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The interacting roles of testosterone and challenges to status in human male aggression[☆]

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ABSTRACT

This paper reviews the literature on sex and cultural differences in physical aggression and argues that only through understanding the interactions among evolutionary predispositions, hormonal influences, and social/situational factors can we possibly make sense of the patterns of human aggression that we see around us. Specifically, it is proposed that the process of natural selection has shaped hormonal responses in males that are sensitive to situations involving challenges to status and/or competition with other males, and that these hormonal changes are essential ingredients of the aggressiveness that occurs in these situations. Models of aggression that focus only on situational and cognitive/emotional triggers of aggressive behavior and attempt to understand human aggression without any reference to biology are destined to be incomplete at best.

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Social scientists have identified many factors that can increase frequency of aggressive behavior in human beings. For example, people are more likely to be aggressive after experiencing pain or frustration (Berkowitz, 1983, 1989; Hennessy & Wiesensthal, 1999; Staub, 1996) or when sweltering in hot temperatures (Anderson, 2001; Anderson & Anderson, 1996; Anderson, Anderson, Dorr, DeNeve, & Flanagan, 2000; Rotton & Cohn, 2000a,b; 2002). Difficult life conditions and lack of nurturance and harsh treatment during childhood can also contribute to aggressiveness (Staub, 1996). Presence of aggressive cues such as weapons seems to increase aggressive tendencies (Berkowitz, 1995; Bettencourt & Kernahan, 1997), as does the consumption of alcohol (Giancola & Zeichner, 1997; Gustafson, 1999; Leonard & Quigley, 1999; Pihl, Lau, & Assaad, 1997). There is a growing consensus that exposure to aggressive behavior of

others in real life, video games, or in the media can increase aggressive behavior in some people (Anderson, Gentile, & Buckley, 2007; Bandura, 1979, 1986, 1997; Bushman, 1995, 1998; Zillmann & Weaver, 1999). Personality traits have also been linked to aggressiveness. Narcissistic people with unrealistically high levels of self-esteem are more aggressive in response to insults than people lower in self-esteem (Baumeister, Bushman, & Campbell, 2000; Bushman & Baumeister, 1998), and people who display Type A behavior patterns marked by extreme competitiveness and irritability also have a tendency to be more aggressive (Baron & Byrne, 2000). It is essential to be aware of the influence of these personal and situational factors, since controlling aggression will necessarily require dealing with these variables. However, the research that has identified the immediate situational causes of violence has done little to explain why some situations evoke more violence than others or why people of various ages and genders respond differently in similar situations. Recent attempts to incorporate these findings into a theoretical framework (e.g., Anderson & Bushman, 2002) focus on cognitive and emotional states as explanatory mechanisms, but ignore any possible role that biological factors might play in human aggression. This of

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necessity provides an incomplete picture, and the influence of non-biological variables can only be properly understood if they are viewed in light of the evolutionary significance that they had for individuals throughout our history as a species. Because the word “aggression” can connote very different behaviors (e.g., an aggressive salesman, verbal aggression), I wish to make it clear that this paper will concern itself very narrowly with physical aggression performed with the intent of causing physical harm to another individual.

1. The complex relationship between testosterone and aggression

There is little question that a predisposition to behave in a physically violent way is linked to biology. A meta-analysis of studies on monozygotic and dizygotic twins conclusively demonstrated a significant heritability of aggression, perhaps accounting for as much as 50% of the variance among individuals (Miles & Carey, 1997). Similarly, a link between aggressive behavior and hormonal activity has been well established (Van Anders & Watson, 2006). Males who are more symmetrical on physical characteristics such as ear height, finger and toe length, and ankle circumference are more aggressive than asymmetric men, presumably because of the influence of hormone levels during development (Manning & Wood, 1998). Testosterone levels in particular appear to be especially important in the regulation of aggression. Injecting testosterone into a variety of animal species, ranging from chickens to monkeys, increases the aggressiveness and social dominance of the injected animals, regardless of whether they are males or females (Ellis, 1986; Monaghan & Glickman, 1992). A look at our closest primate cousin reveals that socially high-ranking male chimpanzees exhibit the highest levels of aggression and the highest levels of testosterone. Furthermore, all adult male chimpanzees show their highest levels of testosterone when in the presence of females who are ovulating, but this is associated only with higher levels of aggression and not significant increases in actual sexual activity (Muller & Wrangham, 2004).

The testosterone–aggression relationship is not as straightforward for humans. Many laboratory and field studies reveal a strong positive relationship between testosterone and levels of restlessness, tenseness, and a tendency toward violence (Archer, 1994; Blum, 1997; Campbell, Muncer, & Odber, 1997; Dabbs, Carr, Frady, & Riad, 1995; Dabbs, Frady, Carr, & Besch, 1987; Dabbs & Hargrove, 1997; Dabbs, Jurkovic, & Frady, 1991; Geen, 1998; Mednick & Volavka, 1980), but other studies have failed to replicate this effect (Archer, 1991, 2006; Archer, Birring, & Wu, 1998; O'Connor, Archer, Hair, & Wu, 2001; Rowe, Maughan, Worthman, Costello, & Angold, 2004). Researchers who have studied inconsistencies in the research literature have concluded that a positive correlation between levels of testosterone and levels of aggression occurs primarily in situations in which males are competing with other males or when the social status of a male is challenged in some way (Archer, 2006; Higley, 2003; Mazur, 1983). If this is in fact the case, the theoretical perspective that might best explain the testosterone–aggression relationship is the “Challenge Hypothesis.”

The challenge hypothesis was developed by John Wingfield and his colleagues to explain aggressive behavior in male pair-bonded birds (Wingfield, 1985; Wingfield, Ball, Dufty, Hegner, & Ramenofsky, 1998; Wingfield, Hegner, Dufty, & Ball, 1990). According to the challenge hypothesis, higher levels of testosterone do not automatically lead to more aggression. Rather, testosterone rises in response to situational cues that represent either a threat to a male's status or a signal that competition with other males is imminent. The increased testosterone facilitates whatever competitive behaviors are necessary for meeting the challenge, which in some cases would include aggressive responses. The challenge hypothesis is consistent with the data obtained in studies across a wide range of vertebrate species (Cavigelli & Pereira, 2000; Ferree, Wikelski, & Anderson, 2004; Hirschenhauser, Taborsky,

Oliveira, Canario, & Oliveira, 2004; Muller & Wrangham, 2004; Wingfield et al., 1998).

Archer (2006) has provided a comprehensive literature review in which he attempts to evaluate the suitability of the challenge hypothesis for studying human aggression. The most relevant research to date are the studies that show how testosterone levels in males rise and fall according to whether the individual wins or loses in competition in sports as diverse as tennis, wrestling, and chess (Archer, 1988, 1991; Booth, Shelley, Mazur, Tharp, & Kittok, 1989; Elias, 1981; Gladue, Boechler, & McCaul, 1989; Mazur, Booth, & Dabbs, 1992; Mazur & Lamb, 1980; Van Anders & Watson, 2006). The effect can also occur among spectators who watch their teams win and lose (Fielden, Lutter, & Dabbs, cited by Campbell et al., 1997). Neave and Wolfson (2003) even found that British soccer players' testosterone levels were higher for home games and for games against traditional rivals! On the flip side of the coin, there is often a pronounced drop in the testosterone levels of men who lose in face-to-face competition, especially if the losing men were socially anxious to begin with (Maner, Miller, Schmidt, & Eckel, 2008; Mehta & Josephs, 2006), and animal studies have confirmed that a decrement of testosterone in male rodents is associated with low dominance behaviors such as “freezing” and inhibited exploration (Edinger & Frye, 2005; Toufexis, Myers, & Davis, 2006).

A meta-analysis of the studies on testosterone levels and sports competition reveals that, in general, an athlete's testosterone level tends to elevate in anticipation of competition, to escalate even further during competition, and that these increases are significantly more pronounced for winners than for losers (Archer, 2006). Studies also show that winning males who make strong internal attributions about the cause of their victory increase testosterone levels significantly more than males who attribute their win to luck or to a weak opponent (Gonzalez-Bono, Salvador, Ricarte, Serrano, & Arnedo, 2000). Along these same lines, it has been demonstrated that males respond to insults with elevated levels of testosterone (Cohen, Nisbett, Bowdle, & Schwarz, 1996). Consistent with the challenge hypothesis prediction that testosterone levels rise and fall in response to social cues for the need to compete, it has been established that men who are actively engaged in parenting behaviors display lower testosterone levels than males who are not active parents (Berg & Wynne-Edwards, 2001; Gangestad et al., 2005; Storey, Walsh, Quinton, & Wynne-Edwards, 2000). In the only study of the testosterone–aggression relationship in humans specifically designed with the challenge hypothesis in mind, Klimesmith, Kasser, and McAndrew (2006) demonstrated that males who interacted with a handgun, historically a powerful cue associated with violent interpersonal confrontations with other males, showed a greater increase in testosterone levels and more aggressive behavior than did males who interacted with a “Mouse Trap” board game. The male participants in this experiment dismantled either a gun or the mousetrap, handled its components, and then wrote instructions for how to assemble the objects. When then given the opportunity to put hot sauce into water that was to be consumed by another person, the participants who handled the gun put in significantly more hot sauce and frequently expressed disappointment upon learning that no one else was actually going to drink the concoction. Mediation analyses suggested that the primary reason that guns increased aggression is that they caused increases in testosterone levels. Thus, cues related to threat or competition may not result in aggressive responses unless testosterone is involved.

2. Sex differences in aggression

For an in-depth and current summary of what we know about sex differences in aggression, the reader is referred to an excellent meta-analytic review by Archer (2004). Archer's review confirms what one would expect given the reliably different levels of baseline testosterone found in males and females. Specifically, although there is some

evidence that females may be more likely than males to engage in some forms of indirect aggression such as social exclusion (Archer, 2004), differences between the sexes in their tendency to engage in violent, physical aggression that can cause pain or injury to others is profound, and this difference is consistent across cultures (Archer, 1994, 2004; Burbank, 1992; Campbell & Muncer, 2008; Daly & Wilson, 1988, 1994a,b; Eagly & Steffen, 1986; Fry, 1998). This difference appears even more strongly in studies of “real-world” aggression than in laboratory studies (Archer, 2004). Males are more likely than females to engage in aggressive fantasies (Hyde, 1986). Men also regularly admit to thinking about the likely outcome of fights with other men that they know; women almost never do this (Fox, 1997). If the aggressive inclinations of males remained at the level of fantasy and idle speculation, there would be little about this sex difference that would cause concern. Unfortunately, males are also more likely than females to translate these inclinations into action. Females are most likely to be killed by husbands or boyfriends, and men are most likely to be killed by other men (Archer, 1994). Male-to-male violence is the most common form of aggression everywhere; men commit over 85% of all homicides and they are also the most frequent victims (Daly & Wilson, 1988; Hilton, Harris, & Rice, 2000). Male homicide accounts for over 91% of same-sex homicides cross-culturally (in cases where the killer and victim are not related to each other, this figure rises to over 97%), and almost all murders committed within families are perpetrated by men (Daly & Wilson, 1988; Wilson, Daly, & Daniele, 1995). The gender difference in aggression is greatest in situations where the aggression is unprovoked; that is, when another person has not behaved aggressively first (Bettencourt & Kernahan, 1997; Bettencourt & Miller, 1996). What evolutionary pressures could have possibly produced such an extreme difference between males and females in their predisposition toward physical violence?

If a capacity for violence has been shaped by natural selection, and if increases in testosterone are a necessary part of the equation, spikes in testosterone levels and violence should both predictably occur in situations that pose a threat to fitness. Hence, there should be a particular set of triggers for aggressive behavior that reflect the adaptive problems faced by our prehistoric ancestors. Evidence indicates that these problems were very different for males and females, and that for a variety of reasons aggression proved to be a more adaptive response for males. Sexual competition for mates has always been more intense for males than for females, especially in the polygamous societies that appear to have been typical in the ancestral environment (Daly & Wilson, 1988). The stakes were very high for men in this environment, as the winners of the intrasexual competition would come away with the greatest number of women (and the most desirable women). The losers ran the risk of genetic annihilation by their failure to successfully win the status and resources necessary to attract mates. Historically, powerful men have always enjoyed greater sexual access to women than men lower in the pecking order, and violence can often be traced to this grim struggle for status and mates among men (Daly & Wilson, 1988, 1994a,b). Thus, men being at greater risk of not reproducing and being less confident of parenthood than women set the evolutionary stage for male selection pressures that would be deadly in more ways than one (Campbell, 1995).

By all indications, a man's social standing and status in a group was often dependent upon how believable his threats of physical violence were (Daly & Wilson, 1988), and men who could maintain a reputation for being tough customers were better able to hang onto their status (Archer, 1994; Weisfeld, 1994). And so it came to be that a quest for dominance became a strongly motivated behavior, especially among males, and the achievement of dominance became a highly satisfying, rewarding state of affairs for those who attained it (Weisfeld, 1994). Violence committed against the right people at the right time was a ticket to social success. For example, among the Yanomamo of South America, men who had killed other men acquired significantly more wives than men who had not yet killed anyone

(Chagnon, 1988). Similarly, in other groups throughout human history, having killed someone was good for one's reputation, and many societies even developed ceremonies for recognizing such an accomplishment (Daly & Wilson, 1988).

Given this environment, it should not be surprising that situations in which a man faces humiliation by damage to his reputation are especially likely to lead to violence, and it is in precisely these same types of competitive/status-challenging situations that testosterone levels elevate. Through natural selection, “face-saving” became a dominant motive that can trigger a violent response completely out of proportion to the event that precipitated it, and even today the most frequent cause of urban homicide is a trivial public dispute between two men that escalates completely out of control (Archer, 1994; Daly & Wilson, 1988). Reputation can be most critical for men at the fringes of the group who have little else to bolster their self-esteem, and they may be especially prone to violence when their “honor” is at stake (Campbell, 1986). Modern crime statistics bear this out, as unemployed and unmarried men are more likely to be involved in murderous disputes, both as the perpetrator and as the victim of such encounters (Wilson & Daly, 1985). These results are entirely consistent with what would be expected if the *Challenge Hypothesis* was true, and consistent with the results of studies that show that men who have attained externally validated levels of prestige actually display lower levels of testosterone and less of a tendency toward aggression (Johnson, Burk, & Kirkpatrick, 2007).

It is no secret that most people fear violent behavior by young men more than violent behavior by older men. There appears to be a sound basis for this fear. In fact, the relentlessness of risky, aggressive behavior by young males has prompted Wilson & Daly (1985) to label this behavioral tendency the *Young Male Syndrome*. Data from Wilson and Daly's (1985) study of the relationship among age, sex, and homicide victimization in the United States for the year 1975 clearly show that the likelihood of a woman being the victim of a murder does not change dramatically throughout her life, although there is a slightly greater chance of this occurring between the late teens and about the age of 40, primarily through their association with young men during this time. The pattern for the males, on the other hand, is striking. Males jump from an equal probability of being murdered at the age of ten (relative to females) to about a six times greater risk in the twenties. Consistent with Wilson and Daly's data, 87% of the 598 homicide victims in the city of Chicago in 2003 were males, and 64% of the victims were between the ages of 17 and 30. Thus, likelihood of being the victim of lethal violence peaks for men between the late teens and late twenties, and then declines steadily through the rest of the life span. Historically, a higher proportion of males between the ages of 15 and 29 in a population has been one of the best predictors of a society's tendency to engage in wars (Mesquida & Wiener, 1996).

How have young males come to be so much at risk? In ancestral environments, competitive success or failure in early adulthood would have determined one's social standing in the social group for the rest of one's life. Consequently, early displays of one's virtues were essential for reproductive success (Daly & Wilson, 1994a,b). High-risk competition between young males provided an opportunity for “showing off” the abilities needed to acquire resources and to meet challenges to one's status. Therefore, a predisposition to engage in this type of behavior at that age would have been strongly selected for (Archer, 1995). The attention paid to the athletic performance of young men in modern societies has undoubtedly developed as a constructive alternative for dealing with the proclivities of young males that evolved in a very different world. This legally sanctioned arena allows young males to exhibit the same skills (throwing, clubbing, running, wrestling, tackling, eye/hand coordination) that would have spelled success in combat or hunting in the ancestral environment.

In summary, male-to-male aggression is at its most intense in adolescence and early adulthood because that is when competition for status and sexual partners is at its peak and also the time when levels

of testosterone are at their highest (Archer, 1994; Daly & Wilson, 1988; Hilton et al., 2000; Palmer, 1993).

3. Societal influences on aggression: cultures of honor

The predisposition of males toward aggressive action is very sensitive to the social context in which they live, because it is the social context that sets the standards for success, status, and reputation. A society with norms that is more tolerant of violence is likely to see greater frequencies of such behavior, especially in its young males. Cultures that place a premium on the quality of a man's reputation may be especially susceptible to male-to-male violence. These *cultures of honor* encourage men to resort to any measures necessary to protect their reputation, including violence.

Cultures of honor develop in societies where law enforcement is weak or absent, where one's resources are easily stolen by others, and where there is an uneven distribution of wealth among its citizens (Cohen & Nisbett, 1997). If the culture of honor happens to have a stable, strong social organization, some anti-social types of violence (such as that committed during a robbery) may be constrained, but violence stemming from disputes between individuals that become a question of "honor" will actually be encouraged (Cohen, 1998). Cultures of honor frequently developed in herding societies; the animals of a herder were simply more portable and easily stolen than the crops of a farmer (Cohen & Nisbett, 1997; Nisbett, 1993). Whenever one is susceptible to such thievery, acting tough can be very adaptive indeed. Young male shepherds were taught to respond swiftly and decisively to insults and to establish a reputation that encouraged would-be rustlers to look elsewhere (Gilmore, 1990; Nisbett, 1993; Nisbett & Cohen, 1996; Schneider, 1971). Consequently, herders have a history of being more violent than people in societies with a different economic base (Lowie, 1954; Peristiany, 1965).

Research has confirmed that modern herding societies display more tolerance for revenge and other honor-related violence than do farming or foraging societies (Figueredo, Tal, McNeil, & Guillen, 2004), but cultures of honor may continue to exist even when the conditions that originally produced them have disappeared. This can occur when deeply embedded group structures and traditions persist (Cohen & Nisbett, 1997). In recent years, most culture of honor research has focused on the regional differences in aggression found within the United States. It has been well documented that rate of violence, especially homicide, is higher in the U.S. West and South than it is elsewhere in the country. (Cohen, 1996; Nisbett, 1993; Parker & Pruitt, 2000). These regional differences exist only for Whites, and the effect is due almost entirely to homicides that occur as a result of arguments and insults (Cohen & Nisbett, 1997). The predilection for Southern violence is even stronger in small cities and towns than in large cities. For example, small towns in the South have triple the homicide rates of small towns in the North (Nisbett & Cohen, 1996). When compared to Northerners, the three categories of violence more accepted by Southerners include violence in self-defense, violence in response to insults, and corporal punishment in the disciplining of children (Cohen & Nisbett, 1994; Nisbett, 1993; Nisbett & Cohen, 1996). Residents of the West and South also view more violent television, enlist in the National Guard at higher rates, and have higher subscription rates to magazines featuring weapons, combat, and physical strength (Baron & Straus, 1989; Lee, 1995a,b). The greater Southern acceptance of honor-related violence was illustrated in studies by Cohen and Nisbett (1997). Letters of reference were sent to companies describing a job candidate with good credential who has been convicted of an honor-related offense. These letters were more positively received by Southern companies than by Northern companies. In a second study, Cohen and Nisbett determined that Southern and Western newspapers treated stories about honor-related crimes more sympathetically than did Northern newspapers. Consistent with these findings, laboratory studies have found that

Southern White males respond to insults with more anger, higher levels of arousal, and elevated levels of testosterone when compared with Northern males (Cohen et al., 1996).

How might this fascinating regional difference be explained? Nisbett (1993) believes that the early economic roots of the South may be responsible. According to Nisbett, the Northern states were settled by farmers who had Puritan, Quaker, and Dutch backgrounds. The South, on the other hand, was peopled by land-owning noble gentry who had a long-standing code of manly honor and also by Scotch and Irish settlers with a long herding tradition. Given the importance of reputation in both of these groups, it should not be surprising that young White Southern men would grow up with a profound sense of obligation when it comes to matters of honor (Fischer, 1989).

Although there are some researchers (e.g., Chu, Rivera, & Loftin, 2000) who believe that the so-called "Southern Culture of Honor" is an illusion resulting from the way in which the research has been conducted, most scholars believe that the data show the South to be a more violent place even when poverty, race, and other factors are carefully controlled (Nisbett, 1993). Although the regional difference holds true only for Whites, some researchers believe that a similar culture of honor has developed among inner-city African-American males throughout the country (Anderson, 1994; Cohen, Vandello, & Rantilla, 1998).

4. Conclusions

The competing explanations for human aggressive behavior need not be mutually exclusive. Traditional social psychological models of aggression tend to focus on the more immediate, proximal triggers of aggression, and evolutionary models focus more on the ultimate causes of such behavior. The accumulated literature on this topic is ambiguous as to whether testosterone is a precursor, a correlate, or a consequence of aggression. However, my reading of the available evidence suggests that the most common chain of events leading to physical aggression by human males begins with a public challenge to a man's status through direct competition with another male, through insult, or by the threat having one's mate poached by another male. These threats to status provoke a biological response marked by heightened levels of testosterone, which facilitate an aggressive response if that is what is called for, or at least permitted by, the situation. Situational factors (such as heat, crowding, or noise) that heighten arousal levels and irritability will exacerbate the response, as will alcohol or any other factors that have a disinhibiting effect, but these factors are *not* the primary cause of the aggression. The degree to which an aggressive response is called for (or at least permitted) will be determined at least in part by the cultural and societal value placed on a man's reputation and honor and the degree to which aggression is considered an appropriate response. Thus, while the relationship between testosterone levels and aggression is complex, it is clearly important, and models that attempt to understand human aggression without any reference to biology are destined to be incomplete at best.

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