Biological Psychology 89 (2012) 99–106

Contents lists available at SciVerse ScienceDirect

Biological Psychology

journal homepage: www.elsevier.com/locate/biopsycho

Effects of panel sex composition on the physiological stress responses to psychosocial stress in healthy young men and women

A. Duchesne[a,*], E. Tessera[c], K. Dedovic[d], V. Engert[e], J.C. Pruessner[a,b]

[a] Department of Psychiatry, Douglas Mental Health University Institute, Montreal, QC, Canada
[b] McGill Centre for Studies in Aging, Faculty of Medicine, McGill University, Montreal, QC, Canada
[c] School of Population and Public Health, Faculty of Medicine, University British Columbia, Vancouver, BC, Canada
[d] University of California, Los Angeles, CA, USA
[e] Max Planck Institute, Leipzig, Germany

ARTICLE INFO

Article history:
Received 5 January 2011
Accepted 21 September 2011
Available online 14 October 2011

Keywords:
HPA axis
Psychosocial stress
Sex difference
Subjective stress
Menstrual cycle
TSST

ABSTRACT

Men and women differ in regard to psychosocial stress responses. Biological and contextual factors are known to mediate these differences; however, few studies investigated their interaction. In the present study, we examined contributions of both contextual and biological factors to the stress response of young healthy adults. Men and women were exposed to a modified version of Trier Social Stress Test. The participants gave a speech in front of a panel of judges, composed of either male or female panelists. Both men, and women presented a cortisol increase only when exposed to opposite sex panelists. Interestingly, this effect was only observed in women in their follicular phase. This finding showed that the induction of a psychosocial stress response does not strictly rely on direct social evaluation, but also depends on the sex composition of the panel. Implications for future studies are discussed.

1. Introduction

The human response to stress is an important mechanism to cope with real or anticipated threat. It influences one's endocrinology, physiology, cognition and behavior.

The stress response is characterized by an increased activity of the sympathetic nervous system and the hypothalamus–pituitary–adrenal (HPA) axis. Stimulation of the sympathetic nervous system releases catecholamines causing increases in heart rate and blood pressure and, alpha-amylase (Nater and Rohleder, 2009; Engert et al., 2011). Activation of the hypothalamic–pituitary–adrenal (HPA) axis leads to the subsequent secretion of corticotropin releasing hormone (CRH), adrenocorticotrophic hormone (ACTH), and lastly cortisol (Chrousos and Gold, 1992; Ulrich-Lai and Herman, 2009). Once activated, these two major stress systems are associated with physiological, affective, cognitive and behavioral adaptive changes (de Kloet et al., 2005; Steptoe et al., 2009; Schwabe and Wolf, 2009). The neuroendocrine stress response has been identified as an important biomarker of susceptibilities to various diseases and is associated with differential disease progression (Derijk and de Kloet, 2008; Kudielka and Wust, 2010; Lutgendorf et al., 2010; Matousek et al., 2010).

For humans, a particular powerful stressor is social threat. In the laboratory, social threat is typically induced by the presence of other humans who seem to evaluate the subject's performance to a difficult task (Dickerson and Kemeny, 2004; Schwabe et al., 2008; Bosch et al., 2009). Social evaluative threat, and the presence of human evaluation, is thus a key component of most psychosocial stress paradigms.

Several contextual and individual factors have been found to attenuate or potentiate the individual neuroendocrine stress reactivity (McEwen, 2008; Kudielka et al., 2009). Sex is one such factor; with differences in stress response between men and women being associated with differences in susceptibility to a range of stress-related illnesses (Lundberg, 2005; Figueira and Ouakinin, 2010; McEwen, 2010). Past research on sex differences in psychosocial stress response emphasized the important contribution of hormonal variations to this phenomenon (Kirschbaum et al., 1999; Childs et al., 2010). For example, Kirschbaum and colleagues exposed men and normally cycling women to the Trier Social Stress Test (TSST), a psychosocial stress paradigm consisting of giving a speech and a mental calculation task in front of an evaluative committee (Kirschbaum et al., 1993, 1999) Kudielka and Kirschbaum, 2005. This study, replicated by several others, revealed that men, and women in the luteal phase produce a similar stress response, which was higher compared to women in the

* Corresponding author. Tel.: +1 514 761 6131; fax: +1 514 888 4099.
E-mail address: annie.duchesne@mail.mcgill.ca (A. Duchesne).

0301-0511/$ – see front matter.
doi:10.1016/j.biopsycho.2011.09.009

follicular phase (Kirschbaum et al., 1999; Rohleder et al., 2001; Wolf et al., 2001; Childs et al., 2010). Similar results were found using another stress task, the Paced Auditory Serial addition test (PASAT; Lustyk et al., 2010). Interestingly, these stress response differences between men and women are not observed when the HPA axis is activated through other types of stressors, such as physical exercise or pharmacological challenges (Kudielka et al., 2009). This suggests that the differential reactivity of men and women to psychosocial stress paradigms is most likely under the influence of not only gonadal hormones, but also other contextual factors, such as the perception and processing of the different aspects of the stressful task.

However, sex differences are also observed when varying the degree and type of social evaluation. In our past studies, we demonstrated that men show a cortisol stress response irrespective of whether the panel is present in the same room or is behind a one-way mirror. Interestingly, women showed a reduced stress response when exposed to lower levels of social evaluation (committee sitting behind a one-way mirror; Andrews et al., 2007; Wadiwalla et al., 2010). These results suggest that degree of social evaluation present differentially affects men's and women's stress responses. The main source of the social evaluation in these tasks is the committee. In the TSST, the evaluative committee is typically composed of one man and one woman (Kirschbaum et al., 1993). This by itself may be an important factor that might contribute to the differences between the sexes observed to date. However, the influence of the sex composition of the panel has received little attention within psychosocial stress literature.

Findings from social psychology studies suggest that opposite sex interactions are linked to increased anxiety and discomfort in both men and women (Martinson and Zerface, 1970; Dodge et al., 1987; McCubbin et al., 1991; Chorney and Morris, 2008). In another study men who scored high on fear of negative evaluation trait showed a heightened cardiovascular reactivity when they were exposed to a female evaluator as opposed to a male evaluator or when they were left alone (Larkin et al., 1998). This is complemented by neuroendocrine studies showing a higher increase in cortisol levels when interacting with the opposite sex during laboratory testing (Roney et al., 2007, 2010a,b; Lopez et al., 2009). In the absence of studies having investigated this systematically, however, the current study aimed to investigate the impact of systematically manipulating TSST panel sex on the neuroendocrine stress response in men and normally cycling women. We hypothesized that men, and women in the luteal phase would show a strong physiological response to the opposite sex evaluative panel, while women in the follicular phase would react equally to the two panel types.

2. Methods

2.1. Participants

Sixty-eight healthy subjects, 43 women and 25 men (respective mean age of 21.67 ± 0.43 and 23.28 ± 0.56), were recruited via online classified ads at McGill University. They completed screening questionnaires prior to inclusion in the study. Subjects were selected through online screening forms; exclusion criteria were: current use of any medication, prior and/or present neurological or psychiatric illness, cigarette smoking, body mass index exceeding 27 and use of recreational drugs on a regular basis (Kudielka et al., 2009). All women reported not using any contraceptive medication and having a normal menstrual cycle for the past six months. Females were either tested in the follicular phase of their cycle (2–13 days following the onset of menstruation) or in the luteal phase (17–29 days following the onset of menstruation). The Douglas Research Ethics Board approved the study. All subjects gave written informed consent and were financially compensated for their participation.

2.2. Stress induction and procedure

Psychosocial stress was induced using a modified version of the Trier Social Stress Test (TSST; Kirschbaum et al., 1993), a well-known social evaluative and mentally challenging laboratory stressor. In the original version, the TSST consists of a 10-min anticipation followed by a 10-min performance phase in which participants have to give a free speech and perform challenging mental calculations in front of two evaluators (Kirschbaum et al., 1993). In the current study, the original paradigm was modified such that participants solely performed a 10-min job interview for a future, self-relevant, position. This modification was introduced to allow for follow-up testing of the same participants in functional MRI using our neuroimaging stress paradigm, the Montreal Imaging Stress Task (MIST), which is purely based on arithmetic (Dedovic et al., 2005).

Testing occurred at the Douglas Research Institute. After giving written informed consent for study participation, participants relaxed for an hour during which they completed online questionnaires and read neutral magazines. Participants were then exposed to the modified TSST. Men (M), women in the luteal phase (W-L) and women in the follicular phase (W-F) were randomly assigned to perform the job interview under the evaluation of either same or opposite sex panel (Panels: M, W). As part of the task explanation, participants were briefly introduced to the panel prior to the anticipation period of 10 min. Six women and four men, all undergrads in psychology between 19 and 24 years of age, were trained to provide neutral social evaluation during the TSST. After testing, subjects stayed for further saliva sampling and to complete additional questionnaires.

Participants were debriefed and informed about the study purpose after finishing all study procedures. All subjects were tested between 2 and 6 pm due to daily circadian variation of cortisol levels (Dickerson and Kemeny, 2004).

2.3. Measures and assays

2.3.1. Psychological questionnaires

All participants completed several questionnaires to control for known psychological modulators of stress reactivity such as self-esteem, depressive symptomatology and personality traits (Burke et al., 2005; Pruessner et al., 2005; Oswald et al., 2006; Abelson et al., 2008; Brooks and Robles, 2009). To assess these factors, we used the revised Beck Depression Inventory (Beck et al., 1996), the Rosenberg self esteem scale (Rosenberg, 1979), and the NEO-five factor inventory (Costa and McCrae, 1992). In addition, we assessed levels of psychological stress experienced within the previous month by administering The Trier Inventory for the assessment of Chronic Stress (TICS, Schlotz et al., 2004). All questionnaire scores were calculated following the guidelines of the respective authors.

2.4. Perceived stress, mood and cognitive appraisal measurements

Perceived stress was assessed throughout the experiment in 10-min intervals using a visual analogue scale, on which participants were asked to visually rate how stressed they felt on a scale from 1 to 10 (Smyth et al., 1998). Subjective measures of mood were assessed twice using the Profile of Mood State-Bipolar (POMS-Bi) (Lorr et al., 2003). The POMS-Bi is a 72-item adjective checklist divided into six subscales: composed–anxious, elated–depressed, agreeable–hostile, confident–unsure, clear minded–confused and energized–tired. Each subscale can have the maximum score of 36; higher scores are associated with better mood. The POMS-Bi was given twice, at baseline and following TSST exposure. Cognitive appraisal was assessed during anticipation using the Primary Appraisal Secondary Appraisal scale (PASA, Gaab et al., 2005).

2.5. Physiological measurements and analysis

Every subject provided eight saliva samples throughout the experiment. Baseline sample was taken following an hour of relaxation at 10 min prior to starting the TSST (−10 min). Preceding the job interview and following 10 min of anticipation, a second sample was taken (0 min). From the end of the TSST, at 10 min intervals, six samples were collected (10, 20, 30, 40, 50 and 60 min). Saliva was collected using salivettes (Sarstedt Inc., Quebec City, Quebec, Canada). After use, salivettes were stored at −20 °C until analysis. Samples were analyzed using a time-resolved fluorescence immunoassay. Intra- and inter-assay variability of this assay were shown to be less than 10% and 12%, respectively (Dressendorfer et al., 1992). With every saliva sample, measures of systolic (SBP), diastolic (DBP) and heart rate (HR) were taken using a wrist inflatable cuff digital blood pressure monitor (life source, UB-512 digital monitor).

2.6. Statistical analysis

Two-way ANOVAs with group and panel as independent variables were performed to confirm the homogeneity of psychological and physiological variables known to impact the HPA axis. For variables that were not normally distributed, we applied logarithmic transformation prior to further statistical analysis. Impact of the experimental variation on the physiological and subjective stress response was calculated using mixed design ANOVAs (time by group by panel), with time being a within repeated measure of either salivary cortisol, autonomic measures, perceived stress or mood. If the assumption of sphericity was violated, computed Greenhouse Geisser corrections (GG corrected) were applied.

We also conducted a two-way between subjects ANOVA (group by panel) with the area-under-the-curve-increase (AUCi) of cortisol, autonomic measures and