COPING STYLE, TRAIT ANXIETY AND CORTISOL REACTIVITY DURING MENTAL STRESS

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Abstract—The present study examined whether salivary cortisol secretion as an index of stress reactivity to continuous mental task performance reflected individual differences in coping styles. During 4 hr of continuous mental tasks significantly higher cortisol levels were found in comparison with a control session. However, individual variability in the cortisol response was high. Correlational data indicate a significant negative relationship between the coping style 'comforting cognitions' and the individual cortisol response during mental stress. During this particular type of cognitive stress, where the subject has no control over the experimental situation, comforting and emotion-focused coping may be effective because of the subject's efforts of trying to reframe the inevitable situation in a positive and self-encouraging way. In contrast, there was no significant relationship between trait anxiety and individual glucocorticoid susceptibility to mental stress.

INTRODUCTION

Organisms are continuously exposed to stressful events or stressors which can affect the homeostasis. Any biochemical or physiological change in response to such a stressor is usually called stress or stress response. For example, increases in plasma epinephrine and cortisol levels are typical biochemical signs of stress. In the last decade evidence has accumulated that the stress response is not caused by the aversive or noxious nature of the stressor per se, but by the ability of the organism to deal with the stressor. If an individual can cope successfully with the environmental challenge, little or no stress is experienced. Thus, coping strategies rather than the nature of the stressor will determine whether or not stress is experienced by an individual [1, 2].

It has been stated that where there is little or no elevation in circulating corticosteroids the individual is effectively coping with the stressor [3]. For example, it has been found that persons with ineffective defences have higher cortisol excretion during psychosocial stress (see Vickers [4]). Baade et al. [5] demonstrated a clear relationship between high levels of cortisol and low performance in parachutist trainees.

Studies on personality traits and coping styles as determinants of interindividual differences in neuroendocrine responses to stress have not yet yielded conclusive results [6, 7]. Bossert et al. [8] could not predict the interindividual differences in the frequency of cortisol responses to laboratory stress tests by any of the psychometric variables (personality traits and coping styles) they had investigated. They question whether psychological factors actually contribute to the neuroendocrine stress

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response. On the other hand, it can be stated that in most studies relating psychological measures to cortisol secretion, urinary free cortisol was used. However, it is questionable whether the stressors are of sufficient magnitude or duration to cause measurable changes in urinary cortisol excretion [9, 10]. Another way of sampling cortisol is by means of saliva [11], which has the advantage of easy and repeated stress-free sampling.

It was the aim of the present study to investigate salivary cortisol secretion during a mental task paradigm in relationship to psychometric measures of coping style and trait anxiety in order to address two questions. Firstly, is the stress related to 4 hr of continuous mental tasks of sufficient magnitude to induce increased cortisol reactivity? Secondly, if so, are subjects characterized by less-effective coping styles or increased trait anxiety more susceptible to increased cortisol reactivity?

SUBJECTS AND METHODS

Subjects

The study was conducted with 24 female volunteers in good physical and mental condition. The subjects were drawn from the following age groups: 41–49 yr (N = 12) and 61–69 yr (N = 12). Each subject was paid and gave her informed consent.

Procedure

The study consisted of two sessions separated by an interval of 6 days. Each subject participated both in a continuous mental task session during four consecutive hours and in a control session. Saliva samples for determination of cortisol were taken at six times in each session (10.20, 12.40, 14.10, 14.45, 15.00 and 15.30). Each day started at 10.15 with instructions and assessment of cognitive functions, followed by a 4-hr experimental period (11.45 15.45).

Together with the instructions at the beginning a Spielberger Trait Anxiety Inventory [12] and a 47-item Coping List (UCL) were completed [13]. During the experimental period the subjects abstained from smoking and drinking coffee or tea. At lunch time (noon), 13.10 and 14.40 each subject received 150 ml of lemonade. The experimental session was only interrupted for 10 min for a quick lunch. In order to control for possible sequence effects the subjects were assigned at random either to a schedule of starting with the continuous session followed one week later by the control session, or to a schedule with a reverse order.

Continuous mental tasks for 4 hr

The rationale behind this program was based on the application of self-paced, motivating cognitive tasks, partly in combination with environmental noise of 65–70 dB, in order to enhance fatiguing or stress effects [14].

The experimental session included the following activities:

Activity 1 (11.45–12.10): repetitive performance of a psychometric test (memory comparison task; paper and pencil version), interrupted for a short lunch.


Activity 7 (14.45–15.05): sham video-recorded speech task, in which the subject was requested to speak about her own positive personality traits. Subjects were allowed 10 min of preparation and then had to talk for 5 min.

Activity 8 (15.05–15.30): self-paced computerized reaction time task with environmental noise.

Control session

Except for the administrations of the divided attention test (12.45 13.10 and 14.15 14.40) the subject was free from 11.45 to 15.45 in the choice of the following activities: reading popular family journals, listening to soft music or watching short segments of amusement video. The subject was left alone in a separate room.
Cortisol reactivity during mental stress

**Trait Anxiety Inventory**

The trait anxiety inventory of Spielberger in an adapted version for the Dutch language [12] was used in order to assess general susceptibility to stress.

**Utrecht Coping List**

The Utrecht Coping List is a 47-item questionnaire describing seven styles of coping, which have been factor-analytically derived [13]. Sum scores are calculated for each of the seven subscales. Subscale 1 (seven items) 'active problem solving' describes a direct and rational approach towards problem situations. Subscale 2 (eight items) 'palliative response' includes items of seeking distraction, trying to feel better by smoking, drinking, or relaxing. Subscale 3 (eight items) 'avoidance and passive expectancy' involves items of problem avoiding or awaiting the consequences. Subscale 4 (six items) 'seeking social support' includes items of seeking help from others. Subscale 5 (seven items) 'depressive reaction' involves items of being overwhelmed by the problem and of being pessimistic about the outcome. Subscale 6 (three items) 'expression of emotion and anger' defines an emotional expressive reaction towards problems. Finally, subscale 7 (five items) 'comforting cognitions' includes items of considering the problem in a relative way, of self-encouragement and of a positive reframing of the situation.

**Salivary cortisol**

Saliva was collected by holding an absorbent cotton roll in the mouth for 1–2 min. The roll was then placed in a capped plastic vial ('Salivette', Sarstedt B.V.). By the end of each session the samples were stored at -20°C until analysis. Experiments in our laboratory have demonstrated that cortisol levels in saliva collected with the Salivette cotton rolls do not differ from levels in matched samples collected in plain tubes (Sulon, pers. commun.). Salivary cortisol was determined by direct radioimmunoassay [16], using 125I-cortisol (Farmos diagnostica, Finland) and anticortisol antiserum (made against the 3-CMO-RSA conjugate), in duplicate, by Dr J. Sulon of the Steroid Laboratory, University Hospital Liege, Belgium. Saliva cortisol was measured from nonextracted saliva (25 μl), as we have found a very high correlation between extracted (with ethylacetate) and nonextracted saliva ($r = 0.99$, $N = 90$, $p < 0.001$), confirming the absence of corticosteroid binding protein in saliva. The lower detection limit of the assay was 0.69 nmol/l, with an intra-assay coefficient of 4.4%. All samples were analyzed in the same assay.

**Analysis**

The four afternoon cortisol samples were compared for each session by repeated measures analysis of variance; paired $t$-tests were used for comparisons between sessions at each sampling time. In addition, individual difference scores were calculated (continuous task session minus control session). Difference scores for the three latest afternoon cortisol samples were highly intercorrelated, therefore the mean of these three differences was calculated as an index of cortisol reactivity. In addition, Spearman rank correlation coefficients (two-tailed tests) were calculated between the individual cortisol response and the scores on the coping list and trait anxiety inventory.

**RESULTS**

The effects of stress on cognitive performance are reported elsewhere.

As can be seen from Fig. 1, following the expected diurnal decline in cortisol secretion in the morning hours there was a significant increase in the four mid-afternoon cortisol samples during the continuous task session compared to the control session ($F(1.20) = 27.47; p < 0.001$), with an average increase of 76%, 39%, 46% and 99% at the respective time points (see also Table I).

There were no significant relations between the averaged difference scores from the three latest afternoon cortisol samples and either the factor sequence ($t = 1.05$, ns) or age ($t = -0.01$, ns).

The correlational data between the psychological variables and the cortisol response are presented in Table II. The data indicate a significant negative correlation between the coping style 'comforting cognition' and the cortisol response ($r_c = -0.41$, $p < 0.05$). In addition, there was a non-significant negative relationship between the coping style 'seeking social support' and the cortisol response...
Fig. 1. Mean cortisol levels (± SEM) in the continuous task session and in the control session (N = 24). The two-tailed significance levels of the paired t-tests for the four mid-afternoon samples between the two sessions are marked with asterisks (*p < 0.05; **p < 0.01; ***p < 0.001).

There was no significant relationship between trait anxiety and saliva cortisol response (r = 0.17, ns).

**DISCUSSION**

Measurement of salivary cortisol levels, as well as providing a simple, stress-free, non-invasive collection procedure, closely reflects in time the changes in plasma levels of the hormone, not suffering from the large lag-time involved with urinary hormone measurements [17]. In the present study it was found that the stress related to 4 hr

<table>
<thead>
<tr>
<th>Time (hours)</th>
<th>Mean Difference (nmol/l)</th>
<th>SD</th>
<th>SEM</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
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<tr>
<td>12.40</td>
<td>-0.66</td>
<td>1.91</td>
<td>0.41</td>
<td>-0.14</td>
<td>ns</td>
</tr>
<tr>
<td>14.10</td>
<td>0.91</td>
<td>0.91</td>
<td>0.20</td>
<td>4.58</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>14.45</td>
<td>0.66</td>
<td>1.14</td>
<td>0.24</td>
<td>2.77</td>
<td>p &lt; 0.01</td>
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<tr>
<td>15.00</td>
<td>0.95</td>
<td>0.93</td>
<td>0.19</td>
<td>5.00</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>15.30</td>
<td>1.16</td>
<td>1.69</td>
<td>0.35</td>
<td>3.35</td>
<td>p &lt; 0.01</td>
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Table 1. Mean difference scores for the five afternoon cortisol samples (continuous task session minus control session). Data are presented together with SD, SEM, t-values and significance levels.
of continuous mental tasks elicited a significant increase in cortisol secretion. Salivary cortisol proved to be a sensitive and useful index of mental stress, in that rather small percentual increases were shown by a large percentage of the subjects. In addition, the administration of the divided attention test in the control session (e.g. 14.15–14.40) induced a short-lasting pronounced increase in salivary cortisol levels. From an individual point of view, it was found that salivary cortisol sampling revealed fairly large differences in cortisol reactivity between subjects after 4 hr of continuous mental tasks.

Individual coping variables have been hypothesized as important factors in the stress process [1]. Coping responses or strategies represent the specific actions that people take in order to deal with a given problem or stressor, for example by talking it over with others, ignoring the situation or taking direct action to solve the problem [18]. In addition, there has been a growing conviction that beliefs about personal control over situational demands play an important role in stress and coping [19]. Beliefs about control can alter the extent to which an encounter is appraised as threatening and can influence coping.

The present results indicate that the coping style ‘comforting cognitions’ was most powerful in predicting the cortisol response during this particular type of cognitive stress, in which subjects had to perform superimposed tasks under strict instructions without having any control over the allocation of experimental time. Coping may have two major functions: the regulation of emotion or distress (emotion-focused coping) and the management of the problem that is causing the distress (problem-focused coping [19]). Folkman et al. [20] have shown that both forms of coping are used in most stressful encounters. The use and effectiveness of coping behaviors have found to be dependent on the appraisal of the situation’s amenability to change. For example, in the present experiment emotion-focused coping could be used to alter the meaning of a situation and thereby enhance the individual’s sense of control over her distress. When there is no possibility to change the superimposed tasks, an adequate adaptation may be to acknowledge the tasks as being inevitable and to try to comfort oneself as much as possible given the temporary stressful condition. The other coping styles were not associated in a specific way to individual cortisol
variability in our experimental paradigm. However, it is possible that these types of coping behavior could give rise to an increased or decreased cortisol secretion during exposure to other types of stress, such as examination stress [21] or lecturing stress [22]. Houston [23] found a relationship between trait anxiety and cognitive coping behaviors. Highly trait-anxious individuals tended to respond with maladaptive cognitive coping behavior to stress. With respect to cortisol reactivity, Hubert et al. [7] found no correlation between trait anxiety and salivary cortisol release in response to a suspense film. The present findings also failed to demonstrate a significant relationship between levels of trait anxiety and individual glucocorticoid susceptibility to stress.

In summary, the present results indicate that 4 hr of continuous mental tasks significantly elevated cortisol levels in saliva in comparison with a control session, and that a psychometric measure of coping was significantly related to salivary cortisol reactivity under these particular conditions.

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REFERENCES


