



A single session of hatha yoga improves stress reactivity and recovery after an acute psychological stress task—A counterbalanced, randomized-crossover trial in healthy individuals



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ABSTRACT

Objectives: Yoga is promoted as an anti-stress activity, however, little is known about the mechanisms through which it acts. The present study investigated the acute effects of a hatha yoga session, displayed on a video, on the response to and recovery from an acute psychological stressor.

Methods: Twenty-four healthy young adults took part in a counterbalanced, randomized-crossover trial, with a yoga and a control condition (watching TV). Participants attended the laboratory in the afternoon on two days and each session comprised a baseline, control or yoga task, stress task and recovery. Blood pressure (BP), heart rate (HR) and salivary cortisol responses were measured. State cognitive- and somatic-anxiety along with self-confidence were assessed before and after the stressor.

Results: Although no difference in the BP or HR responses to stress were found between conditions, systolic BP ($p = 0.047$) and diastolic BP ($p = 0.018$) recovery from stress were significantly accelerated and salivary cortisol reactivity was significantly lower ($p = 0.01$) in the yoga condition. A yoga session also increased self-confidence ($p = 0.006$) in preparation for the task and after completion. Moreover, self-confidence reported after the stress task was considered debilitating towards performance in the control condition, but remained facilitative in the yoga condition.

Conclusion: Our results show that a single video-instructed session of hatha yoga was able to improve stress reactivity and recovery from an acute stress task in healthy individuals. These positive preliminary findings encourage further investigation in at-risk populations in which the magnitude of effects may be greater, and support the use of yoga for stress reactivity and recovery.

1. Introduction

The ancient Indian practice of yoga has been adapted to be a mind-body therapy that is of growing popularity in Australia, Europe and North America, with approximately 7–9% of the population reporting participation in Australia and the USA.^{1–3} Modern yoga combines body postures, breath control and meditation and is thought to promote physical and mental well-being.⁴ In the USA National Health Interview Survey, of those who had practiced yoga, most (78%) reported general wellness or disease prevention as the reason for participation.² Indeed, emerging evidence supports the link between yoga practice and health

for many aspects of physical and mental health.^{5–7} In particular, several reviews have suggested that yoga practice can have cardiovascular health benefits by modifying specific indices of cardiovascular disease risk, such as glucose tolerance, lipid profile, sympathetic activation, cardiovagal function, etc.^{8–10}; and most recently, a systematic review and meta-analysis found no difference in reduction of cardiovascular risk factors between yoga and walking or cycling.¹¹ Despite this positive weight of evidence, there are very few studies that address the mechanisms through which yoga affects cardiovascular health.

One proposed mechanism for the effects of yoga is by altering the response to and recovery from acute stress. The physiological response

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to acute stress has been well studied, both for its immediate effects, and for the chronic effects associated with magnitude of the response. Studies have demonstrated that acute emotional stress itself is potentially harmful to cardiac health, with episodes of anger associated with increased risk of myocardial infarction symptoms.¹² Furthermore, the chronic effects of acute stress reactivity have been established, with greater reactivity linked to the development of hypertension¹³ and atherosclerosis¹⁴ as a function of repeated exposures. Considering such negative effects associated with acute stress responses, some studies have examined the potential for long-term practice of yoga to reduce stress reactivity; with both 8-weeks of heated hatha yoga¹⁵ and 6 months of yoga practice¹⁶ found to reduce the physiological reactivity to stress.

The effects of yoga on stress responses may have an acute component as well as a training (chronic) effect. There is strong evidence that an acute exercise bout can reduce the response to, and recovery from a subsequent acute stressor.^{17,18} It follows, therefore, that the exercise component of a bout of yoga may act in the same way. Meta-analyses have demonstrated that the strongest effects of exercise are seen at higher intensities (greater than 75% maximal heart rate (HRmax), lasting for at least 20 min), and yoga has been reported to be well below this level of intensity (e.g. ~50% HRmax).¹⁹ It is important to highlight, however, that yoga is different from aerobic exercise in its mind-body emphasis, and, therefore, the breathing and meditation aspects of yoga might also be expected to contribute to the reduction of the response to acute stress. Indeed, investigations have shown that participants exhibited lower stress reactivity (eg., BP, heart rate, immune and emotional responses) after 6–12 weeks of meditation training^{20–23}; even short-term meditation interventions (3–5 days) have been shown to lower stress perceptions and salivary cortisol (a marker of Hypothalamic Pituitary Adrenal (HPA) activation) reactivity to a stress task.^{24,25}

Yoga's acute effects on psychological outcomes are well established, with commonly reported improvements in mood, anxiety and depression.⁵ These changes have led to insights in neurobiological changes. For example, improvements in mood immediately after yoga have been associated with higher γ -aminobutyric acid (GABA) levels,²⁶ a neurotransmission system that is also linked to acute stress responses.²⁷ To date, the immediate effect of yoga on psychological responses to acute stress has not been investigated, however, given that acute decreases in anxiety are observed after a bout of yoga and long term yoga practice has been shown to reduce performance anxiety²⁸ and increase self-confidence in medical students,²⁹ it is likely that a single session of yoga could improve psychological aspects of the acute stress response.

The aim of this study was to examine the acute effect of a single hatha yoga session on stress responses using a randomized and controlled crossover design. Considering that physiological reactivity to stress has been shown to be diminished after the completion of a short-term mindfulness meditation training and that an acute bout of aerobic exercise is able to reduce cardiovascular stress responses and improve recovery, we hypothesized that one single session of hatha yoga would attenuate physiological reactivity to and accelerate recovery from a mental stressor. The primary outcomes are cardiovascular and cortisol responses to and recovery from acute stress. In addition, we expected that the yoga condition would result in reduced anxiety and increased self-confidence regarding performance of the stress task, which were the secondary outcomes of this study.

2. Material and methods

2.1. Participants

Twenty-four healthy adults ($n = 13$ male) participated in the present study (mean \pm standard deviation [SD] of age 22.9 ± 3.5 years, body mass index 21.7 ± 2.0 kg/m²). Sample size calculations were based on an anticipated effect size of 0.3, smaller than the moderate size seen in the effects of exercise on the response to acute

psychological stress,^{17,18} and using $\alpha = 0.05$, with 2 interventions repeated measures design (number depending on outcome). Exclusion criteria included a) suffering from an immune, cardiovascular, metabolic, or kidney disease/disorder; b) current illness or infection; c) use of prescribed medication (excluding the contraceptive pill); d) pregnancy or suspected pregnancy; e) being a smoker. In addition, to avoid a stress response associated with novelty, all participants had completed at least one yoga session in the 6 months prior to their first day of testing without injury or adverse effects. In the prior 6 months, 19 participants reported having performed less than 3 yoga sessions. Four participants reported having practiced 4–8 classes and one participant reported weekly yoga practice.

Participants were asked to abstain from vigorous exercise for at least 24 h, alcohol for at least 12 h, caffeine for at least 2 h and food for at least 1 h prior to the beginning of the testing. All participants provided written informed consent and the study was approved by the The University of Sydney Human Ethics Committee (HREC 2015/470). All study data was collected between August 2015 and January 2016.

2.2. Procedures

All participants completed two testing sessions (yoga and control), each commencing between 1 pm and 4 pm, with sessions separated by a minimum of 48 h. The 48-h washout period was determined based on the known duration of the acute exercise-induced hypotensive response (4–16 h).³⁰ The order of the conditions was counterbalanced across participants using a computer generated randomisation order. Following instrumentation and instruction, participants were provided with a standardised snack (700 kJ; 25.8 g carbohydrate, comprising 21 g glucose; 6.2 g fat; 1.4 g protein) and a glass of water (250 mL). Subsequently, the formal baseline measurement period (15 min) began and, after that, participants underwent the assigned condition for 30 min. For the yoga condition, participants were instructed to follow a standardised video of Hatha yoga (30 min), the most commonly practiced form of yoga in Australia.³ This type of yoga consists of a series of easy body postures combined with meditation and breathing instruction and is suitable for participants with all levels of experience. Participants were instructed to follow the yoga video to the best of their ability and a research assistant intermittently monitored the adherence to the practice through a door glass. During the control condition, participants watched an informational video on the history of yoga (30 min) that did not contain elements of meditation. Immediately after the intervention, participants rated their mood using the Immediate Anxiety Measures Scale (IAMS) and then completed a mental arithmetic stress task (21 min). Immediately after the stress, participants again rated their mood using the IAMS and, after that, rested for a further 15 min (recovery).

2.3. Stress task

The psychological stressor utilised was the Paced Auditory Serial Addition Test (PASAT).³¹ During this test, single digit numbers are verbally presented at different rates to the participant, who must add each new number to the one immediately prior to it. Numbers were delivered using an audio tape player and participants answered verbally. The test was administered in 3 sections, with a 1-min break between each one. Section 1 was a 3-min practice and consisted of 31 numbers presented at 3.8 s intervals, followed by 32 numbers presented every 1.9 s. Sections 2 and 3 were each 8 min in duration. Section 2 consisted of four consecutive 2-min periods, whereby 43, 50, 60, and 75 numbers were presented at intervals of 2.8, 2.4, 2.0, and 1.6 s respectively. The presentation rate during the initial 2-min period of Section 3 was 2.4 s per number and, as in section 2, was increased by 0.4 s per number every 2 min.

During the stress task, participants were filmed and their performance played live on a screen. They were told that their performances

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