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Circulating and organizational testosterone and the perception of dominance

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CIRCULATING AND ORGANIZATIONAL TESTOSTERONE AND THE PERCEPTION OF DOMINANCE

An Abstract of a Thesis

Submitted

in Partial Fulfillment

of the Requirements for the Degree

Master of Arts

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ABSTRACT

This project focused on the relationship between both circulating testosterone (T), prenatal exposure to T, and perception of emotions in the faces of others. Based on past research, T was hypothesized to be related to the Theory of Mind (ToM) abilities, which are concerned with reading emotions and intentions of others. More specifically, T was hypothesized to be more strongly related to the perception of dominant emotions compared to the perception of non-dominant emotions. To test this idea, the Test of the Eyes was used, which measures the ability to correctly perceive emotions in pictures of faces (specifically, eyes). To date, this research was the first to examine both circulating T and an indicator of prenatal T in relation to the perception of dominance. Correlational analyses showed that neither exposure to prenatal T, nor circulating T, were related to scores on the ToM test. Consistent with past research, however, women scored better on the test, interpreting emotions better than men. Several different measures of trait dominance were found to be positively related to circulating T, but this relationship was accounted for by gender. Trait dominance was also unrelated to organizational T and to the perception of dominance. Findings, limitations, and future research directions are discussed.

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CHAPTER 1

INTRODUCTION

The relationship between testosterone (T) and the perception of dominance is a complex area of research that has recently emerged. The goal of the current research was to further determine the extent to which this hormone is related to the perception of dominance. Both prenatal (a.k.a. *organizational*) T exposure (measured via 2D:4D ratio) and circulating T (measured via competitive enzyme immunoassay) in relation to dominance and the perception of dominance (measured via The Test of the Eyes) were investigated.

Animal Research

The relationship between T and dominance has been studied extensively in non-human species. For example, in one study, rats that had their natural T removed by castration showed significantly less aggressive behaviors towards non-aggressive intruders compared to rats in the control condition (i.e., those that were not castrated; Albert, Walsh, Gorzalka, Siemens, & Louie, 1986). Other research examined the dominance rank of ducks (Poisbleau, Fritz, Guillemain, & Lacroix, 2005). Those ducks that ranked higher in the group hierarchy tended to have higher levels of T. Primate research shows similar associations. Anestis (2006) discovered a positive relationship between T and social rank among a group of chimpanzees over a 3-year span (see also Muehlenbein, Watts, & Whitten, 2004), as well as between T and the amount of aggressive behaviors observed. Higher T was also associated with lower amounts of

received aggression from others members of the group. These studies suggest that T plays a role in dominant and aggressive behavior in some non-human species.

Human Research on Circulating Testosterone

In animal research, aggression and dominance are rarely distinguished; in humans, however, the understanding of aggressive and dominant behaviors is more fine-grained, and these terms are not used interchangeably. And although animal studies show fairly strong relationships between T and aggression, this relationship in humans is more convoluted (for a brief review see Simpson, 2001). A large-scale meta-analysis of research examining the relationship between T and aggression in humans found a consistent, but weak (r =.14) relationship (Book, Starzyk, & Quinsey, 2001).

Findings regarding T and dominance in humans are generally consistent with those found in non-human studies, though they appear more complicated and nuanced. While psychological literature is often focused on college student samples from Western cultures (see Henrich, Heine, & Norenzayan, 2010), recent research examined a male population from Senegal (Alvergne, Jokela, Faurie, & Lummaa, 2010). T level was found to be related to scores on extraversion, which is positively related to both dominance and sexual behavior. T also appears to be related to certain types of decision making. In one study (Carney & Mason, 2010), students who responded to a moral dilemma with a utilitarian-style response had significantly higher baseline T levels than those who chose a more moral, emotional approach. Mehta and Josephs (2010) also found that those with higher levels of circulating T behaved in more dominant ways. This may imply a more goal-oriented, dominant approach to social dilemmas in people with higher baseline

circulating T. T has also been found to be positively correlated with women's descriptions of their own personal level of dominance (Grant & France, 2001). Furthermore, Sellars, Mehl, and Josephs (2007) found that T was positively related to self-reported trait dominance.

According to prominent researchers in the field, dominant behaviors are those addressing an existing hierarchy and are exhibited in an attempt to benefit the individual in terms of status (Booth, Granger, Mazur, & Kivlighan, 2006). Aggression, which is often related to dominance, can be thought of as a strategy used to obtain dominance or to gain status. Possibly due to the research on animals, these two words are sometimes confused or used interchangeably. Additionally, people often hold "folk psychological" beliefs about those with high amounts of T being extra aggressive, though the research as a whole does not appear to support this notion. In fact, one study in which women's level of T was manipulated by researchers showed that women with supplemented T behaved *more fairly* than those given a placebo in an ultimatum game where monetary offers were made (Eisenegger, Naef, Snozzi, Heinrichs, & Fehr, 2010; see also Bjorkqvist, Nygren, Bjorklund, & Bjorkqvist, 1994 for an early example of a placebo effect of T intake). These findings are counterintuitive if one expects aggressive behavior to stem from high levels of T. On the other hand, by understanding that T is more directly related to striving for social status (sometimes via group acceptance), these results follow logically: someone who is rejected from the group cannot reach a dominant position very easily. In addition, women who were told they had received a T supplement, but were actually given a placebo, behaved significantly less fair based on the numerical value of their

offers. This study by Eisenegger and colleagues (2010) illustrates the contrast between the colloquial perception of T and aggression and the real effects of T on aggression in a lab setting. It should also be noted that this study focused specifically on women, and it is possible that men and women attempt to gain status in slightly different ways and/or might be influenced by T in slightly different ways.

A study done by Schaal, Tremblay, Soussignan, and Susman (1996) further emphasizes the distinction between social dominance and aggression in relation to T levels in adolescent boys. This longitudinal study, which followed boys from ages 6-13, collected measures of physical aggression from teachers and peers. At age 13, saliva samples were collected and social dominance ratings were given by recent peer acquaintances. Boys who were rated as most socially dominant (rated as being *tough* or described as a *leader*) had the highest levels of circulating T; boys who had a history of behaving in physically aggressive ways tended to have a significantly *lower* T level than did nonaggressive boys. This study highlights the distinction between dominance and aggression, which were related in opposite ways to T levels at a later time. Another longitudinal study examined boys of similar ages and found a significant relationship between circulating T and both a self-report measure and a parental description of social dominance (measured as *social leadership*), but found no relationship between T and physical aggression (Rowe, Maughan, Worthman, Costello, & Angold, 2004).

Overall, these studies support the idea that dominance is related to T. And although aggression may be used as a tool to gain dominance or status, aggression itself does not appear to be strongly related to higher T—it may even be related to decreased

amounts of T, as discussed above. Research suggests that, in humans, T is not necessarily related to aggression, per se, but *is* related to dominance (although, see van Bokhoven et al., 2006 for an exception).

Effects of Behavior on Testosterone

Researchers have also found that acting dominant can influence circulating T levels. Carney, Cuddy, and Yap, (2010) found that those who posed in a powerful position (e.g., open arms and body formation, feet up on a desk, etc.) had higher T levels, compared to baseline, than did those who posed in weaker positions (e.g., arms crossed, sitting hunched over). This research suggests that we might be able to increase our own levels of T based on behavior that is associated with dominance and status. Carney et al. (2010) also found that cortisol, a hormone associated with stress-responses, showed the opposite pattern, as was expected by the researchers. That is, cortisol decreased when participants posed in a powerful way and increased when participants posed in a weaker way. Researchers examining the relationship between T and behavior frequently incorporate cortisol into their studies.

For example, in one study, researchers pitted two participants against each other in a competitive game where the outcome was rigged. They found that the willingness to try the same game again was related to whether their T level increased or decreased after losing (Mehta & Josephs, 2006). Those who had a rise in T decided more often to try the game again, theoretically to gain back lost status; those who had a drop in T tended to choose a different, non-competitive activity. Consistent with these findings, a separate study showed that those with high baseline T who won a competition dropped in cortisol,

whereas those who lost had a rise in cortisol (Mehta, Jones, & Josephs, 2008). Because cortisol is released in response to stressful situations, this study may suggest that those with higher T are more concerned and/or physically stressed after losing status than those with lower T. The literature mentioned above supports the idea that T (and perhaps cortisol) is related to dominance behaviors in humans. But it should be noted, not all research is consistent with these findings.

Overall, circulating levels of T appear to be related to dominance. However, contrary to the previously cited studies, Johnson, Burk, and Kirkpatrick (2007) found that circulating T was positively related to personality measures of both aggression and self-esteem, but did not to find an association between T and dominance. A similar study found that neither circulating T nor a proxy measure for prenatal T (2D:4D ratio, to be discussed below) predicted choosing a competitive over a non-competitive activity for men (Apicella et al., 2011). These inconsistencies in the literature could be due not considering additional biological variables (e.g., cortisol, prenatal T), lack of consistent methods for defining dominance, or a failure to measure dominance precisely. More research needs to be done to examine these relationships, as it may be the case that circulating T alone does not fully capture how dominance and aggression are affected uniquely by human biology.

Human Research on Prenatal Testosterone

The previous section was focused on research examining T that exists within/circulates throughout the body (i.e., hormone samples taken from blood or saliva), but surges of T in the womb are also thought to contribute to brain development and

subsequently to personality and behavior. Baron-Cohen (2002) has argued that the male brain is different from the female brain, and that T may prepare the brain in ways that lead to certain personality dispositions and/or certain behavioral abilities or deficits. Specifically, prenatal levels of T are associated with brain formation and development. But it is often impractical, or too late, to measure direct levels of hormones inside a pregnant woman's body when doing this sort of research. To better understand the influence of prenatal hormones on behavior later in life, researchers needed to develop a more practical method to measure early exposure to T.

A well-established, indirect measure of the amount of T an individual was exposed to in the prenatal environment is that of the 2nd and 4th digit (2D:4D) ratio. A smaller ratio between these fingers, meaning the 2nd digit is smaller than the 4th digit, indicates more T was present during prenatal development. Alternatively, a higher ratio, meaning fingers are closer to the same length or that the 2nd digit is larger than the 4th, indicates less T was present during prenatal development (in relation to estrogen level). The 2D:4D ratio has been shown to be a valid cue to prenatal T; lower and higher 2D:4D ratios were found to be related to higher and lower ratios of T to estrogen, respectively (Lutchmaya, Baron-Cohen, Raggat, Knickmeyer, & Manning, 2004; see also Romano, Rubolini, Martinelli, Alquati, & Saino, 2005 for experimental animal studies that confirm this finding). Additionally, the digit ratio is likely established before the 14th week of gestation and is a proxy cue for a specific surge in T in the womb, not for the entire span of gestation (Garn, Burdi, Babler, & Stinson, 1975; for a detailed explanation of the relationship between gonadal development, digit ratio, and specific genes, see Manning,

Scutt, Wilson, & Lewis-Jones, 1998; see also Kondo, Zakany, Innis, & Duboule, 1997). Furthermore, prenatal levels of T are unrelated to circulating levels of T (Honekopp, Bartholdt, Beier, & Liebert, 2007), and are thought to exhibit distinct influences on people, suggesting that circulating and prenatal T may have related but independent influences on human development.

Knickmeyer and Baron-Cohen (2006) argue that prenatal exposure to T, along with other hormones, is likely an influencing factor in sex differences in social behavior—specifically, the skill of reading non-verbal cues and mental states of others. Digit ratios, as a proxy cue to prenatal T, have been found to be related to personality and abilities later in life. For example, men, but not women, have been found to have 2D:4D ratios related to the amount of empathizing and systemizing they do; higher ratios were related to more empathizing and less systemizing, which in this case were defined as the amount that an individual related to the world via social (empathizing) or non-social, law-regulated, input-output-oriented (systemizing) avenues (Baron-Cohen, & Wheelwright, 2004; von Horn, Backman, Davidsson, & Hansen, 2010). Another study found that 2D:4D ratio was associated with sex differences in ability and behavior (e.g., a more masculine left-hand 2D:4D ratio was related to homosexual orientation in women; Putz, Gaulin, Sporter, & McBurney, 2004), yet many predicted relationships did not emerge (e.g., female spatial ability was significant in the wrong direction; a higher more feminine digit ratio was related to better mental rotation score, which is typically a more masculine skill). Furthermore, Valla and Ceci (2011) compiled a group of studies examining digit-ratio, and math/numerical abilities, spatial abilities, and job/academic department choice.

Based on a large review of the relevant literature, they concluded that, although there is an ample amount of evidence supporting the notion that human digit ratios are related to certain abilities and sex differences, much more research needs to be done due to the inconsistencies across studies. These inconsistencies were a driving force of the current research.

Theory of Mind and Testosterone

The research above shows that, while inconsistent, there is some relationship between 2D:4D ratio and certain abilities and/or preferences—often, those related to gender differences. T has also been shown to be indirectly related to an individual's theory of mind (Auyeung et al., 2009; Manning, Baron-Cohen, Wheelwright, & Sanders, 2001). Theory of mind refers to the ability of people to interpret emotions and intentions of others, also referred to as *mind reading* by Baron-Cohen, Jolliffe, Mortimore, and Robertson (1997). A body of literature exists which focuses on the ability, and inability, to correctly perceive emotions and intentions of others. Specifically, this ability is studied in those with autism spectrum disorders (see below). A key deficit in those diagnosed with an autism-spectrum disorder is difficulty assessing what others are feeling or attempting to convey (Frith, Happe, & Siddons, 1994). These disorders are also much more commonly found in men, which may suggest a hormonal influence, as men tend to be exposed to higher levels of T. Baron-Cohen and colleagues developed a test to operationalize the ability of adults to mentalize what others are feeling (Baron-Cohen et al., 1997; Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001); the measure was initially created to test this ability in those with autism-spectrum disorders. The Test of

the Eyes assesses a person's theory of mind ability using pictures of eyes to convey specific emotions (see Appendix B).

One important study found digit ratio to be significantly different in those with autism, Asperger's syndrome, and in control populations; those with autism had the lowest ratio, followed by those with Asperger's, and the control group had the highest relative digit ratio (Manning et al., 2001). Though indirect, this research suggests that prenatal T is related to a disorder that manifests, in part, as a severe inability to understand others thoughts and emotions. More directly, researchers conducting longitudinal research have found links between actual prenatal T levels and theory of mind deficits in 6-10 yr old children (Auyeung et al., 2009). Here, direct levels of fetal T exposure were measured during routine medical examinations before the child was born. Several years later, mothers filled out scales assessing autistic symptomology in their children. Those with higher T exposure tended to score high on all autism spectrum subscales, one being a child's mind reading ability. These results suggest that fetal T is related to deficits later in life, specifically perceptual deficits. One possible explanation for this is that early T exposure might alter brain structure. Using magnetic resonance imaging (MRI), one study found a fairly strong correlation between the level of prenatal T and brain structure later in life (Chura et al., 2010). Boys, ages 8-11, who had higher prenatal T exposure tended to have larger, specific areas on the right side of their corpus callosum. The authors of that study offered that these enlarged brain regions may be a possible mechanism for cognitive and behavioral differences between sexes due to

hormones. Ultimately, though, it remains unclear what types of attributes are fixed in utero (Valla & Ceci, 2011).

There have been several studies considering T and the ability to accurately gauge others' emotions. For example, in a study most closely related to the proposed research, a relationship between circulating T and score on the Test of the Eyes was found (DeSoto, Bumgardner, Close, & Geary, 2007). This study uncovered an overall significant negative correlation between circulating T and scores on the test; that is, for men, higher T was related to worse scores on the Test of the Eyes. However, this pattern did not hold for men with extremely high circulating T (i.e., 3 SD above the mean); these participants showed significantly *better* scores on the Test of the Eyes than men with lower T. In another study, focused on 6-8 year olds, a direct measure of prenatal T exposure (via amniocentesis) found a significant negative relationship between T and score on the children's version of the Test of the Eyes (Chapman et al., 2006). However, findings are not always consistent when using this theory of mind measure. Voracek and Dressler (2006) showed that digit ratio was not related to the Test of the Eyes, nor was it related to other tests that examined empathy with a population of those in their mid-late 20s. The current research was conducted in an attempt to help resolve some of these discrepancies.

By incorporating the findings that suggest T is related to dominance into the research literature showing that perceptual deficits are associated with high T and in those with autism spectrum disorders, a new relationship is proposed. Because T is related to both dominance and problems perceiving emotions, it may be that T (both circulating and exposure prenatally) is associated with perceptual deficits in perceiving

dominance, specifically. Of interest, Watkins, Jones, and DeBruine (2010) found that men who rated themselves as having a more dominant personality were also less able to recognize dominant faces (i.e., faces morphed to look masculine vs. feminine). Though the Watkins study does not integrate T into the relationship, it provides a link between T and the reduced ability to perceive of dominance. T has been shown to be related to dominant behavior and personality, and dominant personalities have been associated (via Watkins et al.) with misperception of dominance. It follows that T might mediate the relationship between dominant personalities and the misperception of dominance found in the Watkins study; high T may lead to more dominant personalities *and* to a deficit in the perception of dominance.

Assessing Salivary Testosterone

A procedure to reliably measure circulating hormones from saliva has been developed and validated (Granger, Schwartz, Booth, & Arenz, 1999). The competitive enzyme immunoassay is a minimally invasive technique that measures unbound levels of T in saliva. This is done by using a microtiter plate coated with T antibodies that naturally bind to T. The process is competitive, meaning that T in samples competes with an added second substance (i.e., horseradish peroxidase linked to T molecules) for binding sites on the antibodies. T existing in a given sample will bind to receptors on the plate, resulting in a lack of binding of horseradish peroxidase-linked-T to the plate. Bound peroxidase is then measured by creating and stopping a chemical reaction by applying specific substances (i.e., tetramethylbenzidine or "TMB" and sulfuric acid, respectively) to each well, which results in a yellow color. The optical density of the

amount of color present in each cell is measured; a higher density signals higher amounts of peroxidase bound to the plate, which means that there were lower amounts of T present in the unknown sample (i.e., optical density and amount of T are inversely related when using this technique).

Accurate measurement of T is also dependent on other variables. There are several aspects to consider when assessing salivary T, including: the contamination of samples by leakage of blood (which can lead to elevated levels of hormones), the specific technique used to collect saliva, the known natural fluctuations of T over time (e.g., over the span of a day, a year, and the lifespan of an individual), and storage of samples (Diver, Imtiaz, Ahmad, Vora, & Fraser, 2003; Granger, Shirtcliff, Booth, Kivlighan, & Schwartz, 2004). Granger et al. (2004) outlined current best practices, including: examining samples visually for possible contamination of blood, asking participants about recent sugar consumption, collecting saliva passively without use of food, stimulating T samples without use of cotton or polyester collection devices, measuring T at consistent set times, and storing samples in a sufficiently cool place to avoid bacterial growth.

CHAPTER 2

CURRENT STUDY

The current research was done in an attempt to better understand the association between the T, dominance, and the perception of dominance. First, the relationship between circulating T and theory of mind deficit was explored. Specifically, T (circulating and prenatal) was predicted to have a negative relationship with the ability to perceive dominance based on unpublished research conducted by the author (Pedersen & DeSoto, 2011). In that study, higher T levels were related to a lower ability to recognize dominant pictures from the Test of the Eyes; T was *not* related to ability to recognize non-dominant pictures of eyes. To the author's knowledge, this is the only research to date linking T and dominance perception, specifically. The current research was conducted to further investigate this relationship and determine if circulating T is specifically related to the ability to perceive dominance.

Second, prenatal T was incorporated into the proposed T-dominance relationship. Previous research has shown that prenatal levels of T (using both direct and indirect measures) are related to perceptual ability and cognition later in life, specifically, theory of mind ability (Auyeung et al., 2009; Manning et al., 2001). Both of these studies focused on populations with autism spectrum disorder. A study on a non-clinical sample (Voracek & Dressler, 2006) did not find any relationship between estimated prenatal T levels and theory of mind ability, however, this research focused on overall mind reading ability as opposed to the more focused construct of perceiving dominance. An additional

goal of the current study was to find out if prenatal T exposure, measured via 2D:4D ratio, was related to the ability to perceive dominant emotions.

Third, these proposed relationships were predicted to be associated with a dominant personality type. However, the connection between T, the personality trait of dominance, and the ability to perceive dominance remains unclear. According to Baron-Cohen's (2002) ideas concerning brain organization, T levels should be the likely origin of both dominant personalities and deficits in understanding the mental states of others. This study addressed the interrelatedness of these variables. Formal hypotheses were as follows:

Hypotheses

H_1: Circulating T levels will be negatively related to scores on dominant pictures of eyes.

H_2: The 2D:4D ratios will be positively related to scores on dominant pictures of eyes; a more feminine 2D:4D ratio will be related to better dominance recognition.

H_3: Both circulating T level and digit ratio will be related to scores on the dominance personality scale; higher T will be associated with more dominant personality scores.

H_4: Dominant personality scores will be negatively related to scores on dominant pictures of eyes.

CHAPTER 3

METHOD

Participants

Participants were 148 (56% male) undergraduate students from a moderate-sized, Midwestern university. Most were white (93%), of freshman standing (69%), and between ages 18 and 20 (93%). They were recruited using an online participant pool system and were given partial course credit for taking part in the study. Participants were told that the study was examining the relationship between biology and personality. Some information was withheld until after the session was finished, as participants were not told that T, dominance perception, or dominant personality traits were being assessed—this was to avoid selection bias of people who have beliefs or feelings about dominance or T. All procedures were evaluated and approved by the local university IRB to ensure participant safety.

Measures

Data on four main variables were obtained from participants. Two measures of T were taken: (1) a measurement of 2D:4D ratio as an estimate of prenatal T and (2) a saliva sample as a direct measure of circulating T. Third, the Test of the Eyes was completed, followed by personality measures assessing dominance.

Prenatal T Measurement

A measure of the right hand 2D:4D ratio was obtained from each participant. Using a digital scanner (HP Deskjet F4480), participants' hands were scanned for later measurement of individual digit ratios. Measurements of digits went specifically from the

first crease at the base of each finger to the finger-tip using a digital caliper for precision, which measures individual pixels as the unit of length/distance. A ratio was calculated by taking the pointer-finger measurement divided by the ring-finger measurement. The scanned images were measured independently by two researchers, and the average digit ratio was used. Reliability between two separate researchers assessing digit length was high (Intra-class correlation coefficients are as follows: second digit measurement = .898, fourth digit measurement = .923, and digit ratio = .935).

Circulating T Measurement

All saliva samples were collected from participants via a passive drool method, a non-invasive way to assess circulating T levels. Samples were assessed using a competitive enzyme immunoassay. All samples were assessed in doublet to allow for subsequent reliability assessment. In terms of the assay process, the method has a lower limit of 1.0 pg/mL, and the standard curve used ranged from 6.1 pg/mL to 600 pg/mL. All curves fit well with the given standards (R^2s > .98). The average intra-assay coefficient of variation (i.e., variation between duplicates of individual samples) was 3.51%, and the average inter-assay coefficient of variation (i.e., variation of high and low control samples within plates) was 22.46%. The average inter-assay coefficient of variation was somewhat high, as Salimetrics, LLC suggests 15% as an acceptable cutoff. This high value was likely due to decreased accuracy of a single plate; the inter-assay coefficient of variation when removing this single plate was much more acceptable at 9.55%. Furthermore, the correlations between T and other variables examined were

virtually unchanged when removing data points (n = 22 participants) obtained from the plate in question.

Due to systematic fluctuations in T—both diurnal and seasonal—participants gave a single saliva sample between 2:00-5:00 p.m., and all sessions occurred during a one-month span, from mid-October to mid-November in 2011.

Personality Measures

A paper and pencil measure of dominant personality traits was completed by participants. This scale was taken from the International Personality Item Pool (IPIP) and was chosen because of its use in a closely related study (Watkins et al., 2010). For general information about the item pool, see Goldberg et al. (2006). The scale has good reliability, with a reported alpha-level of .82 (see the IPIP website), and Watkins and colleagues (2010) reported an alpha-level of .81. Additional filler items were also included to mask what the individual scale was attempting to measure (see Appendix C) and will be discussed below. All scales had adequate reliability (see Table 1).

Test of the Eyes

A paper and pencil measure, the Test of the Eyes (Baron-Cohen et al., 2001), was also completed by participants. The test consists of pictures of eyes accompanied by four word-choices per picture. The participants were asked to match the set of eyes to the single best answer of the given words, as every item has one correct answer. Each correct answer was scored as 1, and an incorrect answer was scored as 0, so possible scores ranged from 0 to 36 as there were 36 items.

Rating of Dominance on the Test of the Eyes

To distinguish between the perception of dominance and the perception of other emotions in the Test of the Eyes, the level of dominance of each correct answer (i.e., one per item) on the Test of the Eyes was assessed. The most dominant items, making up the dominant word score, were identified by a separate group of people in prior research (Pedersen & DeSoto, 2011). Approximately 80 separate word choices exist for the entire measure. A separate group of students ($n = 30$) rated each word on a 1 to 5 Likert-scale, where 1 = submissive and 5 = dominant ($M = 3.04$, $SD = .59$). This resulted in each word having a dominance rating (see Table 4). An arbitrary cutoff was used; those words at/above the 40th percentile were considered dominant words. The remaining words were considered non-dominant. Each overall item (i.e., as opposed to the possible word choices) was then categorized based on what its correct answer was; if the answer to a given item was rated as dominant (i.e., at/above the 40th percentile), the item was categorized as dominant. If the correct answer to a given item was rated as more submissive (i.e., below the 40th percentile), then the item was categorized as non-dominant. Subsequently, there were a total of 11 pictures of eyes classified as dominant items, and the remaining 25 items were classified as non-dominant.

Procedure

After participants were introduced to the study and gave informed consent, their right hands were scanned to calculate 2D:4D ratios at a later time. Each individual placed their hand at the center of the scanner and was asked to keep the hand relaxed, but also to keep their fingers straight and to keep the pointer finger and pinky finger parallel. Participants were told to place hands flat onto the scanner without placing pressure, following suggested procedures of Voracek, Manning, and Dressler (2007). Measurements of only the right hand were taken, as previous research has suggested the right hand is a better indicator of early T exposure and is more significantly related to biological aspects (Manning et al., 1998). Measurements of the digit ratios were obtained using the digital, scanned image and not the person's hand in real-time.

Next, participants provided the saliva sample approximately 10-15 minutes after arrival. Saliva collection was done prior to completion of personality measures to avoid any effects that subsequent measures may have had on T level. Recommendations of Granger et al. (2004) regarding best practices for collection and storage of saliva samples were followed: Participants were asked not to eat, drink, or brush their teeth within an hour of coming to the session, as blood and food can contaminate the hormone analysis (i.e., blood can greatly increase T content in saliva). When they arrived, they were asked to report if they had any known cuts or sores in their mouths, or if they have recently brushed their teeth, had dental work done, etc. because, again, these can be problematic for valid analysis of T. Data from participants who reported any of these characteristics ($n = 19$) were visually reexamined to ensure that they were not abnormally high due to

possible contamination. None were more than 1.5 standard deviations from the mean amount of T and, therefore, were not deemed problematic. However, several participants (n = 12) gave saliva samples that were excluded from the T analysis due to insufficient amounts of saliva. The saliva was obtained via a passive drool technique; all participants used a straw to passively drool into a 2 mL vial for 5 minutes. About half-way through this period, participants were told to imagine either sucking on a lemon wedge or drinking lemonade to facilitate saliva production. Samples were frozen within two hours of collection at -37 degrees Fahrenheit.

Shortly after the T measures were taken, the participants completed the 36-item measure of the Test of the Eyes. The paper and pencil instrument consisted of 36 pages, each page containing one large black-and-white set of eyes and four words to choose from. Each page requires that the participant pick one mood-word that best fits with the set of eyes (see Appendix B).

After completing the Test of the Eyes, the participants filled out a brief personality inventory consisting of several scales: The main dominance scale was an 11-item instrument which assessed the extent to which the each individual thought he or she had a dominant personality. Answers were given on a 1-7 response scale (1 = very inaccurate, 2 = moderately inaccurate, 3 = slightly inaccurate, 4 = neither inaccurate nor accurate, 5 = slightly accurate, 6 = moderately accurate, 7 = very accurate). To mask the purpose of the measure, additional filler measures were included (see Appendix C). Other scales included trait scales of empathy, dominance, social dominance orientation, prestige, and a scale under-development by the author. The entire personality inventory

questionnaire consisted of 55 items in a single randomly placed order. Finally, participants completed a demographics form, asking them to indicate their gender, dominant hand, age, ethnicity, whether they were taking body-building supplements, whether they were taking birth control, whether they had engaged in any recent physical activity, and their current year in school (Appendix D).

CHAPTER 4

RESULTS

Main Findings

It was hypothesized that circulating T levels would be negatively related to scores on dominant pictures of eyes (Hypothesis 1). Pearson correlations were calculated to examine the relationship between circulating levels of T and scores on all parts of the Test of the Eyes (i.e., the overall score, the dominant score and the non-dominant score). Circulating T was not related to the overall score (r (135) = -.068, p = .428), dominant scores (r (135) = -.020, p = .821), nor the non-dominant scores (r (135) = -.081, p = .346). In contrast with previous research, these correlations show no relationship between T and the perception of emotions.

It was hypothesized that 2D:4D ratios would be positively related to scores on dominant pictures of eyes; that is, a more feminine 2D:4D ratio will be related to better dominance recognition (Hypothesis 2). Correlations were calculated between 2D:4D ratios and all parts of the Test of the Eyes. As with circulating T, prenatal T (i.e., 2D:4D ratio) was not related to the overall score (r (147) = .026, p = .757), dominant scores (r (147) = .024, p = .773), nor the non-dominant scores (r (147) = .020, p = .809). In contrast with all previous research, there was no relationship found between T and the perception of emotions.

It was hypothesized that both circulating T level and digit ratio would be related to scores on the dominance personality scale; higher T would be associated with more dominant personality scores (Hypothesis 3). Correlations were calculated between both

circulating and prenatal T and scores on three measures of dominant personality: (1) the dominance scale from the online IPIP item pool, (2) Social Dominance Orientation, and (3) the dominance subscale for the Dominance-Prestige personality scale (Cheng, Tracy, & Henrich, 2010). Circulating T was significantly related to all measures of dominance ($rs > .180$, $ps < .05$; see Table 2), however, these relationships became insignificant when controlling for gender using partial correlations suggesting that gender accounted for the observed relationship between circulating T and dominance in this study—i.e., males showed higher dominance scores *and* higher T levels than women. Digit ratios were not significantly related to any measures of trait dominance (see Table 2). (For interrelatedness of all personality measures, see Table 5).

It was hypothesized that dominant personality scores would be negatively related to scores on dominant pictures of eyes (Hypothesis 4). Correlations were calculated between individual's dominant personality scores and their scores on all parts of the Test of the Eyes. There were no significant relationships found between dominance and scores on the Test of the Eyes (all absolute values for $rs < .120$, $ps > .10$; see Table 3).

All four main hypotheses failed to receive support. In the only instance where there existed significant relationships consistent with predictions, the relationship was accounted for by gender and not the biological measures, specifically. These results suggest that in the current study neither circulating nor prenatal T levels were directly related to the ability to perceive emotions in pictures of faces and were not significantly related to individual trait dominance. Additionally, trait dominance was not related to the ability to perceive emotions in pictures of faces, as was predicted.

Exploratory Analysis

Additional measures (i.e., those assessing participants' gender, empathy, prestige, and handedness) were included to better understand the predicted relationships between biology and the perception of emotion. Several interesting findings emerged in regards to these variables, and they are included here for completeness.

Gender

As mentioned above, many of the assumed effects of T on other variables were actually accounted for by gender differences. Consistent with the theoretical, biological underpinnings of the research, women had lower levels of circulating T (t (135) = 10.21, $p < .001$) and higher 2D:4D ratios (t (147) = -2.71, $p = .008$) than men. However, these two measures of T did not account for gender differences on other variables, as may have been predicted. For example, gender was related to levels of empathy, with women scoring higher on the IPIP empathy scale than men (t (147) = -4.51, $p < .001$).

In addition to women scoring higher than men on levels of empathy, they also tended to have higher overall scores on the conceptually similar Test of the Eyes (t (147) = -2.43, $p = .016$). Gender was also related to the individual components of the overall score, those being dominant and non-dominant picture scores. (Note: Correlations were run here instead of t-tests because they yielded an immediate effect size r which could then be compared.) These correlations showed that women tended to have higher non-dominant picture scores (r (147) = .215, $p < .001$), but there was no relationship between gender and the dominant picture score (r (147) = .084, $p > .10$). Though this is of interest

theoretically, these correlations were compared using Williams' formula (suggested by Steiger, 1980) and were not significantly different (t (147) = 1.57, p = .12).

It is also interesting to note that, although female participants reported higher levels of empathy than men *and* were better able to correctly perceive emotions in pictures of faces, across genders empathy scores were not correlated with scores on the Test of the Eyes (r (147) = -.016, p > .10). This suggests that the Test of the Eyes was measuring something conceptually different than trait empathy, namely, the actual ability of identifying emotions.

Prestige and Digit Ratio

The measure used as a proxy for prenatal T level of participants was their 2D:4D ratios. To reiterate, a higher 2D:4D ratio is often referred to as more feminine, as it signals lower exposure to T in the womb; a lower digit ratio is referred to as masculine and signals higher exposure to T in the womb. In this study, digit ratios were not found to be related to any measures of dominance (all rs < .15), as was predicted. However, digit ratio was significantly related to levels of reported prestige (r (147) = -.231, p < .01); a lower, more masculine ratio was related to reporting higher prestige. This relationship persisted even after controlling for gender effects. And although this finding was not explicitly predicted, it is consistent with research that suggests that prenatal T may be more related to status directly, not necessarily dominance. For example, Coates, Gurnell, and Rustichini (2009) found that in a sample of high-frequency stock traders, a more masculine (i.e., lower) digit ratio was predictive of higher profitability and longer length of time as a trader. In that study, profitability was also partially explained by the traders'

experience, but not by their age, supporting the notion that certain early biological characteristics are distinctively predictive of later behavioral pattern.

Handedness

Exploratory analyses also revealed an unexpected relationship between handedness and reported level of trait empathy. Specifically, those who reported being left handed scored lower on empathy than did right-handed people (t (147) = 2.66, $p <$ .01). There was a low number left-handed participants (n = 18), possibly indicating either a very strong effect of handedness on empathy or a spurious finding. A brief literature search was conducted, but did not uncover any previous literature on left-handed people and their level of trait empathy in non-clinical samples. However, being left-handed has been shown to be associated with occurrence and/or diagnosis of autism-spectrum disorders (Dane & Balci, 2007; Gillberg, 1983) and the authors suggest this may be partially due to differences in brain development in both right and left hemispheres. It is important to note, however, that left-handedness was not related to scores on the conceptually-related Test of the Eyes in the current study, again, possibly indicating a spurious finding.

Table 1

Chronbach's Alpha for Personality Scales

Scale	*Chronbach's α*
DWB	.715
Empathy	.715
Dominance (1)	.837
SDO	.858
Dominance (2)	.698
Prestige	.702

Note: (n = 149)
Note: "DWB" = the dominant world belief scale under development by the author; "Dominance (1)" = the IPIP dominance scale; "SDO" = the social dominance orientation scale from Pratto, Sidanius, Stallworth, and Malle (1994); "Dominance (2)" = the Cheng, Tracy, and Henrich (2010) dominance scale

Table 2

Pearson Correlations Between T Measures and Trait Dominance

			(Controlling for Gender)	
	Circulating T	2D:4D Ratio	Circulating T	2D:4D Ratio
Dominance (1)	.193*	-.107	-.001	-.016
SDO	.191*	-.069	.015	.025
Dominance (2)	.184*	-.142†	.037	-.040

Note: * $p < .05$, † $p < .10$
Note: ($n = 137$ for circulating T *rs*; $n = 149$ for 2D:4D ratio *rs*)

Table 3

Pearson Correlations Between Trait Dominance and Test of the Eyes Scores

	Overall Score	Dominant Pictures	Non-Dominant Pictures
Dominance (1)	-.090	-.110	-.055
SDO	-.043	-.050	-.027
Dominance (2)	-.054	-.042	-.047

Note: $^{*}p < .05$, $^{\dagger}p < .10$; Overall score on the Test of the Eyes is made up of the dominant and the non-dominant scores combined.
Note: ($n = 149$)

Table 4

Ratings of Dominance—Submissiveness for Word Choices on the Test of the Eyes

10 Most Dominant Words	*M*	*10 Most Submissive Words*	*M*
Dominant	4.53	Shy	1.84
Insisting	4.32	Depressed	1.94
Threatening	4.31	Indecisive	2.06
Confident	4.22	Apologetic	2.15
Hostile	4.12	Panicked	2.16
Hateful	4.11	Terrified	2.26
Arrogant	4.01	Embarrassed	2.26
Accusing	3.91	Dispirited	2.26
Defiant	3.90	Nervous	2.32
Impatient	3.79	Regretful	2.36

Note: ($n = 30$)

Table 5

Pearson Correlations Between All Personality Measures

	1	2	3	4	5	6
1. DWB	--					
2. Empathy	-.109	--				
3. Dominance (1)	.372***	.013	--			
4. SDO	.201*	-.147†	.460***	--		
5. Dominance (2)	.231**	-.083	.751***	.465***	--	
6. Prestige	-.019	.112	.293***	.136†	.299***	--

Note: *** $p < .001$ ** $p < .01$, * $p < .05$, † $p < .10$
Note: ($n = 149$)

CHAPTER 5

DISCUSSION

General Discussion

The current study was conducted in an attempt to examine the relationship between both circulating and prenatal levels of T and how they relate to participants' theory of mind abilities. Items on the theory of mind measure were also categorized as to whether a dominant or a non-dominant emotion was being identified, to specifically examine perception of dominance. A main component of this research was also to incorporate measures of trait dominance to investigate how these three components may be associated.

It was predicted that (1) circulating T levels would be negatively related to scores on dominant pictures of eyes, (2) 2D:4D ratios would be positively related to scores on dominant pictures of eyes; that is, a more feminine 2D:4D ratio will be related to better dominance recognition, (3) both circulating T level and digit ratio would be related to scores on the dominance personality scales; that is, higher estimated T would be associated with more dominant personality scores, and (4) dominant personality scores would be negatively related to scores on dominant pictures of eyes.

Circulating levels of T were estimated by obtaining saliva samples from participants and analyzing them with a competitive enzyme immunoassay procedure. Circulating T was found to be unrelated to overall scores and dominant picture scores on the theory of mind test, showing no support for hypothesis one. The null results for this hypothesis are likely not due to poor measurement of T, as levels of inter- and intra-assay

variability were acceptable. Scores on the Test of the Eyes also followed patterns found in previous research, mainly, that women are better at identifying emotions than men. It remains unclear why the expected relationship was not found, as previous researchers found the proposed trend in a very similar population (DeSoto et al., 2007; Pedersen & DeSoto, 2011).

Prenatal levels of T were estimated by measuring the length of participants' index and ring fingers, and dividing the length of the index by the length of the ring finger length (i.e., 2D:4D ratio or digit ratio). Participants' digit ratios were found to be unrelated to overall scores and dominant picture scores on the theory of mind test, showing a lack of support for hypothesis two. It is presumed that the accuracy of the digit ratio was acceptable, as there was a high correlation between the digit measurements of two separate researchers, using the most reliable tool available for measuring digit ratios (Allaway, Bloski, Pierson, & Lujuan, 2009). It is possible that the influence of both circulating and prenatal T is predictive of more action-oriented behaviors rather than simple perception of faces—for example, the previously mentioned study on high-frequency stock traders and their earnings showed that higher prenatal T was associated with better job performance, and circulating T moderated this relationship (Coates et al., 2009). Although, this would not explain how small- to medium-sized effects were previously found in similar perceptual research (e.g., DeSoto et al., 2007; Pedersen & DeSoto, 2011; Watkins et al., 2010).

Several personality measures related to trait dominance were included in this study in an attempt to better understand the predicted—though, unobserved—

relationships mentioned above. Circulating, but not prenatal, levels of T were found to be related to all dominant personality scales, showing initial support for hypothesis three. However, using a partial correlation these effects were shown to have been accounted for by gender of the participants, suggesting that T did not have a direct influence on reported trait dominance. As mentioned above, this may be due to a lack of external validity—that is, the predicted effect may have been more likely if an observational or behavioral variable was utilized as opposed to a self-reported level of dominance. Additionally, it is possible that socialization and gender roles had a larger influence on the dependent measure (i.e., the Test of the Eyes), but this proposition would be in contrast with previous research (e.g., Chapman et al., 2006; DeSoto et al., 2007).

Finally, it was predicted that scores on the dominant personality measures would be negatively related to scores on the dominant picture scores, consistent with Watkins et al., 2010. This relationship was not found; personality scores were not related to scores on the dominant pictures, showing a lack of support for hypothesis four. This may be explained by differences in the way dominance was depicted between the current study and the study done by Watkins and colleagues. Whereas Watkins study utilized a computer-modified "masculinized" face to signal dominance in their study, the current study had a separate group of raters decide which items were to be categorized as dominant. The manipulation of the Test of the Eyes to include subcategories of items to distinguish between dominant and non-dominant emotions may have been a general limitation of this study. And, although this manipulation was used in previous research and led to the support for initial hypotheses, it is difficult to know for certain if the

somewhat arbitrary distinction made between dominant and non-dominant items was a valid and reliable one.

It is also possible that for the circulating T predictions, the sample was simply too small. A preliminary power analysis suggested obtaining approximately 165 participants to reach a power level of .80 using a significance cutoff of $p < .05$. Although saliva data were collected for close to 150 participants, many were excluded due to a small obtained amount of saliva. This may have led to a lack of power to detect the desired effects. In absence of statistically significant support for any of the four main hypotheses, it was impossible to further clarify the previously found links between hormones, trait dominance, and the perception of dominance in others. However, other interesting exploratory findings emerged from this project.

The current research confirmed previously found gender differences on trait scales and on the Test of the Eyes. These findings may suggest that the aspects measured were more closely tied to gender and not necessarily sex-hormones—at least not T. Perhaps the self-report nature of many of the measures used detected more social and cultural influences of gendered behavior and less biological influences, as, anecdotally, men seem to have more aversions towards empathic behaviors and women seem to have preferences for empathic behaviors (see Monahan, 1989 who addresses this cultural stereotype). It may have been beneficial to include social desirability questions regarding the specific scales or regarding instruments measuring social desirability of an individual participant, as this may explain why women reported being more empathic. The Test of the Eyes, though less likely to succumb to self-report bias, could still have been affected

by the extent to which individuals *preferred* to exert personal energy to complete the task. It is possible that men felt less social pressure in regards to—or cared less about—performing well at identifying emotions in faces, regardless of their actual ability to do so or internal hormone levels.

Another replicated finding was that of significant gender associations on non-dominant picture scores (i.e., women scoring higher than men) and a lack of gender association on the dominant picture scores. Although the difference between these scores was not significant, it still may hint at some effect of perceiving dominant emotions, specifically. Future research might address correlates of abilities to identify specific emotions beyond dominance, as this has not been examined prior to the current research.

As mentioned in the literature review, research on 2D:4D ratios and prenatal T has been mixed in terms of associated psychological variables. The results of the current study show that while prenatal T was not related to trait dominance, it was related to levels of prestige—a related but conceptually different characteristic of an individual. This would corroborate previous research which suggests that prenatal T is related to individual status, generally, and not necessarily dominance over others. This relationship should be explored further, and future research might focus on more behavioral approaches to understanding how prenatal T influences people.

Distribution of T Data

Frequencies and distributions of T data were examined in an attempt to uncover why the expected results did not emerge. The data from the current study were compared to those of the project that this research was based on (i.e., Pedersen & DeSoto, 2011).

Disaggregated data of both men's and women's level of T were examined. The current study seemed to have a restricted range of T scores in relation to those obtained in the previous project; minimum and maximum observed levels of T were less extreme in this study compared to the previous study, relatively (range: 19.95 to 194.78 vs. 7.36 to 214.84). Curiously, women had a substantially higher kurtosis score in the current study compared with women from the previous study, and with men from both studies (other slight differences were also observed between the two studies; for distribution information, see Table 6).

Two factors may have contributed to these differences. First, the previous data were analyzed for T by a company that assesses contents of saliva (Salimetrics, LLC), whereas, the data from the current study were analyzed on-campus by the researchers themselves. This seems an unlikely reason for the differences, as the validity and reliability statistics suggested that the current T data fit well with standards and had acceptable levels of variation. An alternative explanation is that the method of data collection may have had an impact of T levels and the distribution of the data. In the current study, data collection was carried out by one male researcher; in the previous study, all data collection was carried out by one female research. Despite the fact that all other procedures were consistent between studies, the gender of the main data collector may have had a differential influence on male and female participants. For example, researchers have shown that T in men increases more when briefly interacting with female confederates than with male confederates (Roney, Lukaszewski, & Simmons, 2007). Similarly, women show higher elevations of hormone levels (i.e., T and cortisol)

in response to observations of highly attractive men compared with observations of less attractive men, observations of women, or non-human neutral stimuli (Lopez, Hay, & Conklin, 2009). It seems plausible, then, that the gender of the researcher may have been a contributing factor to the differences observed in T distributions between the two related studies. This could be a possible reason for a lack of significant findings.

Additionally, and consistent with previous research, the T distributions were positively skewed. This common finding often leads researchers to perform a log transformation on the T data so that assumptions of normal distribution required for some statistical tests are met (e.g., see Manning et al., 1998). A simple, base-10 log transformation was computed, but all statistical findings remained essentially unchanged.

Inability vs. Lack of Experience

It might also be argued that there is a difference between an individual-level deficit to perceive certain types of emotions and a lack of practice and/or experience seeing certain types of emotions. The former perspective, in accordance with Baron-Cohen's (2002) ideas regarding brain formation, would describe a deficit in perceiving emotions as the result of chemicals (i.e., T) influencing the way the brain develops. Individuals exposed to higher T would subsequently be unable to perceive certain emotions because their brain limits their performance on these types of recognition tasks. This ability would be less influenced by having more exposure to and practice with people displaying these types of emotions.

The latter perspective would describe a deficit in perceiving emotions as a result of minimal exposure to dominant emotions, specifically. If T is related to an individual's

dominance, then high-T individuals may not come in contact with dominant emotions in social situations as often as low-T individuals because high-T (i.e., more dominant) individuals might elicit more submissive responses from people they encounter in social interactions. Thus, those with high T might be less able to perceive dominance because they simply have less practice doing so in everyday social situations.

Of course, these two perspectives need not be understood as mutually exclusive. The main question of this project was to determine which avenue might be a more likely explanation, and additionally, to determine whether T was related to the perception of dominant emotions regardless of the perceiver's own level of dominance. This question could not be adequately addressed due to null findings regarding circulating T and perception of emotions. The author, however, is partial to the latter explanation of why perceptual deficits have been shown to be related to T and dominance in previous research. This stance is held mainly because the brain formation perspective currently lacks a well-defined pathway for the influence of T on the brain and the subsequent lessened ability to see emotions in others. The social practice perspective, though not supported here, does include a fairly well-defined pathway for the relationship. Future research should examine both of these perspectives.

Conclusion

Behavior and ability are certainly products of both biology and environmental pressures and should be described as such. The current research has found mixed support for both social and biological influences on personality-related measures. Support for an association between T, dominance, and the perception of emotions was not found. It may

be important to employ a more observational, behavioral approach to move beyond socially desirable gender norms and to discover more covert influences of biology.

This study uncovered some support for the influence of prenatal T on self-reported status, but not self-reported dominance, suggesting a biological role in similar but distinct measures of one's perceived place in a social hierarchy. Furthermore, although prenatal T has been implicated in research examining individual performance on the Test of the Eyes by those with autism and Asperger's, this research did not uncover evidence for a relation between the two variables. Taken together, previous research and the current study may suggest that prenatal T is a correlate of, but perhaps not a causal influence on, the development of deficits in the perception of emotions. The research exploring these exact relationships is sparse and should be further examined to better understand the complicated relationship between biological aspects, trait characteristics, and the perception of emotions in others.

Table 6

Distributions of Testosterone Across Studies

	Current Study (n = 137)				Pedersen & DeSoto (2011) (n = 85)			
	Mean	SD	Skew	Kurt.	Mean	SD	Skew	Kurt.
All N	86.50	37.35	.554	-.095	93.50	49.78	.705	-.140
Men	106.91	32.65	.437	.101	112.43	48.27	.434	-.491
Women	58.72	22.53	.967	2.278	54.97	24.11	.322	-.100

Note: Kurt. = Kurtosis

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APPENDIX A

CONSENT FORM

Introduction: This research is being conducted by Jon Pedersen of the Department of Psychology at the University of Northern Iowa. You are participating voluntarily.
Procedure: Tasks will include digitally scanning both of your hands, taking a small saliva sample, completing a personality inventory, and answering some demographic questions.
Risks/Discomforts: There are minimal risks for participation in this study. Some participants may feel self-conscious when giving saliva samples. There may be slight mental fatigue associated with answering questionnaires.
Benefits: There are no direct benefits to you.
Confidentiality: All information provided will remain confidential and will be reported only as group data. Your responses will be stored in a secure place that may be accessed only using a password and will be destroyed following the study. Only the supervising professor and researchers will be permitted to access the data.
Compensation: You will receive no compensation, unless you have an instructor offering a course credit for research participation through the PSPM system. In that case, you will receive 1 research credit.
Participation: Participation in this research study is voluntary. By signing your name below, you are willingly giving consent to participate in this study. You have the right to withdraw at any time or refuse to participate entirely without penalty.
Questions about the Research: If you have questions regarding this study, you may contact Jon Pedersen at *pederjaa@uni.edu*, or his research supervisor, Dr. Catherine DeSoto, at *cathy.desoto@uni.edu*.
Questions about your Rights as Research Participants: If you have questions you do not feel comfortable asking the researchers, you may contact Anita Gordon at *Anita.Gordon@uni.edu*. If you have any additional questions/concerns, you can contact the office of the IRB of the University of Northern Iowa at 319-273-6148.

I am fully aware of the nature and extent of my participation in this project as stated above and the possible risks arising from it. I hereby agree to participate in this project. I acknowledge that I have received a copy of this consent statement. I am 18 years of age or older.

(Signature of participant)	(Date)	(**Printed** name of participant)
(Signature of investigator)	(Date)	
(Signature of instructor/advisor)	(Date)	

APPENDIX B

TEST OF THE EYES

1. sarcastic

2. stern

3. suspicious

4. dispirited

One of the 36 items to be presented in the Test of the Eyes

APPENDIX C

PERSONALITY INVENTORY

Dominance Scale from IPIP; 10 items, Alpha = .82

(+) *I try to surpass others' accomplishments.*
(+) *I try to outdo others.*
(+) *I am quick to correct others.*
(+) *I impose my will on others.*
(+) *I demand explanations from others.*
(+) *I want to control the conversation.*
(+) *I am not afraid of providing criticism*
(+) *I put people under pressure.*
(+) *I lay down the law to others.*
(+) *I challenge others' points of view.*
(-) *I hate to seem pushy.*

Empathy Scale-JPI from IPIP; 10 items, Alpha = .80

(+) *I feel others' emotions.*
(+) *I suffer from others' sorrows.*
(+) *I am deeply moved by others' misfortunes.*
(+) *I am easily moved to tears.*
(+) *I cry easily*
(+) *I experience my emotions intensely.*
(+) *I feel spiritually connected to other people.*
(-) *I don't understand people who get emotional.*
(-) *I am not interested in other people's problems.*
(-) *I seldom get emotional.*

Dominance Scale from Cheng, Tracy, and Henrich (2010); 8 items, Alpha = .83

(+) *I enjoy having control over others.*
(+) *I often try to get my own way regardless of what others may want.*
(+) *I am willing to use aggressive tactics to get my way.*
(+) *I try to control others rather than permit them to control me.*
(+) *Others know it is better to let me have my way.*
(+) *Some people are afraid of me.*
(-) *I do not enjoy having authority over other people.*
(-) *I do not have a forceful or dominant personality.*

Prestige Scale from Cheng et al. (2010); 9 items, Alpha = .80

(+) *Members of my peer group respect and admire me.*
(+) *Others always expect me to be successful.*

(+) *I am held in high esteem by those I know.*
(+) *My unique talents and abilities are recognized by others.*
(+) *I am considered an expert on some matters by others.*
(+) *Others seek my advice on a variety of matters.*
(-) *Others do not enjoy hanging out with me.*
(-) *Members of my peer group do not want to be like me.*
(-) *Others do not value my opinion.*

Dominant-World Belief Scale; 9 items, Alpha = .87

(+) *When people ask favors of me, I often feel they are insisting that I comply.*
(+) *More often than not, a person's motivations are a result of power-struggle.*
(+) *Generally, I feel that people are attempting to use others for their own gain.*
(+) *I would describe a lot of the people that I interact with as having a tendency toward dominant behavior.*
(+) *I find people to be inherently defiant towards authority.*
(+) *Gaining status is the goal behind many behaviors in our society.*
(+) *People I interact with are always trying to move up the social ladder at the expense of others.*
(+) *I come in contact with many arrogant people on a day-to-day basis.*
(+) *Those individuals who have made the most of their lives most often got there by manipulating others.*

Social Dominance Orientation from Pratto et al. (1994); 14 items, Alpha = .81-.89

(+) *Some groups of people are simply not the equals of others.*
(+) *Some people are just more worthy than others.*
(+) *This country would be better off if we cared less about how equal all people were.*
(+) *Some people are just more deserving than others.*
(+) *It is not a problem if some people have more of a chance in life than others.*
(+) *Some people are just inferior to others.*
(+) *To get ahead in life, it is sometimes necessary to step on others.*
(-) *Increased economic equality.*
(-) *Increased social equality.*
(-) *Equality.*
(-) *If people were treated more equally we would have fewer problems in this country.*
(-) *In an ideal world, all nations would be equal.*
(-) *We should try to treat one another as equals as much as possible. (All humans should be treated equally.)*
(-) *It is important that we treat other countries as equals.*

APPENDIX D

DEMOGRAPHICS QUESTIONNAIRE

1. Are you male or female? Male Female

2. Are you right-handed or left-handed? Right Left

3. What is your age in years? _____ (years old)

4. Have you had any dental work in the past 48 hours? Yes No

5. Have you brushed your teeth in the past 45 minutes? Yes No

6. Do you currently have any wounds or sores inside your mouth? Yes No

7. Which of the following best describes your ethnicity? (check any that apply):

White ____
Black ____
Asian ____
Hispanic ____
Middle Eastern ____
Native American ____
Other (please list): _____

8. Are you currently taking any type of body-building supplement? Yes No

If yes, list what kind(s) (please be specific): _____

9. Are you currently taking any sex steroids? Yes No

If yes, list what kind(s) (please be specific): _____

10. Are you currently taking oral contraceptives/birth control pills? Yes No

11. Have you ingested any nicotine, coffee, or alcohol in the past hour? Yes No

If yes, please list which one, and how long ago this was: _____

12. Have you engaged in any physical activity in the past hour? Yes No

If yes, please describe briefly: _____

13. Please indicate your year in school (circle one):

Freshman Sophomore Junior Senior Fifth year + Graduate