

Separating the “Limbs” of Yoga: Limited Effects on Stress and Mood

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Abstract Though millions of people practice yoga to reduce stress and improve their mood, it is unclear which aspect of yoga is responsible for these effects. To investigate relevant aspects, or “limbs” of yoga, participants who were novices in the practice of yoga engaged in a single yoga manipulation (i.e., poses, breath work, meditation, or listening to a lecture about yoga) for 20 min before experiencing a mild stressor. Participants’ heart rate, blood pressure, mood, and anxiety level were assessed, both immediately after the yoga manipulation and after the mild stressor. The 20-min yoga manipulation did not differentially affect any of the measures, including participants’ stress response after the mild stressor. Results are discussed regarding the individual components of a yoga practice.

Keywords Anxiety · Blood pressure · Heart rate · Mood · Stress · Yoga

Introduction

Ancient Hindu culture considered the physical, mental, and spiritual practice of yoga to be a pathway to health and longevity. Many people engage in yoga because they believe that it improves their overall health and, in particular, reduces psychological stress (Clarke et al. 2015; Li and Goldsmith 2012; Streeter et al. 2007; West et al. 2004). Several recent empirical studies show that yoga lowers blood pressure (Landry 2014), decreases heart rate (Clay et al. 2005), reduces feelings of stress and anxiety (Kumar 2008), and lowers general anxiety responses (Melville et al. 2012; Semich 2014).

Yoga induces parasympathetic nervous system activation (PNS: neurotransmitters responsible for relaxation response, decreasing blood pressure and heart rate; and activation of limbic structures of the brain) and suppresses sympathetic nervous system activation (SNS), which is responsible for the stress response including the release of cortisol

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and epinephrine (Pramanik et al. 2009). Yoga can, over time, cause PNS activation to become dominant over SNS activation, even during stressful situations (Ross and Thomas 2010). Several studies have documented reductions in anxiety and stress following yoga interventions (Beck and Verticchio 2014; Telles et al. 2013). In experienced yoga practitioners, for instance, levels of gamma-aminobutyric acid (GABA; a neurotransmitter that helps induce relaxation and sleep) increased after one session of yoga (Murthy et al. 1998). Studies have been conducted measuring the effect of incorporating facets of yoga (meditation and pranayama) on speech disorders and speech-related anxiety in individuals with a stutter. Yoga has demonstrated reduced anxiety and more confidence and control related to speaking in these individuals (Mc Intyre et al. 1974). Yoga may be an appropriate intervention as it mediates control of reactivity to stress through the regulation of the autonomic nervous system; however, results of studies investigating this effect have been mixed. A recent study did not show a significant difference in stress reactivity for a yoga group compared to a physical education class (Hagins et al. 2013). These mixed findings indicate a need for further exploration.

According to the ancient Hindu mystic Patanjali, yoga includes eight pathways or “limbs” that outline how to live a meaningful life. Patanjali’s third limb, Asanas, is the postures that are commonly associated with the everyday practice of yoga in Western culture. Pranayama, or breath control, is practiced because of the hypothesized connection between breathing, a person’s state of mind and the nervous system. Dhyana, or meditation, is the practice of constant, uninterrupted observation. Though all three of these limbs of yoga have been examined empirically to determine how the application of yoga’s physical poses, breathing, or meditation can affect psychological mood states and physiological stress responses, it remains currently unclear which aspect or limb of yoga may largely account for the reduction in stress response. Arambula et al. (2001) studied a single individual who had practiced yoga for 32 years. Following 15 min of meditation, a slow, abdominal breathing pattern was observed, which is often associated with relaxation techniques. Explanations for the mechanisms by which yoga is effective thereby point to respiration rate as a mediator of the effect (Arambula et al. 2001; Melville et al. 2012). Change in respiration was found to have been affected by the meditative state. A study of 30 men residing at a yoga center found that with nine months of meditation experience, reduced sympathetic activity was inferred from changes in autonomic variables, such as decreased heart rate (Telles et al. 2013).

Short-Term Yogic Interventions

While research has established the health benefits of long-term yoga practice (usually at the rate of about a weekly class for six months), there is also a small body of research exploring short-term or brief session effects. Brief yoga sessions are usually described as 20–30-min long sessions, in contrast to the 90-min length of a typical yoga class. A 30-min session of yoga, humor, and reading decreased acute stress in a sample of health science students (Rizzolo et al. 2009), an important finding because these interventions resulted in a significant reduction in stress in a relatively short amount of time when compared to most multiple-week-long interventions in the literature. West et al. (2004) demonstrated that a one-time 90-min yoga class was able to reduce perceived stress and negative affect as well as decrease cortisol. After single short sessions of yoga individuals with schizoaffective disorder showed significantly decreased state anxiety (Vancampfort et al. 2011). However,

Johnson, et al. (2015) found that a 25-min meditation session was not sufficient to increase attention or working memory.

Current Study

Little research has been conducted measuring the effects of independently practiced limbs of yoga. One study, conducted by Semich (2014), examined how postures or a combination of limbs of yoga (postures, breathing, and meditation) affected stress and mindfulness levels in novice yoga practitioners. Results of this study indicated that a combination of limbs of yoga was most effective in reducing state stress measures when compared to poses. The present study expands on those results by exploring the effects of the limbs of postures, meditation, and breathing individually in comparison with a control. The limbs of yoga were analyzed separately, a research approach that has not been widely utilized in the literature thus far. This study was exploratory, wherein it investigated the individual effects of postures, breathing, and meditation on stress responses, affect, and, anxiety.

The current study also assessed the difference in participants' stress and anxiety reactions to a mild stressor depending upon which yoga experience they had during the session. Because most yoga research uses a holistic approach that combines postures, breathing, and meditation, the current study considered an unexplored question about what effect a separation of limbs might have. Studies of yoga involve novice practitioners trained for several weeks or very advanced practitioners who have trained for years. Few studies use untrained practitioners being exposed to a single brief session of yoga before being measured, and this is an important area of research that has not yet been explored.

Hypothesis 1 It was predicted that yoga postures, breathing, and meditation would differentially affect all measures: heart rate, blood pressure, mood, and state anxiety immediately after engaging in the activity.

Hypothesis 2 It was hypothesized that participant's reactions to a mild stressor would differ as a function of the yoga experience they had during their session

Method

Participants

Participants ($N = 117$, 106 who identified as female, 11 who identified as male) were undergraduate psychology students at Towson University who registered for the study through an online program. The mean age was 19.5 years old. Approximately 91% had "none" or "some, but not consistent" experience with yoga and 95% responded "none" or "some, but not consistent" experience with meditation. Fifteen individuals were removed from the analyses because they were either in pilot sessions or sessions that had experimenter errors.

Yoga Sessions

Single 20-min sessions were conducted by either of two certified yoga instructors, one female and one male, who regularly teach a 90-min yoga classes outside of the university

setting. The instructors were members of the same population from which the participants were sampled. Although Johnson et al. (2015) recently found that a 25-min meditation session was not sufficient to increase attention or working memory, the current study hypothesized these may be due to untrained individuals conducting the sessions. Therefore, the current study hoped to increase the efficacy of the brief yoga session by using trained yoga teachers. Four independent sessions included: postures, breathing, meditation, and a yoga lecture control condition. Table 1 lists the sequence of postures that were used. Table 2 describes the breathing exercises. The meditation was an instructor-lead progressive relaxation based on visual imagery. The lecture was an overview of the history of yoga from ancient times to its contemporary manifestation.

Measures

Anxiety

Trait anxiety refers to a relatively stable aspect of an individual's personality, while state anxiety varies with the current conditions a person is experiencing. The state and trait subscales of the Spielberger State-Trait Anxiety Inventory (STAI; Spielberger and Sydeman 1994), a paper and pencil self-report measure based on a four-point Likert scale with 20 questions per subscale, were used in the current study. The STAI differentiates between the more general and long-standing quality of trait anxiety, and the more specific and temporary condition of state anxiety. Examples of items from both scales are "I feel stressed" or "I feel undecided." The range of the scale is 20 (low anxiety) to 80 points (high anxiety).

Physiological Stress

Systolic and diastolic blood pressure was measured in millimeters of mercury (mm Hg) as an indicator of the stress response. Normal blood pressure for adults is 120/80 mmHg or less. Heart rate was measured by pulse, which is the number of heartbeats per minute (bpm). Normal heart rate for adults is between 60 and 100 bpm. In normal individuals, heart rate goes from a mean of 70.5 bpm before a stressor, to a maximum mean of 96.5 bpm during the stressful task ("Target Heart Rate", n.d.). Both were assessed by a Welch Allyn 420 Series hospital grade automated machine. Data were analyzed for participants with values within normal ranges.

Mood

The Positive and Negative Affect Schedule (PANAS; Watson et al. 1988), was used to measure mood. Positive affect (PA) is a broad affective dimension characterized by feelings of enthusiasm, alertness, and activity. Negative affect (NA), another temperamental factor, also relates to mood states; NA is more directly associated with emotionally distressing experiences such as feelings of sadness, fear, guilt, and anger. Each item on the PANAS was rated on a five-point Likert scale ranging from 1 (very slightly or not at all) to 5 (extremely) to indicate the extent to which the respondent felt a particular way (for example, "alert") at the current moment. The normalized mean score for positive affect is 35.7 (SD = 6.2) and for negative affect is 19.5 (SD = 6.0). Higher scores indicate higher

Table 1 Postures used in the “Poses” condition

Posture	Position
1. Child’s pose	Reclined
2. Cat–cow pose	All-fours
3. Downward facing dog	All-fours
4. Forward bend	Standing
5. Ragdoll	Standing
6. Lateral half-moon	Standing
7. Mountain pose	Standing
8. Sun salutation A (2×)	Standing
9. Low lunge	Standing
10. Half-split	Sitting
11. Easy camel	All-fours
12. Child’s pose	Reclined
13. Warrior 1	Standing
14. Warrior 2	Standing
15. Triangle pose	Standing
16. Staff pose	Sitting
17. Forward bend	Sitting
18. Head-to-knee forward bend	Sitting
19. Boat	Sitting
20. Bridge pose	Reclined
21. Reclined twist	Reclined
22. Happy baby	Reclined
23. Corpse pose	Reclined

Table 2 Types of breathing exercises in the “Breathing” condition

Breathing exercise	Position
1. Noticing the breath	Sitting
2. Deepening the breath	Sitting
3. Lengthening the breath	Sitting
4. Kombucha—sealing the breath	Sitting
5. Breath of joy	Standing
6. Ujjayi breathing	Sitting
7. Nadhi sodhana—alternate nostril breath	Sitting
8. Durga breath—3-part yoga breath	Reclined
9. Breathing in supta baddha konasana	Reclined

levels of positive affect. The full version of the PANAS consists of two 10-item scales for positive affect and negative affect, respectively.

Stressor

Meta-analysis suggests that the Trier social stress test (TSST) is the most useful and appropriate standardized stress-induction protocol for studies of stress. In the original

description of the TSST, researchers sought to design a procedure capable of inducing a reliable stress response in the majority of healthy participants. These researchers found elevations in heart rate, blood pressure, and several endocrine stress markers in response to the TSST (a psychological stressor) compared to a saline injection (a physical stressor). Although the TSST is usually modified to meet the needs of research studies, it consists of a waiting period upon arrival, the anticipation of a speech performance, and a verbal arithmetic performance. This protocol was modified to use only the verbal arithmetic portion and also added a challenging letter-scrambling task that was counterbalanced with the math task.

Procedure

As part of the pre-screening, participants were asked to dress in comfortable clothing. Participants were asked to avoid a heavy meal or caffeine for 1.5 h before attending the session to avoid unnatural increases in blood pressure or heart rate. Sessions were held in a campus dance studio that was well lit with natural light. Testing was conducted in groups of 1–4 people at a time. Upon arriving, participants removed their shoes and sat on individual yoga mats. All participants were allowed 10 min to relax in the session room while the consent form and instructions were provided.

Phase 1 (Baseline and Time 1 Measurement, 10 min)

After the relaxation period, trained research assistants fitted participants with a blood pressure cuff, and baseline blood pressure (BP) and heart rate (HR) were recorded. Self-report measures of the STAI and the PANAS were then completed.

Phase 2 (Experimental Manipulation and Time 2 Measurement, 20 min)

Groups of participants were assigned randomly to one of four 20-min limb manipulations. In the “Poses” condition ($n = 28$), one of two certified yoga teachers led a series of 23 postures typical of a standard yoga class (see Table 1 for the specific positions used). In the breathing condition ($n = 24$), the yoga teacher instructed participants in a series of different breathing techniques (see Table 2 for the types of breathing exercises). In the “Meditation” condition ($n = 25$), participants were led by the yoga teacher in a guided imagery exercise with a focus on awareness of the present moment. In the “Lecture” condition ($n = 29$), one of the certified yoga instructors presented a 20-min lecture about the history of yoga. Blood pressure, heart rate, mood, and state anxiety measures were collected after the manipulation.

Phase 3 (Stress Task and Time 3 Measurement, 10 min)

To induce a mild level of stress, participants were asked to complete two different counterbalanced tasks. For one of the tasks, participants were asked to complete challenging subtraction problems for 2 min (i.e., consecutively subtracting a two-digit number from a four-digit number). At the end of Phase 2, the following script was read to the participant:

A research assistant will be visiting each of you individually and asking you to start at a specific number and verbally count backward by a given amount. For example,

starting with 2083 and counting backward by 17. The research assistant will be keeping track of your performance; if you make a mistake, you will be asked to begin again from the original number. Your performance will be measured by the number of consecutive subtractions you can do. Most participants able to complete 15 consecutive subtractions in the 2-min span with ease, anything fewer than 15 is considered a poor performance.

The starting number for each participant was 1022, which is the value used in the standardized Trier social stress test. If the participant made a mistake, they were prompted with: “That is incorrect, please start over from 1022.” A digital timer was set for 2 min; this timer was not reset if a mistake was made. For the other mild stressor task, participants completed a 2-min lexical task that required them to create as many five-letter words as they could from the prompt word “neuroscience.” Blood pressure, heart rate, mood, and state anxiety measures were collected after both tasks were completed.

Results

Fifteen individuals were removed from the analyses because they were either in pilot sessions or sessions that had experimenter errors. Trait anxiety scores from the STAI-T were entered as a covariate but were not significant. They were not included in any further analysis. Differences in the yoga teachers were assessed with t-tests. No differences reached the level of significance, all p 's > .05. The main analyses were a 4 (type of limbs activity: poses, breathing, meditation, lecture) \times 3 (phase of study: Phase 1 (baseline), Phase 2 (post-manipulation), Phase 3 (post-stressor)) mixed factorial design. Separate mixed factorial ANOVAs were conducted on the dependent variables reported below.

Systolic Blood Pressure

Results indicated a main effect of phase of study, $F(2,216) = 4.54$, $p < .05$, $\eta^2 = .07$. Repeated measures post hoc tests indicated no change in blood pressure from baseline to after the manipulation ($p = .213$). However, blood pressure was significantly higher after the stressor, ($p = .006$). No other results were significant (See Fig. 1).

STAI-S: State Anxiety

Mauchly's test of sphericity indicated that assumptions had been violated, $\chi^2(2) = 32.39$, $p < .05$ and therefore Greenhouse–Geisser corrected statistics are reported. Results indicated a main effect of phase of study, $F(1.57, 163.80) = 76.05$, $p < .001$, $\eta^2 = .42$, power = 1.00. Repeated measures post hoc tests indicated that participants were self-reporting that they were significantly less anxious at Phase 2 compared to Phase 1 and significantly more anxious at Phase 3 compared to Phase 2 and Phase 1 (t 's ranged from 4.86 to 10.42, all p 's < .001). No other results were significant (See Fig. 2).

PANAS: Positive Mood

Mauchly's test of sphericity indicated that assumptions had been violated, $\chi^2(2) = 16.51$, $p < .05$ and therefore Greenhouse–Geisser corrected statistics are reported. Results indicated a main effect of phase of study, $F(1.72, 161.70) = 39.01$, $p < .001$, $\eta^2 = .30$,

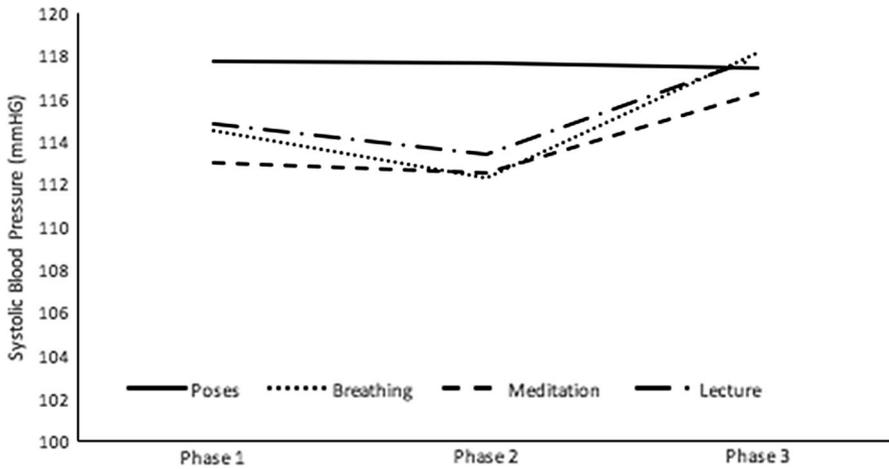


Fig. 1 Systolic blood pressure at each phase of study as a function of condition

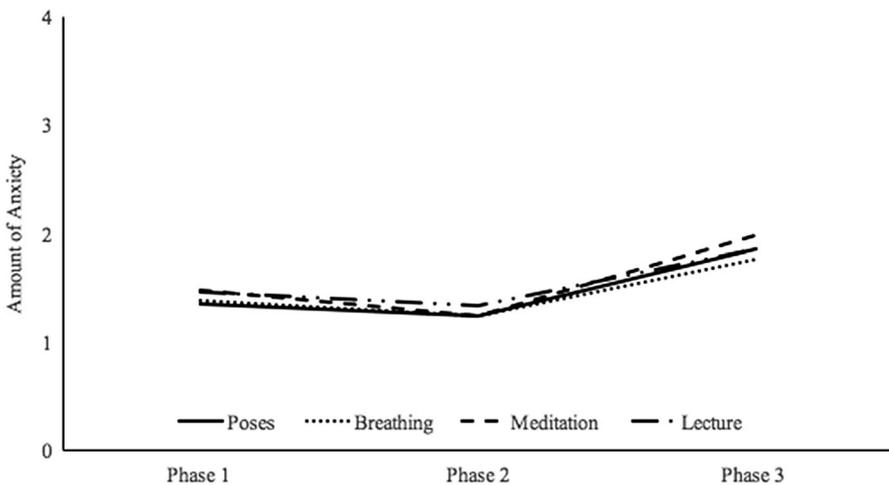


Fig. 2 Amount of anxiety measured by the STAI-S at each phase of study as a function of condition. Lower numbers indicate lower levels of anxiety

power = 1.00. Repeated measures post hoc tests indicated that participants were self-reporting the same amount of positive affect at baseline and post-manipulation. However, participants reported less positive affect at Phase 3 compared to Phase 1 or Phase 2 (t 's ranged from 7.31 to 7.67, p 's < .001). No other results were significant (See Fig. 3).

Math task.¹

Cognitive task.²

¹ Two alternate forms of the task were used. The total number of correct subtractions within a 2-min period were counted and entered in the analysis as the dependent measure. A one-way between groups ANOVA was conducted, $F(3,110) = 1.61$, n.s.

² Non-repeating, legal words containing at least five letters were tallied and used as the dependent measure. A one-way between groups ANOVA was conducted, $F(3,109) = 1.13$, n.s.

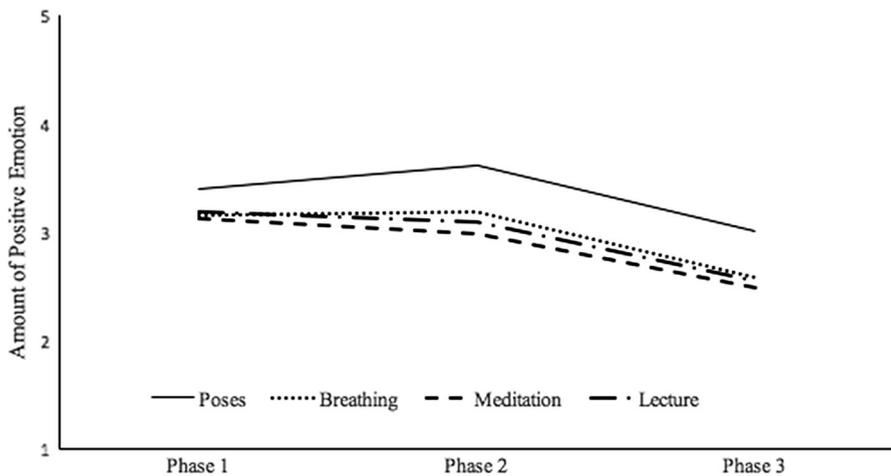


Fig. 3 Amount of positive emotion experienced as measured by the PANAS at each phase of study as a function of condition

Discussion

The present study investigated whether individual limbs of yoga independently affected mood and anxiety. It also investigated whether limbs of yoga affected response to a mild stressor. Results indicated that each limb manipulation significantly lowered state from baseline and also improved mood, but the effect was no different from the control condition. The results indicated that poses, breathing, meditation, and lecture conditions were equally effective in reducing anxiety and improving mood. Twenty minutes of a yogic intervention did not affect responses to the stressor.

Several limitations may have impacted the effectiveness of the manipulation and therefore resulted in negative findings. This study's limitations include the duration of instruction, the level of participant expertise, and a university setting. This study utilized only a 20-min intervention of yogic limbs. It was the shortest duration of an intervention that was found in the literature. The lack of effectiveness in reducing anxiety and its physiological responses may indicate that 20 min of postures, breathing, or meditation does not have an impact on these responses and a longer duration of intervention is needed to see these effects. The study also did not take into account level of previous experience with yoga or meditation. Previous experience with the practice would impact the ability of the participant to be present during the session. Effects of yoga may also be magnified over time with increased practice, and this was not measured during the session. Finally, the participants engaged in the yoga experience in a university setting, which may be distracting or anxiety-inducing on its own.

Future research should include a detailed comparison of procedures used in those studies where brief sessions of yoga produced an effect on stress, and those reporting a null finding. The current study used a very short intervention, 20 min, which may be too short a duration for participants to benefit from a yogic experience. The question of whether a brief intervention works is not settled because the current study did not include a full yoga session, but included sessions of individual limbs. Interventions that span days or weeks, rather than merely minutes, may be more effective in reducing physiological stress,

although shorter interventions may affect subjective measures of mood. Future research should consider including a comparison condition where all aspects of yoga are included. The inclusion of this condition may have the potential for greater reduction in anxiety and a greater enhancement of mood in such a whole versus limb comparison.

The results of the current study also raise the question of whether yoga can be analyzed via separate limbs. Yoga may be effective in reducing stress in individuals because of different parts functioning together. The stress-reducing effects could be achieved because movement through the postures induces a meditative state which affects breathing patterns which in turn affects the parasympathetic nervous system. In this model, yoga is a whole package pathway to stress reduction, but an individual theoretically could achieve the same result with a focus just on breathing. Future studies could compare stress responses in a group of practiced yogis, and another group of people practiced in breath manipulation (but not yoga).

In sum, the current study found that even in the absence of a full yoga session, mild state anxiety can be reduced with 20 min of yogic postures, meditation, or focused breathing; this is true even for individuals with no prior yoga experience. This finding is important because it represents an accessible stress reduction procedure from which most people can benefit as they encounter the small anxieties of everyday living.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Human and Animal Rights Participants were compensated with course extra credit points only. Yoga mats were donated from a local yoga studio. No animals were involved in the conduct of this study. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Ethical Approval The study received the Approval Code 15-A013 from the University IRB committee.

Informed Consent Signed informed consent was obtained from all individual participants included in the study. No deception was involved in the experimental procedure, and participants were fully debriefed afterward.

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