



# Anticipating Stress: To Focus on the Body or Do a Self-Inquiry? The Effects of a Focused and Deconstructive Meditation Session on the Stress Response

Liudmila Gamaïunova<sup>1</sup> · Nicolas Pellerin<sup>2</sup>

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## Abstract

**Objectives** Contemplative practices rooted in Buddhism have been linked to psychophysiological stress reduction. However, most research has been conducted on attentional meditations (e.g., mindfulness), leaving techniques from other meditation families largely unexplored. This study aimed to test the stress-attenuating effects of two different meditations administered before a social stress task.

**Method** Eligible meditation-naïve healthy volunteers ( $n = 71$ ) were randomized into three groups: focused meditation, deconstructive meditation, and active control. Participants listened to a 15-min meditation or a story right before a stressor, and filled out a questionnaire assessing anticipatory stress appraisal, and the activity of the autonomic nervous system was measured throughout the task.

**Results** The results demonstrated that compared to active control, both focused ( $d = 0.84$ , 95% CI [0.30, 1.49]) and analytical ( $d = 1.27$ , 95% CI [0.79, 1.90]) meditations increased heart rate variability before the stressor, but this effect did not continue during the task. Anticipatory cognitive appraisal of threat decreased from pre- to post-intervention in all conditions, demonstrating no specific effect of meditations.

**Conclusions** The results tentatively suggest that while a brief meditation session may not reduce stress during the task, it can effectively decrease physiological activation preceding the stress. Both meditations had a significantly higher effect than active control, suggesting that deconstructive meditations show a similar stress-reducing potential as the well-researched attentional meditations.

**Preregistration** The study is not preregistered.

**Keywords** Deconstructive meditation · Mindfulness · Stress · Cognitive appraisals · Buddhist contemplative practice · Heart rate variability

Contemplative practices rooted in Buddhism have been subject to substantial psychological, neuroscientific, and health research, demonstrating their effects on several outcomes related to physical and mental health (Creswell et al., 2019;

Gu et al., 2015). Particularities of Western Buddhism, allowing a certain porousness between the secular and religious (McMahan, 2017), resulted in the wide use of Buddhist contemplative approaches outside their traditional contexts and for purposes beyond religious or spiritual agendas. Mindfulness—one of the most fundamental practices found across various Buddhist traditions (Anālayo, 2019)—laid the foundation for a wide variety of programs, such as mindfulness-based stress reduction (Kabat-Zinn & Hanh, 2009), mindfulness-based cognitive therapy (Segal et al., 2012), and many others (Zhang et al., 2021). These mindfulness-based approaches focus primarily on enhancing different aspects of attention and meta-awareness (the ability to be aware of the process of consciousness) and can be broadly categorized in the attentional family of Buddhist-derived

✉ Liudmila Gamaïunova  
liudmila.gamaïunova@anthro.ox.ac.uk  
Nicolas Pellerin  
nicolas.pellerin@unimes.fr

<sup>1</sup> Institute for Social Sciences of Religions, University of Lausanne, Lausanne, Switzerland

<sup>2</sup> Laboratoire Activités Physiques et Sportives et processus PSYchologiques : recherches sur les Vulnérabilités, University of Nîmes, Nîmes, France

practices (Dahl et al., 2015). The cultivation of mindfulness in these contexts focuses on its technical aspects (e.g., training of attention and awareness) and, as such, does not require an association with Buddhist philosophical, ethical, religious, or spiritual foundations. While these practices have received the most attention in psychological research, Buddhism offers a much wider range of less explored contemplative approaches.

Attention-based practices represent only a tiny portion of the contemplative methods developed in Buddhist traditions. For example, a famous treatise on Buddhist practice, written in the fifth century by a monk Buddhaghosa, describes not only attentional practices but also techniques for developing relational qualities (such as compassion and loving-kindness) and the approaches for cultivating wisdom with its foundation in Buddhist philosophy (Buddhaghosa, 2020). Current meditation typologies categorize these practices into constructive and deconstructive families (Dahl et al., 2015). The constructive family is represented by meditation practices that focus on cultivating affective patterns that strengthen healthy perception, harmonious relationships, prosocial qualities, and adherence to ethical values. The deconstructive family includes meditations based on self-inquiry, where careful examination of body, cognitive, and affective dynamics leads to insight into the nature of reality and self (Dahl & Davidson, 2019). The contemplative practices from these families usually require a more pronounced engagement with the philosophical, ethical, or spiritual framework of the tradition of origin.

Attention-based practices (e.g., mindfulness) have received the most attention from researchers, followed by constructive meditations, such as loving-kindness and compassion meditation. The latter contemplative approaches have been linked to improving affective (Zeng et al., 2015), psychopathological (Shonin et al., 2015), and health outcomes (Galante et al., 2014). Deconstructive practices, including analytical meditations, have received the least attention in research. Examples of a few studies that have examined wisdom-based contemplative approaches include the exploration of potential cognitive and affective outcomes of reasoning-based analytical meditations (van Vugt et al., 2019), Zen/Chan intuitive inquiry meditation effects on EEG dynamics during self-inquiry (Gao et al., 2023), wisdom-derived practices for prosocial outcomes (Furnell et al., 2024) and recovery from gambling behavior (Furnell & Van Gordon, 2024), Buddhist philosophy-enhanced mindfulness-based stress reduction (Gamaiunova et al., 2022), and a combined wisdom-compassion program for emotional regulation (Gao et al., 2022).

Stress reduction became one of the first health and well-being outcomes studied in relation to Buddhist contemplative practices (Chiesa & Serretti, 2009). Of particular interest is the research focused on the social-evaluative threat,

which arises in response to situations of performance judgment and potential loss of positive self-image (Dickerson & Kemeny, 2004). These types of psychological stressors lead to pronounced physiological changes, activating neural, neuroendocrine, and endocrine systems (Everly & Lating, 2019). On the level of the autonomic nervous system (ANS), this activation results in the increase of the sympathetic nervous system (SNS) and the decrease of the parasympathetic nervous system (PNS) activity (Berntson & Cacioppo, 2004). The protective effect of Buddhist meditation on these and other physiological indices of stress has been well documented (Morton et al., 2020). The stress-reducing effects were observed both in long-term practitioners (Gamaiunova et al., 2019) and as a result of shorter interventions (Creswell et al., 2014). However, most interventions or experimental studies primarily focused on mindfulness-based approaches, bringing further evidence of the stress-attenuating effects only of the attentional family of practices. Fewer studies have examined constructive practices, but existing evidence indicates that compassion and loving-kindness meditation also reduce stress (Pace et al., 2009; Telke et al., 2022). One study made a direct comparison between attention training (attention family) and socio-affective meditative training (constructive family), with the results demonstrating that only constructive practice was effective for stress reduction (Engert et al., 2017). The stress-attenuating effects of wisdom-based or analytical approaches from the deconstructive family of meditations are almost entirely unknown. To our knowledge, only one study looked at the stress-related effects of a modified Mindfulness-Based Stress Reduction (MBSR), with analytical meditations complementing the existing attentional techniques (Gamaiunova et al., 2022). The results demonstrated that compared to the control, the program with additional analytical meditations showed more pronounced results than standard MBSR. Importantly, meditation effects were found not only to affect immediate reactivity to stress but also to influence prolonged stress reactivity, i.e., stress anticipation and recovery. These findings are particularly important, as prolonged stress activation increases total stress output and its negative consequences (Brosschot et al., 2005).

Several models have been proposed to explain the stress-attenuating effects of contemplative practices, with explanatory frameworks ranging from purely neuroscientific (e.g., structural changes in the brain) to psychological or traditional Buddhist (Creswell & Lindsay, 2014; Grabovac et al., 2011; Vago & David, 2012). Being a crucial factor in the initiation of the psychophysiological stress response (Gaab et al., 2005), cognitive appraisals could be considered a potential mechanism through which contemplative practices reduce stress. According to Lazarus and Folkman (1987), the primary appraisal consists in evaluating the incoming stimulus as challenging, harmful,

or threatening, which leads to the psychophysiological activation of the stress response system. Further in the stress timeline, one might engage in secondary appraisal where one's resources are evaluated against the situational demands. When resources are viewed as being lower than demands, a state of stress arises, activating several physiological systems (Everly & Lating, 2019). The ability of meditation to alter the appraisal process has been previously discussed in published literature: for example, Garland et al. (2009) proposed an explanatory framework of meditation's effects on positive reappraisal. The authors suggest that meta-awareness, or the ability to decenter from the current experience, allows one to withdraw from the initial automatic appraisal and actively re-appraise the situation more positively. This model was tested empirically, and the results demonstrated that positive reappraisal is indeed a mechanism explaining mindfulness's effects on stress (Garland et al., 2011). In addition to positive reappraisal, it was proposed that the meditation effect could be seen already at the earlier stages of the stress timeline—on the level of primary cognitive appraisals. Mindfulness was found to be associated with threat appraisal reduction (Weinstein et al., 2009) and an increase in challenge appraisal (Gamaiunova et al., 2023).

Among meditation families, deconstructive meditations might be particularly efficient in altering the stress appraisal process. During self-inquiry, the practitioner learns to carefully examine the dynamics of one's cognitive and affective patterns. Coupled with the corresponding philosophical framework, in particular, teachings of impermanence and non-self in Buddhism, this practice can help to create an alternative cognitive schema through which external events are appraised. Cognitive schemas resulting from engagement with religious or philosophical frameworks have long been known to alter the stress appraisal process (Maltby & Day, 2003; McIntosh, 1995; Newton & McIntosh, 2010). The work of Gao et al. (2017, 2020) suggests that religious connotations of the practice (chanting the name of Buddha) help to bias memory through an engagement of emotional schema—in comparison to non-religious contemplative practices, religiously connoted ones increase affective states such as joy, bliss, or awe. It is plausible that the close association between religious mental representations and affective states arising during practice activates and reinforces cognitive schemas tied to traditional frameworks.

In sum, evidence of Buddhist meditation's effects on stress attenuation has been steadily accumulating. Cognitive appraisals have been proposed as one of the mechanisms explaining this association. However, most evidence has come from research on contemplative approaches from the attentional family, particularly mindfulness, leaving other types, such as meditations from the deconstructive family, largely unexplored.

This study aimed to explore the stress attenuation effect of deconstructive meditation. In particular, it aimed to test whether it could reduce ANS reactivity in anticipation and response to stress as effectively as a body scan, a meditative technique from the attentional family. Secondly, it sought to test whether both meditations would alter anticipatory cognitive appraisals. We hypothesized that compared to control, both meditations would equally attenuate the stress response in anticipation of and during a social stressor, resulting in the less pronounced withdrawal of the PNS (indexed by the root mean square of successive differences, RMSSD) and a less pronounced activation of the SNS (indexed by pre-ejection period, PEP). Further, we hypothesized that both meditations would reduce threat appraisal in the anticipation of stress.

## Method

### Participants

Participants were recruited through paper and online advertisements in the Lausanne region for a study advertised as focused on meditation and attention. Inclusion criteria included age 18–40, no substantial meditation practice (less than 10 h in total), at least upper-intermediate command of French, and ability/desire to participate in a 1-hr laboratory session. Exclusion criteria were set as follows: prior participation in the Trier Social Stress Test, pregnancy or lactation, smoking more than five cigarettes a day, medication that interferes with cardiovascular function, severe obesity (BMI > 30), inability to give consent, current mental disorder, current somatic disorder that might interfere with cardiovascular measures. To determine appropriate sample size, an a priori power analysis was conducted using G\*Power3.1 (Faul et al., 2007) for a one-way ANOVA with three groups, large effect size ( $f=0.4$ ), and an alpha of 0.05. Power analysis was based on previous work, showing large effect size for the effects of contemplative training on cardiovascular indices in a similar experimental paradigm (Gamaiunova et al., 2022). Results showed that a total sample of 66 participants was required to achieve a power of 0.80. Out of 178 interested individuals who filled out the screening survey, 48 did not meet the inclusion criteria and 59 refused to participate, resulting in a sample of 71 participants admitted to the study. Due to the recording problems during the experimental session, 70 cases were analyzed for physiological variables and 71 for self-report (see Fig. 1 for CONSORT flow chart). The individual characteristics of participants are presented in Table 1.

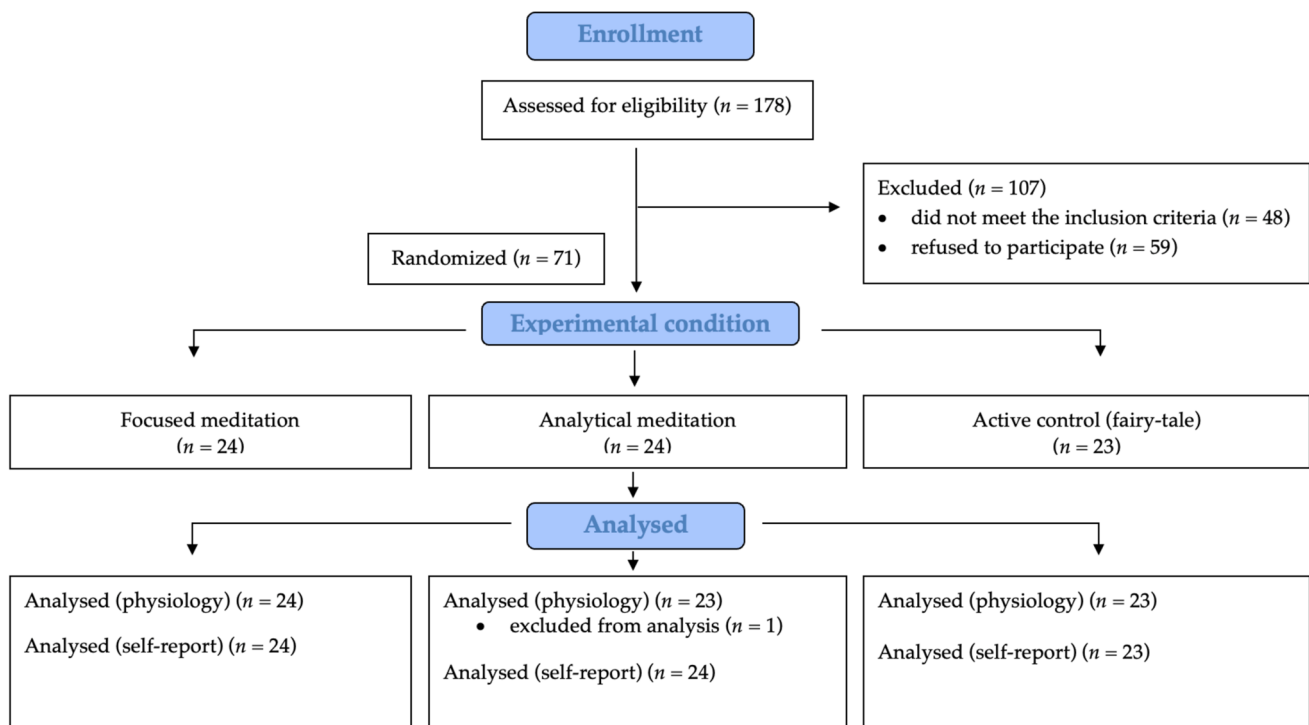


Fig. 1 CONSORT flow chart

## Procedure

After the first contact, potential participants were subject to an online screening. If eligible, candidates received a consent form by email for detailed consideration and were given 2 weeks to decide whether they wanted to participate in the study. In case of agreement, participants were asked to sign the consent form and to schedule a 1-hr visit to the laboratory of the University of Lausanne. Participants received a subject ID (assigned sequentially) and were randomized into one of the three conditions (see “Audio Session”). To balance the influence of sex, we performed stratified randomization: subjects were assigned to two blocks (male or female), and then simple randomization was done within each block to assign each participant to one of the three conditions. The primary author created the randomization plan with the help of an online software (<http://www.randomization.com>). Participants were blinded to their study conditions. At the visit confirmation, participants were asked to abstain from alcohol 24 hr before the session, and from strenuous physical activity, caffeine, food, and smoking for 2 hr before the visit.

After arriving at the lab, participants were asked about compliance with the experimental requirements. Further, they completed a questionnaire assessing demographics and individual characteristics and a pre-experimental check questionnaire (see “Measures”). Afterward, the

participants took part in a modified Trier Social Stress Test (TSST) (Kirschbaum et al., 2008)—a gold standard experimental procedure for inducing social stress. First, the experimenter connected the participants to the MindWare BioNex unit (see “Measures”), instructed them to sit quietly for 10 min, and left the room. After 10 min, the experimenter returned and introduced the task. The participants were told that in 15 min, they would have to give an impromptu speech and do a math task in front of a camera, and trained psychologists would be able to evaluate their behavior. The camera and the microphone were installed on a table, and the research assistants in white blouses (“trained psychologists”) entered the room. After the explanation, the participants were asked to fill in a questionnaire assessing threat and resources (see “Measures”) and told they would do a meditative session before the test. They were given headphones and were instructed to follow the meditation instructions with their eyes closed. After a 15-min meditation or control session, the experimenter returned to the room, asked the participants to fill in a second questionnaire assessing threat and resources, and invited the research assistants in. Following this, the participants were exposed to a simulated job interview (5 min) followed by a mental arithmetic task (5 min) in front of a judgmental audience (two research assistants in white blouses, trained according to the TSST procedure) and a camera. After the task, the participant stayed connected

**Table 1** Socio-demographic and individual characteristics of participants

Socio-demographic and individual characteristics	Frequency		
	Focused meditation ( <i>n</i> = 24)	Analytical meditation ( <i>n</i> = 24)	Active control ( <i>n</i> = 23)
Sex			
Male	8	8	7
Female	16	16	16
Education			
Primary school	0	1	0
Secondary school	11	8	8
Professional school	0	1	0
Gymnasium, pedagogical school, school of commerce	0	0	0
University, polytechnical school, HES	12	14	14
PhD or other post-grade university degree	1	0	1
Occupation			
Student	22	21	21
Employed	2	2	2
Self-employed	0	1	0
Unemployed	0	0	0
Retired	0	0	0
Unable to work (disability)	0	0	0
Marital status			
Single	20	21	19
In a relationship	1	2	4
Married	2	1	0
Divorced	1	0	0
Religious affiliation			
Catholic	6	5	7
Protestant	2	1	2
Other Christian	4	0	1
Muslim	0	5	0
None	12	13	13
		<i>M (SD)</i>	
Age (years)	24.07 (7.21)	22.55 (5.73)	23.23 (2.95)
Personality			
Extraversion	4.02 (1.41)	4.21 (1.53)	4.48 (1.23)
Agreeableness	5.40 (0.83)	5.33 (1.07)	5.40 (0.83)
Conscientiousness	5.94 (0.89)	5.77 (0.93)	5.48 (1.30)
Emotional stability	4.33 (1.10)	4.31 (0.75)	4.65 (0.70)
Openness to experiences	5.42 (1.24)	5.63 (1.04)	5.46 (1.43)
Religiosity			
Organizational religious activity	1.79 (1.10)	1.58 (0.65)	1.65 (1.11)
Non-organizational religious activity	1.75 (1.42)	1.67 (1.58)	1.57 (1.04)
Intrinsic religiosity	1.93 (1.30)	2.03 (1.18)	1.84 (1.15)

to the device for another 10 min. After the end of the session, the participants were disconnected from the device, fully debriefed in oral form, asked to sign a post hoc consent form, and compensated for their participation in the amount of 30 Swiss Francs.

## Measures

### Audio Session

Participants were randomly assigned to one of three pre-test

audio sessions: focused meditation, deconstructive meditation, or active control (listening to a fairy tale). The instructions for focused meditation were based on the body scan technique, a widely used attention-focusing practice in MBSR (Kabat-Zinn & Hanh, 2009). During this meditation, a participant is invited to direct their attention, non-judgmentally, over the body, staying on various parts systematically. The instructions for analytical meditation were based on deconstructive techniques, which use self-inquiry to understand the process underlying emotional, perceptual, and cognitive functioning (Dahl et al., 2015). In this meditation, participants were instructed to look at their habitual ways of constructing a sense of self and their automatic identifications with body, perceptions, and emotions. Further, they were invited to look at the idea of self through the lens of impermanence and analyze how suffering is born from the attachment to a particular image of oneself. The control condition included a fairy tale (“Iron John” by Brothers Grimm)—an active condition used in previous research (Dambrun et al., 2019). All audio sessions were recorded by the same native speaker (female) and had the same length of 15 min. The scripts of the sessions can be found in Open Resource 1 and the audio files are available at the OSF project page (<https://doi.org/10.17605/OSF.IO/X8K3V>).

## Assessments

**Physiological** Continuous ANS data were collected using electrocardiography (ECG) and impedance cardiography (ICG) with a Bionex data acquisition system from MindWare Technologies (Gahanna, OH) at a sampling rate of 1000 Hz. The experimenter recorded data stamps during the procedure by pressing a button on the acquisition computer. Seven spot electrodes were placed on the participant’s chest (Sherwood et al., 1990), and data were captured using Bio-Lab software. Once gathered, the recorded data were processed offline using MindWare Technologies IMP 3.0.10 and HRV 3.0.1 analysis software (Gahanna, OH). A trained researcher reviewed the identification of R-wave peaks and made necessary adjustments. The distance between the front electrodes was measured for each participant and entered manually into the impedance cardiography software. Data summaries for PEP and RMSSD were exported for each minute and averaged over the corresponding experimental intervals: rest (5 min), meditation (15 min), task (10 min), and post-task (5 min).

**Self-Report: Individual Characteristics** In addition to demographic variables, such as sex, age, education, current occupation, marital status, and religious affiliation, we assessed participants’ personality using the Ten-Item Personality Inventory (TIPI) (Gosling et al., 2003), which measures extraversion (McDonald’s  $\omega = 0.63$ ), agreeableness

(McDonald’s  $\omega = 0.21$ ), conscientiousness (McDonald’s  $\omega = 0.41$ ), emotional stability (McDonald’s  $\omega = 0.74$ ), and openness (McDonald’s  $\omega = 0.60$ ). We also measured religiosity, using the Duke University Religiosity Index (Koenig & Büssing, 2010), which assesses intrinsic (McDonald’s  $\omega = 0.89$ ), organizational, and non-organizational aspects of religious involvement (total score: McDonald’s  $\omega = 0.91$ ).

**Self-Report: Pre-experimental Check** To control for the effects of the previous night’s sleep on the ANS activity (Slavich, 2020), we asked participants to indicate before the TSST session how many hours they slept the night before the experiment and the subjective quality of sleep (on a scale from 0 = *very bad* to 100 = *very good*). To control for the emotional state before the experiment, participants were asked how they felt at that moment (frustrated, depressed, excited), all on a scale from 0 = “*not at all*” to 100 = “*a lot*.”

**Self-Report: Threat Index** Threat Index was assessed according to previous work (Tomaka et al., 1993). To assess primary appraisal and coping potential, participants were asked (1) to what degree they saw the upcoming task as threatening and (1) to what extent they could deal with it. Possible responses ranged from 1 = *not at all* to 5 = *completely*. The threat index was calculated by subtracting the resources score from the threat score, with higher scores indicating higher threat, considering the existing coping potential.

## Data Analyses

Statistical analyses were performed in R Statistical Software, v4.1.2 (R Core Team, 2021), and graphs were created using *ggplot2*, v3.5.1 (Wickham et al., 2016). The missing values (1.7% for RMSSD and 1.9% for PEP) were imputed using the R MICE package (Van Buuren & Groothuis-Oudshoorn, 2011). Extreme outliers were identified as values higher than  $Q3$  (upper quartile) +  $3 \times IQR$  (inter-range quartile) or below  $Q1$  (lower quartile) –  $3 \times IQR$ . The analyses were done with and without the outliers and reported accordingly. Holm-Bonferroni correction (Holm, 1979) was applied to control the type II error in multiple tests. The necessary assumptions were checked before all the tests. The criterion for statistical significance ( $\alpha$ ) was set at 0.05. The analytical approaches for each outcome are outlined below.

## ANS Analyses

The effect of the TSST stress task on RMSSD and PEP across the whole sample was tested using a paired Student’s *t*-test, comparing the corresponding mean values at rest and task. To evaluate the impact of the experimental condition on the TSST-related changes in PEP and RMSSD during the audio session and task, we calculated change variables

(delta) by subtracting the resting values from the values of the corresponding period. Further, we conducted one-way ANOVAs using the change score (change from baseline to audio session and stress task) as a dependent variable and condition (focused meditation, analytical meditation, or active control) as the independent variable. In the case of significance, we performed contrasts among all groups.

### Self-Report Analyses

Group differences in personality were assessed using a one-way multivariate analysis of variance (MANOVA), with personality facets as the dependent variable. Differences in religiosity, sleep quantity and quality, and pre-experimental affective state were analyzed using the Kruskal-Wallis test. Group differences in meditation-related changes in the threat index were evaluated with mixed ANOVAs, with time (before and after the meditation) as a within-subject factor and condition (focused meditation, analytical meditation, or active control) as a between-subject factor.

Materials are available at the OSF project page (<https://doi.org/10.17605/OSF.IO/X8K3V>).

## Results

### Preliminary Analyses

#### Individual Characteristics

There was no difference among groups in personality or religiosity (Open Resource 1 in Supplementary Information).

#### Pre-experimental Check

The groups did not differ in the number of hours they slept before the experiment: analytical meditation group ( $Mdn = 7$ ), focused meditation group ( $Mdn = 7$ ), and control ( $Mdn = 7$ ),  $\chi^2(2) = 0.31$ ,  $p = 0.86$ ; nor in the perceived quality of sleep: analytical meditation group ( $Mdn = 70$ ), focused meditation group ( $Mdn = 80$ ), and control ( $Mdn = 80$ ),  $\chi^2(2) = 5.82$ ,  $p = 0.05$ . Similarly, no group difference was detected in the affective state before the experiment, with participants reporting comparable levels of (1) excitement: analytical meditation group ( $Mdn = 72.5$ ), focused meditation group ( $Mdn = 80$ ), and control ( $Mdn = 71$ ),  $\chi^2(2) = 0.91$ ,  $p = 0.64$ ; (2) depression: analytical meditation group ( $Mdn = 10$ ), focused meditation group ( $Mdn = 12.5$ ), and control ( $Mdn = 20$ ),  $\chi^2(2) = 2.83$ ,  $p = 0.24$ ; and (3) frustration: analytical meditation group ( $Mdn = 2.5$ ), focused meditation group ( $Mdn = 10$ ), and control ( $Mdn = 10$ ),  $\chi^2(2) = 0.50$ ,  $p = 0.78$ .

### Stress Induction

There were three outliers in the RMSSD dataset. The stress induction test was successful: the TSST elicited a statistically significant decrease in PEP from rest ( $M = 108.75$ ,  $SD = 12.58$ ) to task ( $M = 85.66$ ,  $SD = 11.70$ ),  $t(69) = 18.13$ ,  $p < 0.01$ ,  $d = 2.17$ , 95% CI [1.85, 2.65]. Similarly, the TSST led to a statistically significant decrease in RMSSD from rest ( $M = 41.85$ ,  $SD = 23.01$ ) to task ( $M = 32.63$ ,  $SD = 15.38$ ),  $t(69) = 4.43$ ,  $p < 0.01$ ,  $d = 0.53$ , 95% CI [0.35, 0.74] (results without outliers:  $t(66) = 3.95$ ,  $p < 0.01$ ,  $d = 0.48$ , 95% CI [0.28, 0.69]).

### Main Analyses

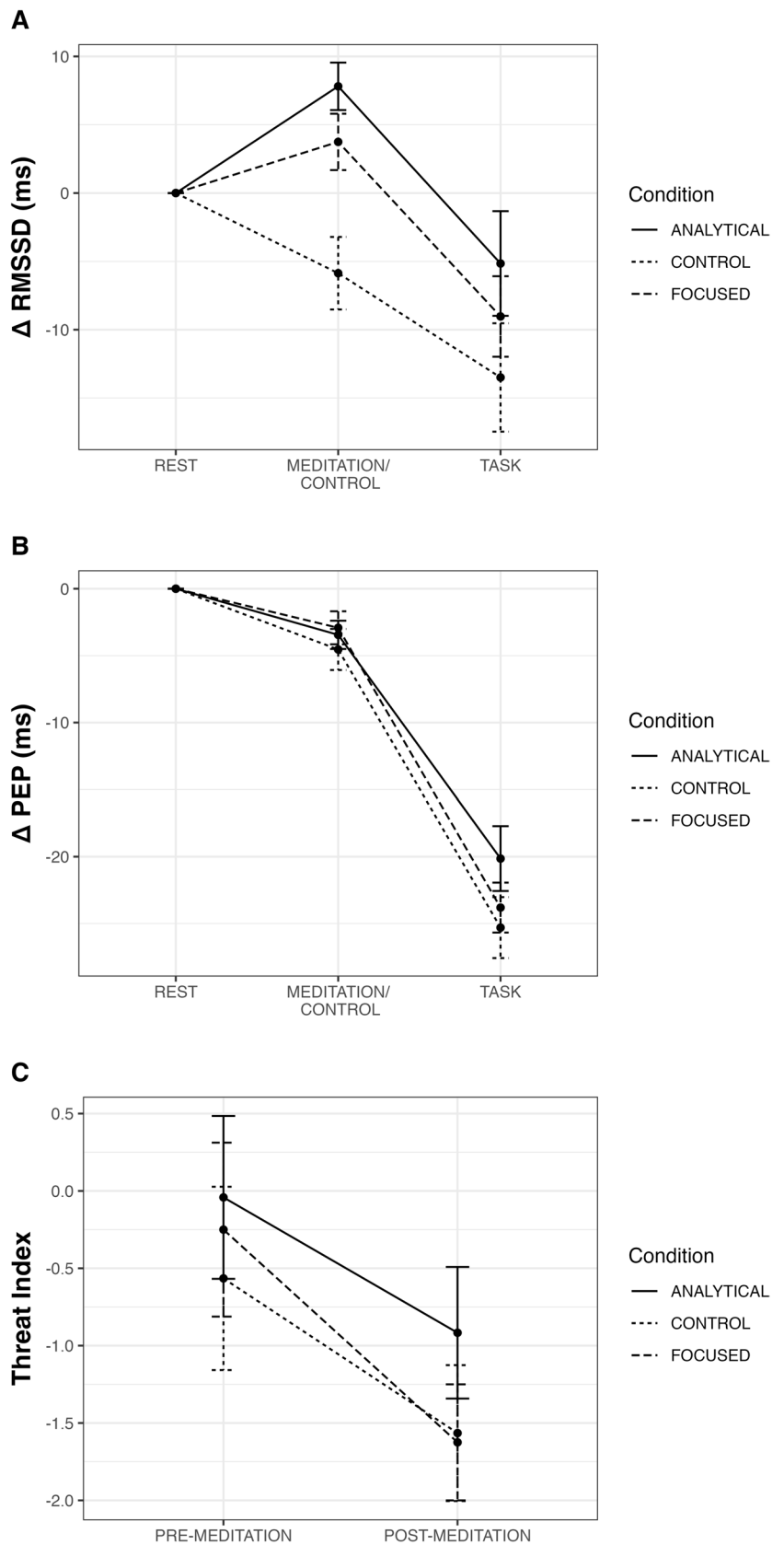
#### Group Differences in Stress Reactivity

The results of the ANOVA for the PEP indicated that the TSST-related activation of the sympathetic branch of the ANS was comparable across groups; neither the change from baseline to meditation periods:  $F(2, 67) = 0.41$ ,  $p = 0.66$ ,  $\eta^2G = 0.01$  (Fig. 2B) nor the change from baseline to task:  $F(2, 67) = 1.45$ ,  $p = 0.24$ ,  $\eta^2G = 0.04$  (Fig. 2B) was statistically significant. The results of the ANOVA for the RMSSD demonstrated that the changes in vagal activity from baseline to meditation were different across groups:  $F(2, 67) = 10.24$ ,  $p < 0.01$ ,  $\eta^2G = 0.23$  (Fig. 2A). The analytical meditation group showed higher levels of RMSSD than the control group:  $p < 0.01$ ,  $d = 1.27$ , 95% CI [0.79, 1.90] as well as the focused meditation group showed higher levels of RMSSD than the control group:  $p = 0.01$ ,  $d = 0.84$ , 95% CI [0.30, 1.49] (Fig. 2A). The group difference in the change of the RMSSD from baseline to task remained insignificant:  $F(2, 67) = 1.33$ ,  $p = 0.27$ ,  $\eta^2G = 0.04$  (Fig. 2A).

#### Group Differences in Threat Index

The results of a mixed ANOVA, with time (before and after the meditation) as a within-subject factor and condition (focused meditation, analytical meditation, or active control) as a between-subject factor, showed no significant time and condition interaction:  $F(2, 68) = 0.48$ ,  $p = 0.60$ ,  $\eta^2G < 0.01$ . The main effect of time was significant, indicating a statistically significant decrease in Threat Index in all three groups from pre- ( $M = 2.69$ ) to post-audio session ( $M = 2.01$ ):  $F(1, 140) = 7.39$ ,  $p = 0.01$ ,  $\eta^2G = 0.01$  (Fig. 2C). The correlation between the perception of the task as threatening and the ability to cope with it was  $r = -0.71$  at the pre-test and  $r = -0.38$  at the post-test.

**Fig. 2** Group differences in the autonomic nervous system activity and Threat Index change. Note: PEP = Pre-ejection period, RMSSD= The root mean square of successive differences between normal heartbeats; ms = milliseconds



## Discussion

This study aimed to test whether an analytical meditation from the deconstructive family of contemplative approaches would be as effective as a well-known meditative technique from the attentional family in reducing physiological activation in anticipation of and during social stress. Further, it tested the effects of meditation on primary cognitive appraisal—one of the psychological mechanisms underlying the stress response. The results demonstrated that both meditations were equally effective in mitigating stress-related vagal withdrawal during the anticipation, but the effects did not persist to the stressful task. The reduction of anticipatory threat appraisal was observed in both meditation and the control conditions.

The study's results provided further evidence of Buddhist meditations' potential to reduce prolonged reactivity and decrease total stress output by lessening physiological activation during anticipation. Vagal activity plays an inhibitory role in the regulation of another stress system, represented by the hypothalamus-pituitary-adrenal axis, and a more substantial decrease in HRV during anticipation has indeed been linked to a larger cortisol response during stress (Pulopulos et al., 2018). The results of this study echoed previous reports, which had shown that participants after MBSR interventions had higher vagal activity during anticipation of stress than participants in a waitlist control group (Gamaiunova et al., 2022). Another study also showed that MBCT practitioners did not demonstrate an increase in anticipatory (pre-stressor) anxiety, while the waitlist controls did (Britton et al., 2012). In sum, contemplative approaches can be proposed to mitigate anticipatory stress, not only as a result of intervention training but also as a short session for meditation-naïve participants. While the mechanisms might vary (e.g., the increase of parasympathetic activity during meditation vs. changes in parasympathetic activity due to the enhanced regulatory process), the resulting decrease in anticipatory stress is noteworthy given the role of prolonged stress reactivity in disease (McEwen, 1998). The results demonstrated that the effects of the meditations on the sympathetic nervous system (measured with pre-ejection period) did not differ from those of the control. While the two branches of the ANS are interrelated, the parasympathetic effects on the heart and the beta-adrenergic drive are not always coupled (Berntson et al., 1991). Our results suggested that, at least during meditation, the effects of pre-stress meditation were primarily on the parasympathetic rather than the sympathetic branch of the ANS.

Although the meditation conditions exhibited lower levels of stress-related changes in vagal deactivation and sympathetic activation from baseline to task, the difference

with the control group did not achieve statistical significance. One possible explanation for these negative findings is the duration of meditation: the effects of contemplative interventions on stress are likely dosage-dependent (Morton et al., 2020). However, previous research has shown that even brief meditation practices can influence stress-related cardiovascular outcomes. For instance, a 4-hr intervention improved HRV during a cognitive task (Shearer et al., 2016), and a short meditation session positively impacted HRV recovery following a failure task (Koerten et al., 2020). A systematic review of brief meditation interventions concluded that even sessions as short as 5 min can lead to positive health and psychological outcomes, serving as a stepping stone to more sustained practice (Howarth et al., 2019).

The anticipatory cognitive appraisal was examined as a possible mechanism for the stress-reducing effects of meditation. Contrary to our predictions, neither meditation condition differed from the control condition regarding the change in threat index from pre- to post-meditation. One explanation for these results is the active control: the content of the non-meditation condition might have led to a similar effect via distraction. The observation that both meditation and listening to distracting audio content could reduce threat perception before stress is, however, important. Anticipatory cognitive appraisals are known to influence physiological parameters in response to stress, such as cortisol (Gaab et al., 2005), proinflammatory cytokine expression (Wirtz et al., 2007), and adrenomedullary activation (Ennis et al., 2001). Exploring any behavioral approach that can lessen anticipatory appraisal, regardless of whether it arises from contemplative traditions, warrants further study. Another explanation for the findings is the measure of anticipatory primary appraisals: the threat index used in this study did not allow the measurement of challenge and threat separately. Indeed, previous studies found higher anticipatory appraisals of challenge in MBSR participants compared to waitlist controls (Gamaiunova et al., 2023) and more benign stress appraisals in mindful individuals (Weinstein et al., 2009). Finally, other psychological mechanisms are plausible: for example, emotion regulation has been explored as one of the most potent explanatory variables behind meditation's effects on stress (Gamaiunova et al., 2021; Prakash et al., 2015; Slutsky et al., 2017).

The key finding of the study was the comparable efficacy between the meditations from the attentional and the deconstructive families. While there are strong theoretical propositions on how Buddhist philosophical and ethical frameworks could enhance our understanding of psychological processes (Loued-Khenissi & Gamaiunova, 2024) and improve standard mindfulness approaches (Van Gordon & Shonin, 2020), the empirical work on other-than-mindfulness contemplative techniques is lacking. One of the obstacles is the

accessibility of these practices: it is unclear whether deconstructive meditations could be administered without prior mindfulness training (Dahl & Davidson, 2019). This study provided preliminary evidence for the possibility of using a deconstructive meditation as a stand-alone technique, and future studies (e.g., García-Campayo et al., 2023) will bring more clarity to this question.

## Limitations and Future Directions

In addition to investigating the efficacy of deconstructive approaches for stress-related and other outcomes, future research would benefit from comparing mechanisms behind different contemplative approaches. Self-inquiry, which lies at the center of meditations from the deconstructive family, is likely to affect different layers of the self-pattern (Gallagher et al., 2024), resulting not only in the ability to switch between experiential and narrative modes but also in a deep comprehension of how the self-pattern is construed. The work of Gao et al. (2022) focused on the investigation of analytical intuitive inquiry meditation suggests another mechanism of deconstructive contemplative approaches. The authors propose that the cultivation of doubt in the process of self-inquiry represents an important cognitive skill that helps in the decision-making process and in the ability to stay focused on the task. Finally, studying contemplative techniques more readily employing elements from original philosophical or ethical frameworks will promote research on meditations from traditions beyond Buddhism. Contemplative practices from other religious or spiritual frameworks are rich and largely unexplored empirically (Kelly, 2013; Komjathy, 2017).

Among the limitations of the study are its small sample size and baseline differences among groups in cardiovascular indices. Replication of the results is needed to reach more definite conclusions.

In sum, this study provides preliminary empirical support that deconstructive meditations could be as effective as attentional (e.g., mindfulness) meditations in reducing anticipatory stress. Further interventional studies with longer interventions and assessments of different psychological mechanisms are needed. Future research should also focus on constructive and deconstructive approaches from different religious and spiritual traditions.

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**Data Availability** Data are available at the OSF project page: <https://doi.org/10.17605/OSF.IO/YU4B2>.

## Declarations

**Informed Consent** All participants of the study have signed an informed consent prior to participation.

**Conflict of interest** The authors declare no competing interests.

**Use of Artificial Intelligence Statement** AI was not used.

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