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# Importance of self-efficacy in psychoendocrine responses to competition and performance in women

Raquel Costa[1], Miguel A. Serrano[2] and Alicia Salvador[2]
[1] Universidad Miguel Hernández and [2] Universitat de València

## Abstract

Cognitive appraisal before competition includes self-efficacy, traditionally defined as motivation and the perceived ability to perform well; presumably, both dimensions would affect the biological response to a contest. We aimed to analyze the role of self-efficacy in the psychobiological response to a competition in women. Forty university students were confronted in pairs on a laboratory competition while hormonal and emotional changes were measured. Our results indicated that self-efficacy was positively related to testosterone levels and positive mood, and also to better performance. These results empirically support the importance of main dimensions of the cognitive appraisal in androgenic and emotional responses to competition. In addition, they emphasize the importance of cognitive processes in this response. In conclusion, the relationship between androgens and self-efficacy may play an important role as a facilitator of performance in competitive settings.

***Keywords:*** self-efficacy, testosterone, performance, mood, competition, women.

## Resumen

***Importancia de la autoeficacia en la respuesta psicoendocrina a la competición y el rendimiento en mujeres.*** La valoración cognitiva que se realiza antes de la competición incluye las creencias de autoeficacia, tradicionalmente definidas como la motivación y la habilidad percibida para llevar a cabo una tarea correctamente; posiblemente, ambas dimensiones afectarían la respuesta biológica a la competición. El objetivo del presente trabajo fue analizar el papel de la autoeficacia en la respuesta psicobiológica a la competición, en mujeres. Cuarenta estudiantes universitarias participaron, por parejas, en una tarea competitiva de laboratorio midiéndose los cambios hormonales y emocionales durante la misma. Nuestros resultados indican que la autoeficacia se relaciona positivamente con los niveles de testosterona y el estado de ánimo positivo, así como con un mejor rendimiento. Estos resultados apoyan empíricamente la importancia de la valoración cognitiva para la respuesta androgénica y emocional a la competición, haciendo hincapié en los procesos cognitivos que median en la respuesta psicobiológica a la competición. En conclusión, la relación entre andrógenos y autoeficacia podría ejercer un papel facilitador de la ejecución en situaciones competitivas.

***Palabras clave:*** autoeficacia, testosterona, ejecución, estado de ánimo, competición, mujeres.

Competitive interactions are a natural way to obtain resources in order to adapt to environmental situations. The appraisal prior to the situation determines the goal striving, investment, emotions and biological changes (Salvador & Costa, 2009; Kriebig, Gendolla, & Scherer, 2012). Self-efficacy stands out as one of the most important cognitive dimensions shaping the way individuals cope with competitive contests (Salvador & Costa, 2009). This construct was defined as beliefs about one's own capacity to mobilize cognitive and behavioral resources to exert control over the task requirements (Bandura, 1997). It refers to expectations of competence, that is, the amount of control subjects expect to have over the generation and execution of their own behavior (Van der Meij, Buunk, Almela, & Salvador, 2010). Self-efficacy has also been related to performance, although the relationship between resource allocation and self-efficacy is not linear (Beck & Smidt, 2012). It has been postulated as a cognitive mechanism that establishes reciprocal influences on emotional and motivational processes at behavioral, experiential, and physiological levels (Bandura, 1997). Therefore, self-efficacy modulates the behavior and modifies the effort or resistance, in order to achieve an adaptive performance (Bandura, 1997; 2012), preparing individuals for action. Salvador and Costa (2009) emphasized the role of self-efficacy in the psychobiological response to competitive settings. However, literature has described positive, negative, or no relationships between self-efficacy and performance (for a review, see Stizman & Yeo, 2013). As Beattie, Fakehy and Woodman (2014) pointed out in novice golfers, that when a task is simple and unchallenging, self-efficacy has less effect on performance improvement; however, when a task is challenging and attainable, self-efficacy has a positive effect on performance improvement. Likewise, some characteristics of the task and the situation, such as involvement

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Corresponding author: Raquel Costa Ferrer
Facultad de Ciencias Sociosanitarias
Universidad Miguel Hernández
03202 Elche (Spain)
e-mail: r.costa@umh.es

(Beh, 1998), difficulty, or the reward (Ritcher & Gendolla, 2007), have also been positively related to performance.

From a psychoendocrinological point of view, most of the research on human competition has focused on testosterone changes associated with the outcome ("winning effect"), that is, changes measured after competition (Salvador, 2005; 2012). However, there is clear evidence that the response to competition begins before the competitive activity starts (Suay et al., 1999; Salvador, Suay, González-Bono, & Serrano, 2003) and has a preparatory purpose (Booth, Shelley, Mazur, Tharp, & Kittok, 1989). These testosterone changes ("competition effect") have been related to the subject's involvement in the situation. Specifically, positive correlations between testosterone and motivation to win (Suay et al., 1999) and internal attribution (Serrano, Salvador, González-Bono, Sanchís, & Suay, 2000) in sport competitions have been reported. However, this consideration does not preclude paying attention to the outcome, that is, subjects' performance. The idea that a certain pattern of psychobiological responses to competition would increase or decrease the probabilities of winning or losing has been defended (Salvador, 2005; Salvador & Costa, 2009). Hence, it is necessary to study the entire psychoendocrinological response to competition in order to also understand the final performance. In this study, we focus on the first part of the entire response, the cognitive appraisal, and specifically self-efficacy, in order to more closely examine the performance reached.

In addition, testosterone has been related to expectations of success influencing confidence (Johnson et al., 2006), and to better performance on cognitive tasks in subjects with high status (Newman, Sellers, & Josephs, 2005). Additionally, Suay et al. (1999) found significant relationships between testosterone changes in competition and motivation to win, but also between cortisol and self-efficacy, pointing out the importance of this stress hormone to better understand the entire process. In sum, these hormones not only contribute to explaining the response to competition; it has been stated that hormonal levels also depend on more subjective factors, particularly those related to the cognitive evaluation of the competitive situation, so that the appraisal (challenge or threat) is associated with the response pattern in competitive settings (Salvador, 2005; Salvador & Costa, 2009). Most studies on this topic have been carried out in men, in spite of the increasing recognition of the importance of competition in women, particularly in some contexts (Cashdan, 1998). In recent years, the number of studies in women has increased, although mostly in sport contests (Bateup, Booth, Shirtckliff, & Granger, 2002; Hamilton, van Anders, Cox, & Watson, 2009; Oliveira, Gouveia, & Oliveira, 2009).

To date, no study has examined the role of self-efficacy in the psychoneuroendocrinological response to a laboratory competition. According to the Salvador and Costa model (2009), self-efficacy emerges as a cognitive appraisal in the proximal context just before competition. In the present study, our main objective was to study the role of perceived self-efficacy in the hormonal (testosterone and cortisol) and emotional (anxiety, positive and negative mood) responses to a laboratory competition, as well as in performance, in young women. As the competition effect in women has mainly been described in the sports context, we aimed to complement these data with others obtained in the laboratory. Based on our model and due to the characteristics of the task to be performed (active coping, difficult but attainable, and completed in competition with other women), we expected that high self-efficacy would be related to higher testosterone levels, better performance and positive mood, and low cortisol, anxiety and negative mood.

## Method

### *Participants*

Forty healthy regular-cycling women aged 22.6±0.42 years old with a body mass index (BMI) of 21.69±0.31 (mean±SEM) were selected from a general sample of students from different faculties at the University of Valencia. They were non-smokers (less than five cigarettes per day), moderately physically active (mean of 3 h per week), healthy, and had not taken any type of medication in the days around the experiment. They were recruited and asked to take part in research on psychobiological responses to a laboratory task.

The women were in the follicular phase (from day 6 to day 10) the day of the experimental session, and they were informed that the previous day they had to maintain normal patterns, avoid drinking alcohol, and refrain from hard physical activity. The day of the experiment they were asked to avoid eating or drinking (except water) or brushing their teeth two hours before the experiment.

### *Instruments*

#### *Psychological assessment*

#### *Self-efficacy*

Situational self-efficacy was measured following Bandura's definition (1997), using three items referring to the capacity, confidence and importance of performing the task successfully, on a Likert scale from 1 to 100: (a) *What do you think your capacity is to win this competition?*; (b) *How much confidence do you have that you will win this competition?*; and (c) *How important is it for you to win this competition?* Self-efficacy was operationalized as the mean of the three items, with a Cronbach's $\alpha$ = .71. Previous studies have included these items to assess situational self-efficacy (van der Meij et al., 2010). Subjects answered in relation to the competition in which they were going to participate.

#### *Mood and state anxiety*

Before and after the competitive task, subjects filled out the Spanish versions of the State Anxiety scale (STAI-S) (Seisdedos, 1988) and the Positive and Negative Affect Scale (PANAS) (Sandín et al., 1999). The STAI-S is composed of 20 items that measure transient emotional states characterized by feelings of tension and apprehension. The PANAS is also composed of 20 items. Half of them make it possible to obtain a global score of positive mood, and the other half of negative mood. The bidimensionality of the questionnaire has been confirmed in Spanish samples, with a validity of $\alpha$ = .89 and $\alpha$ = .91 for positive and negative mood, respectively.

#### *Task*

For this study, a modification of the letter squares test (Cordero, Seisdedos, González, & De la Cruz, 1990) was employed. It was a paper-and-pencil test; each subject received a page with matrixes containing 16 letters (4×4). The subject's task was to find a repeated letter in a line or column as fast as possible. The task was modified by introducing competitive elements. First, participants were seated face-to-face; second, through the instructions, the investigator pointed out that they were going to compete for an economic reward (10 €); and third, the task was divided into five trials, with performance feedback after each, as in real competitions. Task performance was assessed as the number of matrices completed correctly, minus the matrices completed incorrectly.

### *Hormonal assays*

Salivary samples were cleaned and frozen at -40ºC until hormonal determination. All the samples for each subject were run in duplicate in the same assay at our laboratory (Central Research Unit, Faculty of Medicine, University of Valencia, Spain).

Due to low levels in saliva, the testosterone assay required a previous extraction phase with 3.5 ml ether. 125I-testosterone tracer was added and decanted into a tube coated with a high specific antibody provided by a commercial kit (ICN Biomedicals, Costa Mesa, CA). Cortisol was determined by an adapted commercial kit, as recommended in the protocol (Orion Diagnostica, Espoo, Finland). 125I-cortisol tracer and a high specific antibody were used. Cortisol levels were expressed in nmol/l, sensitivity was 1 nmol/l, and internal and external controls were included in the assays. Good precision was obtained, with intra and inter assay variation coefficients below 10%.

### *Procedure*

The experimental session was carried out in the afternoon (between 16:00 and 20:00) in order to control circadian rhythms. Two women arrived at the laboratory, went into Room 1, received information about the general procedure, and signed an informed consent approved by the Ethical Committee. After 10 minutes, the participants received instructions to take the first saliva sample. Thirty minutes after arrival, subjects moved to Room 2, where one experimenter seated them at facing tables. Later, another experimenter told subjects that they were going to compete for a prize, and he explained the competitive task using verbal and written instructions. Then, subjects completed mood and state anxiety questionnaires, while a salivary sample (Pre-task) was taken. Next, subjects participated in the competitive task (15 min) with the economic reward. Immediately after the task, a third saliva sample (post-task) was collected, while women filled out post-task questionnaires. Two other saliva samples were collected 15 and 30 minutes after the end of the task (Post-15, Post-30). Finally, subjects were debriefed and paid for their participation.

### *Data analysis*

Two participants were eliminated because their salivary samples were too small, and seven subjects due to extreme basal values (±1.5 SD in testosterone or cortisol); no other subjects were eliminated on the basis of the $p$<.001 criterion for Mahalanobis distances.

To test the influence of self-efficacy on the hormonal and emotional responses to competition, repeated-measures linear models (GLM) were conducted for testosterone, cortisol, performance, mood and anxiety, with 'moment' (5 levels for hormones and performance; two levels for psychological measures) as within-subjects factor, and 'self-efficacy' as a covariate factor. For *post hoc* testing, repeated measures GLMs or Spearman rank correlation tests were performed to explore significant effects and the direction of the significance ($p$<.05), depending on the case (see Moya-Albiol, Serrano, & Salvador, 2010).

All statistical analyses were performed using SPSS 20.0 for Windows. The alpha level was fixed at 0.05.

## Results

For testosterone, the ANCOVA showed no effect of the 'moment'; however, there was a significant effect of the covariate self-efficacy, $F(1, 29) = 4.41$, $p = .04$, $\eta^2_p = 0.13$. Post-hoc analyses showed positive correlations between self-efficacy and testosterone levels (Table I). Specifically, self-efficacy correlated significantly with basal testosterone and 30 minutes after the task (Post-30), and marginally with pre-competition and Post-15 testosterone ($p$ = .057). Thus, women with high self-efficacy showed higher levels of testosterone before the beginning of the experimental procedure. These differences were marginally maintained around the competition, and they reached significance again 30 min after the task.

For positive mood, the ANCOVA pointed to a significant effect of the covariate self-efficacy, F(1, 38) = 4.33, $p$<.04, $\eta^2_p = 0.10$), but post-hoc analyses did not show any significant correlations.

There were no significant effects for cortisol or for negative mood; for anxiety there was only a tendency for the covariate ($p$ = 0.07).

Finally, there was a significant effect of self-efficacy on performance, $F(1, 37) = 4.27$, $p = .04$, $\eta^2_p = 0.10$. Post-hoc analyses showed a significant positive correlation at the beginning and end of the task, in trials 1 and 5 (see Table 1), with higher levels of self-efficacy being related to higher performance levels.

*Table 1*
Values of correlations between Self-efficacy and testosterone levels, and between Self-efficacy and performance

| Testosterone | Self-efficacy | Performance | Self-efficacy |
|---|---|---|---|
| Basal -45 | r = 0.42, p = 0.019 | Trial 1 | r = 0.32, p = 0.048 |
| Pre-task | r = 0.35, p = 0.057 | Trial 2 | r = 0.19, p = 0.239 |
| Post-task | r = 0.27, p = 0.145 | Trial 3 | r = 0.27, p = 0.091 |
| Post-15 | r = 0.35, p = 0.057 | Trial 4 | r = 0.18, p = 0.263 |
| Post-30 | r = 0.37, p = 0.042 | Trial 5 | r = 0.34, p = 0.036 |

## Discussion

Our main objective was to explore the role of self-efficacy in a competitive situation. In activities where the outcome is highly contingent on the quality of the performance, the anticipated outcome depends mostly on the participants' beliefs about their own ability to perform in these situations. Moreover, when performance determines the outcome, efficacy beliefs can explain most of the variance in the results (Bandura, 1997). Our results showed that women with high levels of self-efficacy have better performance, probably because, as Bandura pointed out, efficacy beliefs can affect people's effort, strength, motivation, and affective states. Additionally, we also found differences in the psychological response, with better positive mood, which suggests that self-efficacy affects the emotional experience of the situation, even in people doing the same task.

The initial hypothesis was that perceived self-efficacy to carry out the task would modulate the testosterone levels. However, our results indicate that the higher the self-efficacy, the higher the testosterone levels throughout the experimental session, including the first sample when participants did not know they were going to compete. Self-efficacy beliefs are the person's perception of his/her ability to resolve a situation successfully, and in a competitive stress context, they may be related to baseline levels of testosterone. Traditionally, testosterone has been associated with dominance (Mazur & Booth, 1998) and a predisposition to dominate others (Schultheiss, Dargel, & Rohde, 2003). Newman et al. (2005) theorized that "high-testosterone individuals have a higher 'need' for status than low-testosterone individuals" (p. 206). It is worth noting that Salvador (2012) pointed out that gonadal hormones help to interpret social stimuli to react in front of the other participant, producing consequences in the response pattern to the social situation. Furthermore, testosterone has been proposed as a proximate mediator of positive illusions, given its role in promoting dominance and challenge behavior, particularly in men. In addition, testosterone levels are related to expectations of success (Johnson et al., 2006). Apart from this, a pre-competitive hormonal response pattern characterized by testosterone increases was described in a subgroup of elite canoeists (Eubank, Collins, Lovell, Dorling, & Talbot, 1997). This pattern has been considered as a facilitator to competing, as anticipatory testosterone was related to lower levels of anxiety. In judo players, only anticipatory testosterone responders showed greater motivation to win (Salvador et al., 2003). Our result goes one step further because, even before situational self-efficacy was assessed, higher testosterone levels were related to high self-efficacy. Consequently, the absence of testosterone increases would play a debilitating role. Thus, according to the challenge hypothesis, testosterone increases in response to situational cues would facilitate competitive behaviors, leading to better performance. However, in the present study, testosterone levels were obtained before the participants knew they would be involved in a competition. In this sense, our testosterone levels cannot be strictly considered an anticipatory response, but rather a "previous level", before coping with a novel situation.

According to our results, the cortisol response does not vary depending on perceived self-efficacy, contrary to what we expected. Bandura (1997) argued that people with low self-efficacy would have greater stress responses. It is possible that the differences in self-efficacy were small, and women reacted similarly to this laboratory stressor, without presumed competitive differences in cortisol. Moreover, the lack of activation of the hypothalamic-pituitary-adrenal (HPA) axis would mean that the task was not appraised as a threat (Seery, Weisbuch, & Blascovich, 2009).

It is worth noting that the appraisal of the situation affects the androgenic and emotional responses to competition, which are positively related to performance. Although the results are marginally significant, self-efficacy is positively related to positive mood, and negatively to anxiety. Previously, authors have stated that emotional arousal may lead to impairments in performance (Bandura, 1997). Furthermore, positive affect has been related to expectancy motivation, which influences general activation (Erez & Isen, 2002). Thus, we think our results indicate that high self-efficacy participants have positive feelings that reduce anxiety, allowing better performance due to increased activation, in contrast to the low self-efficacy participants. Thus, high self-efficacy would lead to active coping. These active coping responses can occur in challenging situations, as previously defended (Salvador & Costa, 2009; Costa & Salvador, 2012). Specifically, psychobiological responses in women with high self-efficacy are compatible with an active coping response. Cognitive processes are involved in triggering differentiated patterns of response. In this sense, this study points out that self-efficacy should be taken into account in competitive situations, to the extent that it would influence the interpretation of the situation as a challenge or threat. If the individual appraises the situation as a challenge, an active coping response pattern is more likely to develop. This pattern would be characterized by increases in testosterone and sympathetic nervous system activation, accompanied by positive mood changes (Salvador, 2012), as found in the present study. Furthermore, previous experience (positive or negative), along with increases or decreases in testosterone and cortisol during the competition, could influence expectations and motivations (Salvador & Costa, 2009), which would modulate planned strategies to cope with competitive situations, modifying the sense of self-efficacy.

In conclusion, the present results empirically support the role of self-efficacy as a relevant variable in hormonal and emotional competitive responses and performance. Therefore, our results indicate that improving self-efficacy in competitive settings, for example, by means of psychological interventions, may increase the probability of success. However, the main contribution of this study is that androgens are related to personal dimensions such as self-efficacy, perhaps playing a role as a facilitator of performance. More research is needed to further examine the role of self-efficacy in testosterone, and even a possible bidirectional relationship, employing a larger number of subjects of both sexes and in different competitive situations.


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