Height, hands & handwriting
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CHAPTER 1
Introduction
1. Introduction

1.1. Social structure, dominance and competition

Avoidance of predators is commonly invoked as the primary driving force for group living in mammals (Shultz, Noë, McGraw, & Dunbar, 2004; Van Schaik, 1983; for an alternative view see Reader & Laland, 2002). Although many benefits arise from group living (e.g., territory defense, alloparenting, etc.), social organization entails at the same time stronger competition for food, shelter, mates and other scarce resources, and consequently, the emergence of dominance hierarchies (Cummins, 2005; Dunbar, 2009; Van Schaik, 1983).

Shultz and Dunbar (2007) observed that among non-primate vertebrates, pair-bonded species have proportionally larger brains than species with alternative mating systems, while in primates, group size appears to have a larger effect on brain size than social system or pair-bonding. These authors proposed that this qualitative shift observed in anthropoid primates would have resulted from the generalization of pair-bonded relationships to all social partners (Shultz & Dunbar, 2007).

Thus, primates would have evolved remarkably large brains to manage unusually complex social environments (Dunbar, 2009; Jolly, 1966; Shultz & Dunbar, 2007; Silk, 2007). In primates, relative brain size has indeed been related to various indexes of social complexity, including grooming clique size (Kudo & Dunbar, 2001), coalition formation (Dunbar & Shultz, 2007), social play (Lewis, 2000), frequency of tactical deception (Byrne & Corp, 2004), and social learning (Reader & Laland, 2002). In humans, these social cognitive abilities might have further expanded allowing for complex social learning and communication systems, and ultimately a theory of mind—i.e., the cognitive capacity to attribute mental states to self and others—in humans (Dunbar, 2009; Herrmann, Call, Hernández-Lloreda, Hare, & Tomasello, 2007; Spelke, Bernier, & Skerry, 2013).

Dominance is a key concept for understanding social structure and inter-individual relationships—including intrasexual competition—however, it is usually poorly conceptualized. Dominance, status, and power, are often used interchangeably (Drews, 1993; Harper, 1985). Schjelderup-Ebbe (cited in Drews, 1993, p. 308) defined dominance as “an attribute of the pattern of repeated, agonistic interactions between two individuals, characterized by a consistent outcome in favor of the same dyad member and a default yielding response of its opponent rather than escalation”. Hawley defined (social) dominance as the differential ability to control resources, regardless of the means by which it is acquired (Hawley, 1999). Puts and his colleagues, in turn, distinguished physical dominance—dominance achieved through aggression or threats of aggression—from social dominance—dominance acquired via skillful leadership and persuasion (Puts, Gaulin, & Verdolini, 2006). In a similar vein, Henrich and Gil-White (2001) distinguished two distinct mechanisms for attaining social rank in human societies: dominance (i.e., the use of force or force threats) and prestige (i.e., excelling in valued domains of activity). Kalma, Visser, and Peeters (1993), in turn, made a distinction between aggressive dominance and sociable dominance. According to these authors, sociable dominance is characterized by a strong need to dominate in a reasonable way, a positive attitude towards others, a central position in groups, and a solid self-esteem; aggressive dominance, in turn, is characterized by a prevailing negative attitude towards others, and a strong motivation to realize one’s own aims, even at the expense of personal relationships (Kalma et al., 1993).

1.2. Dominance, competition, and sexual size dimorphism

While differences in the use of ecological niches, or different responses to predation may result in sexual dimorphism, sexual selection is generally invoked as the main explanation for the
origin of sexual dimorphisms (Moore, 1990). Darwin (1871/1981, p. 256) defined sexual selection as "the advantage which certain individuals have over other individuals of the same sex and species solely in respect of reproduction", and distinguished two different mechanisms: mate choice and competition for mates.

Sexual size dimorphism has been related to high rates of male-male competition and polygyny in anthropoid primates (Clutton-Brock, 1985; Plavcan, 2012; Plavcan & Van Schaik, 1997). It is generally believed that sexual size dimorphism confers an advantage in male-male agonistic competition over access to mates. On average, men are larger than women; in humans, male-biased sexual size dimorphism amounts to about 10 percent, and is relatively constant across human societies (Rogers & Mukherjee, 1992), which would suggest moderate polygyny levels in human societies. In fact, analyses of human Y-chromosome polymorphisms, suggest a recent shift towards monogamy—possibly associated with a transition from mobile to sedentary communities—after a long history of polygyny (Dupanloup et al., 2003), consistent with the moderate sexual size dimorphism levels observed in this species.

The association of human height with physical strength (Archer & Thanzami, 2009; De Andrade Fernandes et al., 2014; Everett & Sills, 1952; Sell et al., 2008), physical aggression (Deaner, Goetz, Shattuck, & Schnotal, 2012), interpersonal dominance (Stulp, Buunk, Verhulst, & Pollet, 2015), antisocial behavior (Ishikawa, Raine, Lencz, Bihrlle, & LaCasse, 2001), perceived fighting ability (von Rueden, Gurven, & Kaplan, 2008), perceived authority (Stulp, Buunk, Verhulst, & Pollet, 2012), leadership and professional achievement (Judge & Cable, 2004) further suggests a link between male height and intrasexual competition in humans.

1.2.1. Relationship between intrasexual competition and the bias in height self-report

In chapter 2, I investigated whether intrasexual competition is associated with self-inflation strategies. I hypothesized that individuals high in intrasexual competition levels would over-report their height mimicking self-inflation mechanisms observed in many animal species. Given that men frequently employ deceptive tactics related to the exaggeration of superiority (Tooke & Camire, 1991), I was interested in exploring the association of the difference between self-reported height and actual (i.e., measured) height with intrasexual competition levels. A sample of junior soccer players—ages 13 through 19—was considered in this study because of the high levels of competition observed in sports and adolescence. I predicted that adolescent males who exhibit high intrasexual competition levels would over-report their own height.

1.3. Behavioral cues to dominance and competition

In many species dominance is mainly achieved via physical aggression and direct confrontation throughout the lifespan. In humans aggressive-coercive behaviors are fairly common in childhood, and become less tolerated as children mature; negative behavior frequency decreases, while positive behaviors increase as social norms are internalized (Hawley, 1999).

As most animals, humans use public information—both inadvertently provided and voluntarily produced by other individuals—for assessing the potential outcome of behavioral choices (Danchin, Girardeau, Valone, & Wagner, 2004). When the interests of two individuals diverge, deceit and selfish-exploitation are expected to arise (Dawkins, 2006). Self-deception mechanisms are proposed to have originated in order to avoid betraying one-self by giving away signs of deceit, (Trivers, 2006, 2011; von Hippel & Trivers, 2011). Furthermore, self-deceptive self-enhancement mechanisms, in particular, would allow individuals to display more confidence than warranted by the current conditions (von Hippel & Trivers, 2011).
In adult human groups intrasexual competition has become highly complex, including a wide range of different tactics and strategies. In intrasexual competition, men frequently engage in deceptive acts and tactics related to the exaggeration of superiority, sexual promiscuity and popularity; while women more frequently engage in acts and tactics related to appearance alteration (Tooke & Camire, 1991).

Nonverbal communication comprises a wide range of dynamic cues in addition to static signals. Body posture and apparent size are believed to convey information about dominance and physical threats. In *The Expression of the Emotions in Man and Animals*, Darwin described different mechanisms resulting in the inflation of the body—e.g., air inhalation, and piloerection—, as a means of exciting fear in the enemy (Darwin, 1872/2009). An expanded body posture has, in fact, been associated with dominance both in primates and humans (Weisfeld & Linkey, 1985). Among chimpanzees, the association between social rank and an expanded posture becomes manifest when a submissive individual male meets an alpha male. While the former assumes a lowered position, looking up at the dominant individual, the latter adopts a stretched posture and makes his hair stand on end, resulting in a marked size contrast (de Waal, 2007). In humans, an association between erectness of posture and dominance—or success—has also been reported. Weisfeld and Beresford (1982) observed an association, in highschool students, of erect posture while receiving midterm grades with the numerical examination score received. These authors also observed an association between erectness of posture and dominance in volleyball players (Weisfeld & Beresford, 1982).

Nonverbal dynamic cues include movements of the limbs, hands, and head, as well as facial expressions (Knapp, Hall, & Horgan, 2013). The relevance of these signalling mechanisms is revealed by the existence of neural circuits responding to these cues (for a review, see Allison, Puce, & McCarthy, 2000). In this vein, particular features of handwritten signatures—which could be considered crystallized hand-movements—have been related to personality traits—signature size has been linked to self-esteem and status feelings (Swanson & Price, 1972; Zweigenhaft, 1970, 1977; Zweigenhaft & Marlowe, 1973), whereas signature size and embellishments have been related to narcissism (Dillon, 1988; Seybert, 2013)—a personality trait characterized by superiority beliefs.

1.3.1. Relationship between expansive personality traits and signature size

Building on the theorizing and research discussed here, in chapter 3, I explored the association between handwritten signatures—a means of presenting oneself to others—with intrasexual competition, sociable and aggressive dominance.

Game avatars and handwritten signatures have been deemed as graphic representations of the self (Chou, 2015; Kettle & Häubl, 2011; Turkle, 1994). Indeed, Duguid and Goncalo (2012) have recently shown that the manipulation of power feelings significantly influences the height of a chosen avatar in a video game, i.e., participants in the high-power condition chose significantly taller avatars than individuals in the low-power condition. It has also been shown that an implicit positive affect task led to increases in signature size relative to an affective neutral task (Rawal, Harmer, Park, O'Sullivan, & Williams, 2014). Drawing from these studies, I was interested in exploring the potential association between signature size, intrasexual competition and other expansive personality traits (e.g., narcissism). In the study reported in chapter 3, I examined the relationship between signature size—using a previously described operationalization, and two novel measurement methods; and controlling for potential confounders. I hypothesized that individuals high in intrasexual competition, dominance, and narcissism would produce larger signatures.
1.4. Prenatal androgens and behavioral sex differences

In many animal species males and females differ not only anatomically, but also exhibit dimorphic behaviors. Behavioral dimorphism is generally believed to stem from sex differences in sensory, motor or central nervous system components. Masculinization of the mammalian developing embryo depends on the sex-determining region Y (Sry) gene. The protein encoded by this gene initiates the differentiation of primordial gonads into testes, which subsequently secrete testosterone, and other androgens, that masculinize the rest of the body (Morris, Jordan, & Breedlove, 2004).

Testosterone, plays a major role in the differentiation of non-reproductive structures (Bardin & Catterall, 1981). In fact, exposure to prenatal sex steroids is critical for the early organization of brain (Auyeung, Lombardo, & Baron-Cohen, 2013; Forger & de Vries, 2015; M. V. Lombardo et al., 2012). Sex hormones effects can be classified into two classes: organizational and activational effects (Phoenix, Goy, Gerall, & Young, 1959). Organizational effects occur early in development producing permanent changes in the brain, whereas activational effects depend on current hormone levels and elicit transient responses (Auyeung et al., 2013).

The differentiation of sexually dimorphic structures in the nervous system is extremely complex. In humans, fetal testes start secreting testosterone approximately by week 10 of gestation, and this hormone, or its metabolites, account for the masculinization of brain and peripheral structures (Forger, Strahan, & Castillo-Ruiz, 2016). Testosterone acts via the androgen receptor (AR), or can be locally converted to estradiol at target cells and exert its action via estrogen receptors. Furthermore, non-genomic effects of androgens have recently been described (Foradori, Weiser, & Handa, 2008). Aromatization of testosterone appears to be required for the masculinization of many brain structures in rodents, while testosterone action via AR would be the main mechanism involved in sexual differentiation of the brain in primates (Forger et al., 2016). Sex steroids can influence axonal and dendritic growth, cell death, and number and type of synapses that a neuron establishes (Arnold, 2009). Recent evidence suggests that pubertal hormones might also exert organizational effects on the developing human brain (Neufang et al., 2009). Neuroanatomical differences promoted by sex hormones are thus generally believed to be a major determinant of dimorphic behavior (e.g., Hines, 2006).

Therefore, prenatal testosterone exposure has been related to a number of sexually dimorphic behaviors and abilities, e.g., male advantage in spatial cognition and math abilities, greater interest of men in uncommitted sex, and greater aggressive tendencies of men compared to women (Forger & de Vries, 2015). Particularly, the male-bias in aggressive behavior has been proposed to have originated as a result of unequal parental investment—individuals of the sex investing less—usually males—would tend to increase their reproductive success by mating with several members of the sex making the larger parental investment—usually females—, this would lead to intrasexual competition, and therefore, to overt aggression (Trivers, 1972). Consistent with this proposal, meta-analytic studies have shown a male bias in physical aggression throughout the lifespan (Archer, 2004; Card, Stucky, Sawalani, & Little, 2008; Eagly & Steffen, 1986).

1.5. Anatomical markers of prenatal androgens

Different types of studies have been used for exploring the behavioral effects of early exposure to prenatal (or perinatal) sex steroids in clinical and typical populations. These studies include the analysis of the effects of increased levels of prenatal androgens in individuals affected by congenital adrenal hyperplasia (Brown, Hines, Fane, & Breedlove, 2002; Oświęcimska et al., 2012), mutations of the androgen receptor gene (Imperato-McGinley, Pichardo, Gautier, Voyer, & Bryden, 1991; Wisniewsky et al., 2000); hormone levels in maternal blood, umbilical cord blood, and ami-
otic fluid (for a review, see Cohen-Bendahan, van de Beek, & Berenbaum, 2005); and opposite-sex twin studies (Heil, Kavsek, Rolke, Beste, & Jansen, 2011; Resnick, Gottesman, & McGue, 1993).

A growing body of evidence strongly suggests that the ratio of the length of second digit to the length of the fourth digit (2D:4D) reflects relative levels of fetal testosterone (Manning, Kilduff, Cook, Crewther, & Fink, 2014; Zheng & Cohn, 2011). 2D:4D ratio has been recognized as a dimorphic character for a long time (Baker, 1888; George, 1930). 2D:4D dimorphism appears to be established during early stages of embryonic development as a result of exposure to prenatal sex steroids (Galis, Ten Broek, Van Dongen, & Wijnaendts, 2010; Lutchmaya, Baron-Cohen, Raggatt, Knickmeyer, & Manning, 2004; Malas, Dogan, Evcil, & Desdicioglu, 2006). Additional evidence for the relationship between second-to-fourth digit length ratio comes from the study of finger length patterns in individuals with congenital adrenal hyperplasia (CAH). CAH women—who were exposed to higher levels of prenatal androgens—exhibit significantly lower right hand 2D:4D ratios than control women, while CAH men exhibit significantly lower second-to-fourth finger ratios than their unaffected relatives (Brown et al., 2002; Ökten, Kalyoncu, & Yaris, 2002). Similarly, 46XY individuals with complete androgen insensitivity (CAIS)—resulting from absent or dysfunctional androgen receptors—have feminized finger ratios (Berenbaum, Bryk, Nowak, Quigley, & Moffat, 2009). Furthermore, experimental manipulation of sex steroids levels in animal models confirmed the role of prenatal androgens on finger length sex dimorphism (Manning et al., 2014; Romano, Rubolini, Martinelli, Bonisoli Alquati, & Saino, 2005; Zheng & Cohn, 2011). Therefore, the 2D:4D ratio provides a simple method for examining the impact of prenatal androgens on human behavior.

1.5.1. Relationship between dominance, intrasexual competition, and prenatal testosterone levels

In chapter 4, I investigated whether prenatal androgens are associated with intrasexual competition, and dominance. Dominance describes an asymmetry in the access to resources—including potential mates—in competitive situations (Drews, 1993). In many species, males compete with one another over access to potential mates. In this vein, high levels of prenatal androgens—measured as 2D:4D ratios—have been related to aggressive dominance in a sample of university students (van der Meij, Almela, Buunk, Dubbs, & Salvador, 2012; but see van der Meij, Almela, Buunk, Dubbs, & Salvador, 2013; Voracek, 2013). I was interested in further exploring the relationship of prenatal testosterone with intrasexual competition, and aggressive and sociable dominance in a high competition context, i.e., in a sample of male junior soccer players. Consistent with previous studies, I expected a negative association of 2D:4D ratios—i.e., higher levels of prenatal androgens—with intrasexual competition, and both sociable and aggressive levels.

1.5.2 Relationship between aggressive behavior and prenatal testosterone levels

In chapter 5, I examined the relationship between actual aggressive behavior in adult life and prenatal androgen levels measured as 2D:4D ratios. It has been argued that sports may have originated as a means for men to develop the skills needed in warfare and hunting, and then developed as a lek where athletes display their attributes which are, in turn, assessed by potential rivals and allies (M. P. Lombardo, 2012). Sports, and particularly territory invasion team sports, are an ideal environment in which to study aggressive behavior, since they provide a socially accepted channel for certain aggressive behaviors. Given the male bias towards physical aggressive behavior, I was interested in exploring the relationship between 2D:4D—a proxy for prenatal androgens—and actual aggressive behavior in the pit. I predicted that the more aggressive players would exhibit lower 2D:4D ratios (i.e., a more masculine hand pattern).
1.6. **Note on studies’ design, data collection and data analyses**

All studies included in the present dissertation were designed by me after a series of initial discussions with my supervisor, Prof. Abraham P. Buunk. I personally collected the data included in the different studies—scales and questionnaires administration, hands and signatures scanning, image processing, data entry and verification, and data analysis. Junior soccer players were measured and weighted by the team’s physician, and information on the number of minutes played by each player and number of yellow and red cards awarded were provided by the team’s officials. Denise del Arca helped me to get familiar with the SPSS package (IBM Corporation, 2012) for data analysis. Dr. Verónica Tutte contacted the soccer team officials and helped in gaining access to the sample of junior soccer players. Dr. Álvaro Cabana assisted me with further data analyses in the signature study. All papers stemming from this dissertation were written in their entirety by me—with the exception of the Results section of the article exploring the relationship between signature size and personality traits, which I wrote together with Dr. Álvaro Cabana. Prof. Buunk provided invaluable comments and feedback for all papers.

Studies 1.2.1, 1.5.1, and 1.5.2 are based on data from the same sample—a highly competitive group of athletes—at a unique time point. The decision to use the same sample for these studies was made based on the relevance of the sample for the different variables analyzed—e.g., intrasexual competition, dominance, and aggressive behavior—and the exceptional opportunity to have access to such a sample, which would contribute to revealing the association between different personality and behavioral variables. The publication of different articles from a single dataset has been singled out as a potentially problematic issue. It has been argued that fragmented publications might be misleading, since these may appear to represent different independent instances, and might therefore distort literature reviews or meta-analyses (American Psychological Association, 1993). The growing concern about this practice and other artificially segmented publications is reflected by several research and editorial articles addressing these issues (e.g., Bailey, 2002; Jackson, Walter, Daly, & Cleary, 2013; Pierson, 2015). In this regard, Fine and Kurdek (1994) proposed two criteria for the legitimate publication of multiple journal articles from the same dataset: i) the various articles cannot be integrated into a single coherent article, and ii) each article has a distinct purpose—e.g., addresses different research questions. Based on these criteria, and similar recommendations made by Pierson (2015)—e.g., each analysis must answer a different research question, requiring also a reframing of the background and the discussion—the articles exploring the association of intrasexual competition and inflated height reports (chapter 2), the relationship of digit ratios and dominance as an attitude (chapter 4), and the link of digit ratios with aggressive behavior in a real world context and sporting performance (chapter 5) would not constitute piecemeal publications, but rather reflect separate studies conducted on the same sample.

1.7. **Final remarks**

The studies undertaken in this thesis were aimed at exploring different dimensions of intrasexual competition and related constructs. I was interested in exploring how an honest signal (height) might be manipulated—either consciously or unconsciously—in relation to intrasexual competition levels. Following the same rationale, I proposed to analyze the relationship between signature size—a graphic representation of the self—and expansive personality traits (e.g., intrasexual competition, dominance, and narcissism). I also intended to explore the contribution of prenatal androgens to male intrasexual competition and dominance by looking at the relationship between 2D:4D ratios and self-reported questionnaires. Finally, I aimed at contributing to the understanding of the male-bias in physical aggression through the analysis of the relationship between actual aggressive behavior and prenatal androgens.
By moving from self-reported physical attributes to inadvertent signals, and from personality traits to biological cues to human behavior, I hope to have made a novel and worthy contribution to the field of Evolutionary Psychology.

1.8. References


