



## Exploring how different types of yoga change psychological resources and emotional well-being across a single session



Crystal L. Park<sup>a,\*</sup>, Lucy Finkelstein-Fox<sup>a</sup>, Erik J. Groessl<sup>b</sup>, A. Rani Elwy<sup>c</sup>, Sharon Y. Lee<sup>a,b,c</sup>

<sup>a</sup> University of Connecticut, USA

<sup>b</sup> University of California, San Diego, USA

<sup>c</sup> Brown University, USA

### ARTICLE INFO

#### Keywords:

Yoga  
Mechanisms  
Positive emotion  
Vitality  
Emotional well-being  
Meditation

### ABSTRACT

**Objectives:** Yoga demonstrates beneficial effects in many populations, yet our understanding of *how* yoga brings about these effects is quite limited. Among the proposed mechanisms of yoga are increasing psychological resources (mindfulness, body consciousness, self-transcendence, spiritual peace, and social connectedness) that may bring about salutary effects on emotional wellbeing. Further, yoga is a complex practice comprising meditation, active and restorative postures, and breathwork; however little is known about how different components may affect mechanisms. We aimed to determine how an acute session of yoga (and its specific components) related to pre- to post- session changes in proposed mechanisms (psychological resources) and whether those changes were associated with positive changes in emotions.

**Design:** 144 regular yoga practitioners completed measures of mindfulness, body consciousness, self-transcendence, social connectedness, spiritual peace, and exercise-induced emotions (positive engagement, revitalization, tranquility, exhaustion) immediately before and after a yoga session (N = 11 sessions, each a different type of yoga). Perceived properties of each yoga session, exercise exertion and engagement with the yoga teacher were assessed immediately following the session.

**Results:** Pre-to post- yoga, levels of positive emotions (engagement, tranquility and revitalization) increased while exhaustion *decreased*. Further, all psychological resources increased and closely tracked improved emotions. Additionally, aspects of the yoga session correlated with changes in psychological resources (mechanisms) and emotions.

**Conclusions:** Yoga may influence multiple psychological mechanisms that influence emotional well-being. Further, different types of yoga may affect different mechanisms. Results can inform yoga interventions aiming to optimize effects through specific mechanisms such as mindfulness or spirituality.

### 1. Introduction

Evidence regarding yoga's beneficial effects on health and well-being in a variety of populations is rapidly increasing.<sup>1</sup> Specifically regarding emotions, studies have found that yoga improves positive emotions and reduces negative emotions.<sup>24,25</sup> For example, in one randomized controlled trial (RCT), women undergoing radiotherapy for breast cancer who participated in twice-weekly yoga experienced reductions in depression and anxiety relative to those in a wait-list control.<sup>26</sup> Studies have generally been more focused on (and shown more consistent effects in) reducing negative affect than in increasing positive affect, although some evidence for improved positive affect as a result of yoga practice has been reported.<sup>27</sup> For example, in an RCT in healthy adults comparing a 12-week intervention of yoga versus

walking, yoga improved positive emotion (positive engagement, revitalization, and tranquility) and reduced negative emotion (physical exhaustion and anxiety) more than did walking.<sup>28</sup>

Of particular relevance to the present study, even a single session of Hatha yoga has been shown to improve mood.<sup>29</sup> One study of college students demonstrated improved exercise-induced feelings (increases in positive engagement revitalization, and tranquility and reductions in physical exhaustion) pre-to-post in each weekly yoga session across a 7-week yoga intervention.<sup>30</sup> However, evidence regarding *how* yoga brings about positive effects on emotions remains limited. To date, few studies have explicitly tested the mechanisms through which yoga operates. For example, a systematic review of mechanisms by which yoga may reduce stress identified only six studies that collectively tested three psychological mechanisms and four physiological mechanisms.<sup>2</sup>

\* Corresponding author at: Department of Psychological Sciences, University of Connecticut, Storrs, CT, 06269-1020, USA.

E-mail address: [Crystal.park@uconn.edu](mailto:Crystal.park@uconn.edu) (C.L. Park).

<https://doi.org/10.1016/j.ctim.2020.102354>

Received 9 November 2019; Received in revised form 23 February 2020; Accepted 24 February 2020

Available online 25 February 2020

0965-2299/ © 2020 Elsevier Ltd. All rights reserved.

Because yoga is a complex practice, many diverse pathways have been proposed to account for its salutary effects on emotional well-being.<sup>3</sup> Improvements in psychological resources are among the most commonly posited of these mechanisms.<sup>2</sup> Specific psychological resources that have been proposed to improve with the practice of yoga and mediate its effects on well-being include mindfulness, body consciousness, self-transcendence, spiritual peace, and social connectedness. Of these, mindfulness—sustaining awareness and acceptance without judgment—has most often been linked with yoga practice.<sup>5–7</sup> However, few studies have examined whether increased mindfulness mediate yoga's beneficial effects<sup>4</sup> and results are inconsistent.<sup>8</sup> For example, in a small study of participants in a residential yoga program, increases in mindfulness mediated effects on perceived stress and quality of life.<sup>9</sup> However, in another clinical trial for women with PTSD, mindfulness increased slightly in both assessment-only and yoga groups, but did *not* mediate the noted improvements in PTSD in the yoga group.<sup>10</sup> Thus, mindfulness may increase with yoga practice but whether these increases mediate yoga's effects remains unclear.

Little research is available on other proposed psychological mechanisms. Body consciousness—awareness of one's body, movements, and internal states—has been asserted to be fostered by yoga practice.<sup>9,11</sup> In one single-arm yoga intervention trial, women reduced their body objectification and higher amounts of practice were associated with improvements in body consciousness for both women and men.<sup>12</sup>

Yoga has a long history as a path to self-transcendence, defined as “awareness of being an integral part of the universe”, yet little research on this pathway has been conducted.<sup>13</sup> One study found that regular yoga practitioners, compared to non-practitioners, were higher in transcendence,<sup>14</sup> and an ethnographic fieldwork study described how yoga led to self-transcendence among prison inmates.<sup>15</sup> Similarly, despite the fact that yoga originated to develop contemplative states of consciousness and spirituality, few yoga studies have focused on spiritual change or its potential to mediate yoga's effects.<sup>16</sup> Yoga practitioners in several studies reported having begun yoga for physical health benefits, but continued their practices for spiritual reasons,<sup>17,18</sup> and an observational study found that higher levels of involvement in yoga were associated with higher levels of spirituality.<sup>6</sup>

Finally, social connectedness—a general sense of interpersonal connectedness with the social world—has been proposed as a mechanism by which yoga may lead to healthful outcomes, but is rarely measured in studies focused on yoga.<sup>19–22</sup> In two qualitative studies, yoga practitioners reported experiencing more positive relations with others as a result of their practice.<sup>21,22</sup> One small pilot study found some evidence for increased social connection in a sample of counselors.<sup>23</sup>

In sum, evidence that the beneficial effects of yoga interventions on salutary outcomes is mediated through increased psychological resources such as mindfulness, spirituality, and social connectedness, is surprisingly scarce. This lack of supportive evidence should not be interpreted as meaning that these resources do not mediate yoga's effects, but rather that a substantial gap in yoga research exists, which the

present study aimed to address. Specifically, we studied changes from just a single bout of yoga to understand whether psychological resources might change following yoga practice and how those changes relate to changes in emotions pre- to post- yoga.

## 2. The present study

As part of a larger project, we conducted a single session of yoga to validate our measure of yoga's essential characteristics.<sup>31</sup> For the present study, we used these data to conduct secondary analyses examining yoga's effects on potential mediators across an acute bout of yoga.<sup>31</sup> Our study had three main aims and one exploratory aim. We first aimed to determine how a single session of yoga influences emotional experience. Based on preliminary studies, we hypothesized that participants would experience both significant increases in positive emotion (defined as positive engagement, revitalization, and tranquility) and decreases in exhaustion (a moderate correlate of physical tiredness or lack of energy, which often decreases post-exercise) following a single session of yoga.<sup>32</sup> These emotional outcomes were selected for their relevance to brief exercise interventions that may be used to regulate acute positive mood and energy levels during periods of stress.

Our second study aim was to test how a set of psychological resources (proposed mechanisms of action for yoga interventions) changed across a single yoga session, hypothesizing that psychological resources will increase. Third, we aimed to test the extent to which these psychological resources, theorized as mechanisms of change, related to changes in any observed changes in exercise-induced emotion across the yoga session. We hypothesized that improvements in psychological resources would coincide with improvements in mood.

Finally, as an exploratory aim, we examined whether increases in psychological resources and improved exercise-induced emotions related to specific components of yoga. Yoga interventions comprise three primary dimensions: Vigor/movement, conscious breath regulation, and meditation/attention control.<sup>33</sup> Interventions vary greatly in the degree to which these dimensions are included, resulting in many different styles and types of yoga.<sup>3</sup> It has been theorized that these different components and emphases differentially influence the effects of the yoga, although little research to date has empirically tested this notion.<sup>33</sup> We examined whether specific aspects of yoga are more closely tied to changes in psychological resources and emotions.<sup>34</sup> A full theoretical model of mediated links between aspects of yoga, psychological resources, and emotion is shown in Fig. 1.

## 3. Method

### 3.1. Participants

Participants were required to be 18 years of age or older, be fluent in written and spoken English, and have participated in at least five yoga classes in the 2 months prior to research participation.<sup>144</sup>

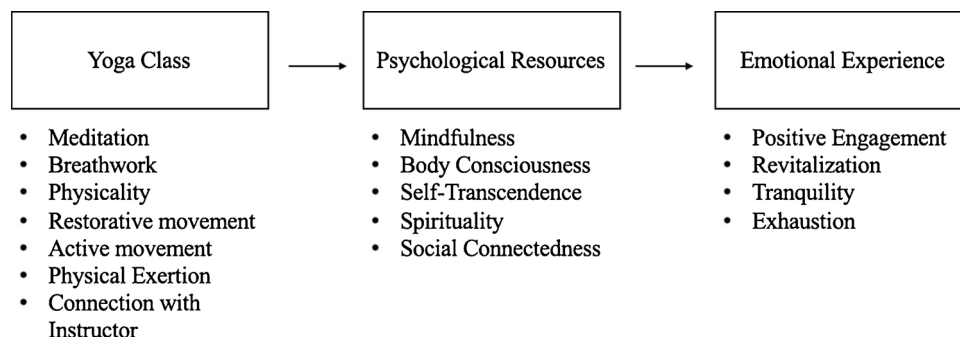


Fig. 1. Theoretical model of yoga's effects on emotion.

participants were included in this study.

### 3.2. Procedure

As part of a larger study, individual yoga classes were held at community partner facilities in three geographic regions (Boston, southeastern Connecticut, and San Diego). Each site offered different styles of yoga, instructors, and locations. Classes were closed to the public so that only research participants were in attendance. Recruitment was conducted through announcements, flyers, and word of mouth at local community partner yoga studios/centers. Participants were recruited through flyers at local yoga studios, advertisements on Craigslist, Facebook announcements, and word of mouth. At each of our 3 study sites, people interested in participating were screened for eligibility. Those eligible were randomized to a yoga class by the graduate research assistant using a random number table generated by a web-based computer program ([www.randomizer.org](http://www.randomizer.org)) and provided a date and time for their class. Neither the research assistant nor the participant had information regarding the type of yoga being assigned, just the date and time of the class.

At arrival for their class, participants provided informed consent and then completed informed consent and a set of pre-yoga session questionnaires. They participated in an hour-long yoga class. After the class, participants completed post-yoga questionnaires and received an honorarium (\$20). Because we aimed to include a wide variety of different types of yoga to maximize variance on the measure of yoga characteristics, a wide range of yoga types were included falling under the broad category of Hatha yoga: Ashtanga, Baptiste, Bikram, Forrest, Iyengar, Kripalu, Kundalini, Pranayama, Restorative, Vinyasa Flow, and Yin. The study was approved by the IRBs at all 3 sites.

### 3.3. Measures

We administered the following instruments both immediately prior to and immediately following each yoga class:

State Mindfulness Scale (SMS).<sup>35</sup> Twenty-one items tapping into a state of mindfulness were asked regarding the experience in the past hour (e.g., “I noticed emotions come and go”). Items were rated from 1 (not at all) to 5 (very well). Reliability and validity of the SMS is very good.<sup>35</sup>

The Private Body Consciousness (PBC) Subscale of the Body Consciousness Questionnaire (BCQ) assessed participants’ body awareness in the past hour.<sup>36</sup> The PBC Subscale consists of 5 items (e.g., “I was very aware of changes in my body temperature”) rated from 0 (extremely uncharacteristic) to 4 (extremely characteristic). The Private Body Consciousness subscale of the BCQ is a commonly used instrument for measuring body awareness that demonstrates adequate reliability and validity.<sup>37</sup>

The Self-Transcendence Subscale of the Temperament and Character Inventory (STS; 38) contains 15 items (e.g., “I often feel that I am a part of the spiritual force on which all life depends”) which were modified to be state-like in terms of experience in the past hour (e.g., “I felt as if I was a part of something with no limits or boundaries in time or space.”).<sup>38</sup> All were rated from 1 (definitely false) to 5 (definitely true). The STS has demonstrated adequate reliability and validity.<sup>38</sup>

The Peace Subscale of the FACIT-Sp consists of four items tapping into feelings of peacefulness and contentment. The items were keyed to refer to the past hour (e.g., “I feel a sense of harmony within myself.”). Items were rated from 0 (not at all) to 4 (very much). The Facit-Sp has demonstrated good reliability and validity in clinical studies.<sup>39</sup>

The Social Connectedness Scale (SCS) comprises 4 items (e.g., “I feel disconnected from the world around me”(reverse-scored)) with instructions to refer to the past hour.<sup>40</sup> Items were rated from 1 (strongly agree) to 6 (strongly disagree), all of which were modified to be state-like. The SCS has demonstrated satisfactory psychometric properties in past research.

The Exercise-Induced Feeling Inventory (EIFI) consists of 12 feelings which participants rate currently experiencing from 0 (do not feel) to 4 (feel very strongly). This instrument has four subscales (Positive Engagement, Revitalization, Tranquility and Physical Exhaustion), has good psychometrics, and has been used successfully in yoga research.<sup>32,29</sup>

The following were measured exclusively post-intervention:

The Essential Properties of Yoga Questionnaire (EPYQ) taps into core dimensions of yoga; for the present study, we assessed body awareness (i.e., focus on body and physical sensations), breathwork (i.e., focus on breath or breathing instruction), individual attention (i.e., feedback or support from instructor), meditation and mindfulness (i.e., emphasis or instruction on non-judgmental awareness or meditation), physicality (i.e., focus on balance, flexibility, and strength), active postures (i.e., attention to correcting posture or attempting difficult postures), and restorative postures (i.e., resting or modifying postures to be less difficult).<sup>31</sup> The EPYQ has demonstrated good reliability through internal consistency and test-retest reliability assessment.<sup>31</sup>

The Borg centiMax (CR100) is an analog scale assessing the extent to which the participant found the class physically taxing, rated from 0 to 100.<sup>41</sup> The Borg scale has excellent psychometric properties.<sup>41</sup>

The Therapist Warmth and Friendliness Subscale of the Vanderbilt Psychotherapy Process Scales (VPPS) assessed the yoga instructor’s display of friendliness, warmth, and personal involvement.<sup>42</sup> It consists of 5 items which we adapted to refer to the yoga instructor/student rather than a therapist/client (e.g., “Showed warmth and friendliness towards the student”) rated from 1 (not at all) to 5 (very much). The VPPS exhibits strong reliability and validity in a variety of therapeutic settings.<sup>43</sup>

### 3.4. Analytic plan

We used descriptive statistics to summarize baseline demographic characteristics of the sample. For our first and second aims, we used t-tests to determine if emotions and psychological resources, respectively, changed across the yoga session. For our third aim, to determine whether changes in the proposed mediators uniquely predicted changes in each emotion when considering all of them together, we first examined whether any demographic variables predicted residual change in any of the emotions, holding Time 1 scores constant, in order to include it as a covariate if necessary. We then calculated change scores (i.e., Time 2 – Time 1) for both our proposed mediator variables and each of the emotions. We then conducted a series of multiple regression analyses in which the change score for each emotion was simultaneously regressed on the change score of all five psychological resources. Finally, for our exploratory aim, we conducted a series of correlational analyses to determine the extent to which characteristics of the yoga session were associated with changes in each of the four emotions over the yoga session.

## 4. Results

### 4.1. Sample characteristics

The sample was largely female (78 %) and educated (29 % had a graduate degree and another 48 % had a bachelor’s degree). Most participants reported their race as White (82 %). Nine percent of participants identified as Latinx. The mean age of participants was 40.0 years ( $SD = 13.5$ ). Participants reported mean length of yoga practice was 7.1 years ( $SD = 7.0$ ).

### 4.2. Changes in emotions and potential psychological mechanisms across the yoga session

Testing our first aim, repeated-measures t-tests indicated that all four assessed emotions significantly improved across the hour of yoga

**Table 1**  
Pre-to-Post-Yoga Session Changes in Emotions and Psychological Resources (Item means).

	Pre-Yoga M (SD)	Post-Yoga M (SD)
<b>Emotions</b>		
Positive Engagement***	2.21 (.93)	2.47 (1.03)
Revitalization***	1.49 (.90)	2.58 (.94)
Tranquility***	2.23 (.91)	3.30 (.91)
Exhaustion***	1.46 (1.01)	.91 (.93)
<b>Psychological Resources</b>		
Mindfulness***	3.45 (.81)	4.29 (.57)
Body Consciousness***	2.17 (.75)	2.65 (.70)
Self-Transcendence***	2.51 (.95)	3.21 (1.03)
Spirituality***	2.59 (.93)	3.32 (.74)
Social Connectedness***	4.48 (.86)	4.79 (.89)

Note: \*\*\*p < .001.

(ps < .001). Results are shown in Table 1. Testing our second aim, t-tests indicated that all measured potential mechanisms increased significantly across the yoga session (ps < .001).

**4.3. Associations between pre-post-yoga session changes in proposed mediators with changes in emotions**

Our third aim was to test whether changes in each proposed mediator related to changes in each emotion. Results, shown in Table 2, indicated that all of the proposed mediators were consistently related to improved emotions across the yoga session with the exception of increases in body consciousness, which was significantly positively related to increased positive engagement but not related to revitalization, tranquility, or exhaustion.

To further examine this aim, we conducted a series of multiple regression analyses to determine whether changes in any of the proposed mediators uniquely predicted changes in each of the emotions when holding the other four psychological resources constant. First, we examined bivariate correlations among all of the demographic characteristics with changes in each of the emotions across the yoga session to determine if demographic variables should be considered covariates in regressions; none was statistically significant. Second, we examined bivariate correlations among all five psychological resources to determine the extent to which our proposed mediator measures were overlapping, which might suggest problematic multicollinearity for multiple regression analyses; we examined correlations both among baseline scores and among change scores in the five proposed mediators (see Table 3). Most of the baseline proposed mediator variables were correlated with others at modest levels; the highest correlation was between mindfulness and self-transcendence (r = .63). Similarly, most of the change scores for proposed mediator variables were correlated with others at modest levels; the highest correlation, again, was between change in mindfulness and change in self-transcendence, (r = .54).

Because preliminary analyses indicated that bivariate associations between psychological variables fell below the threshold for problematic multicollinearity, we proceeded to conduct a series of four regression analyses, one for change in each emotion, simultaneously

**Table 2**  
Bivariate Correlations of Pre-Post-Yoga Session Changes in Proposed Mediators with Pre-to Post-Yoga Session Changes in Emotions.

	Δ Positive Engagement	Δ Revitalization	Δ Tranquility	Δ Exhaustion
Δ Mindfulness	.31***	.39***	.38***	-.20*
Δ Body Consciousness	.18*	.12	.14	.04
Δ Self-Transcendence	.32***	.35***	.36***	-.20*
Δ Spirituality	.23**	.31***	.48***	-.19*
Δ Social Connectedness	.31***	.27**	.26**	-.18*

Note: \*\*\*p < .001; \*\*p < .01; \*p < .05.

entering change scores for all five proposed mediators. 44 Results, shown in Table 3, suggest that increased positive engagement was most strongly associated with increases in social connectedness, increased revitalization was largely driven by increased mindfulness, and increased tranquility was largely driven by increased spirituality. No potential mediators uniquely predicted changes in exhaustion (Table 4).

**4.4. Correlations between yoga session characteristics and pre-to-post-yoga session changes in emotions and proposed mediators**

Finally, to examine whether characteristics of the yoga session were associated with observed changes both in proposed mediators and in emotions, we conducted a series of bivariate correlations in which we examined relationships between core characteristics of the yoga (emphasis on postures, challenge, breathwork, meditation, exertion, teacher warmth) with changes in emotions and proposed mediators. Results, shown in Table 5, indicated that none of the yoga session characteristics were significantly associated with changes in mindfulness, social connectedness, or revitalization. However, yoga with a greater emphasis on restorative postures was associated with greater self-transcendence, spirituality and the emotion of tranquility while yoga with a greater emphasis on breathwork was associated with greater increases in body consciousness and self-transcendence. Higher engagement with the yoga teacher was also associated with greater increases in self-transcendence while greater physical effort was associated with more exhaustion. The yoga session’s emphasis on meditation, physicality and active postures were unrelated to any changes in proposed mechanisms.

**5. Discussion**

Our primary aim was to examine how five psychological resources (i.e., mindfulness, body consciousness, self-transcendence, spirituality, and social connectedness) previously proposed to mediate the effects of yoga on many indices of well-being, including emotions, increase in the course of a single session of yoga. Further, we aimed to determine whether those increases are associated with improvements in emotions across the yoga session. 3,19 As expected, each proposed mediator increased and all of the emotions improved from pre-to post-session. A small number of previous studies have noted significant change in psychological resources and positive and negative emotions following yoga practice, but few have measured multiple potential psychological resources as “mediators”; such analyses allow for comparing the strength of associations between various resources and emotional states. 29

Increases in all psychological resources were significantly associated with improvements in all emotions, with the exception of body consciousness, which was generally more weakly related to emotional improvements than were the other proposed mediators. When examining unique associations of changes in these resources with changes in emotions, controlling for changes in all other resources, a more nuanced picture emerged, with far fewer associations that varied by emotion. These findings were quite novel and remained somewhat robust, considering the intercorrelations among change in psychological resources. The key role that spirituality may play in producing positive

**Table 3**  
Bivariate correlations among baseline psychological resources (above the diagonal) and among pre-post change in psychological resources (below the diagonal).

	Mindfulness	Body Consciousness	Self-Transcendence	Spirituality	Social Connectedness
Δ Mindfulness	xx	.38***	.63***	.44***	.17*
Δ Body Consciousness	.28***	xx	.35***	.01	.13
Δ Self-Transcendence	.54***	.31***	xx	.32***	.17*
Δ Spirituality	.39***	.05	.31***	xx	.53***
Δ Social Connectedness	.31***	.14	.44***	.32***	xx

Note: \*\*\*p < .001; \*p < .05.

**Table 4**  
Regression Analyses of Changes in Proposed Mediators Predicting Changes in Emotions.

	Δ Positive Engagement			Δ Revitalization			Δ Tranquility			Δ Exhaustion		
	B	SEB	β	B	SEB	β	B	SEB	β	B	SEB	β
Δ Mindfulness	.136	.091	.148	.292	.114	.235*	.167	.104	.148	-.162	.142	.120
Δ Body Consciousness	.104	.077	.114	-.044	.095	-.038	.026	.088	.023	.172	.120	.128
Δ Self-Transcendence	.076	.078	.098	.167	.099	.171†	.147	.091	.154	-.105	.122	-.093
Δ Spirituality	.058	.090	.058	.187	.111	.148†	.464	.104	.369***	-.128	.141	-.086
Δ Social Connectedness	.284	.134	.191*	.156	.168	.083	.039	.157	.021	-.267	.208	-.123

Note: \*\*\*p < .001; \*p < .05; †p < .10.

**Table 5**  
Bivariate Correlations between Yoga Session Characteristics and Pre-to-Post-Yoga Session Changes in Proposed Mediators and Emotions.

	Δ Mindfulness	Δ Body Consciousness	Δ Self-Transcendence	Δ Spirituality	Δ Social Connectedness	Δ Positive Engagement	Δ Revitalization	Δ Tranquility	Δ Exhaustion
EPYQ Meditation	-.07	-.01	.03	.02	.02	.06	-.08	.09	.01
EPYQ Physicality	.06	.07	.03	-.08	-.08	.11	.11	.02	.11
EPYQ Restorative	.11	.09	.19*	.20*	.02	.09	.15	.20*	.03
EPYQ Active	-.03	.00	.11	-.01	-.13	.03	.16	.06	.04
EPYQ Breathwork	.07	.25**	.23**	-.01	.07	.14	.02	.16	.16
VPPS	.12	.04	.28***	.00	.00	.19*	.05	.16	.03
Borg	.08	-.05	.04	.03	.03	.03	.14	-.05	.20*

Note: \*\*\*p < .001; \*\*p < .01; \*p < .05.

emotional changes as a result of yoga is particularly noteworthy, as is the important role of social connection, factors rarely discussed in the context of yoga interventions. This notion that different types of positive emotional changes are associated with different potential mediators—and not just those usually proposed, such as mindfulness—is an intriguing one that should be investigated in future research conducted over a longer period of time.<sup>10</sup>

These results also provide some evidence that different aspects of yoga may target distinct psychological mechanisms of change. Indeed, evidence is emerging that various types of yoga may produce different health-related outcomes.<sup>45</sup> Our results suggest why this may be so—yoga varies tremendously in terms of its inclusion of and emphasis on different components such as exertion, meditation, and restoration. Our results suggest that even in a single session of yoga, these different emphases may bring about different results. In particular, we found that yoga emphasizing restoration and breathwork is most likely to bring about salutary changes in emotions and to potentiate psychological resources. Surprisingly, given the evidence supporting meditation’s beneficial effects on positive emotions, greater emphasis on meditation during yoga practice was not significantly associated with changes in any psychological resources nor in emotions.<sup>46</sup> The perceived warmth of the teacher was also associated with salutary changes; this factor is rarely discussed in yoga research but clearly warrants additional attention.

Although these results are rich in hypothesis generation for future research, several limitations must be considered. The study involved just a single session of yoga and the extent to which a single session can serve as an analog for a longer course of practice is unknown. However, other research has demonstrated that even a single session of yoga

exerts positive effects,<sup>45</sup> which is a promising finding, given the need for brief interventions that people can include in their busy lives. In addition, participants in the present study were all experienced yoga practitioners who may have already experienced many changes as a result of their practices; a single session of yoga might affect novices differently than regular practitioners. We were limited to examining a limited set of outcomes (emotions), while yoga practice has been shown to have salutary effects on a wide and diverse array of mental and physical health indicators beyond those included here. The extent to which similar findings may be manifest in studies using a broader range of outcomes (e.g., pain, disability, health behavior engagement) remains to be investigated.

The lack of a control group is also a limitation because we cannot be sure that yoga itself produced the change in emotions. It is possible that participating in research or the group setting or expectations related to emotional well-being may have produced some of the beneficial changes. Although it is unlikely that students were in classes with teachers that they knew or practiced with, and although we explained that all responses would be confidential and analyzed without personal identifiers, it is possible that participants exhibited response bias in trying to “look good” for the yoga teacher. In addition, many other factors unmeasured in the current study might have influenced the results, including the styles of yoga that participants currently practiced or have practiced in the past and participants’ medical histories (e.g., diagnoses, medications).

These results, then, remain quite preliminary and future research is needed to replicate and expand these findings. However, they have important implications for research aimed at understanding how yoga might bring about its noted effects. Different types of yoga appear to

work through different psychological mediators; different psychological mediators, in turn, influence different intervention outcomes. This complexity is both daunting and promising. Although successful study of these phenomena will require very thoughtful selection and measurement of yoga components and psychological mechanisms, this approach stands to greatly advance our understanding of yoga's effects and provide avenues for tailoring and optimizing yoga interventions.

#### CRedit authorship contribution statement

**Crystal L. Park:** Writing - original draft, Writing - review & editing. **Lucy Finkelstein-Fox:** Writing - original draft, Writing - review & editing. **Erik J. Groessl:** Writing - original draft, Writing - review & editing. **A. Rani Elwy:** Writing - original draft, Writing - review & editing. **Sharon Y. Lee:** Writing - original draft, Writing - review & editing.

#### Acknowledgement

The authors want to acknowledge the NIH/National Center for Complementary and Integrative Health to PI Crystal Park 1R01AT006466.

#### Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.ctim.2020.102354>.

#### References

- Gerber MM, Kilmer ED, Callahan JL. Psychotherapeutic yoga demonstrates immediate positive effects. *Pract Innov*. 2018;3:212–225.
- Riley KE, Park CL. How does yoga reduce stress? A systematic review of mechanisms of change and a guide to future inquiry. *Health Psychol Rev*. 2015;9:379–396.
- Gard T, Noggle JJ, Park CL, Vago DR, Wilson A. Potential self-regulatory mechanisms of yoga for psychological health. *Front Hum Neurosci*. 2014;8:770.
- Kinsler PA, Goehler LE, Taylor AG. How might yoga help depression? A neurobiological perspective. *Explor J Sci Heal*. 2012;8(2):118–126.
- Brisbon NM, Lowery GA. Mindfulness and levels of stress: A comparison of beginner and advanced hatha yoga practitioners. *J Relig Health*. 2009;50:931–941.
- Gaiswinkler L, Unterrainer HF. The relationship between yoga involvement, mindfulness and psychological wellbeing. *Complement Ther Med*. 2016;26:123–127.
- Hewett ZL, Ransdell LB, Gao Y, Petlichokoff LM, Lucas S. An examination of the effectiveness of an 8-week Bikram yoga program on mindfulness, perceived stress, and physical fitness. *J Exerc Sci Fit*. 2011;9(2):87–92.
- Shelov DV, Suchday S, Friedberg JP. A pilot study measuring the impact of yoga on the trait of mindfulness. *Behav Cogn Psychother*. 2009;37(5):595–598.
- Gard T, Brach N, Hölzel BK, Noggle JJ, Conboy LA, Lazar SW. Effects of a yoga-based intervention for young adults on quality of life and perceived stress: The potential mediating roles of mindfulness and self-compassion. *J Posit Psychol*. 2012;7:165–175.
- Dick AM, Niles BL, Street AE, DiMartino DM, Mitchell KS. Examining mechanisms of change in a yoga intervention for women: The influence of mindfulness, psychological flexibility, and emotion regulation on PTSD symptoms. *J Clin Psychol*. 2014;70:1170–1182.
- Neukirch N, Reid S, Shires A. Yoga for PTSD and the role of interoceptive awareness: A preliminary mixed-methods case series study. *Eur J Trauma Dissociation*. 2018;3:7–15. <https://doi.org/10.1016/j.ejtd.2018.10.003>.
- Impett EA, Daubenmier JJ, Hirschman AL. Minding the body: Yoga, embodiment, and well-being. *Sex Res Soc Policy J Nsrc*. 2006;3(4):39–48.
- Feuerstein G. *The yoga tradition: Its history, literature, philosophy and practice*. Prescott, AZ: Hohm Press; 2001.
- Fiori F, David N, Aglioti SM. Processing of proprioceptive and vestibular body signals and self-transcendence in Ashtanga yoga practitioners. *Front Hum Neurosci*. 2014;8:734.
- Griera M. Yoga in penitentiary settings: Transcendence, spirituality, and self-improvement. *Hum Stud*. 2017;40:77–100 doi: [s10746-016-9404-6](https://doi.org/10.1007/s10746-016-9404-6).
- Büssing A, Hestück A, Khalsa S, Ostermann T, Heusser P. Development of specific aspects of spirituality during a 6-month intensive yoga practice. *Evid Based Complement Altern Med*. 2012. <https://doi.org/10.1155/2012/98152>.
- Park CL, Riley KE, Besedin E, Stewart VM. Why practice yoga? Practitioners' motivations for starting and continuing yoga. *J Health Psychol*. 2016;21:887–896.
- Penman S, Cohen M, Stevens P, Jackson S. Yoga in Australia: Results of a national survey. *Int J Yoga*. 2012;5:92–101. <https://doi.org/10.4103/0973-6131.98217>.
- McCall MC. How might yoga work? An overview of potential underlying mechanisms. *J Yoga Phys Ther*. 2013;3(1):1.
- Meister K, Juckel G. A systematic review of mechanisms of change in body-oriented yoga in major depressive disorders. *Pharmacopsychiatry*. 2018;51(03):73–81.
- Kishida M, Mama Scherezade K, Larkey Linda K, Elavsky Steriani. "Yoga resets my inner peace barometer": A qualitative study illuminating the pathways of how yoga impacts one's relationship to oneself and to others. *Complement Ther Med*. 2018;40:215–221.
- Ross A, Bevans M, Friedmann E, Williams L, Thomas S. "I am a nice person when I do yoga!!!" A qualitative analysis of how yoga affects relationships. *J Holist Nurs*. 2013;32(2):67–77.
- Thompson Isabel A, Wolf Cheryl Pence, Mott Elisa, et al. Luna yoga: A wellness program for female counselors and counselors-in-training to foster self-awareness and connection. *J Creat Ment Health*. 2018;13:169–184.
- Dwivedi Umesh, Kumari Sony, Akhilesh K, Nagendra H. Well-being at workplace through mindfulness: Influence of yoga practice on positive affect and aggression. *Int Q J Res Ayurveda*. 2015;36:375–379.
- Kale D, Kumari S. Effect of 1-month yoga practice on positive-negative affect and attitude towards violence in schoolchildren: A randomized control study. *Int J Educ Psychol Res*. 2017;3:180–185.
- Chandwani KD, Thornton B, Perkins GH, et al. Yoga improves quality of life and benefit finding in women undergoing radiotherapy for breast cancer. *J Soc Integr Oncol*. 2010;8:43–55. <https://doi.org/10.2310/7200.2010.0002>.
- Uebelacker LA, Tremont G, Gillette LT, et al. Adjunctive yoga v. health education for persistent major depression: A randomized controlled trial. *Psychol Med*. 2017;47(12):2130–2142.
- Streeter CC, Whitfield TH, Owen L, et al. Effects of yoga versus walking on mood, anxiety, and brain GABA levels: A randomized controlled MRS study. *J Altern Complement Med*. 2010;16(11):1145–1152.
- Luu K, Hall P. Examining the acute effects of hatha yoga and mindfulness meditation on executive function and mood. *Mindfulness*. 2016;8(4):873–880. <https://doi.org/10.1007/s12671-016-0661-2>.
- Smith JA, Greer T, Sheets T, Watson S. Is there more to yoga than exercise? *Altern Ther Health Med*. 2011;17(3).
- Park CL, Elwy AR, Maiya M, et al. The essential properties of yoga questionnaire (EPYQ): Psychometric properties. *Int J Yoga Therap*. 2018;28(1):23–38.
- Gauvin L, Rejeski WJ. The exercise-induced feeling inventory: Development and initial validation. *Sport Psychol*. 1993;15:403–423.
- Schmalzl L, Powers C, Henje Blom E. Neurophysiological and neurocognitive mechanisms underlying the effects of yoga-based practices: Towards a comprehensive theoretical framework. *Front Hum Neurosci*. 2015;9:235.
- Schmalzl L, Powers C, Zanesco AP, Yetz N, Groessl EJ, Saron CD. The effect of movement-focused and breath-focused yoga practice on stress parameters and sustained attention: A randomized controlled pilot study. *Conscious Cogn*. 2018;65:109–125.
- Tanay G, Bernstein A. State mindfulness scale (SMS): Development and initial validation. *Psychol Assess*. 2013;25(4):1286–1299.
- Miller LC, Murphy R, Buss AH. Consciousness of body: Private and public. *J Pers Soc Psychol*. 1981;41(2):397–406.
- Mehling WE, Gopisetty V, Daubenmier J, Price CJ, Hecht FM, Stewart A. Body awareness: Construct and self-report measures. *PLoS One*. 2009;4(5):e5614. <https://doi.org/10.1371/journal.pone.0005614>.
- MacDonald DA, Holland D. Examination of the psychometric properties of the temperament and character inventory self-transcendence dimension. *Pers Individ Dif*. 2002;32(6):1013–1027.
- Murphy PE, Fitchett G, Peterman AH, Schover LR. A 3-factor model for the FACIT-Sp. *Psycho-Oncology*. 2008;17(9):908–916.
- Lee RM, Robbins SB. Measuring belongingness: The social connectedness and the social assurance scales. *J Couns Psychol*. 1995;42(2):232–241.
- Borg E, Kaijser L. A comparison between three rating scales for perceived exertion and two different work tests. *Scand J Med Sci Sports*. 2006;16(1):57–69.
- O'Malley SS, Suh CS, Strupp HH. The Vanderbilt Psychotherapy Process Scale: A report on the scale development and a process-out-come study. *J Consult Clin Psychol*. 1983;51:581–586.
- Suh CS, O'Malley SS, Strupp HH, Johnson ME. The Vanderbilt psychotherapy process scale (VPPS). *J Cogn Psychother*. 1989;3:123–154.
- Tabachnick BG, Fidell LS. *Using multivariate statistics*. 4th ed. Boston, MA: Allyn and Bacon; 2001.
- Sullivan M, Carberry A, Evans ES, Hall EE, Nepocatysh S. The effects of power and stretch yoga on affect and salivary cortisol in women. *J Health Psychol*. 2019;24:1658–1667.
- Fredrickson BL, Boulton AJ, Firestone AM, et al. Positive emotion correlates of meditation practice: A comparison of mindfulness meditation and loving-kindness meditation. *Mindfulness*. 2017;8:1623–1633. <https://doi.org/10.1007/s12671-017-0735-9>.