RESEARCH ARTICLE

Individual Differences in the Psychobiological Response to Psychosocial Stress (Trier Social Stress Test): The Relevance of Trait Anxiety and Coping Styles

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Abstract

The main objective of this study was to investigate the contribution of some personality traits to the physiological and psychological response to a standardized laboratory psychosocial stressor (trier social stress test). Cortisol and affective response (anxiety and mood) were analysed in a mixed-sex group composed of 35 young adults who participated in a crossover design (18 men and 17 women). After verifying a statistically significant response to the trier social stress test in all parameters studied in both sex groups, exploratory cluster analyses were carried out to identify sub-groups based on their psychophysiological responses. These analyses showed two different groups: subjects displaying lower psychological response along with higher cortisol response (cluster 1) compared with the group with high affective reactivity along with lower cortisol response (cluster 2). Interestingly, we also found significant differences in trait anxiety and coping styles when the two clusters were compared. Subjects in cluster 1 showed lower scores on trait anxiety and higher scores on active coping, whereas the subjects in the second cluster obtained higher scores on anxiety and on coping focused on emotions and mental disengagement. These findings support the importance of personality traits and coping styles in understanding the overall integrative psychobiological responsiveness to social stress. Copyright © 2014 John Wiley & Sons, Ltd.

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Keywords

psychosocial stress; cortisol; coping styles; trait anxiety

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Introduction

Stress responsiveness involves the functioning of multiple response systems, with changes at cognitive, emotional, behavioural and physiological levels (Campbell & Ehlert, 2012) that could have negative repercussions on numerous disorders and diseases. In the past few decades, attention has been paid to studying individual differences in the stress response, because of the high incidence of disorders related to stressful experiences, many of them with a different prevalence in men and women. Many of these disorders have been related to activation of the hypothalamus–pituitary–adrenal (HPA) axis, which has repeatedly shown sex differences, leading to the consideration that the stress response is different in men and women (Kajantie & Phillips, 2006; Kudielka, Hellhammer, & Wust, 2009).

In fact, most of the literature on sex differences in response to psychosocial stress, mainly using the trier social stress test (TSST), shows that men and women differ in their psychological and physiological responses to acute stress, predominantly assessed by parameters such as anxiety, mood and cortisol. Generally, men show higher cortisol responses than women (Childs, Dlugos, & De Wit, 2010; Cornelisse, van Stegeren, & Joels, 2011; Huart, Chong, Oswald, Lin, & Wand, 2006; Kirschbaum, Kudielka, Gaab, Schommer, & Hellhammer, 1999; Kudielka, Buske-Kirschbaum, Hellhammer, & Kirschbaum, 2004a, 2004b), although depending on the phase of the menstrual cycle or contraceptive use (Espin et al., 2013; Kajantie & Phillips, 2006).

In contrast, higher affective responses have been reported in women than in men (Childs et al., 2010; Kelly, Tyrka, Anderson, Price, & Carpenter, 2008; Walder, Statucka, Daly, Axen, & Haber, 2012), whereas other authors failed to find sex differences in this type of response to acute stress (Cornelisse et al., 2011; Kirschbaum et al., 1999; Schoofs & Wolf, 2011). These heterogeneous results suggest that, as in the cortisol response, the affective response could also be influenced

by other factors, such as the menstrual cycle phase. For instance, Walder et al. (2012) found that state anxiety, anger and hostility were greater in women in the follicular phase compared with men and women in the luteal phase.

In sum, although sex is an important factor involved in the stress response, there are other factors that could moderate stress responsiveness, such as the menstrual cycle phase and some personality traits that could also interact with sex, although the latter have been studied less. However, although it has been generally recognized that personality traits must play a very important role in how people confront daily stressful situations, their influence on the psychophysiological response to stress has been not sufficiently established.

In their meta-analysis on the relationships between the HPA axis and personality traits, Chida and Hamer (2008) indicated that reduced HPA axis reactivity was related to various positive psychological traits or states such as positive mood and active coping. These authors suggested that some personality dimensions, such as trait anxiety, can moderate stress reactions; thus, the study of these dimensions could be an important factor in understanding some stress-related diseases. Furthermore, studies focused on chronic stress indicate that anxiety is related to the way of coping with stressful situations; for example, people with higher levels of anxiety have obtained lower scores on problem-focused coping strategies (Tuncay, Musabak, Engin Gok, & Kutlu, 2008). Coping is one of the factors that may influence the response to social stressors, performance, outcome and possible future consequences. It has been defined as the way we face a threat or a challenge in an attempt to prevent or reduce associated distress (Carver & Connor-Smith, 2010), and it shows two extreme patterns, active or passive (Salvador, 2005, 2012; Salvador & Costa, 2009). According to Carver, Scheier, and Weintraub (1989), whereas active strategies included problem-focused coping, passive coping is defined as maladaptive strategies when faced with stressful situations, such as venting of emotions, denial and mental disengagement. In sum, active and passive patterns of stress response are closed related to stable coping styles in real situations.

Another relevant question is the relationship between mood or anxiety and cortisol changes in situations of psychosocial stress, which has not yet been completely established. Whereas a positive relationship between state anxiety and HPA response to psychosocial stressors has been reported (Oswald, Mathena, & Wand, 2004), other studies have found a negative relationship (Rimmele et al., 2007) or even failed to find significant relationships (Gaab, Rohleder, Nater, & Ehlert, 2005; Kudielka et al., 1998, 2004a). Campbell and Ehlert (2012) reviewed a total of 49 studies in which the paradigm of social stress was always the TSST. They concluded that the subjective experience of stress and the physiological reactions are not always correlated. Physiological measures such as cortisol do not seem to reflect anxiety, at least not at the same point in time.

We aimed to explore some factors involved in individual differences in response to psychosocial stress, employing a standardized laboratory stressor, the TSST. The purpose of the present study was the following: (1) to examine the patterns of psychophysiological response in young men and women in order to verify the two patterns hypothesized, active and passive; (2) to analyse the role of trait anxiety and coping style as possible adaptive/maladaptive mechanisms; and (3) the relationships among subjective and physiological components of the response. We hypothesized two stress response patterns (active/adaptive and passive/maladaptive) that will be differentially associated with some personality traits, such as trait anxiety and dispositional coping. In other words, we consider that personality traits may contribute to explaining differences in both psychological and physiological responsiveness to stress. Furthermore, although sex differences in the psychobiological response to social stress have not been completely established, probably because of a variety of factors that can interact, we expect a different stress cortisol and affective response depending on the subject's sex. Finally, on the basis of Campbell and Ehlert (2012), we do not expect to find significant relationships between anxiety and mood and cortisol response when faced with the TSST.

Method

Participants

One hundred and seven volunteers were interviewed and completed a questionnaire to determine whether they met the study prerequisites. For subject recruitment, announcements were posted, and informative talks were held in the various departments on the university campus. Volunteers were interviewed by trained psychologists and completed an extensive questionnaire to check whether they met the study prerequisites. The final sample was composed of 35 subjects (17 women) between 18 and 35 years old [total sample: $M = 21.06$, standard error of means (SEM) = 0.732]. There were no sex differences in age and subjective socioeconomic status (Adler, Epel, Castellazzo, & Ickovics, 2000) between groups (all $p \geq 0.16$).

Most of them (97%) were college students from different academic areas. The criteria for exclusion were smoking more than five cigarettes a day; alcohol or other drug abuse; visual or hearing problems; presence of a cardiovascular, endocrine, neurological or psychiatric disease; having been under general anaesthesia once or more than once in the past year and the presence of a stressful life event during the past year. Participants were excluded if they were using any medication directly related to cardiac, emotional or cognitive function or one that was able to influence hormonal levels,

such as glucocorticoids or β-blockers. Seventeen women were in the menstrual phase (days 2–5 post-menses). All of them were nulliparous with no gynaecological problems, and they all had regular menstrual cycle lengths of between 24 and 36 days.

Participants who met the criteria were contacted by telephone and asked to attend two sessions that took place in a laboratory at the Faculty of Psychology. Before each session, participants were asked to maintain their general habits, sleep as long as usual, refrain from heavy activity the day before the session and not consume alcohol since the night before the session. Additionally, they were instructed to drink only water and not eat or take any stimulants, such as coffee, cola, caffeine, tea or chocolate, 2 hours prior to the session. The study was conducted in accordance with the Declaration of Helsinki, and the protocol and conduct were approved by the University of Valencia Ethics Research Committee. All the participants received verbal and written information about the study and signed an informed consent form.

Study protocol

This study employed a within-subject design with two completely randomized and counterbalanced conditions in two separate sessions: a stress condition and a control condition. The interval between sessions was less than 10 days for men and 2–3 days for women; the interval was shorter in the female group to ensure that both sessions were carried out in the same phase of the menstrual cycle. The sessions consisted of several phases with equal durations in both conditions. Overall, both sessions lasted approximately 1 h, and they were always held between 16.00 and 19.00 h. Each participant started his or her two sessions at the same time of day. Upon arrival at the laboratory, the weight and height of the participants were measured, and the experimenter checked whether they had followed the instructions given previously. In the last part of the first session, all the participants completed the Coping Orientations to Problems Experienced (COPE) and inventory of situations and responses of anxiety (ISRA) questionnaires, regardless of whether this session was experimental or control.

Stress condition

To produce stress, we subjected the participants to the TSST (Kirschbaum, Pirke, & Hellhammer, 1993). The stress task consisted of 5 min of free speech (job interview) and a 5-min arithmetic task. The participants remained standing at a distance of 1.5 m from the committee. The committee was composed of a man and a woman who were professors at the University of Valencia. Interaction between the participants and committee members was always with the opposite sex. Additionally, a video camera and a microphone were clearly visible. Both the speech and arithmetic tasks were filmed.

The protocol started with a habituation phase of 15 min to allow the participants to adapt to the laboratory setting. During this phase, the participants remained seated. Five minutes after the start of this phase, baseline measures were obtained for anxiety [state anxiety inventory (STAI-S)] and mood [positive and negative affect schedule (PANAS)]. While subjects responded to these questionnaires, they provided the first saliva sample (−20 min pre-stress). After the habituation phase, the introductory phase began (duration of 3 min). In this phase, the participants were informed about the procedure for the stress task. They received the instructions in front of the committee in the same room where the task took place. Next, the participants had 10 min to prepare for the task at hand. At that moment, they provided the second saliva sample (−5 min pre-stress).

Following the preparation phase, the stress task was carried out. The subjects had 20 min to recover after the stress task, and they answered two questionnaires (STAI-S and PANAS) and provided the third saliva sample (+15 min post-stress) during this recovery period. The room used for habituation, preparation and recovery was not the same one used for the introduction and stress task. The participants provided the last saliva sample 25 min later (+40 min post-stress).

Control condition

The control condition was similar to the experimental condition, except that the stressful task was replaced by a control task. This task was designed to be similar to the stress task in mental workload and global physical activity but without the main components capable of provoking stress, such as evaluative threat and uncontrollability (Dickerson & Kemeny, 2004). The control task was composed of 5 min of reading aloud and 5 min of counting without the committee. In the preparation phase, the participants read a book with neutral content. The times for collecting the saliva samples and the phase durations were the same for the two conditions, as well as the questionnaires used to evaluate mood and anxiety.

Salivary cortisol

The participants provided four saliva samples by depositing 3 mL of saliva in plastic vials. They took approximately 5 min to fill the vial. The samples were frozen at −80 °C until the analyses were carried out. The samples were analysed by a competitive solid-phase radioimmunoassay (tube coated), using the commercial kit Coat-A-Count C (DPC, Siemens Medical Solutions Diagnostics, Los Angeles, CA, USA). Assay sensitivity was 0.5 ng/mL. For each subject, all the samples were analysed in the same trial. The findings are expressed in nanomolar units (nmol/L). The within-assay and inter-assay variation coefficients were all less than 8%.

State psychological assessment

State anxiety

To assess state anxiety, the Spanish version (Seisdedos, 1988) of the STAI was used (STAI form E, Spielberger, Gorsuch, & Lushene, 1970). It consists of 20 phrases (e.g. 'I feel at ease' and 'I feel upset') with a four-point Likert scale ranging from 0 (not at all) to 3 (extremely) to evaluate how the participants felt at the moment they gave the answers. The Spanish version of the scale had a Cronbach's alpha ranging from 0.90 to 0.93. In this study, the Cronbach's alpha ranged from $\alpha = 0.81$ to 0.93.

Mood

Mood was evaluated by the Spanish version (Sandín et al., 1999) of the PANAS (Watson, Clark, & Tellegen, 1988). This 20-item questionnaire assesses mood according to two dimensions: positive affect (*interested*, *excited*, *strong*, *enthusiastic*, etc.) and negative affect (NA: *distressed*, *upset*, *guilty*, *scared*, etc.), with 10 items measuring each state. The participants were asked to complete the questionnaire based on how they felt at that particular moment. They responded using a five-point Likert scale ranging from 1 (not at all) to 5 (extremely). Sandín et al. (1999) reported a high internal consistency for the Spanish version, with a Cronbach's alpha for positive affect ranging from 0.87 to 0.89 and for NA from 0.89 to 0.91. In this study, Cronbach's alpha ranged from $\alpha = 0.71$ to 0.85.

Trait anxiety

We employed ISRA (Miguel Tobal & Cano Vindel, 1994), a specialized questionnaire for evaluating trait anxiety that is frequently employed in Spanish studies. This questionnaire includes 24 anxiety items, following Lang's model (1968) using the triple (cognitive, physiological and motor) response system. In addition, this inventory makes it possible to evaluate 22 situations grouped in four factors related to specific situational areas: test evaluation anxiety (F I), interpersonal anxiety (F II), phobic anxiety (F III) and anxiety in daily life (F IV). We used the first situational area, directly related to situations that involve evaluation or accepting responsibilities, and defined by situations such as public speaking tasks, receiving criticism and the possibility of being evaluated negatively. Cronbach's alpha ranges from $\alpha = 0.95$ to 0.98 for the anxiety responses system and $\alpha = 0.96$ for test evaluation anxiety (F I) (Miguel Tobal & Cano Vindel, 1994). In this study, Cronbach's alpha ranged from $\alpha = 0.83$ to 0.89 for the anxiety responses system and $\alpha = 0.93$ for test evaluation anxiety (F I).

Coping styles (COPE)

The dispositional version of the COPE inventory is a theoretically-based self-report questionnaire that addresses different ways of coping (Carver et al., 1989). Subjects must indicate what they *generally* do and feel when experiencing stress. Items are rated on a 4-point scale, ranging from 1 (I usually don't do this at all) to 4 (I usually do this a lot). We employed the Spanish version of the long form, consisting of 60 items arranged in 15 factor scales within the following groups: problem-focused coping (active coping, planning, seeking instrumental support, suppression of competing activities and restraint coping), emotion-focused coping (seeking emotional support, positive reinterpretation, religion, acceptance and humour) and potentially maladaptive emotion-focused coping (venting of emotions, denial, mental disengagement, behavioural disengagement and use of alcohol and drugs). The Spanish version of the scale had a Cronbach's alpha ranging from $\alpha = 0.78$ to 0.92 (Crespo & Cruzado, 1997). In this study, Cronbach's alpha ranged from $\alpha = 0.66$ to 0.81.

Statistical analyses

Analyses of variance (ANOVAs) for repeated measures were used to assess the effects of acute stress on anxiety, mood and cortisol. We measured anxiety and negative mood before and after the stress and control tasks; for cortisol, we added time (−20, −5, +15 and +40 min) as a within-subject factor for both the control and stress conditions. Moreover, to take into account the individual differences in cortisol, anxiety and mood responses in stress condition, compared with the control situation, reactivity to stress ('net reactivity') was defined as the difference between deltas in the stress condition and deltas in the control condition. For cortisol levels, deltas were calculated as the difference between the samples, (+15) and (−5), in the two conditions; for STAI and PANAS, deltas were calculated as the difference between scores obtained before and after both tasks.

Cluster analyses were carried out in order to explore the patterns of psychological and physiological responses (Section on Cluster analysis).

We checked for order effects (whether the stress or control condition was first) by using an ANOVA for repeated measures, which did not reveal any effect of order for cortisol and subjective measures (all $p > 0.168$) or for COPE and ISRA measures (all $p > 0.102$).

Spearman's rank correlation coefficients were calculated in order to assess whether the physiological (cortisol) and psychological changes (anxiety and negative mood) were related to each other and to personality traits (COPE and ISRA).

One-way ANOVAs were used to analyse individual differences on each trait questionnaire (ISRA and COPE) and on psychobiological reactivity to stress, net reactivity of cortisol, STAI and PANAS. To assess group differences, we included group (men versus women or cluster 1 versus cluster 2) as a between-subject factor.

Post hoc planned comparisons were performed using Bonferroni adjustments for the *p*-values. All *p*-values reported are two-tailed, and the level of significance was marked at <0.05. When not otherwise specified, results shown are means ±SEM. We used SPSS 15.0 to perform the statistical analyses.

Results

Psychophysiological response

For state anxiety, a repeated measures ANOVA revealed significant effects of condition ($F(1, 34) = 19.810$, $p < 0.001$, $\eta_P^2 = 0.368$), Time ($F(1, 34) = 13.603$, $p = 0.001$, $\eta_P^2 = 0.286$) and the condition × time interaction ($F(1, 34) = 21.432$, $p < 0.001$, $\eta_P^2 = 0.387$). No differences were found between the stress and control conditions before the task ($p = 0.574$), but we found higher anxiety in the stress condition, compared with the control condition, after the TSST ($p < 0.001$) (Table I).

For negative mood, significant effects of condition ($F(1, 34) = 22.771$, $p < 0.001$, $\eta_P^2 = 0.401$), time ($F(1, 34) = 6.121$, $p = 0.019$, $\eta_P^2 = 0.153$) and the condition × time interaction were found ($F(1, 34) = 34.225$, $p < 0.001$, $\eta_P^2 = 0.502$). Negative mood was similar in both conditions before the tasks ($p = 0.173$), but the increases were higher after the tasks in the stress condition, compared with the control condition ($p < 0.001$) (Table I).

Table I. Differences in means ± SEM, on cortisol (nmol/L), state anxiety and negative mood in response to psychosocial stress (TSST) in the total sample ($n = 35$)

Condition	Time	Cortisol	State anxiety	Negative mood
Experimental	−20	6.10 ± 0.64	15.71 ± 1.04	13.52 ± 0.54
	−5	5.45 ± 0.53		
	15	11.05 ± 1.40	23.67 ± 1.63	18.2 ± 1.06
	40	7.38 ± 0.71		
Control	−20	7.28 ± 0.82	16.37 ± 1.55	14.43 ± 0.77
	−5	6.11 ± 0.58		
	15	4.63 ± 0.38	14.74 ± 1.23	12.45 ± 0.47
	40	3.91 ± 0.27		

For cortisol, a repeated measures ANOVA showed significant effects of condition ($F(1, 34) = 8.506$, $p = 0.006$, $\eta_P^2 = 0.2$), time ($F(1.743, 59.260) = 8.724$, $p = 0.001$, $\eta_P^2 = 0.204$) and the condition × time interaction ($F(1.530, 52.014) = 34.690$, $p < 0.001$, $\eta_P^2 = 0.505$). *Post hoc* comparisons showed no differences between conditions before the task (all $p > 0.142$). However, the levels of cortisol were significantly higher after the TSST (all $p < 0.001$) in the stress condition, compared to the control condition (see Table I).

Cluster analysis

As we wanted to confirm the two response patterns, active versus passive (high and low response to stress, respectively), the net reactivity for cortisol, anxiety and negative mood was entered. The cluster solution resulted from a *k*-means analysis of the entire sample ($n = 35$). Two clusters were identified: Cluster 1 was characterized by low psychological reactivity (anxiety and negative mood) with higher cortisol reactivity, and cluster 2 was characterized by high psychological reactivity (anxiety and negative mood) with lower cortisol reactivity. Cluster 1 was composed of 15 men and 5 women, and cluster 2 had 3 men and 12 women. ANOVA revealed that the differences between clusters on anxiety and negative mood were statistically significant ($p < 0.001$) but not for cortisol ($p = 0.384$). Table II shows the differences in net reactivity according to sex and cluster.

Cluster differences in personality traits and coping styles

Significant differences between the two clusters were found in the three components of anxiety studied: cognitive ($F(1, 34) = 12.110$, $p = 0.001$, $\eta_P^2 = 0.268$), physiological ($F(1, 34) = 20.224$, $p < 0.001$, $\eta_P^2 = 0.380$) and motor ($F(1, 34) = 20.777$, $p < 0.001$, $\eta_P^2 = 0.386$). Furthermore, significant differences appeared on test evaluation anxiety ($F(1, 33) = 19.573$, $p < 0.001$, $\eta_P^2 = 0.372$). The participants allocated to cluster 1 were characterized by lower scores on all components of trait anxiety and the specific situation analysed, compared with their counterparts in cluster 2 (Figure 1).

Table II. Differences in means ±SEM on state anxiety, negative mood and cortisol 'net reactivity' to psychosocial stress (TSST) in the subjects, grouped in two clusters and by sex

Mean scores ± SEM	Cluster 1 ($n = 20$)	Cluster 2 ($n = 15$)	ANOVA
State anxiety	2.16 ± 1.97	19.47 ± 2.24	$F(1, 33) = 30.437$, $p < 0.001$
Negative mood	3.10 ± 1.16	11.39 ± 1.43	$F(1, 33) = 22.293$, $p < 0.001$
Cortisol	7.95 ± 1.82	5.9 ± 1.14	$F(1, 33) = 0.779$, $p = 0.384$
Mean scores ± SEM	Men ($n = 18$)	Women ($n = 17$)	ANOVA
State anxiety	4.94 ± 3.12	14.49 ± 2.19	$F(1, 33) = 6.122$, $p = 0.019$
Negative mood	5.33 ± 1.64	8.05 ± 1.54	$F(1, 33) = 1.446$, $p = 0.238$
Cortisol	8.08 ± 1.72	6.00 ± 1.50	$F(1, 33) = 0.816$, $p = 0.373$

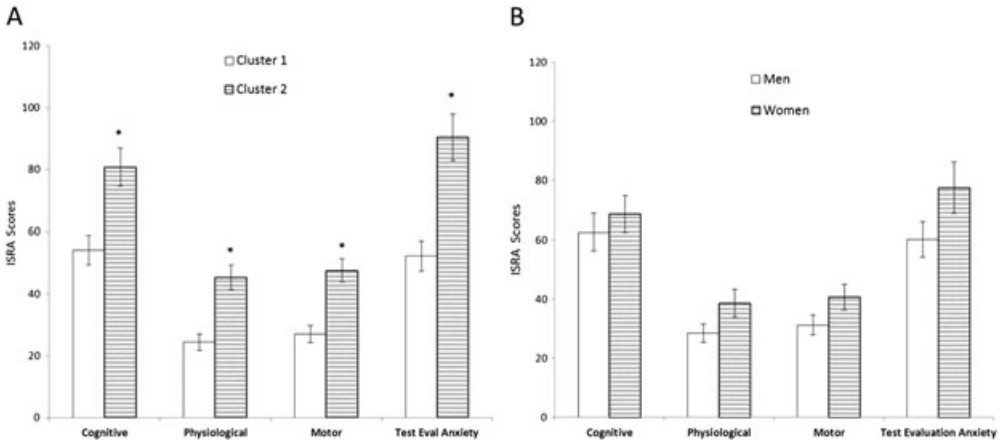

Figure 1. (a) Mean values ± SEM of the three components of anxiety studied and of test evaluation anxiety from the ISRA inventory related to subjects grouped by cluster. (b) Mean values ± SEM of the three components of anxiety studied and of test evaluation anxiety from the ISRA inventory by sex (*$p \leq 0.01$)

Mean values (±SEM) for each anxiety component for clusters 1 and 2 were the following, respectively, cognitive (54.2 ± 4.73 versus 80.73 ± 6.14), physiological (24.48 ± 2.63 versus 45.33 ± 4.05), motor (27.1 ± 2.72 versus 47.6 ± 3.72) and test evaluation anxiety (52.3 ± 4.83 versus 90.4 ± 7.58). All mean scores were in the normal range for Spanish data scales, between percentiles 25 and 75; therefore, the participants did not show subjective severe or extreme anxiety.

Statistically significant differences in coping styles were only found for active coping ($F(1, 34) = 7.683$, $p = 0.009$, $\eta^2_P = 0.0.189$) and planning ($F(1, 34) = 8.402$, $p = 0.007$, $\eta^2_P = 0.203$), but marginal differences appeared for focusing on and venting emotions ($F(1, 34) = 3.897$, $p = 0.057$, $\eta^2_P = 0.106$) and mental disengagement ($F(1, 34) = 3.900$, $p = 0.057$, $\eta^2_P = 0.106$). The participants allocated to cluster 1 obtained significantly higher scores on active coping and planning, whereas, as a trend, the participants allocated to cluster 2 were characterized by higher scores on focusing on and venting emotions and mental disengagement (Figure 2). Mean values (±SEM) on each scale for clusters 1 and 2, respectively, were active coping (12.05 ± 0.38 versus 10.53 ± 0.37), planning (12.45 ± 0.49 versus 10.13 ± 0.65), Focusing on and venting emotions (9.3 ± 0.43 versus 10.73 ± 0.60) and mental disengagement (8.8 ± 0.41 versus 10.13 ± 0.55).

Sex differences in personality traits and coping styles

Sex differences on the trait anxiety scales (ISRA) did not reach statistical significance for the three components of anxiety studied (all $p > 0.08$) or 'test evaluation anxiety' (all $p > 0.10$) (Figures 1 and 2). Nor were significant effects of sex found on the COPE inventory scales (all $p > 0.132$).

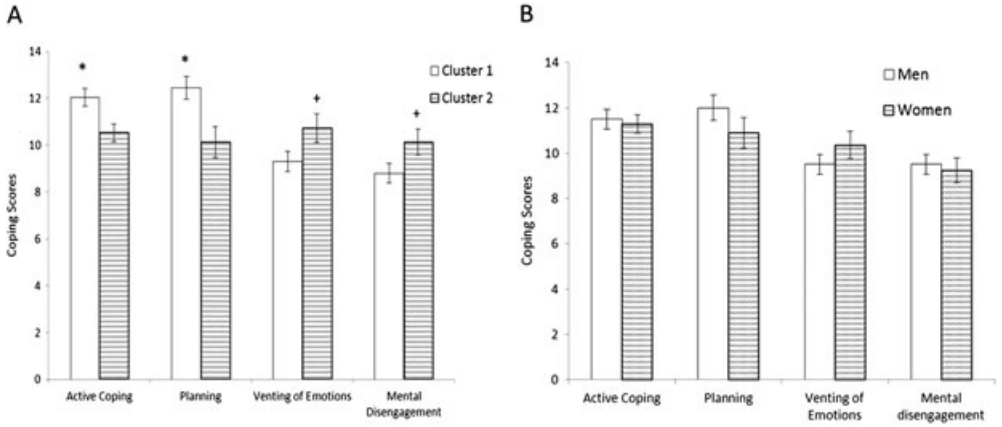

Figure 2. (a) Mean values ± SEM of the scales of the COPE inventory related to subjects grouped by the cluster. (b) Mean values ± SEM of the scales of the COPE inventory related to subjects grouped by sex (*$p \leq 0.001$; +$p = 0.057$)

Relationships among psychophysiological responses and psychological traits

Emotional (anxiety and mood) reactivity did not correlate with cortisol reactivity. However, both anxiety and negative mood correlated significantly with all the ISRA and COPE scales that had shown significant differences between clusters (Table III). On the one hand, anxiety reactivity correlated positively with the triple response system (cognitive, physiological and motor) and with the test evaluation anxiety situational factor (all $p \leq 0.001$). On the other hand, negative mood reactivity correlated positively with the triple response system (cognitive, physiological and motor) and with the test evaluation anxiety situational factor ($p \leq 0.001$). Furthermore, both anxiety and negative mood reactivity correlated negatively with 'active coping' on COPE ($p \leq 0.016$).

In addition, active coping was consistently and negatively correlated with all the trait anxiety scales, whereas the coping factors focused on emotions were positively correlated with the trait anxiety scales (Table IV).

Discussion

The present study investigated some factors involved in individual differences in response to a standardized laboratory psychosocial stressor (TSST). Stress response was assessed by psychological (anxiety and mood) and physiological (cortisol) pre–post measures in an experimental condition and a control condition, employing a crossover design.

Firstly, our results confirmed that the TSST elicited significant changes, with perceived anxiety and negative mood increases and increases in cortisol levels. These results are in line with studies that have examined both the psychological and physiological responses to laboratory psychosocial stressors (Childs et al., 2010; Izawa et al., 2008; Kelly et al., 2008; Kudielka et al., 2004a, 2004b; Rimmele et al., 2007; Scholz et al., 2009).

Faced with this psychosocial stressor, on the basis of previous literature, we expected that sex would influence the stress response, with a higher cortisol response in men (Childs et al., 2010; Cornelisse et al., 2011; Kirschbaum et al., 1999) and a greater affective response in women (Childs et al., 2010), but we only found sex differences in anxiety reactivity. We think these latter differences may be because women were in the earliest follicular phase, which is associated with the perimenstrual syndrome and with more psychological complaints compared with other menstrual cycle phases (Guillermo, Manlove, Gray, Zava, & Marrs, 2010).

Moreover, no significant relationships between psychological variables and cortisol were found; This absence of relationships between cortisol and psychological reactivity to stress agrees with Campbell and Ehlert's conclusions (2012), mentioned previously. Along these lines, Cohen et al. (2009) found that stress-induced anxiety changes were not associated with any of the biological responses studied, among them, cortisol response.

More interestingly, our results suggest that psychological and physiological reactions can apparently work in different ways. The cluster analysis revealed two patterns of response to stress. The first one was characterized by a low psychological reaction, whereas the second one presented a high psychological reaction; subjects displayed a mean net reactivity on anxiety (2.16 versus 19.47, respectively) and NA (3.10 versus 11.39, respectively) (Table II). In addition, each reaction seems to be related differently to the cortisol response (although differences in cortisol response were not significant between clusters), so that low psychological reactivity to acute stress was linked to higher

Table III. Spearman rank correlations between ISRA factors and COPE scales and psychological response to the TSST for the total sample ($n = 35$)

	Cognitive anxiety	Physiol. anxiety	Motor anxiety	Test evaluation anxiety	Active coping	Planning	Focus on emotions	Mental disengagement
State anxiety	rho = 0.579***	rho = 0.693***	rho = 0.565***	rho = 0.689***	rho = −0.432**	rho = −0.288^{+}	rho = 0.318^{+}	rho = 0.264
Negative affect	rho = 0.517***	rho = 0.528***	rho = 0.539***	rho = 0.608***	rho = −0.406*	rho = −0.313^{+}	rho = 0.203	rho = 0.296 $^{+}$

***$p \leq .001$; **$p \leq .01$; *$p \leq .05$ $^{+}p < 0.1$.

Table IV. Spearman rank correlations between ISRA factors and COPE scales for the total sample ($n = 35$)

	Active coping	Planning	Focus on emotions	Mental disengagement
Cognitive anxiety	rho = −0.368*	rho = −0.167	rho = 0.638**	rho = 0.327^{+}
Physiological anxiety	rho = −0.443**	rho = −0.281	rho = 0.377*	rho = 0.325^{+}
Motor anxiety	rho = −0.450**	rho = −0.264	rho = 0.378*	rho = 0.269
Test evaluation anxiety	rho = −0.415*	rho = −0.314^{+}	rho = 0.473**	rho = 0.331^{+}

**$p \leq .01$; *$p \leq .05$; $^{+}p < 0.1$.

levels of cortisol, whereas high psychological reactivity appeared associated with less cortisol reactivity. These results agree with previous findings by Het and Wolf (2007), who reported that increases in cortisol levels were related to a reduction in stress-induced NA in women, using the TSST, and also to pre-treatment with cortisol. Schlotz et al. (2008) also found negative relationships between cortisol and tense arousal in response to the TSST in men and women. Previously, in a study with stressed people, Boudarene, Legros, and Timsit-Berthier (2002) distinguished three types of psychophysiological responses to cognitive tasks. One of them was high emotional reaction without increases in cortisol, which they called biological silence, and they concluded that this response reveals psychological vulnerability. Taking this into account, we think that in this context, cortisol has a positive function, reflecting the response of preparing to deal with stress.

Beyond being a strong psychosocial stressor, the TSST (Kirschbaum et al., 1999) is, in itself, a strong threat to self-concept, because of the personal information the subjects give to their interlocutors (Gonzalez-Bono et al., 2002), in this case, the committee that evaluates them. Moreover, because of evaluating the characteristic of being 'the best applicant' for a job or position, the TSST can be considered an ecologically relevant stressor with an important competitive component (Salvador, 2012; Salvador & Costa, 2009). Therefore, from an evolutionary perspective, the response of the cluster 1 participants to this psychosocial stressor, a low anxiety and NA response with a higher cortisol response, would allow them to deal with situations more effectively, and this adaptive response pattern throughout life would not to be harmful to health. Our results showed that these participants score higher on active coping, apart from obtaining lower scores on trait anxiety.

Moreover, this new classification facilitated by the clusters allowed us to examine how these differences are linked to personality traits such as trait anxiety and dispositional coping. Thus, we can see how the subjects in cluster 2 (high anxiety and NA response with low cortisol response) scored higher on trait anxiety related to the triple response system (cognitive, physiological and motor) and the specific situational area related to the stress test employed (test evaluation anxiety). In addition, these participants also presented higher scores on the coping scales focused on emotions and mental disengagement. Furthermore, the fact that all the trait anxiety factors studied correlate negatively with active coping and, although marginally, with planning, points to how some personality traits and coping styles, such as high anxiety or emotion-focused coping as a maladaptive stress response, could have physiological repercussions and, ultimately, negative consequences for health. Along these lines, Endler and Kocovski (2001) proposed an interactive model of stress anxiety and coping styles, where both personal and situational variables, such as a challenge or a threat, are interconnected, leading to perceived stress. The result would be anxiety changes, which would lead to different coping reactions and biological and behavioural responses. These authors also argued that both perceived anxiety and final reactions respond to personal and situational variables. In our study, we found sex differences in mood response but failed to find them in trait anxiety and dispositional coping, which in part, agrees with this theory. That is, it has been well established that sex plays an important role in emotions, and we confirm this with our cluster composition (the majority of men in cluster 1 and the majority of women in cluster 2). However, the fact that differences in dispositional coping and trait anxiety were only between clusters, and not between sex groups, shows the importance of the personality traits, in addition to sex, in explaining the individual differences.

More recently, Costa and Salvador (2012) reported a passive coping pattern of an emotional nature involving increases in anxiety, negative mood, blood pressure and cortisol in a competitive situation in women. In this study, of the two patterns found using factorial analysis (active and passive coping), cortisol is saturated in passive coping, but without reaching statistical significance. On the contrary, our results show higher cortisol reactivity associated with low psychological reactivity (anxiety and negative mood), whereas lower cortisol reactivity appears related to high anxiety and negative mood. Then, the role that cortisol plays seems to be not very clear, probably because of the complexity of interactions between physiological systems and cognitive processes in different stressful situations (Salvador and Costa, 2009). Moreover, it must be taken into account that the physiological response provoked in this paradigm is a moderate response; other situations that are more stressful than the TSST and produce larger increases could have different effects. To the best of our knowledge, this is the first study to relate trait anxiety and coping styles using this paradigm in healthy young people. In our opinion, these results provide relevant information about some components involved in the stress response, although they did not allow us to establish casual relationships among the variables studied. Thus, whereas sex and/or hormonal status are able to modulate the psychophysiological response to stress, some personality traits play an important role, becoming potential modulators in the response to acute stress, beyond the role of sex.

The findings of the present study, although very interesting and suggestive, must be replicated in a larger sample with a more representative female sample. Future studies should include free-cycling women in different menstrual phases and using contraceptives, and they should control the test–retest interval or employ a between-subjects design. The most important limitation of this study is the sample size for the cluster analysis, so that these results must be considered preliminary, and they should be confirmed in a larger

sample. Moreover, women in the earliest follicular phase seem to show more psychological complaints compared with women in other phases (Guillermo et al., 2010); this fact could be a confounding factor to clear up the results. However, despite all these limitations, we are able to show some very interesting relationships between personality traits and coping styles and psychophysiological response to an acute psychosocial stressor extensively employed in lab research. Understanding how the mechanisms involved in the stress response interact could have important benefits for future interventions, above all to understand and modify subjective perceptions and provide training in how to deal with stress. Further work on these issues, therefore, would be useful for the prevention and treatment of stress-related disorders.

Conflict of interest

The authors have declared that they have no conflict of interest.

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