Psychoneuroendocrinology (2011) 36, 1407—1417

available at www.sciencedirect.com

ScienceDirect

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

Cortisol acutely reduces selective attention for erotic words in healthy young men

Peter Putman *, **Sylvia Berling**

Department of Psychology, Leiden University, The Netherlands

Received 10 November 2010; received in revised form 23 March 2011; accepted 23 March 2011

KEYWORDS
Cortisol;
Selective attention;
Inhibition;
Emotional Stroop task;
Anxiety disorder;
Anxiolytic

Summary Psychological stress prompts activity of the hypothalamic—pituitary—adrenal (HPA) axis resulting in increased release of cortisol. Long-term HPA aberrations have been observed for stress-related affective disorders but research into acute effects of cortisol on affect-regulation has only recently begun. Previous studies reported that exogenous cortisol acutely attenuated automatic attentional processing of task-irrelevant threatening information. This has been taken to suggest that cortisol may have acute anxiolytic properties, possibly through facilitating inhibition of threatening information. However, the role of cortisol in attentional inhibition of non-threatening arousing stimuli remained unclear. Therefore acute effects of 40 mg cortisol on performance of a masked and unmasked emotional Stroop task (EST) were assessed. Results for only the unmasked task demonstrated EST interference (interpreted as increased automatic attention) for erotic stimuli which was abolished by cortisol administration. This implies that effects of cortisol may not be restricted to attenuation of specifically anxiogenic information processing, as previously suggested.

1. Introduction

Psychological stress can activate the hypothalamic—pituitary—adrenal axis (HPA axis) to increase its output of the human glucocorticoid hormone (GC) cortisol. GCs affect the central nervous system (CNS) via activation of the mineralocorticoid receptors (MRs) and also of the glucocorticoid receptors (GRs) when GC levels are very high, such as after severe stress (e.g., de Kloet et al., 2005). Because HPA functioning is related to psychological stress, much research has studied relations between chronic disturbances of the HPA axis and psychopathology. Mostly chronic hypercortisolism has been observed in affective disorders, including major depressive disorder, post-traumatic stress disorder (PTSD), and generalized anxiety disorder (Yehuda et al., 1996; Young and Breslau, 2004; Takahashi et al., 2005; Mantella et al., 2008). For these stress-related disorders, it is hypothesized that the long term aberrations of HPA functioning are partly due to allostatic dysregulation of the HPA negative feedback system, caused by excessive wear and tear on GRs. Until recently, it was unclear what acute effects of cortisol were, if any, on human affect-regulation and the manifestation of negative affect and anxiety.

Recent years have seen a growing interest in this matter. A very large number of studies have reported no acute effects

* Corresponding author at: Clinical, Health and Neuropsychology, Leiden University, Wassenaarseweg 52, PO-Box 9555, 2300 RB, Leiden, The Netherlands. Tel.: +31 071 5274818; fax: +31 071 5274678.
E-mail address: PPutman@FSW.leidenuniv.nl (P. Putman).

0306-4530/$ — see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.psyneuen.2011.03.015

of cortisol on unchallenged self-reported affect (see e.g., Buchanan et al., 2001; Abercrombie et al., 2003; Putman et al., 2007a, 2010a,b; van Peer et al., 2008; Oei et al., 2009; van Peer et al., 2010; the only exception to this rule is Reuter, 2002). Yet, two studies reported reduced negative mood-response to a psychological stressor after a single administration of cortisol in healthy participants (Reuter, 2002; Het and Wolf, 2007; but see also Soravia et al., 2009) and Vasa et al. (2009) reported that a single cortisol administration reduced the negative affective impact of a yohimbine challenge (designed to evoke feelings of panic) in healthy participants. Studies in people with fear disorders have reported beneficial effects of cortisol administration on symptom severity and occurrence of intrusive memories in PTSD (Aerni et al., 2004; Schelling et al., 2006) and self-reported fear levels in phobic patients exposed to their objects of fear (Soravia et al., 2006). These latter effects in anxious patients have been ascribed to a hypothetical disruptive effect of cortisol on traumatic memory retrieval (de Quervain et al., 2000). This may reduce availability of disorder-relevant emotional memories and so reduce fear activation (de Quervain and Margraf, 2008). Thus, the notion has risen that cortisol may acutely influence cognitive processing of emotional information which in turn may affect emotional state after interaction with threatening information in the environment. Such a 'cognitive hypothesis' has previously been formulated as a potential working mechanism for antidepressant noradrenergic and serotonergic agonists (Harmer, 2008). Also for cortisol, such effects may not be restricted to memory processes but may occur in earlier stages of information processing (see also Putman and Roelofs, 2011). Since automatic aberrant attentional processing of emotional information is thought to play a role in the onset and/or aetiology of affective disorders, it is not only of fundamental, but also of potentially clinically relevant interest to study the cognitive hypothesis as applied to cortisol and attentional processing of emotionally relevant information.

Several studies have reported that cortisol reduced threat-selective processing as measured with experimental tasks targeting different aspects of selective attention for threat-related facial expressions (Putman et al., 2007a,b, 2010b; van Peer et al., 2010). Another study (Oei et al., 2009) tested performance on a working memory task involving threatening pictorial distracters which compromise performance. Results showed that cortisol reduced this detrimental interference on working memory from threatening pictures. These four studies using implicit experimental measures of emotional-cognitive processing were performed in healthy participants. Together, they provide evidence that cortisol may also affect early cognitive stages of emotion regulation via attenuation of increased (attentional) processing of task-irrelevant threatening information. However, the designs of some of these early attentional studies do not allow to distinguish between reduced processing of specifically threatening information on the one hand or effects on processing of any emotional, salient and arousing information on the other. Putman et al. (2007a) for instance tested effects of cortisol on performance of an emotional Stroop task using fearful faces. In an emotional Stroop task (EST), deficient inhibition of arousing but task-irrelevant emotional stimuli is measured by comparing color-naming response times (RTs) for emotional stimuli with color-naming RTs for neutral stimuli. Intrusion of, or automatic selective attention toward, the emotional information is measured as a slowing down for color-naming the emotional stimuli (called EST interference). Dorsolateral prefrontal and anterior cingulate cortex (ACC) have been implicated in EST performance (Compton et al., 2003; Haas et al., 2006; Mitterschiffthaler et al., 2008). Putman et al. reported that anxiotypic interference for fearful faces (which was moderated by individual differences in self-reported anxiety) was abolished by cortisol administration. However, only fearful and neutral faces, but no non-threatening but high arousing stimuli were used and the possibility remains that the reported effect may reflect that cortisol increases the ability to inhibit the processing of any arousing or salient task-irrelevant information, not just of threat-related information. Results from Oei et al. (2009) allow the same interpretation.

The present study addressed this hypothetical threat-specificity. To this end, a lexical emotional Stroop task was designed with neutral words (non-emotional animal names), threatening words, and erotic words. This study was performed in an all-male sample. Selective attentional responding seems to occur not only for threat-related information in anxious people (Bar-Haim et al., 2007), but more generally for stimuli that are personally relevant and/or for highly arousing or salient stimuli (e.g., bird names for ornithologists; see Williams et al., 1996; Harvey et al., 2004). Since young men are generally rather responsive to erotic themes, we expected that a sample of young men should consider erotic words quite positive, but this was not a prerequisite; the goal was mainly to present them with emotionally arousing stimuli that were not threat-related. We expected unselected young men to demonstrate reliable EST interference for such words. The critical aim of the study was to test if cortisol would reduce only threat-interference or if it would also reduce interference from the non-threat related but arousing erotic stimuli (such hypothetical increased cognitive control may not even be restricted to the processing of emotional stimuli, but the extant literature does not provide evidence for such effects on emotionally neutral information, see also Schmidt et al., 1999; Wolf et al., 2001). Previous EST-cortisol studies (Putman et al., 2007a; van Peer et al., 2010) presented the facial stimuli very briefly (<20 ms) and backwardly masked to assess pre-conscious automatic attention. Therefore, a masked condition was also included in the present study, even though for lexical stimuli unmasked ESTs may work at least as well as masked ESTs (Phaf and Kan, 2007) and theoretical reasons for assessing unconscious processing (Morris et al., 1999; Van Honk et al., 2005; Putman et al., 2007a) do not apply for lexical stimuli. No specific expectations were held for masked versus unmasked lexical EST performance. These hypotheses were tested in a sample of 30 healthy young men in a double-blind, placebo-controlled crossover design. No effects of cortisol on self-reported affect were expected.

2. Methods

2.1. Participants

Participants were thirty healthy young male volunteers (aged 19–31; M = 22.4; SD = 3.46) recruited on campus. Only