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Hormonal Correlates of Status in Women's College Sororities

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Abstract

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In order to explore the hormonal correlates of status within female social groups, thirty-nine women belonging to the senior pledge class of one of two sororities at Emory University used an ecologically valid status hierarchy generation task to rank fellow senior class members on the characteristics of leadership, likeability, and respect. There was no relationship between any of the three hormones assayed (testosterone, estradiol, and cortisol) and peer- or self-rated status. Similarly, there was no effect of the interaction between testosterone and cortisol on status. These results stand in contrast to other studies that found support for the *dual hormone hypothesis*, in which status attainment is positively correlated with testosterone only among individuals low in cortisol. This discrepancy is potentially due to the task-neutral nature of the sorority and suggests that perhaps the influence of hormones on status attainment is specifically relevant to groups with a task orientation. Additionally, participants completed two questionnaires: the Group Environment Questionnaire (GEQ), to assess feelings of social connectedness with fellow sorority members, and the Adult Nowicki-Strickland Internal-External (ANSIE) control scale, to measure internal vs. external Locus of Control (LOC). In this population, ANSIE score was found to moderate the relationship between peer-rated status and social connectedness as measured by the GEQ-Self subscale, as well as the relationship between testosterone and the difference between self-perceived and peer-rated status, two findings that should encourage the inclusion of LOC assessments in psychobiological research.

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Introduction

Status

In any social group, individuals are afforded varying amounts of status. Those who are conscientious, agreeable (Anderson et al., 2001), confident, competent, and socially adept (Anderson & Kilduff, 2009) generally attain higher status than those lacking these qualities. Higher social status confers greater access to resources and is strongly correlated with health and well-being; in fact, social status within the peer group has been proven to be more strongly correlated with health and well-being outcomes than either objective or subjective socio-economic status (Sweeting & Hunt, 2014).

In its most personal sense, social status arises in the context of a group of individuals who know each other well and interact regularly. An individual's behaviors during such interactions with group members inform both conscious and subconscious evaluations of status. As described by Anderson et al. (2001), status in "face-to-face" groups in which members interact with one another directly "is a function of… the congruence of the individual's personal characteristics with the characteristics valued by the group" (Anderson et al., 2001, p. 116). According to this "functionalist" notion of status, the group develops an implicit consensus as to what traits are valuable and allocates status based on the extent to which each individual embodies these characteristics (Anderson & Kilduff, 2009). Therefore, while an individual's choices and behaviors do influence their standing in the group, social status is by definition *given to* individuals by group members, never unilaterally *taken by* an individual.

This view of status is similar to the "prestige strategy" identified by Cheng et al. (2012), in which individuals earn respect and status thanks to skills, success, and knowledge that is

helpful to and valued by the group. In contrast, the "dominance strategy" (Cheng et al., 2012) depends upon fear, intimidation, and coercion used in the pursuit of status.

Recent research suggests that two hormones, testosterone and cortisol, can influence and be influenced by the social interactions that ultimately determine one's standing in social groups. The present study seeks to examine relationships between testosterone, cortisol, and a third hormone, estradiol, and status attainment among women in college sororities

Hormones

Testosterone is a hormone secreted by the testes in men and, in lesser amounts, by the ovaries in women. Additional contributions in both sexes come from the adrenal gland and extra-glandular conversion of androgen precursors. Cortisol is secreted exclusively by the adrenal cortex. In women, estradiol is produced and secreted by the ovaries, and additional amounts are contributed by the peripheral aromatization of testosterone. All three hormones cross the blood-brain barrier and, at least in principle, have the potential to influence mental processing and behavior by a direct effect on the brain.

Testosterone

Studies report positive correlations between testosterone levels and social aggression (in men, Mazur & Booth, 1998), competitiveness (in men, Mehta & Josephs, 2010), assertive behaviors (in women, Cashdan, 1995), and economic risk-taking (in women, Cardoos et al., 2017), as well as the use of pro-social behaviors to gain status (in women, Boksem et al., 2013; in men, Dreher et al., 2016). In one study with female participants, testosterone administration

was correlated with higher rates of fair offers in the ultimatum game, with no effect on rejection rates (Eisenegger et al., 2010). The authors interpret this as support for a "status hypothesis" of testosterone's effects on human behavior, in which testosterone increases the valuation of, and desire for, status, thus motivating *seemingly* prosocial behaviors (i.e., a 50/50 split of money) that are in fact instrumental behaviors used in the pursuit of status in this context. Indeed, individuals high in testosterone reported higher dominance motivation than those with lower basal testosterone (in women, Grant & France, 2001; in women, Cobey et al., 2015).

One common theory is that testosterone influences an individual's underlying desire to be dominant over others (similar to the "status hypothesis" of Eisenegger et al., 2010), while the specific behavioral strategy (ie: competitiveness versus pro-sociality) used in pursuit of high status will differ depending on the context (Mazur & Booth, 1998; Eisenegger et al., 2011). As would be expected according to this view, higher basal testosterone is correlated with higher status attainment and prestige (in men, Mazur & Booth, 1998; in men and women, Cheng et al., 2018). However, other studies have found such associations to be weak and call for a more nuanced view of testosterone's role in social behavior (Liening & Josephs, 2010).

Cortisol

Cortisol secretion is triggered by situations of physical, psychological, and social stress (both acute and chronic), and an increase in cortisol is often taken as a physiological marker of stress in humans. Theoretically, those occupying low-ranking positions in a social hierarchy are expected to have higher cortisol levels due to the disproportionate helplessness, lack of control over their environment, and resource scarcity they experience compared to higher-ranking individuals (Breier et al., 1987). Indeed, among military and business personnel, leaders (higher

status) have lower cortisol than non-leaders (lower status) (Sherman et al, 2012). High cortisol has also been associated with introversion, shyness, and behavioral inhibition, while low cortisol has been linked to social approach, extraversion, more social connections, and high peer-rated likability (Mehta & Josephs, 2010; Korienko et al., 2014; Decker, 2000).

Estradiol

Correlations between testosterone and estradiol assayed from facial and axillary perspiration in men and women are high (Elliot, Muir & de Catanzaro, 2017; Muir et al., 2008) and, at least in women athletes, estradiol and testosterone are "coupled" in the sense that an increase or decrease in one hormone is accompanied by a corresponding increase or decrease in the other (Edwards & Turan, 2020). A few studies report that estradiol levels are positively associated with dominance striving and implicit power motivation in women and take this as evidence that "estradiol plays a parallel role in dominance motivation in women to testosterone in men" (Stanton & Edelstein, 2009, p. 1111; Stanton & Schultheiss, 2007; 2009).

Testosterone/cortisol interactions

As noted earlier, both testosterone and cortisol have been linked to status-related psychological variables and behavior. Notably, the directions of these relationships are inverse, with high status associated with high testosterone levels but low cortisol levels.

Originally proposed by Mehta and Josephs (2010), the *dual-hormone hypothesis* states that "testosterone should interact with cortisol such that testosterone should be positively related to status-seeking behaviors only when cortisol concentrations are low. When cortisol concentrations are high, the model predicts that testosterone's impact on status-seeking behaviors

should be blocked or inhibited" (Mehta & Prasad, 2015, p. 163). In this view, the individuals who achieve the highest status in their groups will be those with both high testosterone (related to a strong desire for dominance and influence over others) and low cortisol; individuals with high cortisol behave in ways that constrain the establishment of status-related respect and admiration (Hamilton et al., 2015). Some (but not all) studies have demonstrated that testosterone/cortisol interactions are more predictive of aggressive behavior (Dabbs et al., 1991), risk-taking (Welker et al., 2015), dominance motivation and leadership (Mehta & Josephs, 2010), and status (Sherman et al., 2015; Casto & Edwards, 2019) than either hormone alone. See Grebe et al. (2019) for complete review.

In any study of hormones and status, a consideration of *context* is essential. In accordance with a "functionalist" view, status will be differentially distributed among group members as a function of how much each individual exhibits the traits valued by the group. In different contexts, there will be different instrumental behaviors and personality traits that are seen as beneficial and that shall be used in the pursuit of status. In some groups (e.g., the prison population studied by Dabbs et al., 1991), aggression and violence may confer status; in others (e.g., the athletic teams studied by Casto & Edwards, 2019 and Edwards & Casto, 2013), leadership and skill may be more valued. Additionally, the behaviors of individuals with high status motivation will differ between those who employ a "prestige" versus a "dominance" strategy for status attainment (Cheng et al., 2012). For these reasons, it is important to investigate the relationship between hormones and status in a variety of groups, as well as what specific personal qualities may be conducive to status attainment in a particular group.

Hormone-behavior association research in females

Studies of hormones and status have primarily been conducted with men. One reason is that theories of hormones and status have principally focused on the "male" hormone testosterone, implicitly discounting the possibility that the same hormone in lower amounts in women could make important contributions to social behavior (Hamilton et al., 2015; Casto & Prasad, 2017). Even when women are included in studies of hormones and status, the focus is often on groups in domains such as sport, business, and economic decision games—environments in which group members may value stereotypically "male" traits (such as aggression and risk-taking) that are reported to be correlated with testosterone levels (Mazur & Booth, 1998). Individuals in these groups may also be susceptible to making status judgments according to an archetype of male leadership, even if the group consists primarily or exclusively of women. Indeed, in a meta-analysis of personality traits associated with leadership, "masculinity" was found to be highly predictive of leadership perceptions (Lord et al., 1986).

Sex differences in associations between hormones, status, and certain personality traits have been reported. Cheng et al. (2018) found that men with the highest prestige ratings from their peers showed increases in salivary testosterone level over a 10-week period of social community formation, but there was no association between prestige and testosterone for women. Cashdan (1995) reported that social status was *negatively* correlated with salivary androgen levels in co-residential university women. Finally, in a meta-analytic evaluation of the dual-hormone hypothesis, Dekkers et al. (2019) found the moderating effect of cortisol on the relationship between testosterone and status to be stronger for male than female groups.

Sororities as a study population

On more than 670 college campuses in the United States, female students have the option to participate in a sorority: a society for female students that promotes leadership, scholarship, and social outreach. For over a century, these organizations have served an important social function both for their members and for the larger campus community.

Sororities, largely ignored in research on social status, offer many benefits for its study. Most importantly, sororities are a naturalistic social group in which status differentials will emerge over a prolonged period of time as a result of repeated, face-to-face interactions with other members. Additionally, the self-governing nature of sororities offers members the opportunity to hold elected leadership positions, which would make status differentials in the sorority salient. Finally, the sorority is a "task-neutral" group: there is no concrete goal associated with membership in the organization. Though there is an emphasis on engagement in philanthropic activities and academic achievement among sorority members, the primary objectives of membership are the creation of social bonds and the cultivation of positive social experiences.

Some of the benefits of higher status attainment relevant to a sorority population are more and stronger social connections, a greater feeling of belonging within the group, increased sense of fulfillment, and privileged access to leadership positions. Members hoping to gain status in such a group are faced with a number of problems to be solved. Specifically, they must gain an understanding of the social environment and its complex subgroups, evaluate which traits are particularly valued by the group, and determine how to behave in interactions to earn social approval. Therefore, an individual's Locus of Control (LOC) may be related to her success in navigating these problems and her eventual status attainment.

Locus of Control

As conceptualized by Rotter (e.g., 1966), Locus of Control (LOC) is a generalized problem-solving expectancy that determines the degree to which an individual believes that his/her behavior can have an impact on his/her circumstances and life outcomes. “Externally” oriented individuals typically believe that fate, chance, or the actions of powerful others play a substantial role in determining the outcome of events in their lives, and that they themselves are relatively powerless in the face of these influences. Conversely, “internally” oriented individuals are more likely to perceive the course of their lives as a direct product of their own behavior and decisions. LOC impacts the way in which individuals approach and manage problems, and has been a primary focus of thousands of research studies. Among other things, an internal LOC orientation has been associated with longer life expectancy, better subjective well-being, and higher achievement in business, academia, and sports (Nowicki, 2016). External LOC orientation is consistently correlated with greater anxiety and depression (Archer, 1979).

Associations between LOC and social behaviors or relationships that may be relevant to status have also been explored. An external LOC has been associated with greater competitiveness among college-aged women and men (Frederick, 2000) and aggression and bullying behavior in adolescent boys, but not girls (Ostermann et al., 1999). Among children and adolescents, internality is positively related to peer acceptance/popularity, and negatively related to peer rejection (Dahlquist & Ottinger, 1983; Ferrer & Kantz, 1987). Internal adults tend to be more sociable and find interactions more rewarding and satisfying than externals (Rubin, 1993). Notably, while an internal LOC orientation appears to be important for peer relationships and social status among white students, it may be relatively less important for African American, Asian, and Hispanic students (Kang et al., 2015).

Many of the variables associated with LOC orientation (competitiveness, aggression, popularity, social status) have also been found to be associated with an individual's hormonal profile, and there is some evidence of a relationship between hormones and LOC. Preussner et al. (1997) found that the cortisol response to a repeated 5-day stressor was higher for externals than internals. Bollini et al. (2004) reported that participants with a more internal LOC showed a reduced cortisol response to a stressful situation over which they perceived themselves to have control than did more external individuals. The current study examines the potentially moderating influence of LOC on the relationship between cortisol, testosterone, estradiol, and status in a sorority setting. LOC is assessed using the Adult Nowicki-Strickland Internal-External (ANSIE) control scale, a validated measure of LOC orientation (Nowicki & Duke, 1974).

Social connectedness

A central motivation for college women to join a sorority, or any other social group, is the search for a feeling of belonging. Social connection is an important predictor of mental and physical health and should not be neglected in studies of social psychology (Umberson & Montez, 2010). Additionally, the degree to which an individual feels a subjective connection to other members of the group has been associated with both his/her status (as rated by other members of this group) and salivary testosterone levels (Edwards et al., 2006).

In this study, social connectedness is assessed using a modified version of the Group Environment Questionnaire (GEQ). The GEQ is a validated 18-item questionnaire that was originally developed for measuring social cohesion in sports teams (Brawley et al., 1987; Carron et al., 1985). There are two major categories—individual attraction to the group and group integration. Individual attraction to the group, here referred to as GEQ-S (self), measures

"individual members' feelings about the group in terms of their desire to be accepted and identified as a group member, their personal role involvement with the group, and their involvement with other group members" (Carron, et al., 1985, p. 247). Group integration, here referred to as GEQ-G (group), "represents the closeness, similarity, and bonding within the group as a whole" (Carron et al., 1985, p. 248). Two minor categories—social and task—distinguish between an individual's orientations towards "developing and maintaining social relationships" and "a general orientation toward achieving the group's goals and objectives" (Carron et al., 1985, p. 248). As discussed above, the primary goals of sorority membership are inherently social. Therefore, for the purposes of this study, no attempt was made to distinguish between social and task-related goals as represented by these two minor subscales.

The current study – overview

The present study is designed to explore the hormonal correlates (testosterone, cortisol, and estradiol) of peer-rated social status among members of sororities on the Emory University campus. A secondary aim is to determine the extent (if any) to which within-sorority social status either directly or indirectly relates to an individual's Locus of Control (LOC) and the connectedness that she feels to the group.

To this end, using an ecologically valid status-hierarchy generating procedure (Casto & Edwards, 2019), consenting fourth-year members of two sororities ranked other members of their pledge class on each of three attributes related to status: leadership, likability, and respect. Saliva samples were obtained at two different time points for subsequent analysis of testosterone, estradiol, and cortisol levels. Participants also completed the GEQ, to assess her feelings of connectedness to other members of her sorority, and the ANSIE, to assess her Locus of Control.

Methods

Participants

Thirty-nine women belonging to the senior class of one of two sororities at Emory University participated in this study. All participants were between 20 and 22 years of age. Eighty percent of the participants were Caucasian, ten percent Hispanic, and ten percent Asian/Southeast Asian. In sorority A, there were 27 seniors, 20 of whom participated in the study. In sorority B, there were 32 seniors, 19 of whom participated. Two additional women, one from each sorority, signed the consent form but dropped out before completion of the study. All procedures were reviewed and approved by the Emory University Institutional Review Board. Each sorority was paid $200 for their participation in this study.

Recruitment and consent

All sororities at Emory University (fourteen, in total) were contacted and invited to participate in this study. Three chapters were willing to participate and two completed the study in full (see Appendix A). The project coordinator pitched the study to the senior class of each sorority during one of their weekly required chapter meetings—a time during which sorority members are assembled to receive news about chapter events, vote on various proposals, perform ritual, and socialize with other members. Women were informed in detail about the purpose, procedures, risks, and benefits of the study and were given the Informed Consent Form to read and sign. Seniors not present at this meeting were contacted separately and met individually with the study coordinator to obtain informed consent.

Hormone sampling and assay

Participants provided two saliva samples to be assayed for testosterone, estradiol, and cortisol. The first was given at the time of consent (Time 1), and the second during an individual meeting with the study coordinator (Time 2). For most participants, Time 1 corresponded to one of the sorority's weekly chapter meetings. For women not present during this meeting, a separate time was scheduled during which the participant read and signed the informed consent form and contributed her first saliva sample. At Time 2, the project coordinator met one-on-one with each consenting participant in a private room on the Emory University campus. During this session, the participant provided a second saliva sample while completing three questionnaires, described below.

To reduce the effect of circannual (Stanton et al., 2011; Bjornerem et al., 2006) and circadian (Persson et al., 2008; Dabbs et al., 1990; Bao et al., 2003) variation in hormone levels, samples were collected between mid-November 2019 and mid-January 2020, between 17:00 and 20:00 in the evening. Due to scheduling constraints, the Time 1 samples for eleven women in sorority B were collected at 20:45. Time 2 samples, for these women and all others, were within the 17:00 – 20:00 window.

Participants had been asked earlier not to eat, drink, or chew gum within 30 minutes of their scheduled meeting time. Participants rinsed their mouth with water for 60 seconds prior to saliva collection. Each saliva sample was collected via passive drool (facilitated with a plastic collection aid) into a 2 mL plastic vial. Samples were frozen immediately after collection and stored at -80$_{o}$ C. Frozen samples were shipped to Salimetrics (Carlsbad, CA) for analysis for testosterone, estradiol, and cortisol.

Questionnaires

While giving the second saliva sample, participants completed a Personal Information questionnaire (Appendix B) asking about ethnicity and use of contraception. Women using hormonal forms of contraception (e.g. birth control pills) typically have lower levels of testosterone than non-users (Edwards & O'Neal, 2009). This question allowed permitted analysis for this effect. Participants also completed the Adult Nowicki-Strickland Internal-External (ANSIE) Locus of Control scale, and a modified version of the Group Environment Questionnaire (GEQ). Copies of the two questionnaires are included as Appendix C and Appendix D. Later, participants were contacted electronically and asked to provide information about the number of elected leadership offices they had held throughout their time in the chapter as well as the semester during which they joined the sorority. While most women join at the first possible opportunity, during their second semester of freshman year (Spring 2017), a minority of women join in subsequent semesters.

Ranking task

Following the completion of the three questionnaires at Time 2, participants constructed status hierarchies including all the members of her pledge class, including herself, according to the categories of leadership, likeability, and respect, as per the instructions below. (For a discussion of why leadership, likeability, and respect were chosen as pertinent elements of status in this population, see Appendix E).

> *Using these cards, each with the name of one of your sorority sisters on it, please construct three hierarchies based on the three categories of leadership, likeability, and*

respect. I will read you a short description before each one. Please construct the hierarchies based on your own individual perceptions and feelings; not based on how you think anyone else in your sorority would do so. Please remember that none of your sorority sisters will see what you construct, and rankings will not be shared with any other person, so please be as honest as possible.

To ensure that the hierarchies were constructed with the same understanding by all participants, the following definitions were read to each participant before constructing the hierarchies:

Leadership: Does this individual possess the qualities of a good leader, such as commitment to the sorority, ability to delegate responsibilities, positivity, clear communication, and competency? How likely would you be to trust her to make key decisions on the sorority's behalf?

Likability: How much do you, individually, like this individual and enjoy spending time with her?

Respect: How highly do you regard this individual? To what extent do you consider her to be someone who both respects others and commands the respect of others?

For guidance, participants were shown examples of sample hierarchies without names (Figure 1) and told that there was no one way in which they had to structure the rankings. In all

cases, rankings based on leadership were constructed first, followed by rankings based on likeability, and finally respect. Each finished hierarchy was photographed for subsequent coding. The cards were then collapsed and re-shuffled before conducting the next ranking.

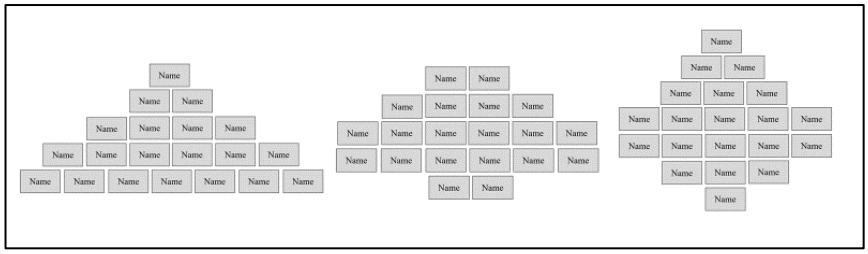

Figure 1 Sample hierarchies to guide participants in the hierarchy generation task (Casto & Edwards, 2019).

To code the status hierarchies, each level of each individual hierarchy was assigned a numerical value starting with "1" at the bottom and ascending "2," "3", "4," and so on depending on the number of levels. These rankings were transformed so that any given individual's ranking was expressed as a percent of the maximum possible rank in that hierarchy. For example, a woman in the second row of a five-level hierarchy would be at the 40th percentile, whereas a woman in the second row of a three-level hierarchy would be at the 67th percentile. The percentile scores given to each participant by all raters were averaged to give an average measure of leadership, likeability, and respect for each participant. Each individual's average percentile in each of these three categories were again averaged together to yield an overall status score. Thus, individuals with low placements for any given status component ended up with a lower average score for that component and a lower overall score than individuals with consistent higher placements.

An individual's "self-ranking" was not included in these calculations. Instead, her average percentile in that category as rated by peers was subtracted from the percentile at which

she placed herself to create a variable representing this "perception gap." Positive values indicate self-over-estimation, and negative values indicate self-under-estimation.

Statistical analyses

Independent and paired-sample t-tests were used to compare means for between and within particular groups as appropriate. Cohen's *d* was calculated to determine the effect size. Pearson bivariate correlations were used to make correlations within particular groups. One-way analysis of variance (ANOVA) for independent groups was used compare hormone values for individuals sampled at different times of the year and day. Two-way random intraclass correlation coefficients for absolute agreement were used to calculate inter-rater reliability for all elements of status. Regression analysis using PROCESS version 3.4 for SPSS (http://processmacro.org) was used to test the moderating effect of different variables on selected relationships between study variables.

Results

Hormone levels

One participant had blood in both her Time 1 and Time 2 samples. These samples were discarded, and the woman subsequently returned to give a third and viable sample. Hormone values for this single sample were taken as her "mean" value so that her data could be included with that of the other participants in analyses involving mean hormone levels. For one woman, estradiol level for the Time 2 sample was below the lower sensitivity limit of the assay. The

lower limit of the assay (.10 pg/ml) was used as that woman's Time 2 estradiol level for purposes of analysis.

Generally speaking, the concentrations of testosterone, estradiol, and cortisol found in this population were all within the normal range for Emory University undergraduate women sampled at approximately the same time of day as the present study (Hernandez, 2018). The intra- and inter-assay coefficients of variation are as follows: testosterone: 4.60% and 9.85%, estradiol: 7.13% and 7.45%, and cortisol: 4.60% and 6.00%. Considering the thirty-eight participants for whom two valid saliva samples were collected, Time 1 sample values were significantly correlated with Time 2 sample values (testosterone: $r(36) = .80$, $p < 0.000$; estradiol: $r(36) = 0.62$, $p < 0.000$; cortisol: $r(36) = 0.84$, $p < 0.000$). However, mean testosterone and estradiol levels for saliva samples obtained during the one-on-one sessions with the experimenter were significantly higher than the means for samples obtained during the recruitment session (testosterone: $t(37) = 3.2$, $p = .003$, Cohen's $d = .06$; estradiol: $t(37) = 2.6$, $p = .016$, Cohen's $d = .44$). Mean cortisol levels for the two sessions were similar and not significantly different. For purposes of analysis and presentation, values for the Time 1 and Time 2 samples were averaged but, as deemed instructive, separate analyses were also conducted for samples obtained at each of these times. Whether for testosterone, estradiol, or cortisol, mean hormone levels for the two sororities were not significantly different. Table 1 shows means and other descriptive statistics for testosterone, estradiol, and cortisol.

For the thirty-eight women for whom two valid saliva samples were collected, 19 were using an oral contraceptive and there were 9 non-users. The remainder were using some other form of contraception (e.g. hormone implant or patch, IUD, or some "mixed" method). Oral contraceptive users on average had lower testosterone and estradiol levels than non-users, while

mean cortisol levels between users and non-users were quite similar. Whether for the Time 1 or Time 2 samples and whether for testosterone, estradiol, or cortisol, differences between the two groups were not statistically significant and no distinction was made between these two groups in subsequent analyses.

An analysis of variance (ANOVA) showed no significant difference between the mean hormone levels for samples collected in November 2019, December 2019, and January 2020. Similarly, there was no significant difference in any of the hormone levels for samples collected in the 17:00, 18:00, 19:00, and 20:00 hours. Therefore, no distinction was made between these groups in subsequent analyses.

Mean testosterone and mean estradiol levels were strongly correlated (see Table 5), This correlation held for Time 1 samples ($r(37) = .80$, $p < 0.000$) and Time 2 samples ($r(37) = 0.66$, $p < .000$) when analyzed separately, as well. There was no correlation between cortisol and either testosterone or estradiol.

Table 1 Descriptive statistics for testosterone (pg/ml), estradiol (pg/ml), and cortisol (µg/dl)

	N	**Min**	**Max**	**Mean**	**SD**
Testosterone	39	16.72	121.35	65.38	25.80
Estradiol	39	0.27	2.85	1.45	0.58
Cortisol	38[1]	0.06	0.42	0.148	0.085

[1]One woman's mean cortisol level (1.91 ug/dl) was far higher than the mean for any other participant. This participant's cortisol value was not included in calculation of the group's mean and SD for cortisol level to give a more representative value for the participant population.

Relationships between status variables

As expected, there was considerable inter-individual variability with respect to average status percentile for leadership (min = 19.24, max = 96.99, mean = 56.81), likeability (min = 32.56, max = 86.00, mean = 59.13), and respect (min = 25.52, max = 92.69, mean = 59.22). There was generally excellent agreement between raters as to the percentile at which they placed an individual in each of the three hierarchies (see Table 2 for intraclass correlation coefficients).

Table 2 Intraclass correlation coefficients for each of the three categories of status in each sorority.

	Leadership	**Likeability**	**Respect**
Sorority A	0.96	0.89	0.91
Sorority B	0.98	0.83	0.93

As shown in Table 3, the three status variables were significantly positively correlated with each other—women ranked high on one variable were typically ranked high on each of the others. Therefore, a single measure of overall status was calculated for each woman as the average of her status percentiles for leadership, likeability, and respect, and this average value was used in all subsequent analyses.

Participants also varied with respect to the number of elected offices held over the course of her membership (an objective measure of status), with that number ranging from 0 to 4. Elected leadership was significantly positively correlated with overall peer-rated status, as well as peer-rated leadership and respect, although not likeability (Table 3). The number of elected leadership positions that a participant had held in the sorority was also significantly positively correlated with self-rated leadership ($r(37) = 0.61$, $p < .000$) and negatively correlated with self-

rated likeability (r(37) = -.40, p = 0.011). Finally, there was a significant effect of the semester during which a woman joined the chapter on overall status, such that women who joined during their freshman year (January 2017) ranked higher than women who joined after this time (t(37) = 4.25, p < .000). This effect was significant true for leadership (t(37) = 3.81, p = .001), likeability (t(37) = 3.73, p = .001), and respect (t(37) = 3.78, p = .001) when analyzed separately, as well. (See Appendix F for more discussion of the effect of the semester during which a woman joined on other variables in this study.)

Table 3 Correlations between measures of status

	Overall Status	**Leadership**	**Likeability**	**Respect**
Leadership	0.92**	--	--	--
Likeability	0.88**	0.65**	--	--
Respect	0.96**	0.83**	0.86**	--
Number of Elected Positions	0.53**	0.71**	0.26	0.40**

**p < .001

Predictors of social status among sorority women

Descriptive statistics for scores on the GEQ-Self, GEQ-Group, and ANSIE are shown in Table 4. A correlation matrix for mean hormones values and other study variables is shown in Table 5.

Table 4 Descriptive statistics for measures of social connectedness and locus of control

	N	Min	Max	Mean	SD
ANSIE	39	3	20	7.95	3.86
GEQ-S	39	51	76	64.44	7.62
GEQ-G	39	44	75	62.44	7.69

Table 5 Correlation matrix for study variables

	T	C	E	Overall Status	Self-rated Status	GEQ-S	GEQ-G
Testosterone	--	--	--	--	--	--	--
Cortisol	-0.012	--	--	--	--	--	--
Estradiol	0.80**	-0.02	--	--	--	--	--
Overall status	-0.10	0.21	-0.05	--	--	--	--
Self-rated Status	0.11	-0.05	0.22	0.35*	--	--	--
GEQ-S	0.08	0.10	-0.04	0.40*	0.14	--	--
GEQ-G	0.18	0.22	0.16	0.12	0.33*	0.45**	--
ANSIE	-0.09	-0.06	-0.06	-0.14	0.09	-0.16	-0.29

*Correlation is significant at $p < 0.05$ level; **$p = .005$

Subjective feelings of social connectedness (as measured by the individual attraction to group subscale of the Group Environment Questionnaire (GEQ-S)) were significantly positively correlated to peer-assessed overall status (Table 5) as well as each individual element (leadership: $r(37) = .34$, $p = .032$; likeability: $r(37) = .42$, $p = .007$; respect: $r(37) = .36$, $p = .023$). There was no relationship between GEQ-S and either self-rated status or the "perception gap" between self- vs. peer-rated status. Impression of group cohesion (GEQ-G) was

significantly correlated with self-rated average status (r(37) =.33, p = .038), though not with any of the individual components of status—leadership, likeability, or respect—as rated by the self. GEQ-G was not related to peer-rated status.

There was no main effect of testosterone, estradiol, or cortisol on any of the measures of status, either as rated by peers or as perceived by the self. This was the case regardless of whether analyses used the Time 1 or Time 2 samples (not shown), or the average of the two (Table 5). Results of a hierarchical regression analysis (using PROCESS version 3.4 in SPSS) to test for the interaction between testosterone and cortisol, testosterone and estradiol, and estradiol and cortisol in predicting overall status were not statistically significant.

Moderating effects of ANSIE

ANSIE and peer-rated status jointly predict GEQ-S

Hierarchical regression analysis using PROCESS version 3.4 for SPSS was used to test the interaction between LOC (measured by ANSIE score) and peer-rated status in predicting self-reported feelings of social connectedness (GEQ-S score). The interaction between LOC and overall status in predicting social connectedness was statistically significant (*b* = -.0418, t = 3.1, p = .0043). The relationship between status and social connectedness for individuals varying along the LOC scale from internal to external are shown in Figure 2. Simple slope analysis indicated that the positive relationship between status and social connectedness holds true for participants with a more internal LOC (at the mean for ANSIE and one standard deviation below it (t = 3.1, p = .0042; t = 4.3, p = .0001)). The Johnson-Neyman technique (Hayes, 2018; Preacher et al. 2007) showed that the turning point from statistical non-significance to statistical significance falls at an ANSIE score between 10 and 9. That is, based on this predictive model, it

is only among the most internal individuals with ANSIE scores of lower than 10 (72% of the sample) that there is a positive relationship between peer-rated status and social connectedness.

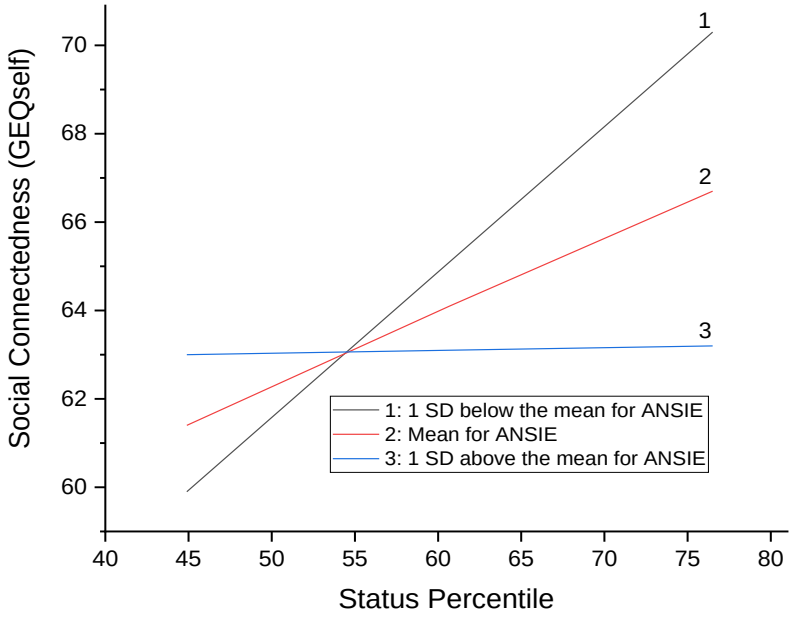

Figure 2 Simple slopes of the interaction between locus of control (ANSIE score) and status in predicting social connectedness (score for GEQ self).

ANSIE and testosterone jointly predict the gap between self- vs. peer-rated status

Although self-ratings of status were correlated with status ratings made by peers (Table 5), the majority of participants (31 of 39 women) rated themselves higher than their peers rated them. PROCESS was used to test the moderating effect of LOC on the relationship between testosterone and the difference between self-rated status and peer-rated status. While neither testosterone nor LOC predicted the gap between self-rated status and peer-rated status, the interaction between LOC and testosterone in predicting this "perception gap" was statistically significant (b = .0736, t = 2.6, p = .015). Figure 3 shows the relationship between testosterone and the "perception gap" for individuals at varying levels of internality/externality as measured

by ANSIE score. Simple slope analysis indicated that there was a statistically significant positive relationship between testosterone and the difference between self-perceived and group judgments of status only for the most external individuals (1 SD above the ANSIE mean, $t = 3.1$, $p = .0039$). Johnson-Neyman analysis showed that the turning point from statistical non-significance to statistical significance falls at an ANSIE score of between 8 and 9 (38% of the sample), with the most external women showing the strongest relationship between testosterone and self-over-estimation of status. Comparable moderation analyses with LOC as the moderator for the relationship between either estradiol or cortisol and the status perception gap were not statistically significant.

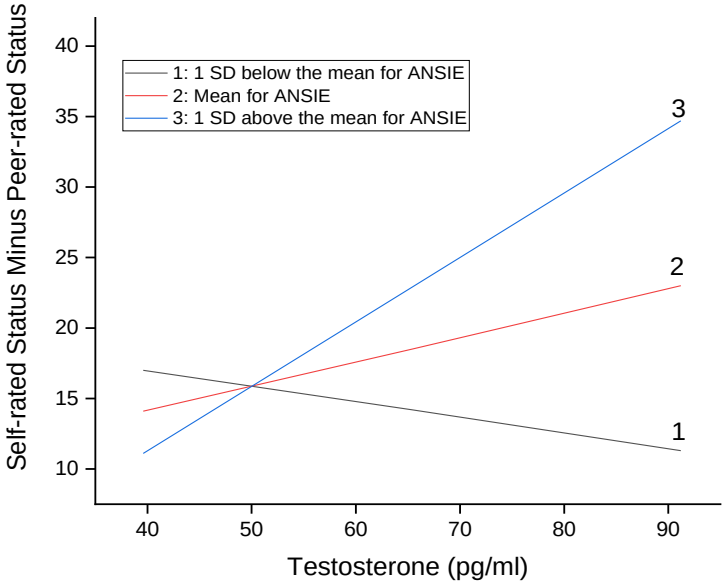

Figure 3 Locus of Control moderates the relation between testosterone and self-rated vs. peer-rated status.

Discussion

Hormone levels

Mean testosterone and estradiol levels for the samples obtained during the one-on-one session with the experimenter were significantly higher than values obtained at the recruitment session. These differences cannot be easily explained; samples were obtained at approximately the same time of day for both samples, so the differences cannot be attributed to the diurnal pattern of secretion for these hormones. Whether for testosterone, cortisol, or estradiol, hormone values for samples obtained for these two sessions were highly correlated, with individual differences in hormone levels conserved across the two sessions and, correspondingly, accurately reflected in the two-session means for the study participants.

Nineteen of the thirty-nine women in the study (49%) reported using some form of oral contraception. Numerous studies have found lower testosterone concentrations for oral contraceptive users as compared to non-users (Edwards & O'Neal, 2009; Stanton et al., 2011; Liening et al., 2009). Hormonal contraceptives also are associated with greater volatility in salivary estradiol (DeSoto et al., 2003), but do not have a significant effect on salivary cortisol measures (Liening et al., 2009). In this sample, there was no significant difference in the mean levels of any of the three hormones between women using oral contraceptives and non-users, and no attempt was made to control for oral contraceptive use in any of the subsequent analyses performed.

Measures were taken to reduce the effect of circannual and circadian variation in hormone levels. Analysis of variance (ANOVA) showed no significant effect of time of year nor time of day on hormone levels. If either circannual or circadian variation in hormone levels had

any effect on the data in this study, it was negligible. Therefore, no attempt was made to control for these factors in subsequent analyses.

Consistent with previous findings (Elliot, Muir & de Catanzaro, 2017; Muir et al., 2008; Edwards & Turan, 2020), there was a strong positive correlation between testosterone and estradiol levels in this population. The vast majority of published studies relating testosterone levels and social behavior do not include the measurement of estradiol. The robustness of the correlation between salivary levels of testosterone and estradiol calls for the inclusion of estradiol assays in any study intending to explore potential relationships between salivary testosterone and behavioral variables of interest. Absent the inclusion of assays for both hormones, an effect attributed to testosterone could just as reasonably be attributed to estradiol. Indeed, the apparent coupling of testosterone and estradiol may require the reconsideration of seemingly well-established behavioral effects attributed to testosterone in published research dating back to the first attempts to relate testosterone and social behavior.

Relationships between status variables

Intraclass correlation coefficients were very high (Table 2), suggesting that sorority women generally agree upon the status position of fellow members, at least as informed by their ranking on leadership, likeability, and respect. However, in both sororities, raters agreed the least on the "likeability" category. This could reflect the possibility that, though there is a relatively standard model of what a good leader or a sorority woman worthy of high regard resembles, different women hold different beliefs about what makes another person likeable and enjoyable to be around.

Scores on the three elements of status—leadership, likeability, and respect—were all significantly correlated with one another (Table 3). Furthermore, the number of elected leadership positions a woman has held, an objective measure of status, was significantly correlated with her overall position in the hierarchies generated by her peers (Table 3). However, there was no correlation between elected leadership position and peer-rated likeability, which suggests that, even in a predominantly social group, likeability is not necessarily one of the primary characteristics that women look for in leaders.

There was also a significant positive correlation between number of elected leadership positions and self-rated leadership, which would be expected: women elected to serve leadership roles in the sorority see themselves as good leaders. However, there was a *negative* correlation between the number of elected leadership positions that a woman had held in the sorority and her self-rated likeability. Being a leader sometimes means making unpopular decisions if one thinks it is in the best interest of the group, as well as enforcing rules of membership and conduct. Perhaps elected leaders may feel that other members of the sorority disagree with or resent their choices, making them rank themselves as less likable than their peers.

Although self -perceived status and status as rated by peers are positively correlated (Table 5), the majority of participants (31 of 39) overestimated their status, placing themselves at a higher status percentile than did their peers. Overestimation of status may be an attempt to resolve cognitive dissonance between the desire to see oneself as a competent, likeable, respectable and respectful person, and the knowledge that perhaps she embodies these traits to a lesser degree than some of her other sorority sisters. Future research should investigate whether frequent self-over-estimation of status is specific to a sorority setting, and the extent to which

individual differences in this tendency are reflective of more general individual differences in personality.

Finally, women who joined the sorority during the second semester of their freshman year had higher peer-rated status—on elements of leadership, likeability, respect, as well as overall—than the women who joined at any later date. This relationship suggests that even in groups in which membership lasts years, there is a significant benefit of having been present during the group's formation, such that founding members can attain a higher status position, on average, than those who joined at a later date.

Correlation between overall status and subjective feelings of connectedness

One of the questionnaires included in this study, the Group Environment Questionnaire (GEQ), assessed participants' feelings of social connectedness within the context of their sorority. The two major subscales of the GEQ assess the degree to which an individual feels a subjective, personal connection to and affiliation with fellow group members (GEQ-S) and the degree to which an individual perceives the group as a whole to be cohesive (GEQ-G). Women's overall peer-assessed status rankings positively correlated with GEQ-S scores: the higher a woman's status with her peers, the greater her feeling of connectedness and bondedness with her sorority sisters. This suggests that a sense of acceptance, belonging, and connection to others are among the "rewards" of status. The relationship between peer-rated status and social connectedness may also be bi-directional or self-reinforcing. That is, women who are skilled in social interactions and easily establish connections with others likely invest more time and energy in establishing the rewarding social relationships that then also form the basis for their attainment of status. Interestingly, there was no correlation between overall status and the GEQ-

G subscale. High status women do not necessarily have a better impression of the group as a whole than low status women. The connection between status and social connectedness in sorority women does not depend on the perception of overall group cohesiveness but, rather, the appraisal of one's personal experiences with other members of the sorority.

A participant's score on the GEQ-G subscale was significantly correlated with her average self-rated status (Table 5). However, GEQ-G score was not significantly correlated with self-rating on any of three elements of status individually, suggesting that the degree to which an individual perceives the group to be cohesive overall does not relate in a meaningful way to her own perception of her status within that group, at least as measured by leadership, likeability, and respect.

Hormonal predictors of peer-rated social status among sorority women

There was no relationship between testosterone, estradiol, or cortisol and any element of status—whether assessed by the self or by peers—in this sorority population, nor was there evidence of a moderating effect of cortisol on the relationship between testosterone and status. This stands in contrast to studies by Edwards and Casto (2013) and Casto and Edwards (2019) on women's sports teams that found a strong moderating effect of cortisol level on the relationship between testosterone and status as assessed by teammates. Differences in *task orientation* between sororities and sports teams could explain this discrepancy. Previous research on the dual hormone hypothesis has focused on groups for which there is a salient goal to be accomplished (sports teams, businesses, laboratory decision-making games, etc.), something that is conspicuously missing in college sororities, which exist primarily for purposes of social bonding.

The absence of a hormone-status relationship in the present study is consonant with the idea that hormones may be associated with status attainment *specifically* in strongly task-oriented groups.

Importantly, the failure to find significant effects of hormones on peer-assessed status in this "task-neutral" group was not due to a lack of status differentials in the group generally. With very rare exceptions (see Strengths and limitations), the participants had no difficulty constructing the three hierarchies. Scores on the three elements of status—leadership, likeability, and respect—were all significantly correlated with one another, and the intraclass correlation coefficients for all three measures were very strong. This indicates that, even in socially-oriented task-neutral sororities, there exist highly salient status differentials of which group members are aware and in tacit agreement. Therefore, it is not the case that task orientation *creates* a stratified status hierarchy in a group. This raises questions as to what other critical differences exist between task- and socially-oriented groups that may explain why a hormone-status association can be seen in the former but not the latter. Two possible explanations are proposed below.

First, the task-neutral nature of the sorority eliminates the possibility of task accomplishment as a route to status attainment. According to Anderson and Kilduff's (2009) "functionalist" theory of status, a group allocates status based on the extent to which each individual embodies the characteristics valued by the group. In a task-oriented group, a fundamental value is likely the extent to which a member can contribute to the accomplishment of common goals. Therefore, a dependable strategy for status attainment is to assist in the achievement of these tasks. Perhaps the influence of hormones on status-relevant behavior is most applicable to instrumental, practical behaviors in the service of group objectives. In task-neutral groups, members do not have the option to tether their pursuit of status to the

accomplishment of group goals, and therefore hormones may be less pertinent to the desire for or attainment of status.

Second, a lack of task-orientation may decrease the impression of inter-individual competition in the group. Mazur, Welker, and Peng (2015) evaluated the emergence of status differences among unacquainted men who engaged in a casual 10-minute conversation in a laboratory setting. Regardless of whether or not there was a monetary reward ($20) at stake for being identified by conversation partners as having the highest status, there was no relationship between testosterone, cortisol, or their interaction on status differences in this setting. The authors conclude that "[testosterone] effects probably become observable only during high stakes competition" (Mazur, Welker, & Peng, 2015, p. 14). While this study included only a small sample of men who knew each other for a short amount of time, the results are consonant with the idea that hormones may exert an observable effect on status-relevant behaviors only in the context of overt, high-stakes competition.

While it is true that high-status sorority women likely obtain greater benefits of group membership than lower-status women, these benefits are less visible than those in a task-oriented group and thus may decrease the desire to compete. In a sports team, for example, teammates are, to an extent, in constant competition with one another for very discernible advantages that also confer a great deal of influence in their group: a position in the starting lineup, increased playing time, and greater recognition, among others. In a sorority setting, the most conspicuous benefit of high status, which also confers influence over others, is the attainment of elected leadership positions; other potential benefits, such as feelings of increased social connectedness and belonging, are relatively inconspicuous. Fewer conspicuous benefits of high status in task-neutral groups may decrease group members' motivation to compete with one another, and this

lack of high-stakes competition may make it such that hormones play an insignificant role on status-relevant behaviors, as suggested by Mazur, Welker, and Peng (2015).

It should be understood that a sorority, while an important group to its members, is unlikely to be the only organization that college women belong to. Some individuals, particularly those with a hormonal profile that would encourage status seeking, may be motivated to devote more of their time, energy, and commitment to a different group, such as a sports team or other strongly task-oriented group in which high status rank confers more conspicuous benefits and greater influence over others. Such women will have lower status among her sorority members, though she may have high status in other groups. Additionally, there likely exist many subgroups within the sorority overall, such that there are strong social bonds to be found at every level of the hierarchy. (Some support for this possibility lies in the fact that the intraclass correlation coefficient of the "likeability" category was notably lower than that of either leadership or respect, suggesting that there is more variability as to how much members of the sorority "like each person and enjoy spending time with her" than the degree to which they believe a given individual is a competent leader or someone they hold in high regard.) Perhaps, then, a woman may be relatively content existing in a low position in the hierarchy, granted that she has strong connections with other women at the same level. Such a situation would allow her to reap a *portion* of the benefits that are normally afforded only to high-status members in task-oriented groups with more visible status differentials, again decreasing the motivation to compete for high status within the sorority.

The female-centric quality of the sorority may also explain the lack of a hormone-status association in this study. Previous research on hormone-status associations have studied groups

in sports, businesses, and economic decision-making games—contexts that may implicitly value "masculine" traits over "feminine" ones. Traits that are stereotypically "male" (i.e. aggression, risk-taking) are often reported to be related to testosterone levels (Mazur & Booth, 1998); in groups that value these traits and allow them to inform evaluations of status, it follows that testosterone will be a predictor of the resulting status hierarchy. A sorority is a uniquely female-centric sphere, in which there is no male archetype for how group members should behave. Perhaps in such a context, women interact and strive for status in ways that 1) are different than in contexts that value traditionally "male" traits, and, therefore, 2) are not strongly influenced by hormones.

ANSIE moderations

ANSIE and peer-rated status jointly predict GEQ-S

Locus of Control, as measured by ANSIE, was not significantly related to hormone levels or any of the other study variables. LOC did, however, moderate the relationship between peer-rated status and social connectedness, with the positive connection between these two variables strongest for the most internal participants (Figure 2).

Locus of Control is conceived as a generalized problem-solving expectancy concerning the degree to which individuals expect that their actions and choices will have an impact on the resolution of problems they face. One "problem" for status-motivated sorority women involves learning how to interact in ways that highlight their possession of the group's valued traits. Individuals with a more internal LOC orientation perceive the circumstances of their lives and solutions to their problems to be largely under their control. Therefore, high-status participants with a more internal LOC recognize their status position in the sorority to be a result of work that

they personally put in 1) to display valued traits and 2) to create and sustain social bonds. Therefore, they may 1) feel a greater sense of identification with the sorority, as they have altered themselves in its image, and 2) experience resulting social bonds as deeper and more valuable to them—feelings that are reflected in higher scores on the GEQ-S. Externals, on the other hand, do not see the connection between their behaviors and their status in the group as clearly. Consequently, even high-status externals may be less likely to consciously conform to group norms and to put in mindful effort to integrate themselves into the group, resulting in a weaker identification with the group and diminished valuation of their social bonds—reflected in lower scores on the GEQ-S. Another possibility is that, among externals, the perception that the strength of their social bonds in the group are a somewhat random occurrence, rather than a product of their behavior, disrupts the proposed reinforcement loop in which high status leads to greater feelings of social connectedness and reward, which further increases the desire to invest time and energy in the group, in turn conferring more status.

ANSIE and testosterone jointly predict the gap between self- vs. peer-rated status

Neither testosterone nor LOC was directly correlated with the ability of participants to accurately perceive their own status in the sorority, but LOC did appear to moderate the relationship between testosterone and the status perception gap for participants (Figure 3). This relationship was specific to testosterone; there was no moderation effect seen when either mean level of estradiol or mean level of cortisol was used as the predictor variable. External women with high testosterone levels made the strongest over-estimates of their own status in the sorority. Eisenegger et al.'s (2010) "status hypothesis" posits that testosterone drives an increased valuation of and desire for status. To some degree, an individual's self-rating may be

an expression of their status aspirations. Thus, a large positive value for the "perception gap" can be attributed to a woman with high status aspirations whose social interactions fall short of achieving this goal. Previous studies have shown a correlation between LOC and accuracy in judging facial expressions, with externals performing worse than internals (Nowicki & Hartigan, 1988). That LOC appears to moderate the relationship between testosterone and the status perception gap may have to do with the difficulty externally oriented individuals have in accurately perceiving their social interactions with their sorority sisters vis-à-vis the granting of status. As per Eisenegger's (2010) argument, in the absence of the self-awareness and the ability to "read" others in order to accurately perceive one's status in the group, testosterone may drive externals' decisions about where to place oneself in the status hierarchy. Highly internal women are generally more accurate in their self-ratings irrespective of their testosterone level, suggesting that a highly internal LOC orientation acts to "buffer" the effects of testosterone-driven self-appraisals of social status.

Strengths and limitations

Sorority/social group: A novel and important element of the present study is its focus on a sorority population. Fellow sorority members presumably share a number of values that motivate the desire to join a sorority and, more specifically, influence the choice of which sorority to pledge. Members spend a considerable amount of time together, in many cases may live together for a year or more in sorority housing, and many come to define the sorority as a central element of their social life in college. This is perhaps the first study of the dual hormone hypothesis in a task-neutral, real-world setting—a strength.

Inclusion of an estradiol assay: Levels of testosterone and estradiol are strongly correlated with one another, in this study as in others (in axillary perspiration: Elliot, Muir & de Catanzaro, 2017; Muir et al., 2008; in saliva: Edwards & Turan, 2020). This correlation suggests that behavioral effects attributed to testosterone in previous studies may just as reasonably be attributed to estradiol, absent the inclusion of an assay for both hormones. In the present study, the inclusion of an estradiol assay provides the important assurance that any significant effect of testosterone on other study variables is associated only with testosterone, and not estradiol.

Incomplete participation: Despite an effort to obtain data from the entirety of each senior class, some women declined to participate. Twenty out of twenty-seven seniors in sorority A, and nineteen out of thirty-two seniors in sorority B participated fully in the study: 74% and 60% of each class, respectively. Thus, all data concerning an individual's rank on the measures of leadership, likeability, and respect represent the collective opinion of a majority, rather than the entirety, of the senior pledge class. One could reasonably question the extent to which the status rankings provided here can be considered an accurate representation of an individual's standing in the sorority. That said, intraclass correlation coefficients among raters were exceptionally high for all three status elements (Table 2). This provides good assurance that the status rankings obtained from the consenting participants accurately represents the status of the women being rated (even those who did not participate in the study) with respect to relative degrees to which they embody important leadership characteristics and are well-liked and respected by group members.

Unfamiliarity: During the ranking task, a small minority of women said that they did not know everyone in the senior class and were not sure where to place those women whom they did not know well. This was surprising, given the long tenure of most women in the group and the numerous opportunities for interactions with other members that group membership affords. Participants were instructed to include all women in their rankings and rank members based on whatever knowledge and personal opinion they did hold, however small. Intraclass correlation coefficients for all subcategories of status were strong, suggesting the influence of these "uninformed' rankings were minimal and perhaps, without the rater's knowledge, aligned relatively well with overall group perceptions.

Menstrual cycle variation: There was no attempt to estimate menstrual cycle phase, nor to control for its effect on the hormone levels of participants because a meaningful attempt to do so would have required more naturally-cycling individuals and more frequent saliva sampling. This is an endeavor beyond the scope of the present study. Whether menstrual cycle phase affects salivary hormone levels to an extent that will have a significant influence on women's behavior as it relates to status striving and attainment is a question that remains to be answered.

Conclusion

The present research is one of the few to investigate hormone-status associations in a sample of women in a task-neutral group. There was no evidence here to support the dual hormone hypothesis, according to which testosterone and cortisol jointly regulate status position. The lack of a hormone-status connection could be due to the task-neutral nature of the sorority,

which 1) excludes task accomplishment as a route to status attainment, and 2) de-emphasizes overt inter-individual competition. However, another possibility is that, in female-centric groups, women will strive for status in ways different from those of men and of women in male-dominated environments. Future studies should seek to isolate these effects by studying groups that are *either* task-neutral *or* female-centric, in order to better identify why some groups do not show hormone-status associations.

In this study, the ANSIE was a significant moderator of the relationship between peer-rated status and self-reported connectedness to the group, as well as between testosterone and self-over-estimation of status. These results should encourage future research on the potential moderating role of LOC on group dynamics as relevant to the attainment of status, subjective feelings of social connectedness, hormonal influences on behavior, and accuracy of self-perception. Such research will help elucidate the mechanisms by which LOC moderates these relationships.

References

Anderson, C., & Kilduff, G.J. (2009). The pursuit of status in social groups. *Current Directions in Psychological Science, 18*(5), 295-298.

Anderson, C., John, O. P., Keltner, D., & Kring, A. M. (2001). Who attains social status? Effects of personality and physical attractiveness in social groups. *Journal of personality and social psychology, 81(1),* 116.

Archer RP (1979). Relationships Between Locus of Control and Anxiety. *Journal of Personality Assessment, 43(6),* 617-626,

Bao AM, Liu RY, van Someren EJ, Hofman MA, Cao YX, Zhao JN (2003). Diurnal rhythm of free estradiol during the menstrual cycle. *European Journal of Endocrinology, 148,* 227-232.

Bjornerem A, Straume B, Oian P, & Berntsen GKR (2006). Seasonal Variation of Estradiol, Follicle Stimulating Hormone, and Dehydroepiandrosterone Sulfate in Women and Men. *The Journal of Clinical Endocrinology & Metabolism 91(10),* 3798–3802.

Boksem, MAS, Mehta, PH, Van den Bergh, B, van Son, V, Trautmann, ST, Roelofs, K, Smidts, A & Sanfey, AG (2013). *Psychological Science, 24(11),* 2306-2314.

Bollini AM, Walker EF, Hamann S, & Kestler L (2004). The influence of perceived control and locus of control on the cortisol and subjective responses to stress. *Biological Psychology, 67,* 245-260.

Brawley L.R., Carron A.V., & Widmeyer W.N., (1987). Assessing the cohesion of teams: validity of the group environment questionnaire. *Journal of Sport Psychology, 9,* 275-294.

Breier, A., Albus, M., Pickar, D., Zahn, T., Wolkowitz, O., and Paul, S. (1987). Controllable and uncontrollable stress in humans: Alterations in mood and neuroendocrine and psychophysiological function. *American journal of Psychiatry, 144, 1419*–1425.

Cashdan, E. (1995). Hormones, Sex, and Status in Women. *Hormones and Behavior, 29,* 354-366.

Casto, K.V. & Edwards, D.A. (2019). Testosterone and cortisol interact to predict within-team social status hierarchy among Olympic-level women athletes. *Adaptive Human Behavior and Physiology*, in press.

Casto, KV & Prasad, S (2017). Recommendations for the study of women in hormones and competition research. *Hormones and Behavior, 92,* 190-194.

Cardoos SL, Suleiman AB, Johnson M, van den Bos W, Hinshaw SP, Dahl RE (2016). Social status strategy in early adolescent girls: Testosterone and value-based decision making. *Psychoneuroendocrinology, 81,* 14-21.

Carron A.V., Widmeyer W.N., & Brawley L.R. (1985). The development of an instrument to assess cohesion in sport teams: the group environment questionnaire. *Journal of Sport Psychology, 7,* 244–266.

Cheng, J. T., Tracy, J. L., Foulsham, T., Kingstone, A., & Henrich, J. (2012). Two ways to the top: Evidence that dominance and prestige are distinct yet viable avenues to social rank and influence. *Journal of Personality and Social Psychology*, *104*(1), 103-125.

Cheng, J. T., Kornienko, O., & Granger, D. A. (2018). Prestige in a large-scale social group predicts longitudinal changes in testosterone. *Journal of Personality and Social Psychology*, *114*(6), 924-944.

Cobey KD, Nicholls M, Leongómez JD, & Roberts SG (2015). Self-reported Dominance in Women: Associations with Hormonal Contraceptive use, Relationship Status, and Testosterone. *Adaptive Human Behavior and Physiology, 1*, 449-459.

Dabbs Jr., JM (1990). Salivary testosterone measurements: reliability across hours, days, and weeks. *Physiology & Behavior, 48,* 83-86.

Dabbs, J.M. J., Jurkovic, G. J., & Frady, R. L. (1991). Salivary testosterone and cortisol among late adolescent male offenders. *Journal of Abnormal Child Psychology, 19(4),* 469–478.

Dahlquist, LM & Ottinger, DR (1983) Locus of Control and Peer Status: A Scale for Children's Perceptions of Social Interactions. *Journal of Personality Assessment, 47(3),* 278-287.

Decker, S.A. (2000). Salivary cortisol and social status among Dominican men. *Hormones and Behavior, 38*, 29-38.

Dekkers, T.J., Agelink van Rentergem, J.A., Meijer, B., Popma, A., Wagemaker, E., Huizenga, H.M. (2019). A meta-analytical evaluation of the dual-hormone hypothesis: Does cortisol moderate the relationship between testosterone and status, dominance, risk taking, aggression, and psychopathy? *Neuroscience & Biobehavioral Reviews*, 96, 250-271.

DeSoto MC, Geary DC, Hoard MK, Sheldon MS, & Cooper L (2003). Estrogen fluctuations, oral contraceptives and borderline personality. *Psychoneuroendocrinology, 28(6),* 751-766.

Dreher JC, Dunne S, Pazderska A, Frodl T, Nolan JJ, O'Doherty JP (2016). Testosterone causes both prosocial and antisocial status-enhancing behaviors in human males. *Proceedings of the National Academy of the Sciences, 113(41),* 11633-11638.

Edwards, D.A., & Casto, K.V. (2013). Women's intercollegiate athletic competition: Cortisol, testosterone, and the dual-hormone hypothesis as it relates to status among teammates. *Hormones and Behavior, 64,* 153-160.

Edwards DA & O'Neal JL (2009). Oral contraceptives decrease saliva testosterone but do not affect the rise in testosterone associated with athletic competition. *Hormones and Behavior, 56(2),* 195–198.

Edwards DA & Turan B (2020). Within-person coupling of estradiol, testosterone, and cortisol in women athletes. *PeerJ, 8,* 8402.

Edwards, D.A., Wetzel, K., & Wyner, D.R. (2006). Intercollegiate soccer: Saliva cortisol and testosterone are elevated during competition, and testosterone is related to status and social connectedness with teammates. *Physiology and Behavior, 87,* 135-143.

Eisenegger C, Naef M, Snozzi R, Heinrichs M, & Fehr E (2010). Prejudice and truth about the effect of testosterone on human bargaining behavior. *Nature, 462,* 356-359.

Eisenegger C, Haushofer J, Fehr E (2011). The role of testosterone in social interaction. *Trends in Cognitive Sciences, 15(6),* 263-271.

Elliot B, Muir C, De Catanzaro D (2017). Sources of variance within and among young men in concentrations of 17β-estradiol and testosterone in axillary perspiration. *Physiology and Behavior, 173*, 23–29.

Ferrer M & Krantz M (1987). Self-control, locus of control and social status in children. *Psychological Reports, 60*, 355-358.

Frederick, CM (2000). Competitiveness: relations with GPA, locus of control, sex, and athletic status. *Perceptual and Motor Skills, 90,* 413-414.

Grant, VJ & France, JT (2001). Dominance and testosterone in women. *Biological Psychology, 58,* 41–47.

Grebe NM, Del Giudice M, Thompson ME, Nickels N, Ponzi D, Zilioli S, Maestripieri D, Gangestad SW (2019). Testosterone, cortisol, and status-striving personality features: A review and empirical evaluation of the Dual Hormone hypothesis. *Hormones and Behavior, 109,* 25-37.

Hamilton LD, Carré JM, Mehta PH, Olmstead M, Whitaker JD (2015). Social Neuroendocrinology of Status: A Review and Future Directions. *Adaptive Human Behavior and Physiology, 1,* 202–230.

Hernandez, H. (2019). Coupling and reactivity of testosterone, estradiol, and cortisol to an academic examination. Unpublished Emory University Honor's Thesis.

Hayes, A.F. (2018). Introduction to Mediation, Moderation, and Conditional Process Analysis, Second Edition. *The Guilford Press*, New York.

Kang, H.S., Chang, K.E., Chen, C., Greenberg, E. (2015). Locus of Control and Peer Relationships Among Caucasian, Hispanic, Asian, and African American Adolescents. *Journal of Youth Adolescence, 44,* 184-194.

Koreinko O, Clemens KH, Out D, & Granger DA (2014). Hormones, behavior, and social network analysis: Exploring associations between cortisol, testosterone, and network structure. *Hormone and Behavior, 66,* 534-544.

Lease AM, Musgrove KT, Axelrod JL (2002). Dimensions of Social Status in Preadolescent Peer Groups: Likability, Perceived Popularity, and Social Dominance. *Social Development, 11(4),* 508-533.

Liening SH & Josephs RA (2010). It Is Not Just About Testosterone: Physiological Mediators and Moderators of Testosterone's Behavioral Effects. *Social and Personality Psychology Compass, 4(11),* 982–994.

Liening SH, Stanton SJ, Saini EK, Schultheiss, OC (2009). Salivary testosterone, cortisol, and progesterone: Two-week stability, interhormone correlations, and effects of time of day, menstrual cycle, and oral contraceptive use on steroid hormone levels. *Physiology & Behavior, 99,* 8-16.

Lord RG, De Vader CL, Alliger GM (1986). A Meta-Analysis of the Relation Between Personality Traits and Leadership Perceptions: An Application of Validity Generalization Procedures. *Journal of Applied Psychology, 71(3),* 402-41.

Lucas JW, & Lovaglia MJ (1998). Leadership status, gender, group size, and emotion in face-to-face groups. *Sociological Perspectives, 41(3),* 617-637.

Mazur A & Booth A (1998). Testosterone and dominance in men. *Behavioral and Brain Sciences, 21,* 353-397.

Mazur A, Welker KM, Peng B (2015). Does the Biosocial Model Explain the Emergence of Status Differences in Conversations among Unacquainted Men? *PLoS ONE 10(11).*

Mehta PH & Jospehs RA (2010). Testosterone and cortisol jointly regulate dominance: Evidence for a dual-hormone hypothesis. *Hormones and Behavior, 58,* 898-906.

Mehta PA & Prasad S (2015). The dual-hormone hypothesis: a brief review and future research agenda. *Current Opinion in Behavioral Sciences, 3,* 163–168.

Muir CC, Treasurywala K, McAllister S, Sutherland J, Kukas L, Berger RG, Khan A, DeCatanzaro D (2008). Enzyme immunoassay of testosterone, 17 β-estradiol and progesterone in perspiration and urine of preadolescents and young adults: exceptional levels in men's axillary perspiration. *Hormone and Metabolic Research 40(11),* 819–826.

Nowicki, S. (2016). *Choice or Chance: Understanding Your Locus of Control and Why it Matters*. Amherst, NY: Prometheus Books.

Nowicki S & Duke M (1974). A Locus of Control scale for noncollege as well as college adults. *Journal of Personality Assessment 38(2),* 136-137.

Nowicki S & Hartigan M (1998). Accuracy of Facial Affect Recognition as a Function of Locus of Control Orientation and Anticipated Interpersonal Interaction. *The Journal of Social Psychology 128(3),* 363-372.

Osterman, K., Kaj, B., Lagerspetz, K. M. J., Charpentier, S., Caprara, G. V., & Pastorelli, C. (1999). Locus of control and three types of aggression. *Aggressive Behavior, 25*(1), 61–65.

Persson R, Garde AH, Hansen AM, Österberg K, Larsson B, Ørbæk P & Karlson B (2008). Seasonal Variation in Human Salivary Cortisol Concentration. *Chronobiology International, 25(6),* 923-937.

Ponzi, D., Zilioli, S., Mehta, P.H., Maslov, A., & Watson, N.V. (2016). Social network centrality and hormones: The interaction of testosterone and cortisol. *Psychoneuroendocrinology, 68,* 6-13.

Preacher, K.J., Rucker, Hayes, A.F. (2007). Addressing moderated mediation hyootheses: Theory, methods and prescriptions. Multivariate Behavioral Research, 42(1), 185-227.

Pruessner, J.C., Gaab, J., Hellhammer, D.H., Lintz, D., Schommer, N., & Kirschbaum, C. (1997). Increasing correlations between personality traits and cortisol stress responses obtained by data aggregation. *Psychoneuroendocrinology, 22(8),* 615–625.

Rotter, Julian B (1966). "Generalized expectancies for internal versus external control of reinforcement". *Psychological Monographs: General and Applied, 80,* 1–28.

Rubin, AM (1993). The Effect of Locus of Control on Communication Motivation, Anxiety, and Satisfaction. *Communication Quarterly, 41(2),* 161-171.

Sherman GD, Lee JJ, Cuddy AJC, Renshon J, Oveis C, Gross JJ, & Lerner JS (2012). Leadership is associated with lower levels of stress. *Proceedings from the National Academy of Sciences, 109(44),* 17903-17907.

Sherman, G.D., Lerner, J.S., Josephs, R.A., Renshon, J., & Gross, J.J. (2015). The interaction of testosterone and cortisol is associated with attained status in male executives. *Journal of Personality and Social Psychology, 110,* 921-929.

Stanton SJ & Edelstein RS (2009). The physiology of women's power motive: Implicit power motivation is positively associated with estradiol levels in women. *Journal of Research in Personality 43(11),* 1109–1113.

Stanton SJ & Schultheiss OC (2007). Basal and dynamic relationships between implicit power motivation and estradiol in women. *Hormones and Behavior, 52,* 571–580.

Stanton SJ & Schultheiss OC (2009). The hormonal correlates of implicit power motivation. *Journal of Research on Personality, 43(5),* 942.

Sweeting H, Hunt K (2014). Adolescent socio-economic and school-based social status, health and well-being. *Social Science and Medicine, 121,* 38-47.

Umberson D., Montez J.K. (2010). Social relationships and health: a flashpoint for health policy. *Journal of Health and Social Beha*vior, *51,* S54–S66.

Welker KM, Gruber J and Mehta PH (2015). A positive affective neuroendocrinology approach to reward and behavioral dysregulation. *Frontiers in Psychiatry 6,* 93.

Appendix A

An attempt was made to add participants from a third sorority to this study; however, less than 50% of the senior pledge class was willing to participate and results of hormone assays were not available at the time of submission. Therefore, the data from this third sorority is not included in this manuscript.

Appendix B

Personal Information Questionnaire

My ethnicity (circle one): Caucasian African/African American Asian/Asian America

Southeast Asian Hispanic Middle Eastern

Native American Other

Are you currently using an oral contraceptive? (Please circle one.) Yes No

Are you currently using any injected, implanted, or patch-delivered hormone-based contraceptive?

(Please circle one.) Yes No

Are you currently using an intrauterine device (IUD)?

(Please circle one) Yes No

Are you currently using a NuvaRing? (Please circle one.) Yes No

Appendix C

Adult Nowicki-Strickland Internal/External Control Scale (ANSIE)

YES NO

___ ___ 1. Do you believe that most problems will solve themselves if you don't fool with them?

___ ___ 2. Do you believe that you can stop yourself from catching a cold?

___ ___ 3. Are some people just born lucky?

___ ___ 4. Most of the time, do you feel that getting good grades means a great deal to you?

___ ___ 5. Are you often blamed for things that just aren't your fault?

___ ___ 6. Do you believe that if somebody studies hard enough, he or she can pass any subject?

___ ___ 7. Do you feel that most of the time it doesn't pay to try hard because things never turn out right anyway?

___ ___ 8. Do you feel that if things start out well in the morning that it's going to be a great day, no matter what you do?

___ ___ 9. Do you feel that most of the time parents listen to what their children have to say?

___ ___ 10. Do you believe that wishing can make good things happen?

___ ___ 11. When you get criticized, does it usually seem it's for no good reason at all?

___ ___ 12. Most of the time do you find it hard to change a friend's (mind) opinion?

___ ___ 13. Do you think that cheering, more than luck, helps a team to win?

___ ___ 14. Do you feel that it is nearly impossible to change your parents' mind about anything?

___ ___ 15. Do you believe that your parents should allow you to make most of your own decisions?

___ ___ 16. Do you feel that when you do something wrong there's very little you can do to make it right?

___ ___ 17. Do you believe that most people are just born good at sports?

___ ___ 18. Are most of the other people your age and sex stronger than you are?

___ ___ 19. Do you feel that one of the best ways to handle most problems is just not to think about them?

___ ___ 20. Do you feel that you have a lot of choice in deciding whom your friends are?

___ ___ 21. If you find a four leaf clover, do you believe that it might bring good luck?

___ ___ 22. Do you often feel that whether or not you do your homework has much to do with what kinds of grades you get?

___ ___ 23. Do you feel that when a person your age is angry with you, there's little you can do to stop him or her?

___ ___ 24. Have you ever had a good luck charm?

___ ___ 25. Do you believe that whether or not people like you depends on how you act?

___ ___ 26. Will your parents usually help you if you ask them to?

___ ___ 27. Have you ever felt that when people were angry with you, it was usually for no reason at all?

___ ___ 28. Most of the time, do you feel that you can change what might happen tomorrow by what you do today?

___ ___ 29. Do you believe that when bad things are going to happen they just are going to happen no matter what you do to try to stop them?

___ ___ 30. Do you think that people can get their own way if they just keep trying?

___ ___ 31. Most of the time, do you find it useless to try to get your own way at home?

___ ___ 32. Do you feel that when good things happen, they happen because of hard work?

___ ___ 33. Do you feel that when somebody your age wants to be your enemy, there's little you can do to change matters?

___ ___ 34. Do you feel that it's easy to get friends to do what you want them to do?

___ ___ 35. Do you usually feel that you have little to say about what you get to eat at home?

___ ___ 36. Do you feel that when someone doesn't like you there's little you can do about it?

___ ___ 37. Do you usually feel that it is almost useless to try in school because most other students are just plain smarter than you are?

___ ___ 38. Are you the kind of person that believes that planning ahead makes things turn out better?

___ ___ 39. Most of the time, do you feel that you have little to say about what your family decides to do?

___ ___ 40. Do you think it's better to be smart than to be lucky?

Appendix D

Group Environment Questionnaire (GEQ)

This questionnaire is designed to assess your perceptions of your sorority. There are no wrong or right answers, so please give your immediate reaction. Some of the questions may seem repetitive, but please answer ALL questions.

The following statements are designed to assess your feelings about YOUR PERSONAL INVOLVEMENT with this sorority. Please CIRCLE a number from 1 to 9 to indicate your level of agreement with each of these statements.

1. I do not enjoy being a part of the social activities of this sorority.

1	2	3	4	5	6	7	8	9
Strongly Disagree								Strongly Agree

2. I am not happy with the amount of time I get to hang out with other members of the sorority.

1	2	3	4	5	6	7	8	9
Strongly Disagree								Strongly Agree

3. I am not going to miss the members of this sorority when I graduate.

1	2	3	4	5	6	7	8	9
Strongly Disagree								Strongly Agree

4. I'm unhappy with my sorority's level of attendance at sorority activities.

1	2	3	4	5	6	7	8	9
Strongly Disagree								Strongly Agree

5. Some of my best friends are in this sorority.

1	2	3	4	5	6	7	8	9
Strongly Disagree								Strongly Agree

6. This sorority does not give me enough opportunities for personal growth.

1	2	3	4	5	6	7	8	9
Strongly Disagree								Strongly Agree

7. I enjoy other parties more than sorority parties.

1	2	3	4	5	6	7	8	9
Strongly Disagree								Strongly Agree

8. I do not enjoy the interactions I have in this sorority.

1	2	3	4	5	6	7	8	9
Strongly Disagree								Strongly Agree

9. For me, this sorority is one of the most important social groups to which I belong.

1	2	3	4	5	6	7	8	9
Strongly Disagree								Strongly Agree

The following statements are designed to assess your perceptions of YOUR SORORITY AS A WHOLE. Please CIRCLE a number from 1 to 9 to indicate your level of agreement with each of these statements.

10. Our sorority is united in ensuring the best experience for every member.

1	2	3	4	5	6	7	8	9
Strongly Disagree								Strongly Agree

11. Members of our sorority would rather go out on their own than get together as a group.

1	2	3	4	5	6	7	8	9
Strongly Disagree								Strongly Agree

12. We all take responsibility for maintaining the reputation of our sorority.

1	2	3	4	5	6	7	8	9
Strongly Disagree								Strongly Agree

13. Our sorority members rarely party together.

1	2	3	4	5	6	7	8	9
Strongly Disagree								Strongly Agree

14. Our sorority members have conflicting aspirations for the goals of our sorority.

1	2	3	4	5	6	7	8	9
Strongly Disagree								Strongly Agree

15. Our sorority would like to spend time together outside of Greek-related events.

1	2	3	4	5	6	7	8	9
Strongly Disagree								Strongly Agree

16. If members of our sorority have a problem, everyone wants to help them resolve it.

1	2	3	4	5	6	7	8	9
Strongly Disagree								Strongly Agree

17. Members of our sorority do not stick together outside of sorority-specific events.

1	2	3	4	5	6	7	8	9
Strongly Disagree								Strongly Agree

18. Our sorority members do not communicate freely about each member's commitment and contributions to sorority life.

1	2	3	4	5	6	7	8	9
Strongly Disagree								Strongly Agree

Appendix E

Leadership

The first category according to which participants were asked to rank their fellow sorority members was leadership. While Anderson et al. (2001) identifies leadership as a dimension separate from, though correlated with, "face-to-face" status, we make the argument that leadership is in fact a determinant of social status in our study population. The degree to which a sorority member is seen as highly competent, committed to the sorority, and trustworthy—in short, a good leader—plays a role in how much status fellow members grant her. Indeed, in Cashdan's 1995 study of hormonal correlates of dominance and status in a female dormitory population, overall status was correlated strongly with *leadership* (along with *popularity with women* and *caring*), identifying these variables as potential determinants of status within a female social group.

In addition to the importance of leadership in determining status in some populations, it is a valuable behavioral trait in its own right and has therefore been the subject of studies interested in hormonal correlates of leadership behavior itself. Mehta & Josephs (2010) found testosterone levels to be predictive of dominant leadership behavior among low-, but not high-, cortisol individuals. However, leadership in this study was assessed by an outside observer during a one-shot laboratory interaction with a stranger; the current study examines hormonal correlates of peer-rated leadership in the context of a naturalistic social group.

Likeability

Our second measure is likeability, the most powerful determinant of social status in peer groups according to some theorists (Lease et al., 2002). Cashdan's 1995 study found that ratings

of a woman's *popularity with women* was significantly correlated with ratings of overall status. It is worth mentioning that, while previous studies have commonly used "popularity" as a component of social status (Casto & Edwards, 2019; Ponzi et al., 2015; Cashdan, 1995), we choose to assess "likeability" rather than "popularity." Our study quantifies status based on the combined perceptions of each individual in the social group. Wording this element as "likeability" more clearly prioritizes each participant's individual opinions, rather than her (potentially erroneous) perception of the opinions of others. Those studies that consider the associations between hormones and popularity among peers found a positive association between testosterone and popularity among low-cortisol individuals, but not high-cortisol individuals (Casto & Edwards, 2019; Ponzi et al., 2015), and a negative association between basal cortisol and peer-rated likeability (Decker, 2000). We aim to explore the relationship between the hormones testosterone, estradiol, and cortisol and peer-rated likeability among members of college sororities.

Respect

Finally, we ask participants to indicate how much respect they have for each of their fellow sorority members. Anderson & Kilduff (2009) distinguish respect as one of the three core determinants of status in "face-to-face" groups. Cheng et al. (2012) identify respect as central to the "prestige strategy" of status attainment, which we assume to be prioritized over a "dominance strategy" of intimidation and coercion for attaining and maintaining status in a social group. The hormonal correlates of earned respect within a small group have yet to be explored.

Appendix F

Using only the participants who joined during Spring 2017 (n = 27) i.e., the women who belonged to the sorority for the longest period of time, there was a trend suggesting that cortisol moderates the relationship between testosterone and status. Specifically, women with high testosterone levels and high cortisol levels received lower status ratings from their peers than did those with high testosterone levels but low cortisol levels (Figure 4). While the moderation analysis was not statistically significant (*b* = -.9987, t = -1.6, p = .12), the trend is in keeping with results from a recent study of women athletes (Casto & Edwards, 2019) and is consonant with the predictions of the dual hormone hypothesis.

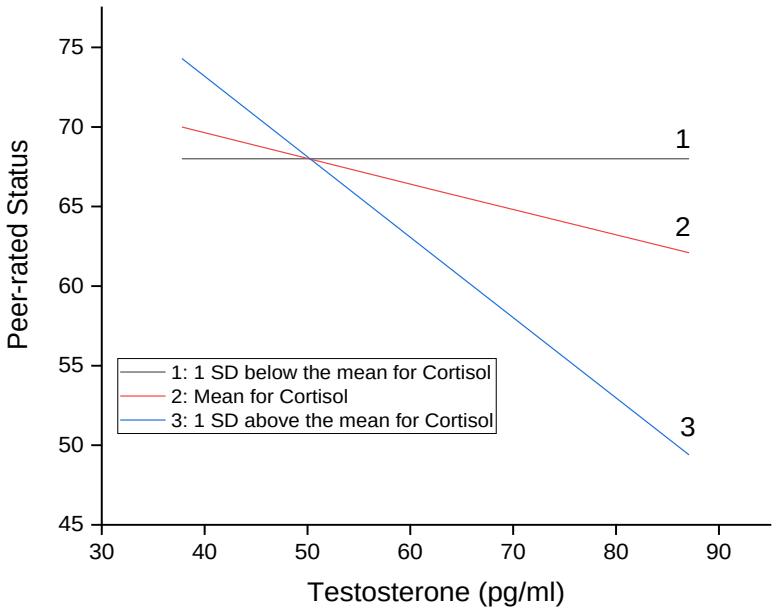

Figure 4 Among women who joined in Spring of 2017 (n = 27), cortisol appears to moderate the relationship between testosterone and peer-rated status.

In this study, women who joined their sorority during their freshman year were typically ranked higher by their peers than women joining the sorority later in their college careers (see

page 18). It is perhaps true that hormone-status relationships in sorority women will be most evident among women whose status has been developed over an extended period of time and/or (more likely) in women for whom sorority connection has a particularly high priority as part of the college experience i.e., for women who choose to join at their earliest opportunity during their college careers.