The Role of Emotion Regulation and Cognitive Control in the Association Between Mindfulness Disposition and Stress

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Dispositional mindfulness is associated with lower levels of perceived stress, with increased emotional regulation and cognitive control proposed as mechanisms underlying these stress-buffering effects of mindfulness. Within aging, these controlled processes represent paradoxically divergent trajectories such that older adults exhibit reduced cognitive control capacities, while emotional regulation abilities are well maintained, and at times enhanced. Our study seeks to examine the role of emotional regulation and cognitive control as possible mediators of the association between mindfulness and perceived stress. In addition, we examined age-related differences in the observed associations among mindfulness, stress, and controlled regulatory behavior. Fifty older adults and fifty young adults were recruited for the study and completed self-report measures assessing mindfulness disposition, perceived stress, and emotional regulation. In addition, computerized measures of cognitive control assessing working memory, inhibitory control, and set-shifting were also administered. We hypothesized a negative correlation between mindfulness disposition and perceived stress such that participants reporting higher levels of dispositional mindfulness would report lower stress. In addition, we hypothesized increased difficulties in emotion regulation and lower cognitive control to mediate this relationship. Corroborating previous literature, results revealed that mindfulness disposition and perceived stress were negatively correlated in both groups. However, emotion regulation, but not cognitive control, was found to mediate the relationship between mindfulness and perceived stress in both groups. Age group was not found to moderate the observed effects. Our findings reveal the role of enhanced emotional regulation abilities as a potential factor associated with the stress-reducing capacity of dispositional mindfulness.

Keywords: dispositional mindfulness, perceived stress, aging, emotion regulation, cognitive control

The contemporary study of mindfulness has seen a surge of interest in the last decade, governed, in part, by the collective realization of the physiological and psychological ramifications of high stress that is increasingly pervading our society. Although this construct of mindfulness has historical roots in the Buddhist traditions (Bodhi, 2011), seminal work by Jon Kabat-Zinn afforded the Western adaptation of these teachings in an 8-week group-based program, popularized as the mindfulness-based stress reduction program (MBSR; Kabat-Zinn, 1990). As such, since its inception, mindfulness has been extensively studied in cross-sectional and longitudinal studies with respect to its associations with self-report (Bränström, Duncan, & Moskowitz, 2011) and physiological (Brown, Weinstein, & Creswell, 2012) metrics of stress. Recently, de Frias and Whyne (2014) provided evidence for the buffering effect of mindfulness on the functional ramifications of stress in older adults, such that higher levels of trait mindfulness in older adults moderated the effect of life stressors on mental health. Building on this nascent literature, in this study, we examined the association between dispositional mindfulness and perceived levels of stress in our sample of older and young adults. We hypothesized, based on existing literature, an inverse association between dispositional mindfulness and perceived levels of stress for older and young adults.

In addition, extending the current literature, we examined if emotion regulation abilities along with cognitive control capacities would be associated with dispositional mindfulness and stress in this sample of older and young adults. Both of these regulatory processes have been recently acknowledged as critical mechanisms in the proposed theoretical models of mindfulness (Hölzel et al., 2011). In fact, embedded within the definition and theoretical conceptualizations of mindfulness is an intentional invocation of sustained nondistraction, thereby allowing one to be fully aware of the experiences of the present moment (Brown & Ryan, 2003; Kabat-Zinn, 1982). Supporting this association between mindfulness and facets of cognitive control, there is empirical support for
expert meditators to perform better than novices on tasks of attentional orienting (van den Hurk, Giomi, Gielen, Speckens, & Barendregt, 2010), conflict monitoring (Chan & Woolacott, 2007; Jha, Krompinger, & Baim, 2007; van den Hurk et al., 2010), and cognitive flexibility (Moore & Malinowski, 2009). There is also support for improvement in cognitive control abilities of working memory and attentional orienting in individuals participating in 6- to 8-week training programs designed to teach skills of concentrative attention and open monitoring (Jha et al., 2007; Jha, Stanley, Kiyonaga, Wong, & Gelfand, 2010; although see Moynihan et al., 2013 and Anderson, Lau, Segal, & Bishop, 2007 for findings of nonsignificant results).

Although limited, cross-sectional studies suggest that higher levels of dispositional mindfulness are also associated with performance on measures of cognitive control, such as inhibitory control and working memory in adolescents (Oberle, Schonert-Reichl, Lawlor, & Thomson, 2011) and young adults (Anicha, Ode, Moeller, & Robinson, 2012). However, within older adults, we are not aware of any cross-sectional studies examining associations of dispositional mindfulness with metrics of cognitive control. Thus, in this study, extending the current literature, we examined if dispositional mindfulness would be associated with various facets of cognitive control in older and young adults.

Furthermore, another critical component of the theoretical framework of mindfulness is the ability to better regulate responses to arising emotional experiences. That is, with increased attention regulation and awareness of the experiences of the present moment, the reactivity of the wandering mind can in fact be reduced, resulting in greater emotion regulation (Bishop et al., 2004). Supporting this conjecture, there is evidence of reduced emotional reactivity in expert meditators relative to novices (Taylor et al., 2011), improvements in skills and neural correlates of emotion regulation after MBSR (Allen et al., 2012; Garland, Gaylord, & Fredrickson, 2011), and positive associations between measures of dispositional mindfulness and self-report measures of emotion regulation (Desrosiers, Vine, Kleimanski, & Nolen-Hoeksema, 2013). Although there are no studies that have examined mindfulness and emotion regulation in the elderly, Raes, Bruyneel, Loeys, Moerkerke, and De Raedt (2013) found dispositional mindfulness to mediate the age-related decreases in negative affect, such that the observed decrease in experience of negative emotions that accompany aging can in fact partly be accounted for by the age-related increase in trait mindfulness levels. Thus, although there is clear evidence for emotion regulation to be associated with mindfulness, there is no study, to our knowledge, that has examined the association between dispositional mindfulness and emotion regulation in a population of older adults.

Taken together, the above reviewed literature presents evidence for the involvement of emotion regulation and cognitive control as possible mechanisms through which mindfulness might be associated with psychological prophylaxis. On the basis of the empirical literature and theoretical formulations of mindfulness, we further examined if emotion regulation and cognitive control capacities would mediate the association between mindfulness and stress in older and young adults. Acknowledging the limitations of conducting such mediational analyses in a cross-sectional dataset given the inherent assumptions of causality (Lindenberger & Pöpper, 1998), these analyses were conducted as a preliminary attempt to examine the pathway through which mindfulness might be associated with stress in a sample of older and young adults.

Furthermore, we believe that the aging brain presents a particularly interesting landscape to study these two processes because of their divergent trajectories as a function of age (Charles, 2010; Hay & Diehl, 2011; Park et al., 2002; Salthouse, 2010). Older adults exhibit age-related deficits in cognitive control of working memory, inhibitory control, and mental flexibility, which have been found to be related to error-prone goal maintenance (Braver & Barch, 2002; Braver, Satpute, Rush, Racine, & Barch, 2005; Paxton, Barch, Racine, & Braver, 2008). On the other hand, although cognitive performance and cognitive control resources may not be efficiently utilized in the elderly, older adults demonstrate well-maintained, and at times, enhanced capacities for emotional regulation (for a review, see Mather, 2012). In turn, these have been hypothesized to support their shifting socioemotional goals related to enhanced emotional regulation and are likely responsible for the greater levels of emotional well-being often reported by adults in their older ages (Carstensen, 1992; Charles & Piazza, 2007; Newsom, Rook, Nishishiba, Sorkin, & Mahan, 2005). Thus, given older adults’ predilection toward regulating emotional experiences, we hypothesized age-related differences in associations among dispositional mindfulness, emotion regulation, and perceived stress such that emotion regulation would play a critical role in the relation between mindfulness and stress for older compared with young adults.

To summarize, the current study had two main aims: (a) to examine if mindfulness disposition would be associated with perceived stress, emotion regulation, and cognitive control in older and young adults such that the relationship between mindfulness disposition and perceived stress would be mediated by emotion regulation and cognitive control capacities in the context of a multiple mediation model and (b) whether age group would moderate the observed mediation by emotion regulation and cognitive control. We hypothesized both emotion regulation and cognitive control capacity to mediate the association between dispositional mindfulness and perceived stress in both cohorts, with emotion regulation being the stronger of the two mediators. In addition, we hypothesized older adults to show stronger associations among mindfulness, emotion regulation, and perceived stress. However, given the dearth of studies examining associations between dispositional mindfulness and cognitive control, we did not have an a priori hypothesis regarding the moderation of cognitive control by age group.

**Method**

**Participants**

Fifty older and fifty young adult participants were recruited to participate in the study from the Columbus, OH community through the use of newspaper ads, flyers, and presentations given at local senior centers. The sample was drawn from a larger study that had two primary aims: (a) to investigate age-related differences in contextual emotion regulation and (b) to examine behavioral and neural associations between individual differences in dispositional mindfulness, emotional regulation, and cognitive control in older and young adults. Here, we present the behavioral data examining age-related differences in associations among dis-
positional mindfulness, perceived stress, and emotional and cognitive control.

Participant inclusionary criteria included being between the ages of 60 and 80 years for older adults and 18 and 30 years for young adults; a score >23 on the Mini-Mental Status Examination (MMSE; maximum score = 30; Folstein, Folstein, & McHugh, 1975); a score of <10 on the Geriatric Depression Scale for older adults and a score of <18 on the Beck Depression Inventory for young adults; corrected near and far acuity vision of 20/40 or better; right-handedness as assessed by the Edinburgh Handedness Inventory; no history of self-reported psychiatric or neurologic disorders, untreated hypertension, or chronic inflammatory diseases; and no regular use of steroid medication or hormone replacement therapy. In addition, a subset of these participants (20 older and 20 young adults) were also required to meet magnetic resonance imaging (MRI) safety criteria that included no metallic implants and an absence of claustrophobia to participate in the MRI portion of the study. All participants provided written informed consent before participating as required by The Ohio State University Review Board.

Procedure

To determine eligibility, potential participants underwent a short phone-screening interview lasting approximately 10–15 min. Data for this current study were collected at study Session 1 and study Session 2, which typically took place approximately 1 week apart. Participants completed computerized cognitive tasks during Session 1. In the period between Sessions 1 and 2, participants completed self-report questionnaires and these questionnaires were collected at study Session 1 and study Session 2, which typically took place approximately 1 week apart. Participants completed computerized cognitive tasks during Session 1. In the period between Sessions 1 and 2, participants completed self-report questionnaires and these questionnaires were collected at Session 2. All participants were compensated $8/hr for their time.

Questionnaires

Mindful Attention Awareness Scale. The Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003) is a 15-item self-report questionnaire scored on a 6-point rating scale from 1 (almost always) to 6 (almost never), which assesses the experience of mindfulness in a general, everyday context. Mindfulness is measured on the basis of attention and awareness of thought, emotions, and actions. Higher scores on the MAAS reflect higher levels of mindfulness disposition. The MAAS has been shown to have good reliability and validity (Brown & Ryan, 2003) as well as having been used in various populations such as in adolescents, cancer patients, and healthy adults (Brown, West, Loverich, & Biegel, 2011; Carlson & Brown, 2005; MacKillop & Anderson, 2007). An example statement is, “I rush through activities without really being attentive to them.” Cronbach’s α for older adults = 0.766 and for young adults = 0.900.

Perceived Stress Scale. The Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983) is a 10-item self-report questionnaire scored on a 5-point rating scale from 0 (never) to 4 (very often), which measures the perception and appraisal of stress in one’s life. Higher scores on the PSS reflect higher levels of stress and more feelings of unpredictability, uncontrollability, and overloading. An example item from the scale is, “In the last month, how often have you felt that you were in over your head?” Cronbach’s α for older adults = 0.855 and for young adults = 0.869.

Difficulties in Emotion Regulation Scale. The Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004) is a 36-item self-report questionnaire measured on a 5-point rating scale from 1 (almost never) to 6 (almost always), which evaluates emotion regulation difficulties with nuanced subscales: nonacceptance of emotional responses (nonacceptance), difficulties in engaging in goal-directed behavior (goals), impulse control difficulties (impulse), lack of emotional awareness (aware), limited access to emotion regulation strategies (strategies), and lack of emotional clarity (clarity). Scores from the six subscales were summed to create an overall measure of emotion regulation difficulty. Higher scores on this scale indicate greater perceived difficulties in emotion regulation capabilities. An example item from the questionnaire includes, “When I’m upset, I feel like I can remain in control of my behaviors.” (reverse-scored; impulse control). Cronbach’s α for older adults = 0.905 and for young adults = 0.886.

White Bear Suppression Inventory. The White Bear Suppression Inventory (WBSI; Wegner & Zanakos, 1994) is a 15-item self-report questionnaire measured on a 5-point rating scale from A (1; strongly disagree) to E (5; strongly agree), which evaluates thought suppression. Higher scores on this scale indicate greater tendencies to engage in suppressing thought processes. An example item from the questionnaire includes, “I always try to put problems out of mind.” Cronbach’s α for older adults = 0.899 and for young adults = 0.894.

Cognitive measures. We assessed the construct of cognitive control by selecting a measure for each of three categories of cognitive control proposed by Miyake et al. (2000): working memory, inhibitory control, and set-shifting.

N-back task. Participants were presented with a series of letters, which appeared one at a time, and were asked to determine whether the letter presented on the screen matched the one immediately prior (1-back condition) or matched the letter that was presented two letters prior (2-back condition). Participants responded using their right-index finger for a match and responded with their left-index finger for no match. Participants first completed a block of practice trials for the 1-back condition and a block of practice trials for the 2-back condition, following which the two conditions were presented twice in a randomized order. Thus, all participants completed four blocks of 30 trials each. Each block started with an instruction screen that lasted for 3,000 ms. Each letter was on the screen for 1,500 ms, with an allowable response window of 2,000 ms and an interstimulus interval of 1,500 ms. Fixation blocks were interleaved before the instruction screens and after the task blocks, each lasting for 4,500 ms. The dependent measures of interests were the n-back costs (NbbackRTCost and NbbackAccCost), reflecting decreased working memory load.

Flanker task. Participants were presented with a series of five arrows on a computer monitor and were asked to respond to the orientation of the central arrow and ignore the peripheral arrows. Participants completed a block of practice trials before starting the experimental block, which included a total of 100 trials. For half of the trials, all five arrows pointed in the same direction (congruent condition), and for the other half of the trials, the central arrow pointed in the opposite direction to that of the flanking arrows (incongruent condition). On 50% of the trials the arrows pointed
left and on the remaining 50% the arrows pointed right. Each stimulus was presented for 1,500 ms and an interstimulus interval of 800 ms. The dependent measures of interests were the flanker costs (FlankerRTCost and FlankerAccCost) reflecting the decrease in behavioral performance resulting from processing incompatible information relative to compatible information.

**Task-switching paradigm.** Participants performed single task blocks and dual task blocks to assess the costs associated with maintaining single versus dual attentional sets (global costs) and the costs associated with set-shifting within a dual block (local costs). Stimuli consisted of single digits (except for 5) presented on the screen one at a time, with the participant responding to a judgment of >5 or <5 if the background was blue and responding to odd/even judgments if the background was pink. All participants first completed two separate practice blocks of the single task blocks. This was followed by a presentation of the experimental single task blocks of 24 trials each. Participants then completed a practice dual task block in which they were asked to respond to the digit on the screen based on the background. They then completed a dual task block of 120 trials, with 60 nontswitch trials and 60 switch trials. Each trial was presented on the screen for 2,500 ms.

The dependent variable of interest included the switch costs associated with maintaining two attention sets (global costs), which were defined as performance decrements in reaction time (RT) and accuracy scores in the nontswitch trials of the dual task block relative to the single task trials. In addition, we also calculated the switch cost associated with shifting between tasks during the presentation of the dual task block (local costs), which were defined as decreased behavioral performance in RT and accuracy scores in the switch trials of the dual task block relative to the nontswitch trials of the dual task block.

**Statistical Analyses.** Analyses were performed using SPSS 21.0 (IBM, Armonk, NY). Two of the 50 older adults did not complete the PSS; thus, all analyses were conducted on the remaining 48 older adults and 50 young adults. Table 1 presents the demographics for older and young adults.

All questionnaire data and cognitive task data were first tested for outliers. Outlier correction was separately done within the two groups. Outliers were defined as any $z$-score $\pm 2.5 SD$ from the mean; scores exceeding this threshold were replaced with $z$-scores equivalent to 2.5 $SD$. Normality of the questionnaire data and cognitive data was checked using the Shapiro-Wilk test for normality. We first conducted bivariate correlations to examine associations between our variables of interest. Table 2 presents the bivariate correlations (Pearson correlations for normally distributed data and Spearman’s rho $\rho$ for non-normally distributed data) between the emotion regulation measures as well as the cognitive control measures. For each of the broad constructs of emotion regulation and cognitive control, we administered multiple measures that would allow us to create a composite score for the respective constructs. As can be seen from Table 2, both measures of emotion regulation (DERS and WBSI) were significantly correlated for both older ($p = 0.51, p < .01$) and young adults ($r = .68, p < .01$). Thus, we created a composite for the emotional regulation construct by taking an average of the two scores. This composite was then multiplied by 1 so that higher scores reflected better perceived emotion regulation abilities. The DERS and the WBSI scores as included in Tables 1 and 2 are the original DERS and WBSI scores, with higher scores reflecting greater difficulties in emotion regulation and increased thought.

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**Table 1**

| Study Sample Demographics and Characteristics for Older Adults ($N = 48$) and Young Adults ($N = 50$) |
|---|---|---|---|
| Demographic/characteristic | Older adults | Young adults | Age comparisons |
| | Mean | SD | Median | Range | Mean | SD | Median | Range | $U = .000^{**}$ |
| Age | 65.40 | 4.83 | 64 | 60–79 | 23.60 | 3.27 | 24 | 18–30 | 1 |
| Education | 17.10 | 2.35 | 18 | 12–22 | 16.34 | 2.27 | 16 | 12–21 | 1 |
| Gender | Male | 17 | — | — | 18 | — | — | 1 |
| | Female | 31 | — | — | 32 | — | — | 1 |
| MAAS | 4.56 | 0.51 | 4.6 | 3.20–5.73 | 4.09 | 0.91 | 4.2 | 2.20–5.80 | 1 |
| PSS | 9.12 | 5.37 | 8 | 1–23 | 15.05 | 6.78 | 14 | 1–28 | 1 |
| WBSI | 36.25 | 11.06 | 35.50 | 16–65 | 43.86 | 12.38 | 44 | 19–68 | 1 |
| DERS | 63.44 | 12.79 | 62.50 | 44–98 | 70.56 | 16.68 | 70 | 37–113 | 1 |
| Task-Switching | GlobalRTCost | 212.78 | 107.50 | 202.31 | 34.10–520.04 | 188.26 | 88.83 | 176.46 | 31–367.39 | 1 |
| | GlobalAccCost | $-0.03$ | 0.10 | .000 | $-0.42$ | 0.10 | 0.01 | 0.03 | 0.006 | 0.09 | 0.10 | $U = 882.50^{*}$ |
| | LocalRTCost | 251.57 | 126.63 | 245.96 | $-194.33$ | 502.31 | 270.41 | 98.94 | 260.90 | 121.42 | 663.98 | $U = 1,161.00^{*}$ |
| | LocalAccCost | 0.02 | 0.05 | .004 | $-0.04$ | 0.22 | 0.03 | 0.05 | 0.016 | $-0.03$ | 0.17 | $U = 1,000.50^{**}$ |
| Nback | NbackRTCost | 164.54 | 118.52 | 181.44 | $-120.15$ | 380.47 | 228.50 | 104.31 | 253.20 | $-56.54$ | 423.56 | $U = 831.00^{**}$ |
| | NbackAccCost | 0.24 | 0.14 | 0.208 | $-0.04$ | 0.60 | 0.13 | 0.09 | 0.13 | $-0.05$ | 0.42 | $t = 4.28^{**}$ |
| Flanker | FlankerRTCost | 95.38 | 47.99 | 89.06 | 8.28–287.12 | 60.66 | 25.96 | 62.51 | 0.13–130.12 | $U = 576.00^{**}$ |
| | FlankerAccCost | 0.04 | 0.05 | .02 | $-0.04$ | 0.2 | 0.03 | 0.03 | .02 | 0.03 | 0.12 | $U = 1,003.00^{**}$ |

*For the flanker task, data were lost for one older adult and one young adult. The results for the flanker task are presented with 47 older adults and 49 young adults.

$p < .05$.  **$p < .01$. 

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MAAS  PSS  ER_Composite  DERS  WBSI  Global RTCost  Global AccCost  Local RTCost  Local AccCost  Nback RTCost  Nback AccCost  Flanker RTCost  Flanker AccCost

MAAS
OA  1  -0.31**  0.33**  -0.41**  -0.34  0.00  -0.11  0.00  -0.15  0.19  0.02  -0.06  -0.14
YA  -0.60**  0.73**  -0.59**  -0.78**  0.17  0.24  -0.15  -0.21  -0.01  0.07  -0.11  0.07

PSS
OA  1  -0.56**  0.48**  0.47**  -0.03  0.13  -0.05  0.08  -0.20  -0.11  -0.28  0.17
YA  -0.64**  0.54**  0.66**  0.02  -0.25  0.02  0.21  -0.03  -0.29*  0.04  -0.11

ER_Composite
OA  1  -0.83**  -0.88**  0.18  -0.19  0.01  -0.18  0.19  0.18  0.20  0.09
YA  -0.94**  -0.89**  0.11  0.18  -0.09  -0.20  -0.01  0.08  -0.12  -0.03

DERS
OA  1  0.51**  -0.20  0.27  0.12  0.05  -0.20  -0.14  -0.08  0.12
YA  0.68**  -0.10  -0.12  -0.01  0.18  0.06  -0.08  0.05  0.08

WBSI
OA  1  -0.09  0.04  -0.11  0.20  -0.10  -0.21  -0.25  -0.26
YA  -0.11  -0.22  0.22  0.20  -0.07  -0.06  0.17  -0.05

GlobalRTCost
OA  1  0.13  -0.47**  -0.32  -0.03  0.31*  -0.40**  -0.31*
YA  0.11  -0.08  0.05  -0.26  -0.12  -0.02  -0.21

GlobalAccCost
OA  1  0.01  -0.28  -0.20  0.14  0.01  0.00
YA  0.19  0.08  0.22  0.04  -0.09  0.19

LocalRTCost
OA  1  0.04  0.03  -0.15  0.10  0.02
YA  -0.05  0.01  0.25  0.17  0.10

LocalAccCost
OA  1  0.03  0.04  -0.08  -0.08
YA  0.04  0.06  -0.09  -0.09

NBackRTCost
OA  1  0.23  -0.07  0.09
YA  0.27  -0.07  -0.12

NBackAccCost
OA  1  0.10  -0.12
YA  -0.01  -0.09

FlankerRTCost
OA  1  -0.08
YA  0.26

FlankerAccCost
OA  1
YA

Note. Higher numbers reflect higher MAAS, higher PSS, higher perceived emotion regulation abilities (ER_Composite), higher difficulties in emotion regulation (DERS), increased thought suppression tendencies (WBSI), greater reaction time cost, and greater accuracy cost. OA = older adult; YA = young adult.

*p < .05. **p < .01.

We first constructed simple mediation models to examine whether emotional regulation and the various metrics of cognitive control separately mediate the association between dispositional mindfulness and stress in both older and young adults. Data on the flanker task were lost from one older adult and one young adult; thus, analyses based on the flanker task included a sample size of 47 for older adults and 49 for young adults. We then constructed and tested two multiple mediation models that took into account all of the mediator variables in one model, thus allowing each mediator to be examined in the context of other mediators. These two multiple mediation models were constructed separately for older and young adults to examine the relative contribution of each of the mediators for the two cohorts.

Finally, again using the PROCESS macro, we examined if age group moderated the conditional indirect effect of dispositional mindfulness on perceived stress. This model allowed us to exam-
ine the moderating effect of age group on the direct and indirect effects of mindfulness on perceived levels of stress. In addition, we calculated Hayes' index of moderated mediation included in the PROCESS macro for SPSS (Hayes, 2014) to test for the presence of moderated mediation. This index tests for a nonzero weight of the moderator in the indirect effect process. In here, a bootstrapping technique with 5,000 resamples was used providing a 95% CI; if the CI did not include zero, then moderated mediation was indicated.

**Results**

Descriptive statistics, including means, medians, standard deviations, and range for all variables of interest, are presented in Table 1. To examine age-related differences, we conducted independent-sample t tests for variables with a normal distribution, and where assumptions of normality were not met, we conducted the Mann–Whitney U test. The two groups did not statistically differ on education (U (98) = 986, p = .12) or gender ratios (χ² = 0.004, p > .05). In addition, older adults, on average, reported higher levels of dispositional mindfulness, t(77.73) = 3.14, p = .002, and lower levels of perceived stress (U (98) = 567.50, p < .001).

Corroborating previous literature, older adults showed lower thought suppression, t(96) = −3.20, p = .002, and fewer difficulties with emotion regulation (U (98) = 843, p = .01) compared with young adults. In addition, older adults demonstrated higher accuracy costs on the n-back task, t(80.79) = 4.28, p < .001, and greater RT cost on the flanker task (U (96) = 576, p < .001). Contrary to our expectations, older adults showed less RT cost on the n-back task (U (98) = 831, p = .009) and lower global accuracy costs (U (98) = 882.50, p = .02).

In addition, Table 2 presents the bivariate correlations among all variables for both older and young adults. As can be seen from the table, for both age groups, dispositional mindfulness was negatively associated with levels of perceived stress (ρ = −0.31 for older adults and ρ = −0.60 for young adults). The composite of emotion regulation was found to be positively associated with mindfulness disposition (ρ = 0.33 for older adults and ρ = .73 for young adults) and negatively associated with perceived stress (ρ = −0.56 for older adults and ρ = −0.64 for young adults). However, the various indices of cognitive control were not found to be associated with either mindfulness or perceived stress (except for n-back accuracy cost in young adults).

Although cognitive control indices were not associated with either mindfulness or perceived stress, we were interested in examining if perceived emotion regulation abilities would mediate the association between mindfulness and stress in the context of other proposed mediators. For this, we first conducted simple mediation analyses using a bootstrapping approach that does not make assumptions about normality of indirect effects. This was done separately for each of the mediators. The results of the simple mediation analyses for older and young adults are presented in Table 3. As can be seen from the table, of the possible mediators examined, the composite score of emotion regulation abilities was found to be the only significant mediator of the association between dispositional mindfulness and perceived stress for older (point estimate of −0.193; CI: −0.410 to −0.062) and young adults (point estimate of −0.157; CI: −0.288 to −0.057). The direct effect of mindfulness on perceived stress was found to be nonsignificant for older adults (point estimate of −0.044; p = .07) and young adults (point estimate of −0.142; p = .89), suggesting perceived emotion regulation abilities to fully mediate the association.

We then constructed our multiple mediation model to examine if the mediation by emotion regulation remained significant even

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<th>IV on M (a)</th>
<th>M on DV (b)</th>
<th>Indirect Effect (a × b)</th>
<th>Direct Effect (c')</th>
<th>Total Effect (c)</th>
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*Note* Significant point estimates (p < .05) as determined by the bootstrapping technique of Preacher & Hayes (2008).

* Please note that for older and young adults, the simple mediation analyses for the flanker task included one less participant than the other models. IV = independent variable; M = mediator; DV = dependent variable.
after including the other mediators. This multiple mediation model, although constructed with a modest sample size and a large number of proposed mediators, was primarily constructed to ensure that emotion regulation abilities would mediate the association between mindfulness and stress even after including other proposed mediators. Figure 1 separately displays the results of the multiple mediation models for older and young adults. Corroborating the results of the simple mediation analyses, we still found only the composite of emotion regulation to be a significant mediator for older adults (point estimate of $-0.175; CI: -0.424$ to $-0.023$) and young adults (point estimate of $-0.157; CI: -0.291$ to $-0.033$). Taken together, the results of the simple mediators are presented in Table 1.

![Diagram](image-url)

**Figure 1.** Results for the multiple mediation model tested in (A) older and (B) young adults. For each of the mediators, the unstandardized path coefficients with $SE$ in parentheses are indicated. Significant indirect pathways are boldfaced. The solid line connecting disposition mindfulness with perceived stress indicates the total effect of mindfulness on stress, and the dotted line coefficient indicates the direct effect of stress. Given that this was the multiple mediation model, simultaneously testing all mediators, the total effect for both older adults is based on $N = 47$ and for young adults is based on $N = 49$ participants.
mediation analyses and multiple mediation analyses evince support for emotion regulation abilities to mediate the association between dispositional mindfulness and perceived stress.

Next, to examine the moderating effects of age group in the observed mediation, we constructed a moderated mediation model to examine if age group moderated the association among (a) dispositional mindfulness and each of the mediator variables, (b) each of the mediator variables and levels of perceived stress, and (c) dispositional mindfulness and perceived stress. The results of this moderated mediation are presented in Figure 2. As can be seen from the figure, none of the interactions were significant, thus suggesting that there were no age-related differences in the associations among dispositional mindfulness, perceived stress, and the examined mediators. Emotion regulation was found to be a significant mediator in this multiple mediation model for older (point estimate of −0.175; CI: −0.448 to −0.026) and young adults (point estimate of −0.157; CI: −0.292 to −0.034), with the index of moderated mediation being nonsignificant (index = 0.019; CI: −0.185 to 0.303).

Discussion

The purpose of the present study was to examine the association between dispositional mindfulness and perceived stress and to identify potential mediators of this relationship in a community sample of older and young adults. We were specifically interested in examining if the relationships that have been observed among dispositional mindfulness, cognitive control, and emotion regulation in young adults would also be found in a sample of older adults and if age group would moderate any of the observed relationships. Corroborating previous literature, the results of our study provided evidence for an inverse relationship between dispositional mindfulness and levels of perceived stress in older and young adults. However, age group was not a significant moderator of this relationship. Furthermore, our findings revealed that perceived emotion regulation abilities fully mediated the negative association between mindfulness disposition and perceived stress; however, as defined in this study, cognitive control was not associated with either mindfulness disposition or perceived stress in either older or young adults. The results from this study highlight the role of enhanced emotional regulation abilities as a potential underlying mechanism contributing to the stress-reducing capacity of dispositional mindfulness; however, these results did not differ as a function of age.

Consistent with prior literature, our findings provide additional evidence for the positive psychological health benefits associated with mindfulness, particularly in the area of stress reduction. A review of randomized controlled trials (RCTs) investigating the effectiveness of mindfulness programs on various symptoms found that mindfulness training resulted in significant reductions in perceived stress in seven of eight RCTs, with pre-post effect sizes ranging from 0.3 to 0.64 (Fjorback, Arendt, Ornbøl, Fink, & Walach, 2011). In addition, cross-sectional studies investigating

![Figure 2](image-url)
dispositional mindfulness have found this trait measure to be associated with subjective reports of stress as well as neuroendocrine markers of stress (Bränström et al., 2011; Brown et al., 2012). Overall, there seems to be consistent support for the stress-buffering effect of mindfulness when examined as an individual difference metric and in the context of mindfulness-based stress reduction programs. Extending this literature to a sample of older adults, our study evinces support for a negative association between mindfulness disposition and perceived stress within this cohort.

Although much has been studied in terms of the associations between mindfulness and improved psychological health and its stress-reducing effects, increasing effort is being directed at understanding the mechanisms through which mindfulness is associated with a range of benefits. Our findings highlight the idea that emotion regulation plays a central role in the relationship between mindfulness and stress. Previous research lends support to this concept of emotional regulation acting as an underlying mechanism of mindfulness. Dispositional mindfulness has been correlated with less difficulty in regulating emotions (Hill & Updegraff, 2012), with individual differences in trait mindfulness associated with several facets of emotion regulation such as emotional reactivity (Arch & Craske, 2010), emotional differentiation (Hill & Updegraff, 2012), and use of reappraisal strategies (Desrosiers, Vine, Klemanski, & Nolen-Hoeksema, 2013). In addition, Garland et al., 2011 found that after the completion of an 8-week mindfulness intervention, dispositional mindfulness significantly increased whereas perceived stress significantly decreased; increases in positive reappraisal were found to partially mediate this relationship in a population of community-dwelling middle-age adults. Furthermore, a central feature of a proposed theoretical framework of mindfulness by Höfzel et al. (2011) involves emotion regulatory processes, which facilitate nonreactivity to present-moment sensations—an important principle of mindfulness.

Consistent with this literature, when we examined the results of our study in the context of emotional regulation and perceived stress, we found evidence for emotion regulation to mediate the association between dispositional mindfulness and perceived stress in older and young adults. Providing data to the theoretical models that propose emotional regulation as a key component underlying the psychological health benefits associated with mindfulness, our study affords support for higher perceived emotion regulation abilities to fully mediate the stress-reducing benefits of mindfulness. From a developmental perspective, our cross-sectional data support the idea that the perceived ability to engage in emotion regulation in older age seems to confer a range of health benefits, including explaining the association between mindfulness and stress. Future research would benefit from a RCT using measures of emotional regulation abilities to directly assess the changes in these abilities as a function of participating in a mindfulness training program.

However, contrary to our hypothesis, we did not find evidence for an age-related moderation of these effects. Specifically, given that older adults not only show intact capacities to engage in emotion regulation, but they also show a chronic activation of emotion regulatory needs, such that prioritizing goals of emotional well-being seem to take precedence over the horizon-broadening goals of young age (Carstensen, Isaacowitz, & Charles, 1999), we hypothesized a stronger association among dispositional mindfulness, perceived stress, and emotion regulation in older compared with young adults. Emotion regulation was found to fully mediate the association between dispositional mindfulness and stress in both cohorts, suggesting the critical importance of this component in the theoretical conceptualization of mindfulness. In this study, we used self-report measures of emotion regulation abilities, and although young adults endorsed greater difficulties with emotion regulation and increased thought suppression, it would be interesting for future research to examine how age-related differences in other facets of emotion regulation, such as the frequency and variability of emotion regulation strategy use, are associated with mindfulness and levels of perceived stress.

Just as older adults exhibit a particular trajectory in terms of emotional regulation, they also exhibit a specific, inverse trajectory related to cognitive control, such that one’s ability to perform fluid tasks related to working memory, inhibitory control, and set-shifting decline with age (Park & Reuter-Lorenz, 2009). However, contrary to our hypotheses, our study did not find any significant relationship between cognitive control and stress, and between cognitive control and mindfulness, in older or young adults. Although cognitive control has also been postulated as another key component of the theoretical models of mindfulness (Höfzel et al., 2011), the empirical data linking mindfulness to improvements in cognitive control have been mixed. Within older adults, Moynihan et al. (2013) recently published the largest RCT of mindfulness training with older adults. Comparing the efficacy of mindfulness training, relative to a wait-list control group, they found evidence for a small improvement on the Trails Making Test; however, these effects were not maintained at follow-up.

Other studies, particularly involving young adults or community samples, have provided evidence for an improvement in cognitive control abilities after engagement in a mindfulness program. For example, Jha et al. (2007) reported improvements in attentional orienting after an 8-week MBSR mindfulness training program relative to a wait-list control. Another study, which involved undergraduate students, reported improvements in selective attention after completing a 5-day meditation period (Tang et al., 2007). In addition, working memory improvements as a consequence of mindfulness training were also reported in young adults, with increased mindfulness practice time related to greater working memory capacity (Jha et al., 2010; Zeidan, Johnson, Diamond, David, & Goolkasian, 2010). However, in contrast to these findings, Anderson et al. (2007) reported no improvements in set-shifting, sustained attention, object detection, or inhibitory control after participation in an 8-week MBSR program.

In addition, and more pertinent to the current study, cross-sectional studies, investigating the association between mindfulness disposition and cognitive control are more limited. In a sample of early adolescents, increased mindfulness disposition levels, indicated by higher scores on the MAAS, significantly predicted greater percentage accuracy scores on the computerized Dots task, a test of inhibitory control (Oberle et al., 2011). Increased mindfulness disposition levels were also associated with increased cognitive control, measured using tasks of working memory, temporal-order, and inhibitory control, in a sample of college-aged students (Anicha et al., 2012).
Extending this literature, our study examined associations between dispositional mindfulness and various cognitive control abilities in older and younger adults. We assessed the multifaceted construct of cognitive control by administering computerized measures of working memory, inhibitory control, and set-shifting. For each of these measures, we calculated performance costs associated with maintaining and manipulating higher cognitive load relative to a less challenging condition. The lack of significant associations between dispositional mindfulness and the performance costs for older and younger adults was contrary to our expectations and provides important guidelines for future research. First, as discussed above, although there is promising support for improvement of cognitive control abilities after an intervention program, few studies have cross-sectionally examined if individual differences in trait mindfulness are associated with metrics of cognitive control. It would certainly be important for future research in this area to examine if cognitive control abilities of older adults do in fact change as a function of participating in a longitudinal training program of mindfulness practices. In addition, at least in the n-back task, whereas older adults showed higher accuracy costs than younger adults, they demonstrated lower RT costs, suggesting a possible speed-accuracy tradeoff. Future studies would benefit from using nuanced computational models that combine RT data and accuracy scores, such as diffusion models (Ratcliff & McKoon, 2008), to clearly delineate the role of various facets of information processing and decisional processes.

There were a few limitations to note about this current study. As stated previously, this is a correlational study examining only relationships at one point in time. Although mediational analyses were conducted to examine the hypotheses of interest, causal interpretations of these mediational analyses cannot be made. To truly determine whether there are certain directionals and underlying mechanisms of mindfulness, the best mode of study would be to conduct a RCT investigating the influence of mindfulness training relative to an active control group in reducing stress in older adults. Another important limitation of the study was the assessment of dispositional mindfulness and emotion regulation using self-report measures, suggesting that the shared methodology of self-report could be an alternative explanation of the observed effects. It would be important for future studies to replicate these findings using behavioral measures of emotion regulation.

Overall, our study contributes to the understanding of mindfulness and its associated benefits in several ways. First, by focusing on older adults, this study adds to the increasing, but limited database of studies examining the benefits conferred by mindfulness in an aging cohort (Gallegos, Hoerger, Talbot, Moynihan, & Duberstein, 2013; Moynihan et al., 2013; Prakash, De Leon, Klatt, Malarkey, & Patterson, 2013; Raes et al., 2013). Second, by simultaneously examining cognitive control and emotional regulation, we were able to provide evidence for emotional regulation abilities, but not cognitive control, to play a significant role in the mindfulness-based positive associations within older adults. In addition, our study involved a comprehensive assessment of cognitive control abilities using measures that tap into the three facets of cognitive control as outlined by Miyake et al., 2000.

References


Received May 23, 2014
Revision received October 13, 2014
Accepted November 14, 2014