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**Valerie Bullen
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Salivary cortisol, stress and arousal following five weeks training in kinesthetic meditation to undergraduate students

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Valerie Bullen, Cathrine Fredhoi, William Bloom, Jan Povey, Frank Hucklebridge, Phil Evans, Angela Clow

This project brought together practitioners from the School of Integrated Health and researchers from the Department of Psychology at the University of Westminster. This collaboration sought to explore an evidence base for the beneficial effects of relaxation and stress management through guided exercises led by William Bloom. In this way we sought to combine our skills with the common goal of exploring the mechanisms by which such interventions may be effective so that we can develop a resilient student which will lead to a resilient practitioner.

Summary

In an investigation designed to explore the impact of a five-week kinesthetic meditation training programme, healthy undergraduate students were allocated to either a control (CG: n=26) or intervention (IG: n=31) group. Salivary cortisol, stress and arousal were measured before and after the five weeks, during which the IG could attend kinesthetic meditation training sessions for one hour each week as well as practice at home with the aid of a CD. There were no statistically significant differences between the groups in demographics or any of the measures at the start of the investigation. Cortisol secretion in the IG group was lower on the day of the final kinesthetic meditation session compared to on a typical day in the same week and the CG measured in the same week. At the end of the five weeks the IG reported more arousal compared to at the start of the programme, whereas the CG reported less. These data confirm that a brief period of kinesthetic meditation training can improve subjective and objective measures of wellbeing.

Introduction

A range of stress management strategies have been developed to enable people to overcome the negative impact of life stress upon mood and health. One of the most studied intermediaries linking stress, mood and health is the hormone cortisol. Cortisol secretion from the adrenal glands is controlled by the brain, which entrains a marked circadian cycle. A healthy pattern of cortisol secretion is characterised by high levels in the morning followed by a steeply declining profile, to low levels in the late evening and middle of the night. High afternoon and evening cortisol concentrations have been associated with high life stress and a range of negative mood and health outcomes.¹ Strategies that can lower levels of cortisol in the afternoon and evening are known to have benefits for wellbeing and health.

Interventions like cognitive behavioural therapy, mindfulness-based stress reduction and transcendental meditation have all been shown to relieve some of the negative psychological consequences of stress and correspondingly lower levels of the hormone cortisol.²⁻⁸

The strategy used here is best described as a kinesthetic meditation. Students are led through a stilling process into a kinesthetic monitoring of how their bodies, in particular their stomachs and solar plexus, feel. They are then led through several processes in which they sense how their mental focus and attitude can directly affect their physical state. This strategy, developed by one of the authors of this paper (William Bloom), works from a foundation of holistic mind-body healthcare, such as the traditional Taoist (Chinese) medical approach.⁹ It differs from other meditation interventions in that it uses no traditional aids, such as mantra or visualisation, but works directly with a self-managed mental attitude in engaged kinesthetic relationship with the body.

It was hypothesised that healthy undergraduate students would secrete less cortisol across the afternoon and evening at the end of a five-week kinesthetic meditation training programme compared to before training and a matched control group tested at the same time. It was also hypothesised that the training programme would decrease self-reported state stress and correspondingly increase self-reported arousal.

Methods

Participants

Fifty-seven healthy undergraduate students (45 female, 12 male; mean \pm SD age 34.6 ± 9.9 years) were recruited to participate in the experiment. They were non-smokers, were not taking medication and had no acute or chronic illness. Participants were allocated to either a control or intervention group (CG and IG respectively). The CG consisted of 26 participants (20 female, 6 male) and the IC consisted of 31 participants (25 female and 6 male). There were no statistically significant differences in demographic variables between the groups. Participants received no financial incentive to take part. The ethics committee of the University of Westminster approved the protocol for this study. All participants provided written informed consent.

Materials

State stress and arousal were assessed using the Stress Arousal Checklist (SACL)¹⁰, a 38-item adjective checklist which gives an assessment of both momentary stress and arousal at the time of completion of the questionnaire. Possible scores ranged from 0-19 for each domain, with higher scores indicating greater stress or arousal.

Participants were given full standardised written instructions and a questionnaire which included demographic questions at the start of the study.

For each study day participants received a saliva sampling kit, consisting of a re-sealable plastic bag labelled with the day of study and containing a record sheet, three SACL questionnaires and three numbered Salivettes, saliva sampling devices (Sarstedt Ltd, Leicester, England).

Procedure

Participants attended a detailed briefing session where they received full verbal and written instructions regarding the procedures of the study. This session included a demonstration and practice in the self-collection of saliva as well as an opportunity to complete the demographic questions. After this participants were divided into the two groups and given additional information about the specific requirements for their group.

The study involved a mixed cross-sectional and longitudinal repeated measures design whereby at the end of the five-week investigative period the IG were compared both with themselves at the beginning of the study and with the parallel CG at the end. Both the CG and IG were studied on a normal weekday at the start of the investigation and on a normal weekday at the end, five weeks later. These days were regular university days on which the students attended a lecture between 2 and 3.30pm (the CG and IG were classmates and following the same programme of study); these days are referred to as the pre- and post-investigation typical days. In addition the IG was studied on a further day in the final week of the investigation. This additional study day was when the IG group received their final kinesthetic meditation training session, which ran between 2pm and 3.30pm; this day is referred to as the final intervention day.

“Strategies that can lower levels of cortisol in the afternoon and evening are known to have benefits for wellbeing”

On each study day participants were instructed to collect saliva and complete a SACL questionnaire at 2pm, 3.30pm (before and after a lecture or intervention) and 8.30pm (at home). During the saliva collection period participants were instructed to take nil by mouth other than water, and not to brush their teeth so as to avoid micro-vascular leakage, for at least 30 minutes prior to each sample collection. Samples were either left at the university immediately after collection or placed in the participant's home freezer as soon as possible after collection and brought into the university within one

week. All samples were then transferred to the laboratory for storage at -20°C until assay. Participants were asked to fill in a record sheet on each day recording awakening time and actual time of collection of saliva samples (in case they deviated from the required sampling regime). Other than these instructions participants were asked to follow their normal routine.

The intervention

Members of the IG were invited to attend a group kinesthetic meditation training session at the same time (2-3.30 pm) one day a week for five weeks. In addition the members of the IG received a free CD designed to aid home practice in the strategies practiced in the group session. Individual attendance at the weekly sessions as well as intensity of practice between sessions was recorded.

Cortisol assay

Samples were thawed and centrifuged at 3,500 rpm for 10 minutes. Cortisol concentration was determined by Enzyme Linked Immuno-Sorbent Assay developed by Salimetrics LLC (USA). Sensitivity: 0.19 nmol/l (lower limit). Standard range in assay: 0.19-49.0 nmol/l. Correlation of assay with serum: $r = 0.960$, $p < 0.0001$, $n = 19$ samples. Intra- and inter-assay variations were both below 10%.

Statistical analysis

A three factor ($2 \times 2 \times 3$) mixed ANOVA was performed on the data set from the typical days with factors of group (IG, CG), week (week 1, week 5) and sample time (2pm, 3.30pm and 8.30pm). When comparing within subject

differences in cortisol data from two days at the end of five weeks a two factor (2×3) within-subjects ANOVA was performed, with factors of day (typical day, intervention day) and sample time (2pm, 3.30pm and 8.30pm). For comparison of cortisol data between groups a 2×3 factor ANOVA was performed with factors of group (IG, CG) and sample time (2pm, 3.30pm and 8.30pm). Stress and arousal data was compared pre- and post-investigation using paired t-tests.

Results

Salivary cortisol concentrations

A mixed ANOVA of cortisol data from both groups on the typical days in weeks one and five revealed the expected main effect of sampling time ($p < 0.001$) confirming a marked diurnal decline in salivary free cortisol secretion from 2pm to 3.30 pm and 8.30 pm. In addition there was a significant main effect for week ($p = 0.047$) with no effect for group, indicating that there was an overall increase in salivary free cortisol secretion from week one to week five and there was no difference between the groups at either week (see Figure 1).

However on the day of the final kinaesthetic meditation session, and after a five-week period of practice in the techniques, a within-subjects ANOVA showed that cortisol secretion in the IG tended to be significantly lower than on a typical day in the same week ($p = 0.07$) and was lower than in the CG measured during the same week ($p = 0.012$) (see Figure 2). Of the original 31 participants enrolled in the IG, 25 attended this final group training session, of which 21 supplied saliva samples at all three time points. Of this group the median number of sessions attended was four (average \pm SD: 3.6 ± 1.1).

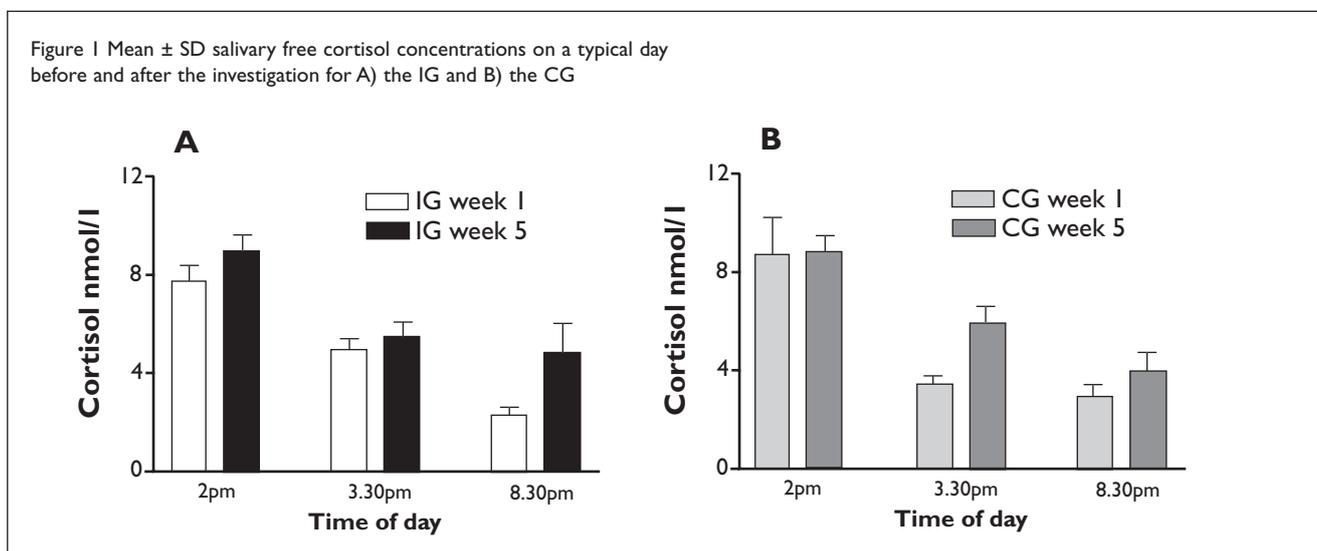
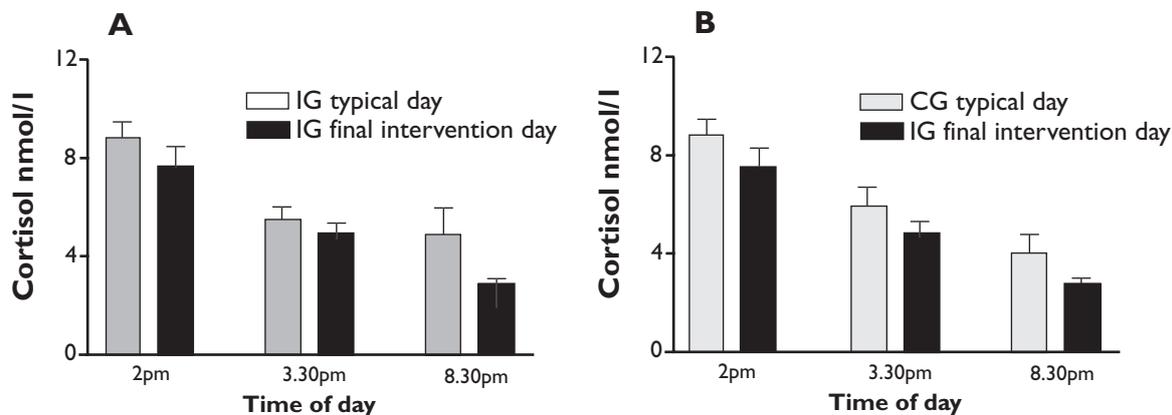


Figure 2 Mean ± SD salivary free cortisol concentrations (nmol/l) for A) the IG on the final intervention day compared to a typical day in the same week and B) the IG on the final intervention day compared control group on a typical day in the same week.



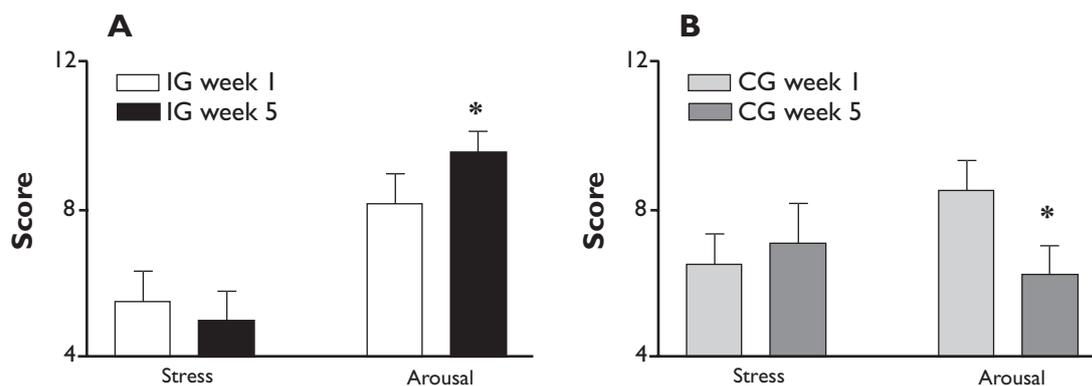
Self reported state stress and arousal

Participants provided measures of self-reported stress and arousal at three time points (2pm, 3.30pm and 8.30pm) on each test day. There was a tendency for both measures to get lower over the course of the day, but measurement times did not interact with any differences between the intervention and control groups over the trial period, so measures from all three time points were analysed as means for each day. Both groups started at similar levels of both stress and arousal at the start of the investigation. However the intervention increased reporting of arousal ($p=0.02$, paired t-test) with no change in reporting of stress at the end of the five-week investigation. In contrast the CG showed a decrease in the reporting of arousal across the five-week study period ($p=0.39$, paired t-test) (see Figure 3). There was no correlational relationship between cortisol concentrations and measures of stress or arousal.

Discussion

Despite no change in levels of self-reported state stress by the end of this five-week investigation on the typical study day the students showed an increase in an objective biological marker of stress: salivary free cortisol concentrations. When studied on a typical weekday, during which the students attended an afternoon lecture, the students who had participated in the group kinesthetic meditation sessions were indistinguishable from their classmates, in relation to both stress measures, at the start and the end of the investigation. In contrast, on the day of the final group training session there was evidence of reduced cortisol levels compared to a typical day in the same week and compared to the control group during the same week. We can conclude from this that benefit derived from kinesthetic meditation sessions was clearly measurable on the day of the session but not detectible on a day when participants were not exposed to the programme.

Figure 3 Mean ± SEM self-reported state stress and arousal for A) the IG before (week one) and after (week five) the stress management training and B) the CG at the beginning and end of the study. (* $p < 0.05$, paired t-tests)



In addition participation in the intervention group was associated with an increase in self-reported arousal over the five weeks whereas participation in the control group was associated with a fall in arousal over the same time period.

This study has provided evidence of increased levels of measurable stress within an undergraduate student population during the latter half of the autumn term. The 'typical' testing days were specifically chosen to be event-free (ie no exams or tests) so we assume that the increased levels of cortisol detected at this time reflects generalised levels of stress rather than related to any specific event occurring on the testing day. This finding is not surprising as academic and workload demands upon the student population do accumulate as the term progresses.

The intervention was shown to be effective in the immediate term by reducing cortisol levels on the day of the final group training session compared to on a typical university day in the same week and the control group measured on the same week. Not all members of the IG attended all five of the available weekly training sessions (median attendance was four sessions, range 1-5). However for the purposes of the analyses, and due to insufficient numbers, all members of the group were analysed as a whole. As a consequence the full impact of the training programme has probably been underestimated as some people may not have fully engaged in it.

This study has provided evidence of measurable stress during the latter half of the autumn term

This is the first report to demonstrate that kinesthetic guided meditation can have an effect upon cortisol levels in healthy young people. However participation in the five-week group training did not attenuate the observed increase in stress as the term progressed. The impact of a range of different stress management approaches on cortisol levels have usually employed longer periods of training. For example in a partly comparable study basal urinary cortisol levels were shown to be lower in students who had practiced transcendental meditation (TM) for an average of 8.5 years, compared to non-practicing classmates.⁷ Relevant to the finding reported here the cortisol levels correlated negatively with number of months of practice; clearly the current study explored the impact of a much shorter period of practice, which may explain why the effects were not generalised to the non-group practice day. Similarly TM training for four months in healthy volunteers reduced average basal cortisol levels

compared to a control group 3 and guided imagery and music therapy also lowered levels of cortisol in healthy volunteers after 13 weeks of training.¹¹

Kinesthetic guided meditation can have an effect upon cortisol levels in healthy young people

It has been demonstrated that a range of interventions designed to alleviate stress can have an impact upon levels of the stress hormone cortisol. Adequate training time to enable participants to engage fully with the process and master the skills and strategies employed is likely to be necessary for these affects to generalise to everyday life situations. It would be interesting to undertake a similar study but with an extended training period and measure the impact upon those who adopted kinaesthetic meditation as part of their everyday lifestyle.

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