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Research Article

A Randomized Control Trial of the Effects of a Hatha Yoga Program on Psychological Well-Being

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Abstract

Hatha yoga is a common style of yoga used for physical, emotional, mental, and spiritual benefits, enhancing quality of life and well-being. The current study used a randomized control trial (RCT) to investigate whether completing an eight-week posture-based *Hatha* yoga program would lead to greater psychological benefits than taking part in an eight-week lecture series about the history and philosophy of yoga. Fifty-five participants (42 female, age range 18-32) completed five self-report measures both before and after an eight-week yoga-related intervention (*Hatha* yoga or yoga lectures). The self-report measures related to participants' affective state (Depression, Anxiety, and Stress Scale), emotion dysregulation (Difficulties in Emotion Regulation Scale), interoceptive awareness (Multidimensional Assessment of Interoceptive Awareness), trait mindfulness, (Five-Facet Mindfulness Questionnaire), and self-compassion (Self-Compassion Scale). All interventions were taught by the first author, a trained yoga instructor. Results indicated that those in the yoga program, but not in the education program, showed significant improvement on measures of stress, mindfulness, and interoception. Mediation analyses revealed that mindfulness was a mediator between yoga program and depression, anxiety, and stress. Emotion dysregulation

was a mediator between yoga program and both depression and stress. Finally, interoceptive awareness was a mediator between yoga program and depression. These results suggest that a short, posture-based yoga practice produces benefits in multiple areas of functioning with underlying mechanisms highlighting the importance of mindfulness, interoceptive awareness, and emotional regulation.

Keywords
Yoga; emotional regulation; self-compassion; mindfulness; interoception

1. Introduction

Yoga is a mind-body practice that originated in India approximately 5000 years ago [1, 2]. In the past decade, yoga has received considerable interest from researchers investigating potential physical and psychological benefits of yoga practice [3, 4]. *Hatha* yoga is a commonly practiced style of yoga. It translates to "forceful yoga" and originally included ascetics practicing extreme physical techniques (e.g., hanging upside down from a tree branch) to cleanse their bodies [5]. In what is considered the most important text on *Hatha* yoga, the *Hathapradīpika* [5, 6] describes four features including how to establish a practice (i.e., location, diet, ethics, cleansing), breath control techniques, 15 *asanas* (physical postures), and *mudras* (techniques designed to direct the breath and body's energy; [5]). The intensely physical nature of traditional *Hatha* yoga began with mainly seated postures for meditation, where an individual would choose one posture and practice it consistently, to a vast array of static and dynamic postures designed to be kind to the body [5]. *Hatha* Yoga has changed significantly since its origins from an intensely physical practice to one which is still predominantly physical, but uses comparatively gentle postures in addition to breath control techniques and meditation over a foundation of ethical living. This is largely similar to how *Hatha* yoga is practiced in Western society, with the exception that ethical living is considered important but is not often explicitly or frequently stated.

The psychological benefits of yoga practice are well-established and researchers are now able to examine more specific and sophisticated research questions. One important issue is determining how the different variables that are affected by yoga *interact.* More specifically, is the link between yoga practice and psychological wellbeing *direct*, or are other factors mediating this relationship? Recently, researchers have begun using mediation analyses to examine the relationships between the different variables affected by yoga. For example, Boni and colleagues [7] demonstrated that mindfulness mediates the relationship between practicing yoga and anxiety. In another study, Gard and colleagues [8] reported that the relationship between yoga intervention and both quality of life and perceived stress were mediated by self-compassion. Quality of life was also mediated by trait mindfulness [8]. These initial mediation studies suggest that the influence of yoga practice on mental health is complex and highlights the need for additional multivariate studies that utilize mediation models. Adding to the complexity of the relationship between yoga and mental health is the fact that the mechanisms underlying yoga's beneficial effects may vary based on the components of yoga being practiced. Current Western interpretations of yogic practices commonly incorporate three traditional features – physical postures (Sanskrit: *asanas*), breath regulation

(*pranayama*), and meditation. Studies incorporating all three of these features boast myriad benefits [3, 9, 10]. However, many Western yoga practitioners take part in yoga classes that focus primarily on physical postures. The challenge for researchers, therefore, is to examine whether an *asanas*-based yoga practice could influence cognitive, and emotional variables independent of formal breath-regulation training or meditation.

The goal of the current RCT study was to understand how the *asanas* of a yoga practice may contribute to benefits associated with mental health and well-being. An *asanas*-based practice was chosen to provide information on the physical aspect of a yoga practice. Most yoga literature focuses on *asanas*, meditation, and *pranayama* (breathwork) combined. There are studies that have individually investigated meditation, breathwork, and non-yoga physical activity; however, not on *asanas* exclusively. Understanding the contributions of each component of a yoga practice may be helpful to assist in catering practices to peoples' preferences, goals, and health concerns. It may also help practitioners elucidate how and when yoga may be used as an adjunct to treatment or may inform individuals' decisions on whether or not to pursue it as a personal practice.

Participants were randomly assigned to a *Hatha* yoga group or to an education group that learned about yoga, but did not actually practice it. A *Hatha* yoga intervention was used due to its foundation in traditional yogic philosophy and its popularity of practice in Western countries [6, 11, 12]. The RCT design used in the current study made it possible to quantify a number of psychological benefits associated with eight weeks of yoga practice. We hypothesized that the yoga classes, but not the educational workshop, would lead to improvements in depression, anxiety, stress, emotion dysregulation, mindfulness, interoceptive awareness, and self-compassion. For mediation analyses, we hypothesized that interoceptive awareness, trait mindfulness, and self-compassion would each be mediators for the relationships between yoga and depression, anxiety, stress, and emotion dysregulation. We also hypothesized a role for emotional regulation as a mediator for the relationships between yoga and depression, anxiety, and stress.

2. Methods

2.1 The Current Study

The current study used an RCT format to identify possible effects of well-being from an eight-week *Hatha* yoga program. An eight-week program was chosen to remain within a similar time frame as the Mindfulness-Based Stress Reduction (MBSR) program [13]; this duration was also consistent with previous research suggesting a minimum of eight weeks of a yoga intervention is required to detect changes (i.e., [4, 14-17]). The measurement of multiple psychological variables before and after a yoga intervention allowed us to determine whether practicing yoga would lead to improvements in participants' self-reported mental health and well-being. Self-reported mental health was measured with the Depression, Anxiety, and Stress Scale (DASS-42) [18]. Four additional questionnaires associated with well-being were included in order to examine how emotion dysregulation [19], trait mindfulness [20], interoceptive awareness [21], and self-compassion [22] changed following eight weeks of practicing yoga *asanas*. Scores from these measures were also used in additional analyses to determine if these constructs mediated the relationship between yoga practice and mental health (i.e., DASS-42 scores).

The rationale for using a yoga education lecture as the control condition was to provide participants with a cognitive-based understanding of yoga compared to an experiential somatic-

based practice of yoga. There was little overlap in content between the groups, as the history and philosophy of yoga were not provided in the Yoga group and the Workshop group did not engage in experiential yoga practices. The only overlap of information was during one Workshop class, where the names of a select few of the *asanas* were provided.

2.2 Participants

A total of 64 participants were recruited for this experiment, with 55 participants completing the study. The sample size was based on power analysis for a repeated-measures ANOVA (Within-Between Interaction) with estimated effect size $f = 0.2$ (to reflect the estimation of a low effect size), power = 0.80, and $p = 0.05$. Participants were between the ages of 18 and 32 (76% female) with little to no yoga or meditation experience in their lifetime. Most of the participants were university students in undergraduate or graduate programs ($n = 46$) and the remaining participants were not students and working full-time jobs ($n = 9$). Ethnicity varied, with 43% of participants identifying as White, 12.7% Chinese, 9% Filipino, 9% South Asian, 7.3% Latin-American, 7.3% Other, 5.5% South East Asian, 1.8% Arab/West Indian, 1.8% Black, and 1.8% Korean. Statistical analyses confirmed that the Yoga and Workshop groups did not differ on any demographic variable.

Participants were recruited by departmental emails distributed through the University of Manitoba, University of Winnipeg, University of Guelph, and University of Alberta. Electronic flyers were posted on social media platforms (Instagram and Facebook) through the University of Winnipeg Neuroscience Students' Association (UWNSA) and the University of Manitoba Science Students Association. Some participants were recruited through word-of-mouth by other participants in the study and through cascade distribution of the electronic flyer over social media platforms. Participants had little-to-no experience practicing yoga, meditation, or any other mind/body practice. This was defined as no more than 10 formal or informal classes in their lifetime and no more than five formal or informal classes in the past year. One formal class was defined as an in-person or live online session that was 60 minutes in length. One informal class included practicing yoga or meditation independently, watching videos, or following along with podcasts or apps for a 60-minute period. Further inclusion and exclusion criteria included participants who were not taking psychiatric medication at the time of the study, were fluent in English, and were between 18 and 32 years of age.

This study was held during peak COVID-19 pandemic periods. For this reason, the study was offered in an entirely online format. To account for potential biases related to the pandemic, other factors were taken into consideration. The time of day the yoga and workshop groups were offered were decided on by the participants using a calendar poll. This allowed participants to have agency and manage their schedules outside of the study. To account for possible greater psychological distress from the pandemic, the first author provided the opportunity for all participants to contact her confidentially to discuss any adverse effects. These are explained in more detail in the Results section. The first author also gave participants a list of mental health resources. There is the possibility that scores on the questionnaires may have been lower due to the pandemic. While this is not possible to verify, the authors note that there is the possibility that if there were no significant differences from the yoga intervention, it may be due to the study taking place during the peak of the pandemic. Online insurance was acquired to teach yoga to individuals across Canada in a remote

fashion. This study received ethics approval from the University of Manitoba Human Research Ethics Board (HS23343).

2.3 Study Flow

A summary of participant recruitment and experimental procedures is provided in Figure 1. Following recruitment, participants were sent a Qualtrics link (Qualtrics, Inc., Provo, UT) with the consent form and an option to agree or not agree to participate. Participants who agreed to participate in the study were then sent another Qualtrics link to complete five questionnaires online (see following section). The order in which the questionnaires were administered was randomized for each participant. Questionnaires were completed remotely and each participant was assigned a number. Participant names were not associated with their questionnaires and the authors were blind to their responses. Following completion of the five questionnaires, participants were randomly assigned to either the workshop or yoga group. Each group consisted of eight weekly, 60-minute sessions on either practicing yoga (yoga group) or learning about yoga (workshop group), for a total of eight hours. Data was collected in two stages, between February and April, 2021 and between April and June, 2021. The first stage was held over winter and spring months, beginning February 16th and ending April 1st, 2021. To accommodate the varying schedules of participants, multiple sections of each class were offered each week; three different times were offered for the yoga group and two different times were offered for the workshop group. To increase the number of participants, a second set of classes were held in spring and summer, beginning May 3rd and ending June 24th, 2021. Similar to the first session of classes, multiple sections of each class were offered each week to accommodate participant schedules; four different times for the yoga group and three different times for the workshop group.

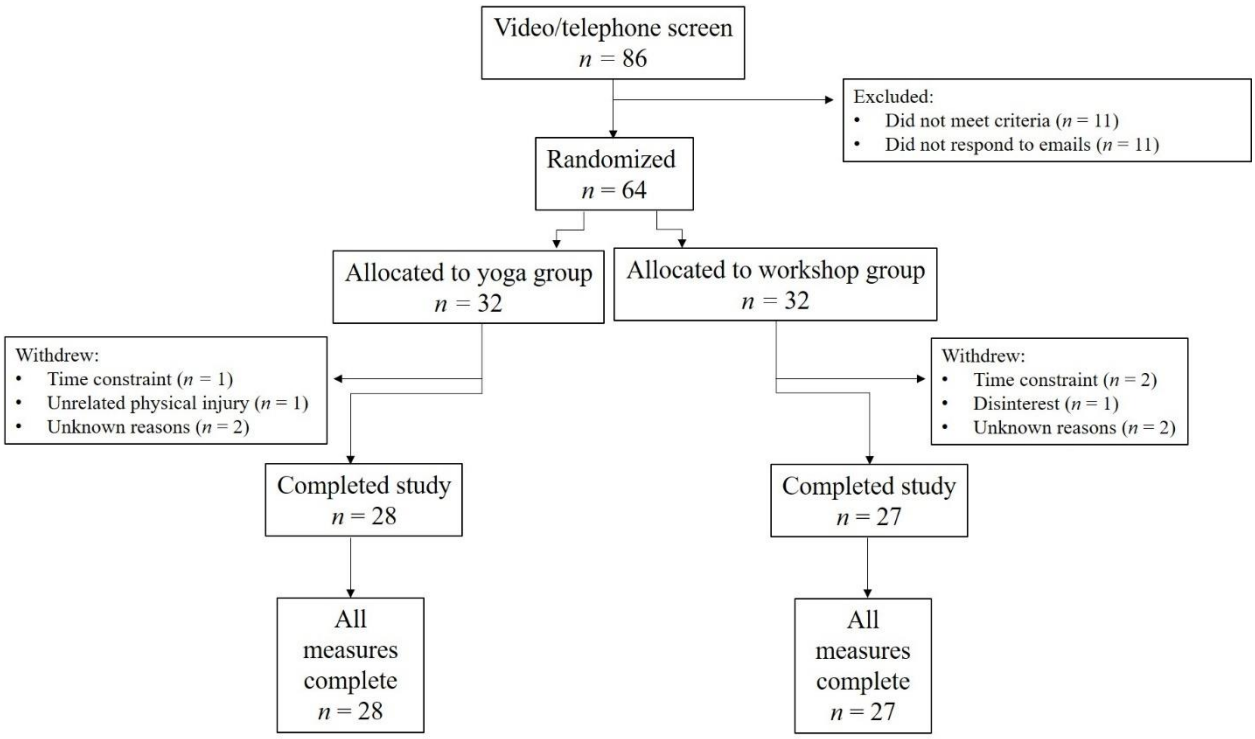

Figure 1 Flow of Participant Recruitment, Randomization, and Study Completion.

Thirty-two participants were placed in the workshop series and the other 32 participants in the yoga group using computer-generated random assignment. Random assignment was completed after all participants completed the questionnaires. It was not possible to complete a blind experiment on account of the first author teaching both groups. However, all measures were completed and submitted remotely and participants were assigned a computer-generated number. Participants were blind to their group assignment until after all pre-measures were complete. Participants were instructed not to engage in any other yoga, meditation, or mindfulness practice during the study until its completion. Attendance was monitored using a spreadsheet throughout the course of the study. Following the completion of the final class, participants were sent the same questionnaires through Qualtrics links. This online format ensured that the PI was blind to assessment outcomes during the experiment. Following the completion of the measures, participants were offered to participate in the group they were not assigned to during the study. One participant completed the Workshop group following the Yoga group and two participants completed the Yoga group following the Workshop group. In these cases, data were only included for a participant's first group.

2.4 Workshop and Yoga Programs

Both the workshop and yoga programs were designed and taught by the first author (Dr. Tracie Parkinson, Ph.D. C.Psych.), whose relevant qualifications include a Bachelor of Education (University of Winnipeg, 2013) and certification as a Registered Yoga Instructor (RYT-200, Chandra Yoga International, 2016). All classes were taught online using the Zoom video conferencing platform (Zoom Video Communications, Inc., San Jose, CA). Videos were enabled and remained on for every class for both groups. All yoga classes were recorded to maintain insurance standards in teaching online yoga classes. This information was relayed to all participants verbally during the recruitment phase and also included in the consent form. Workshop classes were only recorded in the event a participant was unable to attend a class. In the event this occurred, the recording was sent to them. The same was performed for participants in the yoga group. Participants were given seven days to watch the video prior to their next class, after which they were no longer provided access. Data was collected in two stages, between February and April, 2021 and between April and June, 2021. To accommodate the varying schedules of participants, multiple sections of each class were offered each week.

The yoga classes consisted of eight one-hour classes of *Hatha* yoga. Each class had the same format. Classes began with a verbal introduction of the theme and a description on how it would relate to the *asanas*. Participants were then instructed to set their own personal intention for the class. The rest of the class was subdivided into four parts. The first part included 12 *asanas* from *Pawanmuktasana* Series I, a group of simple *asanas* designed to develop body awareness, warm up joints, release bodily tension, and connect breath control with bodily movements. The second part included four rounds of *Suriya Namaskar*, a flow series of 10 *asanas* designed to warm up the body and link breath control with bodily movements. The third part consisted of the main *asanas* for the class that related to the theme. Specific instruction was provided on body positioning, entering and exiting each posture safely and appropriately, and providing alternatives for individuals with injuries or difficulties. This aspect of the class was designed to focus on body positioning, learning self-compassion and acceptance for limitations, developing meditative awareness on the body, and

learning to breathe calmly while holding postures. The fourth part of the class consisted of the same final posture, corpse pose (Sanskrit: *savasana*). During this posture, participants were instructed to lay on their backs, with eyes open or closed, and breathe. Following *savasana*, participants were instructed to come to a seated position. A closing statement was made, which included gratitude to participants for attending and illustrating a yoga tradition by bowing while saying "*namaste*". Additional information about the yoga class curriculum can be found in the Supplemental Materials.

The workshop series consisted of eight, one-hour classes on the history and philosophy of traditional yoga, with comparisons to modern interpretations (see Supplemental Materials for a more detailed description of the lecture series). Each class had the same format. A PowerPoint presentation on the topic was given, with videos, websites, and photographs incorporated to corroborate the concepts. At the end of each presentation, participants were instructed to reflect on the class by identifying what stood out most for them.

2.5 Questionnaires

Participants were provided with an internet link to complete five different self-report questionnaires through Qualtrics. These questionnaires included the Depression, Anxiety, and Stress Scale (DASS-42; [18]), Difficulties in Emotion Regulation Scale (DERS; [19]), Five-Facet Mindfulness Questionnaire (FFMQ; [20]), Multidimensional Assessment of Interoceptive Awareness (MAIA; [21]), and Self-Compassion Scale (SCS; [22]). Four of these questionnaires contain subscales (DERS, FFMQ, MAIA, and SCS). Reliability and validity on the subscales have either been updated in a newer version of the measure (i.e., MAIA) or are under investigation (i.e., Observing subscale of the FFMQ, and the DERS and SCS factor analysis). For this reason, only total scores were used in the present investigation. Analyzing the overall scores of the questionnaires with mediation analyses are novel in the research literature and more in-depth analyses on the subscales of each questionnaire may be a consideration for future studies.

The DASS-42 provides a measure of an individual's experiences with depression (e.g., "I couldn't seem to experience any positive feelings at all"), anxiety (e.g., "I was aware of dryness of my mouth"), and stress (e.g., "I found myself getting upset by quite trivial things") from the past week. This 42-item questionnaire asks participants to rank their responses on a 4-point Likert scale, from 0 ("Did not apply to me at all") to 3 ("Applied to me very much, or most of the time"). Scores are categorized as normal (Depression 0–9; Anxiety 0–7; Stress 0–14), mild (Depression 10–13; Anxiety 8–9; Stress 15–18), moderate (Depression 14–20; Anxiety 10–14; Stress 19–25), severe (Depression 21–27; Anxiety 15–19; Stress 26–33), or extremely severe (Depression 28+; Anxiety 20+; Stress 34+). Higher scores are consistent with greater severity of symptoms and lower scores corresponding to fewer symptoms in each category [18].

The DERS provides a measure of emotion dysregulation. For each of the 36 items, participants indicate the degree to which each statement applies to them using a 5-point Likert scale (from 1 "almost never [0–10%]" to 5 "almost always [91–100%]"). Higher scores on the DERS indicate greater emotion dysregulation; however, there is no clinical interpretation in the same way as the DASS-42. Scores on the DERS are between 36 and 180, and the authors reported averages of 77.99 (women) and 80.66 (men) in their non-clinical adult sample [19].

The FFMQ provides a measure of trait mindfulness, the tendency for an individual to pay attention with an open curiosity to the present moment. This 39-item questionnaire asks

participants to rank each item on a 5-point Likert scale (from "1 = never or very rarely true" to "5 = very often or always true") and provides an overall score for trait mindfulness. Higher scores on the FFMQ are indicative of greater self-reported trait mindfulness [20]. In Baer and colleagues' [23] validity study of the FFMQ, average scores on the FFMQ in a non-meditating adult sample were 126.19 and 150.02 for an adult sample of participants with meditation experience.

The MAIA provides a measure of interoceptive awareness, one's sensitivity to internal signals from the body. This 32-item questionnaire asks participants to rank on a 6-point Likert scale the degree to which each statement applies, providing an overall score. Higher scores on the MAIA indicate greater interoceptive awareness. In their sample, students of various somatic practices/therapies with body awareness components (i.e., yoga, Tai Chi, meditation) had an average score of 3.64, with a minimum score of 1 and maximum score of 5 [21].

The SCS provides a measure of self-compassion. This 26-item questionnaire asks participants to rank on a 5-point Likert scale the degree to which each statement applies, providing an overall measure of self-compassion. Higher scores on the SCS indicate greater self-compassion. Scores between 1.0–2.5 suggest low self-reported self-compassion, 2.5–3.5 suggests moderate self-compassion, and 3.5–5.0 suggests high self-compassion [22].

2.6 Data Analysis

All analyses were performed using IBM SPSS Statistics 28.0 software (IBM SPSS Software, Armonk NY). Three separate analyses were performed to analyze the data. Independent-samples *t*-tests were used to determine if there were any significant differences between the workshop and yoga *pre-program scores* on each self-report measure. ANCOVAs were used to determine if differences between pre- and post-program questionnaire scores were based on the program. Pre-program scores were used as a covariate. Paired-samples *t*-tests were used to identify if any changes seen between the two time points (before and after the program) were significantly different from zero when considering each program independently from one another. Change scores (post-score – pre-score) were used for this test.

Assumptions were tested for the independent-samples *t*-tests using the Shapiro-Wilk test ($p > 0.05$) for normality, Levene's Test ($p > 0.05$) for homogeneity of variances, and outliers ($p > 0.05$). The test was performed regardless of distribution due to the robustness of the test to this assumption. The non-parametric equivalent of this test, the Mann-Whitney *U* Test, was used if more than one outlier was present.

Assumptions were tested for each ANCOVA. These included homogeneity of regression slopes, normal distribution for standardized residuals for the programs and overall model, homoscedasticity (determined by visual inspection of standardized residuals plotted against predicted residuals), homogeneity of variances (Levene's test, $p > 0.05$), outliers (identified if standardized residuals were greater or lesser than three standard deviations), and linearity (visual inspection of scatterplots).

Assumptions for the paired-samples *t*-tests were also tested including normal distribution (Shapiro-Wilk test, $p > 0.05$) and outliers. Outliers were not modified or deleted from the questionnaire data because it is likely that they represented genuine variation in the data rather than being due to measurement error.

3. Results

A total of 55 participants completed the study (Workshop group *n* = 27; Yoga group *n* = 28) and all questionnaires, before and after the eight-week programs. The demographic characteristics of the participants are presented in Table 1. Information on participant enrolment, allocation, follow-up, and analysis are provided in Figure 1.

Table 1 Participant Demographic Information.

	Workshop Series	Yoga Program
Age: Mean ± SD (Range)	23.7 ± 4.1 (19–32)	22.0 ± 2.8 (18–30)
Gender	20 Female 7 Male	22 Female 5 Male 1 Agender
Ethnicity	1 Arab/West Indian 1 Black 2 Chinese 3 Filipino 2 Latin-American 2 Other 1 South East Asian 15 White	5 Chinese 2 Filipino 1 Korean 2 Latin-American 2 Other 5 South Asian 2 South East Asian 9 White
Yoga Experience in Lifetime: Mean Hours ± SD (Range)	6.6 ± 5.9 (0–25)	5.7 ± 5.9 (0–25)
Yoga Experience in Past Year: Mean Hours ± SD (Range)	1.0 ± 2.7 (0–10)	1.5 ± 4.0 (0–20)
Meditation Experience in Lifetime: Mean Hours ± SD (Range)	2.2 ± 3.0 (0–12)	2.7 ± 3.7 (0–15)
Meditation Experience in Past Year: Mean Hours ± SD (Range)	0.9 ± 1.5 (0–5)	0.7 ± 1.7 (0–8)

Three adverse events occurred throughout the study in the yoga group only. One participant reported a physical injury that was unrelated to practicing yoga. This participant withdrew from the study after two classes due to an inability to engage in most of the postures. A second participant reported neck pain while practicing one specific posture. After a conversation with this participant, additional neck modifications were provided discreetly to all participants in all yoga classes. This was done to address possible similar concerns with other participants and also to maintain confidentiality of the individual who experienced the difficulty. A third participant reported emotional difficulties during a specific posture. These difficulties were validated and normalized, and detailed recommendations were provided for this participant confidentially.

In the yoga group, 100% of participants attended and/or watched the video of a minimum of six classes; one participant was unable to attend or watch the videos of two classes. In the workshop

group, 74.7% of participants attended and/or watched the video of a minimum of six classes. No participants in this group missed both a class and video. Video engagement was monitored through participant self-report. An independent-samples *t*-test was used to determine if there were any significant differences in class attendance between the two groups. The yoga group attended more classes than the workshop group ($t(53) = -2.688$; $p = 0.010$) and the workshop group watched significantly more videos than the yoga group ($t(53) = 2.946$; $p = 0.005$). The reason for this difference is unclear, although we speculate that during COVID, listening to a lecture over video by university students was common, whereas participating in a yoga class over video compelled greater attendance due to more active engagement. Importantly, there was no significant difference in absenteeism between the yoga and workshop group ($t(53) = -1.00$; $p = 0.326$).

3.1 Questionnaire Analyses: Total Scores

A summary of participant total scores on each questionnaire is provided in Table 2.

Table 2 Questionnaire Results.

	Pre-Program (M ± SD)		Post-Program (M ± SD)	
Questionnaire	Workshop	Yoga	Workshop	Yoga
DASS-42: Depression	23.62 ± 9.63	26.32 ± 10.36	22.92 ± 9.64	21.57 ± 6.97
DASS-42: Anxiety	21.77 ± 8.31	24.14 ± 8.35	21.15 ± 6.64	20.68 ± 6.16
DASS-42: Stress*	27.35 ± 10.07	29.57 ± 8.56	27.12 ± 8.59	24.82 ± 7.52
DERS	93.96 ± 20.11	93.71 ± 25.91	90.73 ± 22.58	80.75 ± 16.99
FFMQ**	2.85 ± 0.49	3.07 ± 0.50	2.89 ± 0.39	3.27 ± 0.51
MAIA***	2.34 ± 0.57	2.44 ± 0.06	2.41 ± 0.80	2.95 ± 0.70
SCS	2.85 ± 0.57	2.97 ± 0.60	2.83 ± 0.60	3.07 ± 0.64

*ANCOVA significant. $F(1, 43) = 5.023$; $p = 0.029$; $\eta^2 = 0.090$. Yoga group had lower scores on stress after the intervention.

**ANCOVA significant. $F(1, 51) = 6.528$; $p = 0.014$; $\eta^2 = 0.113$. Yoga group had greater scores on trait mindfulness after the intervention.

***ANCOVA significant. $F(1, 51) = 9.541$; $p = 0.003$; $\eta^2 = 0.158$. Yoga group had greater scores on interoception after the intervention.

3.1.1 Depression, Anxiety, and Stress

Results of the DASS-42 are depicted in Figure 2, including mean and standard deviation for both the yoga and workshop groups. Independent-samples *t*-tests demonstrated no statistically significant difference between the yoga and workshop group pre-scores on the Depression ($t(52) = -0.992$; $p = 0.326$), Anxiety ($t(52) = -1.047$; $p = 0.300$), or Stress ($t(52) = -0.877$; $p = 0.384$) scales. Results of the ANCOVA, after adjustment for pre-program DASS-42 score, demonstrate that there was a significant effect for Stress ($F(1, 43) = 5.023$; $p = 0.029$; $\eta^2 = 0.090$). Although there was no significant difference for Depression, ($F(1, 51) = 3.731$; $p = 0.059$; $\eta^2 = 0.068$), it was marginal and in the predicted direction. It is possible that future studies using larger samples may explore the impacts of yoga on depression. No significant difference was observed for Anxiety ($F(1, 43) = 1.803$; $p = 0.185$; $\eta^2 = 0.034$).

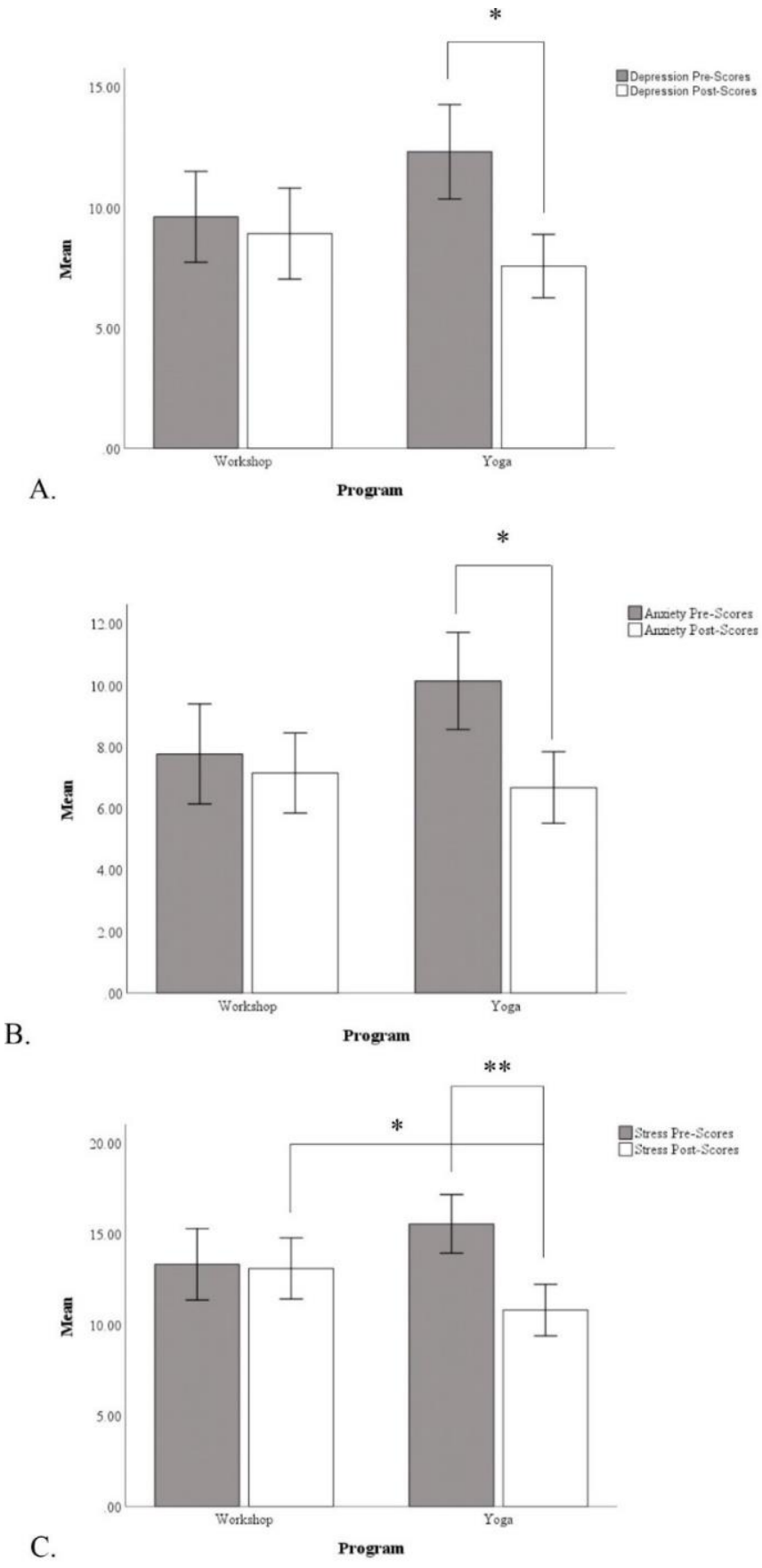

Figure 2 DASS-42 Mean Scores with Standard Error Bars. Note. Significant results indicated by * ($p < 0.05$) and ** ($p < 0.001$).

Paired-samples *t*-tests demonstrate that participant Depression (M = -4.750; 95% CI [-7.411, -2.089]; *t*(27) = -3.663; *p* = 0.001; *d* = -0.692), Anxiety (M = -3.464; 95% CI [-6.187, -0.742]; *t*(27) = -2.611; *p* = 0.015; *d* = -0.493), and Stress scores (M = -4.750; 95% CI [-7.269, -2.231]; *t*(27) = -3.869; *p* < 0.001; *d* = -0.731) all significantly decreased post-program compared to their pre-program scores. In contrast, no significant differences were found in the pre- vs. post-program comparisons for the Workshop group (all *t*-values < 1; *p* > 0.05).

3.1.2 Emotion Dysregulation

The overall scores on the DERS, including mean and standard deviation for both the yoga and workshop groups, are depicted in Figure 3. There was no significant difference between the yoga and workshop group DERS pre-scores (*t*(52) = 0.039; *p* = 0.969). ANCOVA demonstrated that there was no statistically significant difference between the yoga and workshop programs (*t* < 1; *p* > 0.05). A paired-samples *t*-test showed that participant DERS scores significantly decreased post-Yoga program compared to their pre-program scores (M = -12.964; 95% CI [-23.190, -2.739]; *t*(27) = -2.601; *p* = 0.015; *d* = -0.492). For the Workshop group, post-program DERS scores did not significantly differ from their pre-program scores (*t* < 1; *p* > 0.05).

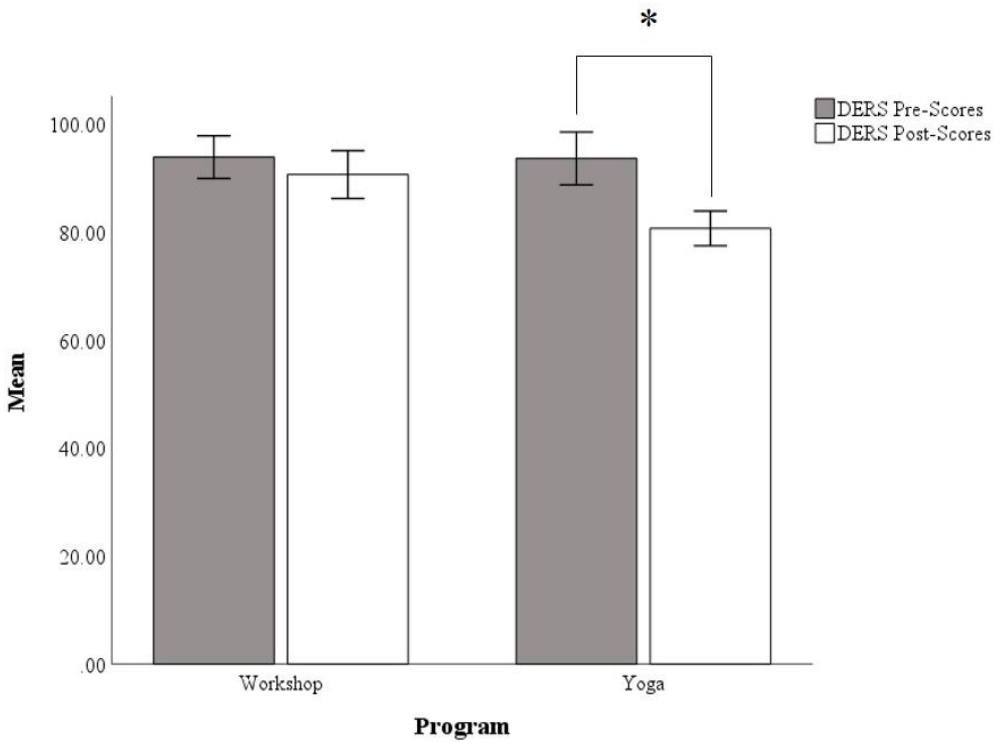

Figure 3 DERS Score Summary (Mean ± SD). Note. Significant result indicated by * (p < 0.05).

3.1.3 Trait Mindfulness

The results for the FFMQ are depicted in Figure 4. There was no significant difference between yoga and workshop FFMQ Total pre-scores using an independent-samples *t*-test (*t*(52) = -1.689; *p* = 0.097). ANCOVA demonstrated that there was a statistically significant difference between the yoga and workshop programs (*F*(1, 51) = 6.528; *p* = 0.014; η^2 = 0.113). A paired-samples *t*-test for the

Yoga group demonstrated that FFMQ scores significantly increased following the eight-week yoga program (M = 0.198; 95% CI [0.0495, 0.346]; $t(27) = 2.737$; $p = 0.011$; $d = 0.517$). No significant change was seen from pre to post program FFMQ scores in the workshop group ($t < 1$; $p > 0.05$).

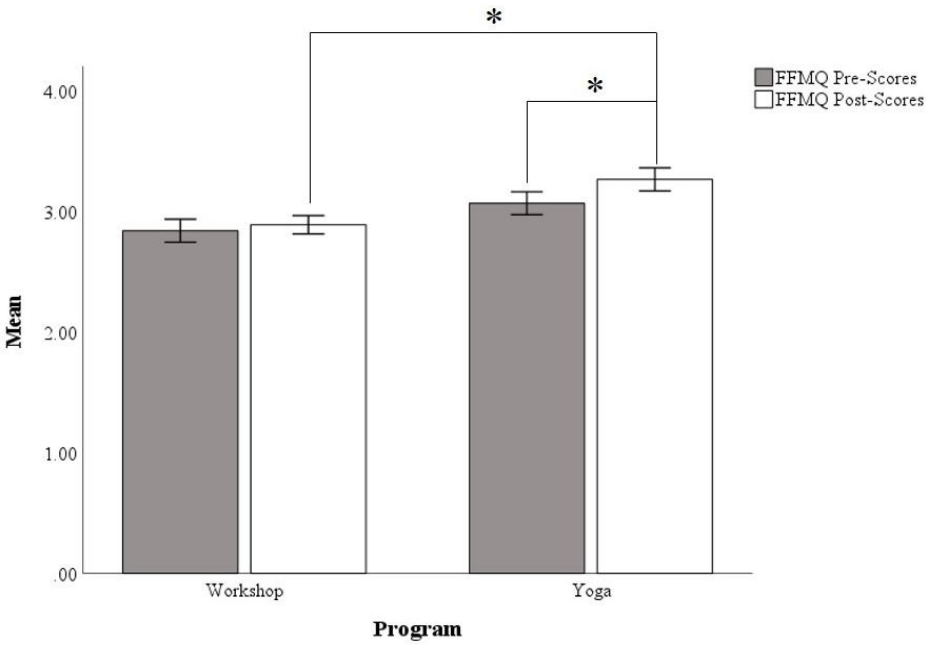

Figure 4 FFMQ Score Summary (Mean ± SD). Note. Significance is denoted using * ($p < 0.05$) and ** ($p < 0.01$).

3.1.4 Interoceptive Awareness

No significant difference was found between groups on MAIA total pre-scores ($t(52) = -0.675$; $p = 0.502$) using independent samples *t*-test (Figure 5). ANCOVA demonstrated a statistically significant difference between the yoga and workshop programs ($F(1, 51) = 9.541$; $p = 0.003$; $\eta^2 = 0.158$). Participant MAIA scores in the Yoga group significantly increased post-program compared to their pre-program scores, as seen from a paired-samples *t*-test (M = 0.502; 95% CI [0.324, 0.679]; $t(27) = 5.820$; $p < 0.01$; $d = 1.100$). For the paired-samples *t*-test in the Workshop group, post-program MAIA scores did not significantly differ from their pre-program scores ($t < 1$; $p > 0.05$).

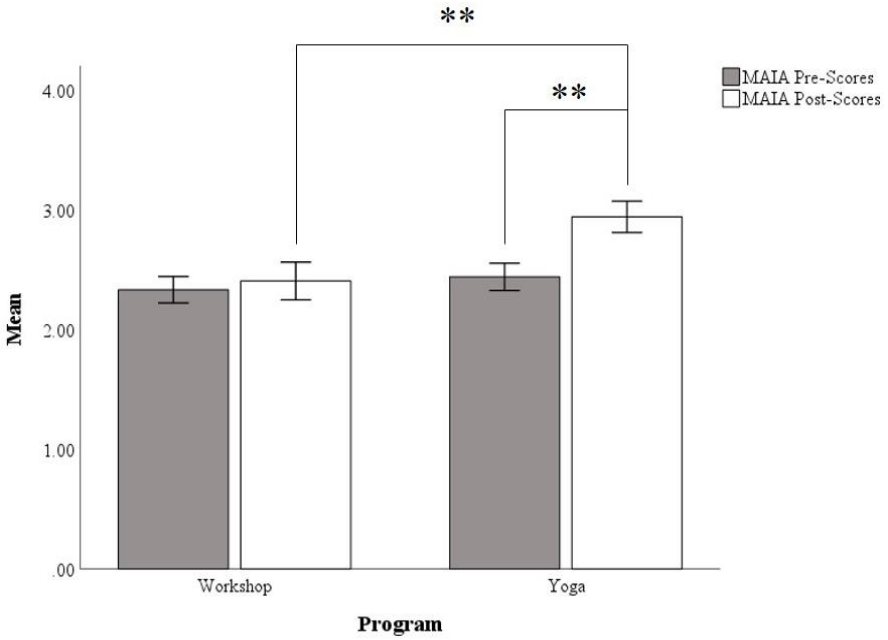

Figure 5 MAIA Score Summary (Mean ± SD). Note. Significance is denoted using * ($p < 0.05$) and ** ($p < 0.01$).

3.1.5 Self-Compassion

The results for the SCS are depicted in Figure 6. An Independent Samples *t*-Test demonstrated no significant difference between groups on the SCS total pre-scores ($t(52) = 0.149$; $p = 0.882$). After adjustment for pre-program SCS scores, there was no statistically significant difference between the yoga and workshop programs using an ANCOVA ($F(1, 51) = 1.249$; $p = 0.269$; $\eta^2 = 0.024$). For the Yoga group paired-samples *t*-test, participant SCS total scores significantly increased post-program compared to their pre-program scores (M = 0.245; 95% CI [0.0944, 0.395]; $t(27) = 3.341$; $p = 0.002$; $d = 0.631$). For the Workshop group, post-program SCS scores did not significantly differ from their pre-program scores using paired-samples *t* -test ($t < 1$; $p > 0.05$).

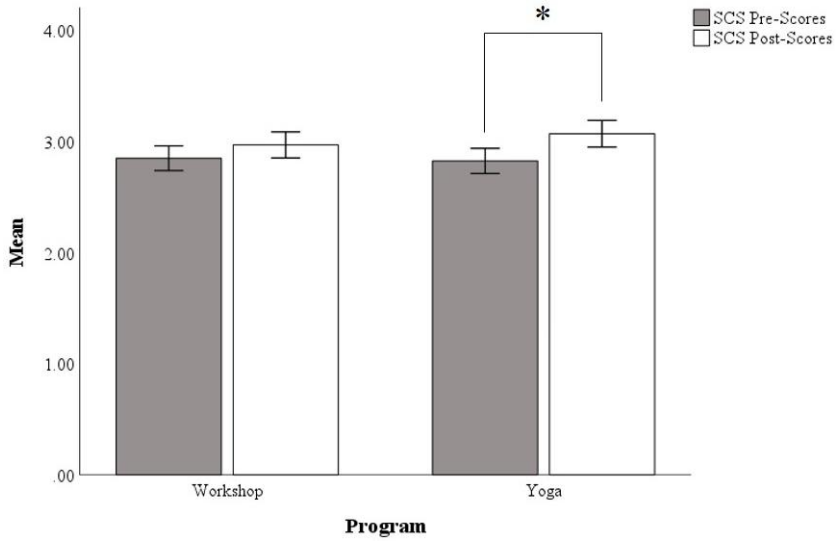

Figure 6 SCS Score Summary (Mean ± SD). Note. Significance is denoted using * ($p < 0.05$) and ** ($p < 0.01$).

3.2 Mediation

Mediation analyses were performed using PROCESS v3.5 in SPSS. Mediation in this context sought to understand which components of yoga (i.e., trait mindfulness, interoception, self-compassion) contributed to its benefits (i.e., reducing depression, anxiety, and stress, and improving emotional regulation). Fifteen mediation models were tested. In each model, yoga program represented the predictor. The outcomes were depression, anxiety, stress, and/or emotion dysregulation, as indicated by scores on the DASS-42 or DERS. Mediators were trait mindfulness (FFMQ), interoception (MAIA), self-compassion (SCS), or emotion dysregulation (DERS). Mindfulness, interoception, and self-compassion were chosen as mediators because they represent essential components of a yoga practice that have been shown to contribute to positive psychological outcomes, including depression, anxiety, and stress. Depression, anxiety, and stress were chosen as outcomes because of their symptomatic nature that relate to mental health conditions (i.e., depression, stress, trauma) and have been shown to be improved by changes in mindfulness, interoception, and self-compassion. The scores of the DERS were used as both an outcome and mediator because emotional regulation can be seen as both a symptom of a disorders (i.e., trauma, Borderline Personality Disorder) and a method of intervention (i.e., Dialectical Behaviour Therapy). Pre-scores for the mediator and outcome were included as covariates. Seven of these models were significant.

The first three models investigated whether trait mindfulness mediated the relationship between yoga program and depression, anxiety, and stress (Figure 7). In the first model, yoga program represented the predictor, depression post-scores on the DASS-42 represented the outcome, and trait mindfulness total post-scores on the FFMQ represented the mediator. Depression pre-scores on the DASS-42 and total FFMQ pre-scores were used as covariates. The second and third models were identical to this model, but used anxiety and stress scores as outcomes. All models were significant and demonstrated mediation, indicating that trait mindfulness mediates the relationship between yoga intervention and depression (Indirect effect = -2.18; $p < 0.001$; $R^2 = 0.66$; 95% CI [-4.46, -0.52]), anxiety (Indirect effect = -1.17; $p < 0.001$; $R^2 = 0.51$; 95% CI [-2.58, -0.10]), and stress (Indirect effect = -2.50; $p < 0.001$; $R^2 = 0.64$; 95% CI [-5.06, -0.57]) scores.

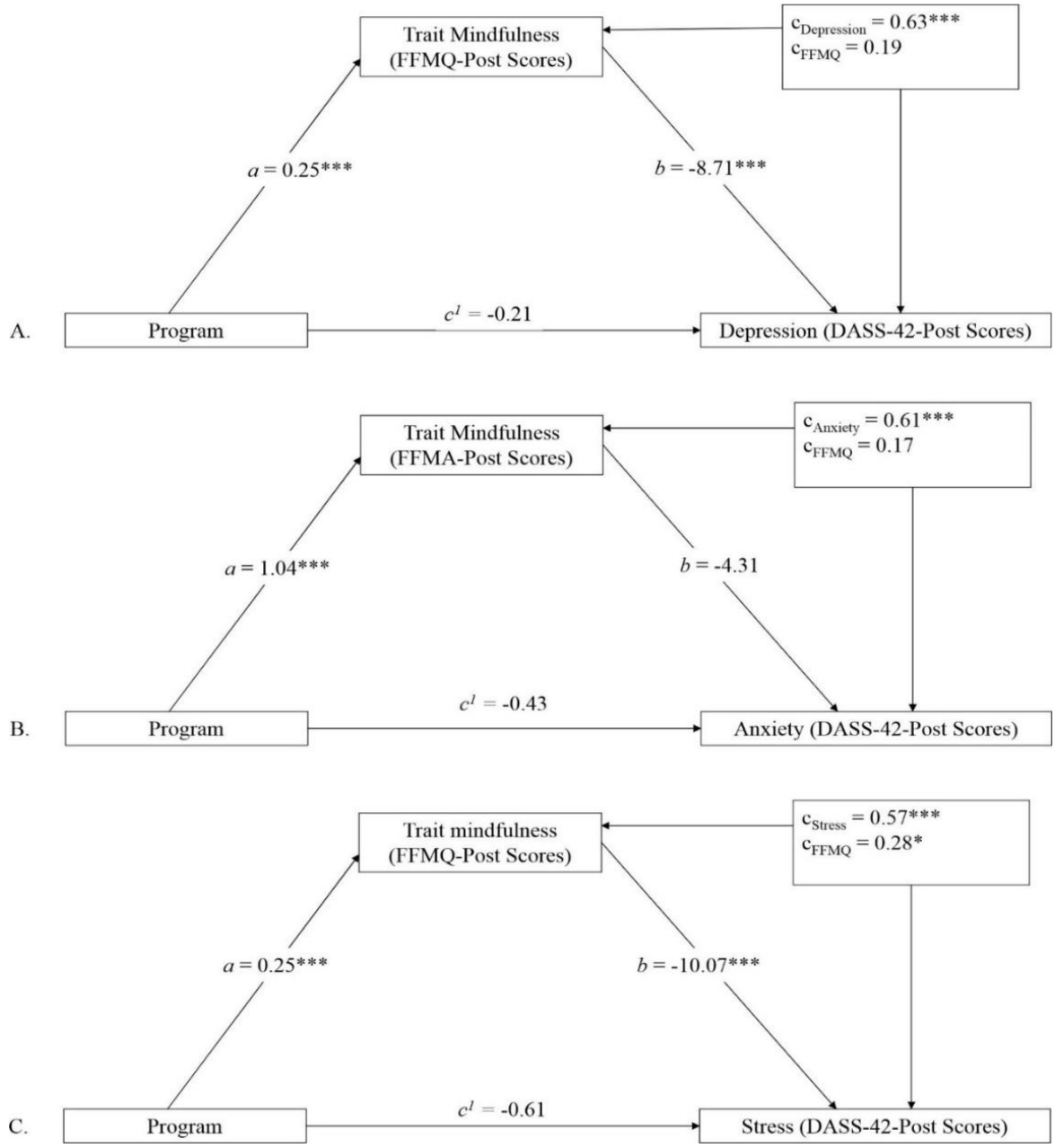

Figure 7 The Relationship Between Program and Depression (A), Anxiety (B), and Stress (C) Fully Mediated by Trait Mindfulness. Note. Significance is indicated by * ($p < 0.05$), ** ($p < 0.01$), or *** ($p < 0.001$). No asterisk indicates a non-significant finding. Covariates are represented as, "$c_{depression}$", "$c_{anxiety}$", and "c_{stress}".

The next model investigated whether trait mindfulness mediated the relationship between yoga program and emotion dysregulation (DERS scores). This model was also significant (Indirect effect = -4.96; $p < 0.001$; $R^2 = 0.55$; 95% CI [-10.42, -0.83]). Similar to the first three models, pre-program scores for the mediator and outcome were used (Figure 8). This model suggests that trait mindfulness mediates the relationship between yoga intervention and emotion dysregulation scores.

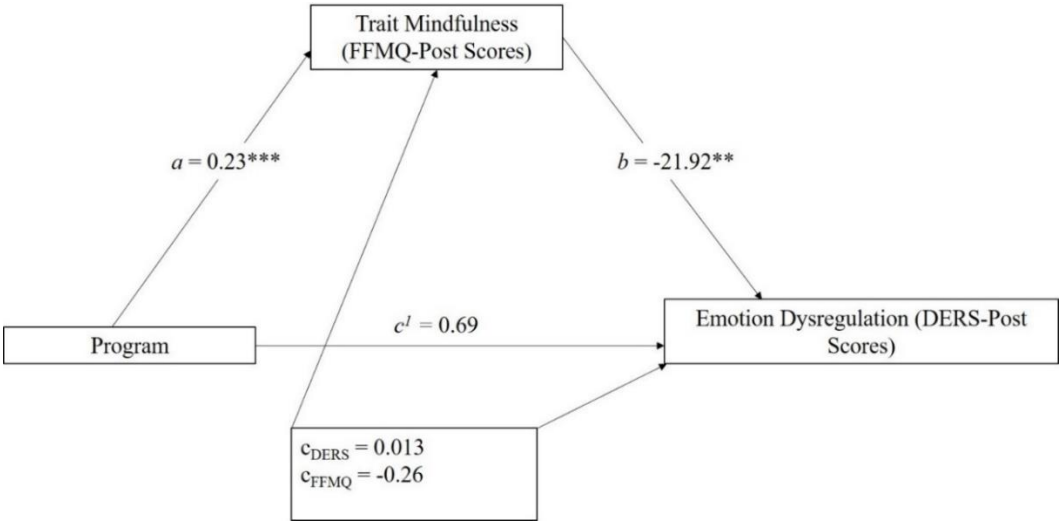

Figure 8 The Relationship Between Program and Emotional Regulation Fully Mediated by Trait Mindfulness. Note. Significance is denoted with ** ($p < 0.01$) or *** ($p < 0.001$). No asterisk indicates a non-significant finding.

The next four models investigated whether interoceptive awareness mediated yoga's effects on depression, anxiety, stress or emotion dysregulation scores. These models addressed the possibility that interoceptive awareness is one of the mechanisms involved in improving mood and emotional regulation. In these models, interoceptive awareness was used as the mediator using MAIA post-scores. The four models used one of depression (DASS-42 Depression), anxiety (DASS-42 Anxiety), stress (DASS-42 Stress), or emotion dysregulation (DERS) post-scores as outcomes. Pre-program scores for the mediator and outcome were used as covariates in each model. Only the first model, with depression scores as the outcome, was significant (Indirect effect = -1.55; $p < 0.001$; $R^2 = 0.61$; 95% CI [-3.78, -0.020]). This model suggests that interoceptive awareness mediates the relationship between yoga and depression scores (Figure 9).

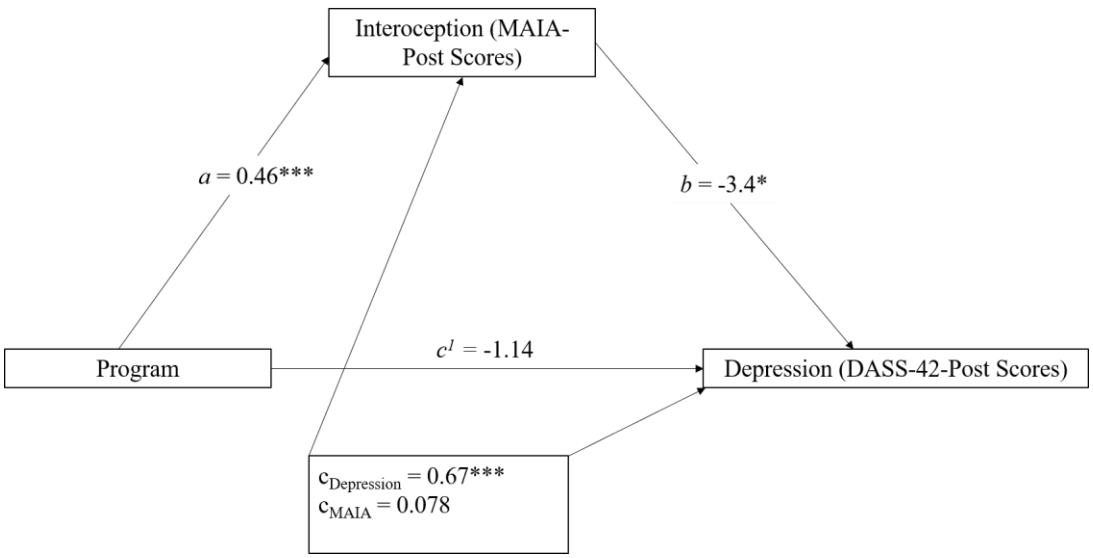

Figure 9 The Relationship Between Program and Depression While Holding Pre-Scores Constant is Fully Mediated by Interoceptive Awareness. Note. Significance is denoted with * ($p < 0.05$) or *** ($p < 0.001$). No asterisk indicates a non-significant finding.

The last three models all used emotion dysregulation (DERS post-scores) as the mediator, with depression, anxiety, and stress as outcomes. The models with depression (Indirect effect = -2.01; $p < 0.001$; $R^2 = 0.67$; 95% CI [-3.91, -0.38]) and stress (Indirect effect = -1.83; $p < 0.001$; $R^2 = 0.60$; 95% CI [-3.59, -0.35]) for outcomes were significant and demonstrated mediation (Figure 10). The model with anxiety as an outcome was not significant (95% CI [-1.89, 0.15]).

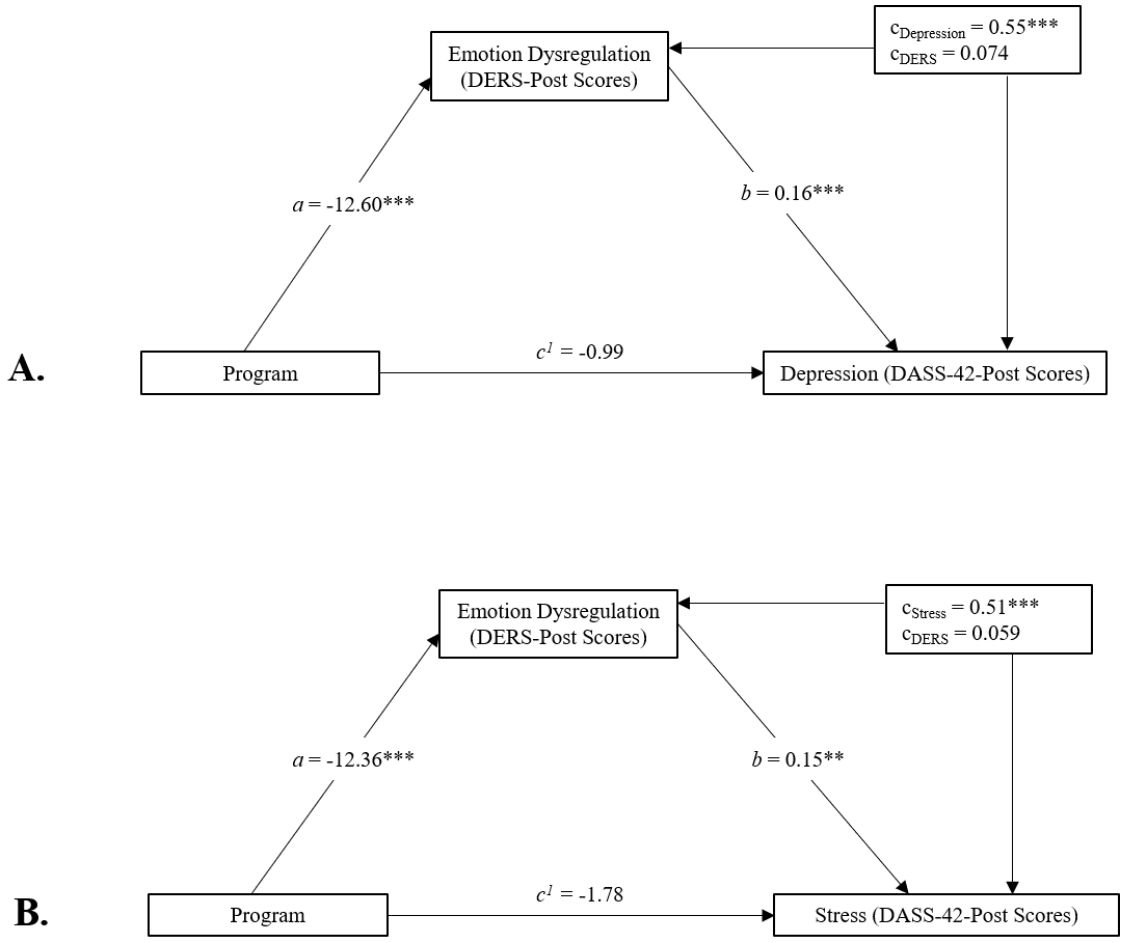

Figure 10 The Relationship Between Program and Depression (A) and Stress (B) Fully Mediated by Emotion Dysregulation While Keeping Pre-Scores Constant. Note. Significance is denoted with ** ($p < 0.01$) or *** ($p < 0.001$). No asterisks indicate a non-significant finding.

The remaining four models all used self-compassion as a mediator (SCS total score). The outcomes were the same as listed for the previous models. Post-scores were used for the mediator and outcome and pre-scores were used as covariates. No mediation was observed in any of these models.

4. Discussion

The results of the current study indicate that eight weeks of an *asanas*-based yoga practice leads to quantifiable improvements in mental health and well-being. When comparing participants within groups, the yoga participants demonstrated reduced depression, anxiety, stress, and emotion dysregulation, with enhanced trait mindfulness, interoceptive awareness, and self-compassion. In

contrast, the workshop participants demonstrated no significant differences on these variables after the program. When comparing the yoga and workshop groups, participants in the yoga group demonstrated improved stress, trait mindfulness and interoceptive awareness. Overall, these results suggest that engaging in a short-term *asanas*-based yoga practice produces benefits in multiple areas of psychological functioning.

These results are consistent with many other studies in the research literature. A recent Randomized Control Trial (RCT) study using a 12-week Kripalu yoga intervention that included *asanas* (physical postures), *pranayama* (breath regulation), meditation, relaxation, and didactic sessions on yoga philosophy found that interoceptive awareness and spiritual well-being improved eight weeks into the intervention; stress reactivity and mindfulness improved after 12 weeks [4]. Other RCT-based experiments have demonstrated that yoga leads to reduced depression [24-26], anxiety [3, 27] and perceived stress [8, 28-33], and increased interoceptive awareness [34], mindfulness [8, 35-38], emotional regulation [9, 39, 40], self-compassion [8, 39, 41], and quality of life [8]. These studies, alongside the current study, suggest that relatively brief yoga programs can produce a variety of psychological and physical benefits.

Although the observed improvements in depression and anxiety were consistent with our hypotheses, it is important to note that such improvements are not consistent across all studies. Decreased depression and anxiety scores have been reported in many instances [26, 27, 42-49]; however, other studies have shown no effect of yoga practice [50-53]. It is unclear what accounts for these differences. One possible explanation may be expectancy effects. Uebelacker and colleagues [54] reported that the higher a participant's expectations for the effectiveness of yoga as a treatment for depression associated with lower scores of depressive symptomology. Pre-conceived beliefs about treatment efficacy may be a fascinating area of exploration in the context of yoga as an adjunct therapy. It is unclear whether this factor influenced the current results.

The current study also suggests that a short-term yoga intervention reduces stress. This finding is consistent with other experiments demonstrating lower stress following a yoga intervention in an RCT. Previous research has noted reductions in perceived stress following yoga interventions featuring *asanas*, *pranayama*, and meditation [8, 55, 56]; other studies have reported similar reductions in stress following interventions consisting only of *asanas* [57]. Effects have also been reported after interventions of variable lengths including eight [45, 58] and 16 weeks [58]. Related studies have indicated that yoga provides benefits to individuals diagnosed with Post-Traumatic Stress Disorder (PTSD; [45, 59, 60]). Taken together, these results suggest that participating in an *asanas*-based yoga program contributes to stress reduction and may be useful in the context of trauma treatment.

The current research indicated a reduction in emotion dysregulation within the yoga program. These results are consistent with other experiments demonstrating improved emotional regulation after yoga programs [9, 40, 61-65]. However, it is unclear whether *asanas* have stronger influences on emotional regulation than other components of yoga. Indeed, Shastri and colleagues [66] reported improvements in emotional regulation with *pranayama* only. Prior to recommending yoga for emotional regulation, it would be beneficial to consider length of intervention and the elements of yoga (i.e., *asanas*, *pranayama*, meditation) that are most helpful.

Mediation analyses indicated that the improvements in emotion dysregulation mediated the relationship between intervention and both depression and stress. This finding is consistent with previous research demonstrating a relationship between improvements in emotional regulation

and reduced depression [67-71] and stress [72, 73]. Clinically, emotional regulation strategies and processes are incorporated in Dialectical Behaviour Therapy (DBT; [74]) and Emotion-Focused Therapy (EFT; [75, 76]) and have shown success for improving clinical outcomes [77, 78]. These therapies incorporate somatic awareness (EFT) and mindfulness (DBT) to improve emotional regulation, two key components of a yoga practice.

The current study also suggests that trait mindfulness is a key factor in yoga's positive effects on mental health. In our experiment, trait mindfulness increased as a result of the yoga intervention. This result aligns with previous research (e.g., [64, 79]). Mediation analyses demonstrated that trait mindfulness mediated the relationship between yoga and depression, anxiety, stress, and emotion dysregulation. These results were consistent with our hypotheses and are also in line with research demonstrating that the relationship between yoga practice and anxiety was mediated by both mindfulness and avoidance [7]. Other research has shown that state mindfulness mediates the relationship between mindfulness training and well-being (positive affect, perceived stress, and cortisol levels; [80]). For example, using an examination of intercorrelations among measures, Park and colleagues [4] reported that changes in mindfulness, interoceptive awareness, spiritual well-being, and self-compassion were strongly associated with reduced perceived stress in participants who completed a 12-week yoga intervention. Together, these studies suggest that non-judgmental, present-moment attention in a yoga practice assists in reducing anxiety and stress and improving well-being.

An interesting avenue for future research would be to examine whether the influence of mindfulness varies based on the components of yoga that are highlighted in the intervention. For example, Saoji and colleagues [81] compared mindful attention in participants who completed eight one-hour weekly sessions of an *asanas*-based yoga intervention with participants who completed the same intervention with an additional 20 minutes of *pranayama* each class. These researchers reported that the *asanas* group demonstrated improvements in anxiety and mind wandering, whereas the *asanas* and *pranayama* group also improved mindful attention [81]. Combined with the present study, these findings suggest that *asanas* in a yoga practice contribute to mindfulness benefits, although breath regulation added to yoga practice might produce additional advantages.

The current results also indicate that awareness of interoceptive information improves over the course of a yoga intervention and that this increase plays a role in yoga's positive effects on depression. This finding is consistent with our hypothesis and with literature suggesting a direct relationship between interoception and depressive symptoms [59, 82, 83]. That is, awareness of internal bodily processes connects the body with the brain and assists with self-regulation [84]. These results are also consistent with research indicating a potential therapeutic role for yoga in the treatment of trauma survivors. For example, Mehling and colleagues [34] reported that practicing movement, breath regulation, and meditation in a 12-week intervention improved MAIA scores in veterans experiencing post-trauma symptoms. Other studies have shown improved interoceptive awareness in participants following a Trauma Sensitive Yoga Intervention [45] and that somatic interventions are effective in reducing PTSD symptoms [85]. Given the emphasis on somatic-based therapies to improve mental health outcomes for trauma survivors in clinical settings [86-89], this is a valuable area for consideration in the research literature.

Self-compassion was another variable that showed improvement within the yoga group. Yoga typically emphasizes being compassionate and kind with oneself. Several studies have demonstrated improvements in self-compassion after yoga interventions [29, 64, 90-92]. Research

has also shown that self-compassion derived from yoga practice can lead to clinical benefits. For example, Crews and colleagues [93] reported improved self-compassion in women who experienced sexual violence following engagement in trauma-sensitive yoga. However, it must be noted that not all of the above studies focused on *asanas.* Therefore, it is possible that other elements of yoga may contribute to improved self-compassion. Indeed, Falsafi [42] reported that following eight weeks of mindfulness or yoga, only the mindfulness group significantly improved on self-compassion scores. Future research should investigate the differential contributions of *pranayama*, meditation, and/or a longer *asanas*-based practice on improvements in self-compassion.

4.1 Limitations and Conclusion

There are several limitations to this study. The online format of the study (with all classes being held online during the pandemic) means the results may not generalize to in-person yoga classes. Social connection was not a measure used in the current study, although there is evidence that it is important in group yoga [4, 94]. That said, there is evidence that tele-yoga can lead to improved mental health outcomes such as decreased stress, isolation, and emotion dysregulation [95, 96]. It is important to note, however, that these studies did not manipulate social interaction as a construct; therefore, it is unclear how tele-yoga's effectiveness compares to in-person sessions. Another limitation was that our study was not free from blinding. The first author recruited participants, instructed all classes, and analyzed the data. It is possible that this lack of blinding produced bias. To assist with this known bias, participants were randomly assigned to their groups using computer-generated codes, they completed all measures remotely in an online fashion in their own time, and unique participant IDs were used to maintain confidentiality. Another potential limitation is related to the sample used in the study. Participants in this experiment were mostly undergraduate students under the age of 30; socioeconomic information was not collected. It is unclear if the benefits observed in the current research would be seen in other age brackets. It is also unclear whether socioeconomic factors should be a consideration. Additionally, this study did not include a measure of personality traits. It is possible that individuals who seek out and engage in a yoga practice have similarities in personality and that these personality traits influence the effects of yoga practice on mental health.

In summary, this study suggests that yoga *asanas* could play a promising role in improving mental health outcomes including depression, anxiety, stress, trait mindfulness, interoceptive awareness, emotion dysregulation, and self-compassion. Furthermore, this study indicates that several different variables—trait mindfulness, interoceptive awareness, and emotion dysregulation—act as mediators between yoga practice and improvements in depression, anxiety, and stress. Together, these results demonstrate that several different mechanisms are at work when yoga reduces depressive symptoms, anxiety, and stress levels. Future studies should consider whether these relationships between variables occur when other elements of yoga are used in an intervention (i.e., *asanas*, *pranayama*, and/or meditation). Examining the mechanisms underlying yoga's beneficial effects and delineating how these mechanisms vary across the different elements of yoga will provide clinically relevant information for therapists considering yoga as a supplement to traditional psychological therapies.

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Author Contributions

Both authors designed this study. The first author collected the data, performed the data analyses, and wrote the first draft of the manuscript. Both authors edited the manuscript in preparation for publication. This research was part of the first author's doctoral dissertation; it has not been published elsewhere.

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Competing Interests

The authors declare no competing financial interests or other conflicts of interest.

Data Availability Statement

The dataset supporting the conclusions of this article is included as supplementary material under the file name "ParkinsonData.xls".

Additional Materials

The following additional materials are uploaded at the page of this paper.

1. Parkinson Data.

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