Mindfulness training reduces neuroticism over a 6-year longitudinal randomized control trial in Norwegian medical and psychology students

Adam W. Hanley [a,b], Michael de Vibe [c], Ida Solhaug [d], Kwynn Gonzalez-Pons [a], Eric L. Garland [a,b,e,*]

[a] College of Social Work, University of Utah, Salt Lake City, UT, USA
[b] Center on Mindfulness and Integrative Health Intervention Development, Salt Lake City, UT, USA
[c] Norwegian Knowledge Centre for the Health Services, Oslo, Norway
[d] Department of Psychology, Faculty of Health Sciences, University of Tromsø, Tromsø, Norway
[e] Huntsman Cancer Institute, University of Utah, Salt Lake City, UT, USA

ABSTRACT

Reducing neuroticism in young adults is likely to reduce future psychopathology and improve quality of life. One method of reducing neuroticism may be mindfulness training. This randomized control study examined the effect of mindfulness training on neuroticism and psychological distress over a six-year time period in a sample of Norwegian medical and clinical psychology students receiving either a modified Mindfulness-Based Stress Reduction (MBSR) training (n = 144) or no intervention (n = 144). Mindfulness training decreased neuroticism and psychological distress over the six-year follow-up period, and decreases in neuroticism were associated with reduced psychological distress at the six-year follow-up. These findings suggest that mindfulness training can have a durable impact on neuroticism, and that mindfulness-based interventions may effectively reduce clinical symptomology linked with neuroticism.

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Accumulating evidence suggests that personality is malleable (e.g., Roberts, Walton, & Viechtbauer, 2006; Krasner et al., 2009; MacLean, Johnson, & Griffiths, 2011), and psychological interventions – designed to replace maladaptive cognitive, emotional and behavioral patterns with new, more adaptive patterns – may be able to adaptively alter personality (Krasner et al., 2009; Magidson, Roberts, Collado-Rodriguez, & Lejuez, 2014; Ortner, Kilner, & Zelazo, 2007; Piedmont, 2001; Smith, Glass, & Miller, 1980). More healthy personality configurations are characterized by decreased neuroticism. Neuroticism is included among the "big five" personality factors and is characterized by "anxiety, hostility, depressed mood, and emotional sensitivity" (Rau & Williams, 2016, p.35). Unsurprisingly, neuroticism is strongly linked with psychopathology, particularly depression (Boyce, Parker, Barnett, Cooney, & Smith, 1991; Duggan, Lee, & Murray, 1990; Dunkley, Sanislow, Grilo, & McGlashan, 2009; Kendler, Gatz, Gardner, & Pedersen, 2006; Ormel, Oldehinkel, & Brilman, 2001) and anxiety (Clark, Watson, & Mineka, 1994; Jorm et al., 2000). Furthermore, evidence suggests that more neurotic individuals are at an increased risk of developing mental illnesses, such as anxiety and depression (Aldinger et al., 2014). Thus, reducing neuroticism in young adults is likely to reduce future psychopathology and improve both present and future quality of life. One method of reducing neuroticism may be mindfulness training.

Mindfulness is a term derived from Buddhist psychology (Dreyfus, 2011; Grossman & Van Dam, 2011) that is popularly defined in the West as "paying attention in a particular way: on purpose, in the present moment, and non-judgmentally" (Kabat-Zinn, 1994, p.4). In recent years, a number of mindfulness training programs have been developed to capitalize on the salutogenic effects of cultivating meta-cognitive awareness of thoughts, emotions, and sensations (Grossman, Niemann, Schmidt, & Walach, 2004; Khoury, Sharma, Rush, & Fournier, 2015). Mindfulness Based Stress Reduction (MBSR; Kabat-Zinn, 1990) is the most common, Western mindfulness training program. MBSR is a multi-week group training program that uses both in-group guided meditations and at home individual mindfulness practice to improve physical and psychological functioning. In general, MBSR participants are instructed to observe the nature of subjective experience, attending to this impermanent, transitory field of phenomena with a nonjudgmental attitude of acceptance. Mechanistically, mindfulness training is believed to improve self-regulation by encouraging attention control, emotion regulation, and self-awareness (Tang,

* Corresponding author at: Center on Mindfulness and Integrative Health Intervention Development, 395 South, 1500 East, University of Utah, Salt Lake City, UT 84112, USA.

E-mail address: eric.garland@socwk.utah.edu (E.L. Garland).

Hölzel, & Posner, 2015). Mindful emotion regulation may be particularly germane to ameliorating neuroticism as neuroticism can be alternatively characterized as emotional instability (e.g., DeYoung, 2015). Thus, mindfulness training may develop an emotional equanimity that is inconsistent with the neurotic personality.

Meta-analytic findings indicate a strong, negative association between dispositional mindfulness and neuroticism (Giluk, 2009; Hanley & Garland, 2017). In fact, neuroticism is more strongly associated with dispositional mindfulness than any other big five personality factor (Giluk, 2009; Hanley & Garland, 2017). Additionally, cross-sectional evidence suggests mindfulness meditation experience is inversely associated with neuroticism (van den Hurk et al., 2011) and longitudinal data indicates that dispositional mindfulness may protect against emotional distress in the form of depressive symptomology (Barnhofer, Duggan, & Griffith, 2011). Yet, despite established cross-sectional relations between these two constructs, the impact of mindfulness training on neuroticism has only been reported in a few studies. In a randomized, wait-list controlled study, Jacobs et al. (2011) found that decreases in neuroticism reported by meditation retreatants predicted a biological maker of health, telomerase activity. In a randomized experiment, Ortner et al. (2007) found that increases in dispositional mindfulness following a 7-week mindfulness training course were negatively associated with neuroticism in a sample of university students. Similarly, in an observational study, Krasner et al. (2009) observed decreased neuroticism after an 8-week mindfulness communication program in a sample of primary care physicians.

These studies provide preliminary evidence that mindfulness training may reduce neuroticism. However, continued examination is needed to better characterize the effects of mindfulness training on neuroticism and other clinically relevant outcomes. First, none of these studies provided follow-up data to examine whether treatment effects endured as long-term personality changes. Second, these studies did not examine whether reductions in neuroticism translated into lower levels of psychological distress, a core concern given well-substantiated links between neuroticism and both depression and anxiety (e.g., Jorm et al., 2000; Hansell et al., 2012). This study's purpose was to address both of these gaps, using linear mixed modeling and univariate latent growth curve analysis to examine the effects of an MBSR program, specifically modified to accommodate medical and clinical psychology students, on neuroticism and psychological distress. It was hypothesized that participants receiving mindfulness training would evidence decreasing levels of neuroticism and psychological distress over the six-year follow-up period. Furthermore, decreases in neuroticism were expected to be associated with reduced psychological distress at the six-year follow-up point.

1. Method

Below, we report how we determined our sample size, all behavioral interventions, and all measures directly involved in the current study. Additional measures were collected in the course of this study to answer different research questions. Alternative outcomes (e.g., subjective well-being, empathy) were collected but not analyzed in the present study as our primary outcome of interest here was psychological distress given the prevalence of psychological distress in medical and psychology students (e.g., Dyrbye, Thomas, & Shanafelt, 2006; Mata et al., 2015). Alternative measures of psychological distress were also collected but were not analyzed in the present study to maintain consistency with our previously reported work in this population (de Vibe et al., 2013, 2015). Two additional personality factors, conscientiousness and extroversion, were also measured but not

analyzed in the present study because of (1) the marked, inverse relationship between neuroticism and mindfulness made neuroticism the most likely personality factor to be impacted by mindfulness training (Giluk, 2009; Hanley & Garland, 2017) and (2) the established relationship between neuroticism and psychological distress (e.g., Aldinger et al., 2014; Dunkley et al., 2009; Jorm et al., 2000). No data was excluded from the analyses reported below.

1.1. Participants and procedures

All first- and second-year medical and clinical psychology students (N = 704) from two Norwegian universities were contacted about participating in the present study. No exclusion criteria were applied. Recruitment was performed through in-class presentations by the study project managers and e-mail notification. A final sample of 288 students participated in the study. Using concealed allocation, participants were randomized into one of two conditions, a modified MBSR course (n = 144) or a control condition receiving no mindfulness training while completing their standard academic curriculum (n = 144). Participants did not differ by age (MBSR: $\bar{x}$ = 23.64, SD = 4.68; Control: $\bar{x}$ = 23.98, SD = 5.65; t_{286} = 0.56, p = .579), relationship status (X^2 = 2.39, p = .122), or field of study (MBSR: medicine n = 86, psychology n = 58; Control: medicine n = 90, psychology n = 54; X^2 = 0.23, p = .63). However, more females were randomized to MBSR (n = 118, 82%) than to the control condition (n = 101, 70%): X^2 = 5.51, p = .019.

The 7-week mindfulness intervention was a modified version of MBSR (Kabat-Zinn, 1990). No elements of MBSR were removed from the 1.5-hour group sessions, but the time spent on exercises, didactic teaching, and group reflection was shortened in response to feedback the researchers received from students during focus groups. The required home practice was also shortened to 30 min, and the day-long retreat was kept as session seven. Mindfulness training sessions were delivered by six instructors (3 women and 3 men) who had prior training delivering MBSR courses and had several years of personal mindfulness practice. Participants were compensated with a $50 book voucher at each data collection point. All survey materials were completed online in a location of the respondent's choosing, and informed consent was obtained before the first assessment period. Participants completed assessment protocols at five time points: (1) pre-training, (2) post-training, (3) two-year, post-training follow-up, (4) four-year, post-training follow-up, and (5) six-year, post-training follow-up. Study approval was granted by the Regional Committee for Medical and Health Research Ethics in Norway, and by the Norwegian Data Inspectorate. This study was pre-registered on ClinicalTrails.gov (NCT00892138) and data can be found at https://osf.io/y5q3u/.

1.2. Measures

Neuroticism was assessed with the Basic Character inventory's (BCI; Torgersen, 1980; Alnæs & Torgersen, 1990) neuroticism scale, which consists of nine, dichotomous items (0 = *agree*, 1 = *disagree*). Norwegian translations of the BCI have demonstrated adequate psychometrics in similar samples (Kjeldstadli et al., 2006; Røvik et al., 2007; Tyssen, Vaglum, Grønvold, & Ekeberg, 2000, 2007). Due to this demonstrated utility, the BCI was selected for use in the current study.

Psychological Distress was assessed with the General Health Questionnaire (GHQ; Goldberg & Williams, 1988), a 12-item measure of psychological distress over the preceding two weeks. Items include, "Thinking of self as worthless," "Under stress," as well as "Lost much sleep", and are scored using a 4-point Likert scale

(0 = *same as usual*, 3 = *much more than usual*). A Norwegian translation of the GHQ has demonstrated sound psychometrics in a similar sample (Nerdrum et al. 2006).

1.3. Statistical analysis

First, chi-squared analyses and a MANCOVA were used to examine group equivalency at baseline. Then, two intent-to-treat analyses using linear mixed modeling with maximum likelihood estimation compared the effect of MBSR vs. control group on neuroticism and psychological distress, adjusting for the observed between-group difference in gender. Sensitivity analyses, adjusting for group attendance were also performed. Next, a univariate latent growth curve model was constructed to assess the impact of the modified MBSR program on the relationship between changes in neuroticism over the 6-year study period and psychological distress. Finally, a mediation test was conducted examining the direct effect of experimental condition on the latent neuroticism intercept and the latent neuroticism slope, and the direct effects of the latent neuroticism intercept and latent neuroticism slope on residualized change in psychological distress (distress at the six-year follow-up point controlling for distress at baseline). Of primary interest in this analysis was the indirect effect of experimental condition on residualized change in psychological distress via change in neuroticism. SPSS 25 was used to determine basic statistics for all variables of interest and to perform the chi-squared analyses, MANCOVA, and linear mixed modeling. Latent growth curve modeling and mediation analysis was done using R's Lavaan package (Rosseel, 2012). Power analysis was performed in G*Power 3.1. To observe a small effect (Cohen's d = 0.10) and assuming a moderate correlation among repeated measures (r = 0.60), power analysis determined a sample size of 156 would be needed ($1 - \beta$ = 0.90).

2. Results

Students attended an average of 5.3 (*SD* = 1.9) modified MBSR sessions, and dropout rates over the course of the entire study are reported in Table 1. At post-testing, more than three-quarters (80%) of the participants in the mindfulness condition continued to practice formal mindfulness exercises, which decreased to 58% at the six-year follow-up. The percentage of participants in the control group that engaged in mindfulness practice increased from post-testing (25%) to six-year follow-up (36%).

Table 1 reports means and standard deviations at each time point for both conditions. Mean values for psychological distress were consistent with levels of psychological distress reported in similar samples of Norwegian medical students ($\bar{x}$'s from 1.5 to 3.4; Rø, Gude, & Aasland, 2007; Tyssen, Vaglum, Aasland, Gronvold, & Ekeberg, 1998). Neuroticism levels were slightly

higher than those reported by similar samples ($\bar{x}$'s from 3.5 to 3.7; Kjeldstadli et al., 2006; Tyssen et al., 2000, 2007; Røvik et al., 2007). Data were normally distributed across both indices (±2; Field, 2009; Gravetter & Wallnau, 2014; Trochim & Donnelly, 2006) at all time points, except one. Only psychological distress at post-testing was found to be moderately leptokurtotic. Little's MCAR test determined data were missing at random (X^2 = 50.11, df = 60, p = .82).

Neuroticism and psychological distress were positively correlated at each measurement point (Table 2).

2.1. Group equivalence

MANCOVA revealed no significant between group differences in neuroticism ($F_{1,284}$ = 0.24, p = .62) or psychological distress ($F_{21,284}$ = 0.04, p = .84) at baseline, adjusting for gender due to females being disproportionally represented in the mindfulness condition.

2.2. Effect of mindfulness training on neuroticism and psychological distress

The first intent-to-treat linear mixed model revealed a significant, but small, Condition (modified MBSR vs. Control) × Time (the five measurement points from pre-testing to six-year follow-up) interaction effect on neuroticism ($F_{4,816.51}$ = 2.50, p = .041, d = 0.28), adjusting for gender. A sensitivity analysis revealed the Condition × Time interaction remained significant after adjusting for MBSR session attendance ($F_{4,816.18}$ = 2.56, p = .038).

The second intent-to-treat linear mixed model revealed a significant, but small, Condition (modified MBSR vs. Control) × Time (the five measurement points from pre-testing to six-year follow-up) interaction effect on psychological distress ($F_{4,852.00}$ = 4.59, p = .001, d = 0.21), adjusting for gender. Again, adjusting for MBSR session attendance did not substantively alter this result ($F_{4,851.62}$ = 4.59, p = .001).

Next, the influence of mindfulness training on psychological distress via changes in neuroticism was assessed. A univariate latent growth curve model of neuroticism was regressed on treatment condition (MBSR vs. control), and a residualized change score for psychological distress (distress at the six-year follow-up point controlling for distress at baseline) was also regressed on the model (Fig. 1). This model demonstrated excellent fit (X^2/df = 1.47, df = 20, p = .082, CFI = 0.988, RMSEA = 0.040). Adjusting for session attendance did not substantively alter model fit (X^2/df = 1.37, df = 23, p = .113, CFI = 0.989, RMSEA = 0.036), and a chi-squared difference test indicated no significant difference between the original model and the attendance adjusted model ($\chi^2 \Delta$ = 2.12, p = .55). Treatment condition evidenced a significant, negative effect on neuroticism's latent slope factor ($p < .001$).

Table 1
Basic statistics for neuroticism and psychological distress at each time point for both conditions.

Variable	Full Sample				Control			MBSR		
	Mean (SD)	Skewness (SE)	Kurtosis (SE)	Alpha	Mean (SD)	SE	n	Mean SD	SE	n
Neuroticism at pre-testing	−4.88 (2.46)	−0.02 (0.14)	−0.94 (0.29)	0.75	4.71 (2.47)	0.21	144	5.05 (2.44)	0.20	144
Neuroticism at post-testing	4.71 (2.45)	0.03 (0.15)	−1.05 (0.29)	0.76	4.63 (2.53)	0.22	137	4.79 (0.20)	0.20	140
Neuroticism at 2 yr follow-up	4.36 (2.34)	0.14 (0.16)	−0.90 (0.32)	0.74	4.31 (2.29)	0.21	117	4.41 (2.41)	0.23	111
Neuroticism at 4 yr follow-up	4.47 (2.38)	0.00 (0.18)	−0.84 (0.35)	0.75	4.68 (2.46)	0.24	102	4.24 (2.28)	0.24	90
Neuroticism at 6 yr follow-up	4.37 (2.42)	0.18 (0.23)	−1.01 (0.46)	0.76	4.86 (2.40)	0.31	59	3.78 (2.33)	0.33	49
Psychological Distress at pre-testing	12.70 (6.09)	0.88 (0.14)	0.41 (0.29)	0.89	12.95 (6.22)	0.52	143	12.44 (5.97)	0.50	144
Psychological Distress at post-testing	11.12 (5.44)	1.38 (0.15)	2.35 (0.29)	0.88	13.06 (6.04)	0.51	138	9.21 (3.95)	0.33	140
Psychological Distress at 2 yr follow-up	11.53 (5.59)	0.97 (0.16)	1.40 (0.32)	0.88	12.35 (6.01)	0.55	118	10.69 (5.00)	0.47	114
Psychological Distress at 4 yr follow-up	11.42 (5.14)	0.91 (0.17)	0.96 (0.35)	0.86	12.06 (5.51)	0.54	105	10.68 (4.61)	0.48	91
Psychological Distress at 6 yr follow-up	11.34 (5.21)	0.88 (0.23)	0.81 (0.45)	0.87	12.00 (5.20)	0.66	63	10.49 (5.15)	0.74	49

Table 2
Bivariate correlations between neuroticism and psychological distress at each time point.

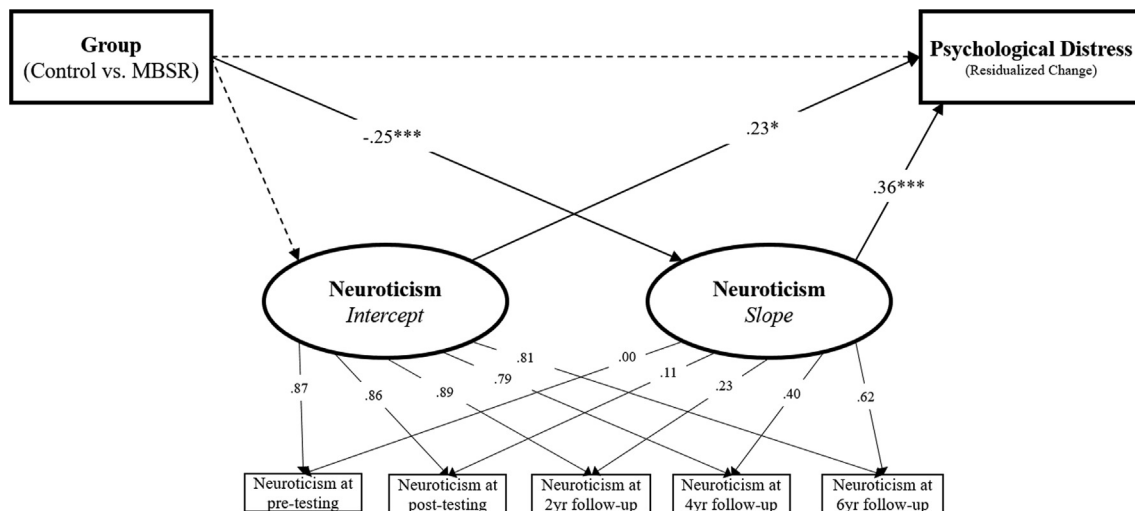| Variable	Pre-testing	Post-testing	2 yr follow-up	4 yr follow-up	6 yr follow-up
	Neuroticism				
Psychological Distress	0.46***	0.26***	0.31***	0.32***	0.37***

Fig. 1. Latent growth curve model of the influence of mindfulness training on neuroticism in relation to psychological distress. *$p < .05$, ***$p < .001$,

Inspection of means (see Table 1) indicated that mindfulness training was associated with significantly greater decreases in neuroticism over time relative to the control condition. Additionally, the latent neuroticism intercept ($p = .045$) and slope ($p < .001$) factors predicted residualized change in psychological distress over six years. Mediation analysis revealed the relationship between treatment condition and psychological distress was mediated by change in neuroticism ($\beta = -0.09$, $p = .020$, 95% CI = -1.649, -0.304). Thus, decreases in neuroticism occasioned by mindfulness training were associated with less psychological distress by the six-year follow-up assessment.

3. Discussion

The purpose of this study was to examine whether mindfulness could reduce neuroticism over time. Neuroticism amplifies stress responses, thereby increasing stress vulnerability (Schneider, 2004; Schneider, Rench, Lyons, & Riffle, 2012; Suls, 2001). Thus, the mindful dampening of neuroticism is likely to attenuate stress vulnerability, and ultimately the expression of psychopathology. Results indicated that participants in a 7-week mindfulness training course evidenced reduced neuroticism over a six-year time span. This finding extends previous reports of decreases in neuroticism immediately following mindfulness training (Jacobs et al., 2011; Krasner et al., 2009; Ortner et al., 2007). However, the current study provides the first evidence that training related decreases in neuroticism are sustained over an extended follow-up period. Results further indicated that the modified MBSR course reduced psychological distress over a six-year time span, and that decreases in neuroticism were associated with decreased psychological distress. This result is consistent with evidence suggesting dispositional mindfulness is associated with less neuroticism over time, which in turn is linked with less depressive symptomology (Barnhofer et al., 2011), and with evidence indicating the mindfulness training decreases psychological distress (Nyklíček, van Beugen, & Denollet, 2013; Van Dam, Hobkirk, Sheppard, Aviles-Andrews, & Earleywine, 2014). However, this study provides the first, direct evidence that mindfulness training related decreases in neuroticism over six years protect against psychological distress. Although the size of the effects of mindfulness training on neuroticism and psychological distress were small they were sustained over participants' entire course of graduate training – a time often marked by stress, depression and anxiety (e.g., Dyrbye et al., 2006; Mata et al., 2015).

Findings from this study are also consistent with previous reports that mindfulness training during graduate school is beneficial for both medical and counseling students (See Lomas, Medina, Ivtzan, Rupprecht, & Eiroa-Orosa, 2018 for a review). As such, the continued exploration of methods for optimally integrating mindfulness training into healthcare professionals' graduate training programs appears worthwhile. An initial consideration in this pursuit involves determining an optimal length for mindfulness training. Results from this study suggest as little as a 7-weeks of a standalone mindfulness training program for first and second years students is sufficient to encourage positive benefits throughout graduate training. However, it may be that more intensive training (e.g., 7 weeks of training plus monthly booster session, or trainings offered throughout the entirety of graduate training) would result in even larger effects than those observed in the current study. It may also be that the mindfulness skills developed during graduate have the potential to result in better quality of life and more skillful clinical practice after graduation. Indeed, a recent systematic review concluded that more mindful health care professionals, reported "[reduced] mental health concerns, [enhanced] well-being-related outcomes (e.g., job satisfaction), and [improved] aspects of job performance" (Lomas et al., 2018). To thoroughly examine this possibility, future randomized controlled trials are needed that follow students receiving mindfulness training during their graduate programs into their professional careers to determine even longer term personal and professional impacts.

Despite the novelty of these findings, limitations should also be addressed. First, as this sample was comprised of Norwegian medical and psychology students – a sample with an unusually high

level of education and undergoing professional experiences not common to many in the population – it may be that results do not generalize beyond this specific population. An additional sampling concern arises from prevalence of female participants in this sample. Continued investigation is needed with more diverse samples to test the generalizability of these findings. Second, a self-selection bias may have influenced results as students agreed to participate in this study with the hope that they would receive mindfulness training. Optimally, future studies would randomize students into either mindfulness training or an equally attractive, active control condition. Relatedly, future studies should inquire about participants' mindfulness practice history, as previous practice involvement may influence study interest and outcomes. Third, minutes of at-home mindfulness practice were not recorded in this study, disallowing a specific examination of the participants that were fully treatment adherent. A unique trajectory of change may have been observed for those participants. Fourth, future studies should also investigate hypothesized, salutogenic mechanisms of mindfulness, such as self-regulation (Tang et al., 2015; Vago & David, 2012), self-compassion (Baer, 2010; Keng, Smoski, Robins, Ekblad, & Brantley, 2012; Neff & Germer, 2013), and decreased rumination (e.g., Baer, 2009; Desrosiers, Vine, Klemanski, & Nolen-Hoeksema, 2013), to more precisely determine how mindfulness training confers the benefits observed in the present study. Better understanding these change mechanisms would allow mindfulness based interventions to be more skillfully tailored for maximal effectiveness. Finally, with respect to measurement, this study is limited by the use of a dichotomously scored neuroticism scale. Future studies may wish to use a neuroticism measure with a broader response scale to better capture change over time. More broadly, future mindfulness studies may also benefit from measuring each of the big five personality factors to identify those elements of personality most amenable to change through mindfulness training.

In conclusion, findings from this study suggest that mindfulness training can change personality, underscoring the malleability of personality and supporting the use of mindfulness-based interventions to treat a variety of psychopathologies linked with neuroticism. Furthermore, mindfulness training appears to have a durable impact on neuroticism, with substantive personality changes observed as long as six-years post-training. Finally, mindfulness-induced personality changes appear to ameliorate psychological distress. Further study is needed to unpack relationships between mindfulness training, neuroticism and psychological functioning, but this investigation provides sound evidence that such pursuits may yield fruitful results with valuable therapeutic implications.

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Declaration of Competing Interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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