Editorial

Introduction to the Special Issue on Human Competition

David A. Edwards[a], Kathleen V. Casto[b], Pranjal Mehta[b]

[a*]Department of Psychology, Emory University, Atlanta, GA, 30322, USA
[b]Department of Psychology, University of Oregon, Eugene, OR 97403, USA

This Special Issue of *Hormones and Behavior* features 20 invited, peer reviewed, original articles, all but one of which deal with human competition. The exception is the penultimate article by Fuxjager et al. that explains how competition research with non-human animals can inform and be informed by research with humans. The first article is by Allan Mazur. And, rightly so – each of the articles in this collection cites his research. In a wide-ranging personal memoir, Mazur recalls his four decades of research, much of it having to do with testosterone and status in competition settings. Then, John Wingfield writes about the development of *the challenge hypothesis* which, together with Mazur's *biosocial model of status*, has provided a theoretical foundation for research on hormones and competition for more than twenty-five years to the present.

Writing about the science of competition and risk, Coates and Gurnell show how fieldwork and laboratory studies complement each other, and that an understanding of the influence of hormones – the emphasis here is on cortisol – on risk preferences leads to a better understanding of fluctuations in financial markets. An agility competition for dogs provides the setting for a beautiful field study (Sherman, Rice Jin, Jones, and Josephs) of sex differences in handlers' affiliative behavior (cover photo) towards their dogs after victory and defeat and in the relationship between changes in handlers' cortisol levels and time spent affiliating with their dogs. Casto, Rivell, and Edwards report that recreational women soccer players, like elite

women athletes in a variety of sports, show a dramatic increase in testosterone and cortisol associated with competition. Furthermore, individual differences in testosterone (but not cortisol) levels were positively associated with athletes' personal appraisals of their match performance.

Do "winners" have elevated levels of testosterone relative to "losers?" Geniole et al. provide a comprehensive meta-analysis of the effects of competition outcome on testosterone competitions in humans. They find that the "winner-loser" effect is most robust in field studies conducted in sport settings. For laboratory studies the effect is not nearly as strong and has been only found in studies of men. The human laboratory studies of the winner-loser effect in this special issue highlight the role of intervening person and context variables on hormonal responses to competition. For example, Wu et al. employ a popular computer puzzle game to explore how testosterone and affect vary in accordance with the margin of victory or defeat. Vongas and Al Hajj report that male winners in a computer-based competition showed a decrease in testosterone levels in a study that also explored competition-associated changes in testosterone in relation to implicit power motivation and after-competition aggression and emotion recognition. Salvador et al. found no support for the winner-loser effect among men competing in chance and merit-based tasks but, importantly, showed that testosterone levels and cardiovascular parameters were higher for merit- compared to chance-based competitions. In women competing against men, Henry et al. report that testosterone, but not cortisol, increased across competition regardless of outcome. Among losers (those whose status is threatened), testosterone was positively related to performance accuracy, but only if cortisol levels were relatively low. In a study with monetary incentives, Eisenegger et al. report that testosterone levels in men were positively associated with task-related competitiveness and, among those who

chose to compete, overconfidence in one's performance. Further, employing a test of a genetic marker for androgen receptors, this study is the first to show a positive relationship between lower number of CAG repeats for the testosterone receptor polymorphism (which corresponds to a higher number of androgen receptors) and competitive performance.

In most competitions, the success (winning) of one individual or group comes at the expense (losing) of another – a situation ripe for creating feelings of hostility and, as a consequence, aggression. The Point Subtraction Aggression Paradigm (PSAP) is a quasi-competitive game in which participants have an opportunity to retaliate against a provocation by "stealing" points from an opponent with no competitive benefit to themselves. As such, stealing is a behavior intended to harm another and is, in this sense, a form of aggression. Geniole, MacDonnell, and McCormick review the use of the PSAP in the study of the neuroendocrinology of aggression and conclude that the frequently noted association between fluctuations in testosterone level and PSAP aggression are directionally positive but, with no studies reporting significant associations for women, the relationship is likely sex-specific. In their multi-study article Welker et al. introduce the idea that *self-construal* i.e., whether individuals view themselves as independent or interdependent with others, in some instances, moderates the relationship between testosterone and aggression.

Retaliation is one of the major themes of an intriguing study by Prasad et al., who first put men and women under social stress (versus a control condition), and then had them play the ultimatum game to assess retaliation in response to unfair financial offers. Social stress appears to moderate the association between testosterone and retaliation, and there are sex differences, independent of testosterone level, in the relationship between stress and retaliation. The hawk-dove game is a two-person game in which can adopt either a dominant (hawk) or submissive

(dove) strategy. As described in the article by Mehta et al., individuals higher in basal testosterone made more hawk decisions than individuals with lower testosterone levels, with acute decreases in cortisol levels also associated with more hawk decisions.

As reviewed by Casto and Edwards (2016), from the first studies in the earlier 80s up to the present, the research literature on hormones and human competition has mostly to do with testosterone and cortisol. This is true for the articles appearing in this collection with two exceptions. Steven Stanton reviews the literature on the actions of testosterone and estradiol in shaping consumer behavior and economic decision making. Then, Ten Velden et al. make the case that oxytocin-motivated in-group cooperation is intuitive rather than deliberated.

The popular but by now widely challenged idea that postural power displays can influence testosterone and cortisol levels is approached in a new way by Smith and Apicella. Power displays and changes in hormone levels occur naturally in association with human competition. In a large-sample study, men were paired against each other in a one-on-one tug-o-war competition – for each pair there would be one winner and one loser. After that, men were asked to assume, with experimenter guidance, either high power, low power, or neutral power poses. The study includes an excellent analysis of what predicts winning and losing this intensely physical competition. With respect to the influence of power posing on hormone levels, null results prompt the authors to conclude that researchers who choose to work in this area should proceed cautiously.

In studies of athletic competition, there is a good balance in the literature between studies with men and studies with women. However, with respect to laboratory research, studies with men greatly outnumber studies with women (Casto and Edwards, 2016; Carré and Olmstead, 2015). That imbalance is reflected in the research articles appearing in this collection. Casto and

Prasad (this issue) persuasively argue for the importance of including women in studies of competition and offer some important recommendations about the analysis and interpretation of gender-related effects in studies of hormones, dominance, and competitive behavior.

Whether for good or bad, even the most ordinary lives are filled with competitions of one sort or another. The articles gathered together in this collection offer a bit of history about research linking hormones – for the most part, testosterone and cortisol – to human competition and provide examples of contemporary ways of thinking about and researching these connections. That hormones can influence and be influenced by various aspects of competition is not in doubt. However, the ways in which these influences are manifest, the settings in which they occur, the conditions for their occurrence, and the interplay between different hormones as they relate to various aspects of competition are fertile areas for scientific inquiry. Readers of the articles in this issue will appreciate the complexity of hormone/behavior relationships in matters of human competition, but also, we hope, be encouraged to explore these complexities with novel research paradigms of their own making.

References

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*Corresponding author

E-mail address: edwards@emory.edu