Self-reported Dominance in Women: Associations with Hormonal Contraceptive use, Relationship Status, and Testosterone

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Abstract

How to achieve social dominance in a group is a recurrent challenge for individuals of many species, including humans. Previous research indicates that both relationship status and contraceptive use appear to moderate women's testosterone levels. If testosterone contributes to social dominance, this raises the possibility for group differences in social dominance between single and partnered women, and between users and non-users of hormonal contraception. Here, we examine associations between relationship status and use/non-use of hormonal contraception and women's self-reported social dominance. In a sample of 84 women, we replicate previous research documenting a significant positive correlation between women's saliva testosterone levels and their self-reported dominance. Consistent with other literature, we also find that women using hormonal contraception have significantly lower testosterone than those who are regularly cycling and that partnered women have significantly lower testosterone than single women. Although we do not find a main effect of either relationship status or hormonal contraceptive use status on women's reported levels of dominance, the interaction between these variables predicted reported dominance scores. This interaction remained significant when participant age and testosterone values were added to the model as covariates. We discuss these results in the context of the existing literature on testosterone and women's social dominance behaviour and with respect to the evolutionary benefits of social dominance in women.

Keywords: Testosterone; Dominance; Hormonal contraception; Relationship status; Self-reported Dominance

Introduction

Social dominance within a hierarchy is often associated with greater access to resources and with a greater ability to influence subordinates (Magee & Galinsky, 2008). Given the potential adaptive benefits of social dominance, considerable effort has been made to understand the underlying mechanisms which regulate its expression. In particular, previous research has considered the potential for a relationship between dominance and testosterone levels. The literature on this topic generally shows a consistent picture when considering non-human animals. For example, correlational studies in male primates have shown that high-ranking individuals produce higher levels of testosterone than their lower ranked counterparts (e.g. Eastern common chimpanzee, *Pan troglodytes schweinfurthii*: Muller & Wrangham, 2004; Rhesus monkey, *Macaca mulatta:* Rose, Holaday, & Bernstein, 1971*)*. Similar correlational effects between testosterone and dominance have been documented among a range of other species including birds (Harding, 1983), and hamsters, dogs and deer (Rada, Kellner, & Winslow, 1976). Work which has experimentally manipulated testosterone, and subsequently measured shifts in dominance, appears to confirm these associations. For example, testosterone reduction results in a loss of social dominance in rats (Albert, Walsh, Gorzalka, Siemens, & Louie, 1986), and implanting or injecting testosterone increases the expression of dominance in a number of other species (e.g. Bouissou, 1990; Searcy & Wingfield, 1980). Among human males, there is also relatively consistent evidence for a positive relationship between testosterone and dominance (e.g. Mehta & Josephs, 2010; Neave, Laing, Fink, & Manning, 2003; Swaddle & Reierson, 2002).

By comparison, the study of dominance in females has received far less attention than it has in males. This is regrettable since females, like males, can benefit from being dominant in a number of different contexts. For example, females can use dominance to compete more

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readily with other females to attract mates and in order to gather resources necessary to achieve status or to stay healthy (Darwin, 1871). Among human females, in contrast to the work in males, the evidence for a relationship between testosterone and social dominance is comparatively mixed and, in many cases, it is only after the consideration of a moderating variable that correlations are found.

Early work examining the relationship between testosterone and dominance in women produced positive correlations. For example, Purifoy and Koopmans (1979) found that 'career-oriented' women (those who had professional careers, technical jobs, or worked in management) tended to have higher testosterone levels than women who did not work or who worked in lower-level clerical roles. In this study, career-orientation was argued to reflect traits such as 'assertiveness', which is considered to be a component of dominant behaviour, thereby suggesting a link between testosterone and dominant career traits. Likewise, in a study where women self-reported the extent to which a series of adjectives applied to them, those with higher testosterone levels identified as being more 'dominant' (Udry & Talbert, 1988). Furthermore, Grant and France (2001) reported that women's self-reported dominance was positively associated with testosterone levels.

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Work that built on these initial studies produced more varied results. For example, Edwards and Casto (2013) found a relationship between dominance and testosterone, but only in women with relatively low cortisol. Mehta & Josephs (2010) documented a similar moderating effect of cortisol on the relationship between testosterone and social dominance in their earlier work. In contrast, Denson, Mehta, and Ho Tan (2013) found the opposite effect, namely that testosterone and dominance were positively related, but only among women with high cortisol. As a result, while there is evidence that cortisol may moderate the

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association between testosterone and dominance, the direction of this effect is inconsistent across studies. Furthermore, other studies have documented null effects for the relationship between testosterone and dominance in women (Kivlighan, Granger, & Booth, 2005; Stanton & Schultheiss, 2007) and one study (Cashdan, 1995) actually found a negative correlation between social rank and androgen levels in women. These somewhat mixed results suggest that the association between dominance and testosterone in women may be more variable than it is among men, and may perhaps be moderated by other socially relevant factors.

Here, we seek to examine how two social factors, namely relationship status and hormonal contraceptive use, might influence women's social dominance. Both relationship status and use of hormonal contraception are known to influence testosterone levels, meaning that there could be group differences in social dominance among single and partnered women, and among users and non-users of hormonal contraception. Research examining the impact of relationship status on endocrine variation suggests that paired individuals have lower testosterone levels than single individuals (e.g. in men, Burnham et al., 2003; in women, Kuzawa, Gettler, Huang, & McDade, 2010; in heterosexual men and homosexual women, van Anders & Watson, 2006). There is some additional evidence that this effect of relationship is moderated differently in men and women. For example, van Anders and Goldey (2010) found that the effect in women was moderated by frequency of sexual activity, while the effect in men was moderated by interest in new partners. With respect to the influence of hormonal contraceptive use on women's hormone levels, prospective studies demonstrate that women exhibit a marked reduction in testosterone following initiation of hormonal contraceptive use (Zimmerman, Eijkemans, Coelingh Bennink, Blankensein, & Fauser, 2013; Zimmerman et al., 2014).

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Dominance is no doubt the product of a series of complex physiological and cognitive components, meaning that there is likely a range of variables that potentially influence its expression. In spite of this, to our knowledge, no previous study examining women's social dominance has considered, or controlled for, both relationship status and contraceptive pill use in the same experiment. This omission is somewhat surprising given the extensive literature suggesting that both variables influence women's testosterone levels. For these reasons, this study was designed to test the following predictions: (1) Women using hormonal contraception will report lower levels of dominance than regularly cycling women; (2) Partnered women will report lower levels of dominance than single women; (3) Self-reported dominance in women will be positively related to testosterone levels.

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Methods

Participants

Participants were 85 women who were recruited from the University of Stirling. All procedures were approved by the Psychology Departmental Ethics Review Board. Participants were aged between 18 and 32 years (Mean = 21.05, S.D. = 3.17, N = 7 missing). Of this sample, 29 women reported to be using some form of hormonal contraception, while 56 reported to have regular menstrual cycles (cycles between 25-35 days in length). Forty-seven of the participants reported to be in a relationship (32 contraceptive users, 15 regularly cycling women), while 38 indicated they were single (11 contraceptive users, 27 regularly cycling women). Of the overall group, eight identified as being non-heterosexual. The final analysis included 82 women. One participant was excluded because her saliva sample was insufficient for assay, one because her testosterone values were greater than 2SD above the mean, and one because she failed to complete the questionnaire measures in their entirety.

Procedure

In the recruitment material for the study it was made clear to participants that they should not eat or drink within one hour prior to the test session. Moreover, participants were asked to avoid consuming alcohol for 24 hours before participation and not to take part in vigorous exercise on the day of testing, because these factors can impact hormone levels (e.g. Gill, 2000; Kraemer & Ratamess, 2005). Experimental sessions took place between 1:00pm and 6:00pm. This window was chosen to help control for diurnal rhythms in testosterone levels (e.g. Dabbs, 1990). Upon reporting to the lab, participants provided informed consent and were then instructed to rinse their mouth with water. Before any questionnaire items were completed, participants provided a saliva sample that was collected in 2ml cryovials via passive drool. Thereafter, participants completed an online questionnaire. This questionnaire contained basic demographic items and the IPIP scale for social dominance, which contains 11 items and is designed to measure individual differences in dominance (http://ipip.ori.org/newIndexofScaleLabels.htm). This measure has been used in a wide range of previous studies and in our study it had good reliability (Cronbach's Alpha = .83). To complete this scale, participants read a series of statements and then indicated, on a scale of one to seven, the extent to which they agree with each. Higher scores indicate higher levels of agreement. Examples of scale items include 'I am not afraid of providing criticism' and 'I am quick to correct others'. Participants also self-identified as being 'partnered' or not, we did not impose a minimum duration of relationship to be considered partnered.

Hormonal assays

Saliva samples were immediately frozen and stored at -20˚C following collection. The samples were then collectively shipped on dry ice to Salimetrics UK Laboratory (Suffolk, UK) where they were analysed for testosterone in duplicate using enzyme immunoassay. On

the day of assay, samples were completely thawed and then vortexed and centrifuged at 3000rpm for 15 minutes. Salimetrics used 25 µl of saliva per determination with a lower limit of sensitivity of less than 1.0 pg/ml. The intra-assay coefficients of variation were between 2.5% and 6.7%. Previous research indicates that testosterone measures obtained from saliva are positively and strongly related to those obtained via serum samples (Johnson, Joplin, & Burrin, 1987; Vittek, L'Hommedieu, Gordon, Rappaport, & Louis Southren, 1985).

Results

Descriptive analyses

The mean testosterone level among our 82 included participants was 72.21 pg/mL, with values ranging from 27.99 pg/ml to 141.27 pm/mL (SD = 26.29 pg/ml). These values are similar to those reported in previous research using a similar sample (e.g. Deady, Smith, Sharp, & Al-Dujaili, 2006; Welling et al., 2007). Spearman's rank correlations indicated that neither the time of sampling (r = -.01, p = .92) nor participants' age (r = -.14, p = .23) were related to measured testosterone levels. This is likely due to the relatively restrictive timeframe in which we collected our samples and the high degree of homogeneity in this sample of women.

The influence of relationship status and contraceptive pill use on social dominance

To determine how relationship status and hormonal contraceptive use influenced self-reports of dominance, we conducted analysis of variance with relationship status and hormonal contraceptive use as fixed-factors and dominance scores on the IPIP scale as the dependent variable. This allowed us to look for group differences between users and non-users of hormonal contraception and single and partnered women. We found no main effect of either relationship status (F = 1.03, p = .31) or hormonal contraceptive use (F = .01, p = .93) in this

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With respect to this section, the first analysis seems a bit redundant at present. Especially if you reorder as above, (but even if not), I would present the second analysis first - include T as a covariate and then (perhaps) report that the interaction remains significant once T and age are removed

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initial model. However, the interaction of these two variables on social dominance was statistically significant (F = 4.73, p = .03; Figure 1), such that, among regularly cycling women, partnered individuals had significantly higher social dominance scores (M = 43.57, S.E. = 2.78) than those who were single (M = 36.32, S.E. = -2.09) (post hoc t = 2.09, p = .04), while among hormonal contraceptive users, single women had higher levels of social dominance (M = 41.45, S.E. = 3.03) than partnered women (M = 38.81, S.E. =1.38) (post hoc t =.90, p > 0.05).

Following these tests, we then proceeded to re-do the overall model with testosterone assay values and participant age added as covariates. Results were similar to those described above, with no main effects for relationship status (F = 1.17, p = .28) or hormonal contraceptive pill use (F = .40, p = .53) but a significant interaction between the two variables (F = 6.45, p = .01). Testosterone levels also proved to be a significant predictor in this model (F = 5.43, p = .02), but participant age did not have a significant effect (F < .01, p = .97).

Note also that a univariate test comparing levels of testosterone among users and non-users of hormonal contraception was significant (F = 9.21, p = .003), with users having lower levels than non-users as is consistent with previous research (e.g. Zimmerman et al., 2013) (Figure 3). In spite of this difference, users and non-users did not differ in their levels of social dominance (F = .07, p = .79). Likewise, women who were partnered had significantly lower testosterone levels (M = 66.38, S.E. = 3.77) than those who were single (M = 79.67, S.E. = 2.47) (F = 5.45, p = .02); but the groups did not differ in social dominance (F = 1.24, p = .27).

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The relationship between testosterone and social dominance

We conducted a one-tailed Spearman's correlation to examine the relationship between testosterone and women's self-reported social dominance. The results of this directional test indicated a weak positive correlation (r_s = .20, p = .04; Figure 2). A partial correlation controlling for participant age, participant relationship status and participant use/non-use of hormonal contraception remained significant (r_s = .0.23, p = .03).

Additional analyses

When looking at the data exclusively among women who were using the combined oral contraceptive pill (N = 9 women used other combined hormonal methods, N = 3 women were using the progesterone only pill), the results of the overall model are consistent with those reported above. There was no main effect of relationship status or contraceptive pill use (F = 2.01, p = .16; F = .84, p = .36), but there was a significant interaction between these terms (F = 6.31, p = .02). Moreover, the impact of testosterone remained significant in this model (F = 7.62, p = .01).

Our results were also similar when we restricted our sample to women who reported to be heterosexual (N = 8 were non-heterosexual). There was no main effect of relationship status (F = .98, p = .33) or hormonal contraceptive use (F = 1.56, p = .22), but the two terms interacted with one another (F = 6.61, p = .01). Testosterone was again a significant covariate in the model (F = 6.44, p = .01).

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Discussion

Our results indicate that, in this sample, women's measured testosterone levels show a positive but weak relationship with their self-reported dominance scores. Although the main effects of relationship status and hormonal contraceptive use on levels of dominance were not

significant, suggesting the absence of overall group differences in social dominance among single and partnered women or among hormonal contraceptive users and non-users, we find that the interaction between these two factors does predict women's self-reported dominance scores. Thus, our results suggest that while testosterone and dominance in women may be positively related, social dominance is also affected by the interaction of a woman's current hormonal contraceptive use and her relationship status. More broadly put, our findings suggest that women's dominance, an important tool to achieve status, varies with current social circumstances.

When examining the documented interaction in more detail, our results indicate that, among regularly cycling women, partnered women tended to have lower testosterone levels than those who were single, but were significantly more dominant. This pattern of results was in contrast to our prediction that partnered women would have lower levels of dominance than single women as a result of lowered testosterone levels. Our prediction was based on a series of studies examining testosterone levels in single and partnered individuals, which show that the former tend to have significantly higher testosterone values, arguably as a result of the greater relative importance of mating effort for this group (Archer, 2006; Wingfield, Hegner, Dufty Jr, & Ball, 1990). Our finding that single individuals have higher testosterone is consistent with results found in several independent labs and across cultures (Burnham et al., 2003; Gray et al., 2004; McIntyre et al., 2006; van Anders & Watson, 2006, 2007). One interesting point with respect to previous research on testosterone and relationship status is that the vast majority have tested only male participants. A few studies do show analogous effects in women (e.g. van Anders and Watson, 2006), although this effect was only present in non-heterosexual women. Other work has documented null or mixed effects in men as well as in women (e.g. McIntyre et al., 2006; Pollet, van der Meij, Cobey, & Buunk, 2011). Our

findings suggest that while testosterone is higher in single women who are regularly cycling compared to those who are partnered, this does not lead to differences in levels of social dominance between the groups. It may therefore be that high testosterone is a necessary, but not sufficient, component for the expression of women's social dominance.

Moreover, the context in which social dominance is expressed may have important implications for the influence of both social and biological variables. The scale we used to assay dominance was also very general, meaning future research could examine how dominance in different domains (e.g. mating versus friendship) is related to variables like hormonal contraceptive use and relationship status, and how this behaviour relates to measured testosterone. Future research could likewise build on the existing findings by measuring women's dominance in a behavioural task rather than via self-report questionnaires. One explanation for our finding that partnered women are more socially dominant may be that the nature of the relationships among the women in our sample may differ from those used in previous studies. For example, relationships may be of differing durations and levels of commitment, or women may differ in levels of sociosexuality. Indeed, several of these factors have previously been examined in association to relationship status and testosterone, but the effects appear to be mixed (Edelstein, Chopik, & Kean, 2011; McIntyre et al., 2006; van Anders & Goldey, 2010; van Anders & Watson, 2007). An alternative explanation may be that relatively dominant women are more likely to seek out and successfully obtain a relationship. Prospective studies which track women's social dominance as they enter and leave relationships will be important to verify effects documented herein.

With respect to the impact of hormonal contraceptive use on women's endocrine levels, research indicates that use of hormonal contraception results in a marked reduction in testosterone levels (e.g. Zimmerman et al., 2013). This was also the case in our study, with users of hormonal contraception having significantly lower levels of testosterone than non-users. Based on this difference, we predicted that women using hormonal contraception might display lower levels of dominance, but we found no main effect of hormonal contraceptive use in our study. This might suggest that a series of complex physiological and cognitive components, beyond solely testosterone levels, combine to influence social dominance levels. Although we attempted to control for the type and method of administration of hormonal contraception by conducting subsequent analyses in our sample, future research could consider the impact on testosterone levels and dominance of specific hormonal contraceptive doses and variants of synthetic estrogen and progesterone (see Cobey, Pollet, Roberts, & Buunk, 2011; Piccoli, Cobey, & Carnaghi, 2014; Welling, Puts, Roberts, Little, & Burriss, 2012). Likewise, further studies could consider the influence of cycle phase in regularly cycling women, as there is some evidence to suggest that testosterone increases near to ovulation (e.g. Alexander, Sherwin, Bancroft, & Davidson, 1990; Bloch, Schmidt, Su, Tobin, & Rubinow, 1998; Dabbs, 1990; Morris, Udry, Khan-Dawood, & Dawood, 1987; Schultheiss, Dargel, & Rohde, 2003; Welling et al., 2007, but see Dabbs, 1990; Liening, Stanton, Saini, & Schultheiss, 2010; Schultheiss et al., 2003), although this effect is unlikely to be large since daily fluctuations (due to circadian rhythm) and seasonal fluctuations in testosterone are often greater than cyclical changes.

The critical question of what mechanism(s) underlies dominance remains. One limitation of the current work is that it used a single assay of women's testosterone levels that was taken in the late afternoon. Future research utilizing a larger range of hormone assays and multiple

samples and including, for example, measurements of waking testosterone levels, are thus warranted. While our sample size is modest, our results emphasise the idea that while dominance among women may be correlated with testosterone level, and thus is biologically based, its expression is also contingent on social variables. Understanding whether and how hormonal contraception influences, or interacts to influence, dominance levels is potentially important for women's ability to make an informed decision about using this modern intervention (Cobey & Buunk, 2012). We hope that our results stimulate further studies that consider a broader range of social variables that may impact the expression of women's social dominance.

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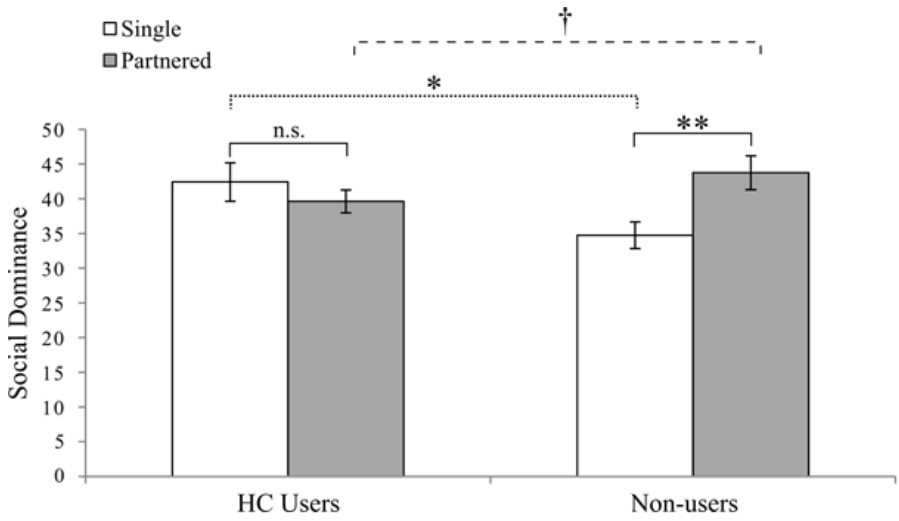
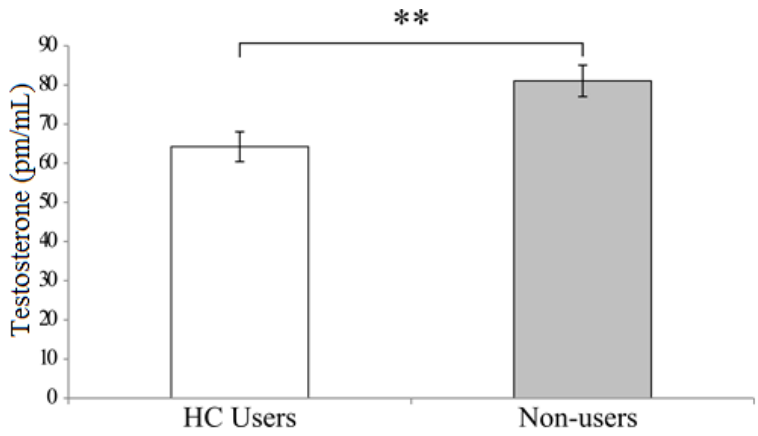


Figure 1. Social dominance for hormonal contraceptive (HC) users and non-users, split by relationship status (single: white bars; partnered: grey bars). Bars represent mean ± 1 s.e.m. For post-hoc tests (pairwise comparisons) the dashed line represents the comparison between partnered HC users and non-users, and the dotted line represents the comparison between single HC users and non-users; †$p < 0.1$, *$p < 0.05$, **$p < 0.01$.



Commented [KC12]: y-axis needs changed to pg/mL

Figure 2. Levels of testosterone among hormonal contraceptive (HC) users were significantly lower than among women who were regularly cycling. **p < 0.01

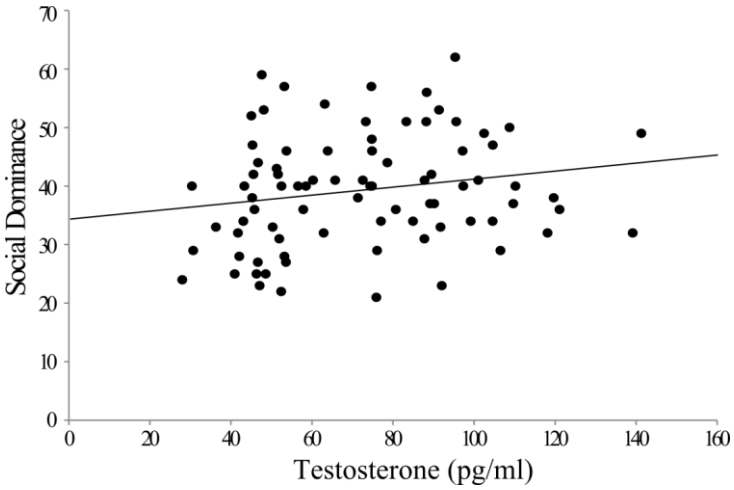


Figure 3. The relationship between testosterone levels and self-reported social dominance levels in women.