, or if it is the result of selection pressures on both sexes. Furthermore, it is important that future studies examine the effects observed here in more diverse samples, including older participants and those outside of universities and/or non-W.E.I.R.D. populations (Henrich, Heine, and Norenzayan, 2010).

Our understanding of how a man's levels of testosterone changes over the course of a relationship is a good example of how research can successfully investigate evolutionary-based hypotheses of human behaviour. The research in this area has broadened the conditions under which it is predicted that levels of testosterone in men will vary (i.e., going beyond classifications based simply on marriage and fatherhood to more precise classifications involving sociosexual orientation and interest in extra-pair sexual activity). However, the underlying evolutionary explanation (changes in testosterone in response to changes in motivation to compete with other men) has remained constant and shows an increased sophistication of our understanding on how this may relate to modern human behaviour. Our contribution adds to this by showing that being in the early stages of a relationship is an additional variable that can be used to assess varying levels of testosterone in men. Future research can draw on these findings and progress our understanding further, for example by employing longitudinal methods to assess changes in levels of testosterone as men go through these different life transitions.

Received 21 August 2014; Revision submitted 17 December 2014; Accepted 19 December 2014

References

- Alvergne, A., Faurie, C., and Raymond, M. (2009). Variation in testosterone levels and male reproductive effort: Insight from a polygynous human population. *Hormones and Behavior*, 56, 491–497.
- Barrett, E. S., Tran, V., Thurston, S., Jasienska, G., Furberg, A.-S., Ellison, P. T., and Thune, I. (2013). Marriage and motherhood are associated with lower testosterone concentrations in women. *Hormones and Behavior*, 63, 72–79.
- Booth, A., and Dabbs, J. M. (1993). Testosterone and men's marriages. *Social Forces*, 72, 463–477.
- Burnham, T. C., Chapman, J. F., Gray, P. B., McIntyre, M. H., Lipson, S. F., and Ellison, P. T. (2003). Men in committed, romantic relationships have lower testosterone. *Hormones and Behavior*, 44, 119–122.
- Dabbs, J. M. (1990). Salivary testosterone measurements: Reliability across hours, days, and weeks. *Physiology and Behavior*, 48, 83–86.
- Edelman, R. S., Chopik, W. J., and Kean, E. L. (2011). Sociosexuality moderates the association between testosterone and relationship status in men and women. *Hormones and Behavior*, 60, 248–255.

- Gettler, L. T., McDade, T. W., Feranil, A. B., and Kuzawa, C. W. (2011). Longitudinal evidence that fatherhood decreases testosterone in human males. *Proceedings of the National Academy of Sciences of the United States of America*, 108, 16194–16199.
- Gray, P. B. (2003). Marriage, parenting, and testosterone variation among Kenyan Swahili men. *American Journal of Physical Anthropology*, 122, 279–286.
- Gray, P. B., Campbell, B., Marlowe, F. W., Lipson, S. F., and Ellison, P. T. (2004). Social variables predict between-subject but not day-to-day variation in the testosterone of US men. *Psychoneuroendocrinology*, 29, 1153–1162.
- Gray, P. B., Chapman, J. F., Burnham, T. C., McIntyre, M. H., Lipson, S. F., and Ellison, P. T. (2004). Human male pair bonding and testosterone. *Human Nature*, 15, 119–131.
- Gray, P. B., Kahlenberg, S. M., Barrett, E. S., Lipson, S. F., and Ellison, P. T. (2002). Marriage and fatherhood are associated with lower testosterone in males. *Evolution and Human Behavior*, 23, 193–201.
- Harman, S. M., Metter, E. J., Tobin, J. D., Pearson, J., and Blackman, M. R. (2001). Longitudinal effects of aging on serum total and free testosterone levels in healthy men. *The Journal of Clinical Endocrinology and Metabolism*, 86, 724–731.
- Henrich, J., Heine, S. J., and Norenzayan, A. (2010). The weirdest people in the world? *Behavioral and Brain Sciences*, 33, 1–75.
- Jasienska, G., Jasienski, M., and Ellison, P. T. (2012). Testosterone levels correlate with the number of children in human males, but the direction of the relationship depends on paternal education. *Evolution and Human Behavior*, 33, 665–671.
- Kuzawa, C. W., Gettler, L. T., Muller, M. N., McDade, T. W., and Feranil, A. B. (2009). Fatherhood, pairbonding and testosterone in the Philippines. *Hormones and Behavior*, 56, 429–435.
- Mazur, A., and Michalek, J. (1998). Marriage, Divorce and male testosterone. *Social Forces*, 77, 315–330.
- McIntyre, M., Gangestad, S. W., Gray, P. B., Chapman, J. F., Burnham, T. C., O'Rourke, M. T., and Thornhill, R. (2006). Romantic involvement often reduces men's testosterone levels—but not always: The moderating role of extrapair sexual interest. *Journal of Personality and Social Psychology*, 91, 642–651.
- Muller, M. N., Marlowe, F. W., Bugumba, R., and Ellison, P. T. (2009). Testosterone and paternal care in East African foragers and pastoralists. *Proceedings of the Royal Society B: Biological Sciences*, 276, 347–354.
- Perini, T., Ditzen, B., Fischbacher, S., and Ehlert, U. (2012). Testosterone and relationship quality across the transition to fatherhood. *Biological Psychology*, 90, 186–191.
- Sakaguchi, K., Oki, M., Honma, S., and Hasegawa, T. (2006). Influence of relationship status and personality traits on salivary testosterone among Japanese men. *Personality and Individual Differences*, 41, 1077–1087.
- Salivary Testosterone Enzyme Immunoassay Kit [apparatus] (2014). Suffolk, UK: Salimetrics Europe, Ltd.
- Simpson, J. A., and Gangestad, S. W. (1991). Individual differences in sociosexuality: Evidence for convergent and discriminant validity. *Journal of Personality and Social Psychology*, 60, 870–883.
- van Anders, S. M. (2010). Chewing gum has large effects on salivary testosterone, estradiol, and secretory immunoglobulin A assays in women and men. *Psychoneuroendocrinology*, 35, 305–309.

Testosterone and relationship length in men

- van Anders, S. M., and Goldey, K. L. (2010). Testosterone and partnering are linked via relationship status for women and “relationship orientation” for men. *Hormones and Behavior*, 58, 820–826.
- van Anders, S. M., Hamilton, L. D., and Watson, N. V. (2007). Multiple partners are associated with higher testosterone in North American men and women. *Hormones and Behavior*, 51, 454–459.
- van Anders, S. M., and Watson, N. (2006). Relationship status and testosterone in North American heterosexual and non-heterosexual men and women: Cross-sectional and longitudinal data. *Psychoneuroendocrinology*, 31, 715–723.
- van Anders, S., and Watson, N. (2007). Testosterone levels in women and men who are single, in long-distance relationships, or same-city relationships. *Hormones and Behavior*, 51, 286–291.
- Webster, G. D., and Bryan, A. (2007). Sociosexual attitudes and behaviors: Why two factors are better than one. *Journal of Research in Personality*, 41, 917–922.
- Wingfield, J. C., Hegner, R. E., Dufty, A. M., Jr., and Ball, G. F. (1990). The “challenge hypothesis”: Theoretical implications for patterns of testosterone secretion, mating systems, and breeding strategies. *American Naturalist*, 136, 829–846.