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Testing men's hormone responses to playing League of Legends: No changes in testosterone, cortisol, DHEA or androstenedione but decreases in aldosterone

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ABSTRACT

Esports, or competitive video gaming, has rapidly increased in online play and viewing. The popularity of esports such as League of Legends may derive in part because it features skills-based coalitional competition. Whereas a sizable literature focuses on adult human hormones and competition, little research has addressed the hormone responses of men playing video games. The purpose of the present study is to investigate the effects of playing a coalitionary-based esport on young U.S. men's steroid hormone levels in a naturalistic study. We tested salivary steroid changes in response to esports club members ($n = 26$) playing League of Legends against other people and the computer. We hypothesized that esports competition would increase testosterone, cortisol, DHEA and androstenedione levels, with more pronounced increases in winners than losers. Participants provided saliva samples before and after competitions lasting 15–27 min in duration. Salivary testosterone, cortisol, DHEA and androstenedione levels did not change overall or between play against people vs. the computer or with respect to winning or losing. However, play duration (range 16–27 min) was positively related to changes in DHEA, androstenedione and testosterone during play against people. Aldosterone levels decreased overall. We suggest that the informal and familiar environment as well as relatively short play duration help account for generally null findings. These findings help document physiological effects of esport play, in turn contributing to a richer understanding of why so many play and watch esports.

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1. Introduction

Electronic sports (esports) is expanding rapidly in the U.S. and many parts of the world (Li, 2016; Seo & Jung, 2016; Taylor, 2012). A variety of social and technical factors contribute to this recent rise in esports popularity. Improvements in Internet speed and computer graphics offer more technically compelling forms of competition, with platforms such as Twitch helping ratchet up the scale of play quality and fandom (Li, 2016). Among young adults characterized by delays in adult milestones like establishing an independent household or having children, a community of predominantly young men can find opportunities for competing, often socially, in esports (Twenge, 2017). The ability to play or watch online with others enables social and competitive experiences even if busy school or work schedules and living circumstances limit face-to-face encounters (Hamari, Hamari, Sjöblom, & Sjöblom, 2017; Lee & Schoenstedt, 2011). A growing number of dedicated esports facilities also foster in-person play and watching experiences.

In 2014, there were some 67 million League of Legends players monthly, and annual revenue was around $1 billion, making it the most popular esport globally (Li, 2016). League of Legends involves teams of 5 players competing against each other to destroy the enemy's "nexus," or base structure. Players select a character (Champion) possessing heroic and symbolic talents. Players coordinate with teammates, with the gaming environment demanding skill and strategy. Reasons for the success of League of Legends may include a low barrier to entry (free play, with purchase of additions like weapons during play possible) and the social aspects of competitive team play. There may be parallels between the success of League of Legends and popular athletic sports in featuring coalitional, skill-based competition (Apostolou, 2015).

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The purpose of the present research is to investigate the effects of playing League of Legends on young U.S. men's steroid hormone levels. A naturalistic study design was employed to test effects on men accustomed to playing League of Legends in a regular venue and community. This research helps contribute to work on the physiological effects of esport play, which itself may be of value in understanding how and why so many play esports recreationally. This research also connects with a body of hormones and human behavior research on the stress response and social competition, taking those concepts and empirical work into this newer niche of esports, potentially thus enriching both areas of study through this relatively novel bridge. If young men playing League of Legends exhibit similar hormone changes observed in other domains of social competition, this may help shed empirical light on the visceral responsiveness and perhaps appeal of esports.

How do steroid hormones reflect and organize human behavior? (Ellison & Gray, 2009; Nelson & Kriegsfeld, 2016)? Hormones such as testosterone and cortisol are pleiotropic, meaning they have multiple effects. Yet these multiple effects often serve functional ends. In response to a stressor such as a stimulus warranting a fight-or-flight response, hormones such as cortisol and aldosterone might increase to prepare the body to rapidly mobilize energy, cognitively focus, and shunt attention away from other less-immediately important functions such as reproduction or digestion (McEwen et al., 2015; Sapolsky, 2017). Moreover, a suite of androgenic hormones such as androstenedione and testosterone may both increase the likelihood of engaging in socially competitive encounters as well as reflect the consequences of such encounters, possibly biasing future behavioral responses to competition (Geniole, Bird, Ruddick, & Carré, 2017; Nelson & Kriegsfeld, 2016; Soma, Rendon, Boonstra, Albers, & Demas, 2015). Androgenic hormones may exert their effects through binding of the androgen receptor, with both rapid-action (i.e., cell surface interactions) and longer-standing effects (i.e., gene regulation) possible. DHEA is an abundant androgenic hormone primarily released by the adrenal gland in young men that may have some direct effects through interactions with other hormones (e.g., antagonistic interactions with cortisol) or neurotransmitters; DHEA can also be converted to the androgenic hormone androstenedione, which itself can be converted to testosterone (Soma et al., 2015). Thus, steroid hormone pathways may permit DHEA and androstenedione to exert primary effects after conversion to testosterone, the primary androgen involved in adult men's behavioral responses.

A large literature addresses hormone responses to men competing. Most of this literature has focused on two hormones—testosterone and cortisol. Drawing upon the “Challenge Hypothesis” for inspiration (Wingfield, Hegner, Dufty, & Ball, 1990), studies have tested patterns in men's testosterone responses to both athletic (e.g., individual and team sports) and non-athletic (e.g., playing poker) competition. In a meta-analysis, Geniole et al. (2017) showed that competition regularly induces acute changes in men's testosterone, and that relatively greater changes in winners than losers more often appear in non-lab settings. For example, winners of chess competitions had relatively higher testosterone changes than losers, with effects more pronounced in close rather than easy matches (Mazur, Booth, & Dabbs, 1992). Moreover, in lab-based poker play, testosterone levels in winners and losers alike rose approximately 10% in 25–30 min of competition (Steiner, Barchard, Meana, Hadi, & Gray, 2010). The magnitude of testosterone change in response to competition may also condition subsequent competitive behavior (Mehta & Josephs, 2006; Zilioli & Watson, 2014).

Relatedly, Casto and Edwards (2016) reviewed research on cortisol responses to human competition, as well as a smaller number of studies that have measured DHEA and androstenedione responses to competition. Findings showed that athletic competition typically led to an increase in cortisol levels, in some cases with elevated levels among winners relative to losers. Context and individual factors such as motivation also mattered, with cortisol findings less consistent in lab settings. McHale et al. (in review) extended the scope of human non-athletic competition and hormone responses to children in Hong Kong, finding that 8–10 year old boys and girls competing in a math competition had decreases in cortisol but no change in DHEA or androstenedione levels. According to the dual hormone hypothesis, testosterone responses to competition are contingent upon low vs. high baseline cortisol levels (Mehta & Prasad, 2015).

Several studies have investigated hormone responses to video gaming. Anticipatory changes in hormone levels before the start of a ping-pong video game match were observed (Mazur et al., 1992). Effects on testosterone and cortisol of playing a violent, multiplayer video game showed that individuals who made the most effort towards their team's victory had an immediate increase in testosterone after the match, whereas the losing team's most active team members faced a delay in testosterone increase, but only if this competition was played before the within-group tournament (Oxford, Ponzi, & Geary, 2010).

Here, we test hormone responses of young men playing League of Legends, a multi-player online battle game thought to activate male coalitional competitive psychology. The study involves men playing in a group of 5 against other groups of 5 players (condition 1) and a control condition playing against the computer (artificial intelligence, or AI). The study has several merits. It is the first to test potential hormone responses of playing League of Legends or any other esport. The study entails measuring a wider array of hormones—testosterone, cortisol, DHEA, androstenedione, and aldosterone—than is typically the case in the literature, and by arguably the gold standard (mass spectrometry) of methods. The inclusion of aldosterone, a hormone involved in water balance and blood pressure, may add novel insight into physiological responses to non-athletic competition. The study also involves testing a potential role of individual experience and performance. We hypothesize that steroid hormones will increase during the competition, with relatively higher increases when playing humans vs. the computer. We also hypothesize that winners will have greater increases than losers in these responses, with potential moderation of hormone change based on performance.

2. Material and methods

The study was conducted at the University of Nevada, Las Vegas (UNLV), in the U.S., in a computer lab facility. The players were male members of a campus esports club. All testing sessions took place on Friday afternoons during regular gaming club meetings. Two test sessions involved teams of players ($n = 26$) competing in groups of 5 against another team of 5 players. Two test sessions, serving as within-subject controls, involved 17 of the same subjects competing in teams of 5 players against the computer (AI). Play against other people and against the computer took place on different Fridays. Players not participating in the study were also allowed to compete, accounting for why numbers of players were not straightforward multiples of five teammates. Only one individual began play against people but dropped out, resulting in 26 (rather than 27) participants, whereas nine individuals did not participate in play against the computer. The study was approved by the UNLV Institutional Review Board.

Subjects provided 2–3 ml of saliva by passive drool. Saliva collection is considered minimally invasive, and has other advantages for purposes of this study: steroid hormone levels in saliva are highly correlated with blood levels; many subjects prefer to provide

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