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The Role of Status Motivation and Social Context in Predicting Competitive Will and Hormonal Response to Competition

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The Role of Status Motivation and Social Context in Predicting Competitive Will and Hormonal Response to Competition

By

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An abstract of
A dissertation submitted to the Faculty of the
James T. Laney School of Graduate Studies of Emory University
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Abstract

The Role of Status Motivation and Social Context in Predicting Competitive Will and Hormonal Response to Competition

By Kathleen V. Casto

The motivation for social status drives behavior in competition. Levels of testosterone and cortisol, hormones related to status motivation, change in response to competition depending on various Person and Context factors. This study employed a novel, effort-based competitive task in which performance is determined by the willingness to endure physical discomfort to be a winner, a measure of individual differences in the motivation to compete, i.e., *competitive will*. Person factors (traits related to status motivation: competitiveness, power/dominance motivation, and achievement orientation) and Context factors (social presence and competition outcome) were tested as predictors of competitive will and hormone response to competition in men and women (N = 158). Results showed that a combination of "status motivation" traits significantly predicted competitive will performance. Individual differences in status motivation also interacted with competition outcome (win/loss) to predict the testosterone change associated with competition – for those who won, higher status motivation predicted higher testosterone change. During competition, cortisol levels increased in men and decreased in women, except for women who competed against men. Social context also influenced competitive will – for those who competed face-to-face, performance in the task was significantly and positively related to co-competitors' times, an effect interpreted as resulting from the psychological drive for social conformity. These results suggest that competitive behavior is driven by paradoxical motives for both social status and affiliation. And, these motives interacting with social context, appear to have important hormonal underpinnings.

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Introduction

The need to attain and maintain social status is a fundamental human motive that drives behavior (Anderson et al., 2015; Reiss, 2004). Evolutionarily speaking, status results in greater access to resources for survival and sexual partners for reproduction (Cheng et al., 2010; Hawley, 1999). Competition, a contest between one or more individuals or groups for a resource that is limited in supply, is a way of determining one's status among others – winners have more status than losers. Because social status has been linked to individual differences in levels of the steroid hormones testosterone and cortisol in various animal species including humans (Decker, 2000; Edwards & Casto, 2013; Edwards et al., 2006; Sapolsky, 1982; for review, Hamilton et al., 2015), considerable research has been directed at understanding the hormonal consequences of both engaging in competition and competition-related shifts in status (for review, Casto & Edwards, 2016a; Mazur & Booth, 1998).

Nearly three decades of research on the hormone response to human competition have made it clear that the direction and magnitude of changes in testosterone and cortisol associated with phases of competition are highly variable (Carré & Olmstead, 2015; Casto & Edwards, 2016a). The complexity of the hormone-competition relationship is due to a variety of moderating or mediating factors that impact physiology and behavior in competitive settings (for review, Hamilton et al., 2015, Oliveira and Oliveira, 2014, and Salvador, 2005). As noted in Casto and Edwards (2016a), these factors fall into two main categories: *Person* and *Context*.

Person factors, aspects of an individual, include personality, experience, beliefs, or motivations that would influence competition-related behaviors and hormonal

response. Three Person factors have received most of the attention in the human competition literature: implicit power motivation, aggressiveness, and sex. Implicit power motivation is the degree with which an individual derives pleasure/reward from "having physical, and mental or emotional impact" on others (Stanton & Schultheiss, 2009, p. 942). Those higher in implicit power motivation tend to be more likely to show an increase in testosterone or cortisol in response to competition (Schultheiss et al., 1999, Schultheiss & Rohde; 2002; Schultheiss et al., 2005; Wirth et al., 2006). However, this relationship appears to depend on sex – with stronger, more consistent relationships found for men than for women (Stanton & Schultheiss, 2007). Likewise, individual differences in the tendency to react aggressively to provocation are positively related to competition-related fluctuations in testosterone, but these effects are specific to men (Carré et al., 2011; Carré & Olmstead, 2015; Geniole et al., 2016). In fact, some research in laboratory settings suggests that women do not have a reliable hormonal response to competition at all (Carré et al., 2013; Mazur et al., 1997). Other Person factors that may influence the testosterone response to competition include self-efficacy (Costa et al., 2016; Salvador & Costa, 2009) and external versus internal attribution of outcome (González-Bono et al., 1999; González-Bono et al., 2000). Although the relationship between Person factors and competition-related changes in cortisol levels has received less attention, cortisol increases associated with social-evaluative stress appear to depend on a sense of uncontrollability (Dickerson & Kemeny, 2004) and to be exacerbated for individuals relatively high in negative affect and accumulated life stress (Brown et al., 1996; Li et al., 2007).

Context factors are temporary conditions within the social-competitive environment that influence behavior and hormonal fluctuations. Potentially important Context factors influencing the testosterone response to competition include the closeness of the competition (e.g. Mehta et al., 2015; Zilioli et al., 2014), the stability of the competitive social hierarchy as established by results of prior competitions (Zilioli & Watson, 2014), whether the outcome is determined by ability or chance (e.g., van Anders & Watson, 2007), whether the competition is intra- or inter-group (Oxford et al., 2010), whether provocations have been delivered by an opponent (Carré et al., 2010), and whether or not the competition occurs in one's home territory (Carré, 2009). The extent to which variations in the competitive context influence levels of cortisol has not been thoroughly studied.

One important and well-studied Context factor important for testosterone or cortisol change associated with competition is *outcome*, win or loss. According to the reciprocal biosocial model of status (Mazur, 1985; Mazur & Booth, 1998), winning a contest for status increases testosterone levels while losing decreases testosterone levels. Further, elevated testosterone after a win motivates future competitive or aggressive encounters, behaviors that would be advantageous for social status. Decreased testosterone following a loss decreases competitive motivation – losers who avoid subsequent competitive confrontations spare themselves from the risk of another defeat and additional loss of social status. Some studies provide support for the biosocial model of status in various competitive settings (Aguilar et al., 2013; Carré et al., 2013; Jiménez et al., 2012; Norman et al., 2015; Oliveira et al., 2009). Others do not, instead showing that winners and losers have comparable testosterone responses to competition (e.g.,

Carré et al., 2009; Mehta & Josephs, 2006; Mehta et al., 2015; van Anders & Watson, 2007). A recent meta-analysis (Geniole et al., 2016) concluded that the winner-loser effect on hormones was most robust in studies conducted outside the lab (e.g., in sport venues), while the effect of competition outcome on testosterone reactivity in laboratory studies was relatively minor and only found in studies of men. Although not part of the original biosocial model of status, some studies also report that cortisol levels are higher following a loss compared to a win (e.g., Jiménez et al., 2012 ; Mehta et al., 2008; Wirth et al., 2006), presumably reflecting the psychological stress of losing status.

Assuming a delay of about 15 minutes for psychological experience to change hormone levels in blood and for blood levels to be reflected in saliva (Riad-Fahmy et al., 1987; e.g., Mehta & Josephs, 2006; Schultheiss et al., 2005; Wirth et al., 2006), researchers typically collect a pre- and post- competition saliva sample, with after-competition intervals ranging from 5-30 minutes. But, hormonal change in response to winning and losing should be specific to only the time period after competition has ended, or when the individual has accepted or conceded to the eventual outcome. Indeed, there appear to be at least two distinct psychological and hormonal phases of competition – the during-competition phase in which testosterone change would (at least theoretically) function to influence *ongoing* performance, and the after-competition phase in which testosterone change would function to influence *future* competitive behavior (Casto & Edwards, 2016a). Thus, the specific phase of the competition event should also be an important Context factor when exploring the endocrine responses to competition and the hormonal effects of winning and losing. Studies of this nature would benefit from more precise sampling to properly differentiate these effects (i.e., collect immediate

post-competition samples as well as subsequent samples to isolate competition effects from post-competition, win-loss effects).

Although conceptually distinct, Person and Context factors are intertwined and interact to influence competitive behavior and related physiology. For example, implicit power motivation and aggression may differentially predict testosterone or cortisol change for a competition that was won compared to a competition that was lost (e.g., Carré et al., 2009; for review, Stanton & Schultheiss, 2009). The extensive number and type of factors that play a role in the hormone-competition relationship and the potential for interactions calls for increasingly complex experimental designs and adequately powered studies to properly analyze for these interacting effects.

Competitive motivation, willingness to compete again, and trait competitiveness

Within the literature on the hormone response to competition, there are two main competition paradigms: athletic (naturalistic) and laboratory (contrived). Moderating Person and Context factors have been largely studied in laboratory settings (for review, Casto & Edwards, 2016a; Geniole et al., 2016). In any given laboratory study, usually only a few individuals show a testosterone or cortisol increase over the course of competition. In contrast, athletic competitions produce significant elevations in testosterone and cortisol in the majority of men and women participants (for review, Casto & Edwards, 2016a). Athletic contests inevitability involve a high degree of physical exertion. But, physical exertion aside, there is another aspect of athletic competitions that make them different from laboratory competition paradigms – athletes invest great psychological and physical energy training and preparing for competition and winning and losing is of real-world significance. Athletic and laboratory competitions

almost certainly differentially activate *competitive motivation*, a Person factor that surely figures in the psychology of social competition. Even the most status motivated individual needs to feel that the competition outcome is of some personal value – that winning or losing matters. Given that laboratory competition is contrived, often involving tasks that are neither exciting (e.g., pressing keys in response to asterisks displayed on a screen or tracing numbers on paper in sequential order) nor ecologically relevant (participants compete alone in a cubicle against a fake competitor), it is no surprise that in studies of laboratory competition, cash prizes are commonly offered to incentivize competitive effort. However, incentivized or not, the degree of competitive motivation among participants is assumed, and, thus has never been quantified in relation to the hormonal response to competition.

Testosterone has been directly linked post-competition *willingness to compete again*. In Mehta and Josephs (2006), men who lost a (rigged) competition and showed increases in salivary testosterone level from before to after the contest were more likely to choose to compete again against the same opponent than men whose testosterone level decreased. Later studies using a similar design likewise found that testosterone increase during a competitive task predicted the subsequent decision to compete again for individuals who won by a decisive margin (Mehta et al., 2015) and aggressive individuals (Carré & McCormick, 2008; Carré & Olmstead, 2015 for a review). Taken together, these results make it appear as though a seemingly idiosyncratic testosterone increase during competition will subsequently increase competitiveness. But, a rise in testosterone level associated with a contest of this kind may be characteristic of highly competitive individuals as would be the choice to compete again after a defeat.

According to social comparison theory, the drive to compete is derived from the basic human need to reduce uncertainty between one's own performance and the performance of others in order to maintain superior relative position (Festinger, 1954; Garcia et al., 2013). For some, this drive is sufficiently strong to prompt greater efforts to engage in situations where relative judgments about performance are made and energize great effort to out-perform fellow co-actors. Because comparison to others through competition is how relative social status is determined, individual differences in *competitiveness*, the "desire to win in interpersonal situations" (Smither and Houston, 1992, p.408), may be a direct predictor of relative social status or the motivation to acquire it.

Given the apparent connection between status-seeking and testosterone, competition-related changes in testosterone levels may depend on individual differences in trait competitiveness. In what appears to be the only study specifically designed to investigate the matter, Apicella et al. (2011) found no association between baseline testosterone and men's self-selection into a piece-rate (the non-competition option) or tournament form of compensation in a maze-solving task, where payment was earned by besting the performance of the last person to complete the study (the competition option). However, Welker and Carré (2015) recently reported that baseline T in men correlates with persistence in attempting to solve puzzles made intentionally unsolvable by the experimenters. Although not included in paper-and-pencil measures of competitiveness (Houston et al., 1992), task persistence is a core quality of highly competitive individuals.

Competitiveness as a trait factor has been measured using a variety of self-report questionnaires such as the Competitiveness Index (Smither and Houston, 1992),

Competitiveness Questionnaire (Griffin-Pierson, 1990), and Competition and Cooperation Attitude Scale (Martin & Larsen, 1976). Factor analysis of all of these scales and related components revealed the context-dependent and multidimensionality of this construct, prompting Houston et al. (2002a) to call for future research to "move beyond [measuring simply] the desire to win and explore the motivational basis of competitiveness" (p.296). Positive correlations between competitiveness and "the need for achievement and dominance" illustrate how the drive to be a winner in everyday social interactions may be just one component of a more fundamental drive for social status (Houston et al., 2002a, p.296). Other important components likely include the drive for personal achievement and power. *Achievement* goals, extrinsically motivated or performance oriented, have been positively linked to competitiveness (e.g., Fairchild et al., 2005; Houston et al., 2002a). Social *power* is having control and influence over others (for review, Fiske & Berdahl, 2007). Like social status, power can be attained through competitive success. Thus, feelings of power and the motivation for power could manifest as competitive behavior or coincide with feelings of competitiveness. The extent to which competitiveness, achievement orientation, and power/dominance motivation relate may collectively characterize the "status-seeking individual" and further, could potentially predict competitive behavior and hormonal responses to competition.

Social facilitation in competition

In one of the first experiments in social psychology, psychologist Norman Triplett asked cyclists to race for time under three conditions – individually against the clock, individually, but with a pacer, and against an actual competitor (Triplett, 1898, cited in

Davis et al., 2009). Racers who competed against a competitor outperformed the other two groups and racers who competed with a pacer outperformed those who competed individually without a pacer. Triplett concluded that both the physical presence of a pacer and even more so, another competitor, released a latent psychological energy that enhanced performance, a social-psychological phenomenon now known as *social facilitation* (Aiello & Douthitt, 2001; Davis et al., 2009). The century of research on social facilitation that followed revealed important factors that affect the relationship between social context and task performance. These factors include the type of task (simple or complex, physical or cognitive), whether the social others are co-actors or an audience, whether the others are familiar or unfamiliar, whether the subject's performance was individually evaluated or not, sex of the subject, and personality characteristics (e.g., extroversion and self-efficacy) (for review, Bond & Titus, 1983; Harkins, 1987; Uziel, 2007). Despite this complexity, social facilitation theory remains one of the most important theories in social psychology research and social facilitation is a factor that is undeniably important for understanding the role of context in social competition.

Although much of the research on social facilitation was conducted with the specific purpose of removing elements of competition from the task performance (i.e., participants are not pitted against each other and performance is not incentivized with a prize), competitive individuals may be particularly apt to compete anyways (Aiello & Douthitt, 2001). This notion is reflected in conjecture by Aiello and Douthitt (2001): "perhaps competitive intentions have an important impact on the way people react to the presence of others" (p.171). Thus, competitive motivation on a task should increase in

the presence of another competitor and this effect is likely to be particularly pronounced in highly competitive individuals. Furthermore, if testosterone and/or cortisol are related to competitive motivation, than social facilitation should affect both performance and hormone response, given the task is effort-based. Research on the hormonal influence of having a physically present competitor could have special relevance for hormone-competition literature where, in many studies, subjects are tested under the belief that they are competing with another person, but the competitor is not physically present or even real.

Present study

Broadly, this study was intended to investigate relationships between personality, social context, competitive behavior, and endocrine responses to competition (Figure 1). Specifically, this study explored the relationship between basal levels of testosterone and cortisol and personality traits related to status motivation (i.e., competitiveness, power/dominance motivation, and achievement orientation) and the degree with which these traits overlap. This study employs a novel, effort-based competitive task designed to measure individual differences in motivation to compete – an individual's level of "*competitive will*" – in which performance is determined by the willingness to endure physical discomfort to be a winner. Using this task, the present study examined the relationships between status-seeking personality, performance in the competitive will task, and basal as well as dynamic levels of testosterone and cortisol. Finally, this study included men and women participants competing in same- and opposite-sex dyads, as well as men and women competing individually (i.e., against competitors not physically present). This intervention was designed to explore the impact of the social presence of a

competitor (same or opposite sex) and the interaction of social-presence and sex of the participant on competitive performance and hormonal responses to competition.

Methods

Participants

One hundred fifty eight individuals (42 men and 116 women) participated in this study. Participants were recruited from the psychology department subject pool comprised of undergraduates enrolled in either of the two introductory psychology courses, each of which provides a research participation option as a condition for the satisfactory completion of the course. To avoid potential cultural conflict, only US citizens whose native language is English were permitted to sign up for the study. This study was approved by our institution's IRB and participants gave written and verbal consent prior to participation.

Each participant provided information regarding whether or not he/she is a varsity athlete, and whether or not he/she identifies as an athlete in general. Of the 116 women, 38 were varsity athletes and an additional 30 identified as an athlete; of the 42 men, 9 were varsity athletes and an additional 23 identified as an athlete. Each participant also gave his/her height, weight, and age in order to calculate body mass index (BMI), a rough measure of fitness. Participants ranged in age from 18 to 24 years old (M = 19.6, SD = 1.5). BMI score ranged from 17.0, considered to be "underweight", to 32, considered to be "moderately obese", but the average BMI score for this sample is considered "healthy" (M = 22.6, SD = 3.0). BMI is used as a control variable to explain potential variance in study outcomes due to fitness.

Oral Contraceptive Use

Women using oral contraceptives (OCs) typically have lower basal levels of testosterone than non-users (e.g. Wiegratz et al., 2003; Zimmerman et al., 2014). But, OC use does not appear to alter competition-related elevations in testosterone (Casto & Edwards, 2016b; Edwards & O'Neal, 2009). At least one study reports that OC use could significantly reduce competitiveness (Buser, 2012). For these reasons, following consent, each female participant provided information regarding contraceptive use. Specifically, women were asked to circle "yes" or "no" to four questions: "Are you currently using an oral contraceptive?"; "Are you currently using and injected or patch-delivered hormone-based contraceptive?"; "Are you currently using an intrauterine device (IUD)?"; and "Are you currently using a Nuvaring?" Of the 116 women participating in this study, 60 said they were not using any form of hormonal contraception, 46 reported using an oral contraceptive, 3 reported using a hormone-based injection or patch, and 7 were IUD users.

Measures

Trait Competitiveness Scale (Comp). The trait competitiveness scale (Appendix A), constructed for the purpose of this study, is designed to measure participants' general level of competitiveness. It contains 16 items on a 5-point Likert scale. The overall scale demonstrates strong internal consistency ($\alpha = .91$). The scale is comprised of two subscales; trait competitiveness (Comp) (12 items, e.g. "I am a competitive person") and competitive self-efficacy (Comp SE) (4 items, e.g., "I have the skills/qualities that make me better than other competitors"). Internal consistency for these individual subscales is strong (competitiveness, $\alpha = .88$; self-efficacy, $\alpha = .82$).

Competitiveness Index, revised (CI). The original CI (Smither & Houston, 1992) was designed to measure global positive and negative attitudes regarding competition. The revised version (Houston et al., 2002b) contains 14-items on a 5-point Likert scale along two subscales: enjoyment of competition (CI Enjoy) and contentiousness (CI Cont). Factor analysis (Houston et al., 2002b) determined that this two-factor structure accounted for 54.1% of the explained variance with the 'enjoyment of competition' subscale showing strong internal consistency ($\alpha = .90$) and the 'contentiousness' subscale showing moderate internal consistency ($\alpha = .74$). Combining the factors for a single measure of competitiveness results in strong internal consistency ($\alpha = .87$). This revised scale demonstrates convergent validity with statistically significant positive correlations to other validated measures of competitiveness; the original CI ($r = .82$), the competitiveness subscale of the Work and Family Orientation Questionnaire ($r = .55$), and the Sports Orientation Questionnaire ($r = .62$). As with these other measures of competitiveness, the CI was also positively correlated with Need for Achievement ($r = .32$; Lindgren, 1976).

Power and Dominance System Scales (PDSS). The PDSS contains 39 items on a 6-point Likert scale and is designed to measure dominance or power motivation along three subscales – personal sense of power (PDSS power), dominance motivation (PDSS DM), and attention to power cues (PDS Att) (Murphy, 2016). It contains 39 items on a 6-point Likert scale. Internal consistency within each subscale is strong ($\alpha = .93$-$.94$). Factor analysis supports the three factor structure and suggests that these scales show convergent and divergent validity – sense of power and dominance motivation positively correlated

(convergent) with measures of psychopathy, number of sexual partners, and aggression and negatively related (divergent) to attachment anxiety (Murphy, 2016).

Social Achievement Goal Orientation Survey, revised (SAGOS). SAGOS, the original 22-item survey (Hopkins & Ryan, 2000), was designed to measure social goal orientation along three factors: social mastery (SAGOS mas), social performance-approach (SAGOS p-app), and social performance-avoidance (SAGOS p-avoid). The revised version, reduced to 13-items (Horst et al., 2007), measures these same factors on a 5-point Likert scale. Confirmatory factor analysis (Horst et al., 2007) supports the 3-factor model with individual scales explaining 44-57% of the variance. Internal consistency was also strong (α = .79-.87). SAGOS has demonstrated validity with each scale moderately and positively related to corresponding academic achievement goals (r = .25-.51, Horst et al., 2007). Additionally, social mastery was also positively related to measures of positive relations with others, while both social performance approach and avoidance were positively related to a measure of fear of negative evaluation from others (Horst et al., 2007). This scale was included as a measure of social achievement orientation.

Academic Motivation Scale (AMS). The AMS (Vallerand et al., 1992) consists of 28 items which are rated on a 7-point Likert scale in response to the overall question, "Why do you go to college?" The scale is designed to measure the degree and source of motivation for going to college along seven subscales, amotivation (AMS Amot), external regulation, introjected regulation, identified regulation, intrinsic motivation to know, intrinsic motivation to experience, and intrinsic motivation to accomplish. Confirmatory factor analysis (Fairchild et al., 2005) supports the seven-factor structure. Internal consistency for each factor is strong (α = .77-.90). External regulation,

introjected regulation, and identified regulation are all positively correlated and together appear to comprise an overarching factor of extrinsic motivation (AMS EM). Intrinsic motivation subscales on this instrument also are strongly positively correlated (AMS IM). Demonstrating convergent and divergent validity, extrinsic scales are significantly and positively correlated with other measures of extrinsic motivation, but also to competitiveness and performance-approach academic goal orientation (Fairchild et al., 2005). Intrinsic scales are significantly and positively correlated to other measures of intrinsic motivation, skill mastery, and mastery-approach academic goal orientation (Fairchild et al., 2005). This scale was included as a measure of academic achievement orientation.

Task-specific confidence, self-efficacy, and motivation. Participants were asked to complete a short survey ("What is the likelihood that you will win this competition?"; "What is your level of confidence in your ability to do well in the task [even if you don't win]?"; "How motivated are you to win?") immediately prior to the competition to gage task-specific confidence, self-efficacy, and motivation.

Competitive Will Task

For the purposes of this study, a novel, effort-based competition was designed to test individual differences in competitive will – willingness to endure discomfort in order to be a winner. Participants held a weight (1 pound for women, 2 pounds for men) at arm's length and shoulder height for as long as they wanted/were physically able. The weight differential between men and women was decided based on pilot studies generating equivalent mean performance times for men and women with a 1:2 weight

ratio. Performance in the task was based on time, in seconds, each participant held up his/her arm.

Willingness to compete again

Following competition, consistent with previous research on testosterone and post-competition competitive choice (e.g., Carré & McCormick, 2008; Mehta & Josephs, 2006), participants were asked to circle their response to this question, "If told you would have to complete a second task, which option would you choose, assuming all options would take the same amount of time? A) Compete again in the same task, B) Compete in a different task, or C) Not compete, but instead complete another questionnaire."

Saliva samples and hormone assay

Participants were instructed not to eat, exercise, smoke, consume soda, coffee or other caffeinated beverages, or food within the hour prior to arriving to the laboratory for the study. Saliva samples were obtained before, immediately after, and 15 minutes after competing in the competitive will task. Immediately before giving a saliva sample, each participant rinsed his/her mouth with water. Approximately 1.5-1.8 ml of saliva was collected for each sample via passive drool in 2 ml plastic vials using plastic saliva collect aids (Salimetrics). For any given sample, collection time varied according to the individual, but typically took between 3-5 minutes. Samples were stored at -20°C initially and then transferred to a -80°C freezer within several hours. Samples were assayed in duplicate for T and C on a single thaw by the Emory Clinical Translational Research Laboratory (Atlanta, GA) using competitive enzyme immunoassay kits from Salimetrics (State College, PA). CV% for low-cortisol and high-cortisol samples were 10.3 and 6.6%, respectively. CV% for low-testosterone and high-testosterone were 18.0

and 6.2%, respectively. All participants were tested in the afternoon between 2-4 PM in order to standardize collection time with reference to normal diurnal fluctuation in testosterone and cortisol levels.

Procedure

Men and women participants were randomly assigned to either be the only participant in the room or one of two tested at the same time. Pairs were also randomly assigned to be either same-sex or mixed-sex pairs. Resulting experimental groups are: women competing individually, men competing individually, women vs. men, men vs. women, women vs. women, and men vs. men. All participants were tested with the same female experimenter. There was one additional group of men (N = 7) and women (N = 20) who filled out questionnaires, but did not compete. Instead, they sat in the same room and interacted with the same female experimenter for approximately 5-7 minutes and provided saliva samples before and after this period of interaction. This group was intended to serve as a quasi-control group to test the effects of interacting with a female experimenter, independent of competing.

Upon arrival, participants read and signed a consent form and were given a brief explanation of the study (i.e., that the study was about the relationships between personality, social context, competition, and hormones). Participants were explicitly told that the purpose of collecting saliva samples was to measure levels of testosterone and cortisol. After consent, they completed questionnaires for approximately 15 minutes and then provided their first saliva sample. Next, the experimenter gave specific instructions about the competition indicating that there was "an overall grand prize of $20 each to the man and woman who holds his or her arm up the longest of all the other same-sex

participants being tested this semester". Participants were not given a reference for performance (i.e., the current leading time and average performance time were not revealed). Pairs were additionally told, "You have randomly been assigned to compete at the same time as another participant. Although the grand prize is only for the overall winner, for today's competition one of you will be a winner and one of you will be a loser." Further, both the participants competing individually and competing in pairs were told "the competition has to do with who has the most competitive will – who can endure the discomfort of holding up their arm the longest in order to attempt to be a winner." Each participant was then taken to an opposite wall of the testing room so that they were standing approximately 4-5 ft. apart from each other and facing the perpendicular wall (not directly facing each other, but capable of making eye contact with a 90 degree turn of the head). Their shoulder height was marked with a line marked on an index card taped to the wall and participants were instructed to hold their arm at that height and to drop their arm when they no longer wished to compete or could no longer physically keep their arm above the line, whichever came first. Additionally, participants were instructed not to start until the experimenter said "Go". Performance time was recorded and revealed to each participant when he or she dropped her arm by placing the timer on the table.

After the competition, participants provided their immediate post-competition sample. Then, they privately ranked their post-competition willingness to compete again and completed a survey (questions having to do with how the participant, men in general, and women in general show their competitive behavior) not included for analysis, but

rather as a "filler" for the 15 minutes between the end of competition and the final saliva sample.

Statistical analyses

In men, testosterone levels were normally distributed, but cortisol levels were not. In women, both testosterone and cortisol levels were skewed. As a result, hormone levels across men and women were standardized (z-score). Main effects involving hormone levels are only reported if they are significant for both raw and standardized values. Raw values are used in tables and figures for ease of interpretation.

Although there is variability in how hormone change is represented in the literature, percent change and the unstandardized residual of pre-competition level predicting post-competition level are the most straightforward and commonly used metrics for hormone change (Casto & Edwards, 2016a). Effects for hormone change are considered significant only if the same effect occurs for both metrics of change. Because hormones were sampled three times (immediately before competition, immediately after, and 15 minutes after competition), there are two periods of time relevant to competition in which hormone change was assessed – from before to immediately after, "change across (or during) competition" and from immediately after to 15 minutes after, "change across (or during) the after-competition interval." Results are reported separately for each competition-related period.

Due to the large number of variables and thus, analyses conducted, where relevant, results were considered significant only after controlling for false discovery rate (Bejamini & Hochberg, 1995) due to multiple tests. Results for independent T-tests and ANOVA for group differences are reported with Cohen's d (and the effect size

correlation r) and partial eta squared for effects sizes, respectively. For hierarchical linear regression analyses, control variables are entered first with variables of interest entered in subsequent models. Thus, change statistics, the effect of a variable of interest above and beyond the control variables, are reported in the results

Analysis by Sex. Men and women were included together in all analyses with "sex" as a factor included to test for a potential sex differences. However, due to the relatively small number of male participants, men are excluded from analyses that require complex experimental group by sex by personality computations. The specific analyses that exclude men are described in the results. Also, due to the different number of men and women, for all main effects reported in which sex was not a significant factor, separate tests were run for men and women to confirm the effect independently.

Results

Descriptive statistics

Means and standard deviations for testosterone and cortisol levels at each time point are shown in Table 1. Values are shown according to sex and competitive social context. On average, men had significantly higher baseline testosterone levels than women, $t(154) = 16.24$, $p < .001$, $d = 2.62$, $r = .79$. Baseline cortisol levels for men and women were not significantly different. OC users ($N = 59$, $M = 38.7$, $SD = 17.0$) had significantly lower levels of baseline T than non-users ($N = 45$, $M = 21.0$, $SD = 8.7$), $t(102) = 6.33$, $p < .001$, $d = 1.25$, $r = .53$. Performance time in the competitive will task within each social context is also shown in Table 1. Average times for women and men

were not significantly different for men (holding a 2 lb. weight, M = 250 sec., SD = 57) compared to women (holding a 1 lb. weight, M = 243 sec., SD = 99).

The percent changes in testosterone and cortisol associated with competition and the after competition phase are shown in Figs 2-5. There was considerable variability among participants in the magnitude and direction of the testosterone and cortisol change associated with the period of competition and the 15 minute after competition interval. In both men and women, change in testosterone and cortisol across competition and the after competition phase did not significantly differ for those who competed compared to those who did not compete. For those who competed, testosterone change across competition and the after competition phase was not significantly different in men compared to women. However, the change in cortisol across competition was significantly higher in men, who increased by 11% on average, compared to women, who decreased by 13% on average ($t(127) = 3.45$, $p = .001$, $d = .61$, $r = .29$). There was no significant difference between men and women in the cortisol change for the 15 minute after-competition interval.

Person factor: Competitiveness, power, and achievement orientation

Overlap among factors. Correlations between measures of competitiveness (Comp; CI), power (PDSS), and achievement orientation (social, SAGOS; academic, AMS) are shown in Table 2. Trait competitiveness is strongly positively correlated the subscales for enjoyment of competition (CI Enjoy) and self-efficacy about performing well in competition with others (Comp SE). These "competitive traits" also showed strong positive correlation with self-reported dominance motivation (PDSS DM). Although the relationships were not as strong, competitiveness was also significantly and positively

related to feelings of power (PDSS power), extrinsic as well as intrinsic academic motivation (AMS EM and IM), and, negatively correlated with amotivation (AMS Amot), an absence of academic motivation. Competitiveness was not related to social goals (SAGOS), whether mastery or performance oriented. Social performance-approach (SAGOS p-app) orientation was positively correlated with dominance motivation (PDS DM) and attendance to power cues (PDSS Att) while social performance-avoidance (SAGOS p-avoid) was strongly negatively correlated with sense of power (PDSS power).

Sex differences. Women, on average, were higher in extrinsic academic motivation than men (women $M = 5.90$, $SD = .83$; men $M = 5.56$, $SD = .81$), $t(155) = 2.26$, $p = .025$, $d = .36$, $r = .18$) and lower in amotivation (women $M = 1.30$, $SD = .61$; men $M = 1.64$, $SD = .83$), $t(155) = 2.73$, $p = .007$, $d = .44$, $r = .21$). Men, on average, were slightly higher in competitiveness, particularly the competitiveness index subscale for enjoyment of competition (women $M = 3.58$, SD = .74; men $M = 3.74$, SD = .82), $t(155) = 2.25$, $p = .026$, $d = .36$, $r = .18$). But, after controlling for false discovery rate, apparent differences between men and women in academic motivation and competitiveness were not significantly different. Men and women were also not significantly different on indices of feelings of power, dominance motivation, or social goal orientation.

Differences by 'identifies as an athlete'. Participants indicated whether or not they identified as an athlete. Participants who identified as an athletes (which includes those who are varsity athletes) were higher in competitiveness (athletes $M = 3.80$, $SD = .57$; non-athletes $M = 3.00$, $SD = .62$), $t(155) = 8.22$, $p < .001$, $d = 1.31$, $r = .55$), enjoyment of competition (athletes $M = 3.95$, $SD = .63$; non-athletes $M = 3.09$, $SD = .72$), $t(156) = 7.88$, $p < .001$, $d = 1.26$, $r = .53$), generalized competition self-efficacy (athletes $M =$

3.84, *SD* = .68; non-athletes *M* = 3.25, *SD* = .75), $t(156) = 4.96$, $p < .001$, $d = .79$, $r = .37$), feelings of power (athletes *M* = 4.51, *SD* = .62; non-athletes *M* = 4.19, *SD* = .75), $t(155) = 2.85$, $p = .005$, $d = .46$, $r = .22$), and dominance motivation (athletes *M* = 3.96, *SD* = .70; non-athletes *M* = 3.59, *SD* = .74), $t(155) = 3.18$, $p = .002$, $d = .51$, $r = .25$) than those who did not identify as athletes. After controlling for false discovery rate due to multiple tests, all differences were still significant. As a result, 'identifies as an athlete' was used as a control variable in relevant subsequent analyses.

Relationship to performance in the competitive will task. With the combined sample of men and women, an initial exploration of the relationships between all personality variables and performance (time in seconds) in the competitive will task (without reference to social context) revealed a significant and positive correlation between performance and competitiveness ($r = .24$, $p = .005$), dominance motivation ($r = .25$, $p = .004$), and intrinsic academic motivation ($r = .26$, $p = .003$), after controlling for multiple tests. Combining these three factors into one variable, "status motivation" (scores for these scales were summed) a hierarchical linear regression revealed that status motivation significantly predicted performance time after controlling for variance explained by 'identifies as an athlete', BMI, and sex ($R^2_{change} = .077$, $F_{change}(3,125) = 10.75$, $p = .001$, $b = 14.64$ (CI: 5.8-23.5), $t = 3.28$, $p = .001$, $r_{partial} = .29$).

This combined factor of status motivation (Comp + PDSS DM + AMS IM) was thus used as a predictor in subsequent analyses. Extrinsic academic motivation, academic amotivation, and all subscales related to mastery or performance oriented social goals were unrelated to competitive will performance and were excluded from the "status motivation" variable.

Relationship to basal and dynamic levels of testosterone and cortisol. Neither baseline testosterone, nor the change in testosterone across competition or the 15-minute after-competition interval were directly related to any of the personality factors tested in this study in either men or women. For women, baseline cortisol, the change in cortisol across competition, and the 15 minute after-competition interval were also not directly related to any measure of personality. In men, there was a negative correlation between cortisol levels at every time point and sense of power (PDSS power) (pre-competition cortisol, $r = -.33$, $p = .031$; post-competition cortisol, $r = -.41$, $p = .006$; 15-min-post-competion cortisol, $r = -.44$, $p = .009$), but not wanting power or attending to power cues.

Consistent with other studies showing that cortisol moderates the relationship between testosterone and dominance, termed the *dual-hormone* effect (e.g., Edwards & Casto, 2013; for review, Mehta & Prasad, 2015), the interaction between baseline testosterone and cortisol were also included in analyses predicting personality and competitive will. Using hierarchical linear regression the interaction of baseline testosterone and cortisol did not predict competitiveness or the combined personality factor of status motivation in either men or women.

Context factor: Presence or absence of a competitor of the same or different sex

Experimental groups are: women competing individually, men competing individually, women vs. men, men vs. women, women vs. women, and men vs. men.

Relationship to performance in the competitive will task. Mean performance times across experimental groups (women competing individually, men competing individually, women vs. men, men vs. women, women vs. women, and men vs. men) are displayed in

Table 1. Univariate ANOVA of experimental group, sex, and their interaction on performance time in the competitive will task showed no significant differences. Even if groups were combined into two categories, social 'presence of a competitor' and 'absence of a competitor' there were no significant differences in performance time across groups. That is, social presence alone did not predict performance times on average nor did the interaction of social presence of a competitor and sex of the competitor. Although means were in the expected direction, performance time being better for those competing 'face-to-face' (social facilitation) than for those competing individually, this difference was not significant because of the great variability in performance time within each group.

The social effect that appeared most salient to performance time was one of conformity. That is, male and female competitors in either same- or opposite-sex dyads dropped their arm within close temporal proximity to each other (Figure 6). This was despite the fact that participants were not technically competing directly, but rather were attempting to hold up their arm long enough to beat all other participants in the study (an unknown standard). Initial correlational analysis among those who competed in pairs (44 pairs, $N = 88$) revealed a significant positive relationship between individual differences in the winners' performance times and the losing co-competitor's performance times ($r = .41$, $p < .001$). A hierarchical linear regression was conducted with control variables ('identifies as an athlete', BMI, and sex) in step one, experimental condition in step two, and co-competitor's performance time in step three. Results showed that co-competitor's time significantly predicted performance time above and beyond whether or not the

participant identifies as an athlete, BMI, sex, and experimental condition (R^2_{change} = .175, $F_{change}(3,85) = 5.02$, $p < .001$, $b = .421$ (CI: .226-.617), $t = 4.29$, $p < .001$, $r_{partial} = .43$).

Relationship to testosterone and cortisol change associated with competition. Social presence condition did not relate to testosterone change during either the competition phase or the 15-minute after-competition interval. For men, there was also no difference between the social presence condition and cortisol response for either time period. For women, change in cortisol from before to immediately after competition was significantly different by experimental condition ($F(2,94) = 6.03$, $p = .003$, partial $\eta^2 = .12$). As shown in Figure 7, post-hoc comparisons revealed that the difference was only significant for the group of women who competed individually (who decreased in cortisol by 22% on average) compared to the women who competed against men (whose cortisol did not change from baseline on average) (mean difference of 23.4%, $p = .016$, CI = 43-4%). No other groups were significantly different.

Person by Context interaction

Due to the relatively low sample size of men in each social presence condition, only women were included in the analyses for Person by Context effects.

Relationship to performance in the competitive will task. A hierarchical linear regression predicting performance time was conducted with 'identifies as an athlete' and BMI in step one, status motivation in step two, experimental group in step three, and the interaction between status motivation and experimental group in step four. As previously described with the combined sample of men and women, status motivation in women significantly predicted performance time ($R^2_{change} = .073$, $F_{change}(3,92) = 7.78$, $p = .006$, b

= 16.25 (CI: 4.7-27.8), $t = 2.79$, $p = .006$, $r_{partial} = .28$), but experimental group alone and the interaction between personality and context did not. The same analysis was run using the singular competitiveness variable (Comp) as well and produced the same results. Thus, the relationship between personality (whether for competitiveness or the combined status motivation variable) and competitive will performance was unaffected by the competitive social context.

Relationship to testosterone and cortisol change associated with competition. A hierarchical linear regression predicting after-competition testosterone was conducted with 'identifies as an athlete', BMI, and before-competition testosterone in step one, status motivation in step two, experimental group in step three, and the interaction between status motivation and experimental group in step four. Status motivation, experimental condition, and their interaction did not significantly predict testosterone change associated with the competition phase or the 15-minutes after-competition interval.

A hierarchical linear regression predicting after-competition cortisol was conducted with 'identifies as an athlete', BMI, and before-competition cortisol in step one, status motivation in step two, experimental group in step three, and the interaction between status motivation and experimental group in step four. As previously described, experimental group significantly predicted the change in cortisol across competition ($R^2_{change} = .025$, $F_{change}(3,91) = 10.82$, $p = .001$, $b = .023$ (CI: .009-.037), $t = 3.29$, $p = .001$, $r_{partial} = .33$), but neither personality alone nor the interaction between personality and context predicted cortisol change across competition or the 15-minute after-competition interval. Thus, the relationship between social context and cortisol change

associated with competition was unaffected by competitive or status motivated personality.

Winning and losing

Among all participants, one man and one woman received a cash prize for best overall performance. But, participants who competed in pairs effectively "won" by performing better than their co-competitor or "lost" by performing worse than their co-competitor. Winning and losing is a context variable that could differentially affect hormonal responses during the period of competition or after. Additionally, winning/losing could moderate the relationship between personality and hormonal response to competition. Winners and losers were compared on all personality variables for all individuals who competed in pairs. Winners (relative to losing co-competitors) were significantly higher in competitiveness (winners $M = 3.60$, $SD = .80$; losers $M = 3.24$, $SD = .68$), $t(86) = 2.26$, $p = .026$, $d = .49$, $r = .24$), enjoyment of competition (winners $M = 3.77$, $SD = .78$; losers $M = 3.30$, $SD = .84$), $t(86) = 2.69$, $p = .009$, $d = .58$, $r = .28$), and status motivation (winners $M = 12.74$, $SD = 2.1$; losers $M = 11.74$, $SD = 1.72$), $t(85) = 2.41$, $p = .018$, $d = .57$, $r = .28$). However, none of these effects remained significant after controlling for false discovery rate.

As a predictor of competition-related and post-competition changes in testosterone and cortisol. For men and women who competed in pairs, a 2 x 2 ANOVA with sex, win/loss, and their interaction predicting testosterone change across competition and within the 15 minutes after competition produced no statistically significant results. The same analyses for cortisol change also produced no significant results.

As a moderator. Although status motivation was not directly related to hormonal responses to competition, previous research suggests that Person factors can interact with competition outcome to predict competition-related changes in testosterone levels. To test this, a hierarchical linear regression predicting the percent change in testosterone from before to immediately after competition was conducted with sex in step one, competition outcome in step two, status motivation in step three, and the interaction between outcome and status motivation in step four. Including only those who competed in pairs, the interaction between win and status motivation significantly predicted change in testosterone across competition (R^2_{change} = .065, $F_{change}(1,82)$ = 6.10, p = .016, b = 5.64 (CI: 1.1-10.2), t = 2.47, p = .016, $r_{partial}$ = .26). As shown in Figure 8, status motivation is positively related to competition-phase testosterone change in winners and negatively related to competition-phase testosterone change in losers. The effect is the same if testosterone change is represented as an absolute change or unstandardized residual change. There was no relationship between status motivation and the change in testosterone during the 15-minute after-competition interval for winners or losers.

Baseline testosterone and cortisol as predictors of competitive behavior

A hierarchical linear regression predicting performance time was conducted with sex in step one, baseline testosterone in step two, and the interaction between sex and baseline testosterone in step three. Baseline testosterone significantly and positively predicted competitive will performance (R^2_{change} = .052, $F(1,121)$ = 7.06, p = .009, b = 17.85 (CI: 4.5-31.1), t = 2.66, $r_{partial}$ = .24). Although the interaction between sex and baseline testosterone was not significant, it explained an additional 5% of the variance in performance time when using raw testosterone values. The same regression analysis was

conducted separately for men and women. Baseline testosterone significantly predicted competitive will performance in women (R^2 = .071, F(1,91) = 3.474, p = .035, b = 2.16 (CI: .656-3.663), t = 2.854, p = .005, $r_{partial}$ = .29). However, the effect was not significant in men. The significant effect in women remained after controlling for OC use, identifies as an athlete, and BMI (R^2 = .051, F(1,87) = 5.17, p = .025, b = 1.42 (CI: .180-2.66), t = 2.76, p = .025, $r_{partial}$ = .24). This effect for women is depicted in Figure 9. Baseline C was unrelated to competitive will performance in women and men. Using hierarchical linear regression consistent with other studies of the dual-hormone effect (e.g., Edwards & Casto, 2013), the interaction of baseline testosterone and cortisol did not predict competitive will performance in either men or women.

Willingness to compete again

After competing, participants selected one of three options, compete again in the same task (different arm), compete again in a different task, or not compete and instead fill out another questionnaire. Sixty-one percent of participants chose to compete again in a different task; 20% chose to compete again in the same task, and 19% chose the 'not compete' option. Winners chose option number one 2.5 times more than losers. A one-way ANOVA revealed that status motivation was significantly different depending on which choice a participant made, F(2,129) = 10.02, p < .001, $\eta^2_{partial}$ = .14. Post-hoc contrasts showed that status motivation was significantly higher for those who chose to compete again in the same task compared to those who chose either of the other two options (compared to option 2, mean diff = 1.02, p = .027, CI: .09-1.9; compared to option 3, mean diff = 2.22, p < .001, CI: .1.0-3.4). Those who chose to compete again in

a different task were also significantly higher in status motivation than those who chose not to compete (mean diff = 1.2, p = .012, CI: .22-2.2).

Testosterone and cortisol change during competition and the 15-minutes after-competition interval were not significantly related to competitive choice (whether a participant chose option 1, 2, or 3) overall or for winners or losers. Additionally, baseline levels of testosterone and cortisol were not related to willingness to compete again.

Task-specific confidence and motivation in relation to hormone response to competition

There were no significant relationships between self-reported task-specific confidence ("What is the likelihood that you will win this competition?" and "What is your level of confidence in your ability to do well in the task even if you don't win?") and motivation ("How motivated are you to win?") and basal or dynamic levels of testosterone or cortisol.

Discussion

The main goal of this study was to explore the influence of Person and Context factors on competitive will and hormonal responses to competition in women and men. Specifically, Person factors related to status motivation (competitiveness, power motivation, and achievement orientation) and Context factors (social presence of a competitor of the same or different sex and competition outcome), were explored in relation to baseline and dynamic levels of testosterone and cortisol as well as performance in the competitive will task.

The main findings are as follows:

1. Competitiveness, power motivation, and academic motivation were highly interrelated. Independent of participant sex, these Person factors, whether considered individually or combined together to form an overarching factor of "status motivation", predicted performance the competitive will task. The higher an individual's status motivation, the longer he or she persisted in the task.
2. Presence of a competitor, the same or opposite sex, did not significantly affect competitive will performance. For those competing in dyads, individual differences in the performance time of winners were significantly and positively predicted by the performance time of the losing co-competitors.
3. In men, cortisol levels at all time points sampled were inversely related to sense of power. Cortisol change across competition period varied by sex and, for women, by experimental group: On average, men's cortisol levels increased across competition and women's decreased, and this difference was significant. But, cortisol did not change from before to after competition for women who competed against men. Cortisol responses for these women were, on average, higher than the responses of all the other experimental groups of women, but were *significantly* higher only compared to the average cortisol response for women who competed individually.
4. The interaction between status motivation and social presence group did not predict competitive will performance or the hormonal response to competition.
5. Among men and women who competed in the presence of another competitor, the interaction between status motivation and competition outcome (win/loss) significantly

predicted testosterone change across the competition period. Specifically, status motivation was positively related to testosterone change, but only among winners.

6. Baseline testosterone significantly and positively predicted performance in the competitive will task, but this effect appears specific to women.

The "status motivated individual": Constituent parts and behavior in competition

Status is one's relative position in a social hierarchy (Ellyson & Davidio, 1985). Having high social status, in the form of prestige, is characterized by three main components: the respect and admiration of others, voluntary deference from those lower in status, and having qualities that others perceive as valuable to their own goals (Anderson et al., 2015). Considered this way, social status is distinguished from having social *power* – which is more about having control over others regardless of how one is perceived (e.g., Cheng et al., 2013; Kemper, 1990; Reiss, 2004). Much like power, *dominance* demands deference and may be manifest in an aggressive style of expressing one's rank over others (Ellyson & Davidio, 1985). It may also be expressed as persistence in the face of a threat to status, a refusal to submit (Burgoon et al., 1998; Ellyson & Davidio, 1985). The term dominance is often used to describe a general style of relating to others that expresses the explicit and implicit motivation for status (Anderson & Kilduff, 2009). Despite the conceptual differences between status, power, and dominance, the primary end result is similar – greater access to limited resources, greater position and influence relative to others. The desire for status, power, and dominance may manifest in similar behaviors in service of the basic human need to survive and prosper. Thus, these terms are often used interchangeably (Burgoon et al., 1998; Winter, 1988)

A *motive* is purpose for behaving (Anderson et al., 2015; Ryan & Deci, 2000a; Sheldon et al., 2001). The desire for social status is considered to be a fundamental human motive (Anderson et al., 2015). Although this desire is universal across human cultures, individuals differ in the extent to which they are motivated for social status and the ways they try to attain and maintain it (for review, Anderson et al., 2015; Reiss, 2004). Some strategies are more successful than others (Cheng et al., 2013; Cheng et al., 2010). Given the very nature of status, only a select few can have it and, even within an individual, status may vary according to social context (Anderson et al., 2015). Importantly, it is the drive to attain status and keep it, not its possession that results in social behavior.

Quantifying individual differences in status motivation is challenging. It's reasonable to assume that those who have status have it because they pursued and continue to pursue it (though not always the case). Thus, status as reflected in, for example, peer rankings, position in a company, winner of a contest, could be a proxy for status motivation. But, the drive for status exists on a continuum and not all those who want status have it or go about getting it the same way (Reiss, 2004). Those who want status most desperately may use tactics that alienate others and those who succeed in demonstrating competence in an effort to gain status may, however, lack characteristics that others find attractive (Anderson et al., 2001; Anderson et al., 2008).

Measuring status *motivation* is made further difficult by the fact that individuals are not necessarily consciously aware that their behavior is motivated by the desire for social status (Nisbett & Wilson, 1977). Because of this, motivations for status, power, and dominance are considered implicit, lying beneath awareness and therefore, not

openly or plainly expressed (McClelland et al., 1989). Moreover, the overt expression of dominance is not typically socially acceptable or even a successful means of achieving status in modern civilized culture, particularly among women (Campbell, 2004; Winter, 1988). Even those aware of their motivation for status may not readily admit it to others. As a result, a singular, straightforward self-report measure of status motivation (e.g., rating one's level of agreement to the statement "my behavior in general is strongly motivated by the desire for social status") will yield results that are, at best, problematic.

Thus, tests have been developed to measure implicit motives via indirect association (i.e., "projective tests"). One such test, the Picture Story Exercise (PSE), requires participants to write imaginative stories based on images of people in ambiguous social situations (McClelland, 1989, a research version of the Thematic Apperception Test). Power motive (n Power), the "concern for having an impact on others, arousing strong emotions in others, or maintaining reputation and prestige" (p. 510, Winter, 1988), has been measured using the PSE (Winter, 1973; for review, Schultheiss & Brunstein, 2001). Although n Power is not related to self-reported measures of dominance or power motivation (e.g., Schultheiss & Brunstein, 2001), it has, in some instances, predicted dominance behavior (for review, Stanton & Schultheiss, 2009). The PSE is labor-intensive to administer and score. But in its favor, power motive measured by the PSE has been shown to be positively related to basal and dynamic testosterone levels (Schultheiss & Rohde, 2002; for review, Stanton & Schultheiss, 2009).

Slightly different than motives, personality *traits* are "dimensions of individual differences in tendencies that show consistent patterns of thoughts, feelings, and actions" (p. 23, McCrae & Costa, 1990). Traits are typically measured through self-report

questionnaires, and function to provide explanations for behavior (McCrae & Costa, 1995). Traits are considered to be conceptually different from motives – motives are the underlying "why" of behavior, while traits represent identifiable patterns of consistency in behavior – but *both* are required to comprehensively describe personality (McClelland, 1989; for review Winter et al., 1998). As Winter et al. (1998) eloquently put it, "traits constitute the stylistic context for the expression of motives" (p. 243).

Researchers have attempted to identify specific measurable status-seeking behaviors that would be exemplars of the underlying motive and trait. For example, experimenters have observed groups of participants in conversation and coded for verbal (e.g., amount of time spent talking, interruptions) and nonverbal (e.g. expansive posture, eye contact) dominance signals (Aries et al., 1983; Burgoon et al., 1998; Mazur, 1985). Mehta and Josephs (2010) assigned participants to the position of "leader" and asked them to instruct a "follower" to complete a puzzle task. As a measure of dominance behavior in leaders, trained observers, using video recordings, made Likert scale ratings of participants' behavioral styles such as how engaged, leader-like, confident, and decisive the participant appeared when giving instructions. Under the contrived setting of a laboratory social interaction, the expression of verbal or nonverbal dominance behaviors do not necessarily relate to self-reported dominance (e.g., Aries et al., 1983). In naturalistic settings, however, status-related behaviors have been shown to be positively correlated to peer-rankings of social status (Small et al., 1983). Actual behavior in these settings is difficult to link directly to underlying motive because there are varying strategies, even ones that would appear opposite that can be utilized in an effort to attempts to achieve status (e.g., Cheng et al., 2013; Cheng et al., 2010). For

example, social influence over others may be gained by forcing submission through verbal or physical aggression, but also by behaving generously in order to increase one's instrumental value (Anderson & Kilduff, 2009).

Status-pursuing behavior is often measured in the context of competition. Formal competitions are a contest for status with agreed upon rules: some individuals prevail and others do not. Within competition, status-seeking can be operationalized as efforts made towards increasing the likelihood of winning. Surprisingly, few studies of human competition have attempted to quantify these efforts as a measure of status-seeking (e.g., Kivlighan et al., 2005; Welker and Carré, 2015). In the present study, we introduced a novel competitive task designed to measure individual differences in the willingness to endure physical discomfort in order to be a winner – *competitive will*. Requiring physical and psychological strength and perseverance, performance in the competitive will task reflects personal characteristics that would be advantageous for success in dominance contests in both early (primitive) and modern human social contexts.

One objective of this study was to derive the component parts, the distinct yet overlapping traits, underlying status motivation. These traits, combined, should predict behavior in a setting where relative status is negotiated (i.e., competition). Given the importance of both traits and motives in understanding behavior, this research complements and extends previous research on the social psychology and neuroendocrinology of implicit power motivation (for review, Stanton & Schultheiss, 2009).

As depicted in Figure 10, trait competitiveness (e.g., identifying as a competitive person, who both enjoys and is confident in his or her competitive pursuits), power

motivation (e.g., wanting to be in-charge, take the lead, be the boss, have an impact on others, have your opinions heard), and motivation to be successful in academic goal-pursuits are highly interrelated factors and combined, could characterize the "status motivated individual". Indeed, these traits significantly and positively predicted competitive will performance in both men and women. The interrelatedness among factors and relation to competitive behavior was independent of participant sex. This result is consonant with previous research to the effect that men and women do not differ in explicit or implicit status or power motivation (Anderson et al., 2001; Winter, 1988). Interpretation of the lack of sex differences is, however, limited by the relatively low number of male participants in the study.

The specific subscales that combined to predict competitive will were competitiveness (from the Trait Competitiveness Scale), power/dominance motivation (from the Power and Dominance Systems Scale), and intrinsic academic motivation (from the Academic Motivation Scale). Competitiveness is the tendency to enjoy and seek out situations in which one's abilities are compared to those of an opponent with the underlying motive of improving or maintaining standing relative to others, to be a winner. As predicted, competitiveness appears to be a core trait through which the underlying status motive is expressed. Thus, it is no surprise that competitiveness was most highly related to the motivation for power/dominance, a straightforward measure of explicit knowledge about one's tendency to want control, influence, relative importance, or leadership positions among others.

Intrinsic motivation is being "energized or activated toward…doing something because it is inherently interesting or enjoyable" (p.54-55, Ryan & Deci, 2000b), "doing

an activity for its inherent satisfactions rather than for some separable consequence (p.56, Ryan & Deci, 2000b). It is derived from the basic human need for competence, autonomy, and self-determination (Ryan & Deci, 2000a; Vallerand et al., 1992). Intrinsic academic motivation (from the college version of the AMS) refers specifically to one's purpose for going to college as deriving from the internal pleasure and sense accomplishment that results from learning (Vallerand et al, 1992; 1993). It is academic achievement that is oriented towards mastery and the pleasure of acquiring knowledge in and of itself. Thus, high intrinsic academic motivation is a good predictor of academic performance in the form of "investment in learning activities, persistence, and level of achievement" (pg. 28, Vansteenkiste et al., 2006). Extrinsic motivation, on the other hand, is doing an activity "in order to attain some separable outcome," for its instrumental value (p.60, Ryan & Deci, 2000b). Extrinsic motivation has a much more complicated relationship with academic outcomes (it may be positively related to externally regulated outcomes such as GPA, but negatively related to creativity and learning), but tends to result in reduced interest, value, and effort contributed towards academic tasks (Fairchild et al., 2005; Ryan & Deci, 2000b; Vallerand et al, 1992; 1993). Although, intrinsic and extrinsic academic motivation are specific to goals in college academics, these motivation styles could extend to other achievement settings (Vansteenkiste et al., 2006).

Extrinsic motivation, in previous research and in the present study, is positively correlated to generalized competitiveness (Fairchild et al., 2005). However, intrinsic motivation was also positively related to competitiveness. That intrinsic, but not extrinsic academic motivation, predicted performance in the competitive will task may appear

surprising. Although competitive outcomes are relevant to others, competitive effort and perseverance, as measured in the present study, are consonant with the achievement orientation style of those who are more intrinsically motivated. Also, achievement and power motives were highly correlated in the present study and elsewhere (Schultheiss & Brunstein, 2001; Sokolowski et al., 2000). The drive to win in competition for many may be less about gaining status relative to his or her competitor (at least explicitly) and more about doing ones best, mastering a skill, fulfilling the need to feel competent and accomplished. Thus, competitiveness may be the shared expression of complementary motives for externally-oriented implicit status and internally-oriented explicit mastery and achievement, with winning a competition satisfying both needs. Perhaps this explains why winning against an unskilled opponent is not as personally rewarding as winning under more challenging circumstances. Mastery gives a sense of personal achievement, competence, and capability – seemingly necessary pre-cursors to either actual or perceived social status.

Hormonal correlates of status motivation and competitive will

The hormones testosterone and cortisol may serve as biological underpinnings of status/power/dominance motivation. Initial research connecting testosterone to social status in humans and non-human primates described how individuals with higher status showed higher levels of circulating testosterone (e.g., Dabbs, 1990; Purifoy & Koopmans, 1979; Rose et al., 1975). However, subsequent research found that measures of status in humans such as socio-economic status and peer-rankings were unrelated to testosterone (Cashdan, 1995; Dabbs & Morris, 1990; Mazur & Booth, 1998). Due to lack of empirical support, the notion that testosterone directly predicts status rank in humans

has been discarded, replaced by the idea that testosterone does not necessarily *reflect status*, but rather, *motivates status-seeking behaviors* in different forms (e.g., aggression) and in certain contexts (e.g., unstable hierarchies). This assertion is known as the *basal model* for testosterone and status-seeking (Mazur & Booth, 1998). The basal model has been supported by literature to the effect that testosterone levels are associated with increased dominance and aggression in various status-threatening or competitive environments (for review, Carré et al., 2011; Carré & Olmstead, 2015; Hamilton et al., 2015). Indeed, in the present study, baseline testosterone was significantly and positively related to competitive will. However, this effect that was mostly specific to women and not particularly strong (accounting for only 4-7% of the variance in competitive will depending on the inclusion of men in the model and controlling for other variables). Newman and Josephs (2009) argue that basal testosterone should be considered as an important "personality variable" for moderating dominance behaviors in various contexts, one that has more predictive validity than self-reported dominance. Baseline testosterone did not relate to personality traits associated with status motivation.

Cortisol appears to moderate the relationship between testosterone and social status. Under the dual-hormone model (Edwards & Casto, 2013, Mehta & Josephs, 2010; for review Mehta & Prasad, 2015) high baseline testosterone predicts high social status and increased dominance-related behavior when baseline cortisol levels are relatively low. High testosterone may also predict low social status or decreased dominance-related behavior when baseline cortisol levels are relatively high (Casto & Edwards, unpublished data). There was no evidence for a dual-hormone effect in the present data. However, in men, there was a significant negative correlation between cortisol levels and

feelings/sense of power (but not power motivation or attention to power cues). That is, men who felt most and least powerful had the lowest and highest cortisol levels, respectively. Although basal cortisol has not previous been linked to trait-level feelings of power, there is a substantial literature on the positive relationship between cortisol levels and "traits characterized by proneness to anxiety and distress" (p. 362, Brown et al., 1996) as well as chronic adversity as a result of low socio-economic position (Li et al., 2007). Thus, cortisol levels may be a trait-like predictor of chronic stress, and resulting self-concept, on a continuum.

In contrast to the basal model for testosterone and status-seeking, the *reciprocal model* proposes that there is a dynamic and bidirectional relationship between status and testosterone – changing levels of testosterone in response to status gained or lost regulate ongoing and future status motivated behavior (Mazur, 1985; Mazur & Booth, 1998). Also known as the 'biosocial model for status' (Mazur, 1985; Mazur & Booth, 1998), increases in testosterone should reflect status gained and promote future dominant behavior whereas decreases in testosterone should reflect status lost and downregulate future dominant behavior. Support for the biosocial model has been found in studies of competition, where testosterone levels increase across competition for those who win, but decreases for those who lose (e.g., Apicella et al., 2014; Carré et al., 2013; Costa & Salvador, 2012; Norman et al., 2015). However, summarizing the extant literature on the "winner-loser" effect, Carré and Olmstead (2015) concluded that a number of studies have reported that male winners have elevated testosterone levels relative to losers, but that a nearly equal number of studies have failed to find such an effect.

It is now increasingly clear that there are numerous Person and Context factors that moderate the testosterone response to competition (for review, Casto & Edwards, 2016a). The present study contributes to this growing body of research. For men and women who competed face-to-face, status motivation significantly and positively predicted testosterone change during competition, but only for those who won. This finding supports the notion that those highest in trait status motivation are more likely to show competition-related increases in testosterone, but only under the context of a win. Because winning in the present study had to do with competitive effort to outlast an opponent, only those who were more effortful than their opponents showed a positive relationship between status motivation and testosterone change. This finding is also consistent with previous research that demonstrates a positive relationship between implicit power motivation as measured by the PSE and testosterone change associated with competition among winners but not losers (e.g., Schultheiss and Rohde, 2002; Schultheiss et al., 2005). Additionally, testosterone increase during a competitive task has been shown to predict the subsequent decision to compete again for individuals who won by a decisive margin (Mehta et al., 2015). Authors of additional studies showing that testosterone change across competition relates to after-competition willingness to compete again suggest that this testosterone increase functions to promote future status-motivated behavior (Carré & McCormick, 2008; Mehta & Josephs, 2006). But, combining evidence from the present study, there is an alternate explanation – that the highly status motivated individual (defined here, in part, by trait competitiveness) is both more likely to show increases in testosterone across competition *and* more willing to compete again, given that they won. Indeed, in the present study, men and women who

chose to compete again after the competition were significantly higher in trait competitiveness and status motivation than men and women who chose either one of the other options.

Hormonal response to competition

Similar to other studies utilizing laboratory competition paradigms (e.g., Mehta et al., 2015; Carré et al., 2013; Norman et al., 2015; van Anders and Watson, 2007), neither testosterone nor cortisol increased across competition systematically in the present study as they would in response to athletic competition (e.g., Bateup et al., 2002; Casto et al., 2014; Casto & Edwards, 2016b; Edwards et al., 2006; Edwards & Kurlander, 2010; Filaire et al., 2009; Gonzalez-Bono et al., 1999). Although studies of laboratory competitions rarely even focus on the overall trends of hormonal change across competition, this marked difference raises questions about the utility of making cross-context inferences. That is, contrived laboratory competition and athletic competition appear to be distinct social (and physical) contexts with respect to their endocrine correlates. The naturalistic setting of athletic competition and the real-world significance of competitions for actual status are facets of the athletic context that are probably important in the relationship between hormones and competition. Thus, attempts to increase these factors in laboratory settings should be a priority.

Perhaps one of the largest and most reliable effects in the field of social neuroendocrinology has to do with the cortisol increase associated with the stress of social evaluation under conditions that are beyond one's control (for comprehensive analysis and review, Dickerson & Kemeny, 2004). In the present study, for both men and women, there was considerable variability in the magnitude and direction of the change

in cortisol across competition, as there was for testosterone. None of the personality traits measured predicted these individual differences. However, on average, cortisol decreased across competition for women and increased across competition for men. Although there does not appear to be a reliable sex difference in cortisol responses to evaluative stress (Dickerson & Kemeny, 2004), men and women may differ in the kind of social-evaluative stressor that elicits a cortisol response, men reacting more to an achievement challenge and women reacting more to social rejection (Stroud et al., 2002). The difference in cortisol response by sex in the present study may be due to systematically, but unintended, increased social-evaluative stress in men compared to women. All men competed in the presence of a female (the experimenter), but only the subset of women who competed in the opposite-sex paired condition competed in front of a man. Perhaps not coincidentally, this group comprised the only women participants who did not decrease in cortisol on average. And, women who had the lowest number of social evaluators, those who competed individually (only in front of the same-sex experimenter), showed the greatest decrease in cortisol across competition. Future studies should explore how social evaluation from same and opposite-sex others impacts the cortisol response to competition.

Social conformity in competitive will performance

In this study, the presence of a competitor of the same or opposite sex did not significantly affect competitive performance, as would be predicted by social facilitation theory (for review, Bond & Titus, 1983; Harkins, 1987; Uziel, 2007). Rather, participants' performance was significantly and positively related to the performance time of his or her co-competitor. It is a well-known social psychological phenomenon

that individuals' perceptions and decision-making are influenced by group norms (e.g., Cialdini & Goldstein, 2004; Turner, 1991). With specific reference to behavior, *social conformity* is considered "the act of changing one's behavior to match the responses of others," (p. 606, Cialdini & Goldstein, 2004). This other oriented behavior serves as a means for meeting the basic human need for affiliation and social-belonging (Asch, 1952; Maslow, 1968). However, social conformity appears to be influenced by a variety of factors including the individual's degree of identification with the social others, i.e., that they share some level group membership (Bond & Smith, 1996; Ellemers et al., 2002).

Drives to perform better in the presence of others (social facilitation) may be regulated by, perhaps more potent, drives to conform – i.e., once an individual has demonstrated at least basic competence (having beat her opponent) she must defer to social norms. This could be particularly true in the context of competition, where performance is determined in direct comparison to others. In sport, it is common, and expected under social rules for sportsmanship, for teams who are soundly beating their opponent (winner has been effectively decided) to curtail efforts through the remainder of the competition period. This prevents the social affront of being overly dominant or self-serving. Even outside of competitive contexts, modesty is a highly valued characteristic, particularly in women (e.g., Hareli & Weiner, 2000; Wosinska et al., 1996). In this study, status motivation and co-competitors' time both independently predicted performance. Indeed, it appears that conformity and status motivation represent two distinct, yet equally fundamental motives (Anderson et al., 2015; Baumeister & Leary, 1995). The need to be better relative to others, to have status and be distinguished, and the drive to belong, to affiliate with others, must paradoxically operate in concert to drive

behavior. One strategy for balancing the duel needs for belongingness and distinctiveness is to become a leader within the group, attaining higher status, while at the same time retaining social support among other group members (Hornsey & Jetten, 2004). Leaders, often the most prototypical members of a group (Hogg, 2001), achieve both conformity and social status; "at once they are the most ordinary and extraordinary members" (p. 255, Hornsey & Jetten, 2004). To have actual social status, one must be both affiliative, playing by the rules of social approval from others, and superior in the valued skills and abilities necessary to lead.

Behaviors driven by status motivation are most effectively employed when relevant to others in a social group, one that the individual identifies with. Status is enhanced by the demonstration of abilities that add instrumental value to the social group. Perhaps this is why social comparisons to and competitiveness with others is based on social proximity (Garcia et al., 2013). That is, people are more competitive with people they know or with whom they have a shared history (e.g. sibling rivalries, intra-conference/division rivalries). And, the more strongly one identifies with their group the more competitive they are going to be within it. Recognizing the role of group processes and social influence on competition performance will be important for a comprehensive understanding of the social neuroendocrinology of competition. Status motivation and underlying hormonal correlates should be considered within the context of social groups (e.g., Oxford et al., 2010) and in reference to individuals' level of group identification and need for affiliation.

Limitations

There are several important limitations to the present study. The relatively low number of men hindered the ability to properly detect sex effects. Data collection for this study is ongoing to increase the sample size across all groups of men and women.

The accuracy of salivary testosterone assay methods has been called into question (Granger et al., 2004; Granger et al. 2007). Recently, a high powered and comprehensive study (Welker et al., 2016) of testosterone and cortisol measured by enzyme immunoassay (EIA) revealed that low levels of testosterone in women were systematically inflated by EIA kits from all the primary manufacturers, including those used in the present study. Additionally, salivary testosterone levels determined by EIA, for men and women, did not closely approximate levels determined by mass spectrometry, the gold standard for assay methodology. Future studies have been urged to consider using mass spectrometry for measuring testosterone levels in saliva in place of immunoassays. Absolute levels of testosterone, rather than relative change, are more sensitive to issues with assay validity. Thus, results from the present study that should be interpreted most cautiously are those having to do with baseline testosterone levels in women.

Conclusion

Personality traits related to status motivation (competitiveness, power motivation, and intrinsic academic motivation) predict competitive will in men and women – those higher in the motivation to compete, to have social power, and to learn, persisted longer in competition. At least for women, baseline testosterone was also related to competitive will performance: the higher the testosterone the better the performance. Thus, baseline testosterone level appears to be a Person factor with a positive influence on status-

motivated behavior. For those who competed face-to-face, performance times for winners were strongly and positively related performance times of their losing opponents. These performance effects appear to demonstrate how the seemingly paradoxical motives for social status and affiliation operate in concert to influence competitive behavior.

Person and Context factors also predicted competition-related changes in testosterone and cortisol levels. For winners, status motivation positively related to the testosterone change from before to immediately after competition, with the highest levels of status motivation associated with an increase in testosterone level. Rapid and transient testosterone increases may be a physiological mechanism by which status motivation manifests in adaptive competitive behaviors, those that would lead to an increase in physical and psychological effort required to defeat an opponent. Cortisol increased during competition in men, but decreased in women. Additionally, women who competed against men were the only group of women who did not decrease in cortisol on average. Thus, it appears that sex and sex of one's competitor may impact the stressful nature of competing and related cortisol response.

Future research with humans should consider the importance of personality and social context in regulating competitive behavior and hormonal responses associated with competition. Additionally, these relationships should be explored in more socially-relevant, ecologically valid settings where the demonstration of status is of personal importance and of value to one's social group membership.

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Table 1. *Means (standard deviations) for testosterone and cortisol levels and performance time in the competitive will task.*

	TestA	TestB	TestC	CortA	CortB	CortC	Time
				Women			
Individual	27.8	25.6	24.4	.161	.119	.148	233
(N = 32)	*(15.9)*	*(16.7)*	(16.4)	(.103)	(.072)	(.111)	(118)
Vs. Woman	32.7	29.8	29.6	.179	.143	.156	252
(N = 44)	*(18.1)*	*(18.1)*	(18.1)	(.179)	(.114)	(.111)	(94)
Vs. Man	35.2	32.1	33.3	.172	.173	.201	241
(N = 18)	*(15.2)*	*(14.0)*	(14.6)	(.098)	(.111)	(.126)	(69)
Control	29.3	25.4	--	.246	.183	--	--
(N = 20)	*(13.5)*	*(12.3)*		(.568)	(.340)		
				Men			
Individual	94.6	86.1	89.8	.153	.145	.240	249
(N = 9)	(20.0)	(22.9)	(32.2)	(.108)	(.106)	(.256)	(39)
Vs. Woman	90.1	87.3	87.1	.136	.151	.233	245
(N = 18)	(36.8)	(32.4)	(32.1)	(.091)	(.114)	(.165)	(71)
Vs. Man	98.6	104.9	85.9	.244	.228	.274	263
(N = 8)	(33.7)	(39.7)	(29.4)	(.191)	(.155)	(.157)	(44)
Control	107.9	105.5	--	.184	.159	--	--
(N = 7)	(37.6)	(40.8)		(.148)	(.089)		

Note. Test = testosterone in pg/ml, Cort = cortisol in μg/dl. A = before competition, B = immediately after competition, C = 15 minutes after competition. Time = length of time in seconds that participants held their arm up.

Table 2. *Correlations between personality measures*

	1	2	3	4	5	6	7	8	9	10	11	12	13
Comp (1)	--												
Comp Self-Efficacy (2)	.658*	--											
CI Enjoy (3)	.822*	.549*	--										
CI Contentious (4)	.301*	.226#	.307*	--									
PDSS Sense of Power (5)	.365*	.522*	.396*	.472*	--								
PDSS Dominance Motivation (6)	.545*	.494*	.562*	.449*	.568*	--							
PDSS Attend to Power (7)	.086	.214#	.039	.234#	.250#	.453*	--						
SAGOS Mastery (8)	-.042	.120	-.159	.004	.143	-.039	.080	--					
SAGOS performance-approach (9)	.089	.055	.040	-.028	-.042	.288*	.284*	-.003	--				
SAGOS performance-avoid (10)	-.074	-.216#	-.114	-.152	-.455*	.050	.094	-.139	.468*	--			
AMS Intrinsic (11)	.196#	.135	.116	-.060	.201#	.135	.238#	.213#	-.004	-.047	--		
AMS Extrinsic (12)	.265*	.164	.115	-.034	.172	.281*	.210#	.164	.177	.174	.408*	--	
AMS Amotivation (13)	-.281*	-.215#	-.221#	-.122	-.264#	-.140	-.075	-.157	.179	.228#	-.268#	-.260#	--

Note. *= <.001, # = <.02

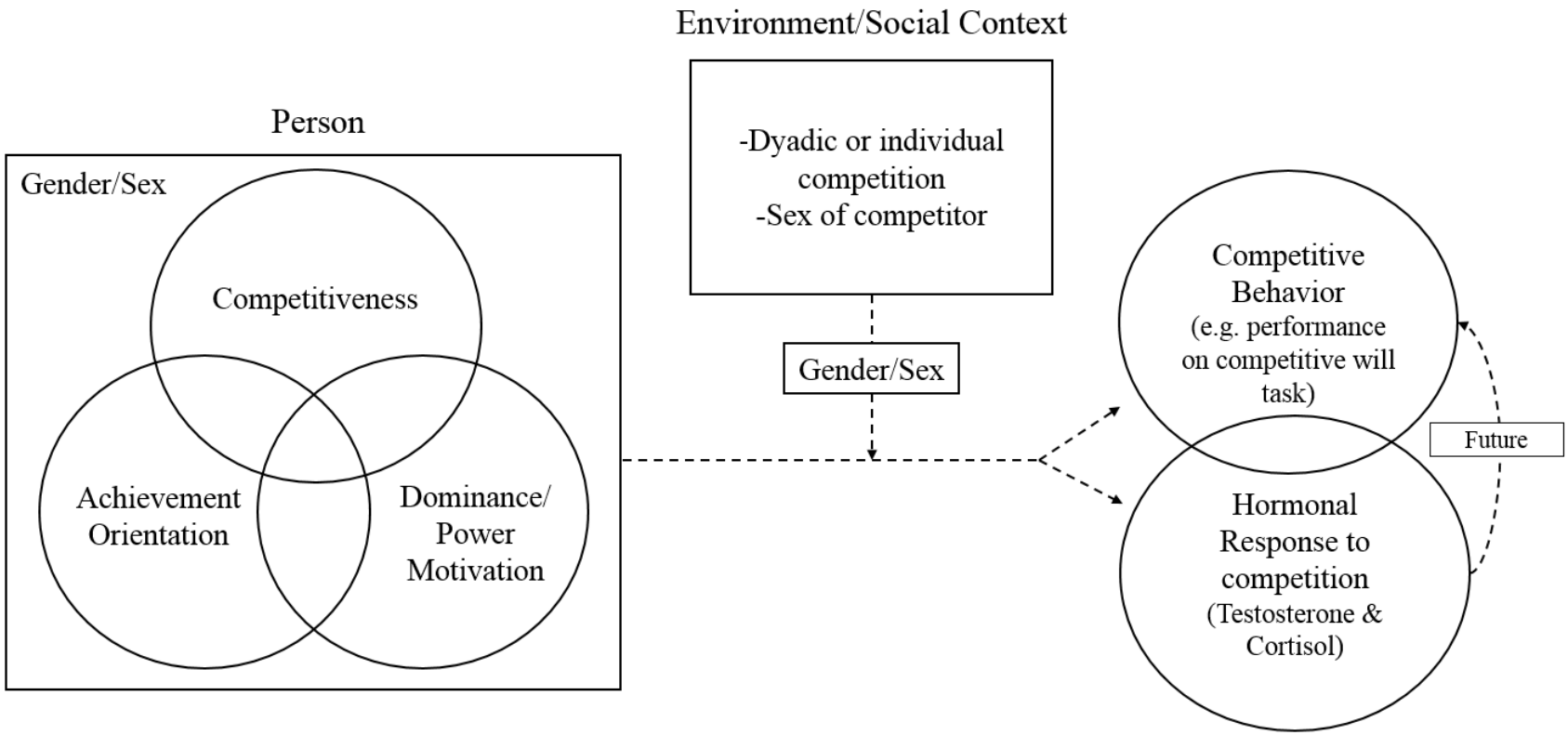

Figure 1. Theoretical model for this study: The interaction of Person and Context factors on competitive behavior and hormonal response to competition.

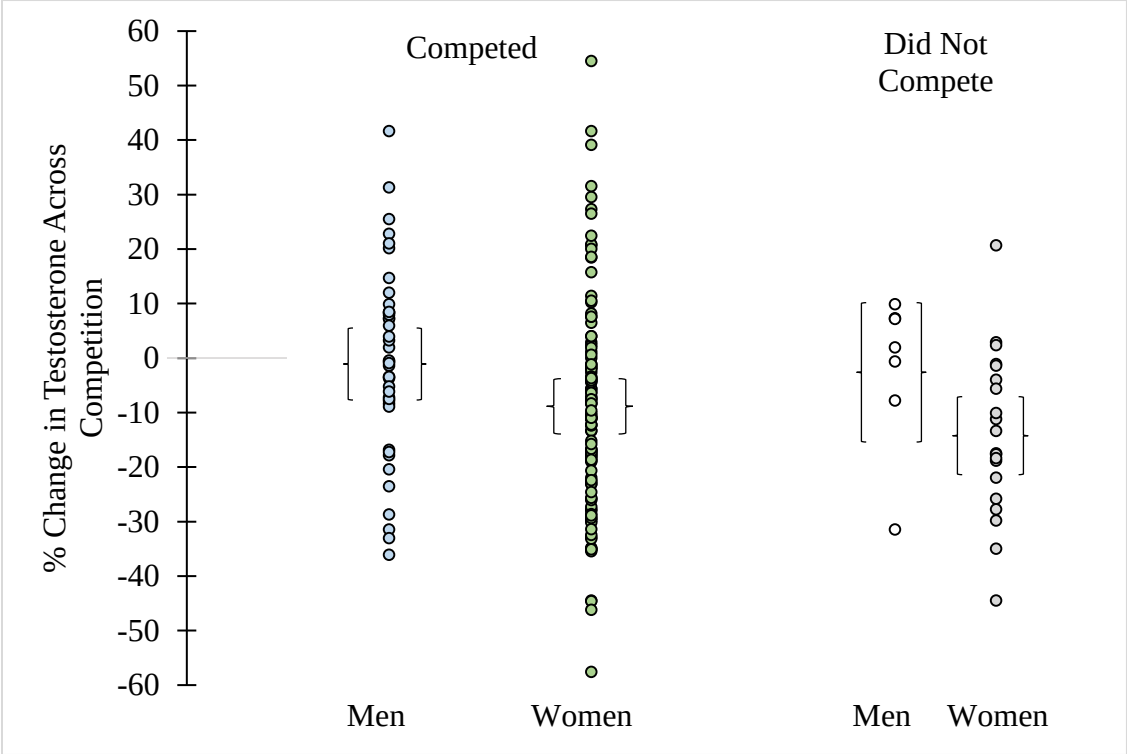

Figure 2. The percent change in testosterone for men and women from before to immediately after either competing in the competitive will task or sitting quietly for 5 minutes. Brackets represent the 95% confidence interval around the mean for each group.

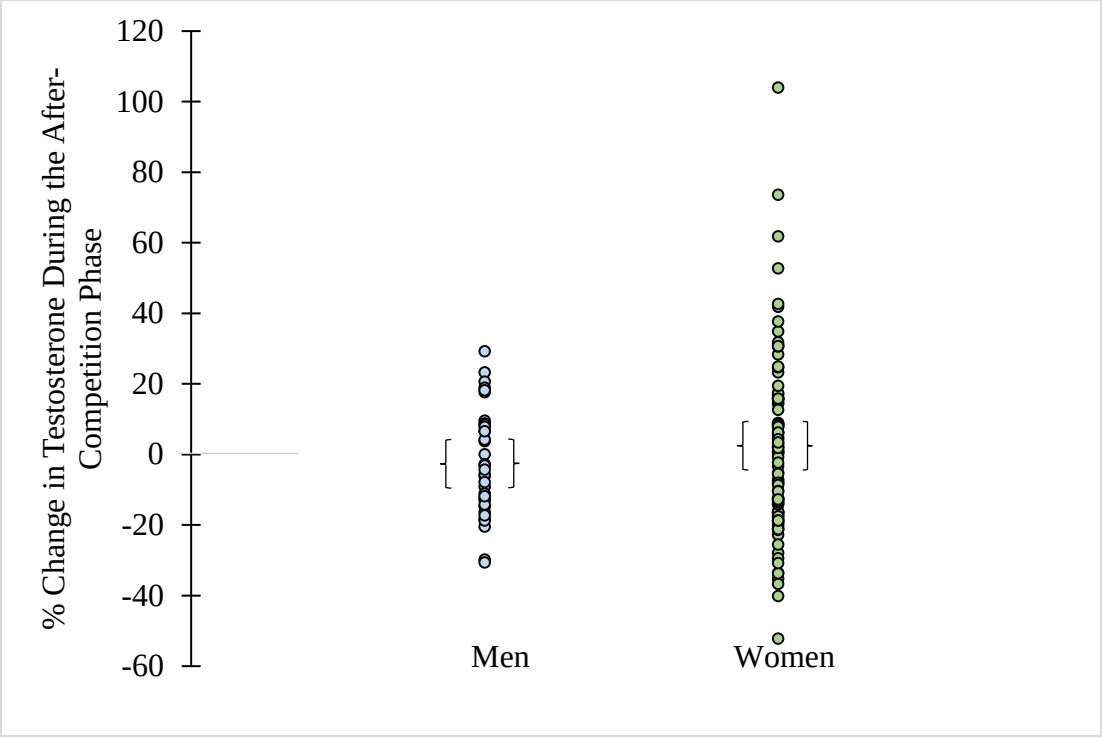

Figure 3. The percent change in testosterone for men and women from immediately after competition to 15 minutes after. Brackets represent the 95% confidence interval around the mean for each group.

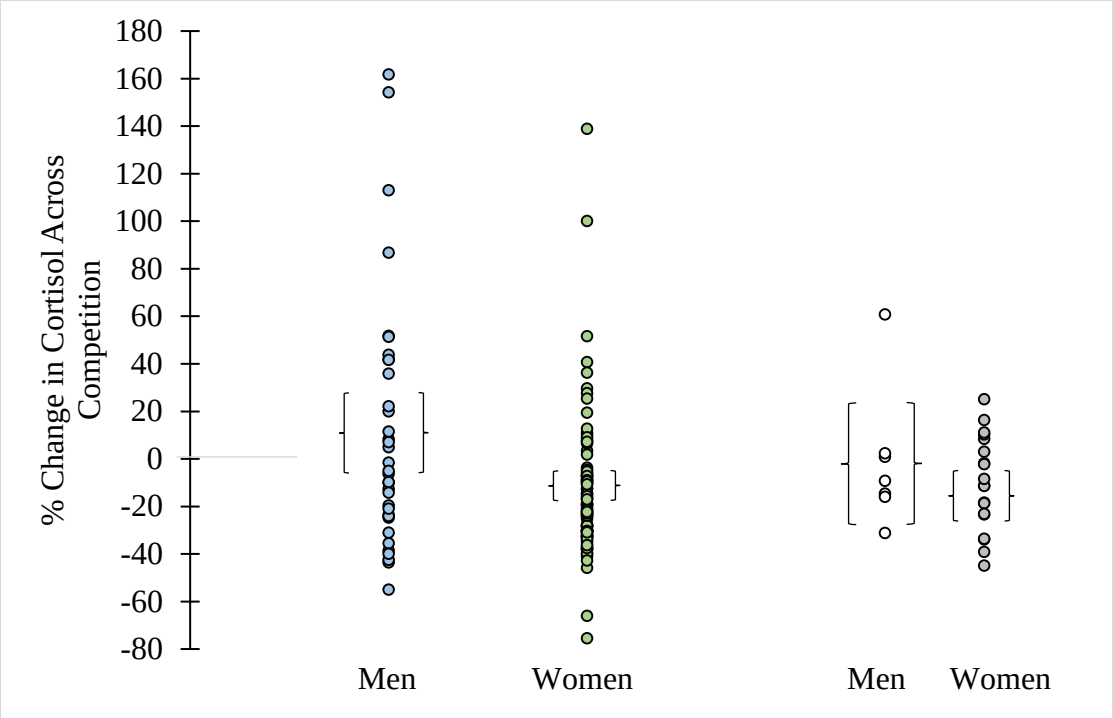

Figure 4. The percent change in cortisol for men and women from before to immediately after either competing in the competitive will task or sitting quietly for 5 minutes. Brackets represent the 95% confidence interval around the mean for each group.

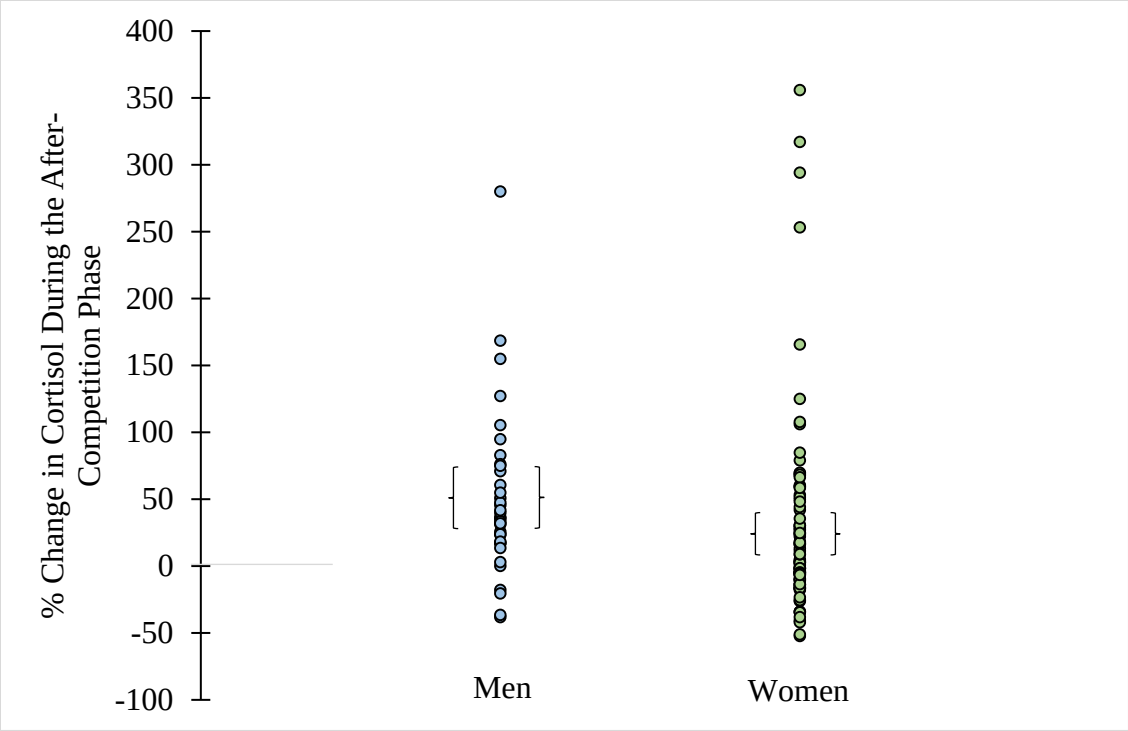

Figure 5. The percent change in testosterone for men and women from immediately after competition to 15 minutes after. Brackets represent the 95% confidence interval around the mean for each group.

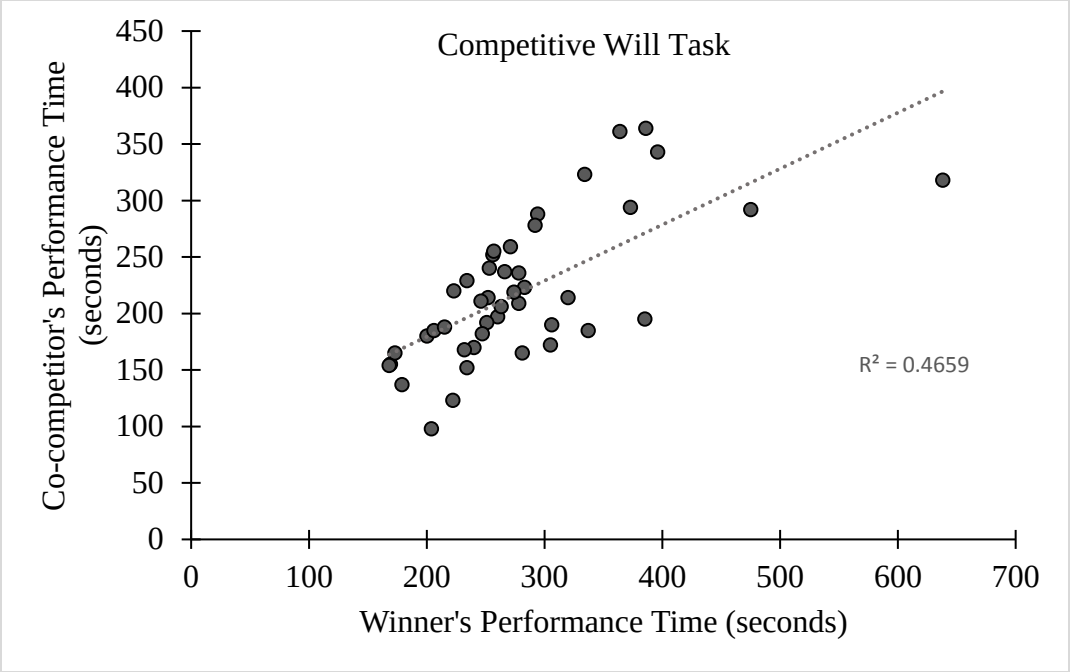

Figure 6. The relationship between a winner's performance time in the competitive will task and his or her co-competitor's time.

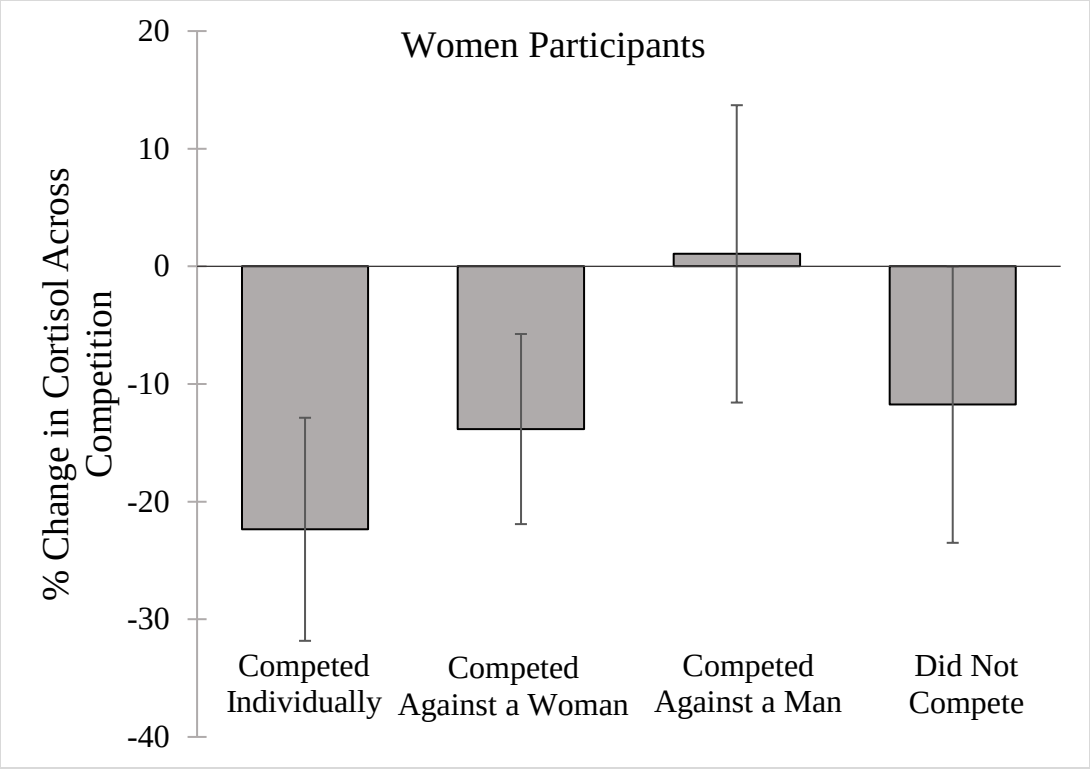

Figure 7. Mean percent change in cortisol across competition by social presence condition for women who competed. Women who did not compete are also shown for reference. Error bars represent 95% confidence intervals.

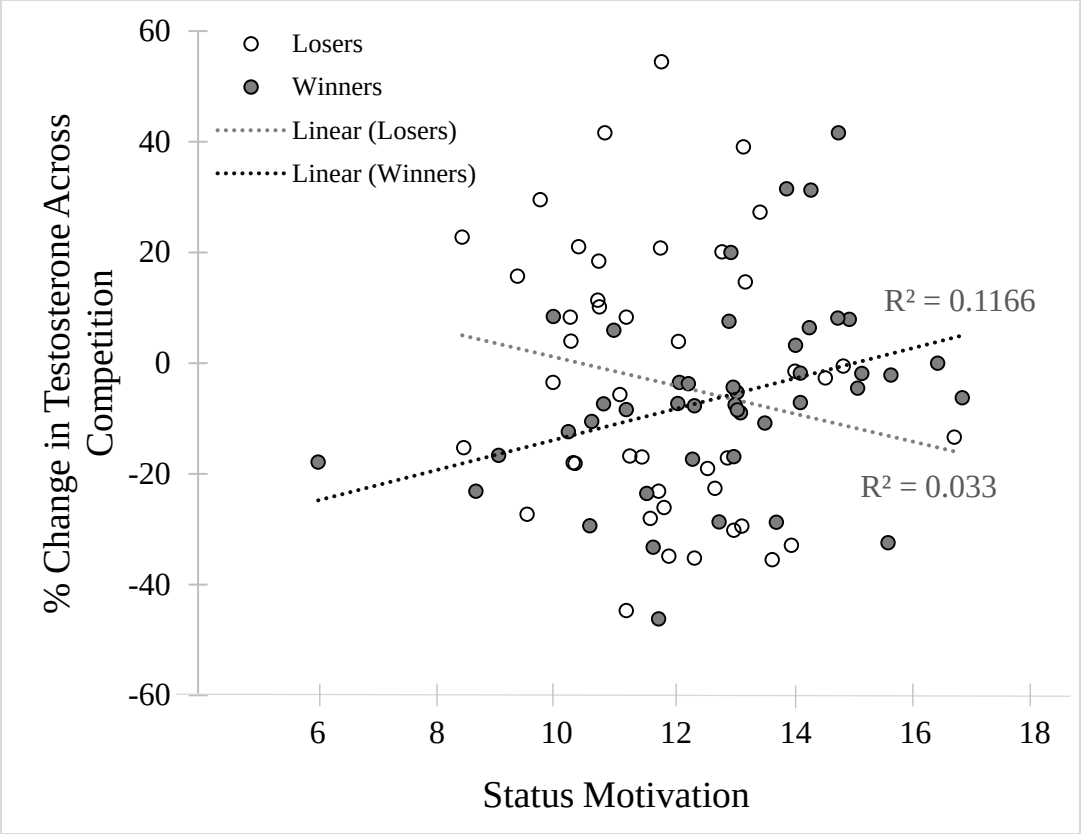

Figure 8. The relationship between percent change in testosterone across competition and status motivation for winners and losers.

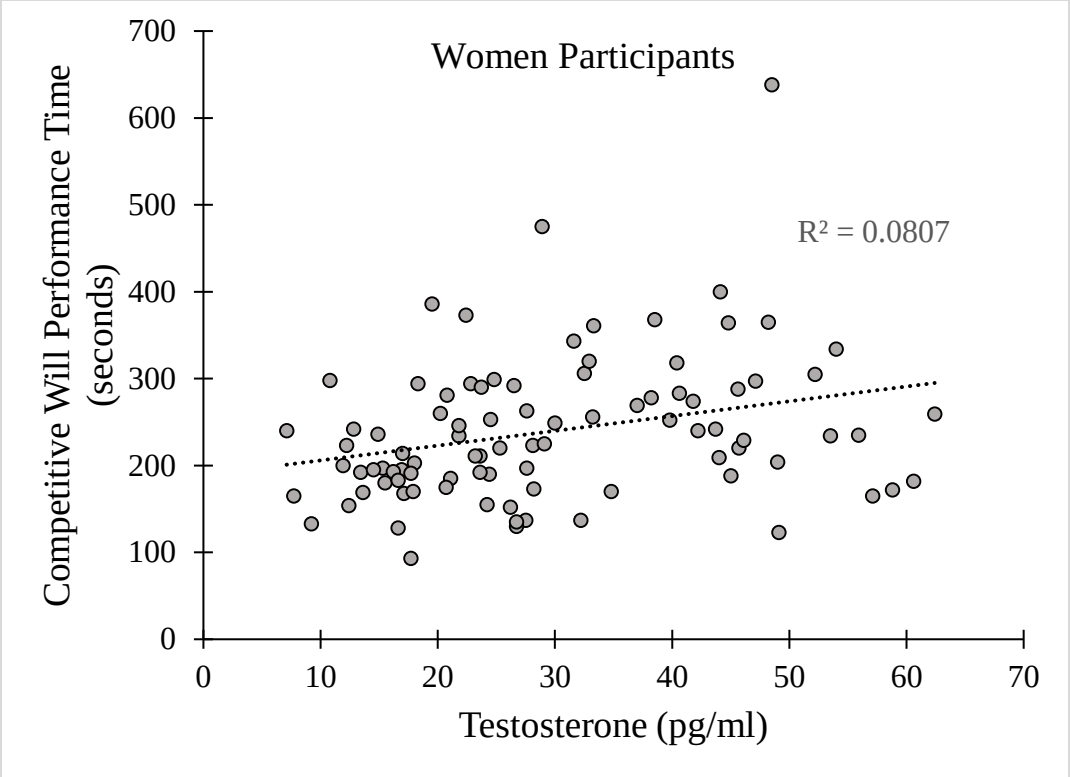

Figure 9. The relationship between baseline testosterone levels and performance in the competitive will task for women.

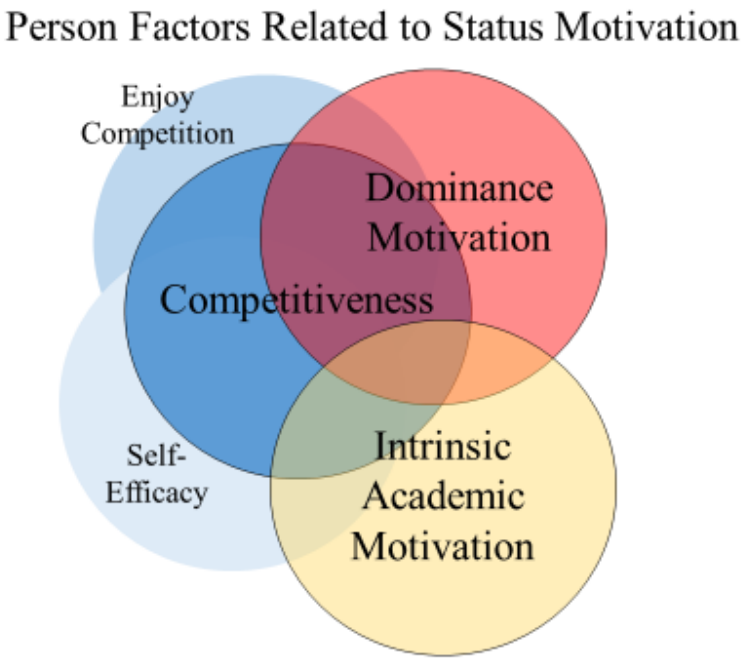

Figure 10. Schematic representation of the correlations between self-reported competitiveness, competition related self-efficacy and enjoyment, power motivation, and academic as well as social goal orientation.

Appendix A

Trait Competitiveness Scale (COMP)

1. I do not give up easily in competition.
2. I am better than others at most things that I do.
3. I'm not necessarily interested in beating others in order to achieve my goals.
4. I hate losing.
5. I try to be the best at everything.
6. I have what it takes to perform well under pressure.
7. I rarely turn down a challenge from another person
8. I want to be better than other people.
9. I have skills/qualities that make me better than other competitors.
10. I am a competitive person.
11. Other people think I am a competitive person.
12. Competitions make me uncomfortable.
13. I'm confident in my ability to perform well on most tasks.
14. I perform better when a task becomes a competition.
15. I'd rather compete against myself (against my own personal bests) than others.
16. I am willing to endure discomfort to be a winner.