Dominant, cold, avoidant, and lonely: Basal testosterone as a biological marker for an interpersonal style

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ABSTRACT

We hypothesized that an interpersonal trait approach would improve our understanding of the behavioral manifestations of basal testosterone. Participants provided saliva samples for testosterone assays on two separate visits and completed the Interpersonal Adjective Scales, the Circumplex Scales of Interpersonal Values, and measures of attachment and loneliness. High testosterone was associated with a distinct interpersonal style that included: attachment-related avoidance, dominance, and disconnectedness. High testosterone was also associated with loneliness, and this relationship was mediated by attachment-related avoidance. These findings add to our understanding of the interrelationships between hormones, personality, and social behavior. The circumplex structure revealed by testosterone’s associations provides evidence for its construct validity as a biological marker of an interpersonally dominant, cold, avoidant, and lonely interpersonal style.

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1. Introduction

Testosterone is a steroid sex hormone that plays a role in the development of male reproductive tissues and secondary masculine characteristics such as body hair. It also shapes affect, behavior, and cognitions related to competition and social status (Eisenegger, Haushofer, & Fehr, 2011). In an attempt to elucidate the physiological underpinnings of personality, researchers have long been interested in personality correlates of high and low basal testosterone levels. Early research examined associations between testosterone and existing personality measures largely without a theoretical model, and findings suggested that testosterone is not related to most broad personality traits commonly used in personality research (e.g., extraversion, agreeableness, neuroticism, persistence; Baucum, Besch, & Callahan, 1985; Dabbs, Hopper, & Jurkovic, 1990; Sellers, Mehl, & Josephs, 2007). One reason for this may be that broad personality traits like extraversion or agreeableness consist of several different lower-order facets that may show diverging associations with testosterone (DeYoung, Weisberg, Quilty, & Peterson, 2013). Recent attempts to link testosterone with personality have been more theory-driven (Maattanen et al., 2013; Sellers et al., 2007). The aim of the present study was to use an interpersonal theoretical model to examine the specific interpersonal style associated with basal testosterone.

Unlike most personality or trait studies on testosterone, many behavioral and experimental studies have tested predictions guided by theory, and examined the associations of basal levels or changes in testosterone with (usually state levels of) aggression, anti-social tendencies, and dominance (Eisenegger et al., 2011). An association between high testosterone and aggressive behaviors is well-established in animals. However, in humans this association is less clear (see Eisenegger et al., 2011), and may be more complex compared to animals (Carré, Gilchrist, Morrissey, & McCormick, 2010). Human studies on the association between testosterone and anti-social behaviors provided somewhat more reliable results (Dabs & Morris, 1990). Finally, findings on the association between testosterone and constructs related to competition in humans are strong and consistent (see Eisenegger et al., 2011). Recent research also suggests that testosterone can interact with the situation to affect theoretically relevant behaviors (Josephs, Sellers, Newman, & Mehta, 2006).

It remains unclear whether testosterone affects behavior, behavior affects testosterone, or there is a bidirectional effect between behavior and testosterone. However, there exists enough evidence indicating that basal levels of testosterone are stable within individuals (Mazur & Booth, 1998; Sellers et al., 2007). Previous personality research did not use an explicit and comprehensive interpersonal theoretical model to study personality traits associated with these relatively stable levels of basal testosterone.
We argue that the behavioral manifestations of high and low basal testosterone levels can best be understood as an interpersonal construct—i.e., a cluster of stable personality traits concerning how people act, think, and feel in their relationships with others. The significance of studying testosterone within this construct is that ultimately, differences in testosterone levels are most meaningful and consequential during interactions with other human beings. In fact, as is the case for vasopressin and oxytocin, there is growing physiological evidence for testosterone as a “social hormone” (van Honk, Terburg, & Bos, 2011). Therefore, in this study we utilized measures based on the circumplex theory of interpersonal relationships (Horowitz et al., 2006; Wiggins, 1979) and other interpersonal constructs such as attachment-related avoidance and loneliness to better understand the precise interpersonal “signature” or phenotype associated with high basal testosterone.

What kind of an interpersonal constellation of traits do we expect individuals with high and low basal testosterone to show? As depicted in Fig. 1, according to the Interpersonal Circumplex Model of personality, all interpersonal traits can be organized around two main interpersonal dimensions: “Communion” (C: connecting with others; affiliation), and “Agency” (A: influencing others; dominance). Any interpersonal construct can be expressed as a blend or combination of these two bipolar dimensions. For example, arrogance is a blend of dominance (agency) and hostility (disconnectedness; unfriendliness), which corresponds to the +A – C (Agentic and Disconnected) octant in Fig. 1. Circumplex measures assess each of the eight octants formed by the two bipolar dimensions of Agency and Communion (Horowitz, Turan, Wilson, & Zolotsev, 2008).

The circumplex method allows researchers to identify each interpersonal trait as belonging to an octant in the circumplex. What octant, then, would best represent the personality structure associated with high testosterone levels? In terms of the Agentic dimension, individuals with high testosterone should theoretically be more agentic and dominant (i.e., the three upper octants), since testosterone is thought to be related to dominance behavior. In terms of the Communal dimension, we hypothesize that testosterone is associated with low communion (unfriendliness; low interpersonal warmth). Our rationale for this hypothesis is based on the argument raised by some researchers that the reason for smaller effect sizes in the association between testosterone and aggression in humans is that, unlike animals, humans generally use means other than overt physical aggression to establish dominance. These strategies include threats, verbal threats, belittling, and denigration (Eisenegger et al., 2011; Mazur & Booth, 1998; Mueller, 1998). We hypothesize that many of these strategies should decrease the degree of affiliation or interpersonal warmth that the person displays.

Therefore, we expect testosterone to be negatively correlated with interpersonal warmth. In fact, there is evidence that high testosterone is associated with different manifestations of low levels of affiliation (Bos, Terburg, & van Honk, 2010; van Honk et al., 2011; also see reviews by Eisenegger et al., 2011; Mehta & Josephs, 2010). This unique combination of high agency and low communion that we expect individuals with high testosterone levels to show corresponds to the upper left quadrant in Fig. 1 (+A – C or the “Agentic and Disconnected” octant; see DeYoung et al., 2013 for a similar argument).

In order to be considered an interpersonal construct, a measure should not only show its highest correlation with the corresponding octant scale, it should also show an expected pattern of correlations with the other seven scales. That is, the construct should have its highest negative correlation with the diametrically opposite scale in the circumplex (Fig. 1). In the case of our theoretical formulation of testosterone as a blend of dominant and disconnected styles, the diametrically opposite scale in the circumplex corresponds to the –A + C (Submissive and Communal) scale—low on dominance combined with high on communion. Therefore, we hypothesized that the –A + C scale would show the lowest (i.e., the highest negative) correlation with testosterone. Furthermore, the two octants to each side of this –A + C scale should yield slightly higher correlations (i.e., less negative correlations), and the two scales that are two octants away from this scale should yield yet higher correlations, and so on.

This pattern of correlations that a variable shows with the eight octant scales, when graphed, yields a cosine curve, similar to the one depicted in Fig. 2. In a perfect circumplex structure, the size of the correlation (the y-axis in Fig. 2) is a direct function of the scale’s angular distance (see Fig. 1) from the scale with the lowest correlation. Obtaining such a cosine curve provides strong evidence for the construct validity for an interpersonal measure, because it confirms a good fit to the circumplex structure (Gurtman, 1993; Turan & Horowitz, 2010).

In this article, we report how basal testosterone is associated with the eight scales of the Interpersonal Adjective Scale (IAS-R;
Wiggins, Trapnell, & Phillips, 1988)—the most widely used circumplex measure of interpersonal traits. In addition, we also examined associations between basal testosterone and the eight scales of the Circumplex Scales of Interpersonal Values (CSIV), which assess interpersonal goals or motives (Locke, 2000). Our rationale in examining interpersonal motives is based on the theoretical position that “...testosterone in social interaction is best conceptualized as bringing motives for seeking social status to the fore” (Eisenegger et al., 2011, p. 263).

We also examined testosterone’s association with attachment-related avoidance. Individuals high on attachment-related avoidance do not trust others to be available at times of stress and therefore tend to be self-reliant, independent, and non-affiliative (Mikulincer, Shaver, & Pereg, 2003; Turan, Goldstein, Garber, & Carstensen, 2011; Turan, Osar, Turan, Damci, & Ilkova, 2002, 2003). This constellation of traits reflects low communion (possibly combined with high dominance), which should be associated with high levels of testosterone.

In brief, we hypothesized that high testosterone is associated with an interpersonal style combining disconnectionedness, dominance, and attachment-related avoidance. This interpersonal style is likely to result in loneliness (Givertz, Woszidlo, Segrin, & Knutson, 2013). Therefore, we also expected high basal testosterone to be associated with greater loneliness.

2. Methods

2.1. Participants

Participants were all young (M = 21.1 years, SD = 4.1) male undergraduate students (N = 85; 53 white, 32 black) participating in a larger study on cortisol and testosterone reactivity to a social stressor. Only male participants were recruited, because we wished to obtain a sample size with adequate power, and given the known sex differences in testosterone levels (Mazur & Booth, 1998), it was not feasible to extend the study to include an equally large number of female participants. Participants were prescreened to exclude those with conditions that might affect hormone levels: having an endocrine or hormone disease, using corticosteroid-based medications or recreational drugs other than marijuana, smoking more than 15 cigarettes a week, getting treatment for depression or anxiety, or having an active non-remitted cancer. Participants with the following conditions were rescheduled for a time when they would be symptom free for at least two weeks: being ill, having gum disease or inflammation in the mouth, having recently had general anesthesia or a fracture.

2.2. Procedures

Participants came to the laboratory on two separate occasions (one week apart; at the same time in the day). This allowed us to obtain an average baseline testosterone level which is more reliable than a one-time sampling value. Participants were instructed to avoid the following on the day of their visits because they could affect hormone levels: (a) strenuous exercise, (b) alcoholic beverages, (c) caffeinated drinks, smoking, and tooth-brushing within 2 h of the experiment, and (d) eating within 1 h of the experiment. Compliance with these requests was confirmed upon arrival in the laboratory.

Visits were scheduled between 1 pm and 4 pm to minimize the effects of circadian rhythms on testosterone levels. In the first visit, participants first rinsed their mouth and completed questionnaires (see below) for about 25 min before providing a saliva sample. In the second visit, participants first rinsed their mouth and completed questionnaires for about 5 min before providing a saliva sample. In both visits, participants completed additional tasks not relevant to this manuscript after providing these saliva samples.

2.3. Saliva samples and testosterone assays

Saliva samples (approximately 1 ml each time) were obtained by having participants drool passively into a test tube using a straw. Samples were immediately placed and stored in a –20°C freezer until transferred to a -80°C freezer. Saliva samples were shipped on dry ice to the Center for Interdisciplinary Salivary Bioscience Research at Johns Hopkins University (Director: Dr. Granger) to be assayed. The mean testosterone intra-assay and inter-assay coefficients of variability were 7.61% and 12.81%, respectively. Testosterone values were in the normal ranges for males (M = 118.72 pg/ml, SD = 39.79, and M = 126.12 pg/ml, SD = 59.96, respectively for visit 1 and visit 2).

2.4. Measures

2.4.1. Revised interpersonal adjective scales (IAS-R; Wiggins et al., 1988)

IAS-R is the most widely used circumplex measure and contains 64 items describing different interpersonal traits (e.g., assertive, cocky, kind, tenderhearted). Participants rated how accurately each trait describes them as a person, with an 8-point response scale from “extremely inaccurate” to “extremely accurate”. The items are organized into eight scales that form a circumplex within an interpersonal space composed of two dimensions: Communion and Agency (see Fig. 1). Each scale represents a different combination of the two underlying dimensions. In the present study Cronbach’s alpha values ranged from .75 to .89 for the eight scales.

2.4.2. Circumplex scales of interpersonal values (CSIV; Locke, 2000)

CSIV is a circumplex measure consisting of 64 items describing different interpersonal goals. The original measure uses a response scale that ranges from “not at all important” to “extremely important”. In the present study, a modified response scale was used: Participants rated each item (e.g., “to feel connected to others”) on a 5-point scale ranging from “I do not try at all” to “I try extremely hard”. Like the Revised Interpersonal Adjective Scales, the 64 items are organized into eight scales that form a circumplex composed of two dimensions: communion and agency. In the present study Cronbach’s alpha values ranged from .71 to .77 for the eight scales.

2.4.3. Experiences in close relationships (ECR; Brennan, Clark, & Shaver, 1998)

The 36-item ECR is the most widely used self-report measure of attachment. It assesses the two dimensions of insecure attachment: anxiety and avoidance. A sample item on the anxiety scale is “I worry about being abandoned,” and a sample item on the avoidance scale is “I am nervous when partners get too close to me.” In the present study Cronbach’s alpha was .91 for attachment-related avoidance and .88 for attachment-related anxiety.

2.4.4. The UCLA loneliness scale (Version 3; Russell, 1996)

This scale consists of 20 items that participants rated on a 4-point scale. A sample item is, “How often do you feel alone?” In the present study internal consistency was high (Cronbach’s alpha = .91).

3. Results

As in previous studies, basal testosterone values were skewed, and were therefore log-transformed prior to analyses. The
intra-class correlation (average measure, two-way random effect model) between the two testosterone measures was .71, and the Pearson $r$ was 0.57 ($p < .01$). This level of moderate stability is similar to the stability of testosterone reported in the few studies examining temporal stability of testosterone (Dabbs, 1990; Sellers et al., 2007). In the analyses below, the mean of the two testosterone values was used.

Attachment-related avoidance showed a significant correlation with testosterone ($r = .38, p < .01$; with a similar correlation when attachment-related anxiety was controlled), whereas attachment-related anxiety was not correlated with testosterone ($r = .09$, n.s.). Correlation analyses also showed a marginally significant positive association between testosterone and loneliness ($r = .22, p = .06$).

Exploratory mediation analysis using the bootstrapping method developed by Hayes (2013) revealed a significant indirect effect of testosterone on loneliness through attachment-related avoidance (coefficient = .22, $p < .05$). That is, attachment-related avoidance significantly mediated the effect of testosterone on loneliness.

For the Revised Interpersonal Adjective Scales (IAS-R), each participant’s mean score was computed for each of the eight scales. Then the correlation between testosterone and each of the eight IAS-R scales was computed. As shown in Fig. 2, these correlations showed the expected cosine pattern, with the highest correlation observed for the “Agentic and Disconnected” scale ($r = .24, p < .05$), and the lowest correlation with the diametrically opposite “Submissive and Communal” scale ($r = -.22, p < .05$).

In order to test the degree to which these correlations between basal testosterone and the eight scales of the IAS-R fit the expected cosine pattern, we used the Structural Summary Method (Gurtman & Pincus, 2003; Wright, Pincus, Conroy, & Hilsenroth, 2009; Wright et al., 2012). This analysis yielded an $R^2$ value of .89. $R^2$ values above .80 are considered a good fit. The Structural Summary Method also summarizes the eight correlations with three parameters: elevation, amplitude, and angular displacement ($\theta$). For the correlations between testosterone and the eight scales of IAS-R in our data, these parameters were as follows: elevation = .03, amplitude = .18, and angular displacement ($\theta$) = 135.15°. Angular displacement reflects the location on the circumplex that is aligned with testosterone, and is measured counter-clockwise from the x axis (the Communal +C Scale). Thus, the angular displacement of 135.15° suggests that testosterone is predominantly associated with both Agentic and Disconnected orientation (see Fig. 1).

Correlations between the Circumplex Scales of Interpersonal Values (CSIV) and basal testosterone also approximated the expected cosine curve (see Fig. 3). The highest correlation was observed for two scales: the Disconnected (−C) scale and the Agentic (+A) scale ($r = .31, p < .01$, for both scales), and the lowest correlation was with the Communal (+C) scale ($r = .09$, n.s.). A Structural Summary Method analysis yielded an $R^2$ value of .74, suggesting an acceptable fit. Elevation was .23, amplitude was .09, and angular displacement was 155.65°. This angular displacement of 155.65° is in the same octant (Agentic and Disconnected) as the angular displacement for IAS-R; however, it is slightly closer to the Disconnected octant (Fig. 1).

The elevation of .23 suggests that on average, the CSIV scales showed a positive correlation with testosterone. We computed the sum of the eight scales for each participant to reflect that participant’s tendency to give high ratings to items in general. This total score may be construed as the person’s general (average) interpersonal motivation, and was substantially correlated with basal testosterone levels ($r = .31, p < .01$). This significant correlation suggests that general interpersonal motivation—dependent of its specific dimension—is related to testosterone (see Fig. 3).

The $R^2$ total score showed marginally significant positive correlations with attachment-related avoidance ($r = .20, p = .08$), and with loneliness ($r = .21, p = .08$). The correlations between the CSIV total score and the eight CSIV scales did not show a good fit to the theoretical cosine curve ($R^2 = .51$). However, the correlations between the CSIV total score and the eight IAS-R scales did show a good fit to the theoretical cosine curve ($R^2 = .51$).

Finally, since we had used two different circumplex measures (IAS-R and CSIV) to assess interpersonal functioning, we also examined the mean of these two measures for each of the eight scales (after standardizing each scale score, see Fig. 4). The Structural Summary Method analysis with these mean scores yielded an $R^2$ value of .93, and elevation = .16, amplitude = .16, and angular displacement ($\theta$) = 144.92° (which is again in the Agentic and Disconnected octant).

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2 Partial correlations between attachment-related avoidance and the eight scales of the Revised Interpersonal Adjective Scales (controlling for attachment-related anxiety) also showed a strong cosine pattern, with the highest correlation observed for the Disconnected scale ($r = .42, p < .01$) and the lowest correlation with the Communal scale ($r = -.44, p < .01$).
4. Discussion

This study aimed to identify a more precise interpersonal signature or phenotype of high basal testosterone than previous studies. This was done by using an interpersonal approach to assess relationships between testosterone levels and interpersonal traits representing different combinations of agency and communion, as well as other specifically interpersonal constructs (attachment-related avoidance, loneliness). Results suggest that high testosterone is indeed associated with a distinct pattern of interpersonal traits and goals. This pattern is characterized by a combination of high disconnectedness (cold, distant), high agency (dominant), low connectedness, and low submissiveness. A recent study emphasized the agentic interpersonal style as a personality correlate of testosterone (Sellers et al., 2007). The present findings suggest that the disconnected style is also strongly related to testosterone, perhaps echoing earlier theoretical and empirical reports on aggression and anti-social tendencies as important correlates of high testosterone levels. More importantly, findings underscore the importance of this unique blend of cold and dominant interpersonal styles as a personality orientation for individuals with high testosterone and of a blend of connected (warm) and submissive interpersonal styles for individuals with low testosterone.

Testosterone’s correlations with the Revised Interpersonal Adjective Scales showed a clear circumplex structure, implicating this unique combination of cold and dominant interpersonal styles, with low levels of connectedness and submissiveness. Results with the Circumplex Scales of Interpersonal Values (CSIV) were similar. The resulting angular displacement for the CSIV scales, although still in the Disconnected and Agentic octant, was closer to the Disconnected octant, thus emphasizing the importance of the disconnected dimension somewhat more. For the mean of the IAS-R and CSIV scores the angular displacement was 144.92°, again indicating a blend of cold and dominant interpersonal styles as a personality orientation for individuals with high testosterone.

The sum of all eight scales of the Circumplex Scales of Interpersonal Values showed a significant positive association with testosterone. This index may be considered to reflect the strength of a person’s general interpersonal motivation regardless of the specific dimension with respect to communion or agency (i.e., a general motivation to act). An association between general motivation and testosterone is in line with previous findings suggesting that testosterone can enhance general motivation for action (i.e., broad-spectrum motivation to engage in action), and with findings that low testosterone levels are associated with lethargy and lack of interest (see Aarts & van Honk, 2009; Eisenegger et al., 2011). It is also possible that the sum of the eight CSIV scores was associated with testosterone because the CSIV sum scores showed a pattern of associations with the IAS scales that was somewhat similar to the pattern of associations that testosterone showed with the IAS scales – at least in terms of the agentic dimension.

The significant associations that testosterone showed with attachment-related avoidance and with loneliness further support a link with a cold-disconnected interpersonal style. Loneliness, in fact, may be a possible consequence of this interpersonal style. Exploratory mediational analyses suggested that the effect of testosterone on loneliness is mediated by attachment-related avoidance. However, our findings are correlational and thus cannot argue for a causal role of testosterone in shaping this interpersonal style.

According to the theory of precarious manhood, men feel a strong need to demonstrate to others that they conform to the prototype of manhood (Bosson & Vandello, 2011). It is possible that this need led our participants, especially those high in testosterone, to rate themselves as more disconnected and more dominant than they actually are. One limitation of this study was the inclusion of only men. Future studies examining the interpersonal style associated with testosterone in women can shed light on the differences as well as similarities between men and women in terms of the personality correlates of testosterone.

5. Conclusions

The present findings add to our understanding of the complex inter-relationships between hormones, personality, and social behavior. Our results place testosterone within a “nomological network” of variables (Cronbach & Meehl, 1955) formed by the eight scales of the Revised Interpersonal Adjective Scales and the Circumplex Scales of Interpersonal Values, as well as attachment-related avoidance and loneliness—thereby establishing the interpersonal nature of testosterone.

Basal testosterone has moderately high heritability (approximately 60%; Booth, Granger, Mazur, & Kivlighan, 2006), and we found it to have moderate temporal stability. Testosterone therefore is a good candidate for explaining individual differences in stable personality characteristics. Personality research traditionally utilized self-report measures. In recent years efforts to understand the biological underpinnings of personality have gained momentum (Canli, 2006). Given the fact that biological measures are sometimes better predictors of behavior than self-report measures (Josephs et al., 2006), approaches integrating self-report measures, biological assessments, and behavioral observations might be needed in order to obtain a fuller understanding of personality.

The present findings provide support for the construct validity of testosterone as a biological marker of a specific constellation of interpersonal traits reflecting a dominant, cold, avoidant, and lonely style. This interpersonal style may have long-term adverse effects. While dominance can lead to positive outcomes such as achievement, maintaining higher status, obtaining power and influence (Mazur, 1973), protecting against depression (Fournier, 2009) and even appearing more attractive to women (Townsend, 1993), recent studies also suggest that dominance can exact long-term negative psychosocial consequences for humans (e.g., criminality when displayed aggressively, in dominants with subordinate roles; risk-taking that leads to cheating in marriage and business; Booth & Dabbs, 1993; Ehrenkranz, Bliss, & Sheard, 1974). The implications of social isolation, loneliness, and avoidant attachment for emotional and physical ill-health also have been documented (Fraley, Davis, & Shaver, 1998; House, Landis, & Umberson, 1988; McWilliams & Bailey, 2010; Murphy, Slavich, Rohleder, & Miller, 2013). The dominant, cold, avoidant, and lonely interpersonal style, therefore, may not only adversely affect the interpersonal relationships of individuals with high testosterone; it may also be a risk factor for emotional and physical health problems. If these problems are detected early, strategies could be employed to ameliorate their negative consequences.

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References
