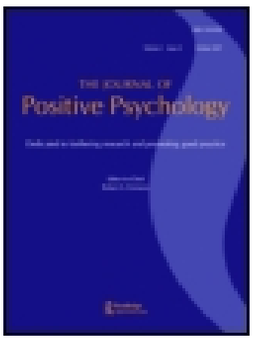

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Meditation buffers medical student compassion from the deleterious effects of depression

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ABSTRACT

Increasing data suggest that for medical school students the stress of academic and psychological demands can impair social emotions that are a core aspect of compassion and ultimately physician competence. Few interventions have proven successful for enhancing physician compassion in ways that persist in the face of suffering and that enable sustained caretaker well-being. To address this issue, the current study was designed to (1) investigate the feasibility of cognitively-based compassion training (CBCT) for second-year medical students, and (2) test whether CBCT decreases depression, enhances compassion, and improves daily functioning in medical students. Compared to the wait-list group, students randomized to CBCT reported increased compassion, and decreased loneliness and depression. Changes in compassion were most robust in individuals reporting high levels of depression at baseline, suggesting that CBCT may benefit those most in need by breaking the link between personal suffering and a concomitant drop in compassion.

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Meditation; compassion meditation, education; compassion; empathy; depression

Introduction

An irony of medical education is that while empathy and compassion are fundamental for the patient–doctor relationship and are linked with clinical competence and positive patient outcome (Del Canale et al., 2012; Halpern, 2003; Larson & Yao, 2005; Neumann et al., 2011; Rakel et al., 2009), empathy declines precipitously during medical training and residency (Hojat et al., 2009; Michalec, 2010; Neumann et al., 2011). Though fine-grained analyses to uncover mediating factors in this erosion of empathy are lacking, the decrease is often linked to a dramatic increase in stress and depression during medical school (Dyrbye, Thomas, & Shanafelt, 2005; Hojat et al., 2009; Neumann et al., 2011), with medical students experiencing higher rates of depression, suicide, and burnout than the general population (Dyrbye, Thomas, & Shanafelt, 2006; Dyrbye et al., 2010; Goebert et al., 2009; Schwenk, Davis, & Wimsatt, 2010; Tyssen, Vaglum, Grønvold, & Ekeberg, 2001). Convergent support for this explanation comes from a broad literature linking psychological malaise with interpersonal deficits. For example, major depression is associated with empathy impairment (Cusi, MacQueen, Spreng, & McKinnon, 2011; Derntl, Seidel, Schneider, & Habel, 2012; Schreiter, Pijnenborg, & Aan Het Rot, 2013). A recent study showed, moreover, that a brief induction of anxiety in otherwise healthy, non-clinical study volunteers leads to increased egocentrism and decreased perspective-taking (Todd, Forstmann, Burgmer, Brooks, & Galinsky, 2015). Within the health care domain, caretaker burnout has been associated directly with depression (Bianchi, Boffy, Hingray, Truchot, & Laurent, 2013) and inversely with empathy (Brazeau, Schroeder, Rovi, & Boyd, 2010; Hojat, Vergare, Isenberg, Cohen, & Spandorfer, 2015; Tei et al., 2014). Taken together, these findings suggest that the extreme stress and negative emotional states that medical students frequently experience may impair social emotions that are fundamental to caretaking, and by extension, to the optimal practice of medicine.

Researchers have long recognized that imprecise construct definitions have hampered research on prosocial emotions and behaviors (Stepien & Baernstein,

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2006), and noted the apparent disconnect between research in the domains of medical education, on the one hand, and in the domains of social psychology and social cognitive neuroscience on the other (Preusche & Lamm, 2015). Studies of medical education emphasize a more cognitive definition of empathy, for example, as a 'cognitive attribute that involves an ability to understand the patient's inner experiences and perspective and a capability to communicate this understanding' (p. 1564) (Hojat, Gonnella, Nasca, & Mangione, 2002). Coupled with this approach is the idea that emotionality and affective sharing may be detrimental to both the physician's professional objectivity and his or her own well-being. In contrast, researchers in psychology and neuroscience often operationalize empathy as containing both cognitive and affective components, which allow one to experience the emotions of another while also identifying those emotions as belonging to the other (de Vignemont & Singer, 2006).

While additional studies regarding the exact nature of optimal caretaker empathy are urgently needed, the current study sets aside this question to focus on a construct closely related to empathy, namely compassion, defined as the deep wish that another be free from suffering, coupled with the motivation to alleviate such suffering (Goetz, Keltner, & Simon-Thomas, 2010; Kim et al., 2009; Klimecki, Leiberg, Lamm, & Singer, 2013). Because studies have shown that enhancing compassion increases prosocial behavior (Leiberg, Klimecki, & Singer, 2011) and suggest that compassion may be an interpersonal stance more closely tied to well-being than is empathy (Klimecki et al., 2013), it is arguably more predictive of behavior than the aforementioned process of empathy and hence more salient for clinicians-in-training (Mascaro, Darcher, Negi, & Raison, 2015).

As increasing attention has been given to the 'dark side' of medical education (Laine, Taichman, & LaCombe, 2015), the need to enhance compassion and well-being in clinicians-in-training has been integral to curriculum changes implemented in medical schools throughout the country (Lovenheim, 2009). However, studies on interventions that might alter the interpersonal trajectory of medical students have been plagued by methodological limitations, such as lack of a control group and non-longitudinal designs (Batt-Rawden, Chisolm, Anton, & Flickinger, 2013). Nevertheless, mindfulness meditation programs have been effectively incorporated into medical education (Dobkin & Hutchinson, 2013; Warnecke, Quinn, Ogden, Towle, & Nelson, 2011), indicating a hunger among students for such enrichments of their training. Similarly, previous studies in both adults and college students suggest that cognitively-based compassion training (CBCT), a form of compassion-focused meditation, may also be effective in enhancing compassion and well-being among medical students. For example, CBCT improves empathic accuracy, a skill that is consistently predictive of relationship quality (Ickes, 2009), and augments activity in brain regions important for thinking of others' mental states and for emotion recognition (Mascaro, Rilling, Negi, & Raison, 2013a). In addition, CBCT significantly attenuates the pro-inflammatory response to psychosocial stress (Pace et al., 2009), and CBCT practice has been linked with a decrease in depression (Desbordes et al., 2012; Dodds et al., 2015).

To examine the efficacy of CBCT for enhancing medical student well-being and compassion, we conducted a 10-week randomized, wait-list controlled study of CBCT in second-year medical students. We had three primary goals. First, we explored the feasibility of recruiting and training students early in their medical school experience, during a period of extreme time demands. To do this, we examined the percentage of the second-year class willing to enroll in the study, while simultaneously testing the hypotheses that a larger proportion of women would enroll, and that baseline variables would predict class attendance and practice time. Second, we evaluated the efficacy of CBCT for altering compassion, loneliness, stress, depression, and general functioning using standardized questionnaires. Third, we evaluated who benefited most from compassion meditation by testing the hypothesis that CBCT would have the greatest impact on compassion among those suffering from depression, stress, and anxiety.

Methods

Study design

This randomized, single-blind, wait-list controlled study was conducted during the fall semester of 2014. Following recruitment and voluntary consent to participate, all participants completed pre-intervention assessments. Participants were randomized into either the 10-week CBCT course or a wait-list control condition. After the 10-week course, all participants, including those in the wait-list group, repeated the pre-intervention assessments (i.e. post-intervention assessment). Participants who complete training and all assessments were entered into a drawing for a $50 Amazon gift card, with 10 winners from each group (CBCT and wait-list control). Participants randomized to the wait-list group were told they would be given priority to enroll in future CBCT courses. The University Institutional Review Board approved the study, and all work was carried out in accordance with the Declaration of Helsinki. Signed informed consent was obtained from all participants after a full description of study procedures and risks and potential benefits, and prior to conducting any study procedures. Anonymity of data was ensured by identifying all data by a randomly

generated participant ID number, and the medical school did not have access to any data.

Participants

Participants were recruited from the second-year class at a prestigious (top-50 US News and World Report 2015 ranking) southern medical school via an optional face-to-face presentation that was advertised using class emails and flyers. There were no exclusion criteria. Participants were between the ages of 22–30 (M: 25.0, SD: 1.89). No significant difference in age, sex ratio, relationship status or race was found between the CBCT and wait-list groups. The majority of participants were white (7/11 wait-list, 17/21 CBCT) and currently in a relationship (8/11 wait-list, 17/21 CBCT) in both CBCT and wait-list control.

Intervention

The CBCT classes met for 1.5 h once per week for 10 weeks. In addition to class attendance, subjects were asked to engage in meditation practice outside of class time for an average of 20 min a day during the 10-week training period. Guided audio recordings were provided as an at-home supplement to pedagogical material presented during class.

CBCT is a compassion meditation protocol designed by study contemplative investigator Geshe Lobsang Tenzin Negi, Ph.D. Although secular in presentation, CBCT is derived from Tibetan Buddhist mind-training (Tibetan *lojong*) practices. These practices differ in important ways from the mindfulness-based practices that have received most of the scientific attention in recent years (Ozawa-de Silva & Dodson-Lavelle, 2011). Whereas mindfulness-based practices emphasize the development and maintenance of a non-judgmental stance toward thought processes and emotional reactions, *lojong* practices apply a cognitive, analytic approach to challenge one's unexamined thoughts and emotions toward other people, with the long-term goal of developing altruistic emotions and behavior toward all people. CBCT has two primary elements: an initial phase in which various propositions are examined that challenge one's commonsense notion of other people as falling into the categories of 'friend, enemy and stranger' and a second phase for development of spontaneous feelings of empathy and love toward an ever-expanding circle of people, beginning with an exploration of the interdependence of one's own life with those of others and then cultivating a sense of gratitude, extended even to strangers and eventually to apparent adversaries. Within the Tibetan Buddhist tradition, concentrative (i.e. shamatha) and mindfulness (i.e. vipassana) practices are typically employed as useful preliminary techniques for establishing the focus and awareness necessary to engage in specific compassion practices.

In keeping with this tradition, the intervention introduced participants to attentional and mindfulness-based techniques (modules 1–2) to improve attention and awareness before commencing specific *lojong* compassion practices in training modules 3–8. The training protocol is highly iterative, such that once the eight modules are completed, each student's daily meditation practice (guided by audio recordings) begins with a brief period of *shamatha* and *vipassana* to calm and focus the mind, followed by analytical practices designed to challenge unexamined assumptions regarding feelings and actions toward others with a focus on generating spontaneous empathy and compassion for themselves and others. A sequence of 10 classes included didactic teaching combined with meditations designed to build a suite of skills, as follows:

(1) *Developing attention and stability of mind*: The foundation for the practice is the cultivation of a basic degree of focused attention and mental stability.
(2) *Cultivating insight into the nature of mental experience*: The stabilized mind is then employed to gain insight into the nature of the inner world of thoughts, feelings, emotions and reactions.
(3) *Cultivating self-compassion*: The participant observes his or her innate aspirations for happiness and well-being as well as those for freedom from unhappiness and dissatisfaction, discerning which mental states contribute to fulfillment of these aspirations and which ones prevent it. The participant then sets an intention to emerge from the toxic mental and emotional states that promote unhappiness.
(4) *Developing equanimity*: Normally one tends to hold fast to categories of friends, enemies, and strangers and to react unevenly to people, based on those categories, with over-attachment, dislike, or indifference. By examining these categories closely, the participant comes to understand their superficiality and learns to relate to people from a deeper perspective of commonality based on the fact that everyone is alike in wanting to be happy and to avoid unhappiness.
(5) *Developing appreciation and gratitude for others*: Although people view themselves as independent, self-sufficient actors, in reality no one can thrive or even survive without the support of countless others. When the participant realizes interdependence with others and the many benefits which others offer every day, the

participant develops appreciation and gratitude for them.

(6) *Developing affection and empathy*: Deeper contemplation and insight into the ways in which myriad benefits are derived from countless others, along with awareness that this kindness should by rights be reciprocated, enables the participant to relate to others with a deeper sense of connectedness and affection. By relating to others with a profound sense of affection and endearment, the participant is able to empathize deeply with them. The participant cannot then bear to see others suffer any misfortune and rejoices in their happiness.

(7) *Realizing wishing and aspirational compassion*: Enhanced empathy for others, coupled with intimate awareness of their suffering and its causes, naturally gives rise to compassion: the wish for others to be free from suffering and its conditions.

(8) *Realizing active compassion for others*: In the final step, the participant is guided through a meditation designed to move from simply wishing others to be free of unhappiness to actively committing to aid their pursuit of happiness and freedom from suffering.

Outcomes

Upon consent, all participants completed self-report questionnaires delivered digitally (Qualtrics) or by paper and pencil, depending on participant preference. The total time required for completion of measures was approximately 20–30 min, and all assessments were completed between 1 and 3 pm on the medical school campus. The psychometric measures were chosen to assess interpersonal health, negative emotional symptomology, and general functioning. The following assessments were administered at both the time 1 and 2 (i.e. pre- and post-CBCT or wait-list):

Interpersonal health

(1) The Compassionate Love for Humanity Scale (CLHS) (Sprecher & Fehr, 2005) is a 21-item scale designed to measure an attitude of concern, caring, and support for humanity that involves a motivation to understand and help others, including strangers, when they are most in need.

(2) The UCLA Loneliness Scale (R-UCLA) (Russell, Peplau, & Cutrona, 1980) is a 20-item questionnaire assessing general feelings of social isolation and dissatisfaction with one's social interactions.

Negative emotional symptomology

(1) The Depression Anxiety and Stress Scale (DASS) (Lovibond & Lovibond, 1995) is a 42-item likert-scale measure that gauges the frequency of symptoms of depression, anxiety and stress during the past week.

General functioning

(1) The Pittsburgh Sleep Scale (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) assesses sleep quality and disturbances during the previous month. A high score is indicative of more disturbances and lower sleep quality.

(2) The Substance Use Inventory is an 8-item measure that assesses the quantity and frequency of substance (tobacco, alcohol, marijuana, prescription drug) use and other addictive behaviors (e.g. gambling) during the previous 30 days.

(3) Exercise was assessed with two questions regarding frequency of physical and aerobic exercise over the past month.

In addition, at the Time 1 assessment, participants were administered an Interest in Meditation Scale (IMS), a 6-item likert-scale measure that we created, which asked them to rate how interested they were in learning compassion meditation to help manage stress, improve personal relationships, and improve physical and mental health, and the extent to which they hoped it would make them a better doctor. Answers were summed into a composite score for analysis. During the 10-week CBCT course, daily practice time for each previous week was collected at the beginning of each week's class, along with class attendance. At the Time 2 assessment, participants completed a perceived efficacy questionnaire that asked how effective they found CBCT for reducing stress, enhancing well-being, empathy and compassion, and for improving interpersonal relationships.

Randomization and blinding

Independent of the present study and intervention, each of the second-year medical students belonged to 1 of 16 small groups that met regularly (approximately twice each week) and which served a social and pedagogical function. Each group was composed of between six and nine students. In order to minimize sharing between CBCT and wait-list groups, all second-year students were pre-randomized based on their small group prior to consent: half

of the small groups were randomized to CBCT, half to the wait-list control condition. Small group pre-randomization was conducted by random digit generation. Given optional enrollment, between 0 and 6 students from each small group enrolled (mode = 4). All study participants were blind to group assignment at the Time 1 assessments, and all experimenters were blind throughout the entirety of data collection, data entry, and statistical analysis.

Statistical analysis

Descriptive statistics (means, standard deviation, standard error) were used to characterize baseline demographics and responses to pre- and post-intervention psychometric assessments. Meditation practice time was the sum of 9 weeks of self-reported daily practice time. Missing items in the psychometric scales were estimated with expectation maximization (Graham, 2009) (missing items never accounted for more than 5% of total data) using other items within the scale as predictor variables. One CBCT participant inaccurately reported her practice times for one week by adding an additional day of practice. We replaced that week's practice time measurement with a within-subject average of practice times from all other weeks. All analyses were two-sided and the alpha level was set at $p < 0.05$. Statistical analyses were conducted using SPSS 22 for Windows.

Baseline differences between the CBCT and wait-list groups were assessed using independent *t*-tests for continuous variables and chi-squared tests for categorical variables. For our more exploratory aim of examining how second-year medical students participate in CBCT, chi-squared tests were used to evaluate the hypothesis that more women than men enrolled in the study, and bivariate correlation analyses were conducted to test the hypothesis that pre-intervention levels of interest in meditation and compassion would be positively correlated with practice time and class attendance. Within the CBCT group, bivariate correlations were conducted to examine the relationship between baseline psychometric characteristics and practice time, class attendance and CBCT efficacy. Next, independent *t*-tests were performed to evaluate baseline differences between CBCT completers and CBCT dropouts.

To address our second aim of evaluating the efficacy of CBCT, we examined group by time interactions by calculating repeated measures ANOVA followed by paired and independent sample *t*-tests for all interpersonal health, negative symptomology, and general functioning outcomes. Because of the nested nature of the randomization, small group assignment was entered as a covariate in all repeated measures analyses to control for shared experiences between group members that may have occurred irrespective of the intervention. We also conducted bivariate correlation analyses between practice time, attendance and changes in all relevant outcomes.

For our third aim of examining who benefited most from compassion meditation, we tested whether pre-intervention levels of stress, depression, or anxiety (DASS) moderated the effects of group assignment on compassion (CLHS). To this end, we first conducted bivariate correlation analyses for all four measures to determine collinearity. Next, we conducted linear regression analyses in which the Time 2 outcome measure (CLHS) was our dependent variable. We then asked, controlling for the Time 1 levels of the dependent variable, whether the interaction of the depression, anxiety, or stress (DASS) with group predicts variance in the dependent variable above and beyond that predicted by the DASS and group independently. An example of one such regression equation follows:

$$\begin{aligned}\mathrm{CLHS}_{\mathrm{Post}} &= b_0 + b_1(\mathrm{depression}_{\mathrm{Pre}}) \\ &+ b_2\left(\mathrm{Group\ Status}\left[1\text{: wait-list, } 2\text{: CBCT}\right]\right) + b_3\left(\mathrm{CLHS}_{\mathrm{Pre}}\right) \\ &+ b_4\left(\mathrm{Group\ Status} \times \mathrm{depression}_{\mathrm{Pre}}\right)\end{aligned}$$

where b_0: y-intercept; b_1: regression coefficient associated with variation in pre-intervention levels of depression; b_2: regression coefficient associated with the presence or absence of meditation effects (CBCT or wait-list); b_3: regression coefficient associated with variation in pre-intervention CLHS; b_4: regression coefficient associated with the interaction effect of group status and pre-intervention depression.

Results

Of the 132 students (68 female) in the second-year class, 59 students (33 female) enrolled in the study and a total of 32 participants completed the study [CBCT = 21 (13 female), wait-list = 11, (7 female)]. More women ($n = 35$) than men ($n = 24$) enrolled at baseline, and although the sex ratio of the entire class and our enrollees did not differ significantly, the effect trended toward significance: (χ^2 [2, $N = 132$] = 2.60, $p = 0.10$). Significantly, more participants in the wait-list control group dropped out than did participants enrolled in CBCT (χ^2 [2, $N = 59$] = 7.95, $p = 0.004$). Nine participants withdrew from the CBCT group, with two of those participants withdrawing due to scheduling conflicts. The seven participants who withdrew due to non-scheduling conflicts did not differ significantly from CBCT completers on any demographic characteristics or psychometric scores. However, the CBCT dropouts did show a trend toward having less initial interest in meditation than did CBCT completers (t[20] = 1.79, $p = 0.085$). Given the large number of wait-list participants who did not complete the second assessment, we performed post hoc *t*-tests on all baseline scores within the wait-list group

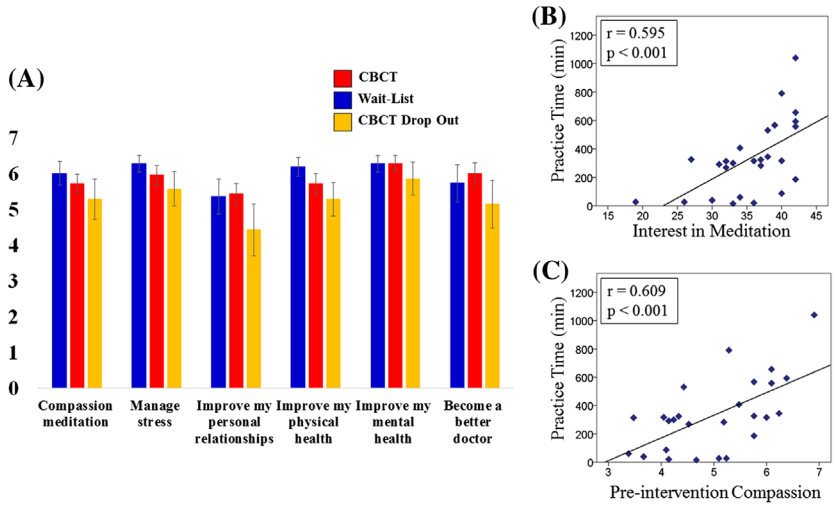

Figure 1. (A) Degree of agreement on a 6-item likert-scale measure assessing interest in meditation; Bivariate correlation between total practice time, (B) interest in meditation, and (C) pre-intervention levels of compassion.

as a function of dropout to examine whether those who dropped out were significantly different from those who completed the study. The 18 participants who did not complete the Time 2 assessment did not differ significantly from the 11 who did on any of the demographic characteristics or psychometric scores. We did not perform intent-to-treat analyses as all participants that dropped out of the intervention were missing Time 2 assessments. Because there were almost as many non-completers (46%) as completers (54%), intent-to-treat analyses may not accurately interrogate the effects of the intervention.

Participants for whom we have complete data in the CBCT and wait-list control groups did not differ on any measure at baseline (Suplemental Tables S1 and S2). Within the CBCT group, participants averaged a total of 334.2 min of practice time (SD = 258.6) over 9 weeks, which means that they practiced 26.5% of the instructed amount (1260 min). CBCT participants attended an average of 5.72 classes (SD = 3.36) over the course of the 10 weeks. Pre-intervention interest in meditation and compassion were both positively correlated with practice time (IMS, $r = 0.595$, $p = 0.001$; CLHS, $r = 0.609$, $p = 0.001$) and attendance (IMS, $r = 0.487$, $p = 0.012$; CLHS, $r = 0.572$, $p = 0.002$) (Figure 1).

Paired *t*-tests revealed a main effect of time within the CBCT group for compassionate love (paired *t*-test, $t[20] = 3.119$, $p = 0.005$), loneliness (paired *t*-test, $t[20] = -3.615$, $p = 0.002$), sleep (paired *t*-test, $t[20] = 2.586$, $p = 0.018$), depression (paired *t*-test, $t[20] = -2.969$, $p = 0.008$), and exercise ($t[20] = -3.036$, $p = 0.007$). Specifically, students randomized to CBCT reported decreased depression and loneliness, an increase in compassion, and less exercise. There was no significant change between the pre- and post-assessments within the wait-list control group for any of these measures (paired *t*-tests, $p > 0.05$). We observed a significant difference for compassion at the post-assessment between the CBCT and wait-list groups ($t[28] = 2.767$, $p = 0.010$), with the CBCT group having significantly more compassion than the wait-list control group. CBCT subjects (19 of 21) reported an average CBCT efficacy rating of 42.37 (SD = 16.36) or 70.6% of the maximum possible efficacy rating. There were no significant correlations for practice time, attendance, or CBCT efficacy with changes (post–pre) in the psychometric scales.

Repeated measure ANOVAs controlling for small group assignment revealed significant group by time interactions for compassion ($F[128] = 4.36$, $p = 0.046$), loneliness ($F[128] = 6.84$, $p = 0.014$), depression ($F[128] = 4.64$, $p = 0.040$), and exercise ($F[128] = 7.86$, $p = 0.009$) (Figure 2). There were no group by time interaction effects for anxiety, stress, substance use, or sleep.

Linear regression revealed a 2-way interaction between depression and group status on compassion ($\Delta R^2 = 0.053$, $F[127] = 6.417$, $p = 0.017$, $b = 0.112$, $t[27] = 2.533$, $p = 0.017$). Individuals who reported higher levels of depression at the pre-intervention assessment received more benefit from CBCT in terms of compassion scores and did not show the decrease in compassion reported by those in the wait-list group (Figure 3). Depression and compassion scores were not correlated at the pre- or post-intervention assessment. There were no two-way interactions between anxiety or stress and group status in terms of compassion.

Discussion

The current study explored the feasibility and efficacy of compassion training for second-year medical students,

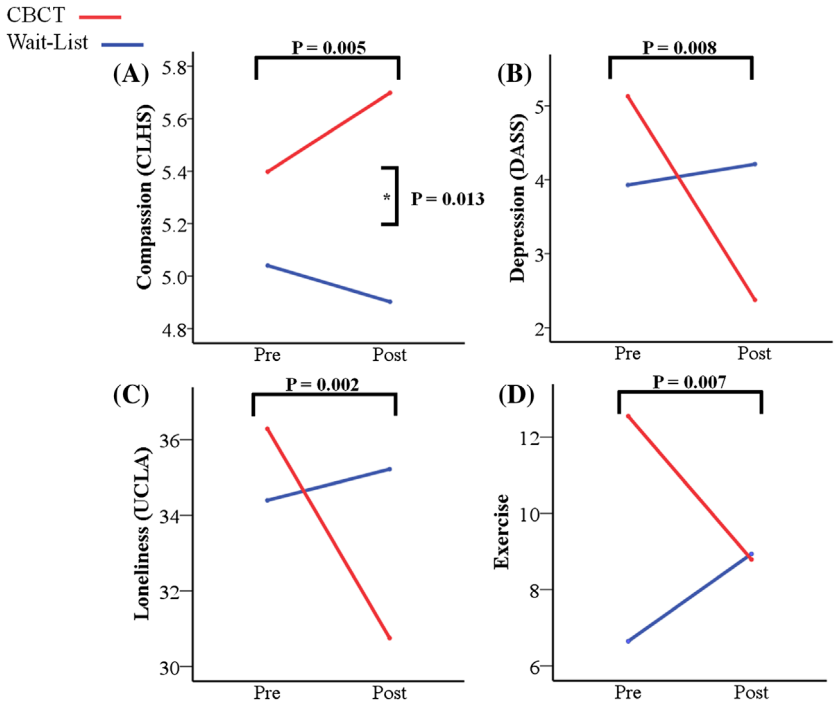

Figure 2. Repeated measure ANOVAs for compassion (CLHS), depression (DASS), loneliness (UCLA), and exercise, controlling for small group assignment.

Notes: All four measures showed a significant effect of time within the CBCT group and significant group by time interactions. Compassion also showed a significant effect of group at the post-intervention assessment.

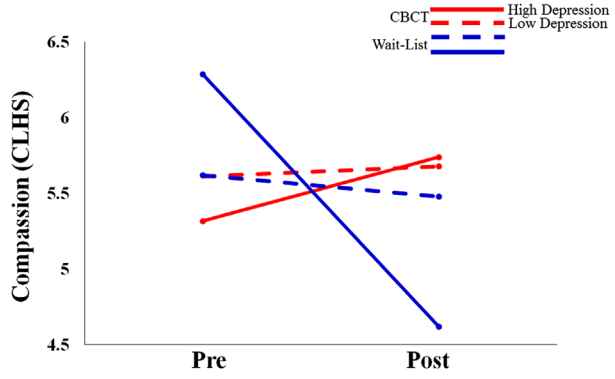

Figure 3. For visualization, compassion scores were dichotomized based on the pre-intervention values of the moderator variable (depression).

Notes: Solid lines are compassion scores for those in the upper quartile for depression at the pre-intervention assessment; dashed lines are compassion scores for those in the lower quartile for depression at the pre-intervention assessment.

and examined the possibility that training may be effective by breaking the link between negative emotion and decreased compassion. Students randomized to CBCT experienced a decrease in loneliness and depression and increased compassion. Since medical students suffer from higher rates of burnout, loneliness, depression, and suicidality than do the general population (Dyrbye et al., 2006, 2010; Goebert et al., 2009; Schwenk et al., 2010; Tyssen et al., 2001), we believe compassion meditation has great potential for enhancing student well-being as an addendum to medical curricula.

Importantly, our moderation analysis revealed that the effects of CBCT on compassion were most pronounced for individuals who self-reported high levels of depression at the beginning of the study. Specifically, those suffering from more symptoms of depression who were randomized to the wait-list group experienced a drop in compassion. Within the wait-list group, pre-intervention levels of depression predicted post-intervention compassion scores, controlling for pre-intervention compassion (post hoc partial correlation approached significance: $R = -0.60$, $p = 0.065$). In contrast, those randomized to CBCT were able to maintain compassion even with the demands of the second-year curriculum. To our knowledge, this is the most empirically robust evidence for the frequently claimed but less formally tested notion that depressive symptoms are responsible for the drop in empathy evident during medical school (Dyrbye et al., 2005; Hojat et al., 2009; Neumann et al., 2011). Moreover, this finding suggests that CBCT buffers students from empathy erosion and is most beneficial for those who are most vulnerable. The value of identifying interventions that positively alter prosocial emotions during medical education is highlighted by the now robust literature showing that physician empathy predicts clinical effectiveness (Del Canale et al., 2012),

the duration of their patients' illnesses (Rakel et al., 2009), and the likelihood of malpractice claims (Levinson, Roter, Mullooly, Dull, & Frankel, 1997).

No intervention, however efficacious, will be successful if medical students are not interested in or willing to participate, and for this reason an important aspect of this study was an examination of student enrollment in CBCT. Despite a randomized study design that offered CBCT as an optional and additional class time for students, almost half (44.7%) of the second-year class enrolled. Of those, a larger proportion were women than would be expected based on the sex distribution of the entire class, which trended toward statistical significance. Given a recent study indicating the women in medical school may be more likely to suffer from depression (Schwenk et al., 2010), CBCT may be a particularly helpful intervention for enhancing well-being for female medical students. However, we did not find that sex predicted differential outcomes for CBCT participants, supporting the idea that while women may be more likely to enroll in CBCT, its effects are certainly not limited to women.

We also sought to characterize how enrolled students engaged with CBCT. Within the group randomized to compassion training, both interest in meditation and baseline levels of compassion predicted subsequent practice time and class attendance. The latter finding, that pre-existing levels of compassion predicted engagement with CBCT, is consistent with a previous finding from our group (Mascaro, Rilling, Negi, & Raison, 2013b) and lends support to the understudied idea that personality variables affect an individual's ability or propensity to practice meditation. The finding that interest in meditation predicted practice time, class attendance, and dropout (trend) underscores the importance of student interest and challenges the idea that alternative interventions should be mandated for all medical school students. Instead, these data taken in combination suggest that CBCT should be offered to interested students as an option within assorted programming to enhance well-being and compassion. Related, the effects of CBCT are particularly interesting in light of the finding that those randomized to CBCT reported exercising less frequently at the post-intervention assessment. Students have a finite amount of time, so engagement in one activity may alter their ability to engage in other health behaviors. The findings presented here reflect such a zero sum game and suggest that CBCT is beneficial despite the possibility that participation in it detracts from other healthy engagements.

We view this as a feasibility study with inherent limitations that warrant future research. For example, given the apparent benefits of mindfulness training for medical school students (Dobkin & Hutchinson, 2013; Warnecke et al., 2011), direct comparison of CBCT to mindfulness interventions will be important for understanding best practice for a student population with already extensive time demands, and may reveal specific effects unique to mindfulness or compassion training (Desbordes et al., 2012). Our finding that baseline interest and compassion predicted CBCT engagement further underscores the importance of identifying multiple routes for addressing students of diverse temperaments and circumstances, especially important given research that shows that underlying personality variables shape the development of physician empathy in medical school (Costa et al., 2014). Moreover, others have pointed out the multi-faceted nature of medical empathy as well as widespread disagreement regarding the construct (Pedersen, 2009; Preusche & Lamm, 2015), and this study sheds little light on the complex nature of sociocognitive changes that may result from CBCT or how they may alter physician competence or patient outcomes. Relatedly, we and others have noted the importance of using implicit measures of empathy and compassion in order to minimize social desirability and demand characteristics (Mascaro et al., 2015), and the interpretations of this preliminary study rely on self-report. That said, the fact that self-reported meditation efficacy was not correlated with any changes minimizes the demand characteristics confound, because we would expect that individuals altering their responses to fit the experiment's perceived purpose would also report high levels of CBCT efficacy.

Finally, while we interpret these data as preliminary evidence for the efficacy of CBCT for altering well-being and compassion, it remains possible that non-specific aspects of compassion training better account for student outcomes. For example, some have pointed to a 'hidden curriculum' within medical education, the non-codified culture of medical school that informs and internalizes values, beliefs, and attitudes and guides future behavior (Hafferty & Franks, 1994), and which may in part cause the socioemotional upheaval during medical school (Batt-Rawden et al., 2013). It is possible that by offering and endorsing CBCT, the hidden curriculum was altered in a way that affected student compassion and well-being. This interpretation is supported by the fact that attendance and practice time did not predict outcomes. Regardless, the current findings indicate that CBCT may be beneficial for enhancing compassion and for reducing depression and loneliness, and warrant future studies to more definitively determine the mechanisms of CBCT's effects as well as the long-term trajectory and its impact on clinical practice and patient outcome.

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