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Testosterone And Interpersonal Attraction: A Placebo-Controlled Design

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TESTOSTERONE AND INTERPERSONAL ATTRACTION: A PLACEBO-CONTROLLED DESIGN

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1 INTRODUCTION

The Human Mating System

Although much work in evolutionary psychology has explored conflicting reproductive interests between the sexes (e.g., Buss, 1989), there is also strong consensus that the formation of human pair-bonds is an adaptive response to socioecological pressures (Mellen, 1981; Schacht & Kramer, 2019). While no single selective pressure is sufficient to explain the emergence and maintenance of monogamy, across taxa, monogamy is likely influenced by the defensibility of mates and resources, costs and benefits of parental care and mating multiply, offspring need, infanticide risk, and mating competition (reviewed in Klug, 2018).

Despite our slow life histories, humans are an unusually fecund hominoid species with short interbirth interval (Gurven & von Rueden, 2006; Kaplan et al., 2000). Compared to our closest primate cousins, average interbirth interval in chimpanzees is about 66.7 months, whereas among an ethnographic sample of foragers the average interbirth interval was 41.3 months (Kaplan et al., 2000) and is lower still in modern industrialized populations (e.g., Berg, Miettinen, Jokela, & Rotkirch, 2020). Among humans, the altricial nature of our offspring favors the evolution of monogamy by increasing paternal investment (Schacht & Kramer, 2019). By enhancing paternity assurance[1], monogamy defrays the costs to men of forgoing promiscuous mating and enhances the benefits of investing in the offspring of a single relationship (Marlowe, 2000; Schacht, Davis, &

[1] Consistent with this supposition, Scelza and colleagues (2020) recently found that men's experience of sexual jealousy—an emotion whose putative function is to protect an extant relationship from interlopers—varied across societies as a function of paternal investment. Specifically, cultures in which paternal investment was low, men's experience of sexual jealousy was blunted.

Kramer, 2018; Trivers, 1972). Paternal investment has been directly shown to enhance offspring fitness (Schacht, Davis, & Kramer, 2018; Trivers, 1972; Winking & Koster, 2015). For instance, among the Ache, Hiwi, and !Kung divorce or paternal death was associated with higher rates of child mortality (reviewed in Kaplan, Hill, Lancaster, & Hurtado, 2000, but see Sear & Mace, 2008) and among Mayangna/Miskito horticulturalists of Nicaragua, direct investment on the part of the father enhanced offspring "quality"—measured in terms of height and weight—and increased the wife's marital satisfaction (Winking & Koster, 2015).

Yet multiple mating strategies are apparent across societies and individuals. How can we describe the overall pattern? Frequency of marriage systems across society indicates that ~85% permit polygyny, yet most marriages even within polygynous societies are monogamous (Murdock & White, 1969). The dominant human mating system can be described as one of 'social monogamy'[2] defined as forming a long-term pair-bond in which both adults live in close proximity, usually sharing a residential unit. Rates of extra pair paternity are quite low ranging from 0-11% (median 1.7-3.3%)[3] (reviewed in Schacht & Kramer, 2019). By comparison, the rate of extra pair paternity among socially monogamous birds is estimated at over 20%.

Relationship Maintenance: A Recurring Adaptive Challenge

[2] Social monogamy is contrasted with 'genetic monogamy' which is defined as mating with only one other individual for life.

[3] Congruent with a male provisioning account, cultures in which promiscuity is high tend to adopt avuncular investment patterns whereby men direct care towards their sisters offspring—offspring for whom a man can be certain of kinship—rather than their putative offspring (van den Berghe, 1979).

Given the adaptive value of pair-bonding over evolutionary history of our species, the human psyche is equipped with a host of mechanisms aimed at maintaining the integrity of the pair bond, from the devaluation of attractive alternatives (Johnson & Rusbult, 1989), to increased vigilance directed towards potential rivals (e.g., Maner, Gailliot, Rouby, & Miller, 2007), to mate guarding (Buss, 2002). Indeed, extradyadic relations are the primary cause of relationship dissolution (Centraal Bureau voor de Statistiek, 2009).

In line with this goal, work by Lydon and colleagues (1999; 2003) has demonstrated that responses to relationship threats are calibrated according to the level of threat imposed (and commitment to the relationship), such that a romantically uninterested, unavailable, or undesirable alternative does not induce any or at least not a very strong devaluation processes, whereas a romantically interested and desirable alternative does induce strong devaluation processes. This effect has been replicated by an independent lab as well (Carré personal communication, 2018). Consistent with the 'commitment calibration hypothesis', Cole, Trope, and Balcetis (2016) observed that participants involved in romantic relationships only displayed a devaluation effect in conditions in which an attractive alternative posed a high threat to their current relationship. This effect was absent in conditions of low relationship threat. Similarly, Miller and Maner (2010) found that men in committed relationships showed the same devaluation effect, but only when the alternative was in her fertile window—a time in which a clandestine sexual liaison could spell ruin to an extant relationship.

These relationship protection mechanisms extend beyond simply devaluating the attractiveness of available alternatives as well. For instance, Visserman and Karremans

(2014) showed that when women were presented with behavioral information of an attractive alternative, women involved in romantic relationships evidenced memory biases recalling more instances of negative behaviors than did unpaired women. Furthermore, this effect was not driven by enhanced memory processes among unpaired women as the effect still emerged when comparing paired women presented with behaviors of either a same-sex target or an attractive alternative. Taken together, these findings indicate that mating-effort should be conceptually broadened to not only include mate-seeking but perhaps relationship maintenance as well.

Testosterone and Mating Effort: A Proximate Approach for Understanding Evolutionary Processes

Testosterone is an androgen steroid hormone produced by the Leydig cells in the testes, zona fasciculate and zona reticularis of the adrenal cortex , and stroma cells in the ovaries and whose primary function is the expression of sexual phenotypes including behavioral phenotypes. Indeed, a long history of research in the field of endocrinology has demonstrated the role of testosterone in social behavior (Nelson, 2005). Aristotle writing in about 350 B.C. noted the relationship between castration and the reduction or all-together absence of archetypal male behaviors and in a classic 19th-century experiment the Swiss-German physician and professor Arnold Adolph Berthold demonstrated that male chicks castrated prior to adulthood do not show many behavioral characteristics of roosters, but if the testes are reimplanted, the chick develops into a normal male (Quiring, 1944).

Nevertheless, testosterone has often been over-generalized as causing prototypical dominant and antisocial behavior (Eisenegger et al., 2010), including infidelity

(Egan & Angus, 2004; Klimas, Ehlert, Lacker, Waldvogel, & Walther, 2019). Beliefs about testosterone's effects can in fact bias behaviors towards behaving in a manner congruent with such biases. For instance, in a placebo-controlled double blind study, Eisenegger and colleagues (2010) found that women administered testosterone behaved more fairly in a bargaining task, but importantly, those who believed that they received testosterone behaved less fairly[4].

Although dominance and testosterone are sometimes found to be correlated (e.g., Schaal, Tremblay, Soussignan, & Susman, 1996), when one steps back and takes a broader view that encompasses the animal kingdom—at phylogenetic resolution—it is possible to view testosterone as serving as a reproductive motivator rather than a mechanism of dominance and aggression. For instance, the challenge hypothesis predicts (and is supported up by reams of empirical data across taxa—e.g., Moore, Hernandez, & Goymann, 2019; Gray et al., 2019; Wingfield et al., 2019) that in times of reproductive effort, e.g., annual breeding seasons, testosterone increases among males (e.g., Wingfield et al., 1990). While this is often interpreted to aid animals in competing for mates, it may support mating effort more broadly—including, for example, relationship maintenance in addition to attaining dominance, access to mates and territorial disputes.

In humans, testosterone is associated with relationship status (e.g., van Anders & Watson, 2006) and mating-effort. Roney and Gettler (2015) purposed 'the testosterone-relationship cycle' whereby mate-seeking and baseline testosterone reciprocally bolster each other, but once in a committed monogamous relationship, mate-seeking and

[4] As an aside, the former finding is not wholly inconsistent with testosterone-status accounts, as maintaining status often involves behaving in a fair manner (Anderson, Hildreth, & Howland, 2015; Heinrich & Gil-White, 2001).

testosterone decrease. Longitudinal evidence is consistent with this account. For instance, single men with higher testosterone levels were more likely to be married 4.5 years later than men with lower levels of testosterone (Gettler, McDade, Feranil, & Kuzawa, 2011). Indeed, among societies that permit polygynous marriage (e.g., among Swahili men; Gray, 2003) and among individuals pursuing polyamorous relationships (e.g., van Anders, Hamilton, & Watson, 2007), entrance into a relationship is not associated with decrements in testosterone. These exceptions seem to prove the rule that testosterone functions to aid mate-seeking.

Furthermore, endogenous changes in testosterone have also been implicated in modulating mating/parenting[5] trade-off (see Storey et al., 2000). For example, Zilioli and colleagues (2016) demonstrated that testosterone responses to short-term mating cues differentiated mating-oriented and parenting-oriented individuals. Those who self-reported greater interest in babies evinced a decrease in testosterone after exposure to erotica (ibid.). Ronay and von Hippel (2010) found that when in the presence of young women, testosterone rose concomitantly with increased risk-taking. This has been taken as evidence that surges in testosterone aid in mating-effort. Germain to the present research, van der Meij and colleagues (2012) found that competition induced changes in testosterone were positively associated with these young men's manifest affiliative behaviors in a subsequent interaction. Importantly, these changes were only associated with affiliation when the interaction partner was female. Nonetheless, little research has investigated changes in testosterone in the context of relationship maintenance, instead

[5] Here parenting encompasses maintenance efforts of the intimate, procreative relationship.

focusing on relationship initiation processes. For a more comprehensive review of the functional significance of dynamic testosterone, see Zilioli and Bird (2017).

In general, single men are usually found to have higher levels of testosterone than paired men (e.g., van Anders, Hamilton, & Watson, 2007). Furthermore, there is some longitudinal evidence that at times around marriage and divorce, testosterone levels are lower and higher respectively (Mazur & Michalek, 1998), suggesting that testosterone increases reproductive fitness by increasing multiple mating (van Anders, Hamilton, & Watson, 2007). However, when reproductive fitness is drawn broadly enough to fully capture fitness, mating motives can include expression of fidelity (Pultorak, Fuxjager, Kalcounis-Rueppell, & Marler, 2015) and when analogous circumstance occur over evolutionary timescales, selection forces may mold mechanisms to enhance these functions, e.g., offspring investment via pair-bond maintenance (Quinlan, 2007).

An emerging, albeit diverse, body of evidence points to the potential role of an androgenic mediator on the expression of fidelity in pair-bonded males. The most direct test of this hypothesis was conducted in our very distant cousins, the California mouse (last common ancestor 80 million years ago). Specifically, Pultorak and colleagues (2015) showed that injections of testosterone *decreased* ultrasonic vocalizations—which are integral in courtship behaviors in this species—in the presence of a receptive female if the male had already formed a pair-bond (unpaired males treated with testosterone increased ultrasonic vocalizations when presented with a novel female). Given the paucity of research on transitory changes in testosterone among paired men, it is unclear whether such changes play a similar functional role as those described by Pultorak and colleagues (ibid.) or whether such changes parallel the baseline correlational findings indicating

relationship instability (e.g., Klimas, Ehlert, Lacker, Waldvogel, & Walther, 2019; Mazur & Michalek, 1998).

Integration of Testosterone's Effects on Human Male Mating

While the correlational evidence strongly indicates that maintaining high levels of testosterone is associated with relationship instability (e.g., Edelstein, van Anders, Chopik, Goldey, & Wardecker, 2014; Mazur & Michalek, 1998; Klimas, Ehlert, Lacker, Waldvogel, & Walther, 2019), it is important to remember that 1, these data are correlational—testosterone levels may reflect behavioral antecedents (e.g., engaging in extra-pair matings which in turn increase testosterone levels), and 2, these data rely on baseline measures of testosterone, thus it remains unclear the degree to which the functional consequences of baseline levels serve the same functions as acute changes (Ball & Balthazart, 2020). For instance, studies of human aggression consistently find that baseline testosterone is a poor predictor of aggression, whereas endogenous acute changes are more strongly associated with aggression[6] (Geniole et al., 2019). Thus, in the present study, a testosterone administration approach was taken, permitting a causal analysis of the effects of acute changes in testosterone on mate-seeking and mate-protection behaviors among single and paired men.

Hypotheses

[6] Interestingly, meta-analytic estimates of effect size of baseline and administered testosterone, which is akin to acute changes, are similar in magnitude (*r's* = 0.071 and 0.055 respectively; Geniole et al,. 2019). Why this is the case remains unclear but may reflect that testosterone is largely a 'marker' of behavior rather than causal, that as the meta-analytic estimate indicates, it is at least partially causal. Alternatively, the effects of manipulated testosterone may have been diminished due to a reduction in the ecological validity endemic to laboratory designs. Indeed, a recent meta-analysis on the effect of competition outcomes on testosterone found that field studies reported larger effect sizes than do laboratory designs (Geniole et al., 2016).

Primary Hypotheses

(H1) Based on the hypothesis that testosterone serves both mating-seeking and mating-protection functions, it was hypothesized that single men who received testosterone would display greater affiliative behaviors (described below) than single men who received placebo when exposed to the female confederate (mate-seeking effect). Conversely, paired men who received testosterone were hypothesized to show fewer affiliative behaviors relative to paired men who received placebo when exposed to the female confederate. The same pattern of results was expected to emerge for the affiliative behavior sub-facets general interest, self-presentation, and positive facial affect.

(H2) Based on the same logic as outlined in hypothesis one, it was hypothesized that single men who received testosterone would be quicker to initiate conversation (as indexed by the variable conversational latency described below) with the confederate relative to single men who received placebo, the assumption being that decreased latencies reflect heightened mate-seeking behavior. Consistent with the mate-protection hypothesis, paired men who received testosterone were hypothesized to show increased latency relative to paired men who received placebo.

(H3) (Proceptivity): Based on the idea that men may be differentially sensitive to affiliative signals displayed by women as a function of both relationship status and hormonal state, it was hypothesized that the effect of proceptivity (described below) and hormonal state would differ by relationship status. It was expected that proceptivity would moderate the effect of drug treatment such that among single men, testosterone would sensitize men to the confederate's proceptivity behavior and men would thus evince more affiliative behaviors as proceptivity increased relative to men who received placebo.

Conversely, if testosterone serves as a relationship protection mechanism, proceptivity should represent a threat to the man's extant relationship and therefore, it was hypothesized that paired men after receiving testosterone would decrease their affiliative behavior as a function of the confederate's proceptivity behavior relative to paired men when after receiving placebo.

Secondary Hypotheses

(S.H1): It was hypothesized that single men who received testosterone would perceive the confederate as being more attractive relative to single men who received placebo. Conversely and consistent with the mate-protection testosterone hypothesis, it was hypothesized that paired men who received testosterone would perceive the confederate as less attractive relative to paired men who received placebo.

(S.H2): Based on prior work, it was hypothesized that single men who received testosterone would report greater sexual interest in the confederate compared to single men who received placebo. Conversely, paired men who received testosterone were expected to report less sexual interest in the confederate compared to paired men who received placebo.

CHAPTER 2 METHOD

Participants

Participants were recruited from a larger study on testosterone and decision-making that was being conducted in the laboratory on the same day prior to the current study. A health screening was conducted prior to enrolling participants in the study to ensure the prospect was not currently taking prescription medications affecting hormone levels (e.g., glucocorticoids), current diagnosis of a psychiatric disorder, drug dependency, or membership on a sports team where testosterone is a banned substance.

The participant subject pool comprised 322 heathy heterosexual men between the ages of 18 to 40 years old who were either single or are involved in a romantic relationship who were recruited via advertising on local media sites, through medical participant databases, and through local colleges and universities in and around North Bay Ontario, Canada. After completing the decision-making study, the potential participant was asked if he would be interested in completing a second short study for an additional five Canadian dollars. Of the original 322 participants, 212 opted to participate. Neither drug treatment nor relationship status affected opt-in rates, X^2 (1, N = 322) = 0.642, p = .423; X^2 (1, N = 322) = 0.003, p = .959; drug treatment and relationship status, respectively. Furthermore, those who chose to participate compared to those who did not were similar across the Big Five personality traits (p's > 0.284).

Of those who opted to participate, relationship status was missing for two participants and an additional twenty indicated that he was either homosexual, bisexual, or asexual, leaving a final sample of 190 exclusively heterosexual men. The average of the final same was 23 years old (SD = 5.19) and comprised 80.5% self-identifying their

ethnicity as Caucasian (see Table 1). Ninety-seven reported being in an exclusive committed relationship (51%).

Procedure

As part of a larger protocol investigating the effects of testosterone and economic decision-making, men were asked to come into the laboratory for a single two hour session starting from 10 AM in order to control for effects of circadian rhythm on hormone levels (Diver, Imtiaz, Ahmand, Vora, & Fraser, 2003). The economic decision protocol entailed completing a battery of questionnaires and computer based neuroeconomic decision-making games.

After arriving in the laboratory and providing consent, participants were administered either the testosterone nasal gel or placebo using a double blind, placebo treatment protocol, between-subjects design. Half of the men received a 11 mg single dose of a testosterone replacement medication (Natesto®) used for the treatment of hypogonadism while the other half received a placebo. Natesto® has been shown to rapidly increase testosterone concentrations to the high-normal physiological range within fifteen minutes of administration among eugonadal men (Geniole et al., 2019). However, because nasal administration of testosterone produces erroneous salivary testosterone measures, all analyses of the effect of testosterone were restricted to group level differences (i.e., treatment vs placebo; no continuous measure of testosterone will be collected). Among the 190 men who opted to participant in the current study, drug treatment and relationship status were independent from one another, X^2 (1, N = 190) = 1.02, p = .312. Forty-nine single men received placebo, forty-four single men received testosterone, forty-four paired men received placebo, and fifty-three paired men received

testosterone. The confederate performed no better than chance at guessing whether or not the participant had received testosterone or placebo, $t(191) = -1.010$, $p = .843$.

After the other portion of the protocol was completed, the participants were given the option to participate in a second study ostensibly also on decision-making. After agreeing to participate, they were told that the computer was currently in use and asked if they would not mind waiting briefly in a conference room.

In the conference room, the participant was seated across from an attractive research confederate who was presumably there for a singles study (thus indicating that she was romantically available. The conference room was equipped with cameras to capture the interaction.

The confederate was instructed to be friendly and warm to the participant and to initiate conversation if the participant failed to do so after 60 seconds had elapsed. If the participant did not initiate conversation within the first minute the confederate engaged the participant in a scripted conversation (e.g., “Are you here for a research study”, “Are you a student here at Nipissing”, etc.). The entire interaction was three minutes long.

After the three minutes elapsed, the research assistant re-entered the room and collected a few self-report measures aimed at measuring the participant’s romantic interest in the confederate (described below). The participant was then debriefed and dismissed.

Measures

Relationship Status: Participants indicated their relationship status via self-report. Forty-three percent indicated that they were single, 4.7% reported that they were dating one person but were not committed, 37.8% reported exclusively dating one person,

1% reported being in a common law marriage, 2.1% reported being engaged, 9.3% reported being married, and 0.5% reported being in an open relationship (see Table 2). For simplicity, relationship status was dichotomized into “single” and “paired”. The category of ‘single’ comprised participants who reported being single, dating but not committed, and being in an open relationship as these relationship statuses all entail being on the “mating market” and testosterone may function to serve mating-effort (e.g., van Anders, Hamilton, & Watson, 2007), whereas participants who reported exclusively dating one person, common law marriage, engaged, and married were categorized as being ‘paired’.

Behavioral measures:

Male affiliative behaviors. Two female observers were trained to interpret and reliably rate the participants’ behavior from audio-video recordings. The raters were blind to the participant’s drug treatment status and relationship status (unless he explicitly stated whether he was in a relationship in the course of the interaction with the confederate). Neither rater performed better than chance at guessing drug treatment status of the participants (average percent correct across raters = 47%; $t(192) = -1.080$, $p = .859$, $t(191) = -0.576$, $p = .717$).

The observers rated the participants across nine affiliative behaviors, the same nine items used by van der Meij et al. (2012) described above to operationalize men’s affiliative behaviors. The nine items were attention, interest, confidence, questions asked, talkativeness, talked about self, disclosed details about self, smiling, and eye contact. Inter-rater reliability was across the nine items was high, (Cronbach’s α ranged from 0.838

to 0.959, average Cronbach's α = .884). As such, the ratings were then averaged across raters to produce nine affiliative behavioral items.

Following past work (van der Meij et al., 2012), a composite index of affiliative behavior was computed by adding together all nine items representing *affiliative behaviors.* Cronbach's α for the full scale was high (α = .902). Additionally, the first five items (attention, interest, confidence, questions asked, and talkativeness) were added together, representing *general interest* (Cronbach's α = .873). Talked about self and revealed details about self were added together, representing *self-presentation* (α = .836). Finally, the items smiling and eye contact were added together, representing *positive facial cues* (α = .662). The three affiliative behavior sub-facets were correlated with each other (*r* between .532 and .791, *p*'s < .001). See table 4 for correlations among the affiliative behavior facets and means and standard deviations.

Female affiliative behaviors. Two male observers were trained to interpret and reliably rate the confederate's behavior from audio-video recordings. The observers rated the confederate across nine affiliative behaviors, attention, interest, confidence, questions asked, talkativeness, talked about self, disclosed details about self, smiling and eye contact. Inter-rater reliability across the nine times varied (Cronbach's α ranged from 0.391 to 0.824, average Cronbach's α = 0.70). The ratings were then averaged across the raters to produce nine affiliative behavioral items. Cronbach's α for the full scale was high (α = .921).

A composite index of affiliative behavior was computed by adding together all nine items representing *proceptivity.* Cronbach's α for the full scale was high (α = .921). Additionally, the first five items (attention, interest, confidence, questions asked, and

talkativeness) were added together, representing *general interest proceptivity* (α = .894). Talked about self and revealed details about self were added together, representing *self-presentation proceptivity* (α = .804). Finally, the items smiling and eye contact were added together, representing *positive facial cues proceptivity* (α = .697).

The three proceptivity affiliative behavior sub-facets were correlated with each other (*r* between .536 and .837, *p*'s < .001). See table 5 for correlations among the affiliative behavior facets and means and standard deviations.

***Latency to Initiate Conversation*:** Latency to initiate conversation was coded as a continuous variable between 0 and 60. Conversation initiation was considered to have occurred if the participant engaged the confederate in conversation beyond a simple salutation (e.g., saying "hi"). Since in the absence of conversation the confederate initiated a scripted conversation at the 60 second mark, the maximum latency score was coded as 60. The average latency was 27.5 seconds (*SD* = 26.3 seconds).

Self-Report Measures:

Perception of Confederate's Attractiveness. Participants rated the confederate's attractiveness on a single item ("Did you find the woman attractive?") using a ten-point Likert scale from 1, not at all, to 10, very much so. The average attractiveness rating was 7.85 (*SD* = 1.67).

Mating Interest. Participants self-reported their interest in pursuing a short-term relationship with the confederate ("Would you be interested in her for a short-term relationship—one-night stand?") and their interest in pursuing a long-term relationship with the confederate ("Would you be interested in her for a long-term relationship—be her boyfriend?") using a single ten-point Likert scale from 1, not at all, to 10, very much so for

both measures. The average of men's short-term mating interest was 5 (*SD* = 3.24) and long-term interest was 3.98 (*SD* = 2.86). Men's short-term and long-term mating interests were also strongly correlated ($r = .525$, $p < .001$)

Men's Perception of the Confederate's Mating Interest. Participants self-reported their perception of the confederate's interest in pursuing them for both a short-term relationship ("Do you think she was interested in you for a short-term relationship—one-night stand?") and for a long-term relationship ("Do you think she was interested in you for a long-term relationship—be your girlfriend?") using a single ten-point Likert scale from 1, not at all, to 10, very much so for both measures. Men's perception of her short-term and long-term mating interest were strongly correlated ($r = .631$, $p < .001$). Men's overall perception of the confederate's mating interest was then computed by summing the two perceptual measures together to create a single measure of perceived sexual interest that ranged from 2 to 20 ($M = 6.16$, $SD = 4.23$).

Validation Analyses:

Men. Bivariate correlations between men's short-term mating interest (i.e., interest in pursuing a one-night stand), long-term mating interest (i.e., interest in pursuing a long-term relationship) and the affiliative behavior overall composite and sub-facets showed poor agreement (*r*'s ranged from .007 to .153), indicating that men's affiliative behavior may not reflect men's mating motivations. The only correlation that was significant was between men's self-presentation behavior and short-term interest ($r = .153$, $p = .038$).

Rather than reflecting men's mating interests, affiliative behaviors were more strongly related to men's big five personality traits. The composite measure of men's affiliative behaviors was significantly correlated to extraversion ($r = .253$, $p < .001$),

conscientiousness (r = .147, p = .046), and emotional stability (r = .168, p = .022). Men's general interest was positively correlated with extraversion (r = .277, p < .001) and emotional stability (r = .156, p = .034). Lastly, men's self-presentation was positively correlated with extraversion, r = .162, p = .028. All other behavioral-personality correlations were not statistically significant (p's > .056).

Confederate. Bivariate correlations between the confederate's short-term mating interest was positively correlated to her facial cues (r = .152, p = .044) and her self-presentation (r = .163, p = .030). Her overall affiliative behaviors and general interest did not reach statistical significance (p's > .063).

Data Analyses

The hypotheses regarding relationship status, drug treatment, and the interaction on affiliative behavior, latency, attractiveness, and sexual interest were tested by conducting univariate ANOVAs in which all effects were entered simultaneously into the model. Post hoc analyses entailed examining simple effects.

The hypotheses regarding the relationship status, drug treatment, proceptivity, and the interaction terms on affiliative behaviors and perceptions of sexual interest were tested by conducting ANCOVAs, treating the proceptivity measure as a continuous, mean centered, covariate. All effects were entered simultaneously in the model. Three-way interactions were decomposed into two-way interactions conditional on the moderating variable of relationship status and simple effects were then used to further characterize the nature of significant effect.

Results were considered statistically significant at the alpha = 0.05 level. All statistical analyses were conducted using Jamovi (version 1.2.22.0), an open source statistical package.

CHAPTER 3 RESULTS

Primary Hypotheses:

Does testosterone and/or relationship status modulate men's affiliative behaviors? (H1)

Men's Overall Affiliative Behavior. The results of the two-way ANOVA examining the effects of drug treatment and relationship status on men's overall affiliative behavior revealed a main effect of relationship status, $F(1, 181) = 6.187$, $t(181) = -2.49$, $p = 0.014$), whereby paired men were more affiliative toward the confederate ($M = 20.4$, $SD = 4.63$) relative to single men ($M = 19.6$, $SD = 4.68$). There was no main effect of drug treatment, $F(1, 181) = 1.289$, $p = .258$, and no drug by relationship status interaction, $F(1, 181) = 0.316$, $p = .575$.

Men's General Interest in Confederate. The results of the two-way ANOVA examining the effects of drug treatment and relationship status on men's general interest revealed a main effect of relationship status, $F(1, 181) = 7.257$, $t(181) = -2.69$, $p = 0.008$, whereby paired men showed more interest in the confederate ($M = 3.65$, $SD = 0.829$) relative to single men ($M = 3.33$, $SD = 0.824$). The main effect of drug treatment was not significant, $F(1, 181) = 0.860$, $p = .355$, nor was the drug by relationship status interaction significant, $F(1, 181) = 0.082$, $p = .775$.

Men's Positive Facial Cues. The results of the two-way ANOVA examining the effect of drug treatment and relationship status on men's positive facial cues during the interaction with the confederate failed to reveal any significant effects; drug treatment, $F(1, 181) = 2.161$, $p = .143$; relationship status, $F(1, 181) = 3.399$, $p = .067$; interaction between drug treatment and relationship status, $F(1, 181) = 0.433$, $p = .512$.

Men's Self-Presentation. The results of the two-way ANOVA examining the effect of drug treatment and relationship status on men's self-presentation behaviors while interacting with the confederate also failed to reveal any significant effects; drug treatment, $F(1, 181) = 0.098$, $p = .755$; relationship status, $F(1, 181) = 0.544$, $p = .462$; interaction between drug treatment and relationship status, $F(1, 181) = 0.082$, $p = .775$.

Does testosterone and/or relationship status modulate men's latency to initiate conversation? (H2)

The results of the two-way ANOVA examining the effect of drug treatment and relationship status on men's latency to initiate conversation revealed a main effect of relationship status, $F(1, 176) = 9.452$, $t(176) = 3.07$, $p = 0.002$, whereby paired men initiated conversation with the confederate sooner ($M = 21.7$, $SD = 25.3$) relative to single men ($M = 33.5$, $SD = 26.1$). There was no main effect of drug treatment, $F(1, 176) = 1.345$, $p = .248$, and no drug by relationship status interaction, $F(1, 176) = 0.394$, $p = .531$.

Does the confederate's proceptivity behavior modulate the effect of testosterone and/or relationship status on men's affiliative behaviors? (H3)

Pairwise Probes of Proceptivity Measures on Men's Affiliative Behaviors

To test whether the confederate's proceptivity behavior (her manifest affiliative behaviors) modulated the effects of testosterone and/or relationship status on men's affiliative behaviors, a series of three-way ANCOVAs were conducted using the confederate's proceptivity behavior (as indexed by the measures of affiliative behavior) to predict the indices of men's affiliative behaviors.

Men's Overall Affiliative Behavior*:* The results of the three-way ANCOVA revealed a main effect of the confederate's overall affiliative behavior, $F(1, 177) =$

216.860, β = 0.742, p < .001. The main effect of drug treatment was not significant, F(1, 177) = 0.326, p = .569, nor was the main effect of relationship status, F(1, 177) = 3.154, p = .077, and no significant two-way (p's > .646), or three-way (p = .657) interactions emerged.

Men's Self-Presentation*:* The results of the three-way ANCOVA[7] revealed a main effect of the confederate's affiliative behavior on men's self-presentation behavior, F(1, 177) = 56.063, p < .001, β = 0.494, p < .001 indicating that the confederate's affiliative behavior was positively associated with men's self-presentation behavior. The main effect of drug treatment was not significant, F(1, 177) = 0.155, p = .695, nor was the main effect

[7] A similar pattern of results emerged when the model used the confederate's general interest behavior or her positive facial cues on men's self-presentation behaviors: **(1)** The three-way ANCOVA including her general interest revealed a trending three-way interaction between drug treatment, relationship status, and general interest (p = .075). Tests of simple interactions revealed that the interaction between drug treatment and the confederate's general interest was significant among single men, F(1, 88) = 8.200, p = .005, but was not significant among paired men, F(1, 89) = 0.041, p = .840, however, the main effect of the confederate's general interest behavior was significant, F(1, 89) = 22.912, p < .001, *beta* = 0.453, *SE* = 0.143, t(89) = 4.787, p < .001. Among single men receiving placebo, the confederate's general interest was not significantly related to men's self-presentation, *beta* = 0.168, *SE* = 0.171, t(177) = 1.39, p = .165. In contrast, among single men receiving testosterone, the confederate's general interest was significantly positively related to men's self-presentation, *beta* = 0.702, *SE* = 0.195, t(177) = 5.10, p < .001. See Figure 3. **(2)** Similarly, the three-way ANCOVA including her positive facial cues revealed a significant three-way interaction between drug treatment, relationship status, and positive facial cues (p = .014). Tests of simple interactions revealed that the interaction between drug treatment and the confederate's positive facial cues was significant among single men, F(1, 88) = 6.941, p = .010, but was not significant among paired men, F(1, 89) = 0.903, p = .345, however, the main effect of the confederate's positive facial cues was significant, F(1, 89) = 39.021, p < .001, *beta* = 0.553, *SE* = 0.128, t(89) = 6.247, p < .001. Among single men receiving placebo, the confederate's positive facial cues was significantly positively related to men's self-presentation, *beta* = 0.251, *SE* = 0.170, t(177) = 2.02, p = .045. In contrast, among single men receiving testosterone, the magnitude of the effect of the confederate's positive facial cues was larger and significantly positively related to men's self-presentation, *beta* = 0.715, *SE* = 0.160, t(177) = 6.11, p < .001. See Figure 2.

of relationship status, $F(1, 177) = 0.152$, $p = .687$. None of the two-way interactions were significant (p's > .244), though drug treatment by affiliative behavior interaction was trending, $F(1, 177) = 3.422$, $p = .066$. In addition, there was a significant three-way interaction, $F(1, 177) = 4.318$, $p = .039$ (see Figure 1). Decomposition of this three-way interaction revealed that drug treatment interacted with the confederate's affiliative behavior for single men, $F(1, 88) = 8.510$, $p = .004$, but not for paired men, $F(1, 89) = 0.024$, $p = .877$, indicating that the effect of the confederate's overall affiliative behavior did not differ between drug treatment groups. Indeed, among paired men the main effect of the confederate's overall affiliative behavior was significant, $F(1, 89) = 30.279$, $\beta = 0.504$, $SE = 0.025$, $t(89) = 5.503$, $p < .001$. Results of simple effects revealed that for single men who received testosterone, the confederate's affiliative behavior was significantly positively associated with men's self-presentation behavior, $\beta = 0.721$, $SE = 0.033$, $t(177) = 5.60$, $p < .001$. In contrast, for single men who received placebo, the confederate's affiliative behavior was not significantly related to men's self-presentation behavior, $\beta = 0.197$, $SE = 0.0305$, $t(177) = 1.65$, $p = .100$.

Men's General Interest in Confederate: The results of the three-way ANCOVA revealed a main effect of the confederate's overall affiliative behavior, $F(1, 177) = 196.634$, $\beta = 0.725$, $p < .001$ and a main effect of relationship status, $F(1, 177) = 4.184$, $\beta = 0.209$, $p = .042$. The main effect of drug treatment was not significant, $F(1, 177) = 0.067$, $p = .796$, and no significant two-way (p's > .403), or three-way ($p = .588$) interactions.

Men's Positive Facial Cues: The results of the three-way ANCOVA revealed a main effect of the confederate's overall affiliative behavior, $F(1, 177) = 132.899$, $\beta = 0.657$,

$p < .001$. The main effect of drug treatment was not significant, $F(1, 177) = 0.984$, $p = .323$, nor was the main effect of relationship status, $F(1, 177) = 0.910$, $p = .341$, and no significant two-way (p's > .595), or three-way ($p = .348$) interactions.

Secondary Hypotheses:

Does testosterone and/or relationship status modulate men's perception of a the confederate's attractiveness?

The results of the two-way ANOVA examining the effect of drug treatment and relationship status on men's perception of the female confederate's attractiveness revealed that drug treatment had no effect, $F(1, 186) = 0.481$, $p = .489$, no effect of relationship status, $F(1, 186) = 0.774$, $p = .380$, and no interaction, $F(1, 186) = 0.087$, $p = .769$. The average attractiveness rating among single men who received placebo was 8.08 ($SD = 1.79$), 7.84 ($SD = 1.43$) for single men who received testosterone, 7.80 ($SD = 1.32$) for paired men who received placebo, and 7.70 ($SD = 1.99$) for paired men who received testosterone. The overall average attractiveness rating was 7.85 ($SD = 1.67$).

Does testosterone and/or relationship status modulate men's self-report short-term and/or long-term sexual interest in the confederate?

Short-Term Sexual Interest. The results of the two-way ANOVA examining the effect of drug treatment and relationship status on men's interest in pursuing a short-term relationship with the confederate revealed a significant main effect of relationship status, $F(1, 186) = 14.962$, $p < .001$, however, the main effect of drug treatment was not significant, $F(1, 186) = 0.012$, $p = .912$, and no interaction, $F(1, 186) = 0.330$, $p = .566$. Single men reported significantly more interest in pursuing a short-term relationship ($M = 5.90$, $SD = 3.01$) relative to paired men ($M = 4.13$, $SD = 3.23$), $t(186) = 3.87$, $p < 0.001$).

Long-Term Sexual Interest. The results of the two-way ANOVA examining the effect of drug treatment and relationship status on men's interest in pursuing a long-term relationship with the confederate revealed a significant main effect of relationship status, $F(1, 186) = 17.353$, $p < .001$, however, the main effect of drug treatment was not significant, $F(1, 186) = 0.173$, $p = .678$, and no interaction, $F(1, 186) = 0.424$, $p = .516$. Single men reported significantly more interest in pursuing a long-term relationship ($M = 4.84$, $SD = 2.78$) relative to paired men ($M = 3.16$, $SD = 2.70$), $t(186) = 4.17$, $p < .001$.

Exploratory Hypotheses

Does the confederate's proceptivity behavior modulate the effect of testosterone and/or relationship status on men's perceptions of her sexual interest?

Exploratory analyses were conducted to test whether men's perception of the confederate's sexual interest varied as a function of her behavior, drug treatment, relationship status, and the interaction between these variables. Four ANCOVAs were conducted predicting men's perception of her sexual interest using drug treatment, relationship status, and the confederate's affiliative behavior.

Confederate's Overall Affiliative Behavior*:* The results of the three-way ANCOVA examining the effect of drug treatment, relationship status, and the confederate's overall affiliative behavior failed to reveal a main effect of drug treatment, $F(1, 182) = 0.724$, $p = .396$, nor was the main effect of relationship status significant, $F(1, 182) = 1.862$, $p = .174$, however, the main effect of the confederate's overall affiliative behavior was trending, $F(1, 182) = 3.746$, $p = .054$. This trending effect was qualified by a significant two-way interaction between drug treatment and the confederate's overall affiliative behavior, $F(1, 182) = 4.780$, $p = .030$ (see Figure 4). The two-way interaction

between drug treatment and relationship status was not significant, $F(1, 182) < 0.001$, $p = .994$, nor was the two-way interaction between relationship status and the confederate's overall affiliative behavior, $F(1, 182) = 0.161$, $p = .161$, nor was the three-way interaction, $F(1, 182) = 0.366$, $p = .546$. Decomposing the two-way interaction between drug treatment and the confederate's overall affiliative behavior revealed that among men receiving placebo, the effect of the confederate's overall affiliative behavior on men's perception of her sexual interest was not significant, $\beta = -0.019$, $SE = 0.116$, $t(182) = -0.186$, $p = .853$. In contrast, among men who received testosterone, the confederate's overall affiliative behavior was significantly related to men's perception of her sexual interest, $\beta = 0.305$, $SE = 0.126$, $t(182) = 2.792$, $p = .006$, indicating that when men were on testosterone, the more affiliative behavior shown by the confederate, the more the men perceived her as being sexually interested in him.

Confederate's Self-Presentation*:* The results of the three-way ANCOVA examining the effect of drug treatment, relationship status, and the confederate's self-presentation behavior failed to reveal a main effect of drug treatment, $F(1, 182) = 0.546$, $p = .461$, nor was the main effect of relationship status significant, $F(1, 182) = 3.246$, $p = .073$, however the main effect of the confederate's self-presentation behavior was significant, $F(1, 182) = 9.377$, $p = .003$. This effect was qualified by a significant two-way interaction between drug treatment and the confederate's self-presentation behavior, $F(1, 182) = 5.538$, $p = .020$ (see Figure 5). The two-way interaction between drug treatment and relationship status was not significant, $F(1, 182) = 0.080$, $p = .778$, nor was the two-way interaction between relationship status and the confederate's self-presentation behavior, $F(1, 182) = 0.267$, $p = .606$, nor was the three-way interaction, $F(1, 182) =$

0.636, p = .426. Decomposing the two-way interaction between drug treatment and the confederate's self-presentation behavior revealed that among men receiving placebo, the effect of the confederate's self-presentation behavior on men's perception of her sexual interest was not significant, β = 0.052, SE = 0.614, t(182) = 0.487, p = .627. In contrast, among men who received testosterone, the confederate's self-presentation behavior was significantly related to men's perception of her sexual interest, β = 0.394, SE = 0.577, t(182) = 3.951, p < .001, indicating that when men were on testosterone, the more self-presentation behavior shown by the confederate, the more the man perceived her as being sexually interested in him.

Confederate's Positive Facial Cues: The results of the three-way ANCOVA examining the effect of drug treatment, relationship status, and the confederate's positive facial cues failed to reveal a significant main effect of drug treatment, F(1, 182) = 0.783, p = .377, relationship status, F(1, 182) = 1.845, p = .176, and the confederate's positive facial cues, F(1, 182) = 2.747, p = .099. The two-way interaction between drug treatment and relationship status was not significant, F(1, 182) = 0.007, p = .933, nor was the interaction between relationship status and the confederate's positive facial cues, F(1, 182) = 0.134, p = .715. The two-way interaction between drug treatment and the confederate's positive facial cues was significant, F(1, 182) = 4.897, p .028 (see Figure 6). Finally, the three-way interaction was not significant, F(1, 182) = 0.021, p = .884. To qualify the significant two-way interaction, simple effects revealed that among men who received placebo, the confederate's positive facial cues was not related to men's perception of her sexual interest, β = -0.041, SE = 0.647, t(182) = -0.389, p = .698. In contrast, among men who received testosterone, the confederate's positive facial cues

was significantly related to men's perception of her sexual interest, $\beta = 0.283$, $SE = 0.634$, $t(182) = 2.764$, $p = .006$, indicating that when men were on testosterone, the more the confederate evinced positive facial cues, the more the men perceived her as being sexually interested in him.

Confederate's General Interest in Confederate: The results of the three-way ANCOVA examining the effect of drug treatment, relationship status, and the confederate's general interest failed to show a significant main effect of drug treatment, $F(1, 182) = 0.730$, $p = .394$, and relationship status, $F(1, 182) = 1.746$, $p = .188$, however the main effect of the confederate's general interest was trending, $F(1, 182) = 3.534$, $p = .062$. The two-way interaction between drug treatment and relationship status was not significant, $F(1, 182) = 0.001$, $p = .972$, nor was the two-way interaction between relationship status and the confederate's general interest, $F(1, 182) = 0.394$, $p = .531$, however the two-way interaction between drug treatment and the confederate's general interest was trending, $F(1, 182) = 3.516$, $p = .062$ (see Figure 7). The three-way interaction was not significant, $F(1, 182) = 0.435$, $p = .511$. Simple effects of drug treatment revealed that among men who had received placebo, the confederate's general interest was not significantly related to men's perception of her sexual interest, $\beta < 0.001$, $SE = 0.636$, $t(182) = 0.004$, $p = .997$. In contrast, among men who had received testosterone, the confederate's general interest was positively related to men's perception of her sexual interest in him, $\beta = 0.280$, $SE = 0.709$, $t(182) = 2.523$, $p = .012$, indicating that men on testosterone perceived the confederate's general interest as indicative of her sexual interest in him.

Chapter 4: Discussion

Testosterone has long been implicated as a proximate hormonal mechanism in the expression of reproductive strategies in humans (Goetz, Weisfeld, & Zilioli, 2019). Past work suggests that testosterone mediates the trade-off in reproductive effort between mating-effort and parenting-effort, the latter of which is bolstered by the formation and maintenance of monogamous relationships and therefore testosterone tends to be viewed as deleterious to the maintenance of such bonds (e.g., Gettler, Mcdade, Feranil, & Kuzawa, 2011; Mazur & Michalek, 1998).

Despite this growing body of evidence that testosterone is associated with reproductive behaviors in humans, the effects of acute or transitory changes on men's reproductive behaviors, not just the elicitors of testosterone release, remains somewhat poorly understood (for review, see Ball & Balthazart, 2020; Zilioli & Bird, 2017). Studies probing the causal effects of testosterone on reproductive variables in humans through exogenous administration were primarily conducted in the 1970's and 1980's and were generally conducted with very few participants, used hypogonadal men or men reporting sexual disfunction, often were not placebo-controlled, and employed chronic administration regiments which provide a poor model for the exploration of the functionality of pulsatile testosterone naturally produced by social stimuli (for a review, see Albert, Walsh, & Jonik, 1993). Few of the contemporary administration studies employing single-dose designs that more closely parallel acute endogenous testosterone fluctuations examine mating variables, and as far as I know, none have investigated mating related behaviors as was done in the current study (see table 1 in Carré & Robinson, 2020).

In the present study, men's affiliative behaviors were not associated with testosterone treatment, nor did relationship status moderate the association. However, relationship status was related to men's affiliative behaviors, albeit in an unexpected manner. Men's overall affiliative behavior was higher among paired men relative to single men, as was men's general interest and, though only trending, men's positive facial cues. These results differ from past findings such as those of van der Meij and colleagues (2011) who found that increases in endogenous testosterone were positively associated with single men's general interest, positive facial cues, and self-presentation. This may indicate that acute changes in endogenous testosterone are a marker rather than a cause of mating-effort given that exogenous testosterone did not produce similar effects.

However, when the female confederate's affiliation behaviors—behaviors that may have been interpreted as proceptive behaviors—were considered in concert, then an interaction with relationship status and testosterone emerged. Specifically, the confederate's overall affiliation behavior, positive facial cues, and though trending, general interest, interacted with testosterone treatment, and relationship status to predict men's self-presentation, but not men's overall affiliative behaviors, positive facial cues, or general interest. Interestingly, self-presentation was the only facet of affiliation behavior that was positively associated with men's self-report sexual interest in the confederate (see table 4).

Additionally, among the affiliative behaviors measured, self-presentation likely shares the most construct overlap with mating-effort (c.f., Birnbaum et al., 2017); the remaining behaviors may be confounded with general friendliness, which when operationalized as extraversion, indeed, were more strongly associated with extraversion.

Consistent with this account, when general interest, positive facial cues, and self-presentation were regressed on extraversion, self-presentation was the only predictor that did not explain unique variance in extraversion, demonstrating the distinctiveness of self-presentation from general friendliness.

These proceptivity effects were driven by single men, such that among single men who received testosterone, the confederate's proceptivity behaviors were positively associated with men's self-presentation, whereas among single men who received placebo, the confederate's proceptivity behaviors were not associated with men's self-presentation. Contrary to the relationship protection hypothesis, the confederate's proceptivity behaviors were positively associated with men's self-presentation regardless of drug treatment status, indicating that testosterone may not serve as a relationship protection mechanism, at least as measured via behavioral affiliation.

That the effect was restricted to single men may suggest that testosterone acts by reducing men's fear of rejection, a psychological factor that may explain their singlehood (Birnbaum et al., 2018). Testosterone has known anxiolytic effects in animal models (e.g., Frye & Seliga, 2001) and reduces fear related behaviors among men (e.g., resource concession; Geniole et al., 2019). Therefore, the confederate's affiliative behaviors may have become more salient as a function of freeing men's attentional resources from fearful cognitions centering on rejection (Birnbaum et al., 2018), and may have been processed as indicative of reciprocal liking (Eastwick & Finkel, 2009) further reducing approach anxiety, ultimately manifesting in single men's increased self-presentation behavior.

The hypothesized effects of testosterone and relationship status on mating-effort and relationship protection, respectively, as indexed by latency to initiate conversation with the confederate were not supported. Contrary to my hypothesis, relationship status was associated with latency, but in the opposite direction, whereby paired men initiated conversation sooner than single men. This may have been due to the fact that in the present sample, paired men reported higher emotional stability relative to single men, and emotional stability was related to latency. However, a subsequent analysis failed to establish emotional stability as a mediating variable (relationship status remained statistically significant after including emotional stability in the model).

Unlike the above account regarding testosterone's potential anxiolytic effects, latency was inconsistent with this proposed mechanism. If testosterone reduced anxiety rooted in fears of rejection, latency to initiate conversation should have been lower among single men treated with testosterone. However, latency is just one manifestation of approach behavior. The additional evidence of reciprocal liking in the form of the confederate's affiliative behaviors may have been needed to fully overcome this inhibition. Since she was instructed to refrain from initiating engagement for the first minute of the interaction, these cues were absent by design. Her mere presence was insufficient, suggesting that dynamic testosterone is insufficient to produce behavioral change in the absence of additional socio-contextual factors.

Past research has indicated that men protect their relationship by devaluing the attractiveness—"derogation effect"—of potential alternative relationship partners (e.g., Lydon, Fitzsimons, & Naidoo, 2003; Simpson, Gangestad, & Lerma, 1990). Conversely, perceptions of attractiveness motivate romantic desire (Eastwick, Luchies, Finkel, & Hunt,

2014). As such, I predicted that testosterone would interact with relationship status to affect evaluations of the confederate's attractiveness in line with these goals (i.e., increase attractiveness among single men and decrease attractiveness among paired men). Contrary to my prediction, perceptions of attractiveness of the confederate did not differ as a function of drug treatment or relationship status and no interaction emerged. Attractiveness was however strongly related to men's short-term and long-term mating interest validating its importance in mate pursuit (ibid.) (see table 4).

Past correlational research has indicated that baseline testosterone is associated with successful pursuit of short-term mating strategies (Peters, Simmons, & Rhodes, 2008). Furthermore, putative psychological mediators of such strategies, such as attitudinal and desire subscales of the sociosexuality inventory (a measure of one's attitudes, desires, and behavior towards uncommitted sexual activity) have been associated with testosterone levels (Puts et al., 2015). As such, I expected to find a drug treatment effect on short-term mating interest. Contrary to this prediction, men's self-reported interest in pursuing a short-term relationship with the confederate was not associated with drug treatment status. However, relationship status strongly predicted men's short-term mating interest such that single men reported more interest than paired men. The same pattern emerged for men's self-reported interest in pursuing a long-term relationship with the confederate.

Another way in which testosterone may mediate reproductive behaviors is through modulation of men's perceptions of women's behavior. Indeed, it has long been observed that men tend to overperceive women's behavior as indicative of sexual interest (e.g., Abbey, 1982), the functional understanding of which has been posited as serving

reproductive ends by increasing mating opportunities and decreasing missed mating opportunities (e.g., Haselton & Buss, 2000). Recent evidence suggests that the proximate mechanism of this effect may be men's sociosexual orientation (Lee, Sidari, Murphy, Sherlock, & Zietsch, 2020); specifically, these participants seemed to have projected their own sociosexual orientations on the potential relationship partner.

Importantly, past research has found that sociosexual orientation is associated with testosterone (Puts et al., 2015; van Anders, Hamilton, & Watson, 2007). Indeed, Puts and colleagues (2015) found that sex differences in sociosexual orientation were mediated by baseline testosterone levels. Additionally, Stern and colleagues (2020) found that testosterone was specifically related to the 'desire' sub-facet of men's sociosexual orientations, thus, if testosterone increased men's desire, this motivation may have led to processes that increased men's perceptual biases.

Consistent with this account, in the present study, drug treatment interacted with the confederate's proceptivity behaviors to predict men's perception of the confederate's sexual interest. Among men who had received testosterone, the confederate's proceptivity behavior was associated with the men's perception of the confederate's sexual interest; conversely, among men who had received placebo, the confederate's proceptivity behavior was not associated with men's perception of the confederate's sexual interest. This effect emerged regardless of relationship status. This may indicate that testosterone sensitizes men to women's behavior, and in turn her behavior is perceived as indicative of sexual interest. Intriguingly, this interaction was strongest for the confederate's self-presentation (or self-disclosure)—a behavior that is typically employed as a strategy for increasing intimacy (e.g., Birnbaum et al., 2017)—the same

behavioral component that was associated with short-term sexual interest among men, consistent with a projection account (e.g., Lee et al., 2020). Indeed, Birnbaum and colleagues (2020) found that when mating-motivations are activated, romantic interest mediates the relationship between mating-motivation and perception of a potential relationship partner's romantic interests. That is, one's own romantic interest tended to be projected onto others when placed in a sexually aroused state. To the degree that testosterone likewise activates mating-motives, a similar projection mechanism may be responsible for the current results.

Limitations and Future Directions

The present study was not without its limitations. First, the sample participants were young (average age was 23 years old). According the U.S. Census Bureau, in 2018, the average age of a man at his first marriage was 29.8 years old. This is notable to at least two reasons. First, younger men are less committed to partners than older individuals (Booth & Edwards, 1985). Second, while this study was well suited to investigate testosterone's effects on relationship initiation, it was not well suited to address its effects on relationship maintenance as this age demographic of men may not be as invested in their extant relationships (despite young love's protestations to the contrary). Indeed, few of the paired men in the current study were married (~9.5%). This leads to yet another limitation.

Although I did not find evidence to support the role of acute testosterone in relationship protection processes, it remains unclear as to whether other aspects of relationship protection may be functionally served by such changes. For instance, a recent study found that men's, albeit baseline, testosterone was associated with

intrasexual competitiveness, which in turn was related to cost-inflicting mate-retention tactics (e.g., partner possessiveness) (Arnocky, Albert, Carré, & Ortiz, 2018). Broadening the spectrum of factors associated with relationship stability may further elucidate potential mechanisms through which testosterone exerts either positive or negative effects on relationship stability. For instance, Rusbult's Investment Model proposes three factors that support commitment to a relationship and, ultimately, relationship stability (Rusbult, Martz, & Agnew, 2005). The three factors are investment in the relationship, satisfaction with the relationship, and the presence of attractive alternatives. The present research essentially only tested the one component, presence of an attractive alternative. However, other researchers have found that testosterone is associated with the other components of Rusbult's model as well. For instance, Waldvogel and Ehlert (2018) found that testosterone was inversely related to perceived role constraint among fathers with young children, indicating a potential decrease in investment. In another study, Hooper and colleagues (2011) found that testosterone was negatively associate with commitment. Importantly, these studies used baseline testosterone; it is therefore unclear whether acute changes in testosterone would produce similar effects.

Jealousy may be another relationship protection factor influenced by testosterone, though as far as I know, the only study to investigate the relationship between jealousy and testosterone explored the effects of jealousy on testosterone responses, not testosterone effects on jealousy. Moreover, the effect was restricted to women (Ritchie & van Anders, 2015). The point is that there are many more facets of relationship protection outside of derogation effects that may be served by acute changes in testosterone.

As mentioned previously, Rusbult's Investment Model posits that investment in a relationship leads to greater relationship commitment. Since pair-bonds are posited to have evolved as a mechanism for enhancing offspring provisioning and survival, including pair-bonded fathers would provide a stronger test of testosterone's role in relationship maintenance. Stable committed relationships are associated with lower testosterone levels, and more so with fatherhood. Both represent significant investment in a procreative relationship and would provide a stronger test of the potential role of testosterone surges in relationship maintenance.

Another limitation of the present study was that it employed a single confederate. While she was rated towards the higher end of attractiveness, she was older than the average participant; youthfulness has long been recognized as an evolved mating preference among men (e.g., Kenrick & Keefe, 1992). Additionally, it is unclear how generalizable these results are given that there are undoubtably a multitude of idiosyncrasies that I was not able to control for using a single confederate.

While the idiosyncrasies of the confederate remained unexplored, some prominent individual differences related to men's reproductive behavior remained unexplored as well. For instance, future research should explore the potential moderating roles of men's sociosexuality and life-history strategies given that past work has implicated both of these factors as being relevant to men's testosterone and mating strategies (e.g., Puts et al., 2015).

Another potential direction would be to examine the effects of transitory testosterone across repeated social engagements (i.e., exposure to the same potential relationship partner across multiple days). This may make more ecological sense, as

most sexual relationships are developed over multiple interactions rather than first meetings; in this case, acute changes in testosterone may be a strong component in initial attraction, motivating future mating-effort directed toward the person who first elicited the hormonal response. This conceptualization is also consistent with some research on testosterone and aggression which has shown that acute changes in testosterone at time one are not related to concurrent behavior but rather predictive of aggressive behavior occurring hours to days later. For example, Fuxjager and colleagues (2011) demonstrated that transitory testosterone at time one increased aggression at time two. Similarly, across successive competitions between men, endogenous increases of testosterone on the first day predicted competitive ability on the second day (Zilioli & Watson, 2014). Mating dynamics may parallel these findings; thus, future research should examine the effects of transitive transitory testosterone across courtship opportunities.

Similarly, the time course effects of testosterone are not well explored. It is unclear whether rising testosterone produces different behavioral effects than falling testosterone. That is, the same concentration of testosterone may produce different psychophysiological effects depending on if it is increasing versus decreases, much like blood alcohol content is known to have differing effects depending on rising verses falling levels (for a brief discussion of time course effects, see Carré & Robinson, 2020).

Conclusion

Here, using a single dose of exogenous testosterone, I was able to show for the first time that testosterone plays a casual role in increasing behavioral indicators mating-effort among healthy young men in terms of enhanced synchrony between proceptive signals of a potential relationship partner and men's self-presentation behaviors and

increased perception of these signals as indicative of sexual interest. While the perception effect of testosterone was observed regardless of relationship status, the behavioral effects of testosterone and proceptivity on men's self-presentation were restricted to single men. Thus, relationship status remains an important variable to consider when designing studies on testosterone and reproductive phenotypes. Given the past correlational evidence, and the lack of evidence of a protection effect here, at this time, it seems more probable that acute changes in testosterone, like stable levels, pose a threat to extant intimate relationships rather than relationship protection. Indeed, the current study provides further evidence for testosterone's role in aiding relationship initiation. These results indicate that acute changes in testosterone may play a functional role in increasing mating-effort among men.

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Table 1. *Demographics.*

	Total *N*	Mean	SD	Range
Participants	192			
Age		23.1	5.19	18-43
Caucasian	141			
Asian	12			
African	11			
Native American	9			
Hispanic	2			
Multi-ethnic	13			
Nationality: other	2			

Table 2. *Relationship Status Demographics.*

	Total *N*
	190
Single	83
Non-exclusively dating one person	9
Exclusively dating one person	73
Common law marriage	2
Engaged	4
Married	18
In an open marriage	1

Table 3. *Men's Affiliation Behavior Across Drug Treatment and Relationship Status*

	Drug Treatment			
	Placebo		Testosterone	
Relationship Status:	Single (N = 48)	Paired (N = 42)	Single (N = 44)	Paired (N = 51)
Measures	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Attention	4.25 (1.17)	4.47 (1.15)	3.92 (1.12)	4.48 (1.10)
Interest	3.71 (1.14)	3.91 (1.24)	3.47 (0.98)	3.89 (1.09)
Confidence	3.62 (1.12)	4.06 (1.07)	3.42 (1.03)	3.82 (0.91)
Asked Questions	1.35 (0.40)	1.67 (0.95)	1.38 (0.60)	1.61 (0.74)
Talkativeness	4.06 (1.06)	4.36 (1.10)	4.04 (1.17)	4.27 (1.03)
Talked about Self	3.42 (0.90)	3.62 (1.00)	3.36 (1.03)	3.58 (0.97)
Revealed Details about Self	2.34 (0.95)	2.42 (1.20)	2.39 (1.21)	2.29 (0.87)
Smiling	3.02 (1.16)	3.27 (1.42)	2.91 (1.13)	2.98 (1.15)
Eye Contact	4.25 (1.28)	4.37 (1.29)	3.72 (1.26)	4.40 (1.07)

Table 4. *Zero-Order Correlations, Means, and Standard Deviations of Men's Outcome Variables*

Measure	1	2	3	4	5	6	7	8	9
1. Short-Term Sexual Interest	--								
2. Long-Term Sexual Interest	.525***	--							
3. Perceived Sexual Interest	.518***	.444***	--						
4. Perceived Attractiveness	.391***	.485***	.184*	--					
5. Conversational Latency	.007	.084	-0.11	.021	--				
6. Overall Affiliative Behavior	.011	.007	.235**	.106	-.699***	--			
7. General Interest	.009	.016	.235**	.103	-.709***	.980***	--		
8. Positive Facial Cues	.034	.035	.216**	.121	-.544***	.881***	.791***	--	
9. Self-Presentation	.153*	.046	.199**	.125	-.494***	.590***	.532***	.552***	--
M	5.00	3.98	6.16	7.85	27.5	19.5	3.49	3.61	2.92
SD	3.24	2.86	4.23	1.67	26.3	4.71	0.84	1.04	0.936

Note. $*p < .05$, $**p < .01$, $***p < .001$

Table 5. *Zero-Order Correlations, Means, and Standard Deviations of the Confederate's Affiliative Behaviors*

Measure	1	2	3	4
1. Overall Affiliative Behavior	--			
2. General Interest	.987***	--		
3. Positive Facial Cues	.923***	.837***	--	
4. Self-Presentation	.662***	.654***	.536***	--
M	23.3	4.28	3.96	3.05
SD	3.66	0.661	0.684	0.731

Note. $*p < .05$, $**p < .01$, $***p < .001$

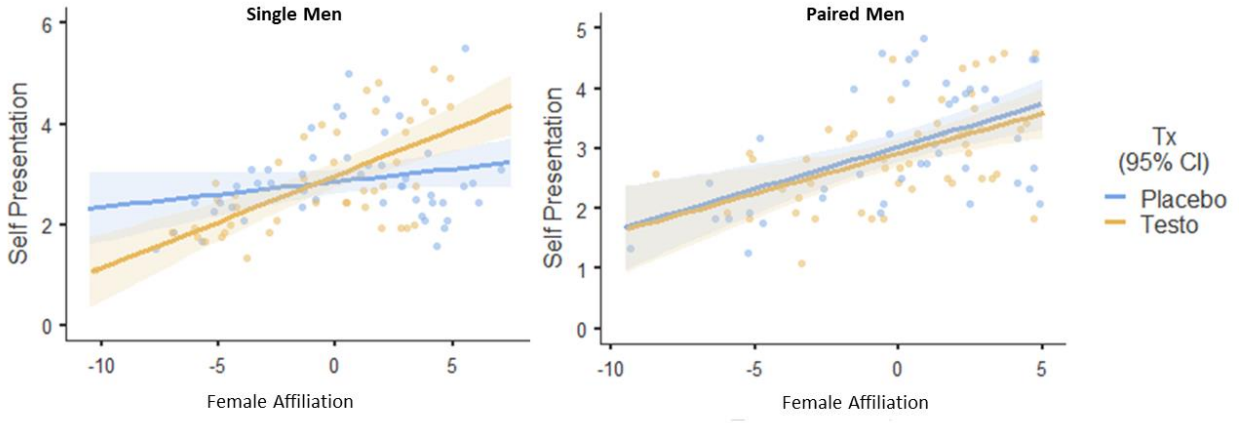

Figure 1. Men's self-presentation as a function of drug treatment, relationship status, and female's overall proceptivity behavior. Shaded bands represent 95% confidence intervals. The effect of the female's proceptivity behavior was significant among single men who received testosterone but was not significant among single men who received placebo. Female proceptivity was significant among paired men but did not differ as a function of drug treatment.

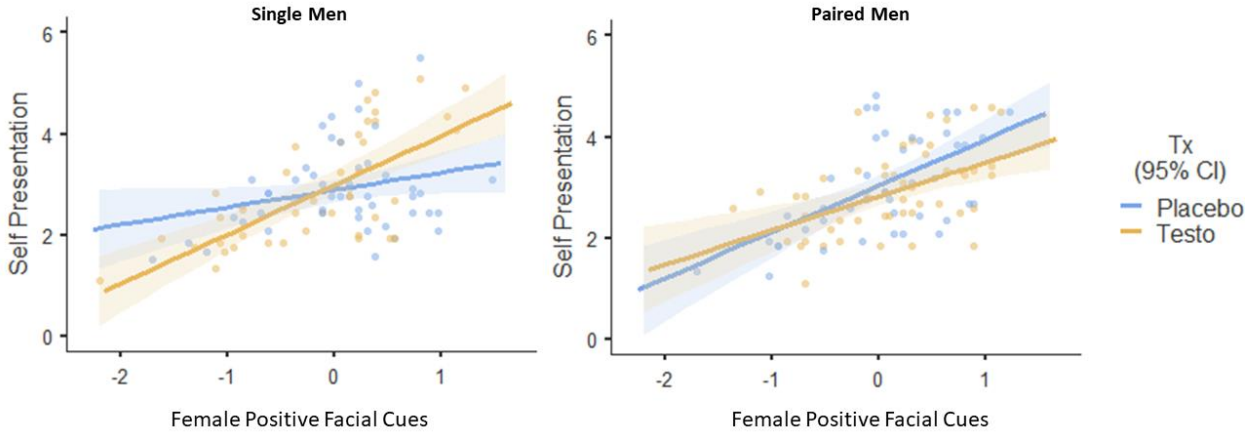

Figure 2. Men's self-presentation as a function of drug treatment, relationship status, and female's positive facial proceptivity cues. Shaded bands represent 95% confidence intervals. The effect of the female's positive facial proceptivity cues was significant among single men who received testosterone but was not significant among single men who received placebo. Female proceptivity was significant among paired men but did not differ as a function of drug treatment.

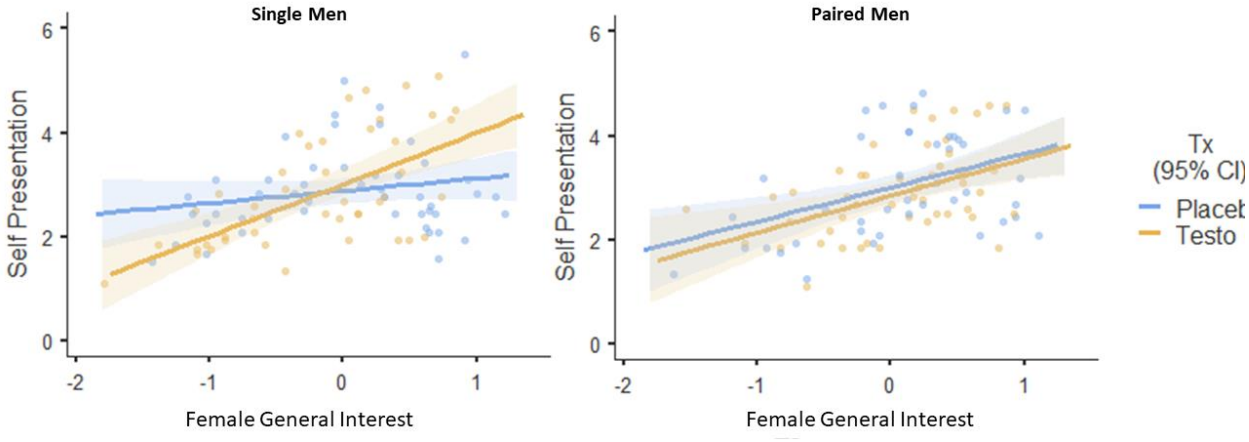

Figure 3. Men's self-presentation as a function of drug treatment, relationship status, and female's general interest proceptivity behavior. Shaded bands represent 95% confidence intervals. The effect of the female's general interest proceptivity behavior was significant among single men who received testosterone but was not significant among single men who received placebo. Female proceptivity was significant among paired men but did not differ as a function of drug treatment.

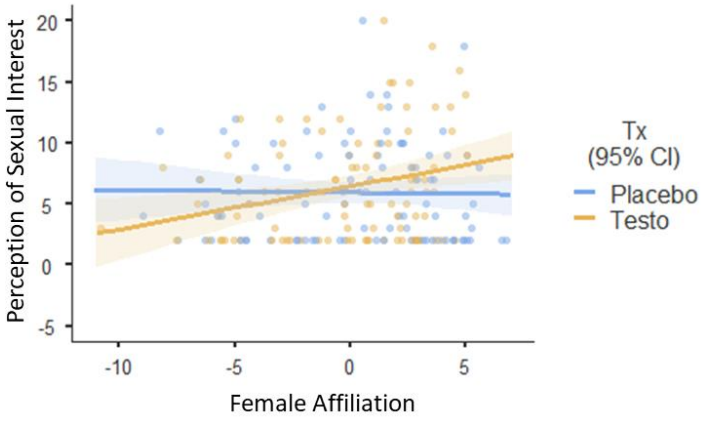

Figure 4. Men's perception of the female's sexual interest as a function of drug treatment and female's overall proceptivity behavior. Shaded bands represent 95% confidence intervals. The effect of the female's proceptivity behavior was significant among men who received testosterone but was not significant among men who received placebo.

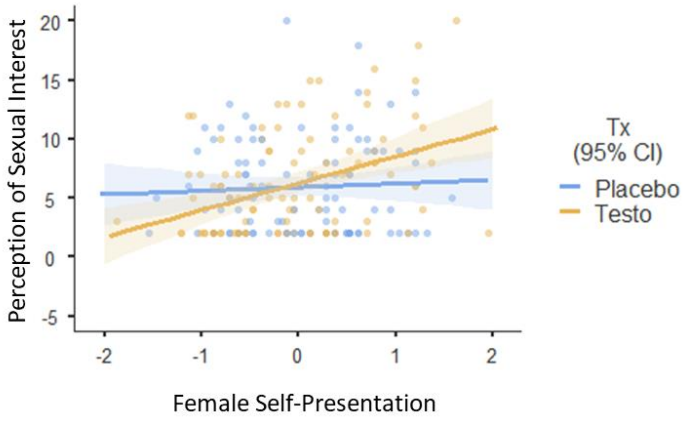

Figure 5. Men's perception of the female's sexual interest as a function of drug treatment and female's self-presentation verbal behavior. Shaded bands represent 95% confidence intervals. The effect of the female's self-presentation was significant among men who received testosterone but was not significant among men who received placebo.

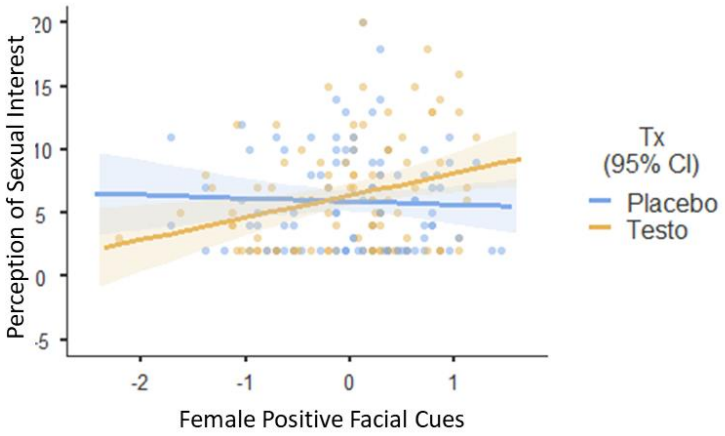

Figure 6. Men's perception of the female's sexual interest as a function of drug treatment and female's positive facial proceptivity cues. Shaded bands represent 95% confidence intervals. The effect of the female's positive facial proceptivity cues was significant among men who received testosterone but was not significant among men who received placebo.

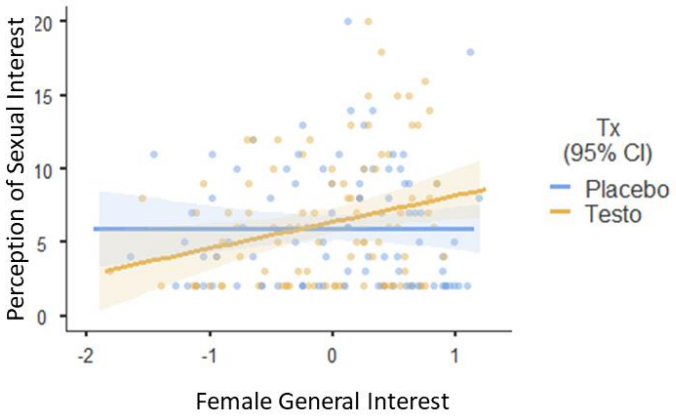

Figure 7. Men's perception of the female's sexual interest as a function of drug treatment and female's positive facial proceptivity cues. Shaded bands represent 95% confidence intervals. The effect of the female's positive facial proceptivity cues was significant among men who received testosterone but was not significant among men who received placebo.

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ABSTRACT

THE POTENTIAL ROLE OF TESTOSTERONE AS RELATIONSHIP PROTECTION MECHANISM

by

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December 2020

Advisor: Dr. Glenn Weisfeld

Major: Psychology (Social-Personality)

Degree: Doctor of Philosophy

Testosterone has long been implicated as a neuroendocrinological mechanism in the expression of reproductive strategies. Humans the world over form and maintain pair-bonds suggesting that pair-bonds may serve to enhance reproductive fitness. However, infidelity is a perennial threat to these bonds. The data in humans suggests that testosterone is associated with mate-seeking but may be detrimental to relationship maintenance. However, past work has relied on correlational studies and additional findings from nonhuman animal models suggest that acute changes rather than baseline concentrations in testosterone may in fact protect extant pair-bonds. The present research sought to test the causal role of testosterone in both mate-seeking [single men] and relationship maintenance [paired men] behaviors and perception using a between subject, double blind, placebo treatment protocol. The study recruited 212 healthy men, roughly half of whom were in a committed relationship and half single. The participants were briefly exposed to an attractive female confederate during which time the participants' verbal and non-verbal behavior was recorded. Results indicated that among single men, testosterone moderated the effects of several of the confederate's proceptivity behaviors on men's self-presentation, such that her affiliative behavior was

positively correlated with the men's self-presentation. These results were restricted to single men; testosterone did not alter men's courtship behavior among paired men, suggesting that acute changes in testosterone may not serve as a relationship protection mechanism in men. Additionally, testosterone caused men, regardless of relationship status, to perceive the confederate's self-presentation behavior as indicative of her sexual interest. The results provide the first causal evidence for testosterone as a mate-seeking mechanism in healthy adult men and provide an outline to the psychological pathways through which testosterone alters men's mating psychologies.

AUTOBIOGRAPHICAL STATEMENT

Stefan Goetz majored in social psychology with a minor in quantitative methods as a doctoral student at Wayne State University under the direction of Glenn Weisfeld and previously Justin Carré. The overarching goal of his research is to explicate the mechanisms through which evolutionary adaptations influence social behavior, with a focus on the adaptive consequences of intra- and inter-sexual selection. He is specifically interested in the role of hormones in integrating early life experiences and ongoing social circumstances into adaptive adult mating strategies including status striving and maintenance. He is also interested in evolutionary theories of emotion and their relevance to social behavior.