Mindfulness (2021) 12:2743–2753
https://doi.org/10.1007/s12671-021-01738-x

ORIGINAL PAPER

Mindful Versus Diaphragmatic Breathing: Spirituality Moderates the Impact on Heart Rate Variability

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Accepted: 26 August 2021 / Published online: 20 September 2021

Abstract

Objectives Both mindful breathing and deep diaphragmatic breathing are used in the treatment of emotional disorders and can help people learn to modulate the body's stress response. While both result in deep, slow breathing, the two approaches are quite different in their origins. We tested whether individual differences in spirituality might moderate their efficacy.

Methods Forty-eight undergraduates from the University of Pennsylvania completed baseline measures of spirituality as well as respiration rate, tidal volume and heart rate variability (HRV) at rest. Participants were then randomly assigned to a video that guided them through a mindful breathing exercise (which mentioned "a long tradition of meditation style exercises that have been used for literally thousands of years") ($N = 21$) or a diaphragmatic breathing exercise ($N = 27$).

Results Both types of training resulted in lower respiration rate and higher tidal volume over baseline (all ts > 3.78, ps < 0.001), but only diaphragmatic breathing resulted in significant increases in HRV ($t(26) = 6.29$, $p < 0.001$). Spirituality moderated the impact, such that spiritual people benefited equally from both types of breathing training, but less spiritual people benefited more from diaphragmatic breathing than from mindful breathing ($F(4,46) = 3.69$, $p = .06$).

Conclusions These results suggest that spirituality may moderate the impact of mindfulness-based interventions (MBIs) in the American context. Discussion focuses analyzes how our results may reflect a misunderstanding of eastern wisdom traditions as they were characterized during colonial times.

Keywords Mindfulness · Diaphragmatic breathing · Breathing retraining · Religion · Spirituality

The last two decades have seen an explosion of interest in and research on mindfulness-based interventions (MBIs; Cullen, 2011) which has paralleled the development of third wave approaches to cognitive behavioral therapy (Hayes & Hofmann, 2017). Mindfulness and acceptance-based approaches in particular focus more on observing and accepting thoughts, emotions and experiences than on actively attempting to change them, as traditional cognitive behavioral therapy (CBT) tends to do. This leads to very interesting questions regarding how and when to integrate the two approaches, especially with regard to the roots of MBIs in eastern wisdom traditions (Shonin et al., 2013). In particular, one might ask for *whom* each approach is likely to work.

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Between 2009 and 2011, the APA Division of Clinical Psychology and Division of Psychotherapy jointly sponsored a Task Force with the aim, in part, of identifying effective methods of adapting treatment to individual patients (Norcross & Wampold, 2011). This reflects a growing interest in "treatment matching," or personalized medicine (Norcross, 1991). Early theoretical and empirical endeavors in treatment matching focused on tailoring psychotherapy to a client's specific problem or disorder (Lambert, 2011). While such approaches can be illuminating, they neglect a deeper understanding of the person and person-centered characteristics, beyond the disorder (Wampold, 2001).

Past research in psychotherapy treatment-matching has typically studied the comparative efficacy of whole treatments, with moderator variables generally being psychopathology-related including baseline depressive symptoms (Arch & Ayers, 2013; Gould et al., 2012), personality factors such as obsessiveness (Barber & Muenz, 1996), and anxiety sensitivity and diagnostic severity (Arch & Ayers, 2013). Gould et al. (2012) studied how baseline depressive symptoms, gender and grade-level predicted the efficacy of a 12-week mindfulness program on self-regulatory outcomes of urban youth, showing that lower baseline depression predicted greater benefit from the intervention. A study comparing the efficacy of CBT and MBSR for anxiety (Arch & Ayers, 2013) found that among people with no to mild depressive symptoms and those with high anxiety sensitivity at baseline, CBT outperformed MBSR. However, among those with average anxiety severity and moderate to severe depressive symptoms at baseline, MBSR outperformed CBT. Similarly, Wolitzky-Taylor et al. (2012) compared CBT to ACT and found that baseline anxiety sensitivity and co-morbid mood disorders moderated the impact of treatment type on anxiety disorders. These studies suggest the importance of considering individual characteristics when determining optimal treatment. However, two features of these studies stand out as potential limitations. First, they compare the efficacy of entire treatments, which might not take into account the heterogeneity of responses to particular skills and interventions within each treatment. Second, the moderator variables are generally psychopathology related, precluding matching on broader aspects of the individual beyond the disorder.

One way to address these limitations is to focus on a specific technique or intervention, such as breathing retraining, that is embedded within a larger treatment. Breathing exercises are common to many therapeutic approaches including traditional CBT, Relaxation Training, Panic Control Therapy (PCT) and MBIs such as Mindfulness-Based Stress Reduction (MBSR) and Mindfulness Based Cognitive Therapy. Studying the comparative efficacy of a particular intervention accounts for heterogeneity in within-treatment response and supports the creation of a "menu of options" that clinicians can select from while determining optimal treatment—which has been to found to more effectively account for comorbidities, diverse caseloads and particular client characteristics (Chorpita et al., 2005; Weisz, 2012; Wetherell et al., 2009).

In traditional CBT approaches, breathing retraining (typically called deep or diaphragmatic breathing) entails identifying maladaptive patterns of breathing associated with sympathetic nervous system arousal (fast, shallow, thoracic breathing) and *correcting them* in a skills based way with more adaptive patterns characterized by slow, deep, abdominal or diaphragmatic breathing (Hazlett-Stevens & Craske, 2009). This results in enhanced parasympathetic functioning and greater sympatho-vagal balance, creating physiological and psychological conditions that promote the experience of reduced stress and enhanced relaxation (Modesti et al., 2015; Russo et al., 2017).

Diaphragmatic breathing has a direct impact on making breathing slower and more abdominal (Yokogawa et al., 2018) and involves clear, concrete instructions to that end. Diaphragmatic breathing has long been known to reduce stress. It has been shown to activate the parasympathetic nervous system (Harvey, 1978), reduce blood pressure and heart rate (Jerath et al., 2006), maximize heart rate variability (HRV) and reduce respiration rate (Kniffin et al., 2014; Prinsloo et al., 2013), reduce symptoms of depression and anxiety (Chen et al., 2017; Tweeddale et al., 1994), and promote a sense of relaxation (Rama et al., 2007). Its efficacy in stress reduction has been established in both clinical (see Chen et al., 2017; Tweeddale et al., 1994) and non-clinical populations (see Kniffin et al., 2014; Ma et al., 2017; Paul et al., 2007).

In MBIs, on the other hand, exercises typically focus on *observing* the breath, rather than actively trying to change it (mindful breathing). Mindful breathing instruction involves guiding participants to observe the physical sensations of their body and breath (e.g., the movement and temperature of one's breath), intently and without judgement (Kabat-Zinn, 1994), and allows their breathing to naturally become deeper and more abdominal without directly telling them to do so. This approach of mindful breathing is rooted in the teachings and meditation practices of Theravada Buddhism (Thera, 1962, 2001), Mahayana Buddhism (Suzuki, 1970) and schools of Hindu philosophy (i.e., Advaita Vedanta and Yoga) expressed through modern and contemporary writings of Nisargadatta Maharaj (1973) and J. Krishnamurti (1979; in Kabat-Zinn et al., 1985). Non-judgmental observation of oneself forms a core part of Buddhist and Hindu practices and epistemologies, aimed at reducing mental reactivity and facilitating insight into the nature of life and self "as they are" (Kabat-Zinn, 2002). It is additionally considered as an avenue to experientially examine ideas about human experience/existence discussed in these traditions (Chadha, 2015). When these practices were brought to the West, there was an attempt to present them in ways that would be accessible to the Western (including American) audience and sensitive to the Enlightenment era science/religion dichotomy. They were thus presented independent of "religious and cultural beliefs associated with them in their countries and traditions of origin" (Kabbat-Zinn, 1982).

The efficacy of mindful breathing has generally been studied in the context of MBSR treatment. MBSR has been shown to reduce depression, anxiety and pain (Kabat-Zinn et al., 1986; Shapiro et al., 1998), reduce stress (Oman et al., 2008), reduce rumination and increase positive thoughts (Jain et al., 2007). Mindful breathing has also been shown to reduce negative affect and emotional volatility in response to negative stimuli (Arch & Craske, 2006) and reduce test anxiety (Cho et al., 2016). The efficacy of mindful breathing, like diaphragmatic breathing, has been established among both clinical (see Kabat-Zinn et al., 1992; Colgan et al., 2016) and non-clinical populations (see Collard et al., 2008; Oman et al., 2008).

In fact, paced breathing, diaphragmatic breathing, and mindful breathing all tend to result in a lower rate of respiration, higher tidal volume (indicating more abdominal than thoracic breath), and increased heart rate variability (HRV) (Hunt, et al., 2017, 2018). All three of these outcomes are linked to less anxious arousal and better stress regulation (Grossman, 1983; Lutfi, 2017; Shearer, et al., 2016). HRV is the degree of fluctuation in the length of intervals between heartbeats. It reflects the relative ratio of parasympathetic and sympathetic nervous system activity and is a marker of a person's ability to downregulate the stress response. Higher HRV is associated with reduced perceived distress (e.g., Dishman et al., 2000), anxiety (Licht et al., 2009) and depression (Kemp et al., 2012). Thus, higher HRV at rest has been shown to be associated with better psychological and physical health outcomes.

However, there are key differences that might make one approach or the other more or less acceptable to and effective for different individuals. First, diaphragmatic breathing focuses on teaching the individual to directly manipulate or change the breath, while mindful breathing involves providing guidance to increase awareness of one's breath, indirectly resulting in more abdominal breathing. Second, diaphragmatic breathing is less likely to have obvious associations with religious or spiritual practices. Mindful breathing, owing to its roots and historical development, may be more likely to be associated with spiritual and religious practices of South and East Asia even if it is presented independent of them (Brown, 2016). Indeed, at least one conservative Christian group (The American Center for Law and Justice) has protested the introduction of mindfulness curricula in public schools because they view it as infringing their religious rights (Highnett, 2018). By extension, we considered it possible that one's own degree of spirituality could influence people's responses to these interventions.

Religion and spirituality were identified in the APA Interventional Task Force recommendations as one of the four client characteristics worthy of adapting therapeutic practice to (Norcross & Wampold, 2011). Spirituality was defined as a search for the sacred, while religion was thought to differ from spirituality in additionally encompassing rituals, prescribed behaviors and/or non-sacred goals such as group validation (Hill et al., 2000). Despite this recommendation, there appears to be limited treatment-matching research that considers religion or spirituality as moderators. One study by Greeson et al. (2015) explored whether spiritual and religious background, along with other demographic factors, moderated the efficacy of MBSR in reducing depressive symptoms. All participants in this study completed the MBSR program and no moderating effects emerged. Other studies have conducted correlational analyses examining the moderating role of spirituality and religious coping in the relationship between stress and depression (Ahles et al., 2016; Lee, 2007), stress and health (Kumar & Kumar, 2014) and social isolation and psychological well-being (Momtaz et al., 2011). To our knowledge, no study has yet explored the moderating effects of spirituality on the efficacy of commonly used breathing interventions using an experimental design.

Thus, the aim of this study is to directly compare the effects of mindful breathing as incorporated in MBSR (Kabat-Zinn et al., 1985) and deep diaphragmatic breathing as taught in CBT for anxiety (Gosch et al., 2006; Greenberg, 2006) across people with different degrees of spirituality on the outcome measures of respiration rate, tidal volume and HRV. We hypothesized that those who were more spiritual might do better (e.g., show higher HRV) with the awareness-focused mindful breathing (as it might evoke familiar associations or experiences) while those who were less spiritual might benefit more from skills-based diaphragmatic breathing (without the unfavorable association with religious or spiritual traditions). These predictions formed the core moderation hypothesis in our study. Past research has suggested that stress management interventions require a degree of practice for participants to reap maximal benefits (Jain et al., 2007). Thus, we chose to test the efficacy of diaphragmatic breathing and mindful breathing on physiological measures of stress reactivity both acutely and after one week, with participants being instructed to practice during the intervening time.

Methods

Participants

Participants were 48 undergraduate students recruited from psychology courses at a the University of Pennsylvania (a selective University in the mid-Atlantic region of the United States) who consented to participate in the study in exchange for extra credit in a psychology course. Twenty-seven were randomized to the diaphragmatic breathing condition and twenty-one to the mindful breathing condition using the coin toss feature of random.org. Participants were 67% female, and 46% Caucasian, 31% Asian, 13% Hispanic and 10% African American. With respect to religion, 52% of participants reported being Christian, 25% explicitly atheist or agnostic, 10% Jewish, 10% unidentified or "none," and 2% Hindu. Informed consent was obtained from all individual participants included in the study.

Procedure

Participants completed the online consent form and a set of pre-intervention surveys prior to coming to the lab for their initial appointment. Upon arriving at the lab, participants donned the Hexoskin in a private room. We had several sizes of the Hexoskin for male and female participants. Next, all participants, regardless of condition, were instructed to sit comfortably and quietly in an empty room for five minutes to establish baseline resting measures of heart rate variability, breathing rate and tidal volume.

After five minutes, the experimenter (who remained blind to condition) re-entered the room and told participants to click on “Video 1” or “Video 2” (depending on which condition they had been randomized to) once the experimenter had left the room and closed the door. Participants were asked to watch the video and follow the instructions, notifying the experimenter when they were done. These videos had been previously recorded by the PI and were matched for length. Each video contained standardized instructions and modelling for how to engage in either mindful breathing or diaphragmatic breathing. The mindful breathing video simply guided the participant in mindful awareness of the breath as is typically done in MBSR protocols. The instructions made no mention specifically of Buddhism, Hinduism, or Yogic traditions, but did reference that mindful breathing was part of a very long tradition of meditation style exercises that have been used for literally thousands of years. Thus, the mindful breathing instructions suggested that the exercise was associated with a traditional background of religion and spirituality.

After the video ended, the recording device was unplugged and participants removed the Hexoskin. They were reminded of their follow-up appointment the following week and were requested to practice the technique they had learnt in the video every day until their follow up.

Upon arrival for the follow-up appointment, participants filled out a brief questionnaire that asked their perception of the technique they had learnt (e.g., its helpfulness and appeal) and the extent to which they practiced the technique during the past week.

Participants then changed into the Hexoskin and were asked to sit comfortably and quietly in an empty room for the follow-up recording. Rather than having them sit idle, this time around participants were asked to practice the technique they had learnt the previous week. However, they received no further guidance during this follow-up appointment.

Measures

Pre-intervention Surveys

Spirituality The Beliefs and Values scale is a 20-item self-report measure that assesses spirituality that may or may not be linked to religious belief. It was designed specifically for use in clinical and health research. Items include “Although I cannot always understand, I believe everything happens for a reason” and “I believe prayer has value”, scored from 0 (*strongly disagree*) to 4 (*strongly agree*). The scale has good construct validity and internal consistency with $\alpha = 0.94$ (King et al., 2006).

Prior yoga, Breathing, and Meditation Experience We asked participants whether they had any prior experience in breathing techniques, yoga and meditation, measured as a simple yes or no answer.

Post-intervention Survey

The post intervention survey consisted of a number of questions. Participants were asked the number of days they had practiced the technique in the past week and the extent to which they found it helpful, appealing, a good fit for them, and how much they were likely to continue to the practice or to recommend it to a friend. All items were scaled from 1 *(not at all)* to 5 (*extremely*).

Equipment and Data Capture

Cardiac and respiratory measures were captured using fitted Hexoskin Smart Shirts (https://www.hexoskin.com/pages/health-research). The Hexoskin shirts have cardiac and respiratory sensors along the upper chest and waist that capture continuous ECG and respiratory data in real time. For ECG, technical specifications include the following: 1 channel (256 Hz); heart rate: 30–220 BPM, 1 Hz; QRS event detection: 4 ms resolution; RR intervals: 4 ms resolution. For respiratory data, technical specifications include: breathing (2 channels, 128 Hz); breathing rate: 3–80 BPS, 1 Hz; tidal volume (last inspiration): 80 mL–10L, 1 Hz; minute ventilation 2–150 L/min, 1 Hz; inspiration and expiration events, 8 ms resolution. The Hexoskin connects to a small data-collective device that time stamps physiological data and can be connected to a computer for data exporting.

Respiration Rate and Tidal Volume

The Hexoskin measures respiration rate in the average number of breaths per minute and tidal volume in milliliters per inspiration. The data were downloaded from the Hexoskin portal into MATLAB. Visual inspection of the scatterplots was used to remove outliers. Outliers were values that are not physiologically possible and likely due to equipment error. Using MATLAB, we chunked the respiration rate and tidal volume data into the time intervals associated with each phase of our study and computed average values for baseline, intervention, and follow-up.

ECG Cleaning and Extraction of HRV

In the seminal review of HRV analysis, one recommended measure of HRV is the standard deviation of the normal-to-normal intervals (SDNN; Task Force of the European Society of Cardiology, 1996). SDNN is now widely used among researchers as a measure of HRV. Medicore's Heart Rate Variability Analysis System reported that average SDNN above 50 ms indicates "high normal," which reflects good "ANS's regulat[ory] function and coping ability," while a value below 35 ms is poor with a "risk of developing stress induced disease" (Medicore, n.d., p. 27). Moreover, unlike some other indices (such as RMSSD), it is sensitive to respiratory processes (Laborde et al., 2017). One systematic review of normal SDNN values in healthy individuals found a mean value of 50 ms and a median value of 51 ms (range: 32 – 93 ms) from data gathered from 27 studies reporting SDNN values from short-term HRV analysis (Nunan et al., 2010).

All HRV cleaning and analysis was done blind to subject condition. To clean and analyze HRV data, raw continuous ECG data were first downloaded from the Hexoskin portal into MATLAB. RR interval data were imported into gHRV, where the "filter" function was used to remove outliers consistently across all HRV data. The "filter" function in gHRV automatically calculates the cumulative mean threshold based on the points and eliminates points that exceed this threshold or fall outside of accepted physiological values (Rodríguez-Liñares et al., 2014). In addition, the data were visually inspected to ensure that no outliers remained, as recommended by Laborde, et al (2017) and Quintana, et al. (2016). Cleaning ECG data to remove outliers prior to calculating the HRV metrics is common (e.g., Mankus et al., 2013) and such cleaning is helpful because even Kubios software can misidentify R-spikes (e.g. Visted et al., 2017). Careful cleaning and artifact detection and deletion is crucial, since even a single artifact can lead to substantial, but spurious variance (Berntson & Stowell, 1998).

Cleaned HRV data were then exported and opened in Kubios. Kubios provides additional built-in artifact correction. In Kubios, HRV data were cleaned using the RR series option, selecting for "strong correction" under artifact correction and "smoothn priors" under remove trend components. Kubios thus detected any remaining artifacts and replaced them using a cubic spline interpolation in order to preserve normal RR intervals (Tarvainen et al., 2014). After the artifact correction was complete, the SDNN was acquired using a fast Fourier transform (FFT) approach, so that the SDNN reflected the true variation within each RR-interval across a given period of time, which generally ranged from 20–100 ms (Tarvainen et al., 2014). Once cleaned, the data were imported into SPSS Version 25 statistics software for further analysis.

Results

There were no significant differences in any of the self-report or physiological variables by condition at baseline. Unfortunately, a few participants did not return to the lab for the one-week follow-up, leading to some attrition from both groups (four from the deep breathing group and 3 from the mindful breathing group). In addition, occasional technical failures (e.g., a broken wire in a Hexoskin vest) led to lost data on some variables for some participants. Thus, degrees of freedom vary across some analyses.

Breathing Rate

Breathing rate decreased significantly in both conditions both during the video and at 1-week follow-up with no further coaching or instruction. For the diaphragmatic breathing group, paired samples *t*-tests showed that the change from baseline to video was significant at [$t(26) = 12.8$, $p < 0.001$] and that difference was maintained at follow-up [$t(21) = 5.72$, $p < 0.001$]. For the mindful breathing group as well, paired samples *t*-tests also showed that the change from baseline to video was significant [$t(20) = 7.64$, $p < 0.001$] and was maintained at follow-up [$t(17) = 2.74$, $p = 0.014$]. However, an ANCOVA (controlling for baseline respiration rate) showed that participants in the diaphragmatic breathing group showed slower respiration than the mindful breathing group during the video [$F(1,47) = 5.66$, $p < 0.05$], though the between-group difference was no longer significant at one-week follow-up. See Fig. 1.

Tidal Volume

The results for tidal volume followed a very similar pattern. Both groups showed dramatically increased tidal volume (over baseline) both during the video and at follow-up. For

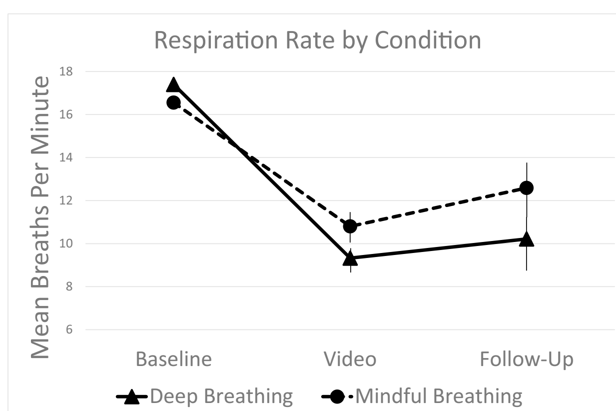

Fig. 1 Respiration rate by condition

the diaphragmatic breathing group, the paired samples *t*-test change from baseline to video was significant [t(26) = 6.55, $p < 0.001$] as was the difference between baseline and follow-up [t(22) = 4.32, $p < 0.001$]. For the mindful breathing group, the paired samples t-test change from baseline to video was significant [$t(20) = 3.78$, $p = 0.001$] as was the difference between baseline and follow-up [t(18) = 2.15, $p < 0.05$]. In the case of tidal volume, ANCOVAs testing between group differences and controlling for baseline were significant both during the video [$F(1,47) = 9.82$, $p < 0.005$] and at follow-up [$F(1,41) = 5.58$, $p < 0.05$] with the diaphragmatic breathing group showing greater tidal volume at both points. See Fig. 2.

Heart Rate Variability

In the case of HRV, in the diaphragmatic breathing group, paired samples *t*-tests showed significant increases from baseline both during the video [$t(26) = 6.29$, $p < 0.001$] and at follow-up [$t(22) = 3.08$, $p < 0.01$]. For the mindful breathing group, however, paired samples *t*-tests showed only non-significant increases in HRV during the video [$t(19) = 1.69$, $p = 0.11$] and at follow-up [$t(17) = 1.90$, $p = 0.07$]. There was a significant between group difference during the video favoring the diaphragmatic breathing group [$F(1,46) = 6.83$, $p = 0.01$]. However, the group difference had disappeared at follow-up [$F(1,40) = 0.25$, *ns*].

Moderators

In addition to the main effects of type of training, we examined several potential moderators, including spirituality, prior experience and practice effects. There was a marginally significant interaction effect between spirituality (as measured by the beliefs and values scale) and condition on HRV [F(4,46) = 3.69, $p = 0.06$], such that deep diaphragmatic breathing was equally efficacious for all participants regardless of spirituality, but those low in spirituality did not respond as well to mindful breathing as they did to diaphragmatic breathing. For these analyses, spirituality was treated as a continuous variable. For the purposes of graphing and interpretability, spirituality was divided into high and low groups based on a median split. Effect sizes allow another way to compare the magnitude of the difference between the groups. For individuals who were *low* in spirituality, the difference between deep breathing (which was effective at raising HRV) and mindful breathing (which was not) was Cohen's $d = 1.59$, a very large effect. Similarly, within the mindful breathing intervention, the difference for those high in spirituality (who saw increases in HRV) versus those low in spirituality (who did not) was also very large at Cohen's $d = 1.67$. Interestingly, deep diaphragmatic breathing worked somewhat better even for those high in spirituality, compared to mindful breathing (Cohen's $d = 0.31$). See Fig. 3, which shows change in HRV from baseline to the video across the four possible groups. Interestingly, spirituality did not moderate the impact of condition on the respiratory variables, i.e., breathing rate and tidal volume, suggesting that beliefs had more impact on HRV itself than on the mechanics of breathing.

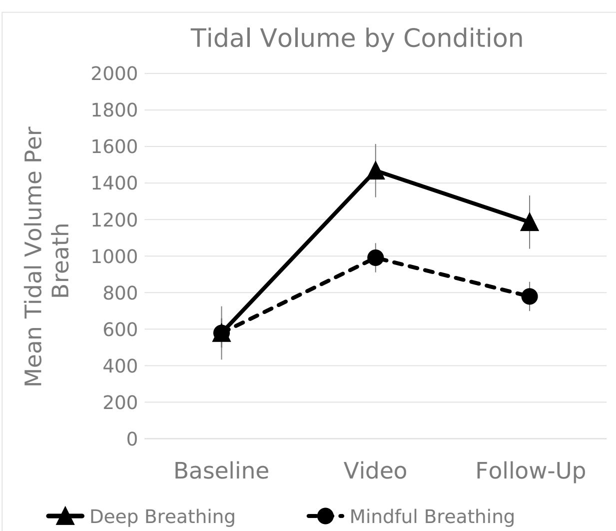

Fig. 2 Tidal volume by condition

Prior Exposure to Yoga, Meditation, or Breathing Training

We did not find evidence that prior exposure to breathing techniques, yoga or meditation mattered in the efficacy of the techniques [all *ns.*].

Practice Prior to Follow-up, Perceived Helpfulness, and Good Fit

There was no significant difference in frequency of practice between the two groups and no effect of practice in the week between the instruction in the lab and the follow-up measures. On average, participants reported practicing between 3–4 days in the week between baseline and follow-up (M = 3.86, SD = 1.57), suggesting moderately good adherence. Participants received no reminders to practice during the week. In addition, there was no significant difference in how acceptable participants rated the intervention as being, and acceptability of treatment had no impact on follow-up respiration or HRV, nor was it correlated with practice. Finally, there was no interaction between spirituality and condition on rating the acceptability of the approach. That is, less spiritual participants do not seem to have been consciously aware of finding the mindful breathing approach less helpful or acceptable.

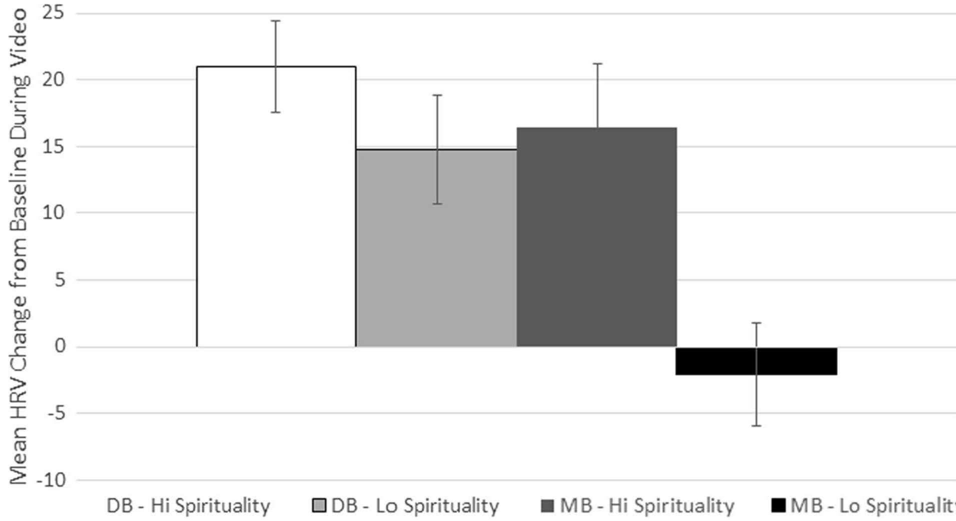

Fig. 3 Change in heart rate variability from baseline to video by condition and spirituality. For the purposes of graphing, spirituality was divided into high and low groups via median split. Error bars represent standard error of the mean

Discussion

The goal of this study was to compare the efficacy of diaphragmatic breathing and mindful breathing on reducing stress reactivity both acutely and over time, using measures of heart rate variability, breathing rate and tidal volume, and exploring self-reported spirituality as a moderator of their efficacy. Both diaphragmatic breathing and mindful breathing resulted in significant changes in respiration rate and tidal volume in the moment. Diaphragmatic breathing also resulted in significant increases in HRV, while mindful breathing only resulted in significant increases in HRV for more spiritual individuals. Diaphragmatic breathing was consistently more effective compared to mindful breathing acutely on the three physiological measures of stress. Compared to baseline, both techniques continued to be efficacious 1-week later—with the effect of condition remaining only for tidal volume. Consistent with our hypothesis, spirituality mattered in predicting which technique worked best for participants. Diaphragmatic breathing worked equally well regardless of whether one was spiritual or not, while mindful breathing did not work well for those who were not particularly spiritual.

Limitations and Future Research

There were several important limitations to this study. First, the sample size was fairly small and consisted of undergraduates at a highly selective university in the United States. This limits the generalizability of the results substantially. It may be that people in the general population, even those who don't see themselves as particularly spiritual, would be more open to mindful breathing and find it more effective than some of the participants in our study. Our results are also situated in the American context, with its particular perceptions of eastern tradition and spirituality. They might look different in other cultural contexts. Second, the intervention was a very short, single session, analog intervention with a healthy sample. Most stress management programs occur in multiple sessions and require between-session practice for sustained benefit, especially in the face of increased stress (Jain et al., 2007). Indeed, Kabat-Zinn has pointed out that mindfulness meditation "is a way of being that takes ongoing effort to develop and refine." (Kabat-Zinn, 2003, p. 149). He would surely take issue with our single session of video-taped instruction. A longer intervention measured over a longer period of time would perhaps provide more insight into the conditions needed for sustained benefit. Third, our measures were specific to physiological stress reactivity and we did not test other outcomes that mindfulness-based interventions have been shown to enhance such as insight and equanimity (Eberth et al., 2019).

Lastly, while we had our hunches about why less spiritual people might benefit less from mindful breathing, we did not directly collect data on their attitudes towards mindful breathing and its origins. Thus, our interpretations of the mechanism behind the moderation effects are speculative, and future research would be required for a deeper understanding of these effects. Our findings certainly do not suggest that breath observation and open awareness practices are not useful therapeutic strategies for many people.

Despite the limitations, this study suggests that an individual difference variable beyond psychopathology severity and comorbidity might moderate the efficacy of an acceptance-based MBI breath awareness exercise, but not a skills-based CBT breathing retraining exercise. Overall, deep diaphragmatic breathing was slightly more efficacious at increasing HRV than mindful breathing for all participants, but this effect was particularly notable for individuals low in spirituality. It suggests that for someone who is not spiritually inclined (i.e., does not think life has a spiritual or sacred dimension) at least in the American context, diaphragmatic breathing is likely to create more sympathovagal balance than mindful breathing, and is likely to be a more effective treatment component. This might be true even in the absence of a conscious preference.

Our results also provide insight into how practices like mindful breathing and their traditions of origin may be viewed in the West and across the world. In line with our hypothesis, our results suggest that less spiritual people benefitted less from mindful breathing relative to diaphragmatic breathing. If this was because of bias on their part, it suggests that mindful breathing and its origins are being viewed as religious/spiritual traditions that are incongruent with their beliefs. What might be the implications of this for how we understand and situate our results?

With the emergence and explosion of MBIs in the West, what has gone less acknowledged is the fact that the traditions they are rooted in—Buddhist and philosophical Hindu traditions—were not always categorized as single uniform "religious" traditions that were at odds with that which was "not religious." The categorization of "religion" and their labelling as single entities (e.g., "Buddhism" and "Hinduism") were in fact created by European colonists during their encounters with these traditions in the eighteenth and nineteenth centuries (Misra, 2002; Silk, 1994; mentioned in Kabbat-Zinn, 2000). These were rooted in the colonists' own lens of religion. The consequences of seeing them as "religions"—the perception that they necessitate belief and therefore are at odds with scientific thinking, and the need to separate practices from the ideas/theories which may be religious—are products of this colonial conceptualization and represent ways that they continue to persist.

However, these traditions look strikingly different when viewed from an indigenous lens. From this perspective, they are not singular religions the way European colonists interpreted them, which imply they necessitate belief and separate believers and non-believers. Instead, the guiding principle of these traditions is dharma, which among several meanings can be interpreted as living according to one's essential nature and aligned with the universal principles (see Koller, 1972). Dharmic traditions encompass many sub-traditions that in myriad ways, contain ideas articulating how one can deepen one's understanding of oneself and the world, and practices and ways of living to experientially explore these ideas. Self-observation, experiential inquiry and questioning the nature of human experience and existence are, among others, valued epistemologies in these traditions (Howard, 2017). Belief is thus neither required, imposed nor rejected, and the goal of self-understanding superseded the paths that one would take to realize it. In fact, many schools were explicitly atheistic/agnostic, as seen in Buddhism, Jainism, and several schools of Hinduism (Cohen, 2019). Pluralism is inherent to the dharmic framework and is evident in the vast number of traditions that have coexisted. It is important to note, though, that while these traditions are inherently pluralistic and secular, they are not without boundaries and are based in an interdependence between ideas, practices, and credible teachers who make the ideas and practices accessible.

The mischaracterization of these dharmic traditions as "spiritual religions" (from the western lens of religion) seems to have greatly restricted our understanding of them and, in modern scholarship and practice, has prevented integration of their ideas and practices. As our study suggests, it may also preclude acceptance across a broader spectrum of people who don't identify with spirituality. Although consensus on their characterization is debated (Howard, 2017), these dharmic traditions may be better understood as pluralistic and experiential philosophies or ways of life with the goal of greater lived understanding of oneself and the world. Perhaps, striving towards such an understanding will yield "win–win" collective benefits, both on the part of indigenous seekers and practitioners who want integration of ideas and practice, and skeptics who do not identify with "spiritual" beliefs or the frameworks of religion.

Overall, our study suggests that less spiritual people might not respond as well to mindful breathing compared to diaphragmatic breathing. We also consider how a mischaracterization of these traditions as 'religions' rather than pluralistic and experiential philosophies, one that is rooted in colonial interpretations, may be in the background of these effects. Thus, we suggest the importance of decolonizing our understanding of eastern wisdom traditions and other indigenous traditions for greater collective benefit—both on the part of indigenous seekers and practitioners, and the modern-day globalized audience.

Author Contribution MGH designed the study, analyzed the data, and wrote the paper. TR collaborated in the design of the study, in collecting and cleaning the data, and in writing the paper. FC collaborated in the design of the study and in collecting and cleaning the data. MO collaborated in the design of the study and in collecting the data, and performed most of the HRV data cleaning.

Declarations

Conflict of Interest The authors declare no competing interests.
All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional IRB at the University of Pennsylvania and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

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