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It Takes Balls to be a Girl Boss: Assessing the Influence of Androgens in the Emergence of Female Leaders

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Abstract

In the vast majority of mammalian societies, males enjoy the highest social ranking, a dichotomy that is largely modulated by sex hormones known as androgens. However, in some species, like the spotted hyena (*Crocuta crocuta*), these pervasive sex roles have been reversed, such that highly "masculinised" females have become the dominant sex. Drawing on observations from the natural world, this paper explores the relevance of the endocrinological mechanisms underlying the emergence of female leaders in these species to humans and considers to what extent androgens may influence the procurement and ultimate trajectory of female leadership in a species where women must overcome societal, as well as biological, challenges.

In the society of the spotted hyena (*Crocuta crocuta*), it is the female who rules the roost. Through natural selection, they have evolved to become the dominant sex, with almost all female adults and their offspring dominating all immigrant adult males[1,2]. This matrilineal hierarchy is unusual in the broader scope of mammalian societies, where male dominance typically prevails[3].

The anomalous socioecology of the hyena has long fascinated scientists because, although aberrations of female dominance can be observed elsewhere in the animal kingdom, it is perhaps most dramatically elucidated in this large carnivore. The female hyena exhibits many characteristics that would typically be associated with males, such as heightened aggressive behaviour and larger body size[4]. Interestingly, they have even undergone virilisation, or masculinisation, of the external genitalia, such that the clitoris is elongated into a fully erectile pseudopenis[1]. The female hyena therefore represents a unique case of the reversal of the sex-based designation of anatomical and behavioural characteristics within the natural world. However, while this anomaly has been the subject of a plethora of scientific research over the years, the evolutionary drivers of the processes underlying it, as well as the biological mechanisms modulating it, remain somewhat enigmatic.

In early attempts to understand the observed phenomenon, researchers looked towards the influence of androgens, such as testosterone, in the endocrinological profiles of female hyenas[1]. Throughout the mammalian class, these hormones are linked to aggression and dominance, although this is typically observed in males[5]. They assist in the determination and organisation of social hierarchies, with more aggressive animals exerting dominance over their conspecifics[6]. Aggression is generally sexually dimorphic, with males displaying higher levels than females in most species of mammals, including humans[7]. The reversal of this behavioural trait is therefore significant in the ascension of female hyenas to a position of power, thus providing a starting point for investigating the potential regulatory role of endocrines in the masculinisation of this species.

Androgens are the hormones responsible for the development of male secondary sexual characteristics, as well as the modulation of sexually dimorphic behaviours[7,8]. They assert their influence through both organisational and activational effects, with the former being associated with prenatal exposure to hormones, whilst the latter is mediated by circulating androgens[9,10]. Although they are predominantly seen as male hormones, these

endocrines are in fact present in both sexes[8]. In the case of the hyena, it was originally expected that females would exhibit elevated levels of androgens, potentially even exceeding those observed in their male counterparts. Contrary to this prediction, plasma testosterone levels have not been found to be significantly different between the sexes, and thus androgens have essentially been ruled out as a regulator of the observed anatomical masculinisation[4]. However, they do continue to be implicated in the modulation of female aggression, with a number of studies highlighting the potential role they play in determining the ultimate trajectory of aggressive behaviour in juvenile and adult females[3]. The plasticity of this behavioural trait, such that individuals assert varying levels of aggression, is now believed to be heavily influenced by maternal hormones, with pups who are exposed to elevated prenatal androgens being consistently more aggressive throughout life than those who experienced lower levels[3]. While the hyena may serve as an extreme example of female virilisation in the natural world, the study of the drivers and mechanisms involved in their evolution of female dominance may act as an interesting case study to gain an insight into the influence of endocrinology in the emergence of female leaders in other species, including humans.

Further examples of female masculinisation can be seen in our closer relatives, namely in primates. The social structure of strepsirrhines (such as lemurs and bush babies) is similarly distinguished from the typical community organisation of mammals, owing to female dominance hierarchies. Females in this clade commonly exhibit size monomorphism; an absence of bimaturation and masculinised external genitalia[12]. Convergent evolution of female dominated social structure has also been observed in old-world monkeys, where elevated aggression and dominance have again been linked to androgens. For example, in the rhesus monkey (*Macaca mulatta*), the female offspring of pregnant monkeys injected with testosterone exhibit more aggressive and threatening behaviour than control females. This increased aggressiveness is maintained into adulthood, where they

continue to exceed their untreated female conspecifics in terms of aggression[13]. Contemplation of these observations and processes in our close relatives therefore begs the question; could female leadership in human society also be modulated by androgens? If the behavioural alterations caused by these "masculine" hormones have assisted in the female ascension to dominance elsewhere in the animal kingdom, is there a possibility that they also act as drivers in the acquisition of leadership roles by women? Ultimately one might ask: are elevated androgen profiles associated with the successful emergence of female leaders?

Androgens have previously been linked to high performance in humans in areas such as sport and entrepreneurship[14]. A recent novel study also suggested that androgen prevalence on a national scale may even influence the number of Nobel laureates a country produces[14]. These hormones have been implemented in the success of both men and women in these areas owing to the effects they have on characteristics such as intelligence, risk taking, aggression, dominance and physiology. Interestingly, there is a conspicuous overlap in the constellation of characteristics that are influenced by androgens and those that are commonly associated with leadership. Leaders are perceived by the public to be individuals exhibiting high levels of intelligence, dominance and often aggression[15]. By drawing parallels between this and the observed effects of androgens on success in other fields, it becomes apparent that there could be some degree of hormonal mediation of the traits that are conducive to leadership acquisition in women. While there appears to be no existing endocrinological studies that conclusively show a link between androgen levels and female leadership, it would follow logically that these hormones may influence the successful procurement of dominant roles by females. This argument is strengthened when studies addressing the role of androgens in female dominance in other mammals are considered.

However, in any attempt to extrapolate observations from the animal kingdom to human subjects, it is paramount that we consider the added cultural complexities presented by mankind.

Thus, owing to the intricacies of our minds, perceptions and societies, the answer to the question of what defines a female leader is unlikely to be quite as straightforward when posed in relation to humans. For example, societal perception strongly dictates the success of individuals in their rise to power, by defining certain personality traits that the public believe exemplify good leaders. A seminal meta-analysis completed using 85 years worth of research revealed that the trait of dominance is perceived to be the most accurate and consistent predictor of the emergence of leaders from groups examined[15]. Similarly, aggressiveness is a trait that is commonly recognised by society as one that contributes to the emergence of leaders. Although dominance and aggression are often perceived as intertwined, they are, in fact, quite distinct from one another. Aggressive actions are those that are carried out with the apparent intention to inflict injury or harm to a conspecific, whereas dominance is exerted in order to obtain a status advantage[7]. While the assertion of dominance may incorporate aggressive behaviours, they are not mutually inclusive. Both traits are commonly identified as those of a good leader, however there is a conspicuous disparity in the value assigned to the expression of these qualities in male versus female leaders. Gender biases in the public conceptualisation of leadership therefore dictate that while dominance, assertiveness and aggression are admirable traits in men, they are less so in women. Women are instead expected to adopt a leadership approach that incorporates compassion and communality, as opposed to the agentic strategies utilised by men[16]. Deviation from this prescriptive stereotype, through the expression of dominance and aggression, may provide female leaders with competence scores that rival those of their male counterparts, however there is a social cost incurred exclusively to women for this choice of leadership technique, such that their social dexterity is called into question for failing to be “nice” enough[17]. While this may not necessarily stop women from leading in an agentic manner, it is certainly likely to discourage them from exhibiting aggressive or dominant behaviours. When considering the potential role of androgens in

the emergence of female leadership, it is therefore important to note that the dominance of females in the animal kingdom is largely linked to an increase in aggressive behaviour, which may not necessarily be conductive in human society. Therefore, owing to the higher proportion of females who acquire leadership roles through the utilisation of communal rather than agentic strategies, there is some doubt placed upon the significance of androgens in determining the emergence of female leaders.

In addition to the influence of societal perceptions, the biological mechanisms that modulate an individual's choice to pursue a role of dominance, and the leadership technique they subsequently adopt, are likely to be complex. No hormone exists in isolation and it is important to consider the interactions of androgens with other molecules, which may be facilitative or inhibitory. For example, research suggests that elevated androgens does contribute to dominance in women, but only when cortisol levels are low[21]. This proposed system of joint regulation is indicative of the likelihood that the underlying mechanisms are multifaceted and complex. This may place a further limitation on the potential influence of androgens on female leadership. This is furthered by the long-standing theory derived from evolutionary psychology, which postulates the sexual dimorphism of the human mind, such that the two biological sexes differ in terms of temperamental and cognitive characteristics[18]. These differences on such a fundamental level of brain functioning are believed to have profound impacts on the preferences of individuals in a number of domains, including their choice of occupations. While men are predisposed to occupying roles that involve risk-taking owing to "masculine" characteristics such as dominance, females are believed to be more inclined to enjoy occupations as caregivers, due to their higher expression of nurturing behaviour[18]. This occupational segregation may play an important role in the emergence of female leaders, by inherently dissuading women on a subconscious level from inhabiting leadership roles that involve high stress and risk. However, this dimorphism in terms of cognitive functioning and the resulting behaviours are believed to

be altered in female mammals exposed to heightened levels of circulating androgens[19]. This again reiterates the potential for these endocrines to influence the emergence of female leaders, by overwriting an innate process that may dissuade women from assuming dominant positions. It is important to keep in mind, however, that even if this intrinsic factor is overcome, women must still face the obstacles posed by cultural conceptualisations of female leadership.

Societal opinions and expectations are therefore an issue of paramount importance when considering the potential influence of biological virilisation on female leadership. Historically, these cultural perceptions have been a major barrier to women assuming leadership roles in any capacity, with these obstructions persisting in many parts of the world today. However, even in societies that are considered advanced in terms of gender equality, there continues to be an underrepresentation of females in leadership. Data released by the statistical office of the European Union revealed that of the 9.4 million people within the EU that held managerial positions in 2019, only 36% were women, a proportion which has remained relatively consistent since 2012.[20] Female representation is less again in higher tiers of management, with only 17% of senior executive roles throughout the EU filled by women. These figures would suggest that women are still not equally represented at leadership level. While this may be a temporal issue, whereby a time lag has prevented new-found cultural ideals of equality from trickling up to the highest hierarchical levels, it is likely that gender biased public perceptions continue to hinder the emergence of female leaders. For this reason, the behavioural alterations associated with social structures marked by female dominance in other species may be limited in their relevance to leadership in women, owing to the social repercussions incurred by expressing androgen modulated behaviours. This said, there is a possibility that androgens may in fact play a role in the choice of leadership technique within female leaders. While these endocrines may not be a significant explanatory variable that set female leaders apart from other

women, there is a possibility that the subset of individuals who choose to lead in an agentic rather than communal manner in spite of gender stereotypes may be marked by elevated androgen levels compared to controls.

Potential evidence for this level of modulation can be seen, for example, in the reported overrepresentation of women with polycystic ovaries (a condition that is linked to elevated androgen profiles) amongst female Olympians[21]. The androgen levels of elite female athletes has become an increasingly contentious issue, regardless of whether these hormones are taken as performance enhancing drugs (exogenous in nature) or are produced in excess by the body itself owing to a hormonal aberration (endogenous, e.g. hyperandrogenism)[22]. This controversy arises from the implications of these sex hormones in the development of "male-like" characteristics, such as muscle mass, strength, oxygen-carrying capacity and aggression[22]. In fact, women with elevated androgen levels have been shown to have an estimated 2-5% competitive advantage over competitors who fall within the normal female range.[22] This may serve as an extreme example, in a field with high physical demands, however, there is certainly the potential for some level of comparison, owing to the role that elevated androgens play in both the development of sporting prowess and leadership traits. This, in combination with what we know about the expression of dominance and aggression from our mammalian relatives, provides a scientific foundation on which further investigation could be based. This concept could potentially be a very interesting field for future research to determine whether a biological variant contributes to the selection of more aggressive leadership techniques amongst women in positions of power. Is there potentially an overrepresentation of women with elevated androgen profiles, or higher prenatal exposure to androgens, amongst the subset of female leaders who clearly exhibit dominance in their approaches?

Drawing from observations pertaining to female aggression in hyenas and rhesus monkeys, the organisational impacts of androgens is a pertinent area for further research, such that the

selection of agentic leadership techniques by females may be influenced by elevated aggression resulting from exposure to high levels of maternal androgens. This hypothesis would be markedly harder to investigate than one involving the activational impacts of androgens, owing to the ease with which circulating hormones can be measured. Meanwhile, the androgen levels experienced by an adult whilst *in utero* obviously cannot be measured retrospectively. However, research has shown that a correlation exists between prenatal androgen exposure and the second (index finger) to fourth (ring finger) digit ratio (2D:4D) in adults, with smaller ratios being indicative of higher maternal androgens[9]. This correlative measure has commonly been used to determine the influence of organisational androgens on performance in male athletes, however the ratio has also been shown to be reflective of prenatal hormone exposure in women. Using this non-invasive, putative measure of the influence of maternal androgens could help to gain an insight into the biological factors influencing the choice of agentic leadership techniques in women, as opposed to the communal strategies typically seen within those who ascend to power. Similarly, it would be interesting to establish whether activational androgens have an influence on the emergence of agentic female leaders. Is there an overrepresentation of women with elevated androgen concentrations (owing to hyperandrogenism or polycystic ovary syndrome for example) in women who lead in an assertive or dominant manner, thus mirroring the disproportionate number of women with these conditions seen in elite athletes? Furthermore, is there an overlap in these activational and organisational effects? Are women with elevated androgen profiles more likely to produce female offspring who are aggressive leaders, owing to higher exposure to "male" steroid hormones whilst *in utero*?

In conclusion, many questions persist in relation to the potential endocrinological moderation of leadership in women. While the observed virilisation of females in some of our mammalian relatives has undoubtedly propelled them into positions of dominance in their social hierarchies, the significance of the behavioural alterations associated with elevated androgens in

women is discernibly more difficult to unravel owing to the added complexities of human minds, perceptions and societies. With this said, the masculinisation of women may still play a profound role in determining the trajectory of leadership styles and techniques within the subset of women who have assumed leadership roles. Looking into the future, as we strive towards achieving gender equality and the reversal, and ultimate elimination, of sex based roles, the potential influence of androgens could show that there is still much for us to learn from the female spotted hyena.

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