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Psychobiological responses to critically evaluated multitasking

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ABSTRACT

In order to understand psychobiological responses to stress it is necessary to observe how people react to controlled stressors. A range of stressors exist for this purpose; however, laboratory stressors that are representative of real life situations provide more ecologically valid opportunities for assessing stress responding. The current study assessed psychobiological responses to an ecologically valid laboratory stressor involving multitasking and critical evaluation. The stressor elicited significant increases in psychological and cardiovascular stress reactivity; however, no cortisol reactivity was observed. Other socially evaluative laboratory stressors that lead to cortisol reactivity typically require a participant to perform tasks that involve verbal responses, whilst standing in front of evaluative others. The current protocol contained critical evaluation of cognitive performance; however, this was delivered from behind a seated participant. The salience of social evaluation may therefore be related to the response format of the task and the method of evaluation. That is, the current protocol did not involve the additional vulnerability associated with in person, face-to-face contact, and verbal delivery. Critical evaluation of multitasking provides an ecologically valid technique for inducing laboratory stress and provides an alternative tool for assessing psychological and cardiovascular reactivity. Future studies could additionally use this paradigm to investigate those components of social evaluation necessary for eliciting a cortisol response.

1. Introduction

The way in which individuals respond to daily stressors is a determinant of reactivity of the sympathetic-adrenal-medullary (SAM) and hypothalamic-pituitary-adrenal (HPA) axes and contributes to allostatic load. In order to fully understand the reactivity of these axes it is necessary to observe individuals while they are experiencing stress. Naturalistic stressors provide ecologically valid measurement opportunities; however they can be expensive and lack control and standardisation. Alternatively, laboratory stressors allow for the controlled manipulation of stimuli and more specific assessment of the causal factors involved in psychobiological stress responding. A variety of laboratory stressors comprising cognitive challenge, public speaking, emotion induction and interpersonal stress are used for this purpose; however, these tasks typically serve no function outside of the laboratory (Chida and Hamer, 2008). To obtain a comprehensive snapshot of how an individual would respond to a stressor encountered in a real-life setting, laboratory stressors should have ecological validity and be representative of experiences in natural settings. Such settings rarely involve exposure to a single stressor as modelled in the laboratory, but instead individuals typically deal with multiple sources of stress (Chida and Hamer, 2008). Ecologically valid stressors should therefore comprise multiple stimuli and be representative of the types of situations encountered in everyday life.

The Multitasking Framework (Wetherell and Sidgreaves, 2005) comprises eight individual cognitive tasks and elicits stress via the manipulation of workload intensity by increasing the difficulty and number of tasks (up to a maximum of four during one presentation) that a user must attend and respond to. Although the Multitasking Framework does not simulate a specific environment, it comprises tasks that are required in many working environments, such as calculations, continuous visual and auditory monitoring, and relevant stimuli identification. Moreover, as successful performance requires sustained effort, repeated multitasking does not lead to habituation of responding (Wetherell et al., 2004). Several studies have demonstrated the efficacy of the Multitasking Framework as

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an acute stressor as evidenced by increases in stress, anxiety and fatigue (e.g., Haskell et al., 2010; Johnson et al., 2011; Wetherell and Carter, 2013); cardiovascular reactivity (e.g., Kelly-Hughes et al., 2014); and mucosal immunity (e.g., Wetherell and Sidgreaves, 2005). Only one study; however, has reported an increase in cortisol reactivity following multitasking (Scholey et al., 2009). Compared with SAM responding, the HPA axis has a particularly high threshold for activation and acute increases in cortisol are typically observed in conditions of perceived uncontrollability involving motivated performance tasks accompanied by social evaluative threat (i.e. threats to a valued aspect of self-identity or where the self is at risk of being negatively judged by others; Dickerson and Kemeny, 2004). The Multitasking Framework is a motivated performance task and involves elements of uncontrollability; but, it does not involve social evaluative threat, and cortisol reactivity would therefore not necessarily be predicted.

All of the conditions necessary for reliably inducing a cortisol response are, however, present in other laboratory stressors notably, the Trier Social Stress Test (TSST), which involves a preparation period followed by the presentation of free speech and mental arithmetic to a socially evaluative panel whilst being recorded. This paradigm is associated with robust increases in cortisol and has become a standard protocol for stress induction in healthy (e.g., Kirschbaum et al., 1993; Kirschbaum et al., 1995) and clinical (e.g., Buske-Kirschbaum and Hellhammer, 2003) populations of all ages (e.g., Kudielka et al., 2004; Jessop and Turner-Cobb, 2008). There is, however, a need to develop alternative stress protocols that involve other sources of stress and are appropriate for repeated testing (Kudielka and Wust, 2010). In natural settings, exposure to social evaluation is omnipresent; for example, giving presentations and being monitored during the performance of tasks in the workplace are commonplace and involve perceived threats to ones abilities, competencies or traits (Gruenewald et al., 2004). A laboratory paradigm that is additionally representative of these settings would therefore be advantageous. As mentioned above, cognitive multitasking is analogous to a range of environments requiring attendance and response to multiple stimuli and is associated with cardiovascular and psychological stress reactivity. Given that critical social evaluation typically elicits HPA activation, the combination of multitasking and critical evaluation could therefore provide an easily administered acute stressor paradigm representative of everyday stressful situations. The aim of the current study is, therefore, to assess whether a critically evaluated multitasking paradigm elicits activation of psychological, cardiovascular and HPA reactivity.

2. Method

2.1. Participants

All recruitment and study procedures were granted ethical approval from the Faculty Ethics Committee in line with the regulations of the institution and relevant regulatory bodies. A total of 50 healthy participants (range 18–38, M_{age} = 19.6, SD = 2.83; females = 34, males = 16) were recruited from an undergraduate population and randomly allocated to either multitasking only (M_{age} = 19.89, SD = 3.93; female = 17, male = 8) or multitasking with critical evaluation (M_{age} = 19.32, SD = 0.85; female = 17, male = 8). Eligibility criteria included: aged 18–40; resting blood pressure less than 140/90 mmHg; not pregnant or breastfeeding; no self-reported anxiety or stress-related disorder. In addition, data were recorded for a number of factors that can alter HPA function; specifically, Body Mass Index (BMI); use of the contraceptive pill (N = 21); menstrual cycle stage (first half = 8; second half = 14); and smoking status (N = 6) were also recorded as appropriate.

2.2. Materials

The Multitasking Framework (Purple Research Solutions, UK) is a platform for the presentation of performance-driven, cognitively demanding tasks and is analogous to working environments that require attendance and response to simultaneous stimuli. This study used four tasks: auditory monitoring, visual monitoring, number entry, and memory search. All tasks are points drive with points awarded for correct responses and points deducted for missed or incorrect responses. Participants are instructed to be as fast and accurate on all of the tasks as possible in order to achieve as high a score as they can. The running total score is displayed in the middles of the screen whilst the tasks are running. A full description of the Framework is provided in Wetherell and Carter (2013). Blood pressure and heart rate were recorded using an Omron M3 IntelliSense.

2.2.1. Questionnaires

The (10 item) Perceived Stress Scale (PSS-10: Cohen et al., 1983) measured how often in the last month participants felt that life was unpredictable, uncontrollable, and overwhelming. The 16 item Bond-Lader Visual Analogue Scales (Bond and Lader, 1974) measured the mood states of Alert, Content, and Calm. Two single item 100 mm VAS measured the states Anxious and Happy. The NASA-TLX (Hart and Staveland (1988) assessed Mental, Physical and Temporal Demand, Effort, Performance and Frustration.

2.2.2. Salivary cortisol

Participants were asked to refrain from eating or drinking (other than water) for 1 h preceding the study. Saliva was collected using Salivettes (Sarstedt, Germany). All samples were frozen (−20 °C) and assayed using the enzyme-linked immunosorbant assay method (Salimetrics-Europe, UK; intra and inter-assay coefficients <10%).

2.3. Procedure

All testing took place at least 1 h following awakening and between 1200 and 1600. On arrival participants were seated, an inflatable cuff was placed on their non-dominant arm and they were familiarised with the procedure. Following a rest period of 15 min, participants were given a 2-min demonstration of the tasks and were informed that they must be as fast and accurate on all of the tasks in order to obtain as high a score as possible. Each participant provided 4 saliva samples during the testing session: immediately before and after the framework (20 min) and 10 and 20 min following stressor cessation. Heart rate and blood pressure were recorded pre-stressor, mid-way and post stressor. Mood was assessed immediately before and after the stressor and perceived workload was assessed following stressor cessation. For the 'multitasking only' condition, the researcher left the room while the participant completed the task, re-entering only to take heart rate/blood pressure readings, whilst in the 'critically evaluated multitasking' condition the researcher remained in the cubicle, standing behind the participant and providing negative feedback throughout the session (see Table 1). Additionally, in the 'critically evaluated multitasking' condition a web-cam and a video camera was trained on participants' side profile, and participants were informed that both devices would record throughout the session. All testing was conducted by a female researcher within the age range of participants.

2.4. Treatment of data

Mood, cardiovascular parameters and cortisol were assessed