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Normalisation of salivary cortisol levels and self-report stress by a brief lunchtime visit to an art gallery by London City workers

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As a psychophysiological I investigate the way emotion (typically negative mood states or stress) affects bodily functions and, in the long run, health. Recently people have questioned whether the health benefits associated with a positive outlook and good social support are merely a buffer for these negative effects or whether they have direct and independent pathways to health. My research has involved development of methodologically sound ways to explore these sorts of questions by measurement of free cortisol concentrations in saliva.

Summary

- *We studied the impact of a brief lunchtime visit to an art gallery on City workers' levels of the stress hormone cortisol as well as self-report levels of stress and arousal.*
- *Average levels of cortisol and self-report stress were significantly reduced by the visit, levels of arousal were unchanged.*
- *On arrival at the gallery levels of cortisol were elevated relative to expected values. Following the gallery visit the cortisol concentrations had normalised to those expected for the time of day.*
- *The observed drop in cortisol was rapid and substantial; under normal circumstances it would take about 5 hours of normal diurnal decline for cortisol levels to fall to this extent.*
- *We conclude that the gallery visit caused rapid normalisation (recovery) from the consequences of high stress.*

Introduction

Measurement of the steroid stress hormone cortisol is increasingly employed as an objective biomarker of stress.¹ Cortisol has a diverse set of actions ranging from effects on blood pressure, stored reserves of energy and the balance of the immune system. It regulates these systems in normal (non-stressful) day-to-day living as well in response to a stressor: stress causes additional bursts of cortisol secretion. Healthy cortisol secretion shows a marked circadian cycle with highest levels in the morning falling to lower levels in the evening and during the early phases of sleep. This changing circadian pattern is vital for informing other body systems when it is night and day so that they can operate to maximum efficiency. Stressful living conditions can disturb this healthy pattern resulting in inappropriately high cortisol concentrations for the time of day. Disturbed cortisol circadian profiles have been linked to ageing,² clinical depression³ and a range of stress-related physical disease (eg Sephton *et al*⁴).

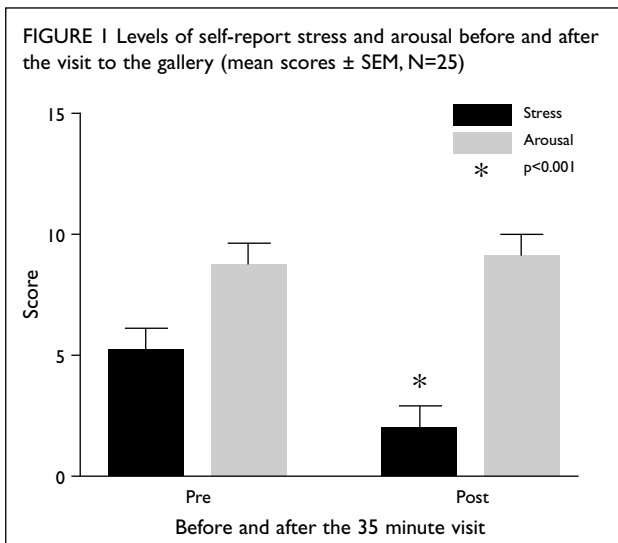
It takes about 15 minutes for a stressor to illicit increased cortisol secretion, the time course of which can be accurately tracked by measuring the hormone in sequential saliva samples.⁵ There has been extensive research into such stress-induced cortisol responding.⁶ There has been less research exploring the impact of positive experiences within a naturalistic setting on cortisol levels although it has been shown that the size of the cortisol response to a standard stressor can be attenuated by cognitive behavioural therapy.^{7, 8}

Very little research has been carried out into effects of naturalistic, non-therapeutic interventions such as are presented in this article. The current study set out to explore self-reported stress and arousal as well as salivary cortisol levels of a group of London City workers during a lunch hour, before and after a visit to The Guildhall Art Gallery.

Procedures

Email invitations were sent out to office workers in the vicinity of the Guildhall Art Gallery in the City of London. The invitation included free gallery entrance, participation in a study on stress as well as a free sandwich lunch at the end of the study. On a typical working day small groups of volunteers arrived at the gallery at pre-arranged 15 minute intervals during their lunch break (between 12.30–1.30pm). On arrival at the gallery each group was directed to a quiet meeting room and welcomed by our researcher. Having given informed consent participants were asked to complete a short questionnaire (the Cox Mackay Stress Arousal Checklist).⁹ This questionnaire assessed their state of stress and arousal upon arrival at the gallery. At the same time they were asked to supply a saliva sample using the convenient Salivette saliva sampling device.

This process was repeated 35–40 minutes later, after they had completed a visit to the gallery exhibition area.



Participants were free to explore the gallery in any way they pleased; the only requirement was that they did not leave the building and that they return to the meeting room 35 minutes later. In this way we could study the psychological and physiological impact of the short gallery visit. Saliva samples were used to determine levels of cortisol. Samples were thawed and cortisol concentrations were determined by Enzyme Linked Immuno-Sorbent Assay developed by Salimetrics LLC (USA). (For details of assay procedures see¹⁰).

Participants

28 participants agreed to take part in the study, 14 males and 14 females. Mean age was 33.6 years (range 22–58). However three participants failed to provide complete data sets and the following results are presented for 25 of the original 28 participants.

Results

There was a fall in self-reported stress after the gallery visit compared with immediately before the visit. This difference was statistically significant using paired t-tests (mean \pm SEM scores pre and post: 5.28 \pm 0.94 and 2.89 \pm 0.57 respectively, $t=3.643$, $df=24$, $p<0.001$). There was no difference in level of arousal pre vs. post the gallery visit (mean \pm SEM scores pre and post: 8.60 \pm 0.68 and 9.40 \pm 0.72 respectively) (See *Figure 1*). There was a corresponding drop in the average levels of cortisol after the 35 minute gallery visit (mean \pm SEM cortisol concentrations pre and post: 5.82 \pm 0.76 nmol/l and 3.94 \pm 0.25 nmol/l respectively, $t=2.913$, $df=24$, $p<0.008$), see *Figure 2*.

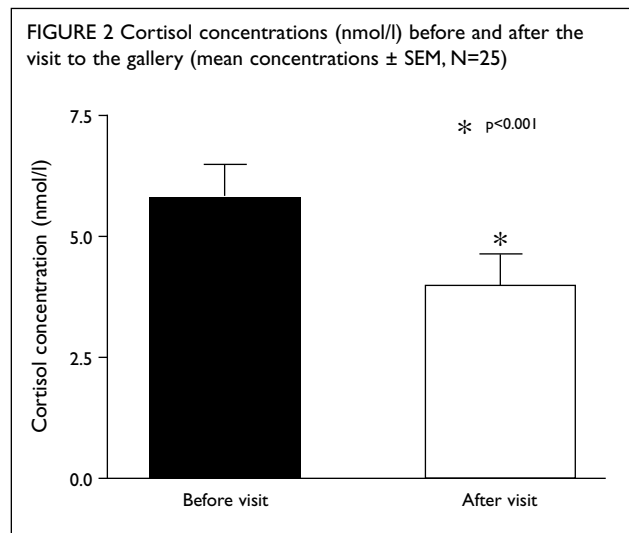
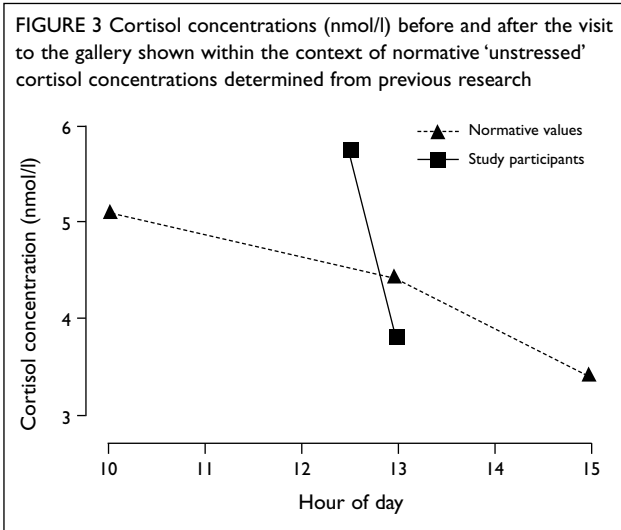


Figure 3 shows that when the participants entered the gallery their cortisol levels were higher than would have been expected or predicted from our previous



research on participants of similar age and without excessive stress in their lives. We can conclude that, on average, at arrival the participants showed evidence of relatively high levels of stress. However within the space of 35 minutes average levels had dropped to below the normal range. This fall in cortisol concentration (1.87 nmol) is greater than the average fall in concentration from 10am to 3pm ie in five hours (1.68 nmol/l). In other words, the visit induced a fall in cortisol concentration equivalent to that which takes about five hours under normal circumstances (the normal, healthy pattern of cortisol secretion is for a gradual decline in concentrations over the day.¹¹

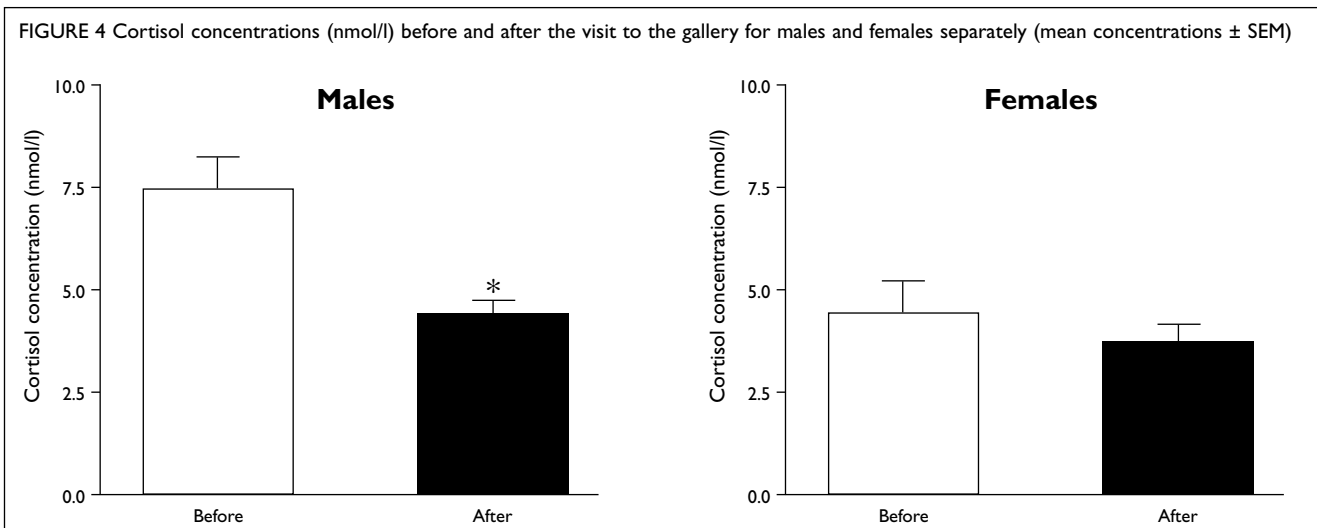
There was a tendency for the male participants to have higher levels of cortisol on arrival at the gallery, although this did not reach statistical significance (mean ± SEM concentrations: 7.44 ± 1.31nmol/l and 4.54 ± 0.78 nmol/l for males and females respectively, $t=2.001$, $df=23$, $p= 0.057$). However males did have significantly higher cortisol levels after the end of the gallery visit (mean ± SEM concentrations: 4.58 ± 0.38 nmol/l and 3.54 ± 0.29 nmo/l respectively, $t=2.224$, $df=22$, $p< 0.04$), see *Figure 4*.

Although the males tended to show higher cortisol levels on arrival at the gallery and were higher at the end of the visit the results reveal that they were more responsive than the female participants. When analysed separately only the male participants showed a decrease in their salivary cortisol levels ($t=2.625$, $df=10$, $p<0.03$) whereas the females did not ($t=1.492$, $df=13$, $p=0.159$). This gender difference in the objective measure of stress was not reflected in gender differences in self-report measures of stress.

Post hoc examination of the data revealed that there were 16 participants who responded to the gallery visit with a fall in cortisol ('responders') and nine who did not show a reduction ('non-responders'). Further analyses showed that the 'responders' were those participants who arrived at the gallery with high levels of cortisol whereas the non responders arrived with significantly lower levels of cortisol (mean ± SEM concentrations: 7.53 ± 0.94 nmol/l and 2.77 ± 0.34 nmol/l respectively, $t=3.697$ $df=23$ $p<0.005$) (see *Figure 5*). At the end of the gallery visit there was no difference between the average cortisol concentrations of the two groups (mean ± SEM concentrations: 4.03 ± 0.33 nmol/l and 3.80 ± 0.41 nmol/l respectively).

Discussion

This study has demonstrated that a brief lunchtime visit to an art gallery had substantial influences on both the subjective experience of stress as well as levels of the stress hormone cortisol. On arrival at the gallery average levels of cortisol were higher than normative values but these dropped rapidly to below the norm for the time of day. Indeed analyses revealed that cortisol levels only dropped in those participants who entered the study with relatively high levels: the gallery visit induced normalisation to desired cortisol levels for the time of day. Recent research points to the importance of



maintaining a healthy circadian pattern of cortisol secretion and this study demonstrates that even brief respites within a hectic working lifestyle can buffer the effects of stress. Furthermore it was interesting to observe marked gender differences in this study. Although they did not report more stress the males had higher cortisol levels than the females, but in line with the normalisation phenomenon, it was the males that responded more markedly whereas the less physiologically stressed females did not show a significant fall in cortisol. It is well known that males are more responsive to stressful events¹² and it is interesting to observe in this study that this responsiveness also works in the direction of reducing cortisol concentrations.

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