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Commentary

Competition and testosterone

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"You've got to learn to survive a defeat. That's when you develop character."—Richard M. Nixon, Dallas *Times-Herald*, 10 December 1978.

"This [defeat] taught me a lesson, but I'm not sure what it is."—John McEnroe, *The New York Times*, 9 February 1987.

Our heroes in sport, business, and life are often individuals who persevere after defeat to eventually triumph. At work and play, even the most mundane lives are filled with competitions of one sort or another. In even the most loving relationships, partners struggle over matters of status. If these competitions lack the epic proportions of, say, a stage in the Tour de France or a run for public office, there are surely few persons who have not experienced the sting of setback or defeat.

In this issue, Mehta and Josephs (2006) report that the direction of change (increase/decrease) in saliva testosterone level for men after losing one-on-one competitions with other men predicts whether or not they will choose to compete again against the same opponent. In their study, college undergraduate men were brought together in pairs to compete against each other in a test of an ostensibly important type of intelligence called "spatial processing speed." The competition was rigged. One of the men, randomly chosen beforehand, was given easier puzzles so that he would be the first to complete them, making him the clear "winner." The other would, of course, be the loser. Saliva samples were obtained immediately before and 15 min after the competition and were subsequently assayed for testosterone (T) and cortisol (C). After the second sample was obtained, participants were given a choice: they could either compete again with the same opponent on six new puzzles or complete a questionnaire on food, music, and entertainment preferences. As would be expected, participant T levels after competition were not exactly the same as before competition. To determine whether or not change in T level was related to whether or not men chose to compete again, the authors divided their participants into three groups according to what happened to T level after competition. About a third of the participants showed a clear increase in T. About a third of the men showed a clear decrease in T. Each group (the middle group was not included in the analysis) contained both winners and losers. For winners, the direction of change in T was not related to whether men chose to compete again or not. But, for the losers change, in T was significantly related to choice—the majority of losers who increased in T chose to compete again and the majority of losers who decreased in T chose the non-competitive alternative. The relationship appears specific to testosterone—analyzed the same way, changes in cortisol were not related to choice for either winners or losers. Although the authors are appropriately cautious about causation, a reasonable inference is that a change in T level occurring during or immediately after a losing competition influences a man's thoughts about competing again against the same opponent.

As is the case with virtually all other human studies of the hormonal correlates of competition, C and T were assayed from samples of saliva. With certain caveats (e.g., Granger et al., 2004), C and T levels measured in saliva reflect blood levels of these hormones (e.g., Kahn et al., 1988; Shirtcliff et al., 2002). Virtually any stressor (competition can be that) increases the secretion of adrenocorticotropic hormone (ACTH) from the anterior pituitary gland; ACTH, in turn, stimulates the adrenal cortex to secrete cortisol (Goodman, 2003). In competitions that involve prolonged physical exertion, an increase in plasma T (e.g., Bateup et al., 2002; Booth et al., 1989; Edwards et al., 2006) is probably due to a combination of physical (Cadoux-Hudson et al., 1985; Cumming et al., 1986; Kargotich et al.,

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1998) and psychological factors. Psychological factors predominate in sedentary competitions, but exactly how they bring about rapid changes in T in human males is not known. Interested readers are referred to Sapolsky's (1987) work with free-living baboons for a plausible model.

Some background will help put the Mehta and Josephs (2006) study in historical and theoretical context. By the end of the 1970s, studies in non-human animals, particularly birds and rodents, showed that testosterone could promote aggressive behavior. Studies in humans followed, but were less convincing. Even so, there was sufficient evidence to lead Archer (1991) to acknowledge a weak and inconsistent connection between testosterone and aggression in human males. In 1985, Alan Mazur suggested the importance of distinguishing aggression and dominance. Individuals act *aggressively* where their intent is to inflict physical injury; individuals act *dominantly* if their intent is to achieve or maintain status over another (p. 382). Mazur proposed thinking about aggression as but one form of dominance behavior. So, where in non-human animals the influence of testosterone on dominance motivation might be manifest in aggressive behavior, in humans the influence of testosterone on dominance is likely to be expressed in more varied and subtle ways. Drawing upon a now larger group of studies, Archer (2006) concluded that the literature as a whole indicates an association between testosterone, aggression, dominance, and status striving. An exploration of these relationships and related controversies may be found in the excellent review by Mazur and Booth (1998).

Mazur's reciprocal model of status and dominance provides one of the richest and most influential theoretical conceptualizations of how testosterone and status-striving are related in primate species. Mazur (1985) proposed that rising or elevated levels of T facilitate attempts to achieve or maintain high status, and falling or depressed levels of T inhibit such attempts (p. 382). Furthermore, causation can also be reciprocal: successful attempts to achieve status might increase plasma T, while defeat could depress T level. The model is important for several reasons: (1) it explicitly recognizes the dynamic nature of hormone secretion; (2) it emphasizes that short-term changes in T level may affect cognitive processes having to do with the perception of status; and (3) it also emphasizes that the perception of status itself may influence the secretion of T. Of course, overcoming others in competitive confrontation (i.e., dominance) is not the only way to elevate status. *Eminence* refers to the elevation of social rank earned through socially valued accomplishment, and Kemper's (1990) monograph is recommended for its remarkably coherent synthesis of the literature up to 1990 as it relates to connections between eminence, dominance, and testosterone.

Competitions are formalized contests for status—winners have more status than losers. So it is reasonable that natural and contrived competitive settings have been used to determine whether or not T level varies in accordance with winning and losing as Mazur's model posits. For the most part, these studies have been conducted with men. Although there are some reports that after-competition T levels are higher in winners than losers, this effect is notably absent in others (see Archer (2006) and Salvador (2005) for reviews from different perspectives). Indeed, in Mehta and Josephs (2006), the average change in T after competition relative to pre-competition baseline was about the same for winners and losers. Why so much variation between studies?

One reason is that individual differences in personality influence the impact of winning and losing on T level. For example, people are said to have a power motive to the extent that they derive emotional satisfaction from having an impact on others. Personalized power (p Power) has to do with asserting oneself over others, and socialized power (s Power) is about trying to influence others through prosocial acts. Schultheiss et al. (1999), in a study with men using virtually the same competition protocol later used by Mehta and Josephs, reported that after-competition T in winners was highly correlated with the urge to assert (p Power), but only in men who had little interest in prosocially influencing others (i.e., individuals low on s Power). In another study (González-Bono et al., 1999), this one involving a game between two men's professional basketball teams, mean after-game T levels for winners and losers were similar. But, for members of the winning team, the higher a player's tendency to attribute the win to luck, the lower his after-game T level. On the losing team, the higher a player's tendency to attribute the outcome to deficiencies in his own performance, the lower his T level. Taken together, these studies make the point that T responses to victory or defeat are highly idiosyncratic. When groups include competitors with (as examples) widely varying power motives and different tendencies to attribute outcomes to either external or internal factors, we should not expect competitive outcomes to accurately predict group means for after-competition T level.

In Mehta and Josephs (2006), most of the losers who increased in T chose to compete again while most of the losers who decreased in T chose the alternative. Putting this in a status context, the authors explain: "losers who increased in T chose to compete again as an attempt to reclaim their lost status, and losers who decreased in T fled from a second competition in order to avoid any further status loss." With respect to causation, it is altogether possible that T change has no direct influence on a man's choice but is merely a correlate of his predisposition to compete again (or not) after a defeat. The authors are correct in noting that the question of causation can probably only be answered by experimentally increasing and decreasing post-competition T levels for competing participants. Absent such a study, however, the results presented here are the clearest evidence yet that transient changes in T level associated with defeat *may* influence how men deal with the prospect of competing again against the same opponent.

In Mehta and Josephs (2006), it is generally true that if T level went up men chose to compete again and if T level went down men chose the non-competitive alternative. But there were exceptions—a minority of losers who increased in T chose not to compete again and a minority of losers who decreased in T did choose to compete again. Whether the relationship between T change and a decision to compete again is causal or correlational, to the extent that the relationship is modulated by personality, we should expect its expression to be consistent in any given

individual from one competition to another. Surprisingly, hormonal responses to winning and losing have not been studied in repeated, carefully controlled, and similarly staged competitions with the same set of individuals. They should be.

It is important to note that there was no relation between direction of T level change and choice in winners—the effect is specific to losers. The authors explain this by reasoning that, although an increase in T should promote status-seeking, the choice offered the winners gave them no opportunity to improve their status—another win against a proven loser would not further increase the status of the winner and a defeat (always possible) would only decrease his status.

Mehta and Josephs (2006) offered men a choice between competing again and doing something else within 15 min of the initial competition. If a change in T affects how a man cognitively deals with defeat vis á vis subsequent competition, the structure of this cognition is likely to endure in memory long after T level returns to baseline. What if presenting the opportunity to make the choice was postponed until the same participants were brought together again 1 week later? Would the choices of the losers still be in general accordance with the direction of T level change (relative to baseline) immediately after the end of the competition? It would be if an increased level of T produces a reward state (Wood, 2004) and a decreased level of T produces something akin to punishment. But whatever the cause, this result would be an example of how a transient change in hormonal state may affect behavior long after its immediate physiological effects have dissipated.

The Mehta and Josephs (2006) study included only men. It is fair to say that women have been understudied with respect to hormones and competition. The relatively small literature on the subject is reviewed by Archer (2006) who concludes that competitively challenged women can show increases in T and that, similar to men, T in women may be correlated with personality characteristics such as aggressiveness and dominance behavior. Competitive fires can burn as furiously in women as in men, but the motivations that fuel the fires may be quite different. Kathleen DeBoer (2004) writes that men compete to prove themselves and women compete to express themselves. If competition means something different to women and men, we should probably not expect to find the relationships between T change after losing and subsequent decisions about competing again to be the same for women and men. A follow-up to Mehta and Josephs (2006) with women would be important for what it could potentially reveal about gender similarities/differences with respect to T and competition.

T changes after losing predict subsequent decisions to compete again in men. Explanations that have to do with T effects on status-seeking, reward and punishment, face-saving and revenge, and persistence are all mentioned by Mehta and Josephs (2006). Choosing between them at this point is more a matter of personal preference than scientific directive. The question of causation remains unanswered. Even so, while the lessons of the contemporary literature connecting testosterone and human competition are still a bit opaque, with the publication of this study, it is now clearer than ever before that there are important ones waiting to be revealed.

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