Social Dominance in Relation to other Putative Basic Emotions in Humans

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COMPULSORY DECLARATION

This work has not been previously submitted in whole, or in part, for the award of any degree. It is my own work. Each significant contribution to, and quotation in, this dissertation from the work, or works, of other people has been attributed, and has been cited and referenced.

Signature:____Date:______________

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Abstract

There is a significant body of research within the general neurosciences that has begun to investigate a behavioural state in animals and humans, which appears to suggest the existence of a ‘social dominance instinct’. One such finding is that across mammalian species, groups of cohabiting animals reliably organise themselves into dominance hierarchies characterised by differential allocation of social and resource-holding power, and that testosterone and cortisol appear to underpin these social mechanisms. While the literature is considerable, the emotional aspects of this intrinsic tendency have received less attention, and systematic attempts to ascertain to what extent the neural circuitry, and its associated affects and behaviours, can be accommodated within the primary emotional taxonomy proposed by Panksepp (1998) have not been undertaken. Based on the Affective Neuroscience Personality Scales (ANPS), developed to measure the relative influence of basic affective systems on human temperamental variability, this research used hormone assays and factor analytic methods to explore the latent structure of the ANPS when DOMINANCE items are included. Participants (n=461) from a South African university population completed online versions of the revised scales and a series of criterion-related measures. In addition, a subsample (n=106) was tested for basal salivary testosterone and cortisol. Findings from an exploratory factor analysis revealed a distinct social dominance factor, conceptualised broadly as incentive for gaining and maintaining social influence, for which moderate to strong correlations with criterion assessments were observed. Hormone assays indicated that in males with high testosterone, the testosterone: cortisol ratio was strongly, positively correlated with DOMINANCE, but no other basic emotion traits, and that in females with elevated testosterone, DOMINANCE was uniquely related to the cortisol: testosterone ratio. These findings situate social dominance within a social stress paradigm and indicate the existence of largely independent neurobiological substrate of trait DOMINANCE. Consequently, this research offers support for the hypothesis of a distinct primary affective system governing social dominance incentives. The evidence supporting this hypothesis and critical directives for future research initiatives are discussed.

Introduction

There are perhaps few psychological motivations that have been as influential in shaping the historical narrative of the human race than that of *power*. Many authors from divergent fields have argued that the ‘will to power’ (Nietzsche, 1901) is among the fundamental dimensions of the interpersonal realm; that it is the basis upon which human goals and desires are pivoted and negotiated (Dunbar & Burgoon, 2005). In fact, Bertrand Russel (1938) suggested that “the fundamental concept in social science is Power, in the same way that Energy is the fundamental concept in physics” (p.10). Up until recently, such ideas on the nature of the human psyche remained speculative; however with the advent of the neuroscience revolution, social phenomena have re-emerged as neurobiological entities. Indeed, there is now a significant body of research within the general neurosciences that has begun to investigate a behavioural state in animals and humans, which appears to suggest the existence of a ‘social dominance instinct’. One such finding is that across mammal species, groups of cohabiting animals reliably organise themselves into dominance hierarchies characterised by differential allocation of social and resource-holding power, and that testosterone appears to underpin these social mechanisms. In this context, social dominance is generally understood as the motivation to gain and maintain influence or status within an established social system (Eisenegger, Haushafer & Fehr, 2011).

While the literature is considerable, the subjective psychology of this intrinsic tendency has received less attention, even though the study of adaptive behavioural patterns has often been framed within discussions of ‘basic emotions’. Of the many taxonomies that have been proposed to date, the body of work that Jaak Panksepp (1998) has called ‘affective neuroscience’, is arguably one of the most elaborated and scientifically robust framework within which to study affective processes and their neural correlates. This work is driven by the assumption that evolution has imprinted several psycho-behavioural potentialities within the neural architecture of the mammalian brain, and it provides a neurological explanation and classification system of the mechanisms that generate the basic or archetypal ‘feeling states’. Given that Panksepp’s taxonomy does not at present elucidate the emotional incentives for social power, the aim of this research was to situate social dominance within the context of the Affective Neuroscience Personality Scales (ANPS), which plot the major trajectories of human personality in terms of stengths and weaknesses in primary emotional traits. The guiding question of this research was whether trait dominance would emerge as a distinct temperamental variable in human personality, and importantly, whether this construct has a significant relationship to baseline testsoterone.

Basic Emotion Theory

Theorists in the basic emotion tradition argue for the existence of a finite set of discrete, fundamental emotions arising from the inherited neural architecture of the brain/mind. Though disagreements about the specific types of emotion categories and their definitions, their prevalence and activation in everyday life (Tracy & Randles, 2011) and their relationship to non-basic emotion states (Ekman, 1999; Levenson, 2011) continue to be points of debate, there appears to be a general consensus about the biological underpinnings of primary emotions; that they have dedicated intrinsic systems which recruit and motivate adaptive responding to the environment, highlighting the basic ‘command’ capacities of these processes (Ekman, 1999; Izard, 1977; Panksepp, 1998; Plutchik, 1980). Emotional feelings, then, are “unique experientially valenced ‘state spaces’ that help organisms make cognitive choices” (Panksepp, 2003, p.6).

Opponents of this view reject the idea of discrete instinctually valenced states, and instead advocate for a social-constructivist or cognitive-appraisal (Ortony & Turner, 1990) view of emotions, in which the primacy of language and the role of learning predominate. While there are obvious merits in appreciating the manifest cognitive processes involved in emotional processing, the failure of these traditions to incorporate the mounting neurobiological evidence in the emotion literature reduces their heuristic potential in the study of core affect. A phylogenetic approach to affective processes (Plutchik, 1980) allows the study of emotions to be grounded within the broader context of their functional utility, in relation to not only other psychological mechanisms, but also the kinds of environmental challenges that have remained fairly constant throughout their evolutionary past. From this perspective, an appreciation of the psychological mechanisms underpinning the behavioural strategies aimed at the attainment of social and resource-holding power within the competitive context of group living, fits appropriately within the basic emotion paradigm. These mechanisms, however, have received little attention in taxonomies, despite their central organizing role in the social sphere.

Arnold and Gasson (1954) were among the first to propose the existence of an emotion concerned with dominance behaviour, which they labelled ‘courage’, broadly defined as the will to boldly contend with and overcome challenges. However, their definition of ‘courage’ appeared to extend beyond that of the social sphere, and was generalisable to all ‘threatening’ circumstances, suggesting that what they were alluding to was probably more of an emotion schema (Izard, 2007). More recently, Ekman (1999), in a revised list of basic emotions, included two categories relevant to *social* dominance, namely ‘achievement pride’ and ‘embarrassment’. Yet there is little neurobiological data available on the particulars of these affective states, which have been largely premised on research into facial expressions. Following in this methodological tradition, some compelling lines of evidence for the existence of a ‘pride’ emotion have been offered by Tracy and colleagues (Tracy & Randles, 2011; Tracy & Robins, 2008), who argue that it may be a motivational state geared toward the attainment of social status (Cheng, Tracy & Henrich, 2010). Here, the functional characterization has merit -- that pride provides the positive valence to encourage behaviours that promote status seeking-- but their focus on the self-conscious aspect of the affect suggests that their level of analysis extends beyond basic processing. Rather, ‘pride’ may represent the cognitive self-appraisal of having successfully achieved social status. It is imperative therefore that researchers in the emotion sciences specify clearly the level of analysis at which they are theorising.

The emphasis in these models on top-down, verbal descriptions of a ‘dominance affect’ and their associated facial expressions (Ekman, 1972) are useful for labelling the variation of feelings, but they are incapable of *fully* capturing the rudimentary elements of these states (Panksepp, 2010) and they often reflect cultural expectations and values concerning particular events (Mesquita, 2007). In this context, feelings associated with social power and dominance have historically seldom been regarded as arising from a distinct basic emotion, although the concept has occupied a salient position in many psychological texts (Maslow & Flanzbam, 1936). This disparity is perhaps a result of the nature of language -- it may blur the function of actions and reactions across contexts where instincts for ‘power’ may have been conceptualised simply as ‘aggression,’ as it is colloquially understood[1]. Moreover, the complexity of social dominance and the lack of appropriate methods for its induction and measurement in laboratory settings have most likely contributed to its relative oversight.

Progress in this area may depend on the principle of functional neural architecture, which minimises the ambiguities inherent in language and grounds the study of emotions in the organization of the brain. This is arguably the most important question facing emotion research today (Panksepp, 1998) and many investigators are in fact beginning to sharpen their focus on the neurophysiological underpinnings of emotions, and in doing so laying the foundation for powerful research strategies for the study of affective mechanisms in a field that has traditionally been mired by the limits of subjectivity.

Panksepp’s Basic Emotion Taxonomy

Affective neuroscience. To date, the body of work broadly known as affective neuroscience developed by Panksepp (1998) is one of the most elaborated and comprehensive theoretical frameworks for understanding affective processes, though as yet does not include social dominance incentives. Affective neuroscience proposes that basic emotional states arise from biologically adaptive ‘command’ systems in the ancient limbic brain and upper brainstem, which mediate challenges related to survival and reproductive success in an evolutionary context (Panksepp, 1998; Panksepp & Biven, 2011). As such, primary affective processes are assumed to be ‘unconditioned’, unlike secondary learning or higher tertiary processes, and the complexity of their associated subjective feeling states and specific anatomic and chemical properties are best explored by the study of the underlying neural circuitry. When these causal properties are understood, we are in a better position to interpret the exact nature of the function and quality of the associated *feelings,* and more importantly, the social and clinical implications of this knowledge. This approach further exemplifies a key assumption of affective neuroscience, namely that there exists within all mammalian brains a great number of psychoneural homologies,

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[1] One of the major limitations of research on dominance is the lack of standard operational definitions. This has meant that meta-analyses of the literature lose their validity since the kinds of behaviours under study differ according to how dominance is defined.

making it possible adopt a cross-species approach towards the conceptualisation of the essential properties of human affect. Indeed, Darwin cautioned that “the difference between man and the higher animals, great as it is, is certainly one of degree, and not kind (1871/1981, p.105).

Following from this assumption, Panksepp (1998) has suggested six precise neural criteria for assigning ‘basic’ status to emotions, together with the necessary psychological criterion of unique affective valence. While most basic emotion theories offer a set of criteria for stipulating what constitutes a distinct primary emotion, these standards are commonly quite general, providing less heuristic value (Ekman, 1999). Elaborated definitions, encompassing the antecedents, the neurophysiological events and behavioural manifestations therefore have the advantage of facilitating robust hypothesis testing and aiding in discriminating between various basic affective states.

In Panksepp’s taxonomy, basic emotions must consist of 1) genetically predetermined circuits designed to respond unconditionally, via activation of various sensory modalities, to stimuli arising from major life threatening or reproductive circumstances, 2) the ability to organise diverse behaviours, 3) the ability to change the sensitivities of relevant sensory systems, 4) the capacity for neural activity that outlasts the precipitating circumstances, 5) the ability to come under the conditional control of emotionally neutral environmental stimuli, and 6) the presence of reciprocal interactions with brain mechanisms that elaborate higher decision making processes and consciousness. Together, these six criteria constitute the fundamental constraints of affective neuroscience concerning the neural organisation of emotions in the brain.

Presently, seven primary emotional ‘command’ systems have been described by Panksepp. They are SEEKING, RAGE, FEAR, LUST, CARE, PANIC/GRIEF and PLAY[2]. Table 1 provides a brief overview of the functions, mechanisms and chemistries associated with these basic emotion systems. Each system is arranged hierarchically in the brain so that both higher order cognitive functions and lower level motor and physiological outputs can be coordinated (Panksepp, 1998). Because of this organisation, a primary emotional response will necessarily involve lower-

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[2] The capitalisation of these terms serves as a reminder that the labels represent brain operating systems, not the vernacular meanings of the words.

Table 1

Summary of the Anatomies and Chemistries of Primary-Process Emotional Systems

Basic Emotion System	Key Brain Areas	Key Neurochemistries
SEEKING Curiosity, anticipation, expectancy, desire.	Nucleus Accumbens – Ventral Tegmental Area (VTA); Mesolimbic and Mesocortical outputs; Lateral Hypothalamus; Periaqueductal Gray (PAG).	Dopamine (+); Glutamate (+); Opioids (+); Neurtensin.
FEAR Anxiety, alarm foreboding.	Central and lateral amygdala to medial hypothalamus and dorsal PAG.	Glutamate (+); Diazepam Binding Inhibitor; Corticotrophin Releasing Factor; cholecystokinin, alpha –MSH; Neuropeptide Y.
CARE Nurturance, warm maternal feelings.	Anterior cingulate, BNST; Preoptic area; VTA; PAG.	Oxytocin (+), prolactin (+); Dopamine (+); opioids (+-).
RAGE Anger, frustration, hate.	Medial amygdala to Bed nucleus of Stria Terminalis (BNST); Medial and perifornical hypothalamus; PAG.	Substance P (+); Acetylcholine (+); Glutamate (+).
PLAY Joy, delight, playfulness.	Dorso-medial diencephalon; Parafascicular area; PAG.	Opioids (+-); Glutamate (+); Acetylcholine (+); Thyrotropin releasing hormone?
PANIC/GRIEF Loneliness, grief, separation distress.	Anterior cingulate; BNST; Preoptic area; Dorsomedial Thalamus; PAG.	Opioids (+-); oxytocin (-) Prolactin (-); CRF (+); Glutamate (+).
LUST Erotic feelings, sexual desire.	Cortico- medial amygdala; BNST; preoptic & ventromedial hypothalamus; PAG	Steroids (+); Vasopressin; Oxytocin; Luteinizing Hormone- releasing Hormone (+); cholecystokinin (-).

Adapted from Panksepp (1998).

level behavioural consequences, enabling the study of these particular behaviours in animals to serve as reliable indicators of internal feeling states. The observed coherence in adaptive behaviour supporting seemingly distinctive functional goals may therefore serve as a valuable entry point for enquiries into potentially new basic emotional processes.

With this in mind, and remembering that an evolved psycho-behavioural mechanism mediating the stable formation of dominance hierarchies has yet to be comprehensively accounted for within Panksepp's basic emotion taxonomy, consideration is warranted. There is in fact a rich literature documenting the regularity across mammal species in social ranking systems, in which the phenomenon appears to effectively dissipate the harm associated with the demands of intra-individual competition (Beisner, Jackson, Cameron, & McCowan, 2011) in ways that cannot satisfactorily be accounted for by other basic emotions.

Phylogeny of social dominance. Close ethological studies have situated motivations for social dominance succinctly within the evolutionary trajectory. It has been observed that across most species, cohabiting groups organise themselves into dominance hierarchies, characterised by ranked allocation of social and resource-holding power. While traditional ideas about animal societies suggested that their structure is an evolutionary adaption for the survival of the group as a whole, more recent ideas have interpreted structural variation as a function of the evolution of individual reproductive strategies (Clutton-Brock, 2009). As such, the establishment of hierarchies appears to be driven primarily by individual motivation for reproductive dominance, with mating as its proxy (Moxon, 2009). Indeed, early research showed that levels of intra-sexual competition are affected by the type of breeding system present in a species (Darwin, 1871/1981).

Animals with high rank not only enjoy preferential access to mates (Ellis, 1995; Pusey & Williams, 1997) but are also found to have greater control over territory (Murray, 2006) and to have priority access to other desirable activities (Vargas-Pérez, Sellings, Grieder & Díaz, 2009) and high-energy foods during critical periods (Foerster, Cords & Monfort, 2011). Such is the value of these resources that a stable prioritising hierarchy is essential if within-group competitive fighting, which is highly costly, is to be kept to a minimum (Beisner, et al., 2011). To illustrate this point, research has shown that with the removal of powerful group members in pigtailed macaques, levels of aggression and conflict rise significantly, destabilising the effectual operation of the group (Flack, Krakauer & de Waal, 2005). The importance of rank therefore extends beyond that of dominant individuals, preventing the death or harm of subordinate members.

The problem of competing for resources, and more importantly mates, has a long evolutionary history, supposedly pre-dating mammals. Evidence for basic dominance behavioural patterns can be found in reptiles (Baxter, Ackermann, Clark & Baxter, 2001), fish (McGhee & Travis, 2010) and crustaceans (Issa, Drummond, Cattaert & Edwards, 2012) suggesting that these instincts have their origins in the ancient part of the brain, what MacLean (1990) has termed the ‘reptilian brain’. It is reasonable to speculate that dominance incentives may have evolved to mediate the general appetitive-dopaminergic system in social settings, which invigorates all animals to respond to their environments in ways that enhance their chances of acquiring available resources, supposedly before that of their fellow group members. Of course, “this can easily lead to a behavioural free-for-all if the brains of several animals, each seeking to be first in line, are aroused in the same way at the same time” (Panksepp, 1998, p.168). While Panksepp (1998) has suggested that social dominance incentives might best be understood in terms of behaviours learned within the context of PLAY and RAGE, with other authors interpreting them broadly as aggression (Sewards & Sewards, 2002), the emergence of a *unique* psycho-behavioural mechanism to counteract this fundamental problem would certainly fall within the ‘laws' of natural selection. Attempts to interpret this adaptive function within the conceptual content of Panksepp’s taxonomic system have not yet been systematically advanced and the field is therefore ripe for investigation. More importantly, there is currently an abundance of empirical findings in the neurobiological literature that can now be organised according to the neural criteria to consider the argument for the inclusion of social dominance as a distinct basic emotion. The following discussion will attempt to convey this empirical support.

Arguments for the Inclusion of DOMINANCE as a Basic Emotion

A great deal of the work done on basic emotional processes has come from carefully constructed animal models. This depends on the kinds of evidence that are required in the neural analysis of emotions, with direct electrical or chemical stimulation of key brain sites and subsequent analysis of behaviour and conditioning constituting the gold standard in inferring the neural underpinnings of emotional states. Of course, this approach is largely unethical in humans. However it is only through human research that the subjective quality of the affective valence of basic emotions can be understood, and thus research in this field must always be triangulated. The vast proportion of empirical discoveries on DOMINANCE has therefore come from animal research, but with the advent of new technologies and novel procedures, human data is now beginning to accumulate.

Criterion 1 and 2. The first two of Panksepp's criteria call for the existence of *genetically predetermined circuits* that are designed to *respond unconditionally* to the environment in *organised, adaptive behavioural and physiological patterns*. Much of the evidence here comes from studies looking at the role of testosterone in mediating the kinds of behaviours related to dominance and their associated neural underpinnings.

Behavioural patterns. In most mammalian species, the behavioural patterns involved in establishing dominant-subordinate relationships are characterised by dyadic agonistic encounters involving overt physical aggression (Berdoy, Smith & MacDonald, 1995; Sapolsky, 2005) and intimidation calls (Kitchen, Seyfarth, Fischer & Cheney, 2003; Pasch, George, Hamlin, Guillette & Phelps, 2010). This kind of aggression appears to be distinct from RAGE, responding specifically to within-group social challenges, such as territorial intrusions or competition for food or mates, and has been termed 'territorial' or 'inter-male' aggression, although it is found in both males and females (Albert, Jonik & Walsh, 1992). In rats, it consists of piloerection and lateral attack directed towards unfamiliar conspecifics, and new research has indicated that it is characterised predominantly by superficial wounding (Litvin, Blanchard, Pentkowski, Blanchard, 2007). As such, this kind of behaviour might be better understood as a type of *assertiveness* instead of an overt intention to harm.

In males these responses are enhanced by cohabitation with a female, while for females, pregnancy or lactation appears to have this same effect (Albert, et al., 1992). In primates such as the chimpanzee, agonistic behaviour may involve aggressive charging displays characterised by piloerection and dragging of nearby branches. When these displays are of the non-vocal sort they usually result in physical attack which is an integral strategy for establishing dominance and may involve hitting, kicking, stamping, slamming or biting (Goodall, 1986). Because human social norms preclude physical antagonism, subtler signals of dominance generally take place within the confines of organised competition such as in sport or routine interpersonal interactions in which an upright posture, a slight upward turn of the chin (Tracy & Robbins, 2008), a facial expression characterised by raised eyebrows, glares or direct eye contact (Mazure, 1985) and disproportionately more verbalisation mediate these negotiations.

In animals, overt measures of antagonism usually give way to various kinds of non-physical intimidation displays or territorial scent marking[3] (Arteaga, Bautista, Martínez-Gómez, Nicolás & Hudson, 2008; Johnston, 1981) which play an important role in the maintenance of hierarchies after a stable linearity has formed. Commonly, dominant animals employ threatening displays to reaffirm their status. Often, these behavioural patterns represent attempts to increase perceived body size and consist of changes in posture or movement. Some species of bird exhibit aggressive 'head-down' dive displays (Rothstein, 1980) and ruffling of the feathers to announce dominance status (Piaskowski, Weise & Sigler Ficken, 1991), while in primates this effect is achieved by strutting, an erect posture (Mazure, 1985), a slight upwards jerk of the chin or a bipedal swagger (Goodall, 1986). In small rodents like gerbils, dominants are found to frequently crawl over their submissive opponents (Rieder & Lumia, 1973) and in rats, aggressive grooming appears to be a behavioural privilege of the dominant (Spigel, Trivett & Fraser, 1972).

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[3] For rodents, as in many other species, olfaction appears to play a major role in social status communication (Johnston, 1981; Arteaga, Bautista, Martínez-Gómez, Nicolás & Hudson, 2008). The nature and age of chemical compounds excreted during urine and flank marking convey important information about the identity and dominance status of the individual, and their ability to secure territory (Humphries, Robertson & Beynon, 1999; Ralls, 1991). The most recently deposited scent mark conveys territorial dominance and volatile, polymorphous urinary proteins enable recognition from competitors and potential mates (Humphries, Robertson & Beynon, 1999). In bank voles and many other rodent species, the enlargement of the male preputial glands which secrete the sex pheromone, hexadecyl acetate into the urine, has been associated with social dominance (Gustafsson, Andersson & Meurling, 1980), and in general, dominant animals mark more frequently than their submissive conspecifics (Ferris, 1992). Moreover, urination behaviour of dominants and subordinates differs, with dominants using their urine primarily for communication, while lower ranking individuals as an act of elimination (Rozenfeld, Le Boulangé & Rasmont, 1987). Interestingly, if either of a pair of hamsters is flank glandectomised, the level of aggression fails to deescalate as is generally observed across consecutive encounters and this points to the role of scent marking in maintaining dominant/subordinate structures without having to resort to overt physical aggression (Ferris, 1992).

Loud vocalisations may accompany dominance displays such as in the double-syllable ‘close’ calls of gorillas (Harcourt & Stewart, 1996), the ‘wahoo’ calls of baboons (Kitchen, et al., 2003) or the trilled songs of male Alston’s singing mice (Pasch, George, Hamlin, Guillette & Phelps, 2010). Similarly, birds employ noisy whistling or chattering to intimidate conspecifics (Piaskowski, et al., 1991) and some species partake in ritualised vocal expressions of dominance and subordination (Tello, 2001). In humans, frequency is key for signalling dominance, with low frequency vocalisations achieving this effect (Hodges-Simeon, Gaulin & Puts, 2010).

These behavioural repertoires are integral to the stability of social hierarchies; however, there are other mechanisms at work in maintaining social order, particularly in primates, and these include active reconciliation (de Waal, 1986) and policing by bands of dominant members (Flack, et al., 2005). Furthermore, the formation of coalitions represents an important contributor to group stability (Mazure, 1985). Lower-ranking individuals may enlist the help of a dominant member during times of harassment and in this way it appears as though the disproportionate power held by a dominant is not just tolerated, but also valued (de Waal, 1986). In fact, in human societies too, research on the perceptions of another’s social standing has shown that those who are regarded as having both high status and power tend to be judged by their subordinates as being warm and approachable (Fragale, Overbeck & Neale, 2011).

Modulation by testosterone. Studies using social rank as a dependent measure have contributed substantially to our understanding of the neurochemical underpinnings of DOMINANCE, with the sex steroid, testosterone, accounting for a great deal of the variance in related behaviours. Testosterone is one of the main sex steroids that regulates both short-term responses like behavioural reactions and long-term processes such as in sexual differentiation. The Leydig cells of the testes are the primary site of production in men, while in females, testosterone is produced in the ovaries and adrenal glands (Mazur & Both, 1998). Males have roughly 10 times the amount of circulating testosterone than females, although females tend to be more sensitive to the hormone (Durdiakova, Ostannikova, Celec, 2011).

In primates and rats, superior rank is typically associated with higher testosterone levels (Gould & Ziegler, 2007; Wobber, et al., 2010) and descent in rank due to some sort of setback appears to correlate positively with increasing age

(Goodall, 1986), which itself has been linked to reductions in testosterone level (Harman, Metter, Tobin, Pearson & Blackman, 2001). In the classic study on flocks of hens, Allee and colleagues (1939) demonstrated how low ranking hens would rise in the social order and begin crowing if they were injected with testosterone propionate. Other research has followed in this vein, with several studies altering social systems via the manipulation of testosterone (Ferris, 1992; Veiga, Viñuela, Cordero, Aparico & Polo, 2004).

Opposing ideas about determinants of rank discount the role of hormones and instead suggest that dominant individuals attain their high rank due to larger body size and strength. However, many studies have failed to find a relationship between physical size and dominance (Berdoy, et al., 1995; Favre et al., 2008; Hughes & Strassmann, 1988; McGhee & Travis, 2010; Meese & Ewbank, 1973) although in some species the acquisition of high rank may actually cause an increase in body size and mass (Faulkes & Abbott, 1997 as cited in Clutton-Brock, 2009). Differences in both individual attributes and social experiences appear to act together in accounting for dominance (Chase, Tovey, Spangler-Martin & Manfredonia, 2002), and a more integrated view suggests that the determination of rank can be attributed to individual variations in behavioural 'styles' or personality (Anestis, 2005; Goodall, 1986; McGhee & Travis, 2010). Research in this domain has suggested that animals adopt functionally distinct behavioural profiles that are consistent across varying environmental situations (Sih, Bell & Johnson, 2004) with certain traits having important implications for overall fitness (Dingemanse & Réale, 2005).

In humans, rank is less useful as a reliable indicator of underlying neurophysiological events, since it is often institutionalized or governed by cultural codes. Instead, individual behavioural traits marked by interpersonal dominance may better represent differences in the conditioned activity of the associated neurochemistry. Although some have questioned whether hormones are capable of 'over-riding' the recent neo-cortical structures in humans that constrain such types of social-emotional behaviours (Dunbar & Shultz, 2007; Keverne, Martel, Nevison, 1996), research has shown that testosterone has in fact been linked to perceived social dominance in adolescent boys (Schaal, Tremblay, Soussignan & Susman, 1996), preferences for high status (Josephs, Sellers, Newman & Mehta, 2006) and tendencies to be confident (Baucom, Besch & Callaan, 1985), outgoing (Dabbs & Ruback, 1988), socially assertive (Cashdan, 1995) or aggressive (Cashdan, 2003).

Experimental research is relatively scare but one study has shown that in male participants administered either testosterone or placebo, those given testosterone tend to more readily deliver a ‘punishment’ to a game partner when they were told that they were beginning to lose (Kouri, Lukas, Pope & Oliva, 1995), possibly suggesting that they were trying to regain lost status.

Some studies, however, have failed to find a consistent correlation between testosterone and social status (Maruniak, Desjardins, & Bronson, 1977; Sannen, Van Elsacker, Heistmann & Eens, 2004), suggesting that the relationship between testosterone and dominance rank is complex. It might be worth noting that rank conveys a *position* in a society, not an active behavioural state like competitiveness, which simply *encourages* a specific outcome, and this may explain the discrepancy in some correlational findings. Moreover, testosterone does not appear to be the only hormone influencing dominance; through aromatization, estradiol has been implicated in some instances (Ogawa, Washburn, Taylor, Lubahn, Korach & Pfaff, 1998) and the stress hormones, cortisol and the catecholamines, may also play a role in mediating the action of testosterone (Sapolsky (1985, 1986). For instance, Koolhaas and colleagues (1999) have shown that territorial animals tend to have a behavioural style characterised by ‘proactive coping’. In fact, the concept of stress resilience is now being linked to a mounting body of evidence implicating testosterone in the down regulation of the HPA stress response (Hermans, Putman, Baas, Gecks, Kenemans & van Honk, 2007) and this may prove to be a mechanism enabling approach behaviour in intraspecific competition.

Consistent with these ideas, Sapolsky (1985, 1986), in his pioneering work on baboons, illustrated how biological reactions to a stressful event were dependent on rank. Surges in testosterone could be observed in high ranking individuals, which were preceded by the release of catecholamine, while in low ranking members testosterone levels dropped after a rise in cortisol. Sapolsky concluded that the change in testosterone was dependent on the appraisal of the stressor - whether it was interpreted as manageable and therefore accompanied by a release of catecholamines, or uncontrollable and followed by cortisol. This makes sense on an intuitive level, however other authors have reported a positive correlation between high ranking members and glucocorticoids as a result of the acute stressors associated with maintaining dominance (Gesquiere, Learn, Simao, Onyango, Alberts & Altmann, 2011). One study which has reconciled such contradictions has been the work by

Czoty, Gould and Nader (2008) who have suggested that while some dominant monkeys show higher concentrations of cortisol, subordinate monkeys tend to have increased reactivity of the HPA axis and consequently are more sensitive to stressful situations. Nonetheless, consensus on the exact role of stress hormones in dominance is yet to be achieved.

Neural substrates. More conclusive have been studies using immunocytochemistry and artificial stimulation which have identified a common set of neural structures underpinning dominance behaviours across different species, suggesting the existence of a unified affective system outlined by the high density of testosterone receptors in the preoptic and anterior hypothalamus (AH) (Albert et al., 1992; Ferris, 1992, Kruk, van der Poel, Meelis, Hermans, Mos & Lohman, 1983; Pan, Xu, Young, Wang & Zhang, 2010), medial amygdala (Koolhaas et al., 1990), bed nucleus of the stria terminalis (BNST), lateral septum (LS) (Albert et al., 1992; Ferris, 1992, Rosen et al., 2006) and the periaqueductal gray (PAG) (Bamshad & Albers, 1996).

While more data is needed, it is possible that this circuit is genetically predetermined. Research has shown that in naive animals isolated from birth, levels of testosterone serve as a reliable indicator of differences in behavioural dominance (Arteaga, Bautista, Martínez-Gómez, Nicolás & Hudson, 2008). More interestingly, gaze-aversion tasks in humans using prolonged aversion latencies to threatening faces as an indicator of social dominance, have provided some evidence that testosterone motivates these incentives unconsciously, prior to neocortical processing, as it does in other vertebrates (Terburg, Aarts & van Honk, 2012).

Much of the research in this area focuses on the role of arginine-vasopressin (AVP), since studies have shown that this peptide is sustained by the genetic expression of testosterone in the brain (De Vries, Buijs, van Leeuween, Caffe & Swaab, 1985; De Vries, Crenshaw & Ali Shamma, 1992). Moreover, males have significantly higher brain concentrations of vasopressin and as such most studies on testosterone/dominance relationships have been on male samples. Data stemming from animal models is considerable. One of the more rigorously studied testosterone-dependent behaviours is inter-male aggression, which has been dissociated from other forms of aggression such as affective rage or predatory attack (Panksepp, 1998). Inter-male aggression can be elicited by microinfusion of AVP in gonadally intact male rats (Koolhaas, van der Brink, Roozendaal & Boorsma, 1990) and has been reliably suppressed by castration (Albert, Walsh, Gorzalka, Siemens & Louie 1986) or ovariectomy (Albert, et al., 1990). Following testosterone replacement, this behavioural tendency returns (Simon & Masters, 1988). In a comprehensive review of the topic, Albert et al. (1992) characterised the involvement of the anterior hypothalamus in the mediation of hormone-dependent aggression. Electrolytic lesions have been found to suppress these types of agonistic interactions in male rats while electrical stimulation has been successful in promoting displays of unprompted aggression towards male conspecifics. Thresholds for stimulation are affected by the levels of circulating testosterone, with greater stimulation being necessary in the absence of androgens (Bermond, Mos, Meelis, van der Poel & Kruk, 1982). However, contrary to most findings, Pan et al. (2010) has observed greater activation in the anterior hypothalamus of subordinates, compared to dominants.

Other research has focused more specifically on the medial preoptic area of the anterior hypothalamus in which increases in neuronal activation have been related to displays of aggression in rodents, and more strongly in dominants (Pan et al., 2010). Comparable findings have been obtained from studies looking at the lateral septum of mice. Lesions here have been found to reduce intraspecifc agonistic behaviour and promote social contact (Booth, Meyer & Abrams, 1979) and also reverse dominant-subordinate relationships between pairs of rats (Constanzo, Enloe & Hothersall, 1977), while a greater density of AVP innervation in lateral septum of female hyenas has been associated with their higher levels of aggression and dominance (Rosen, et al., 2006). Similar findings have been reported for other behaviours involved in social dominance in animals such as aggressive scent marking and vocalisation.[4]

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[4] *Scent Marking.* Rodent territorial studies have demonstrated that AVP receptor binding in the hypothalamus, medial amygdala and BNST significantly reduces after castration (Johnson, Barberis & Albers, 1995, Zhou, Blaustein & De Vries, 1994) and is accompanied by an overall reduction in aggressive flank marking behaviour (Albers et al., 1988), which has been identified as a key behavioural means of securing territory. This may be due to a complete elimination of AVP-immunoreactive cells following castration (De Vries et al., 1985). Successful elicitation of flank marking in hamsters has been achieved with AVP microinjection into the MPOA-H (Ferris et al., 1984), even when the animal is housed separately from other conspecifics (Ferris, 1992); and when in pairs, AVP induced flanking in subordinate animals increases despite the presence of a previously established dominant, indicating that this behaviour can be induced under atypical social conditions (Ferris, Meenan, Axelson & Albers, 1986). Similar findings have been obtained from research on dogs, with lesions of the MPOA-H resulting in a decline in urine marking responses (Hart & Ladewig, 1979). *Vocalised Signals of Dominance*. There is less research on the neurochemical control of vocalised signals of dominance but some studies have argued for a role of testosterone in their expression.

Research in humans is considerably scarcer, partly owing to the difficulty of designing appropriate studies and to the limits of imaging technologies, but more generally due to ethical constraints on conducting invasive research. Furthermore, many of the behavioural paradigms adopted in this area of research are carried out in laboratories, in highly artificial settings that may not be as effective in provoking genuine emotional responses. Even so, research by Hermans, Ramsey and van Honk (2008) has corroborated some animal findings, indicating that activation in the amygdala, hypothalamus and the orbitofrontal cortex is associated with social threat processing. Crucially, these neural responses were found to be more robust after testosterone administration and that baseline profiles of high testosterone and low cortisol were related to greater activation in these subcortical regions. There is nonetheless a pressing need for more studies that directly manipulate AVP or testosterone levels to supplement these promising findings.

Distinguishing DOMINANCE from other basic emotion. Because of the great degree of structural and chemical overlap in basic emotions, their involvement in DOMINANCE requires systematic scrutiny. The PLAY, RAGE and LUST systems represent the most likely candidates in accounting for DOMINANCE, although the evidence, as it stands, casts some doubt on the likelihood of their primary involvement.

PLAY. To begin with, while social play and inter-male aggression may share some superficial similarities, the behavioural variations of the two are in fact quite different, with playfulness lacking the hostile gestures of real aggression (Panksepp,

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Castrated male Alston’s singing mice show a marked reduction in frequency and quality of trilled songs emitted during inter-male aggression, and also exhibit more displays of subordinate behaviour (Pasch et al., 2011). In most species of birds, the quality and frequency of singing produced in the context of reproduction and aggression is modulated by testosterone (Ball, Castelino, Maney, Appeltants & Balthazart, 2003), but the effect of this steroid on these measures of singing appears to be influenced by the social context, such as being in the presence of a conspecific (Boseret, Carere, Ball & Balthazart, 2006). Indeed, recent research has suggested that the ventral tegmental area (Heimovics & Riters, 2005), medial BNST, anterior hypothalamus, ventromedial nucleus of the hypothalamus, and a subdivision of the lateral septum (Heimovics & Riters, 2006) underlie singing specifically in the breeding season when testosterone is high, and that partially distinct circuits may underlie singing within the contexts of territorial defence or mate attraction (Heimovics, Cornil, Ball & Riters, 2009). Differences in dopamine receptors appear to account for this distinction and with regard to the latter, sexually motivated song may exclusively involve the MPOA (Alger, Maasch & Riters, 2009).

1998). The two states actually appear to be mutually exclusive, so that if play fighting does result in real aggression, the tell-tale signs of joyful play disappear (Thor & Holloway, 1984 as cited in Panksepp, 1998). This comes as no surprise since testosterone has been found to reduce rough-and-tumble play (Normansell & Panksepp, 1990 as cited in Panksepp, 1998).

Although it seems as though the PLAY circuit is largely distinct from that controlling aggression, Panksepp (1998) suggests that it may change qualitatively during development to bare the characteristics of adult dominance contests. This suggestion will have to be reconciled with the fact that the two systems appear to have distinct neural circuitry. Studies using *in situ hybridization* have identified the principal structures involved in rough-and-tumble play to be the ventromedial hypothalamus, the deep and dorsolateral tectum, the inferior colliculus, dorsal PAG, dorsal and ventral striatum and the somatosensory cortex (Gordon, Kollack-Walker, Akil & Panksepp, 2001).

Another important substrate may be the parafascicular complex which has been found to elaborate playful urges (Panksepp, 1998), highlighting the somatosensory control of the ludic state. For behaviours involved with dominance, olfaction appears to be the more relevant system in controlling the associated motivational state and anatomical studies have shown that axons of the accessory olfactory system project via the accessory olfactory bulb to the medial amygdala, BNST and specific targets in the hypothalamus (Veyrac et al., 2011). Homogeneity, however, between the PLAY system and dominance is the involvement of the medial preoptic area. As illustrated previously, this region plays a significant role in territorial scent marking, and during play the widespread release of opiods has been observed (Numan, 1988 as cited in Panksepp, 1998). Nonetheless, we must consider the possibility that the coherence observed in the various dominance behaviours is coincidental, and that the individual action tendencies are perhaps learned in the context of infantile play.

RAGE. The RAGE circuit may also be a logical substrate of dominance drives, but empirical findings indicate that the circuitry underlying affective attack and intermale aggression are in fact distinct (Panksepp, 1998). Electrical stimulation studies have shown that enraged responses can be elicited from the corticomedial amygdala, the rostral-caudal extent of the medial hypothalamus and the dorsolateral

PAG (Panksepp & Zellner, 2004). Furthermore, the behavioural repertoires of RAGE and DOMINANCE can at times appear quite similar; for instance, both piloerection, threatening vocalisations and discernible sympathetic signs are common to both states (Bhatt, Gregg& Siegal, 2003). However, different chemistries appear to mediate the two, with RAGE activated by Substance P, acetylcholine and glutamate (See Table 1). Instead, when we consider both the neural markers and contextual specificity of dominant behaviour, LUST might represent a more likely contender.

LUST. Both DOMINANCE and LUST systems involve steroid hormones and AVP, and activity in the BNST, medial amygdala and the preoptic hypothalamus. Moreover, behavioural research has reported that some male aggressive dominance displays are strikingly similar to courtship displays (Goodall, 1986), however studies of the underlying circuitry suggest that sexual and aggressive behaviours may activate different patterns (Xie, Kuenzel, Anthony & Jurkevich, 2010). For example, spatially segregated cell groups within the lateral septum respond differentially to agonistic and copulatory behaviour, with the posterior aspects of the ventral zones of the caudal lateral septum responding specifically to the former (Xie et al., 2010). Other investigations have found that the anterolateral BNST, the dorsal PAG and the anterior nucleus of the hypothalamus are selectively activated by social aggression while the posteroventral BNST and the preoptic area respond only to mating (Kollack-Walker & Newman, 1995) even though the preoptic area has been implicated in intermale aggression (Pan et al., 2010).

However, certain patterns of activation are common to both sets of behaviour and include activation of the medial amygdala, the anteromedial and posteromedial BNST, ventrolateral septum and the ventral premammillary nucleus of the hypothalamus. In the caudal subdivision of the medial nucleus of the amygdala, the anterodorsal level of the posteromedial BNST, the paraventricular nucleus and ventromedial nucleus of the hypothalamus, all these structures are equally activated by mating or agonstic behaviour, however, the number and/or distribution of Fos-reactive neurons differ (Kollack-Walker & Newman, 1995). Hence, despite the differences between these two apparent systems, similarities do exist and may have important conceptual implications. It is worth considering to what extent the adult organism can ever be separated from its role as a primarily sexual organism. For instance, when we look to female sexuality, we see that oxytocin functions as an organising force, impressing a nurturing quality on it (Panksepp, 1998). Similarly, male sexuality may be shaped by DOMINANCE.

In sum, what emerges from the literature is a set of closely connected structures that appears to modulate, via the action of testosterone on AVP, behavioural solutions for the attainment of resource-holding power in the competitive context of group living. These behavioural patterns appear functionally distinct from those associated with Panksepp's existing basic emotions and evidence from the neurosciences provides tentative support for some distinct neural substrates underpinning DOMINANCE.

Criterion 3. Arousal of the neural circuitry associated with DOMINANCE appears to prepare the organism for social challenge by modulating the sensitivities of critical sensory and perceptual functions. This is in accordance with the third of Panksepp's criteria, in which the idea of basic emotion circuits as being intrinsic operating systems for coherent and adaptive responding to key survival challenges is exemplified by their ability to change the sensitivities of relevant systems. There is a growing body of evidence suggesting that testosterone up-regulates vigilance related to social threats, perhaps via activation of the amygdala. For example, the amygdala response in healthy men to angry faces appears to correlate positively with levels of testosterone (Derntl, Windeschberger, Robinson, Kryspin-Exner, Gur, Moser, et al., 2009) and similarly, sympathetic heart-rate responses to threatening faces have been shown to increase with exogenous testosterone administration (van Honk, Tuiten, Koppeschaar, Thijssen, Hermans & Putman, 2001). Intranasal AVP may in fact bias participants to respond to neutral social stimuli as if they were a threat, based on the findings of corrugator supercilii electromyogram responses to neutral faces equivalent to those of angry expressions (Thomson, Gupta, Miller, Mills & Orr, 2004).

The effects of testosterone on physiological reactivity may in part depend on a *social* context, which differentiates from typical RAGE encounters, and novel research has indicated that AVP-induced increases in salivary cortisol and pulse rate are contingent on the presence of a social evaluative threat, such as the possibility of being judged negatively by peers (Shalev, Israel, Uzefovsky, Gritsenk, Kaitz & Ebsten, 2011). This highlights the role of testosterone in the successful mediation of socially competitive situations.

Criterion 4. There is some evidence that these neural processes associated with DOMINANCE sustain adaptive behaviour for some time following the termination of antecedent events, providing support for Criterion 4, which stipulates that neural activity of basic emotions should outlast precipitating circumstances. Research in men has shown that surges in testosterone, which frequently occur in reaction to a status challenge, remain elevated in the winners alongside an elated mood, but not in losers (Booth et al., 1989; Mazur, et al., 1992). Mazur's (1985) biosocial model of status is an attempt to account for these observations and it posits that post-competition rises in testosterone in successful candidates function as a feedback loop to promote readiness for the engagement in subsequent status contests. In support of this model immunocytochemical studies have demonstrated that, in baboons, winning contests increases the expression of androgen receptors in the medial BNST and also in key areas mediating reward and motivation, the ventral tegmental area and the nucleus accumbens, when won in the home territory (Fuxjager et al., 2010).

Panksepp's basic emotion theory succinctly accounts for the activity of testosterone in dominance behaviours. While the arousal of basic emotions is related to the external properties of specific fitness events, once aroused, the intrinsic affective energies of these systems are capable of independently sustaining relevant activity for quite some time (Panksepp, 1998). The locus of control may therefore shift from external prompts to internally valenced states, which play an integral role in facilitating adaptive learning.

Criterion 5. A key function of basic *emotion* circuits therefore, as opposed to simple *survival* circuits (Le Doux, 2012), is that they mediate sophisticated learning via the influence of subjective valenced states, which signal adaptive properties of important life events. Criterion 5 thus requires that primary process emotions should be able to come under the conditional control of neutral environmental stimuli through prior exposure, indicating learning. A number of studies have demonstrated that testosterone enhances spatial and visuo-motor learning (Aarde & Jentsh, 2006; Schultheiss, Wirth, Torges, Pang, Villacorta & Welsh, 2005; Spritzer, et al., 2011), a finding that fits coherently with the role of this hormone in territorial behaviour. Moreover, AVP neurons within the medial amygdala in particular have been shown to improve social memory and recognition of conspecifics in male rats (Le Moal, et al.,

1987) and sex differences in the BNST, as a result of early testosterone exposure in males, appear to account for the enhanced learning effect after a stressful event as seen in males, but less so in females (Bangasser & Shors, 2008). Furthermore, AVP has been shown to enhance event-related potentials indicative of cognitive processing (Dodt, Pietrowsk, Sewing, Zabel, Fehm & Born, 1994) and facilitate analgesia in rats (Frye & Seliga, 2001)- neural processes which both evidently contribute to the effective negotiation of social challenge.

Whether behaviours involved in dominance are motivated by the gain for which they afford or by an emotional state intrinsic to the acts themselves is not yet entirely clear. Dominance incentives seem to persist despite not always translating into direct and immediate gain and there is some literature demonstrating the rewarding effects of testosterone. Studies on hamsters have demonstrated self-administration of oral testosterone, indicating a preference over placebo (Johnson & Wood, 2001). Moreover, conditioned place preferences have been established in rodents via intra-nucleus accumbens injections of testosterone (Packard, Cornell & Alexander, 1997) and systemic action (Alexander, Packard & Hines, 1994) although the reinforcing effects may act principally through the mesolimbic dopamine system (Johnson & Wood, 2001).

The conditional control of primary emotional systems is perhaps best exemplified in the development of emotional traits and may explain why certain individuals experience to a greater or lesser degree and frequency particular mood states. This is consistent with Mazur’s biosocial theory of testosterone and status (1985), where the outcomes of events, conceptualised here as learning experiences, influence future experience. Initial victories marked by surges in testosterone may pave the way for subsequent dominance incentives (Mehta & Josephs, 2006), and in this way individual differences in capacities to experience, and preferences for, DOMINANCE may be established.

Criterion 6. Testosterone’s ability to influence subsequent behavioural choices highlights the final of Panksepp’s criteria of basic emotions, which emphasises their core function as executive operating systems underpinned by extensive and interacting circuits with those areas of the brain that carry out higher-order decision-making and consciousness, based on meaningful experiences with the environment. The implication here is that basic emotions underpin complex goal-directed behaviour, and indeed, there is accumulating evidence that the role of testosterone in social behaviour is best conceptualised as a motivational mechanism geared towards status seeking and attempts to maintain social influence over groups (Eisenegger, et al., 2011; Josephs, Sellers, Newman & Mehta, 2006; Mazure & Booth, 1998). Changes in testosterone are therefore context-specific, requiring opportunities for alterations in status (Sapolsky, 1991) and may depend in part on individual preferences or aversions to status seeking (Josephs et al., 2006). For instance, Mazur, et al. (1992) have observed that the rise in testosterone in winners in competitions only occurs if the subjects sincerely felt that the contest was a challenge, and as such the phenomenon is not strictly related to victory per se, but rather to status incentives. Similarly, the ‘home advantage,’ as seen when sporting teams consistently outperform their visiting opponents, appears to be underpinned by a greater increase in testosterone in the home team (Neave & Wolfson, 2002), and which is highlighted by increased activation in brain reward areas in animal models (Fuxjager et al., 2010). In appropriate settings, testosterone may therefore predispose individuals to *act* on their competitive impulses, consistent with research in women which has shown that those low in the hormone are less likely to assert themselves in competitive situations while higher levels more often lead to aggressive verbal retaliations (Cashdan, 2003), perhaps in attempt to out-stress opponents.

This contextual view on the social role of testosterone has resonance with the *challenge hypothesis* proposed by Wingfield and colleagues (Wingfield, Hegner, Dufty, Ball, 1990), which argues that testosterone rises in the face of sexual arousal and challenge, and ultimately facilitates competitive behaviour, including inter-male aggression. Conversely, when efforts should be channelled towards caring for offspring, testosterone levels drop to facilitate this task. AVP in the lateral septum has in fact been linked to the kinds of goal-directed behaviour that deal with threat by disrupting complex stimulus processing in favour of more elementary stimulus-response learning (Englemann, 2008). In this way, testosterone may aid in the preparation of social competition marked by the down-regulation of interpersonal trust, which has been linked to the action of oxytocin (Bos, Terburg & van Honk, 2009) and biasing egocentric decision-making (Wright et al., 2012).

Wingfield’s et al. (1990) findings are important because they bring to attention the relationship between DOMINANCE and nurturance and what appears to be a reciprocally inhibiting interaction. Although some research has illustrated that testosterone may facilitate certain parental responses to distressed infants (Bos, Hermans, Montoya, Ramsey& van Honk, 2010), generally it is accepted that testosterone declines upon parenthood (Silverin & Wingfield, 1982) and is not compatible with parental nurturance (Archer, 2006; De Ridder, Pinxten, & Eens, 2000). While affiliation may be an important aspect of social dominance, it is reasonable to assume that dominant behavioural tendencies do not share the same mechanisms as those underpinning the CARE system, even though domineering parental styles may be imbued with caring intentions. In addition to this, research in humans has shown that a single dose of testosterone diminishes facial expression mimicry (Hermans, et al., 2006) - a phenomenon that is proposed to signal unconscious, rudimentary empathising processes and which is therefore associated with pair bonding. As might be expected, recent research indicates that testosterone appears to correlate negatively with the ability to correctly infer others' internal emotional states, referred to as emotional intelligence (van Honk, Schutter, Bos, Kruijt, Lentjes & Baron-Cohen, 2011). These findings further cast doubt on the involvement of playful urges in social dominance, in which social intuition may be essential for reciprocal social interactions.

In sum, the brain-based definition of DOMINANCE, as articulated above in accordance with Panksepp's six neural criteria, provides support for its consideration as a distinct basic emotion. The literature, as it stands, points to distinct subcortical substrates, aroused principally by testosterone and AVP, with reciprocal interactions with both lower-level and higher order systems in the brain, which together promote the successful negotiation of socially competitive situations. While animal models have proven pivotal in the theoretical enquiry into DOMINANCE, their utility is diminished in trying to characterise the uniquely valenced feeling states that organisms experience at a subjective level, and which constitutes the primary criterion in basic emotion theory.

Subjective valence. At present human research remains the only means through which to address the bewildering problem of subjective experience. Currently, in comparison to behavioural and neurological findings, there is very little published data on the precise nature of the valenced feelings that drive DOMINANCE activities. A great proportion of the work in this field *implies* an underlying affective experience in discussing goal-directed behaviours (Archer, 2006; Cashdan, 2003;

Mazur & Booth, 1998) but few have directly addressed the topic. Competitiveness, for example, features prominently in the literature and may infer a state characterised by tension, which has in fact been associated with testosterone (van Honk, Tuiten, Verbaten, van den Hout, Koppeschaar, Thijssen, 1999) but such observations will need to be reconciled with findings of the rewarding properties of testosterone (Johnson & Wood, 2001). More specifically, it is unlikely that the subjective feeling state of DOMINANCE is negatively valenced, since social defeat has been interpreted as an animal model of depression, suggesting that social dominance functions as a buffer against the development of the condition (Kroes, Panksepp, Burgdorf, Otto & Moskal, 2006).

Perhaps the most illuminating findings are those that report an increase in personal esteem, such as in a study by Cashdan (1995), which found a positive correlation between androgens and self-regard. From this point of view, preferences for status (Mehta & Josephs, 2006) and behaviours channelled toward its attainment (Archer, 2006) may be invigorated by feelings of personal agency and worthiness. However, there is as yet no consensus on the specific affective valence underlying DOMINANCE, or whether or not such feelings can be dissociated from those already described in Panksepp's taxonomy.

There is some evidence that DOMINANCE may share the affective quality of the SEEKING system, based on findings that surgically menopausal women whose hormone replacement therapy had been supplemented with testosterone experienced more feelings of energy, elation and composure than those whose had not. Many more authors though, have inferred a state similar to RAGE in their reports of DOMINANCE and its relationship to aggression, such as in a study by van Honk et al. (1999), in which testosterone was linked to moods characterised by anger and tension. However, these studies are limited in their ability to differentiate between basic emotions because of the narrow scope of their assessment tools. For instance, in both the above studies, the Profile of Mood States (McNair, Lorr & Droppleman, 1992) questionnaire was used, in which only feelings related to tension, fatigue, depression, anger, vigour and confusion were measured.

The limited scope and paucity of data on the subjective effects of testosterone is perhaps a legacy in the neurosciences of the dogma of behaviourism, but nevertheless presents an inviting gap in the literature, despite the challenges associated with designing and implementing appropriate and feasible research initiatives.

State-trait models. At this point, a more feasible approach to distinguishing the emotional state underpinning DOMINANCE from Panksepp's established basic emotions is through the Affective Neuroscience Personality Scales (ANPS*)* (Davis & Panksepp, 2011; Davis, Panksepp & Normansell, 2003), which measure individual differences in temperamental variability on dimensions of SEEKING, RAGE, FEAR, PLAY, CARE and PANIC/GRIEF[5].

Based on the literature that has emerged from findings in affective neuroscience, the scales were constructed to represent the relative influence of activity of primary emotions across time and between individuals. They are based on the premise that strengths and weaknesses in the functioning of affective systems, as a result of prior learning experiences and genetic discrepancies, predispose individuals to experience certain emotions, and therefore reflect in individual personality as emotional traits. This idea has previously been propositioned by Spielberger (1975) and is consistent with Corr's (2008) *Reinforcement Sensitivity Theory* in which stable personality attributes represent disparities in the reactivity to affectively valenced environmental stimuli.

The idea that differences in the functioning of neurobiological systems underpin variations in personality is not a new one, dating back to ancient Greece in which the four bodily humours were thought to be responsible for specific patterns in personality. Currently, much of what is taken for granted regarding the link between brain behavioural systems and personality can be attributed to a few key authors whose work has formed the theoretical basis for development in this field. Hans Eysenck (1947/1998) was among the first to propose a biologically based theory of personality, in which variations were interpreted as a function of differences in the sensitivity to sensory stimulation. Largely influenced by this work, Jeffrey Gray (1981) reformulated these ideas in his *Biopsychological Theory of Personality* to

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[5] Of note is that LUST, one of Panksepp's basic emotions, was not included in ANPS, as the authors felt it to be less relevant to modern conceptualisations of personality. Few, if any, scales designed to measure lust as a personality trait exist, and the possibility that LUST may better be categorised as a homeostatic affect should not be entirely overlooked.

emphasise the importance of behavioural activation or inhibition systems in the shaping of personality, and whose work remains the theoretical foundation of Corr's (2008) more recent ideas.

In sum, the literature on social dominance has focused largely on the behavioural aspects of this emotional action tendency, but has essentially neglected the qualitative feeling-state that accompanies it. Without this final criterion, the emotional underpinnings of DOMINANCE remain speculative. For this task, human studies currently provide the only avenue through which subjectivity can be investigated. Operating under the assumption that the pillars of human personality are anchored in brain emotional systems, the study of emotional traits offers a window into their affective underpinnings. As such, an understanding of the neurobiological factors influencing trait DOMINANCE therefore constitutes an important step toward characterising and distinguishing its primary source.

Trait Dominance: Conceptualization and Neurobiology

The significance of social dominance as a scientific construct in the literature on individual differences is exemplified by the many psychometric instruments and techniques that attempt to measure it. While they vary to some degree in their conceptualization of trait dominance, most authors have understood it to be a sustained psychological motive geared towards achieving influence in social groups (Gough & Bradley, 2005; Jackson, 1967; Mehrabian, 1996). Not only do trait dominant individuals aspire toward social status, but they are often found to be successful in achieving it and are frequently appraised by others as being competent regardless of their actual level of expertise (Anderson & Kildiff, 2009).

Scales measuring trait dominance differ to some extent though in terms of the kinds of behavioural strategies they emphasise as a means to achieving social eminence. For instance, Gough and Bradley's (2005) dominance items on the California Psychological Inventory assess a prosocial orientation in which dominance incentives are channelled along socially sanctioned outlets such as leadership, achievement and perseverance. This is in quite stark contrast to Hamby's (1996) Dominance Scale, which underscores authoritarianism in trait dominance. Within the Big Five personality structure, dominance is generally understood to be a dimension of Extraversion, or Agenic Extraversion (Zuckerman, 2005) in particular in which sensation-seeking and nonconformity separate this trait from Extraversion proper. Interestingly, animal studies using an amended version of this five-factor model to include dominance have successfully described chimpanzee personality using this dimension (King, Weiss & Sisco, 2008), positioning social dominance as a fundamental cross-species, social-relational concept.

There is however some debate in the literature as to whether or not trait dominance can be measured accurately using self-report instruments, since these motivations may operate unconsciously and may therefore be less amenable to introspection (Stanton & Schultheiss, 2009; van Honk et al., 2004) and in addition to this, in climates of social equality, individuals may be socialized to regulate their dominance incentives in favour of group needs. This has lead some researchers to develop measures of implicit trait dominance, such as in the Picture Story Exercise method developed by Smith (1992), involving coding of imaginative stories in which participants are asked to respond to pictorial cues. These stories are then rated thematically for power imagery. This method has been found to reliably predict dominance behaviour, but seldom relates to self-report measures of trait dominance (Stanton & Schultheiss, 2009). Other implicit assessment strategies, for example in the study by Demaree, Robinson and Everhart (2005) in which participants were asked to select from a variety of characters varying in terms of their levels of trait dominance in film clips, one with which they most identified, have managed to find a significant relationship with self-report scales. Those identifying with the dominant character were more likely to be higher in trait dominance, as measured by Mehrabian and Hine’s (1978) revised Trait Dominance-Submissiveness Scale. High scores on this scale were in turn positively correlated with positive affect and scores on the Behavioural Activation Scale (BAS) (Carver & White, 1994), which measures reward-responsiveness, fun-seeking and behavioural drive and which has been established elsewhere as a reliable indicator of implicit trait dominance (Terburg, Hooiveld, Aarts, Kenemans & van Honk, 2011). The BAS may therefore constitute an important self-report resource in identifying trait dominant individuals.

Because of the problems associated with measuring trait dominance via self-report questionnaires, some researchers argue that it is best assessed using biological indices (Leining & Josephs, 2010). As in the animal literature, investigations into the neurobiology of this emotional tendency in humans have consistently implicated the involvement of testosterone (Mazur & Booth, 1999, 2006), although the picture is somewhat complex and it is likely that cortisol, serotonin and testosterone's synthesis to vasopressin and estradiol have a role to play (Leining & Josephs, 2010). Moreover, psychological variables such as social anxiety (Maner, Miller, Schmidt & Eckel, 2008), event appraisal (Mazur, Booth & Dabbs, 1992) and preferences for status (Josephs & Sellers, 2006) may moderate the effect of testosterone on behaviour, making the study of trait dominance in laboratory settings difficult. Nonetheless, despite fluctuations in hormone levels, basal (baseline) levels of testosterone have been found to have good temporal stability with high test-retest reliability (Dabbs, 1990; Sellers, Mehl & Jospehs, 2007), and while women do exhibit slight instabilities in their hormonal cycles throughout the month, Dabbs (1990) argues that they are small enough to disregard in behavioural research. These findings highlight the psychometric properties of testosterone as a biological indicator of individual difference.

While a great deal of empirical support has come from behavioural data, self-reported trait dominance has in fact been linked to circulating levels of testosterone (Grant & France, 2001; Cashdan, 1995), although these relationships have been modest in the .24 range. In a more recent study, Sellers, Mehl and Josephs (2007) were able to reliably replicate these findings, reporting a significant correlation between salivary testosterone and scores on The Need for Power subscale (Jackson, 1967). Another important finding in their study was that no relationship between testosterone and the Big Five traits were observed, with exception of a negative correlation with Conscientiousness in women. This has not been uniformly observed though as some research has implicated testosterone in Extraversion (Zuckerman, 2005).

Other studies using testosterone as an independent variable have regularly focused on its role in trait aggression and generally report modest positive correlations (Book, Starzyk & Quinsey, 2001). However Booth et al. (2006) argue that this relationship becomes insignificant when social dominance is considered as a mediator variable. Aggression may instead best be conceptualised as a multifactorial construct, in which testosterone is one of many contributing factors. This idea resonates with the animal literature, in which territorial aggression functions to assert social dominance but is in fact not overly aggressive in higher primates (de Waal, 1986). As such, the role of primary enraged feelings and intentions are perhaps not central to incentives for social influence.

Besides aggression, propensities toward sensation-seeking have also been modestly linked to testosterone in some studies, but not all (Rosenblitt, Soler, Johnson & Quadagno, 2001). Certain authors have stressed that the role of testosterone in this trait pertains to impulsivity (Fujisawa, Nishitani, Ishii & Shinohara, 2011), while others have implicated it in susceptibility to boredom (Campbell, Dreber, Apicella, Eisenberg, Gray, Little, 2010). It is certainly possible that this hormone may contribute to both facets of sensation-seeking because of its role in approach behaviour and the relative insensitivity to punishment, however, it is unlikely from an evolutionary perspective that the primary emotional role of testosterone relates to the pursuit of ‘risky’ business *per se*, but perhaps rather to the dismissal of social codes that regulate such behaviours. This, of course, may be mediated by trait dominance. Alternatively, this body of data may implicate a role for SEEKING in the social emotional functions of testosterone.

Taken together, and with consideration to the lingering uncertainties in the literature, the above findings provide support for a relatively unique neurobiological profile for trait dominance. However, keeping in mind the untenable relationship between testosterone and self-report data, research that places testosterone and trait DOMINANCE in the context of established emotional traits may at present represent the most appropriate means through which to interpret testosterone’s role in primary temperamental variability. If state-trait relationships are taken to be synergetic, an analysis of the relationship between trait dominance and those associated with Panksepp’s established basic emotions should provide a means through which to determine whether or not the social emotional behaviours mediating the attainment of social power constitute a distinct primary brain process, or if not, how the existing taxonomy may best account for the manifestation of this psycho-behavioural state.

Specific Aims and Hypotheses

The aims of the present study were therefore threefold: Firstly, to develop and conceptualise a psychometric tool measuring trait dominance, using a factor analytic design, and to test the criterion validity of this scale. Secondly, to draw on this methodological approach to determine whether or not the items measuring DOMINANCE emerge as an independent factor. Furthermore, since LUST has not been included in the present ANPS, it was necessary to develop and validate a subscale for it as part of the present objectives. Lastly, owing to its stability over time and conception as a personality variable, this study aimed to explore the relationship between baseline testosterone, DOMINANCE, LUST and the primary emotional traits of the ANPS, with consideration to possible interactions with cortisol.

Given these aims, this research sought to test the following hypotheses, which have emerged from above review of the literature:

1. Trait DOMINANCE will distinguish itself from the seven established basic emotion traits, as defined in the ANPS. Hence, scale items formulated to represent the neurobiological literature on behavioural dominance and testosterone will load proportionately on a unique factor.
2. In general, males will score higher on trait DOMINANCE than females.
3. Baseline testosterone will correlate uniquely with trait DOMINANCE, although this may depend on an interaction with cortisol.

Design and Methods

The current research fell within a quantitative paradigm and employed a psychometric approach in addressing the question of whether or not trait DOMINANCE represents a conceptually distinct temperamental variant in human personality. To achieve this end, an exploratory factor analytic design was applied to develop measurement models of both trait DOMINANCE and LUST, which were then validated and explored using correlational statistics. The *ANPS* constituted the primary measure of factor comparison, but a number of additional self-report questionnaires were carefully selected to assess criterion-related measures, namely social extraversion and agreeableness, social anxiety, negative affect and sexual desire for the *DOMINANCE* and *LUST* scales respectively. Furthermore, basal testosterone and cortisol were evaluated to observe their relationship to basic emotion traits.

DOMINANCE and *LUST* Item Pool generation

Since one of the key aims of this research was to develop and validate *DOMINANCE* and *LUST* scales to be included in the *ANPS*, the methods adopted here followed an iterative process, including item pool generation, item reduction, and final item selection, followed by more advanced factor analytic procedures for further refinement and loading comparisons with the *ANPS*.

Item generation. In developing the *DOMINANCE* and *LUST* sub-scales, initial item pools were generated with the intention of assessing the behavioural and affective components of the target constructs based on an extensive review of the neurobiological literature. These findings formed the basis for the ‘nomological net’ (Cronbach & Meehl, 1955) against which to ground construct validity. Significant self-report instruments from the personality literature with conceptual congruence were also reviewed and taken into account in the item generation process. In particular, items from the BIS/BAS scales and those few that were intended to represent social dominance in the ANPS were considered as potential trait dominance markers. In short, the *DOMINANCE* subscale was preliminarily conceptualised as general interest in status and its pursuit (Stanton & Schultheiss, 2009; Eisenegger, Hausher & Fehr, 2011), being drawn to positions of leadership (Gough & Bradly, 2005), a desire to gain and maintain social and resource control in social groups (Sapolsky, 1991; Ferris, 1992), to assert one’s opinions and actions and derive pleasure from doing so (Stanton & Schultheiss, 2009), feelings of competitiveness (Mazur & Booth, 1998; Cashdan, 2003) and self-importance (Cheng, et al., 2010) and a willingness to use measures of intimidation to get one’s way (Carre, McCormick & Harir, 2011; Terberg, Hooiveld, Aarts, Kenemans & van Honk, 2011).

LUST was defined as frequent erotic and genital arousal, sexual desire and interest in pursuing sexual activities (Panksepp & Biven, 2011), feeling sexy, sensual or seductive, being flirtatious or promiscuous, having sexual fantasies, dreams or daydreams (Beck, Bozman & Qualtrough, 1991) and an orientation towards hedonism. It is important to note that at this stage in the research, these conceptualisations functioned merely as ‘working definitions’, awaiting further refinement through exploratory factor analytic methods.

These initial item pools were over-inclusive and sampled proportionately from the various content domains as described above. Care was taken to word items simply and unambiguously at a reading level appropriate for those with only a moderate education. A small panel of university students reviewed and verified these qualities. All items were formatted in line with the ANPS which will be described further on, and hence following in this tradition, approximately half the items were constructed to be scored in the negative so as to avoid response sets. Special concern was taken toward accessing behavioural tendencies and subjective personal feelings as opposed to more cognitively-mediated self judgments (Davis, et al., 2003). For example, “I do not like to assert influence over others” was preferred to “I think it is inappropriate to assert oneself over others”. This was particularly important since research has shown that measures of self-report dominance often fail to accurately predict behaviour (Stanton & Schultheiss, 2009) -- a phenomenon which may be accounted for by erroneous introspection on the part of the actor (McClelland, Koestner & Weinberg, 1989) or a lack of ability thereof, or alternatively, a failure of the instrument to appropriately define the construct. This latter issue may stem from the fact that explicit trait dominance scales have not previously been conceptualised principally from data arising from the neurobiological and animal literatures.

Items from the Reward and Drive subscales of the BAS (Carver & White, 1994) were deemed particularly suitable for inclusion in the item pool as many of these items gauge trait dominance implicitly and therefore address the issues referred to above. The seven items in the ANPS designed to be dominance items were also included. Lastly, phrases that implied an invested motivation were incorporated into the items as a way of addressing the situation-specific relationship between testosterone and behaviour. For example, a phrase such as “When I see something I want, I move in on it straight away,” is contextually specific and was preferred to “I don’t hesitate to claim what’s on offer”.

Item reduction. Large item pools were reduced to more manageable sizes through the use of a pilot study. 46 students from varying faculties of the University of Cape Town responded to an online questionnaire in which they were asked to complete the ANPS alongside DOMINANCE and LUST items. Items were analysed for their correlation with total scale scores using corrected item-total correlation measures. These indices are useful as a means of identifying ‘rogue’ items which behave inconsistently with other scale items and therefore do no correlate well with the latent factor of interest. Items with weaker correlations, indicating poorer reliability, (below 0.5) were discarded from their respective DOMINANCE and LUST item pools. Highly redundant items, adding no variance to the underlying factors, were also excluded and a final pool of DOMINANCE items which adequately sampled the content domain was retained for further criterion-related and factor analyses. At this point, the 14 best LUST items were selected for development of the final scale. Further item analysis was not deemed necessary since LUST is already established as a basic emotion and its conceptualision apparent in the literature.

Participants

In keeping with current opinion on the minimum sample size to validate a factor analysis (Mundfrom, Shaw & Tian, 2005), 461 participants of varying cultural backgrounds and academic disciplines from the University of Cape Town (UCT) were recruited via e-mail invitation and through the UCT psychology department’s Student Research Participation Programme (SRPP). Age ranged between 17 and 35 years (M = 21.56 years) and 319 of these volunteers were female. For hormone assays, 101 participants (70 females) were recruited from this initial sample and were excluded on the basis of self-disclosures of: regular drug use and smoking, pregnancy, diagnosed psychiatric disorder, use of the contraceptive pill or any form of chronic medication and homosexuality. All those who participated in this study were screened prior to data collection for tendencies towards responding in a socially sanctioned manner using lenient criteria for the short form of the Marlowe-Crowne Social Desirability Scale (Reynolds, 1982).

Materials

Self-report measurements. Aside from the ANPS, which formed the key criterion against which to compare factor loadings of the newly constructed item pools, questionnaires were chosen as indicators of convergent and discriminant validity for the development of the *DOMINANCE* and *LUST* scales. More specifically, the Sexual Desire Inventory (SDI*)* (Spector, Carey & Steinberg, 1996) served as a conceptual basis for LUST items, while construct validity for

DOMINANCE items were evaluated on the basis of their relationships to scores on Extraversion and Agreeableness of the Mini International Personality Item Pool (Mini-IPIP*)* (Donnellan, Oswald, Baird, & Lucas, 2006), The Social Interaction Anxiety Scale (SIAS) (Mattick & Clarke, 1989), Behavioural Inhibition and Behavioural Activation Scales (BIS/BAS) (Carver & White, 1994) and Patient Health Questionaire-9 (PHQ-9) for a rough measure of negative affect. In choosing these instruments, psychometric properties, including reliability and validity, were also considered in the selection process.

ANPS. As described in brief above, the ANPS (Davis, et al., 2003, Davis & Panksepp, 2011) was designed to reflect the relative influence of six distinct brain affective systems, namely PLAY, SEEK, CARE, FEAR, ANGER (rage) and SADNESS (panic/grief), in the development of personality. Refer to Table 2 for descriptions of these basic emotion traits. Although LUST was excluded from the model, the authors chose to include a SPIRITUALITY subscale because of its clinical significance in psychiatric research and treatment. For the purposes of the current research, this dimension was not administered. From the outset, the development of these scales was driven by the speculation that they might form the affective basis of the widely endorsed Five Factor Model (FFM) of personality. Indeed, high correlations between the two models have been reported (Davis, et al., 2003). The authors do, however, acknowledge this contribution as a ‘work in progress’ and have encouraged further research to incorporate objective, biological markers in the study of basic emotions and individual traits. The present research therefore hoped to make a contribution in this regard, with reference to testosterone.

Each subscale in the ANP*S* consists of 14 items in the form of statements designed to represent the various facets of the primary affective tendencies. A number of filler items were also included to serve as validity and social desirability checks. Respondents are given four possible categories of response- strongly agree; agree; disagree; strongly disagree. In keeping with normative studies, these scales were scored such that a 0 reflected the lowest value and 3, the highest. As such, participants were able to score in the range of 0 to 42 for each subscale.

The ANPS has good psychometric properties (Davis, et al., 2003) and has been validated by researchers in the clinical domain (Reuter, Panksepp, Schnabel, Kellerhoff, Kempel & Hennig, 2005; Savitz, van der Merwe & Ramesar, 2008).

Table 2

Conceptualisation of Basic Traits in the Affective Neuroscience Personality Scales

Basic Emotion Trait	Definition	System
Seeking	Feeling curious, feeling like exploring, striving for solutions to problems and puzzles, positively anticipating new experiences, and a sense of being able to accomplish almost anything.	SEEKING
Playfulness	Having fun versus being serious, playing games with physical contact, humour and laughter, and being generally happy and joyful.	PLAY
Caring	Nurturing, being drawn to young children and pets, feeling soft-hearted towards animals and people in need, feeling empathy, liking to care for the sick, feeling affection for and liking to care for others, as well as liking to be needed by others.	CARE
Fear	Feelings of anxiety, feeling tense, worrying, struggling with decisions, ruminating about past decisions and statements, losing sleep, and not typically being courageous.	FEAR
Anger	Feeling hot-headed, being easily irritated and frustrated, experiencing frustration leading to anger, expressing anger verbally or physically, and remaining angry for long periods.	RAGE
Sadness	Feeling lonely, crying frequently, thinking about loved ones and past relationships, and feeling distress when not with loved ones.	PANIC/ GRIEF

*Information adapted from Davis, Panksepp and Normansell (2003).

For the purposes of this study, the ANPS embodied the key constructs from which DOMINANCE and LUST were to be distinguished.

SDI. The SDI is an 11-item self-administered scale developed by Spector, Carey and Steinberg (1996) to measure sexual desire, as defined by interest in a variety of sexual activities and cognitions. It is deemed to be a reliable tool and independent research has demonstrated its construct validity (Davis, Yarber, Bauserman, Schreer & Davis, 1998). For the purposes of the present study, the SDI served as a validity check and it was therefore expected that high scores on LUST would correlate positively with scores on the SDI.

Mini-IPIP. The Mini- International Personality Item Pool (Donnellan, Oswald, Baird & Lucas, 2006) is a 20 item short-form of the original 50-item IPIP based on the Five Factor Model of Personality. It was constructed to overcome problems associated with lengthy assessments without compromising reliability. The Mini-IPIP was validated by the developers over 5 studies in which its psychometric properties were established (Donnellan et al., 2011) and these have subsequently been confirmed elsewhere (Sibley, Luyten, Purnomo, Mobberley, Wootton, Hammond, 2011). In the present study it was deemed to be advantageous over the original pool because of practical time constraints and concerns about participant's concentration limits.

SIAS. The Social Interaction Anxiety Scales (Mattick & Clark, 1989) is a 20-item questionnaires which measures anxiety and tension in everyday social interactions and was conceptualised as a companion measure in the assessment of social phobia. High alpha scores have been reported (Heimberg, Mueller, Holt, Hope, 1992), and moreover, it has been demonstrated that scores on the SIAS are sensitive to the clinical effects of cognitive behavioural therapy (Mattick, Peters & Clark 1988). This scale was included in the current batch of self-report tools as a measure of discriminant validity for the DOMINANCE scale, in that trait dominance was hypothesised to relate negatively to anxiety in the social sphere.

BIS/BAS. The BAS (Carver & White, 1994) consists of three subcomponents, namely Fun Seeking (BASF), Drive (BASD) and Reward Responsiveness (BASR) and is a measure of novel and appetitive reward seeking. The questionnaire requires the participant to respond to 24 statements according to the degree to which it pertains to them. Scores per item range from 1-4 but were reformatted to 0-3 in the present research to be congruent with the ANPS formatting. Although the BAS does not directly measure dominance, studies in neuro-economics have demonstrated a reliable implicit relationship between trait dominance and BASD and BASR (Scheres & Sanfey, 2006). Implicit measures of trait dominance are particularly important in light of the literature documenting a failure in self-report dominance to accurately predict behaviour. In the context of the proposed research, the BAS will be utilised as a measure of convergent validity for the DOMINANC*E* subscale.

PHQ-9. The PHQ-9 is a component specific to depression of the Primary Health Questionnaire, which is self-report inventory open to the public domain. It is a simple and easy scale to administer and both its reliability and validity as a measure of clinical depression have been established in an extensive series of studies on clinical populations (Kroenke, Spitzer & Williams, 2001). The questionnaire consists of 9 statements pertaining to the DSM-IV criteria for Major Depressive Disorder and response options range from ‘not at all’ (0) to ‘nearly every day’ (4). A depression rating was incorporated into the present study as an approximate means through which to explore the theoretically hedonic nature of trait dominance and testosterone since a great deal of animal research has established a link between chronic social submission and depression.

Personal information sheet. Age, gender, cultural background, home language, academic discipline and contact details were gathered online prior to the completion of questionnaires. Information regarding stage of menstrual cycle and use of contraception was also obtained for the female sample. Furthermore, all participants were asked to briefly divulge their sexual history in a fixed-response format and their sexual orientation.

Testosterone and cortisol assay

Basal testosterone and cortisol levels were assessed through saliva sampling, which has been established as a valid and noninvasive procedure that therefore has several advantages over serum assays (Kirschbaum & Hellhammer, 2000). Collection took place between 2pm and 3.30pm to control for diurnal fluctuations in basal testosterone and when testosterone is most stable. Although many authors have argued that several samples across time are required to obtain a reliable baseline cortisol reading, due to logistical issues, only one collection was possible. Moreover, despite this cautioning, few reliability analyses on cortisol have been published but in a recent study, cortisol was in fact found to be highly reliable over a 2-week period in both men and women, with correlation coefficients of .93 and .73 respectively, emerging in a sample of 122 (Leining, Stanton, Saini & Schultheiss, 2010).

In routine fashion, participants were asked not to brush their teeth, eat or drink anything during the one-hour preceding their saliva donation and to not drink any alcohol up to twelve hours prior. Upon arrival, they were directed to discrete stations where they were instructed to rinse out their mouths thoroughly with water in order to remove any debris that may have contaminated their sample and then to deposit unstimulated saliva into a sterile, 5ml polypropylene tube with the use of a small plastic straw. Samples were then labelled and stored at -20 degrees Celsius before being transported to a private laboratory, *Dresden Lab Service*, in Dresden, Germany to be analysed, and as such assays were performed blind. Saliva samples were frozen immediately after each laboratory session and stored at -20 degrees Celsius until analysis. After thawing, sampling tubes used for passive drooling were centrifuged at 10,000 rpm for 5 minutes, resulting in mucous compounds being restricted to the lower part of the tube. Salivary testosterone and cortisol concentrations were measured using a commercially available chemiluminescence-immuno-assay with high sensitivity (IBL International, Hamburg, Germany).

Procedure

In phase 1 of this study, interested participants were provided with a web link to pursue at their convenience which directed them to a webpage outlining the details of what participation would involve, followed by an electronic informed consent form. To control for expectation effects, the specific aims of the study were not divulged, but it was instead stated that the research was hoping to explore personality constructs from an evolutionary perspective. All self-report measures were formatted into electronic versions and the site was designed such that a response to all questions was required before progression to the next page was enabled. After filling out their personal information, participants first completed the ANPS so as not to have their responses influenced by the potentially provocative content of the remaining questionnaires, followed by the DOMINANCE and LUST item pools, and finally the complementary criterion-related measures.

In the second phase of this research, saliva samples were collected from a subset of participants derived from the initial sample. Participants reported to a private room in the Psychology Department of UCT at allocated timeslots between 2pm and 3.30pm. There they were seated and provided with the necessary equipment to provide a saliva sample as well as consent forms and a personal information sheet which included questions regarding compliance with the preparatory instructions stated at the time of recruitment. Because they were not given chewing gum to stimulate saliva production, the average time taken to donate a 5ml sample was 15 minutes. Those who were not able to produce an adequate sample were invited to reschedule and return at a later date. Care was taken to ensure that participants felt at ease and were reminded that they were free to opt out of the study at any point in time. Once finished, they were informed that debriefing would take place once data collection was completed.

Statistical Analyses

Prior to analysis, all data was captured on an MSExcel database and screened for missing information after which it was analysed using the *Statistical Package for the Social Sciences* (SPSS) version 19.0. Outliers were defined as values above or below the 3 standard deviation mark and removed from the data set. All statistical assumptions were tested prior to analyses and moderately skewed distributions were corrected with log transformations.

Factor analysis, which is a method used to uncover the latent structure of a correlation matrix, was employed as the preferred technique of data reduction in the development of DOMINANCE and LUST scales. These scales were then validated against criterion-related measures using Pearson’s product moment correlations and *t*-tests.

Relationships between the developed scales and the ANPS, and baseline testosterone and cortisol levels were then explored using zero order correlations, a moderated hierarchical regression analysis and through the use of hormonal ratio statistics. To test whether cortisol moderates the influence of testosterone on primary emotional functioning, a the moderated regression using the Aiken and West (1991) approach was adopted, in which intercepts and slopes were used to graph the dependant variable (DV) at one standard deviation above and below the means for testosterone and cortisol levels. This was then followed by a simple slopes analysis to plot the relationship between the DV and testosterone at high and low levels of cortisol, and test whether these slopes differed significantly from zero. Lastly, a ratio statistic between testosterone and cortisol (and vice versa) was calculated by converting basal hormone levels into standardised scores and then calculating the ratio score using simple division. This value was then used as an independent variable in correlational analyses.

Results

Scale Development

Prior to running a factor analysis, the data was screened for factorability. Problem items, which deviated substantially from the normal distribution as per measures of skewness, kurtosis and inspection of histograms, were removed and due to a forced-response, online questionnaire format, no missing data was observed. Sample size was deemed satisfactory (n=461) based on Gorsuch's (1983) and Cattel's (1978) rules of 200 and 250, respectively. Furthermore, the subjects-to-variable criterion of no less than 2, promulgated by Kline (1971), was well within reasonable limits at a ratio of 3.8. Confirming this, the Kaiser-Meyer-Olkin measure of sampling adequacy for this kind of analysis was .83, which exceeds the suggested value of .6 (Field, 2009). Bartlett's test of sphericity x^2 (6786) = 25159.45, $p < .05$, was significant indicating sufficiently large inter-item correlations for factor analysis and communalities (table) were all above .3. Lastly, diagonals of the anti-image correlation matrix all surpassed the basic criteria of .5, demonstrating suitability of all items for inclusion in the analysis.

An exploratory factor analysis using a principal axis factoring extraction method was used since the central aim of the investigation was to firstly identify and interpret a hypothesized DOMINANCE (D) factor, and secondly, to explore the latent structure of the ANPS with the inclusion of LUST and D items. An in-depth discussion of the factor structure of the ANP*S* exceeds the scope of the current inquiry; however, of concern was merely their independence from a D factor. Initially, items from all scales of the ANPS and LUST and D items pools were included in the factor analysis.

Prior to rotation a preliminary analysis was run to explore the criteria for extraction of factors. 31 factors emerged based on the Kaiser-Guttman criterion of retention of factors with eigenvalues over 1 and which accounted for 65.74% of the total variance. This rule has however received widespread criticism for resulting in over-extraction (Velicer & Jackson, 1990) and in the context of the current analysis was deemed misleading. Horn’s parallel analysis technique, which is generally found to correct for over-estimation resulting from Catell’s scree test and Kaiser’s criterion, instead indicated only 21 factors- a solution that also far exceeded the current theoretical reasoning. Instead, a careful inspection of the scree plot and consideration of both the explained variance and interpretability of the loadings took preference in estimating the number of factors to extract, and while somewhat ambiguous, this approach suggested three solutions of 4, 6 and 10 factors accounting for 27.91%, 33.74% and 42.38% of the total variance explained, respectively.

These three solutions were examined using a direct oblimin rotation with Kaiser normalization. In all three solutions, primary loadings above .4 were retained and a clear, ‘superordinate’ D factor emerged. However, in the 10-factor solution, the explicit facet (concern with *social status and control*) of the construct was separated from a more implicit aspect (sense of *reward entitlement),* emerging as two distinct factors. What is important to note regardless, is that within that solution, ANPS items loading on factors representing Panksepp’s established emotions did not subsume these two dominance dimensions. In the 10-factor solution, D factors emerged as the first factor, accounting for 10.01% of the variance and the 6th factor, contributing 2.73%. The 4-factor solution specified D as the first factor, contributing 10.01% of the variance, and in the 6-factor solution, the D factor emerged as the 6th factor, explaining again, 2.73% of the total variance. In all three solutions, 13 of the 14 LUST items formed a coherent LUST factor.

In the 6 and 4 factor-solutions, basic emotion items merged along broad emotional dimensions such as neuroticism and sociability. Since there is now sufficient neurobiological evidence indicating that GRIEF and FEAR, and PLAY and SEEKING, are distinct affective systems, it was felt that these simpler factor solutions carried less interpretive power. Nonetheless, of importance is the fact that despite these variations in factor solutions, the majority of the D items remained constant across these varying outputs.

The 10-factor solution was therefore preferred because its structure most closely fit the theoretical organisation of the basic emotions. Factor loadings for this final solution are displayed in Table 3. The 10 emergent factors, as opposed to a hypothesized 8 (consisting of the seven primary emotion traits already described in Panksepp’s taxonomy with the inclusion of D), described generally a RAGE, PLAY, FEAR[6], SEEKING, GRIEF and LUST factor, but D and CARE were split into two discrete dimensions. On a theoretical level, this was deemed acceptable since self-report scales are always cognitively mediated and it was felt that this accounted for the separation. For instance, with regard to the two CARE factors, while on a biological level the neurophysiology mediating caring behaviour emanates from a unitary system (Panksepp, 1998), tertiary-level processes may create a cognitive distinction between a general caring disposition and ‘caring for pets or animals’, since a host of other variables may influence the latter, such as concern for hygiene, fear of certain animals etc.

Based on this 10-factor solution presented in Table 3, a two-dimensional D construct was identified for development into the D subscale of the *ANPS*. All items with primary factor loadings above .4 were selected, amounting to 13 items in total, however, due to *ANPS* formatting constraints, one additional item with a satisfactory coefficient was incorporated into the final *D* scale. Item clusters suggest that Factor 1 represents implicit *Reward Entitlement* and Factor 6, an explicit motivation for *Social Influence*. A composite score of these two factors was created to represent the *D* scale, based on the total score accrued by each participant on the 14 individual items. Higher values out of a maximum score of 43 indicate a more dominant disposition. Composite scores were also created for each sub factor.

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[6] As is typically described in personality research, items that assess negative affect tend to converge into a superordinate ‘neuroticism’ factor (Clark & Watson, 1995); and this was observed to some extent since many of the FEAR and GRIEF items merged into a coherent factor.

Table 3

Factor Loadings for Exploratory Factor Analysis with Oblimin Rotation of ANPS Items and Dominance and Lust Item Pools

	Factor									
Item	1	2	3	4	5	6	7	8	9	10
When I want something I usually go all-out to get it (BAS)	**.58**	-.11	.05	.02	.00	-.25	-.03	.11	.15	-.16
If I see a chance to get something I want I move on it right away (BAS)	**.53**	-.13	.06	.00	.10	-.12	-.03	.09	.04	-.05
I go out of my way to get things I want (BAS)	**.53**	-.08	-.03	-.04	.09	-.22	-.07	.02	.06	-.13
When I see an opportunity for something I like I get excited right away (BAS)	**.51**	.12	-.04	-.09	-.01	-.04	.07	.08	-.08	-.19
When I go after something I use a ‘no holds barred’ approach (BAS)	**.42**	-.13	.00	-.04	.20	-.16	-.01	.09	-.10	-.01
People who know me well would say that I have a powerful character (D)	.36	-.14	.12	-.11	.11	-.20	-.15	.08	-.06	.12
I often worry about the future (F)	.04	**.68**	-.05	.00	.01	-.08	.02	-.05	-.04	.01
I sometimes cannot stop worrying about my problems (F)	.08	**.65**	.03	.02	.00	-.09	.00	-.05	.08	-.02
I often feel nervous and have difficulty relaxing (F)	.02	**.64**	.03	.05	.02	-.05	-.05	.01	.13	.07
I rarely worry about the future (F)	.03	**.58**	.00	-.04	-.01	-.10	-.09	-.05	-.03	-.17
There are few things that make me anxious (F)	-.14	**.58**	-.01	.02	.04	.04	-.04	.03	.07	-.17
I often feel sad (G)	-.13	**.57**	-.05	-.08	.13	.08	-.05	.11	.10	.19
I often worry about whether I am making the correct decision (F)	-.05	**.56**	.05	.05	.03	-.03	.06	-.04	-.08	.06
I often feel lonely (G)	-.07	**.55**	-.09	-.02	.08	.07	.06	.10	.11	.14
People who know me well would say that I am an anxious person (F)	-.10	**.54**	.03	.06	.03	.03	-.06	-.05	.13	-.04
I rarely become sad (G)	-.15	**.50**	.03	-.08	.28	.15	-.11	.14	.13	-.06
I often have the feeling that I am	.03	**.45**	.23	.10	.23	.15	-.08	.01	.13	-.01

Table 3

Factor Loadings for Exploratory Factor Analysis with Oblimin Rotation of ANPS Items and Dominance and Lust Item Pools

	Factor									
Item	1	2	3	4	5	6	7	8	9	10
going to cry (G)										
Fear of embarrassment often causes me to avoid doing things or speaking to others (D)	.02	**-.45**	.27	-.05	.02	-.08	-.19	.11	.01	-.07
I often think of what I should have done after the opportunity has passed (F)	-.02	**.44**	-.01	.05	.05	-.07	.13	-.03	-.19	.15
I have very few fears in my life (F)	-.05	**.43**	-.02	.06	.06	.11	.00	-.05	.08	-.27
I rarely have the feeling that I am close to tears (G)	.01	**.42**	.23	.01	.16	.14	-.10	-.01	.16	-.17
I would not describe myself as a worrier (F)	-.12	**.41**	.09	.04	.10	-.06	-.01	.09	.07	-.09
I almost never lose sleep worrying about things (F)	-.01	**.40**	.13	.01	.15	-.03	-.10	.16	.14	-.13
I like taking care of children (C)	-.02	-.04	**.69**	.00	-.07	-.03	.07	-.16	-.12	.07
I do not especially like being around children (C)	-.09	-.04	**.68**	-.03	-.16	-.05	-.05	-.10	-.10	-.04
I often feel a strong need to take care of others (C)	.02	.15	**.54**	.00	-.01	-.05	.15	.00	-.02	.04
Caring for a sick person would be a burden for me (C)	.00	-.07	**.45**	.05	-.04	.10	.12	.00	-.02	-.04
I am a person who strongly feels the pain of other people (C)	.10	.21	**.45**	-.01	.02	.10	.14	.00	.04	.03
I hardly ever fantasize about having sexual intercourse (L)	-.09	.07	-.13	**-.77**	.01	.01	-.06	.06	.01	-.03
I would consider myself to be a sexually passionate person (L)	.10	.02	.15	**-.76**	-.01	.02	.05	-.06	-.04	.07
I rarely have sexual thoughts (L)	-.13	.10	-.10	**-.76**	.00	-.04	-.02	.08	.00	.00
For me, being sexually intimate is a great source of pleasure (L)	.07	-.05	.09	**-.74**	.03	.00	.09	-.03	.10	.03

Table 3

Factor Loadings for Exploratory Factor Analysis with Oblimin Rotation of ANPS Items and Dominance and Lust Item Pools

	Factor									
Item	1	2	3	4	5	6	7	8	9	10
I have not been in the mood for sex in a long time (L)	-.08	-.02	-.04	**-.71**	-.01	-.03	.04	-.04	-.02	.04
Sometimes I wonder if I am capable of feeling sexual desire (L)	-.06	-.13	.05	**-.69**	-.05	.00	-.08	.00	.02	-.12
I am very aware of my sexual desires (L)	.14	.03	.08	**-.69**	-.06	.05	-.14	.01	.07	.10
It is unusual for me to experience genital arousal (L)	-.10	-.01	.01	**-.68**	.06	-.02	-.03	.08	.04	-.07
I enjoy sensual experiences (L)	.10	.05	-.02	**-.64**	-.06	.01	.17	.01	-.03	.06
I often find myself fantasizing about sexual foreplay (L)	-.04	.18	-.03	**-.63**	-.02	.01	.01	.01	-.05	.17
I find sex a bit boring (L)	-.05	-.08	.14	**-.59**	-.02	-.01	-.01	-.07	-.05	-.09
I feel uncomfortable thinking about sex (L)	-.03	-.13	-.07	**-.58**	.06	.02	-.06	.11	-.04	-.01
I do not like to deny myself pleasure (L)	.17	-.09	-.18	**-.41**	.06	-.01	.09	.05	.04	-.01
I rarely get angry enough to want to hit someone (R)	-.02	-.05	.02	.00	**.70**	.04	-.06	-.01	-.02	.07
People who know me well would say I almost never become angry (R)	.00	-.10	-.10	-.06	**.69**	.02	-.04	.08	.12	-.12
I hardly ever become so angry at someone that I feel like yelling at them (R)	.07	-.06	.06	.03	**.68**	.01	-.05	-.07	.06	-.10
When I am frustrated, I rarely become angry (R)	-.03	.03	-.02	.00	**.67**	.01	.09	-.05	-.08	-.10
When people irritate me, I rarely feel the urge to say nasty things to them (R)	-.04	.01	-.07	.01	**.59**	-.11	-.07	.03	-.03	-.12
When I am frustrated, I usually get angry (R)	.08	.12	.04	.02	**.57**	-.04	.17	-.09	-.02	.04
I cannot remember a time when I	-.17	.09	.01	-.05	**.55**	-.04	.13	.09	-.01	.13

Table 3

Factor Loadings for Exploratory Factor Analysis with Oblimin Rotation of ANPS Items and Dominance and Lust Item Pools

	Factor									
Item	1	2	3	4	5	6	7	8	9	10
became so angry that I wanted to break something (R)										
When things do not work out the way I want, I sometimes feel like kicking or hitting something (R)	-.02	.16	.02	.06	**.55**	-.05	.05	-.06	-.09	.23
When I get angry, I often feel like swearing (R)	.05	.04	-.14	-.19	**.52**	-.02	.20	.01	-.12	-.02
My friends would probably describe me as being hotheaded (R)	.10	-.08	.00	.02	**.47**	-.04	-.06	-.08	-.08	.12
When someone makes me angry, I tend to remain fired up for a long time (R)	.12	.19	-.19	.04	**.40**	.03	.01	-.17	.01	-.01
When working on a project, I like having authority over others (D)	-.01	.07	.02	-.03	.01	**-.72**	.09	-.06	.07	.12
I like to be the one in a group making decision (D)	.12	-.03	.05	-.02	.07	**-.62**	.05	.07	.09	.07
I prefer to watch and observe than take the lead in group work (D)	-.04	-.14	.12	.03	.10	**-.61**	-.04	.16	.11	-.08
I find it satisfying being in a position of leadership (D)	.05	.02	.07	-.08	-.06	**-.60**	-.06	-.02	-.04	.10
I usually feel agitated when I do not win (D)	.26	.20	-.20	.03	.09	**-.46**	.00	-.19	.06	.02
Striving to be better than my peers is not important to me (D)	-.02	.15	-.13	.00	-.03	**-.46**	-.04	.04	.04	-.18
I compete in challenges to win (D)	.22	.11	-.19	-.04	.00	**-.43**	-.10	.01	-.05	.09
I usually avoid activities in which I would be the center of attention (D)	-.05	-.23	.12	-.06	.19	-.38	-.15	.10	-.19	-.21
I love being around baby animals (C)	-.07	-.09	.10	.03	.05	.03	**.82**	.01	.04	.00
I feel soft-hearted towards stray animals (C)	.05	-.02	.06	.03	.11	-.01	**.75**	.01	.04	.05

Table 3

Factor Loadings for Exploratory Factor Analysis with Oblimin Rotation of ANPS Items and Dominance and Lust Item Pools

	Factor									
Item	1	2	3	4	5	6	7	8	9	10
I would generally consider pets in my home to be more trouble than they are worth (C)	-.08	-.18	.07	-.03	.06	.04	**.65**	.09	.13	-.05
I think it is ridiculous the way some people carry on around baby animals (C)	.00	-.02	.07	-.06	-.02	.03	**.47**	.01	.03	-.27
I am usually not interested in solving problems and puzzles just for the sake of solving them (S)	-.09	.02	-.04	.00	-.06	.00	.01	**.61**	-.02	.00
I am not the kind of person that like probing and investigating problems (S)	-.07	.11	-.07	-.07	.00	-.11	-.02	**.60**	.08	-.05
I am not an extremely inquisitive person (S)	.07	.03	-.03	-.11	.04	.02	-.03	**.55**	-.01	-.13
I am usually not highly curious (S)	.01	.12	-.10	-.15	-.09	-.01	.06	**.49**	-.05	-.05
My curiosity often drives me to do things (S)	.27	-.02	-.02	-.07	.01	.01	.12	**.46**	-.09	.20
Seeking an answer is as enjoyable as finding a solution (S)	.18	-.02	.02	.05	-.15	-.04	-.03	**.45**	.02	.10
Almost any little problem or puzzle stimulates my interest (S)	.08	.08	-.03	-.04	-.06	-.06	.07	**.43**	-.07	.15
I do not particularly enjoy kidding around and exchanging wisecracks (P)	-.12	.07	-.15	-.07	.07	.04	-.06	.09	**-.63**	-.10
I am very playful (P)	.15	.03	.09	-.10	.07	.00	.03	.02	**-.63**	.08
People who know me well would say I am a very fun-loving person (P)	.24	.02	.16	.01	-.09	.04	-.05	-.05	**-.62**	-.07
I like to joke around with other people (P)	.06	.05	.02	.00	.06	-.01	.03	.07	**-.58**	.02
My friends would probably describe me as being too serious (P)	-.02	-.20	-.04	.00	.04	.20	-.03	.02	**-.53**	-.19
I am a person who is easily amused	.19	.01	.07	-.02	-.04	.17	-.06	-.08	**-.52**	-.03

Table 3

Factor Loadings for Exploratory Factor Analysis with Oblimin Rotation of ANPS Items and Dominance and Lust Item Pools

	Factor									
Item	1	2	3	4	5	6	7	8	9	10
and laughs a lot (P)										
I do not tend to see the humor in things many people consider funny (P)	-.06	-.03	.00	-.11	-.10	-.02	-.03	-.01	**-.42**	-.23
I like all kinds of games including those with physical contact (P)	-.12	-.01	.18	-.02	-.05	-.19	.02	.10	**-.42**	.22
I see life as being full of opportunities to have fun (P)	.36	-.14	.10	-.05	-.07	.13	-.02	.11	**-.42**	.00
I dislike humor that gets really silly (P)	-.19	-.01	.05	-.15	.07	.00	.10	-.08	**-.41**	-.01
It would not bother me to spend the holidays away from family and friends (G)	.08	-.02	.09	.06	-.04	-.07	.08	-.11	-.08	**-.46**
I do not especially want people to be emotionally close to me (C)	-.03	.08	.29	-.15	-.12	-.09	.19	.08	.01	-.39

Note. Factor loadings > .40 are in boldface as well as DOMINANCE items. Negatively worded items have been reverse-scored. Factors: 1 = *Reward Entitlement*; 2 = Panic/Grief - Fear; 3 = Care; 4 = Lust; 5 = Rage; 6 = *Social Influence*; 7 = Care (animals); 8 = Seeking; 9 = Play; 10 = Panic/Grief - Care. Items: S = SEEKING; F = FEAR; C = CARE; R = RAGE; P = PLAY; G = PANIC/GRIEF; L = Lust pool; D = Dominance pool; BAS = Dominance items selected from the *Behavioural Activation Scales*.

Internal consistency for *D* was examined according to Cronbach's alpha and indicated good reliability with $\alpha = .85$. Descriptive statistics for this scale as well as the LUST scale are presented in Table 4.

Gender differences were explored using *t*-tests. No effect for gender was found for D, with male and female average scores roughly equivalent. However, there was a modest but statistically significant difference on the *Social Influence* dimension, *t (459)* = -2.83, *p* < .05; where males scored higher than females. Gender differences were not apparent on the *Reward Entitlement* dimension. Males tended to score significantly higher on LUST, *t* (459) = -4.54, *p* < .01, and based on scores from the *ANPS,* a significant difference was found on measures of CARE (t (459) = 4.75, *p*

> .01), GRIEF (t (459) = 7.1, *p* < .01) and FEAR (t (459) = 2.66, *p* < .01), in which females scored higher but not on any of the other scales.

Table 4

Descriptive Statistics for DOMINANCE, Dominance Sub-scales and LUST (N = 461)

	No. of items	*M (SD)*		Skewness	Kurtosis	Alpha
		Male	*Female*			
Reward Entitlement	6	9.52 (.24)	9.84 (.15)	-.17	-.09	.79
Social Influence	8	17.69 (.41)	16.38 (.25)	.21	.48	.80
DOMINANCE	14	27.21 (.57)	26.23 (.35)	.19	.40	.85
LUST	14	31.07 (6.82)	27.72 (7.49)	-.41	.15	.91

Pearson product-moment correlations for D and criterion-related variables as well as intercorrelations with the *ANPS* are summarized in Table 5. D was found to be positively correlated with trait Extraversion and Conscientiousness from the Mini IPI demonstrating convergent validity, and significant inverse relationships were observed with the SIAS, the BIS and the Agreeableness scale of the Mini IPI. This pattern generally confirms the criterion validity of the factor, however, no significant association was found with the PHQ, a measure of depressed mood. D was related to all scales of the ANPS, with the exception of CARING. These findings were mostly confirmed in both D subscales.

Table 5

Intercorrelations of the Affective Neuroscience Personality Scales

	M	DOMINANCE	SEEKING	FEAR	CARE	RAGE	PLAY	GRIEF
	26.52							
SEEKING	28.31	.36**						
FEAR	22.56	-.13**	-.21**					
CARE	27.41	-.00	.17**	.09*				
RAGE	21.24	.22**	-.06	.28**	-.12*			
PLAY	26.45	.17**	.41**	-.29**	.36*	-.12**		
GRIEF	24.52	-.08	-.12**	.62**	.30*	.27**	-.11*	
LUST	28.78	.25**	.32**	-.10*	.14**	.11*	.32**	.00

*p < .05, two-tailed; **p < .01, two-tailed; Sample: n = 461 (141 males, 320 females).

Validity of the LUST scale was established with a strong positive correlation with the

SDI, *r* (459) = .74, *p* < .01, and was also found to be significantly related to D *r* (459) = .25, *p* < .01. Furthermore, *t*-tests indicated that there was an effect for history of sexual activity on measures of LUST (*t* (360) = -10.19 *p* < .01), where those with no history of sexual activity tended to score significantly lower than those who were currently sexually active.

Testosterone and Cortisol Assays

Table 6 provides descriptive statistics for testosterone and cortisol assays. A successful log transformation was performed on the testosterone distribution in the combined and female samples since it was negatively skewed. As expected, *t*-tests confirmed significantly higher concentrations of salivary testosterone in males, (*t* (104) = -14.09, p < .01), but no significant differences were found for cortisol.

Table 6

Descriptive Statistics for Hormone Assays

	Total (n =106)		Males (n =36)		Females (n =70)	
	M	SD	M	SD	M	SD
Testosterone (pg/ml)	39.82	36.58	80.96	31.79	18.68	13.69
Cortisol (nmol/l)	5.66	3.53	6.01	4.70	5.47	2.77

Hormone Correlations. Contrary to previous research, in the combined sample of males and females and after controlling for gender, no significant correlation was observed between testosterone and cortisol. However, when analysed separately, testosterone and cortisol were weakly positively correlated in the male group only, *r* = .28 *p* < .05.

Correlation analyses between testosterone and self-report measures were performed after controlling for gender and are presented in Table 7. No significant correlation was found between testosterone and DOMINANCE; however, against expectation, a significant negative correlation was found between the *Reward Entitlement* dimension, made up predominantly from items from the BAS Drive scale, and testosterone in the total sample. This relationship neared significance in males, but not in females. Consequently, this pattern of association was also observed for the

BAS Drive scale. There was a significant negative relationship between SEEKING and testosterone in the male group and a trend towards significance was observed in females[7]. Confirming this association, Imagination from the Mini-IPI also yielded a significant negative relationship to testosterone in females. Additionally, in males, RAGE was significantly and negatively associated with testosterone levels. In both the male and female group, the PHQ, which measures depression, yielded a significant negative correlation with testosterone. Lastly, and contrary to previous reports, testosterone was found to be significantly negatively associated with LUST in females.

Table 7

Testosterone and Cortisol Correlations

Measure	Testosterone (pg/ml)		Cortisol (nmol/l)	
	Males (n =36)	*Females (n =70)*	*Males (n = 36)*	*Females (n = 70)*
DOMINANCE	-.20	-.14	-.06	-.10
Social Influence	-.10	-.10	.02	-.01
Reward Entitlement	-.27^	-.15	-.15	-.13
SEEKING	**-.29***	-.18^	-.03	-.07
FEAR	-.10	-.03	-.22	**-.27***
CARE	-.11	.00	-.24^	.03
RAGE	**-.32***	.16	.04	**-28***
PLAY	-.09	-.20^	-.24^	.17
GRIEF	.02	-.18	.05	**-.21***
LUST	-.05	**-.30****	.22	-.08
Extraversion	-.19	.10	-.00	.06
Neuroticism	-.24	-.11	-.3	**-.35****
Agreeableness	-.04	-.03	-.10	-.11
Imagination	-.22	**-.31****	.15	.13
Conscientiousness	.00	.08	-.02	.12
BIS	-.02	-.02	-.16	**-.22***
BASD	-.28^	-.15	-.07	-.11
BASR	-.09	-.02	-.22	-.02
BASF	-.25	-.06	.03	.15
PHQ	**-.38***	**-.25***	-.19	**-.26***
SDI	-.21	**-.33****	.28^	-.04

* p < .05, two-tailed; ** p < .01, two-tailed; ^ p near significant < .07 > .05.

---

[7] One would expect testosterone and SEEKING to be related to some degree, and this observed effect may therefore be a result of familywise error introduced by the large amount of variables tested. However, since a negative correlation between testosterone and Imagination of the Mini- IPIP was also observed, this provides some confidence regarding the validity of the findings since Imagination has been found to load on SEEKING in factor analyses (Davis, et al., 2003).

In the female group, small but significant negative correlations between cortisol levels and FEAR, RAGE, GRIEF, Neuroticism, the BIS, the SIAS and the PHQ were observed. These findings were surprising, but a thorough treatment of this exceeds the scope of the current project. In males, only PLAY was significantly related to cortisol, yielding a negative correlation. These findings suggest tentatively that cortisol may function differently between men and women.

Moderation Analysis. To determine whether cortisol may in fact moderate the relationship between testosterone and DOMINANCE, a moderated, hierarchical multiple regression analysis was conducted on the combined male and female sample. A model was created such that DOMINANCE was entered as the dependent variable, the predictor, Gender, entered in step one to control for sex differences; Testosterone, and Cortisol in step two; the Testosterone x Cortisol interaction term specified in step three; and lastly, the Gender x Testosterone x Cortisol interaction entered in step 4. This model, however, was not found to be significant, suggesting that in this sample, cortisol does not moderate the relationship between testosterone and scores on the DOMINANCE scale.

Hormone Ratios. Finally, the relationship between DOMINANCE and hormone ratios were investigated. Testosterone and Cortisol distributions were standardized and individual ratios for testosterone: cortisol (T/C) and cortisol: testosterone (C/T) were calculated and correlated with scores from DOMINANCE and the ANPS. Significant findings are reported in Table 8. Since endocrine functioning differs to some extent across the sexes, male and female groups were analysed separately. Furthermore, outliers as defined by 3 or more standard deviations from the mean were removed prior to each analysis, amounting to 2 cases per group. In males, 2-tailed tests indicated that that the T/C ratio was significantly and positively correlated with DOMINANCE, as well as *Social Influence*, but not *Reward Entitlement*. Importantly, no significant correlations between the T/C ratio and the ANPS were observed. The C/T ratio was not related to DOMINANCE, however, SEEKING and PLAY were significantly correlated in a negative manner. Additionally, C/T in this male group was significantly and positively related to GRIEF. These findings most likely reflect the reciprocal relationship between the two hormonal systems and perhaps the psychologically unsettling effects of greater cortisol levels in males with high testosterone (See Josephs et al., 2006).

In the female sample, no significant correlations were observed with the T/C ratio, however, surprisingly, for the C/T ratio, a weak trend towards significance emerged for both DOMINANCE and *Social Influence* (p = .06 and .08 respectively).

In order to explore the role of testosterone in these significant hormone ratio relationships further, baseline testosterone levels were divided into subgroups consisting of ‘above average’ and ‘below average’ as well as the upper and lower thirds of the distribution in both male and female groups for additional analyses. Previous research on testosterone and dominance has endorsed the latter approach to subgrouping since interest lies in understanding pronounced motivations for social dominance instead of normal aspirations (Josephs & Sellers et al., 2006). A summary of these findings can be found in Tables 8 and 9 for males and females separately.

In males with testosterone above the mean, there was a significant, strong positive correlation with both DOMINANCE and *Social Influence*, the latter yielding a slightly stronger effect. However, in this group, no significant correlation was observed for *Reward Entitlement*. No significant correlations were observed in the subgroup with below-average testosterone, and a Fisher r-to-z transformation confirmed that correlations between testosterone and *Social Influence* were significantly different between the two subgroups, z (17) = 1.91, p < .05. These findings were replicated and strengthened in males whose testosterone levels were in the upper third of the distribution indicating that high testosterone underpins this relationship. It is important to bear in mind that these unusually strong correlations may be an artefact of the reduced sample size caused by median/ third splits. However, since significance emerged even when testosterone level was not controlled for, but gradually increased as a function of elevations in basal testosterone, this offers some assurance regarding the validity of these results. Importantly, in both the below-average and bottom third testosterone male group, none of the dominance variables reached significance and were not related to the T/C ratio.

Furthermore, in males with high testosterone, a significant, negative correlation emerged between the C/T ratio and PLAY and SEEKING, and a significant positive relationship with GRIEF. However, when these relationships were tested in the low testosterone male group, no significant findings were reported.

Table 8

Significant Testosterone: Cortisol Ratio Correlations with Dominance in Males

Testosterone Subgroup	DOMINANCE	*Social Influence*	*Reward Entitlement*
Whole Sample *(n = 34)*	**.41****	**.45****	.26
Above Mean *(n = 17)*	**.58***	**.66***	.29
Below Mean *(n = 17)*	.11	.07	.15
Upper Third *(n = 11)*	**.65***	**.73***	.47
Lower Third *(n = 11)*	.06	.08	.04

* p < .05, two-tailed; ** p < .01, two-tailed; ^ p near significant < .07 > .05. No significant findings were observed for the ANPS or LUST scale. ‘Above Mean’ = those with testosterone scores above the mean.

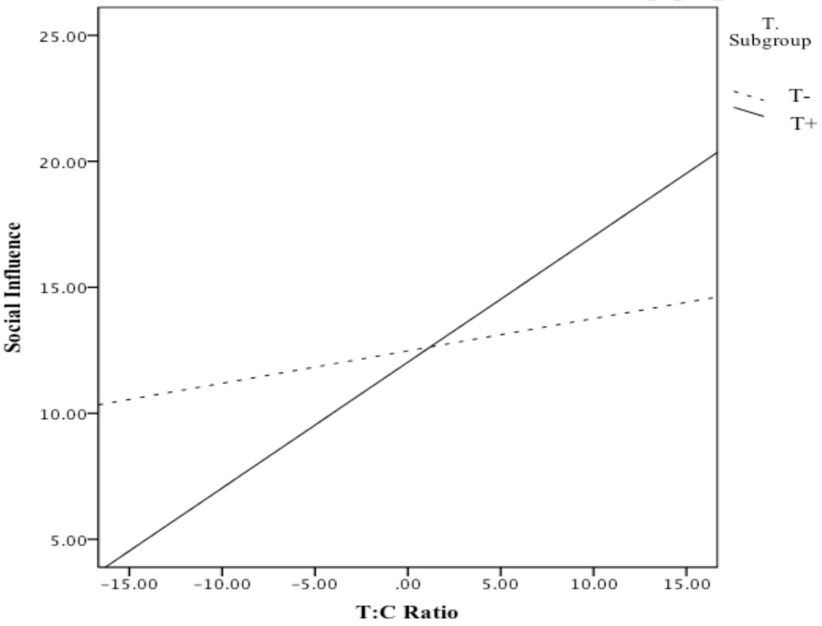

Figure 1. Pearson’s correlations between T:C ratio and *Social Influence* scale in males across testosterone subgroups. [T-] = Subgroup with testosterone levels below the mean; [T+] = Testosterone levels above the mean.

In the high testosterone subgroups of the female sample, the C/T ratio was significantly related to DOMINANCE and *Social Influence,* with *Reward Entitlement* nearing significance. A Fisher r-to-z transformation confirmed that correlations between testosterone and *Social Influence* and *Reward Entitlement* were significantly different between the two subgroups z (17) = 1.91, p < .05. Stronger correlations emerged in females with testosterone in the upper third of the distribution, suggesting that, as in the male sample, this change in strength occurs as a function of testosterone. Additionally, as reported in the male sample, in the low testosterone female groups, no significant findings appeared. These findings highlight the role of high testosterone in DOMINANCE and suggest that cortisol may act in a contrasting fashion in males and females.

Table 9

Significant Cortisol: Testosterone Ratio Correlations with Dominance in Females

Testosterone Subgroup	DOMINANCE	*Social Influence*	*Reward Entitlement*
Whole Sample *(n = 68)*	.23^	.21^	.20
Above Mean *(n = 34)*	**.37***	**.35***	.31^
Below Mean *(n = 34)*	-.04	-.12	.08
Upper Third *(n = 17)*	**.45***	**.43***	.34
Lower Third *(n = 17)*	-.12	-.23	.06

* p < .05, two-tailed; ** p < .01, two-tailed; ^ p near significant < .07 > .05. No significant findings were observed for the ANPS or LUST scale.

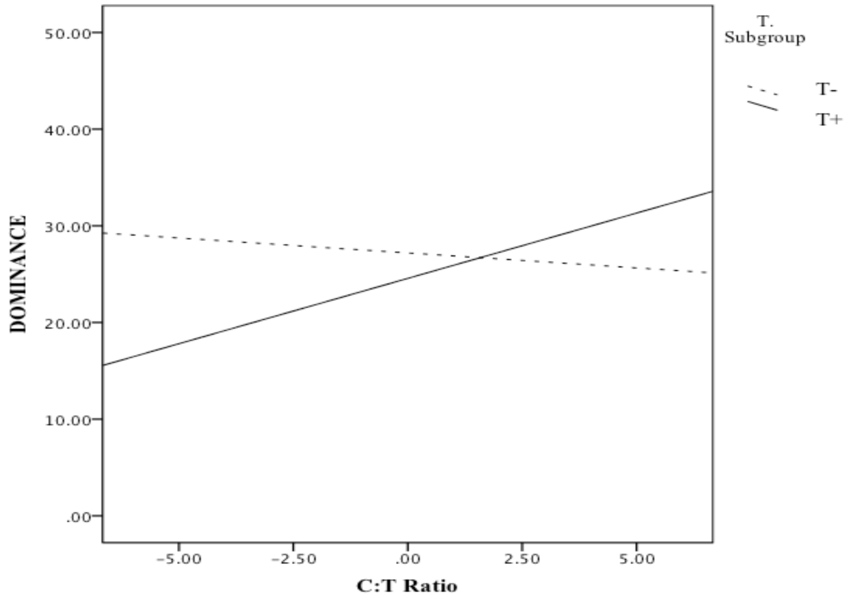

Figure 2. Pearson’s correlations between C:T ratio and DOMINNCE scale in females across testosterone subgroups. [T-] = Subgroup with testosterone levels below the mean; [T+] = Testosterone levels above the mean.

Discussion

Based on the mounting body of evidence linking testosterone with the biologically adaptive range of behaviours underlying social dominance, this research set out to explore whether or not incentives for social influence manifest as a distinct psychological construct within the structure of the ANPS, and how the steroid hormones, testosterone and cortisol, relate to these basic emotional traits. Although the neuroscientific literature on social dominance is substantial, much of the work here has been carried out within the paradigms of behavioural and cognitive neuroscience and has subsequently focused on the behaviours that mediate dominance relationships and the outcomes of those challenges. As a result, findings regarding the role of testosterone in these action tendencies and events have often been conflicting and a variety of hypotheses, some less robust than others, have been proposed to explain these discrepancies (Mazur & Booth, 1998; Archer, 2006; Stanton & Schultheiss, 2009; Chichindaze et al., 2012). There is a pressing need for an organizing concept capable of grounding the vast array of findings in the field within a unified theoretical framework. The affective neuroscience approach (Panksepp, 1998) addresses this issue, reasoning that the foundations of emotional consciousness stem from evolved ‘command’ systems in the ancient neurodynamics of the mammalian brain. Situating social dominance within the theoretical content of the ANPS may offer insights into its primary process foundations.

Recently, Panksepp and Biven (2011) have suggested that dominance-type urges are likely to arise from the interplay of several primary-process emotional systems, namely, SEEKING, RAGE, PLAY and FEAR and that the coherence observed in this type of behaviour most likely reflects learning. However, consistent with the hypothesis driving the current study, factor analyses indicated that DOMINANCE probably represents a unique facet of basic temperamental variability. Psychometric models of DOMINANCE and LUST were developed as part of this research in order to examine the latent structure of the ANPS with the inclusion of these new item pools, using exploratory factor analysis, wherein DOMINANCE emerged as a discrete factor. In support of this finding, ratios calculated from salivary assays between testosterone and cortisol were found to correlate uniquely with DOMINANCE, highlighting the relative independence of this system at the neurological level from Panksepp’s established ANPS. Specifically, the testosterone:cortisol ratio in males with high basal testosterone was found to be strongly and positively associated with DOMINANCE, and in females, this relationship was reversed, such that in those with above average basal testosterone, a positive correlation emerged between the cortisol:testosterone ratio and DOMINANCE.

Conceptualisation of trait DOMINANCE and LUST

In the first phase of this research, measurement models for DOMINANCE and LUST were developed using psychometric analyses of items designed to represent prominent findings from the neurobiological literature. Thus, although constructed primarily on the basis of primary-process data, the findings here nonetheless reflect cognitively mediated processes. Results from an exploratory factor analysis performed on these two pools together with all items from the ANPS revealed both DOMINANCE and LUST to be distinct factors, with the remaining factors closely fitting the original structure of the ANPS.

The LUST scale was found to be internally consistent and emerged largely as expected, represented by three broad categories, specifically: sexual desire, physiological arousal and sexual mentation. This conceptualization of lust is consistent with descriptions offered by other authors (Spector, et al., 1996). For instance, Beck, et al. (1991) found that both males and females use the experience of genital arousal and sexual daydreams to infer states of sexual desire. Importantly, these three conceptual categories representative of the LUST scale reflect the arguments substantiated in Panksepp’s theory of basic emotions. The hierarchical arrangement of primary process emotional systems in the brain elucidates why lust is experienced at the subjective, physical and cognitive levels. Moreover, criterion validity can be inferred from the strong correlation which emerged between LUST and the SDI, however, this finding is not surprising since there was a great degree of similarity in the content of items from both scales.

Of significance was that self-reported sexual behaviour was more common in individuals who tended to score higher on the LUST scale. This reflects an important aspect of criterion-validity as many self-report measures do not predict behaviour, and this is especially the case with sexuality (Beck, et al., 1991). Particularly because of the sensitive nature of the LUST content, this finding serves as a reassurance that social desirability biases operating during data collection were kept to a minimum. However, one cannot neglect the possibility that disclosures regarding sexual activity were fabricated. Nevertheless, this concern is somewhat reduced by the finding that males scored significantly higher on LUST, reaffirming a previously reported observation regarding sex differences in libido (Peplau, 2003), and subsequently, the validity of the current data.

Since LUST has already been established as a basic emotion system, its conceptualisation during this investigation was of less importance than that of DOMINANCE. One of the primary aims of the current study was to use the data reducing technique of factor analysis to interpret the psychological construct representing social dominance incentives. Results obtained from three similar factor solutions suggested a distinctive 2-dimensional model of social dominance, the first titled *Reward Entitlement (RE),* and the second reflecting an explicit desire for *Social Influence (SI)*.

The items representing *RE* were comprised almost exclusively from the BAS and have been interpreted here as an implicit sense of self-worth and agency enabling the recruitment of desired resources, freely from the pressures of social submission. Higher scores on the BAS, which are thought to index greater activation of the behavioural activation system described by Gray (1981), encourages the pursuit of reward and inhibits behavioural inhibition, which itself is fuelled by sensitivity to punishment and would theoretically underpin submissiveness. Indeed, Terburg and colleagues (2011) have used the Drive and Reward Responsiveness scales of the BAS as an implicit measure of social dominance in their research. Individuals with high scores on this measure tend to prolong their gaze to social challenge cues such as angry faces (Terburg et al., 2011) and have been found to offer fairer payoffs in the Ultimatum game (Scheres & Sanfey, 2006), possibly due to their increased concern for being evaluated in a socially esteemed light (Eisenegger, Naef, Snozzi, Heinrichs & Feir, 2010).

No sex differences were found for *RE*. Since females are known to be more sensitive than males to the reinforcing effects of stimulants (Roth, Cosgrove & Carroll, 2004), the impression that this factor does not simply reflect reward seeking, but rather, the agency required to obtain those desired objects within socially controlled contexts is substantiated. The item, “People who know me well would say that I have a powerful character” supports this interpretation. This distinction is important because the BAS has been linked to the mesolimbic dopaminergic system (Alcaro, Huber & Panksepp, 2007), which underpins SEEKING; and indeed, a moderate relationship between SEEKING and *RE* was observed here. On the basis of this observation, one cannot exclude the possibility that *RE* may be more related to the SEEKING impulse than those for social dominance. However, although the SEEKING item, “Sometimes I feel like I could accomplish almost anything” bares striking similarity to the *RE* item stated above describing a sense of powerfulness, it failed to load on SEEKING in the exploratory factor analysis. Nonetheless, *RE* was found to correlate moderately with SEEKING and it is reasonable to speculate that a central function of dominant behaviour is to mediate anticipatory urges within the competitive social environment. As such, discussions about one system cannot be had without a treatment of the other. The SEEKING system has, after all, been described as the ‘grand daddy’ system of the emotions (Panksepp, 2011).

The second dimension, *SI*, is perhaps more consistent with established conceptualisations of social dominance, particularly the ideas put forward by Eisenegger et al. (2011) who have defined the term as “the motivation to achieve or maintain high social status; that is, to obtain power, influence, or valued prerogatives over another individual” (p.263). The composition of items representing the *SI* factor conveys both satisfaction in authority and social status and a competitive spirit geared toward attaining these attributes. As such it is conceptually related to *RE*, in that *power* determines access to rewarding resources and explains why these two dimensions tended to merge in many factor solutions. Importantly, this factor emphasises the positively valenced affective nature of the trait, that individuals who score high on this subscale tend to feel satisfaction and enjoyment out of situations in which they are able to control and influence groups of people. Indeed, prior research has shown that trait dominance is related to greater positive affect as measured by the Positive and Negative Affective Schedule (PANAS) (Demaree et al., 2005).

Unlike *RE*, a significant effect for gender was found for *SI* where males tended to score higher than their female counterparts. From the point of view of evolutionary theory, this finding resonates with Buss and Schmitt’s (1993) sexual strategies theory. This theory argues that because of the greater amount of parental investment required of females, they must be more selective in choosing their mating partner and subsequently this has increased the disposition toward competition for mates among males. Social dominance may therefore be less imperative for female fitness than it is for males' and may as such explain this finding.

Table 10

Definitions for Dominance Scales

DOMINANCE	Egocentrism and agency in competitive contexts, underpinned by both SI and RE dispositions.
Social Influence (SI)	Satisfaction in maintaining authority and social status, explicit competitiveness.
Reward Entitlement (RE)	Implicit sense of self-worth and agency in socially competitive contexts.

Together, DOMINANCE, composed of the subscales *RE* and *SI*, describes an emotional disposition underpinning egocentrism and agency in competitive contexts in which there is potential for social ascendancy. There is a substantial body of evidence that supports this view. Of the various psychometric models that have been developed to measure trait dominance, the conceptualisation presented here aligns most closely with Gough and Bradley's (1996) scale, which denotes a prosocial variant of social dominance that stresses perseverance in the pursuit of leadership goals. Anderson and Kildiff (2009) have argued that, through the use of both verbal and nonverbal strategies, trait dominant individuals attain influence in social groups. In fact, on the basis of these implicit strategies, members of the group perceive these individuals as having greater expertise and therefore greater decision-making power.

The disposition toward egocentrism and agency is further supported by significant correlations reported here between DOMINANCE and the SIAS, measuring social anxiety, and Extraversion -- the former yielding a negative relationship and the latter a positive. Trait dominant individuals tend to be self-assured (Gough & Bradly, 2005) and drawn to the social sphere, often as a means for exhibitionism which refers to the penchant for attracting attention to oneself (Mehrabian & O'Reily, 1980), or less frequently, as a platform for nonconformity (Zuckerman, 2005). Furthermore, they are found to thrive in positions in society involving confrontational social interaction, such as in management (McClelland & Boyatzis, 1982), the law (Daicoff, 1997) and the military (Gimble & Booth, 1996).

On the other hand, those low in trait dominance tend to be socially inhibited and non-assertive (Gough & Bradly, 2005). Adjacent to these findings, the competitiveness highlighted in the SI factor is supported by the animal literature on dominance which has consistently implicated success in competitive contexts as a key attribute of dominant individuals, in which they appear to have an advantage in gaining access to coveted resources and rewarding activities (Vargas-Pérez et al., 2009), particularly so in times of environmental instability in which competition and stress is enhanced (Foerster, et al., 2011). These findings emphasise the centrality of *social* capital in trait dominance. Determination in the pursuit of resources outside of this context may have less relevance to this construct.

In sum, it has been shown here that DOMINANCE appears to encompass an emotional disposition characterised by self-confidence, egocentrism and ultimately agency in the pursuit of social influence and status, as attained in competitive social contexts. Crucially, the extent to which the existing basic emotional traits, as conceptualised in the ANPS, can account for this adaptive behavioural function is questionable. The method of factor analysis applied here is limited, however, in answering this question since self-report data inevitably reflects tertiary level processes, and therefore, neurobiological variables in the form of testosterone and cortisol assays were incorporated into the design of this study.

Hormone Assays

Phase 2 of this research aimed to examine the relationships between the hormones, testosterone and cortisol, and the ANPS, DOMINANCE and LUST scales. Drawing from research implicating basal testosterone as a marker of individual differences (Sellers, Mehl & Josephs, 2007), it was hypothesized that this hormone would preferentially correlate with DOMINANCE and that this association would in some way depend on interactions with cortisol due to the reciprocal relationship between these two hormonal systems (Johnson, Kamilaris, Chrousos & Gold, 1992).

Considering only testosterone, no significant relationship with DOMINANCE or its subscales emerged in this study. This was not entirely unexpected since a growing body of literature has begun to draw attention to the necessity of considering cortisol in the relationship between testosterone and dominance (Mehta & Josephs, 2010; Carré & Mehta, 2011; Terburg, Morgan & van Honk, 2009). Furthermore, some have argued that self-report measures like the one developed here are incapable of accessing dominance motives since they may operate unconsciously (Josephs et al., 2006; Terburg et al., 2012). Nonetheless, weak correlations have been reported elsewhere (Grant & France, 2001; Cashdan, 1995; Sellers, et al., 2007).

The relationship between testosterone and DOMINANCE was, as such, further examined by considering cortisol interactions and this was studied in the male and female samples separately. This was attempted firstly by running a regression analysis with a testosterone x cortisol interaction term to test whether different levels of cortisol moderate the association between testosterone and DOMINANCE. This was not found to be significant; however, when the ratio between testosterone and cortisol was considered, significant findings emerged.

In the male sample, a positive correlation emerged between the baseline T/C ratio and DOMINANCE. Crucially, when the sample was divided into low and high testosterone subgroups, the relationship between this ratio and testosterone strengthened to a great degree in the high testosterone group on the *SI* dimension and composite factor only, but failed to reach significance for *RE* or for any dominance variable in the low testosterone group. What this appears to demonstrate, is the critical role of elevated testosterone in its association with DOMINANCE, specifically, *SI*, which yielded the strongest correlation, and that cortisol moderates this relationship, in that basal cortisol levels must be low *relative* to testosterone. This may explain why the moderated regression analysis failed to reveal a significant result in the current study. That Mehta and Josephs (2010) were able to demonstrate that the link between testosterone and a dominant disposition depends specifically on low cortisol may be explained partially by their considerably larger sample size and smaller reported effect size. Nonetheless, this data is consistent with the growing body of evidence implicating cortisol in the relationship between testosterone and dominance (Carré & Mehta, 2011; Sapolsky, 1982; Leining & Josephs, 2010).

The findings presented here reflect the general ideas put forward by Terburg, Morgan and van Honk (2009) who have proposed that the T/C ratio predisposes to social aggression as articulated in their triple balance model of emotion. As it stands, however, to the best of my knowledge, this is the first empirical study on social dominance to adopt this approach and report significant findings. Terburg and colleagues have argued that this ratio underpins the balance between the central behavioural activation and inhibition systems, the former promoting approach behaviour and the latter, sensitivity to punishment. Testosterone appears to inhibit the autonomic activity promoted by activation of the HPA axis, which represents a component of the fight-or-flight response and of which cortisol is the end product. Likewise, elevated cortisol may inhibit the action of testosterone. Elevated levels of cortisol have been linked to shyness and introversion, characteristic of behavioural inhibition (Kagan, Reznick & Snidman, 1987; Kalin, Larson, Shelton & Davidson, 1998; Smider, Essex, Kalin, Buss, Klein, Davidson, 2002), despite these types of psychological propensities not having been found to correlate with cortisol in the male sample presented here. This may be attributable to the small sample size. Furthermore, these systems form the theoretical basis of the BAS/BIS scales, and therefore it is surprising that the T/C ratio was not found here to correlate with *RE*, which is constituted almost exclusively from items from the BAS drive and BAS reward responsiveness subscales. The exclusion of items from the Fun subscale in RE may account for this discrepancy, implying that the BAS system represents generalised, as apposed to exclusively social approach. Regardless, this model clarifies the mechanisms underpinning the involvement of cortisol in social dominance, that it counteracts the action of testosterone, and therefore that in males, greater levels of testosterone appear to be necessary in order to facilitate approach behaviour.

Findings from the literature confirm this role of testosterone as facilitating behavioural activation, specifically, the kind that promotes social approach. Research by Josephs et al. (2006) has shown that individuals with elevated levels of testosterone harbour preferences for high status, suggesting that they are drawn to the social sphere. Additionally, these individuals enjoy competing in challenges, even after a loss (Mehta & Josephs, 2006). Likewise, these individuals do not seem to be intimidated by social threat signals (Terburg et al., 2012) More importantly, despite the fact that items from the DOMINANCE scale were constructed to reflect the literature on the neuropsychological functions of testosterone, it is nevertheless reassuring to note that the relationship between the final version of this scale and testosterone has been established here, and is as such consistent with previous findings. Specifically, Eisenegger et al. (2011) have argued that the role of testosterone in social interactions pertains to the pursuit and maintenance of social status, and consequently, testosterone underpins the formation of dominance hierarchies. In particular, baseline levels of the hormone have been linked to general dispositions toward dominance (Grant & France, 2001; Rowe, Maughan, Worthman, Costello & Angold, 2004; Carré, Putman & McCormick, 2009; Vermeersch, T'Sjoen, Kaufman, Vincke & Van Houtte, 2010), endorsing it as a biological marker of trait dominance. For instance, Carré et al. (2009) found that trait dominance, measured using the dominance subscale of the Personality Item Pool Scales, but not behavioural aggression, predicted basal testosterone in men.

Results from analyses performed on the female sample indicated that while the T/C ratio did not correlate with DOMINANCE, a significant positive association was found on both dimensions when the C/T ratio was considered in subgroups with elevated testosterone. Crucially, as with the male sample, testosterone appeared to drive this relationship since in the low testosterone groups, the positive correlation between DOMINANCE and C/T failed to reach significance, but strengthened considerably in the high testosterone subgroups. Despite the fact that research on dominance in women is sparse in comparison to the male literature, findings generally confirm this link between social dominance, specifically status seeking and competitiveness, in women (Cashdan, 1995; 2003). Nonetheless, these results were unexpected as cortisol is thought to play a behaviourally inhibitive role (Kagan, Reznick et al., 1987; Kalin et al., 1998; Smider et al., 2002), yet the present data indicate that in this sample of women, elevated basal levels of cortisol, relative to high testosterone, predict social dominance incentives.

It must be noted, though, that some authors have cautioned against considering only one aspect of the HPA response to challenge, and that the overall pattern, specifically the reactivity, amplitude, rate of recovery and base rate should all be taken into account when making references to stress (Seeman & Robbins, 1994). Regardless, consistent with the present findings, other studies have in fact found women's cortisol levels to increase in anticipation of sporting competitions and that cortisol has been shown to be negatively related to opponent evaluations (Bateup, Booth, Shirtcliff & Granger, 2002), suggesting here that cortisol does not necessarily predispose to feelings of social intimidation in women. Interestingly, in a study consisting of largely all females, it was found that social phobia and high trait shyness was associated with low cortisol levels (Beaton, Schmidt, Ashbaugh, Santesso, Antony, McCabe et al., 2006) and it has been demonstrated elsewhere that while in competent males, elevations in cortisol prior to competition are reduced, this is not observed in females (Bateup et al., 2002).

It is an established fact that sex differences exist in the HPA response to stress (Kudielka, & Kirschbaum, 2005; Kirschbaum, Wüst, Hellhammer, 1992), and furthermore, that these physiological responses do not necessarily reflect or parallel the subjective, psychological reaction to stressors (Buske-Kirschbaum, Jobst, Psych, Wustmans, Kirschbaum, Rauh, Hellhammer, 2003; Kirschbaum, Kudielka, Gaab, Schommer, Hellhammer, 1999), implying that verbal reports of emotional feelings may not appropriately index HPA arousal. This may explain why the present data yielded significant negative correlations in the female sample between cortisol and measures of negative affect, such as FEAR, GRIEF, neuroticism and RAGE. Even so, sex differences in physiological reactions to acute stress may explain these findings. Wang, Korczykowski, Rao, Fan, Pluta, Gur et al. (2007) reported that in males, psychological stress increases metabolic activity in the right prefrontal cortex, accompanied by a reduction in the left orbital frontal cortex. In females however, this response was characterised by greater activation of the limbic system, especially the ventral striatum, putamen, the insula and the cingulate cortex. Additionally, this female response to stress showed a lower correlation with cortisol when compared to the male sample, a finding that has been confirmed many times elsewhere (Collins & Frankenhaeuser, 1978; Earle, Linden, Weinberg, 1999; Kirschbaum, Klauer, Filipp, Hellhammer, 1995).

The present findings point to differences not only in the neurophysiology of DOMINANCE, but also in the stress response in males and females. Certainly, this is not entirely astounding as testosterone and cortisol production differs across the sexes. Specifically, women not only produce up to seven times less testosterone than men, but the site of production differs too, with female production occurring predominantly via peripheral metabolism of deyhdroepiandrosterone (DHEA) and in males, activation of the HPG axis (Parker, 1991). Since the adrenal gland secretes DHEA in response to challenging situations in women and is related to changes in cortisol, it is plausible to expect that the interactions between testosterone and cortisol in relation to DOMINANCE differs to those observed in males (Bateup et al., 2002).

These observations support the theory proposed by Taylor and colleagues (2000) who have argued that, subsequent to the initial physiological stress response, the behavioural response to challenge in females may be better characterised by what they have termed, ‘tend-and-befriend’ as opposed to fight-or-flight seen in males.

This response is thought to address the unique adaptive challenges faced by females with regard to their maternal investment in offspring by promoting nurturing behaviours aimed at protection and the maintenance of important social networks that support this process. This response may be largely underpinned by oxytocin (Jezova, Jurankova, Mosnarova, Kriska & Skultetyova, 1996), since this hormone also forms part of the general stress response, and in males may be inhibited due to their comparatively elevated levels of androgens (Jezova et al., 1996) and reduced levels of estrogens (McCarthy, 1995).

What this body of literature points to is a potential difference between the genders in terms of the function of the stress response in relation to coping with sex-specific, *socially* adaptive challenges. For males, high levels of cortisol in the context of threat, perhaps due to an appraisal based on prior defeats, may encourage submission because of the especially hostile nature of male competition. In females, social conflict appears to be less physical, and research has in fact shown that women are more prone to passive forms of aggression (Crick & Grotpeter, 1995). As such, it seems plausible that inhibition of behaviour is less pertinent in the face of a social threat for females, but that the stress response is instead geared towards behaviours that support the formation of alliances. In this context, testosterone-fuelled DOMINANCE might centre more on the *management* of group members and resources in females. Interestingly, Edwards, Wetzel and Wyner (2006) and Bateup and colleagues (2002) found that during team sporting activities, the anticipatory rise in testosterone in women was additionally associated with increased perceptions of social connectedness and bonding with teammates, supporting this relationship between stress and dominance. Conversely, male DOMINANCE may involve attempts at *controlling* and *outperforming* conspecifics, as would be expected according to the theory of sexual selection. These ideas may explain why women's cortisol-testosterone interaction in the present study was found to relate to RE as well as SI. Moreover, since a concern with status, specifically, was emphasised in the SI subscale, this may clarify why the relationship between DOMINANCE and the hormonal correlate was considerably weaker in the female sample. Nonetheless, these ideas remain speculative and further research is required to explore the matter further.

To summarise, although testosterone on its own was not found to correlate with DOMINANCE, a significant association between testosterone and DOMINANCE appeared when cortisol was taken into account. Specifically, in males with elevated levels of basal testosterone, the T/C ratio was positively related to SI. In females however, both high levels of testosterone and cortisol emerged as significant predictors of DOMINANCE, in that the C/T ratio correlated positively with both RE and SI in women with elevated levels of circulating testosterone. These findings highlight the importance of adopting a duel-hormone approach in the study of the social-emotional functions of testosterone, specifically because DOMINANCE emerges in socially stressful contexts. Furthermore, the effect sizes reported here add significantly to the self-report literature on dominance and suggest that the kind conceptualised here may better represent the biological system since they are stronger than many of the hormonal correlates reported to date (see Cashdan, 1995; Grant & France, 2001; Sellers, et al., 2007). Importantly though, the data presented here suggest that the nature of social dominance urges may differ to some extent across males and females.

DOMINANCE in Relation to Panksepp’s Basic Emotions

Despite these reported sex differences in the physiology of dominance, which centre largely on cortisol and not testosterone, the findings presented here from both male and female samples support a role for testosterone in not only the emotional incentives for social dominance, but also the explicitly and verbally reported motivations for this goal. This lies in contrast to the ideas described by other research in which desires for dominance are thought to operate unconsciously (Stanton & Schultheiss, 2009; Terburg et al., 2012). However, these studies did not take the hormonal ratio between testosterone and cortisol into account; this may explain the discrepancy. The role of cortisol in understanding the phylogenetic functions of testosterone is particularly important, since it situates the dominance response in the social stress context, in that it appears to have evolved to mediate the demands associated with competition among members of a society. What this implies, therefore, is that those high in trait dominance may be better able to cope in socially stressful situations in which the wills of others must be contended. Corroborating this, the DOMINANCE scale conceptualized here describes an emotional disposition that appears to equip the individual with the psychological resources necessary for approaching socially competitive environments, in which there is a potential to reap social influence with agency and conviction. Findings from the literature on testosterone have accumulated to the extent that the intrinsic neuropsychological mechanisms underpinning this disposition can now be theoretically appreciated.

Four lines of evidence suggest these mechanisms. Firstly, testosterone may bias attention toward signals indicating social challenge, such as status cues (Mehta & Josephs, 2006), or threatening faces (van Honk et al., 1999; Terburg, 2012), the latter of which has also been linked directly to trait dominance (Terburg et al., 2011). This may be supported by the ability of testosterone to inhibit fearful reactions prompted by biologically salient fear cues (van Honk & Schutter, 2007). Secondly, testosterone may promote egocentric thought processes and predispose toward self-centred decision-making aimed at enhancing personal gains (Wright, Bahrami, Johnson, Di Malta, Reed, Frith et al., 2012). Related to this, deficits in empathic ability have been linked to higher levels of testosterone. Van Honk et al. (2011) and Montoya et al. (2012) have demonstrated that the administration of testosterone attenuates social intelligence and moral reasoning abilities, depending on the second-to-fourth finger digit ratio, which serves as a proxy for prenatal testosterone exposure. Furthermore, those with high basal testosterone tend to be regarded by others as having diminished levels of empathic insight. Interestingly, it has been shown elsewhere that impoverished empathic abilities actually support the achievement of personal gain, denoting its role in social dominance (Galinsky, Maddux, Gilin & White, 2008).

Finally, testosterone appears to have an impact on subjective experience, and this mechanism may underlie all of the above findings. Although the literature does not fully elucidate this issue, the present data indicates that social dominance is supported by positive affect, specifically, feelings of agency, competitiveness, power and satisfaction, with other research reporting more general descriptions of ‘positive affect’, specifically before and after victory (Salvador, et al., 1991; Mazur & Booth, 1998) even if it is experienced vicariously (Bernhardt, Dabbs, Fielden & Lutter, 1998), or reduced fearfulness (Eisenegger et al., 2011). The rewarding effects of testosterone have been documented in a number of studies (Frye, et al., 2002; Packard, et al., 1997; Johnson & Wood, 2001; Wood, 2008), suggesting that the modulation of the dopaminergic system by testosterone may play a role in the hedonic tone associated with dominance. However, there is evidence to contradict this view or that testosterone is associated with any feeling at all (Gonzalez-Bono, et al., 1999). Even so, as it stands, the reinforcing effects of androgens have not yet fully been elucidated and the present findings cannot contribute reliably to this area of inquiry.

Nonetheless, the concept of basic emotional systems provides a useful organizing principle through which to interpret the psycho-behavioural functions of testosterone in its relationship to social dominance. Applying this conceptual framework to the present data and existing literature succinctly resolves several areas wherein findings have been unexpected and provides a better explanation for the data accumulated to date. One such finding has been that testosterone only appears to influence behaviour under certain conditions (Josephs et al., 2006), leading some to believe that aspirations for social dominance may exist only implicitly (Staton & Schultheiss, 2009). Clearly, the present findings challenge this view since it has been demonstrated here that verbally reported desires for social influence are related to high levels of testosterone. Social emotions are, however, context dependent, both internally and externally. For example, PLAY in young animals will only be exhibited when their biological homeostatic needs are met and they feel safe and secure in their environment (Panksepp, 1998). Likewise, dominant behaviour appears to require the appraisal of a challenge (Mazur, et al., 1992), either via secondary learning processes or unconditional stimuli. Indeed, primary processes are designed to respond specifically to cues that signal key survival challenges and many items from the DOMINANCE scale, specifically the SI dimension, allude to *challenging* social contexts.

This insight is critical for conducting research in this field. For instance, a similar dilemma was faced by researchers struggling to demonstrate the reinforcing effects of oxytocin, until they adopted a socially (and therefore contextual) reinforcing paradigm, after which they were then able to demonstrate facilitation by oxytocin of the reward process (Panksepp, Nelson & Bekkedal, 1997).

The issue of reinforcement signifies another important area in which basic emotion theory provides coherence. Like Mazur and Booth’s (1998) biosocial theory of status, many studies have linked testosterone to the reinforcement of favourable social outcomes (Mazur & Lamb, 1980), yet there is also a great deal of findings which have failed to establish the link between testosterone and winning (Mehta & Josephs, 2006; Gonzalez-Bono et al., 1999; Suay, Salvador, Gonzalez-Bono, Sanchis, Martinez, Martinez-Sanchis et al., 1999; Salvador, 2005). Crucially, framing the role of testosterone as an intrinsically rewarding state of active coping, discrepant findings with regard to contextual outcomes are resolved. Thus, one should err against using situational factors such as outcomes and hierarchical positions as the dependent variable in testosterone research and consider the role of affect instead. Primary process emotional feelings support “intentions-in-action” (Panksepp, 2010b), supposedly accounting for the anticipatory rise in testosterone observed prior to and following competition, as enunciated in criterion 3 of Panksepp’s neural definition of basic emotions. Indeed, the findings presented here have drawn attention to the invigorating feelings involved in explicit social dominance incentives, suggesting that this is what drives the disposition.

Nevertheless, the exact nature of testosterone’s role in primary emotional affect remains contentious. This study was not able to decisively characterise the unique affective valence underlining the orientation toward social status, nor was it able to answer conclusively the question of whether or not DOMINANCE is underpinned by a unique emotional brain system. It has, however, tentatively addressed the first and sixth of Panksepp’s criteria for basic emotions, in that it was able to demonstrate a link between a distinctive component of temperamental variability with an apparently select adaptive function, and a largely unique neurophysiological substrate.

While the pattern of results reported here supports the distinction of social dominance, Panksepp and Biven (2011) have maintained that it emerges at the secondary level, reflecting behaviours acquired during the interplay of SEEKING, RAGE, FEAR and PLAY. A corresponding argument may therefore be that in challenging contexts, particularly those involving reproductive payoffs, secondary dominance urges culminate at the point when SEEKING impulses are thwarted, leading to the provocation of RAGE when FEAR is low and the implementation of behaviours successfully acquired in the combative context of juvenile PLAY. Based on this idea, testosterone may serve to promote these behaviours by announcing the potential to acquire important fitness gains. In line with this, in the self-report data, DOMINANCE was found to correlate moderately with both RAGE and SEEKING, and negatively with FEAR.

Despite the plausibility of this alternative explanation, a number of findings from both the present research and the existing literature contradict it and tentatively support the alternative hypothesis that the circuit suggested by the concentration of testosterone and AVP receptors constitutes a unique emotional system, which supports emotional incentives for social influence.

Here it was found that when controlling for sex, basal testosterone correlated negatively with SEEKING and approached significance when correlated with RAGE in the combined male and female sample. When looking specifically at the male group, the negative relationship between testosterone and RAGE reached significance, as did that between testosterone and LUST in the female group. Additionally, in all sample groups, testosterone had an inverse relationship with the PHQ, which measures depressed mood. However, contrary to what was expected, a negative relationship emerged between testosterone and RE, but not for CARE. Furthermore, FEAR and testosterone were not significantly related.

Results from these correlation analyses demonstrate that testosterone does indeed affect behaviour at the primary emotional level, and because of the predominance of negative correlations observed here, specifically with SEEKING, RAGE, LUST and the PHQ, doubt is cast upon the hypothesis put forward by Panksepp and Biven (2011) regarding the involvement of these emotions in the psycho-behavioural state mediating social competition.

Importantly, these correlational findings suggest that the mood enhancing effects of testosterone, which have consistently been replicated in other research (Davis, 2005; Margolese, 2000), may not exclusively be due to the positive feelings of the SEEKING system, despite findings that the rewarding effects of testosterone may occur via this dopamine system (Packard et al., 1998). Indeed, early research has shown that high dosages of anabolic steroids have mood enhancing effects, possibly underpinned by their ability to upregulate androgen receptors in the PAG (Teledgy, 1987) – a core site of instinctual affect (Panksepp, 1998). Additionally, there is evidence which suggests that the positive hedonic effects of testosterone may depend on their aromatization to androstanediol (Rosellini, Svare, Rhodes & Frye, 2001), which in turn acts at $GABA_A$/benzodiazepine receptor sites in the nucleus accumbens and which in turn synapse on DA neurons (Frye, 2007). These findings tentatively suggest that segregated cell groups within the DA system may distinctively underpin SEEKING and testosterone-reward. Moreover, Mutzel and colleagues (2011) have demonstrated in house sparrows that excited exploratory behaviours, which are now well known to be supported by the SEEKING system (Panksepp, 1998), are not associated with circulating levels of testosterone, nor does testosterone administration have affect this behaviour.

Few researchers in the field have concentrated on the role of affect in supporting the behavioural functions of testosterone. Recently however, Chichindaze and colleagues (2012) have recognized the centrality of hedonic feelings in dominance contests and have proposed that the pre-encounter rise in testosterone occurs on the basis of excited anticipation of victory, without which no changes in testosterone are observed. Although these authors acknowledge the role of a positive mood state in the facilitation of competitive behaviour, they do not differentiate the intrinsic valence of testosterone to that of the ML DA system, and instead interpret the reinforcing effects of testosterone as ‘generalized reward’, as mediated by the dopaminergic circuit (Koob & Le Moal, 1997). However, qualitatively, the feeling state as described by items from the SEEKING scale and which centre on curiosity and interest, does not appear to correspond with the emotional valence driving dominance urges, even though an active SEEKING system may be critical in supporting these functions. Importantly, there is little data linking the psychobehavioural state induced by dopamine agonists to the determination and unimpeded drive that characterises DOMINANCE (Dackis, Gold, Sweeney, Byron, & Climko, 1987; Drevets, Gautier, Price, Kupfer, Kinahan, Grace et al. 2001; Johanson & Uhlenhuth, 1980). Indeed, the finding here that no positive relationship between testosterone and SEEKING emerged is supported by this literature.

While the neurophysiology associated with SEEKING may play an important role in facilitating the androgenic reward, it does not appear to account for the valenced emotional state accompanying anticipatory rises in testosterone observed prior to competition. The curiosity and anticipation driving exploratory behaviour may in fact be counterproductive to the highly channelled behaviours involved in dominance contests.

Since RE has been conceptualised here as an agenic and egocentric orientation toward the attainment of goals, it was quite unexpected that in both the combined and males samples it yielded a significant negative correlation with testosterone, albeit a weak one. Considering earlier findings that 16% of the variance in SEEKING can be explained by *RE*, and that SEEKING too is negatively related to testosterone, the factor solutions described earlier which split the *RE* dimension from *SI* may be a better representation of the social dominance construct. In support of this, correlational analyses indicated *SI* to be only weakly related to SEEKING. Moreover, while the current study attempted to measure the subjective emotional feelings underpinning social dominance, the composition of items representing *RE* only *implies* the nature of the implicated feelings and it is possible that interpretation here was inaccurate. Despite the scarcity of data on this topic however, there does appear to be some evidence that testosterone supports affect in a unique way, promoting feelings of competitiveness (Cashdan, 2003), and confidence (Gough & Bradley, 2005) as well as agency and social satisfaction, as reported here. For the time being, however, these conjectures remain speculative, but provide fertile avenues for future research.

Supporting the observed distinction between SEEKING and DOMINANCE in the factor analysis, despite reports that dominants are generally highly successful in acquiring coveted resources within group settings, their sole acquisition does not appear to drive the DOMINANCE impulse, as implied by the negative relationship reported here between exploratory urges and testosterone. Instead it is more likely the motivation for social capital that underscores this disposition. Supporting this idea, van der Meij and colleagues (2012) recently confirmed that elevations in testosterone that accompany intermale competition are associated with increased levels of affiliation with women following such an event. DOMINANCE may simply recruit the SEEKING system, as do all the other basic emotional systems (Panksepp, 2010, dialogues in clinical neuroscience), but its unique function may be in the acquisition of social status and the associated fitness gains.

Taking this functional context into account, i.e., DOMINANCE appears to uniquely support behaviours aimed at attaining and maintaining social status and the agency it affords, the involvement of RAGE circuitry seems unlikely. Hence, consistent with the present finding, namely that high scores on DOMINANCE are inversely related to RAGE, the hostility and “fiery mental storm that persuades us that the offending agent is below contempt and deserves harm” (Panksepp, 1998, p.191) may instead be counterproductive during social competition. Moreover, the psychological factor underpinning social dominance was found in this study to be largely characterised by positive affect, unlike the negatively valenced state of RAGE (Panksepp, 1998), suggesting that RAGE and its associated hostility may not be principally involved in this disposition. However, a positive association between angry mood and testosterone has been documented elsewhere (van Honk et al, 1999), a finding which may reflect the process of reward-frustration in the context of competition.

Importantly, though, RAGE falls short of explaining the complex goal-directed activities of behaviours aimed at securing social influence. For instance, if we look to the rat intruder paradigm as an example of this, evidence now indicates that the antagonistic response initiated by the resident male results only in superficial wounding (Litvin, et al., 2009) and as such should not be interpreted as an outburst of fury intended to harm the intruder as would be expected if RAGE underpinned these activities. Instead, DOMINANCE represents a highly goal-directed agenda, but more importantly, testosterone has been found to increase utilitarian decision-making in favour of the wider group (Carney & Mason, 2010), and as such appears to be more related to leadership than intentions to harm. Recent findings have supported this idea, demonstrating that intranasal AVP, but not placebo or oxytocin, significantly increases cooperation in the Prisoner’s Dilemma game when a player is confronted with a cooperative gesture (Rilling, Demarco, Hackett, Thompson, Ditzen et al., 2012).

Notably, differentiation among group members along dispositional dominance and the testosterone continuum has been shown to significantly increase productivity as a function of reduced interpersonal conflict (Ronay, Greenaway, Anicich & Galinsky, 2012). RAGE, of course, facilitates conflict by promoting approach behaviour toward signs of threat. Of note here is that while administration of AVP has been shown to specifically reduce the ability to recognize negative emotions, such as accusing or hostile faces to a greater degree than positive emotions (Uzefovsky et al., 2011), this ability to recognize threat may be critical in the elicitation of RAGE and therefore dissociates the chemistry involved in social dominance from that supporting enraged attack. This observation, together with the current data showing testosterone to be associated with lower levels of trait anger, further suggests that the relationship between testosterone and DOMINANCE is not likely mediated by RAGE. As such, at the group level, the unique adaptive function of testosterone therefore appears to centre on its ability to mediate competition and coordinate societal activities in a fashion that minimises harm and maximizes overall functioning. This idea is supported by ethological research conducted by de Waal (1986), which emphasises the revered status of dominants- that they are regarded by group affiliates as valuable members and not simply feared as is proposed in more hostile interpretations of dominance (Hamby, 1996).

Nonetheless, debates regarding the relationship between aggression and testosterone feature prominently in the literature (Eisenegger et al., 2011; Booth, et al., 2006; van der Meij, et al., 2012). Indeed, some have argued that trait dominance underpins interpersonal violence and is largely characterised by aggressiveness (Hamby, 1996). There is in fact a large body of research that underscores aggression as the defining feature of social dominance (Carré & McCormick, 2008; Terburg, et al, 2009). However, many of the paradigms used to index aggression in human testosterone administration studies do not necessarily have sufficient ecological validity[8], and furthermore, correlational findings have often been drawn from criminal populations (Booth et al., 2006) in which dominance incentives are not controlled for. Hence, based on the finding here that individuals with high testosterone were inclined to have low RAGE scores, the hostility sometimes associated with androgen fuelled social interactions should not necessarily be equated with the emotional variety underpinning RAGE. This assumption is supported to some extent by the study carried out by Carré and McCormick (2008), who have shown that aggressiveness is not related to competitiveness. Hence, even though antagonism in social dominance cannot be denied, these findings contribute to the debate regarding the involvement of enraged feelings in social dominance, and suggest that RAGE may have less contribution to these urges than is proposed by Panksepp and Biven (2011).

The finding here that testosterone was not associated at all with PLAY was somewhat surprising since the behavioural patterns observed during rough-and-tumble play in animals and the structured games in humans more closely reflect the theoretically benign temperamental state underpinning DOMINANCE. Trait dominance has in fact been reported as a strong discriminator of preferences for physical activity (Mehrabian & Bekken, 1986) and sensation seeking (Campbell, et al., 2010), and both dispositions appear to be positively valenced. Yet, studies have shown that while infantile play among mammals resembles adult territorial aggression, if either animal gains an advantage exceeding 70%, the playful vocalizations characteristic of this joyful state cease immediately (Panksepp, 1998). The weak correlation reported here between DOMINANCE and PLAY confirms this interpretation.

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[8] For example, the Ultimatum game, which requires two people to decide how to divide a sum of money with varying payoffs, is commonly used in testosterone/ dominance research. When one player rejects an offer from their partner, neither player receives a payoff, and this is interpreted as an aggressive act.

Supplementing these arguments, many dominance behaviours, which are also elicited by testosterone and vasopressin such as aggressive scent marking and vocalisations, are not part of the PLAY repertoire and appear to be uniquely related to social status incentives (Johnston, 1981; Ball, et al., 2003). Following from these observations and in response to the proposal that social dominance may be learned in the context of juvenile play, one would expect that the acquisition of dominance displays would be underscored by a playful disposition, since learning requires experience, and more experience would translate into a more playful disposition. Studies carried out on chimpanzees have however supported this idea, revealing that young chimps isolated from their playmates tend to grow up into submissive adults (Goodall, 1986). However, the finding that dominance behaviours can be elicited spontaneously by direct chemical stimulation of deep brain sites (Ferris, 1992; Koolhaas, et al., 1990), suggests that they are not simply learned during prior playful interactions. Of course, many other factors may underpin submission in adult life.

Indeed, the current data from hormone assays do not support any link between PLAY and testosterone and are consistent with the negligible findings observed in the self-report data between trait playfulness and DOMINANCE. Nonetheless, the lack of any relationship to testosterone was interesting, considering that juvenile ludic urges are often played out in socially competitive contexts. Since a negative correlation in the female sample between PLAY and testosterone approached significance, this may be indicative of gender differences in the socialization of play amongst children; that young girls prefer to structure their play around domestic scenarios and not the challenges associated with rough-and-tumble play preferred by boys (Adler, Kless & Adler, 1992). However, the stressful context in which adult dominance plays out may function to inhibit PLAY. Panksepp and Burgdorf (1999) have demonstrated that social and environmental stressors inhibit playful urges in young rats (Panksepp & Burgdorf, 1999). This literature and the findings presented here extend previous observations that testosterone has in fact been found to have an inhibiting effect on play urges and castration at a young age may increase play (Panksepp, Siviy & Normansell, 1985 as cited in Panksepp, 1998). Even so, the literature on play is still markedly underdeveloped.

With regard to the stressful social context, the same argument may be said for LUST as it is a commonly reported finding that sexual libido is reduced in times of increased psychological strain (Laumann, Nicolosi, Glasser, Paik, Gingell & Moreira et al., 2005). It is therefore unlikely that these two systems contribute in a significant way to the development of a socially dominant disposition. However, research has consistently implicated testosterone in both male and female libido (Isidori, Gianetta, Gianfrilli, Greco, Bonifacio, Aversa, et al., 2005; Davis, 2000). The observation reported here, therefore, that in the female sample a negative correlation emerged between LUST and testosterone, was unanticipated. However, the female sexual response is also modulated by estrogen and progesterone (Panksepp & Biven, 2011), potentially underpinning the slight variances in the nature of sexual desire across the sexes. Because the female sexual response is principally modulated by the effects of estrogen and progesterone on oxytocin (Panksepp & Biven, 2011), it is characterised less so by ‘pursuit’ as seen in male sexuality, and more by ‘receptivity’. For instance, oxytocin mediated sexual arousal in female rats gives rise to lordosis, which is a sexually receptive position (Takeo, Kudo & Sakuma, 1995). Importantly though, the findings here that trait LUST was not positively associated with testosterone in either group resonates with the ideas put forward by Davis and Panksepp (2011), who have argued that LUST may be less relevant in the development of human personality. Accordingly, baseline, as apposed to state-dependent, testosterone, the former which has been interpreted as a marker of individual difference, may not index LUST, but rather, another aspect of personality.

It would make sound theoretical sense to propose that low levels of fearfulness facilitate social dominance. Past research has indicated that participants treated with testosterone take longer to avert their eyes from threatening faces (Terburg et al., 2012) and that in women, conscious perceptions of fear are attenuated (van Honk, Peper & Schutter, 2005). However, no significant finding between basal testosterone and fearfulness emerged in the present study. It may be useful to draw a distinction between the variety of fear that underpins social anxiety, which is certainly involved in dominance relations, and FEAR. Approach behaviour in the face of genuine bodily threat in which one’s life is at risk does not appear to represent any real fitness adaption, unlike the great advantages that boldness in the social arena affords.

Based on both the evidence accumulated to date and the present findings, testosterone does not appear to sustain SEEKING, RAGE or PLAY, but is however, heavily involved in LUST (Panksepp & Biven, 2011). As already mentioned, administration of testosterone is ineffective in stimulating exploratory behaviour (Mutzel, et al., 2011) and appears to inhibit PLAY. Key chemistries of RAGE involve the neuropeptide, Substance P and glutamate (Panksepp, 1998) and not testosterone, and while testosterone is powerful in recruiting the male sexual response, the nature of male sexuality is necessarily an ‘aggressive’ one, in the same way that female sexuality is more closely linked to nurturance. Instead, direct stimulation of sites known to support dominance, a method which is considered the most powerful approach in affective neuroscience, has shown that microinfusions of AVP elicit intermale aggression in animals (Koolhaas et al., 1990) and in humans can evoke angry grimaces indicative of social threat displays while simultaneously attenuating perceptions of friendliness (Thompson et al., 2006).

Moreover, elevated levels of basal testosterone have repeatedly been linked to high rank in societies (Ferris, 1992; Mazur & Booth, 1998; Rosen, 2006; Sapolsky, 1991) and personality traits characterised by social approach (Baucom, et al., 1985; Casdan, 2003, 1995; Dabbs & Ruback, 1988; Josephs, et al., 2006; Schaal, et al., 1996). Indeed, the present finding, regarding the correspondence between increased testosterone levels observed in males and their higher scores on the *SI* subscale of DOMINANCE in comparison to females, is supported by this literature. Likewise, in this sample, males were found to score significantly higher on *SI* than females, which is consistent with reports of a higher degree of socially dominant traits in males compared to females (Furnham & Henderson, 2011; Feingold, 1994) and which have been affirmed cross-culturally (Costa, Terracciano & McCrae, 2001).

Since no effect for sex was reported for measures of SEEKING, RAGE or PLAY, this supports the finding that these traits do not satisfactorily account for the social dominance incentives. It was, however, unexpected that no relationship between CARE and testosterone emerged in the present data set. According to the Challenge hypothesis, testosterone should drop in the face of childrearing demands (Wingfield, et al., 1990), and a negative correlation was therefore anticipated. However, it is likely that the reciprocal relationship between dominance and nurturance exists at the state, and not the trait level, especially in males.

The finding reported here, specifically that testosterone relates uniquely in a positive manner to DOMINANCE, is consistent with data from studies on the neural underpinnings of social dominance. The neural structures containing high densities of AVP receptors appear to be largely distinct from those involved in the established basic emotions. In particular, the lateral septum (Singewald, et al., 2011) and the AH may constitute essential substrates of DOMINANCE (Albert et al., 1992; Ferris, 1992, Kruk, et al.,1983; Pan, et al., 2010), one that has been dissociated from sexual motivation (Ferris & Pottegal, 1988) despite the close proximity to sites associated with LUST. However, AVP receptors have been documented in other parts of the hypothalamus implicated in SEEKING, RAGE and PLAY, such as the lateral (Ferris & Pottegal, 1988), medial and ventromedial (Behrendt, 2011) hypothalamus, respectively. In fact, lesions of the medial hypothalamus have been found to suppress certain attack behaviours involved in intermale aggression (Albert, Dyson, Walsh & Gorzaika, 1987), suggesting that this structure may play a pivotal role in social dominance.

On the basis of these findings, the possibility that testosterone acts merely as a modulator of the existing primary processes, as opposed to the key chemistry facilitating a unique basic emotional substrate cannot be ruled out. Importantly though, if testosterone does simply function as a modulator, the present findings showing that high levels of testosterone are related to low levels of SEEKING and RAGE, do not support an intuitive modulatory function of the hormone in this context- that testosterone up-regulates RAGE and SEEKING.

In sum, the data that has emerged from the present study tentatively supports the view that a DOMINANCE system should be added to in Panksepp's taxonomy. This system appears to mediate the adaptive problem associated with competition for social mobility in the context of group living. Specifically, testosterone may support the kind of agentic attitude that is necessary to encourage individuals to approach challenges that promise social status with vigour and enthusiasm in order to increase the likelihood of success in this arena. This function may be sustained by a testosterone facilitated bias in attention to status cues, egocentric thought processes, reduced ability to appreciate the minds of others and a positive mood state. As it stands, the existing taxonomy does not account for these psycho-behavioural mechanisms of testosterone or the challenge gap that they appear to mediate.

Limitations and Future Directions

Many of the findings presented here are consistent with previously published work in this field, which reinforces their validity to some extent. However, this study was not without its limitations. The sample size, especially that of the male group, was small despite being varied at the cultural level and should be expanded on in future studies.

Furthermore, as an attempt to counteract the small variations in assay readings over the course of an afternoon, collecting saliva samples at three different time points, and possibly over days, would have resulted in a more reliable reading for cortisol in particular, since several studies have confirmed a single measurement for testosterone to be reliable (Dabbs, 1990; Sellers, Mehl & Jospehs, 2007). Unfortunately, practical constraints prevented this from being done in the present study.

Another important caveat is that women’s menstrual cycles were only recorded for self-reported data, and not at the time of the hormone assays. This was particularly problematic since cortisol levels are known to vary by stage of this cycle and it may explain the relatively lower correlations reported for DOMINANCE in the female group in comparison to the male sample. However, saliva samples were only analysed for cortisol as an afterthought, after the opportunity for recording menstrual cycles had past. Data pertaining to the second-to-fourth finger digit ratio would have been valuable in this regard, in discerning whether or not the level of prenatal exposure to testosterone mediates the relationship between hormone assays and self-reported dominance. Several studies have documented this relationship and it is possible that in the present study, this ratio could have yielded interesting interactions with testosterone.

A final concern relates to the methodology. This study partly rests on the assumption that baseline levels of testosterone can be used as a proxy for the relative activity of DOMINANCE, hypothesised to be a distinctive primary-brain process. This assumption follows from the notion that basic emotion systems provide the building blocks and motivational templates upon which personality and temperament can develop (Panksepp & Watt, 2011). Dominance urges were therefore studied within the context of the ANPS, which represents a correlational approach to primary affect, in which surface descriptions of affective manifestations at the tertiary level are used to estimate complex brain processes. One of the core shortcomings of this design therefore relates to falsifiability, that is, the research hypothesis cannot adequately be addressed using this methodological design. Panksepp and Watt (2011) have warned that human correlational research is incapable of clarifying the ‘ancestral tools for living’ that evolutionary forces have embedded within the neural architecture of the mammalian brain. For this, animal models are essential. Nonetheless, human research will always have its place in affective neuroscience since the variation of raw feeling tones among the basic emotions can only be elucidated on the basis of human subjective reports. It is therefore another shortcoming that the present research did not adequately tap into the precise valence underpinning the urge to dominate in the social sphere.

Much potential for progress in research on humans in this field will stem from studies that utilize designs involving the administration of intranasal AVP and testosterone. This approach will allow for causal manipulation of the key chemistries involved in social dominance, but will depend crucially on carefully designed research paradigms that are capable of providing an ecologically valid context in which DOMINANCE can be reliably elicited. Within this initiative, the value of the present study pertains to its development of a DOMINANCE scale which has been statistically differentiated from the established basic emotions, and which can potentially be used as an index of basal cortisol. Hence, this scale can be used as a data screening tool in future research to identify individuals who would be suitable for administration studies as defined by a specified cortisol bracket, depending on their gender.

Closing Remarks

Panksepp's conception of the basic emotions comes closest to what is colloquially understood as 'human nature'. There is the temptation in animal studies to draw on their behavioural patterns in describing their *essence*, but in humans, it is hard not to appreciate the temperamental variability that colours each individual in very unique and sometimes calamitous ways. Understanding these prototypes of mind is of utmost importance if we are to approach the problem of human psychological suffering. If there is indeed an 8th primary emotional brain system, or even a small amount of evidence to suggest so, investigations along this line of enquiry are certainly warranted. Undoubtedly, the prospect of a distinct emotional system generating feelings of social confidence will have endless ramifications in the clinical realm, not to mention the lives of countless women around the world using daily contraceptive pills that dramatically reduce testosterone levels.

On these grounds, and a greater yearning to fully appreciate the instinctual mind, this study sought to situate the emotional incentives for social dominance in humans within the theoretical framework of Panksepp's ANPS in order to test the hypothesis that DOMINANCE is a unique variant of primary emotional functioning.

A psychometric model for trait DOMINANCE was developed on the basis of salient findings from the neurobiological literature, and was factor analysed alongside items representing the other basic emotional traits of the ANPS. Emerging as a distinctive factor, defined as the emotional disposition toward egocentrism and agency in competitive contexts in which there is potential for social ascendancy, DOMINANCE was then further explored and found to relate positively to the ratio between basal testosterone and cortisol. Specifically, in males with high basal testosterone, the T/C ratio was found to be strongly and positively associated with DOMINANCE, while in females, both high levels of testosterone and cortisol emerged as significant predictors of DOMINANCE, in that the C/T ratio correlated positively with DOMINANCE in those with elevated levels of the hormone. Critically, no positive correlations emerged between testosterone and the existing basic emotion traits.

The method adopted here tentatively addressed two key criteria for primary emotional processes; firstly, that they must provide solutions to major life or reproductive challenges and must be constituted by unique neurophysiological substrates, and secondly, that they must underpin higher goal-directed behaviours (Panksepp, 1998). The data presented here provide the first empirical indication that the psycho-behavioural state underpinning social dominance may indeed constitute a unique variant of primary affective consciousness, as defined by Panksepp’s classification. Moreover, these findings emphasise the need to situate the study of dominance within a social stress paradigm.

Perhaps more importantly though, the discussion presented here calls into question the view offered by Panksepp and Biven (2011), to the effect that social dominance urges are likely to arise from the interplay of several primary-process emotional systems, namely, SEEKING, RAGE, PLAY and FEAR. Although, we should not underestimate the maxim that the ‘whole’ is greater than the sum of its parts, that when certain primary affects become initiated simultaneously, their combined activity takes on seemingly unique and disparate qualities. Future research will help to extend the current findings presented here, but irrespective of its ‘basic’ status, social dominance represents an integral facet of social life in a vast array of species and a succinct account of it within the theoretical content of affective neuroscience must form an indispensable component of the ongoing research initiative.

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