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# Causal attribution and psychobiological response to competition in young men

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ABSTRACT

A contribution to a special issue on Hormones and Human Competition.
Psychoneuroendocrine effects of competition have been widely accepted as a clear example of the relationship between androgens and aggressive/dominant behavior in humans. However, results about the effects of competitive outcomes are quite heterogeneous, suggesting that personal and contextual factors play a moderating role in this relationship. To further explore these dimensions, we aimed to examine (i) the effect of competition and its outcome on the psychobiological response to a laboratory competition in young men, and (ii) the moderating role of some cognitive dimensions such as causal attributions. To do so, we compared the responses of 56 healthy young men faced with two competitive tasks with different instructions. Twenty-eight men carried out a task whose instructions led subjects to think the outcome was due to their personal performance ("merit" task), whereas 28 other men faced a task whose outcome was attributable to luck ("chance" task). In both cases, outcome was manipulated by the experimenter. Salivary steroid hormones (testosterone and cortisol), cardiovascular variables (heart rate and blood pressure), and emotional state (mood and anxiety) were measured at different moments before, during and after both tasks. Our results did not support the "winner-loser effect" because no significant differences were found in the responses of winners and losers. However, significantly higher values on the testosterone and cardiovascular variables, along with slight decreases in positive mood, were associated with the merit-based competition, but not the chance-based condition. In addition, an exploratory factorial analysis grouped the response components into two patterns traditionally related to more active or more passive behaviors. Thus, our results suggest that the perception of contributing to the outcome is relevant in the psychobiological response to competition in men. Overall, our results reveal the importance of the appraisal of control and causal attribution in understanding human competitive interactions.


## 1. Introduction

In recent decades, the relationship between steroid hormones and human aggressive/dominant behavior has increasingly been investigated in the context of competition (for reviews see Carré and Olmstead, 2015; Casto and Edwards, 2016; Eisenegger et al., 2011; Geniole et al., 2017; Salvador, 2012). This research has mostly been carried out in the context of two influential hypotheses about the relationships among status, reproductive fitness, and steroid hormones: the biosocial status hypothesis (Mazur, 1985) and the challenge hypothesis (Wingfield et al., 1990). A "competition effect" has been established that includes anticipatory changes and other changes during competition, particularly in athletes (Casto and Edwards, 2016). This effect was clearly established by Suay et al. (1999), comparing the hormonal responses of judoists in a control session, during combat, and on an ergometry test.

The main hormone focus of this topic is testosterone (T), although cortisol (C) has also been included in many studies because they are the main hormones involved in status (Hamilton et al., 2015). However, it is also worth noting that competition is an acute social stress situation (for a review see Salvador, 2005; Salvador and Costa, 2009), and stressful stimuli elicit changes in main systems such as the hypothalamic-pituitary-adrenal (HPA) axis and the autonomic nervous system (ANS). In agonistic/competitive situations, T is added to the typical increases in the products of HPA-axis (cortisol, corticosterone) and SNA activation (Henry and Stephens, 1977; Koolhaas and Bohus, 1989; Koolhaas et al., 1999, 2010). In this context, there is also evidence that behavioral coping patterns in facing competitive situations are associated with different biological responses (Koolhaas et al., 2010) called "coping patterns". An active pattern would be characterized by increases in the sympathetic nervous system (SNS) activity and T, whereas a passive

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pattern would imply less activity, a predominance of HPA-axis activation, and no activation of the Hypothalamic-pituitary-gonadal (HPG) axis. In agonistic interactions, the active pattern is more likely to be associated with victory, and the passive pattern with defeat.

Although little information is available about the role of the SNS in competition and its outcome, studies have shown that competitive tasks elicit greater SNS reactivity than non-competitive ones (García-León et al., 2003). Findings show higher heart rate (HR), blood pressure (BP) (Beh, 1998), and heart rate variability (HRV) responses (Veldhuijzen van Zanten et al., 2002), as well as higher levels of cardiovascular (CV) activity, in pre-competitive and competitive periods, compared to baseline, in women in competitive situations (Abad-Tortosa et al., 2017; Costa and Salvador, 2012). Overall, these data support the active coping response described by Obrist (1981), who predicted that stress would elicit a response characterized by beta-adrenergic activation, with a sympathetic impact on the heart proportional to the level of the demands. Thus, the "competition effect" has been described in HR, systolic BP (SBP), and HRV (Harrison et al., 2001; García-León et al., 2003; Veldhuijzen van Zanten et al., 2002).

Regarding the "winner/loser effect", numerous studies have tried to find a different testosterone response related to the outcome in competition, with varied results. In short, several studies have reported higher increases (or lower decreases) in T in winners than in losers (f.i. Carré et al., 2013; Edwards et al., 2006; Jiménez et al., 2012; Pesce et al., 2015), no differences between winners and losers (f.i. Mehta and Josephs, 2006; Salvador et al., 1987; Suay et al., 1999; van der Meij et al., 2012; Welker and Carré, 2014), or even higher increases in losers than in winners (f.i. Filaire et al., 2001). Thus, the research yields quite heterogeneous results (Archer, 2006; Carré and Olmstead, 2015; Casto and Edwards, 2016; Salvador, 2005). This disparity in the results reveals the need to include a number of factors to account for the variability in T responses in winners and losers (Carré and Olmstead, 2015; Salvador, 2005). Thus, potential moderating factors have been considered, including mood (Mazur and Lamb, 1980), physical fitness and previous success history (Salvador et al., 1987), physical exertion and motivation to win (Suay et al., 1999), power-motivation and anxiety (Maner et al., 2008; Schultheiss et al., 2005), among others. Recently, several reviews have included a number of factors that must be taken into account in clarifying this topic. Geniole et al. (2017) emphasized the importance of examining the role of individual differences and social contextual factors as moderators of the effect of outcome on T. These factors have been categorized as personal and contextual (situational) factors (Casto and Edwards, 2016; Hamilton et al., 2009).

Some of the most widely studied personal factors are some personality dimensions such as power motivation and dominance. Schultheiss and colleagues studied the moderating role of power motivation (i.e. non-conscious need to dominate or have an impact on others), reporting that it explained the T response in winners 15 min after competition (Schultheiss et al., 1999; Schultheiss and Rohde, 2002). Mehta and Josephs (2006) did not find T or C differences depending on outcome. However, they analyzed the proneness to competition and found that only losers with high T changes decided to compete again; they concluded that these short-term T changes are related to status-seeking behavior. Similarly, Carré et al. (2009) found that changes in testosterone after losing predicted subsequent aggressive behavior. The sex/gender of the competitors is also quite important, with the majority of the research on this topic carried out in men, although this has changed greatly in recent years; in general, the effects are clearer in men than in women (Geniole et al., 2017). Age, although mentioned, has not specifically been studied in this area.

The number of possible different contextual (situational) factors is quite high. For instance, Geniole et al. (2017) identified home-away, status of the opponent, ability vs chance, or a close or decisive outcome, as well as other factors such as time (morning, afternoon), duration of the competition, or collection timing, or naturally or manipulated outcome, in addition to methodological aspects (hormonal determination method, serum or saliva…). The meta-analysis carried out by Geniole et al. (2017) reported a large degree of heterogeneity in the "winner-loser" effect, mentioning the location of the competition (that is, "studies on competition carried out in laboratory or in natural settings or field") as a factor particularly relevant. They found that the strength of the "winner-loser effect" is much stronger in studies conducted outside the lab. This conclusion contradicts what was reported by Archer (2006, pp. 327): "although sport produces larger increases in T than a contrived competition, overall winners and losers differ more during contrived than sport competitions". This point is relevant since these competitive contexts (field vs lab) frequently imply different degree of investment, ego-involvement and causal attributions in the measure that the outcome depends, or not, on performance of the competitor.

Results from individual and team sports showed that the T response was related to athletes' attributions of their outcome, rather than the true, objective outcome (González-Bono et al., 1999, 2000; Serrano et al., 2000). For example, a study with judoists who participated in a competition among clubs showed that the T response was positively associated with attribution of the outcome to personal effort (Serrano et al., 2000). Trumble et al. (2012) found that competition-induced T increases were associated with self-reported performance but not with outcome in men playing soccer in an energetically stressful environment. In basketball players, González-Bono et al. (1999) found that the T response correlated negatively with external attribution in winners and positively in losers. These results suggest that in a real, highly competitive situation, T changes are not necessarily a direct response to the outcome; instead, they are related to the contribution the individual makes to the outcome and the causes he/she attributes to it. In basketball, González-Bono et al. (2000) found a negative correlation between post-match T and external attribution (to luck). These results support the idea that the causal attribution of the outcome contributes to the variance in T responses to real confrontations, at least when the outcome is highly dependent on personal merit, as in sports contests. In addition, Zilioli and Watson (2012) emphasized the importance of studying personality traits and individual differences in causal attribution that could contribute to understanding the responses to outcome. The question of whether participants attribute their outcome internally to effort/ability or externally to chance or luck, and the relationship between this attribution and the endocrine response, remains unanswered.

In the laboratory, Mazur and Lamb (1980) investigated the effect of outcome on a chance task (lottery game), without finding an effect of outcome. They concluded that T increases would appear only in merit situations involving personal effort. Subsequently, in a luck task that consisted of coin tosses, McCaul et al. (1992) reported significant T increases in winners and decreases in losers, and positive mood in winners and negative in losers, even though the outcome was a consequence of external factors such as luck or chance. Therefore, in a situation of external attribution, subjects could not appraise the task as depending on their contribution/performance or effort or being under their control. In this regard, van Anders and Watson (2007) carried out a study to determine whether ability (internal attribution) was a requisite for T changes on a computer-based vocabulary task; they concluded that winning due to one's ability elicited T increases or attenuated decreases. However, they also found that subjects attributed the outcome similarly to luck and to their own ability in both experiments.

In this context, we proposed an integrative approach that includes hormonal, cardiovascular, and psychological components of the response to human competition, emphasizing the importance of the subject's cognitive appraisal of the situation (Salvador, 2005; Salvador and Costa, 2009). According to this approach, people who appraise the situation as important, controllable, and depending on their own effort are more likely to employ an active pattern of responses. However, when the individual appraises the situation as uncontrollable, he/she would adopt a more passive response pattern. As mentioned above,