Memory and Aging: The Role of Mindfulness and Control Beliefs

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ABSTRACT

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Background: The maintenance of functional independence throughout adulthood and into old age is a central focus of lifespan developmental psychology research. Previous studies have lauded the benefits of mindfulness practices in enhancing an individual’s control beliefs and overall well-being. Control beliefs have also been positively associated with functional health including a good memory in old age. We examined the individual and interactive effects of naturally-occurring mindfulness on both general and domain-specific control beliefs. We also explored the intersection of mindfulness and control beliefs as related to memory performance across adulthood.

Methodology/Principle Findings: We conducted a national daily diary study including participants from a sample of 83 young, middle-aged, and older adults ages 21 to 94. We collected demographic, dispositional mindfulness, and general control belief data using a self-report baseline questionnaire. Via daily telephone assessments, we measured memory performance using recall and recognition tasks. Participants recorded daily memory control beliefs and daily mindfulness using a seven-day diary protocol. Regardless of age, dispositional mindfulness was positively related to general control beliefs and daily mindfulness was positively associated with daily memory control
beliefs. Mindfulness alone did not sufficiently contribute to recall or recognition memory performance. Contrary to predictions, the salutary effects of dispositional mindfulness in predicting memory performance only applied to individuals with a low sense of general control.

Conclusion/Significance: The results of this study are encouraging in that the benefits of mindfulness are not limited to deliberate meditative practices or interventions. The naturally-occurring tendency toward engaging in non-judgmental awareness offers similar advantages for maintaining general and domain-specific control throughout adulthood and old age. Our results suggest that interventions designed to improve functional independence throughout adulthood must consider mindfulness in the context of pre-existing control beliefs.
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Memory and Aging: The Role of Mindfulness and Control Beliefs

The process of aging remains fundamentally unique in its universal relevance to every race, culture, and social class of human beings. Shared participation in growing older has undoubtedly fueled the recent wealth of research in the field of aging psychology. The desire to control the trajectory of the natural aging process is evidenced by the emergence of a $40 billion-a-year and growing anti-aging industry (Lachman, 2006). While genes substantially predict relative “success” in aging, behavioral factors and psychological beliefs purportedly play significant roles as well (Lachman, 2006). The general purpose of this study was to examine the plasticity of cognitive aging by assessing the interrelationship of mindfulness, control beliefs, and memory performance. It is proposed that mindfulness can serve as a protective factor for control beliefs and memory performance in later life.

*Mindfulness explored*

The concept of mind-body dualism, or the characterization of the mind and body as fundamentally separate entities, has predominated the field of Western medicine throughout ancient and modern history alike. The psychological concept of mindfulness affirms the existence of an intimate relationship between the two entities of mind and body. Agreement upon a single operational definition of the construct of mindfulness endurably challenges researchers, psychologists, and religious figures. The present study conceptualized mindfulness using the most referenced definitions. Mindfulness as a
naturally occurring trait has been defined as enhanced attention to and receptive awareness of one’s current internal experiences and external surroundings (Ryan, 2003). In contrast to deliberate cognitive constructs such as attentional focusing, mindfulness emphasizes an open awareness of moment-to-moment occurrences. According to this proposed definition, compulsive or automatic behavior fundamentally jeopardizes mindfulness (Deci & Ryan, 1980). Mindfulness defined accordingly has recently garnered weighty attention in the fields of applied clinical psychology and mainstream healthcare. This research uniquely sought to extend mindfulness theory to the study of lifespan development and age-related cognitive declines in an effort to identify modifiable factors that could contribute to maintaining independence in old age.

*Dispositional versus daily mindfulness*

The benefits of possessing an innate propensity toward acting mindfully prompts further exploration of the extemporaneous qualities associated with this trait on a daily basis. The term 'dispositional mindfulness' refers to the frequency with which one engages in mindful behaviors (Baer, 2004, 2006, 2008). Given the impracticality of manipulating stable character traits, researchers have recently shifted focus to a similar, yet distinct construct: state mindfulness. State mindfulness can be described as a particular mode of being attentive to the happenings of the present moment (Frewen, Lundberg, MacKinley & Wrath, 2011). State mindfulness induction training is essentially intended to draw one’s complete attention to the present experience on a moment-to-moment basis (Kabat-Zinn, 1991). Measurement of state mindfulness as collected during a guided meditation or breathing practice, typically utilizes a bell-like device to notify the individual to instantaneously rate his or her relative level of attentional control (Frewen,
Lundberg, MacKinley & Wrath, 2011). Capitalizing upon the universal capacity to
cultivate open awareness has served in the treatment of anxiety, depression, psoriasis, and
immune function (Kabat-Zinn et al., 1998). Our daily diary methodology assumed that a
daily measure of mindfulness closely approximates the state-based measure. This
research explored how mindfulness, as measured by both dispositional and daily
assessments, might relate to control beliefs and counteract seemingly inevitable age-
related declines such as memory performance.

Control beliefs, memory, and aging

Research on memory decline associated with aging need not suggest a fatalistic or
uniform pattern of aging (Lachman, 2006). While it is widely accepted that older adults
demonstrate diminished free recall abilities due to encoding deficiencies, other studies
have suggested minimal age-related differences in accuracy on item recognition memory
tasks (Ratcliff, Thapar, & McKoon, 2004). Moreover, sufficient evidence has shown that
maintaining an overall sense of control is a fundamental indicator of successful aging
(Rowe & Kahn, 1998). Relatively higher levels of overall control functionally protect
against physical and psychological decline associated with normal aging. Control beliefs,
or subjective feelings of control over desired outcomes, reportedly diminish with age
(Lachman, 2005; 2006; Krause, 2007; Krause & Shaw, 2003). Social learning theory
offers evidence as to why older adults generally report lower general and domain-specific
(i.e. memory) control beliefs (Bandura, 1961). Older adults learn through peers and
media influence to reflexively associate aging with physical frailty or cognitive declines
such as memory loss. As one grows older, this automatic internalization contributes to a
distortion of personal abilities. Namely, normal biological aging automatically appears as
the only cause of memory loss. Importantly, age-related differences in control beliefs occur with sufficient variability. Age-related stereotypes have been found to impact not only cognitive abilities but also physiological health. This phenomenon has been measured by the occurrence of later-life cardiac events (Levy, Zonderman, Slade, & Ferrucci, 2009). It has been found that control beliefs mediate the relationship between negative age-related memory stereotypes and memory performance (Levy, Hausdorff, Hencke & Wei, 2000). Mindless acceptance of insinuated physical limits associated with aging likely exacerbates performance deficits (Lachman, 2006). In contrast, mindfulness encourages responding creatively to external obstacles (Langer, 1989). Our research explored how mindfulness and control beliefs potentially interrupt the automatic and maladaptive processes hindering memory performance in older adults.

**Mindfulness and control beliefs**

Several models of mindfulness have explored the multifaceted relationship between mindfulness and sense of control. The Langer model of mindfulness describes the construct as a personal outlook based on four tendencies: novelty-seeking, engagement, novelty producing, and flexibility (Crum & Langer, 2007). Langer’s research suggests how “loosening cognitive commitments” enhances sense of control by drawing attention to situational distinctions and variability (Langer, 2009). This concept was originally explored in Langer’s landmark 1979 “counterclockwise” study. This groundbreaking experiment involved transporting elderly men to an artificial atmosphere designed to make them feel 20 years younger. Furthermore, heightening the elders’ sense of control by adjusting environmental and psychological cuing contributed to dramatic improvements in memory, mood, agility, and eyesight (Langer, 2009). A more recent
study demonstrated that chambermaids who mindfully acknowledged their everyday work as exercise, in the absence of actual behavioral changes, showed significant decreases in weight, blood pressure, body fat percentage, and body mass index (Crum & Langer, 2007). These findings suggest that in the presence of sufficient control, illusory or not, it may be possible to “think ourselves young” (Langer, 2009). The link between mindfulness and control beliefs purportedly underlies the beneficial nature of daily mindfulness as a construct worthy of study.

Control beliefs and memory performance

The function of mindfulness as related to memory performance warrants further discussion of the control beliefs-memory performance relationship. Proposed mechanisms underlying the control beliefs-memory performance relationship have thus far focused on various other factors, such as state anxiety. In the context of a challenging situation, low sense of personal control has been associated with heightened cortisol levels (Kelly, Hayslip et al., 1998). Furthermore, according to Eysenck’s Processing Efficiency theory (1992), anxiety interrupts proper working memory function by introducing peripheral distractors. Specifically, anxiety has been shown to mediate the relationship between control beliefs and episodic memory performance (Lachman & Agrigoroaei, 2011). Reducing excess performance-related state anxiety could confer certain perceptions of control.

Mindfulness and Memory Performance

Anxiety as a target of mindfulness interventions is by no means a new concept. Mindfulness athletic training programs have demonstrated repeated success in reducing performance-related anxiety (Bernier, Thienot, Codron, & Fornier, 2009). Moment-to-
moment acceptance of uncertainty and ambiguity potentially protects against the development of such performance-hindering anxiety (Langer, 2009). An open, receptive awareness of possibility purportedly buffers the individual from such influences. This is thought to occur indirectly via an increase in self-regulation and attention to variability of the present moment (Brown & Ryan, 2003). Essentially, both general and task-related control beliefs purportedly originate through a heightened awareness of one’s moment-to-moment existence. Mindfulness, one such mode of experiencing moment-to-moment existence has been shown to enhance actual self-control of attention, which in turn offers certain functional advantages (Friese, Messner & Schaffner, 2012). Maintaining a mindful disposition well into old age may be beneficial for memory, which is an important function for maintaining independence.

The present study

Aim 1 of this study investigated the relationship amongst trait characteristics including age, general control beliefs, and dispositional mindfulness. Specifically, it was hypothesized that older adults would report lower general control beliefs as compared to younger adults. Furthermore, we proposed that high dispositional mindfulness would be associated with high levels of general control beliefs. Lastly, we predicted that dispositional mindfulness would moderate the age-related differences in general control beliefs. Older adults high in dispositional mindfulness should appear more similar to the younger adults in terms of general control beliefs.

Aim 2 of this study introduced daily mindfulness into the control beliefs-performance relationship within the specific domain of memory. We sought to reexamine the relationships between age, recall and recognition memory performance, and memory
control beliefs. We further explored the potential relationship between age and daily mindfulness. We hypothesized that daily mindfulness would be positively related to recall and recognition memory performance. Furthermore, it was predicted that daily mindfulness would moderate the relationship between memory control beliefs and both forms of memory performance. Regardless of age, individuals high in daily mindfulness and high in memory control beliefs were expected to outperform others on both recall and recognition memory assessments.

Aim 3 of this study explored the intersection of the two dispositional measures on daily memory performance. Particularly, we evaluated the individual and interactive effects of dispositional mindfulness and dispositional control on daily recall and recognition memory performance. We hypothesized that both dispositional mindfulness and general control beliefs would positively associate with both recall memory and recognition memory performance. Furthermore, it was hypothesized that there would be a statistically significant interaction between general control and dispositional mindfulness across both forms of memory. Across all ages, individuals high in dispositional mindfulness and high in general control beliefs were expected to demonstrate superior recall and recognition memory as compared to those low in dispositional mindfulness and/or low in general control beliefs.
Method

Participants

Participants in this sample were 83 volunteers from across the United States, recruited via public advertising or personal contact. Participants were aged 21 to 94 ($M=50.72; SD=21.33$). This sample consisted of 56.3% women and the average level of education ranged from 5 (graduated high school) to 12 (professional or doctoral degree) ($M=9; SD=2$). A recruitment letter was sent to community organizations and churches and fliers were posted at hospitals, coffee shops, libraries, and other local domains. The recruitment message was also advertised in local newspapers. We recruited distant participants with social media posts, word-of-mouth telephone calls, and e-mail contact with participants involved in past Brandeis University research studies. Upon completion of the study, participants were offered an honorarium of $10.00 for each day the diary form was returned on time and an additional $30.00 for returning the study materials on time. Thus, participants were able to earn up to $100.00 upon completion of the study. Participants received partial payment for all completed portions of the study. Participants were excluded from the study based on the following criteria: learning the English language after age 10 or making two or more errors on the Short Portable Mental Status Questionnaire (SPMSQ) (Pfeiffer, 1975).

Materials

Demographic information and dispositional measures
Demographic information was collected during the first telephone correspondence between researcher and participant. The researcher collected data including age, gender, marital status, level of educational attainment, race and ethnicity, native language, subjective age, height and weight, and current employment situation.

Dispositional mindfulness was measured using Brown and Ryan’s Mindful Attention Awareness Scale (MAAS) (2003). The MAAS has been repeatedly validated and employed in a variety of previous studies (Brown et al., 2007). The MAAS is a 15-item scale measuring the relative presence of fundamental mindfulness qualities, with particular emphasis on individual propensity toward awareness and acceptance of present-moment happenings. The scale consists of a collection of statements regarding daily experiences. Items are rated by frequency on a 6-point Likert-type scale (1=almost always, 6=almost never). Example items include: “I find it difficult to stay focused on what’s happening in the present”, “I find myself preoccupied with the future or the past” and “I snack without being aware that I’m eating.” Composite dispositional mindfulness scores are calculated by averaging across the fifteen items. Scores range from 1 to 6 (α=.84) with higher scores reflecting relatively higher levels of dispositional mindfulness.

General control beliefs were measured using the Mastery and Perceived Constraints Scale (Lachman & Weaver, 1998). The Mastery and Perceived Constraints Scale is designed to assess general control beliefs in an adult population and has been extensively validated (Pearlin & Schooler, 1978; Lachman & Weaver, 1998). This self-administered 12-item scale evaluates two aspects of sense of control: personal mastery and perceived constraints. Sample items from the subscales include: “I can do just about anything that I really set my mind to” (personal mastery) and “There is little I can do to
change many of the important things in my life” (perceived constraints). Items are rated on a 7-point Likert-type scale (1=strongly disagree, 7=strongly agree). Perceived constraints items 3, 6, 8, and 12 are reverse scored. Personal mastery and perceived constraints subscores are calculated by summing individual items within each scale. These values are standardized and summed to produce a bi-dimensional measure of general control beliefs ranging from 1 to 7 (α=.67), with higher scores indicating higher levels of general control beliefs.

**Daily and Domain-Specific Measures**

*Recall memory* was quantified using a daily memory assessment activity. Measurement of free recall memory involved listening to a list of 15 words belonging to a specified category of the day. For all participants, categories were introduced, one per diary day, in the following order: colors, furniture, countries, sports, articles of clothing, musical instruments, and insects (Battig & Montag, 1969). Participants were asked to immediately recall the words. An immediate free recall score was calculated by rewarding one point for each correctly recalled item.

*Recognition memory* was assessed with a new list of words including both the 15 original words as well as 10 interspersed decoy words drawn from the same category (Battig & Montague, 1969). Participants were asked to respond ‘yes’ or ‘no’ if the word belonged to the original list. Using signal detection analysis, the total number of correct items (hit rate) was adjusted by the number of incorrect items (false alarm rate) to determine a corrected recognition score as originally computed by Mickley & Kensinger, (2008). A second, nonparametric measure of sensitivity, $A'$, devised by Pollack and Norman (1964) was also computed. $A'$ typically ranges from .5 (the signal cannot be
distinguished from noise) to 1 (perfect performance). A complete history as well as the mathematical derivation of \( A' \) is fully described by Stanislaw and Todorov (1999).

*Daily mindfulness* was measured using an abbreviated version of the Mindful Attention Awareness Scale (MAAS) (Brown & Ryan, 2003). The MAAS-Daily is a 5-item validated adaptation of the complete MAAS assessing engagement in mindfulness on a given day (Weinstein, Brown & Ryan, 2009). On a 6-point Likert-type scale, participants were asked to indicate the extent to which each item was experienced on that specific day (0=not at all, 6=very much). Sample items include: “I was doing something without paying attention” and “I was finding it difficult to stay focused on what was happening”. Items of the MAAS-Daily are reverse-scored then summed with higher scores reflecting relatively higher levels of daily mindfulness (1=least mindful, 6=most mindful, \( \alpha = .83 \)).

*Domain-specific memory control beliefs* were assessed using an adapted version of the domain-specific items adapted from the MIDUS questionnaire (Lachman & Firth, 2004). On a 4-point Likert-type scale, participants indicated the level of domain-specific control experienced on the day of assessment (0=not at all, 4=complete control). Control beliefs were assessed in the domains of memory, health, physical activity, schedule, social relationships, and overall control. For the purposes of this study, daily memory control beliefs were measured using only the response to the memory-specific question of control. Scores range from 0-4 with higher scores indicating relatively higher levels of daily control beliefs in the domain of memory.

**Design**
The proposed study was conducted as part of a larger collaborative project exploring aging, objective and subjective physical and cognitive health, and psychosocial wellbeing. The present study utilized only a subset of the data. Numerous other measures were collected (i.e. cognitive function, physical health, and subjective well-being) yet this research addressed the specific factors of age, mindfulness, control beliefs, and memory performance, and only those variables will be presented. The primary criterion variables of interest included general control beliefs and memory performance (both free recall memory and recognition memory measures). The predictor variables included dispositional mindfulness, daily mindfulness, general control beliefs, memory control beliefs, and age. Aim 1 of the study explored dispositional measures as related to general control beliefs. Aim 2 explored the domain of memory using average weekly measures of memory control beliefs, mindfulness, recall memory, and recognition memory. Lastly, Aim 3 explored the intersection of dispositional measures as related to daily memory performance.

**Procedure**

The study was conducted through mail and telephone contact. Researchers telephoned all participants who expressed interest in the recruitment ads and letters to conduct the prescreening process. Performance on the SPMSQ (Pfeiffer, 1975) was used to determine study eligibility. This 10-item, dementia screener gauges orientation in time and place, personal and general knowledge recall, and simple mathematics ability. Participants scoring two or more errors on the SPMSQ were deemed ineligible to participate. Ineligible participants were offered participation in future studies affiliated with the Lifespan Development lab. If eligible, individuals were offered the opportunity
to participate and were further assessed for cognitive function using the Brief Test of Adult Cognition by Telephone (BTACT) (Lachman & Tun, 2008).

Interested eligible participants were sent a FedEx package including all study materials: an informed consent form, the background questionnaire, the baseline questionnaire, and seven copies of the daily diary questionnaire along with several self-addressed, pre-stamped envelopes. The next day, participants were contacted to ensure receipt of the materials, to provide instructions for the study, and to answer any questions. Participants completed the informed consent, the background questionnaire, and the baseline questionnaire and returned these documents using the provided envelopes. Upon receipt of these preliminary materials, the researcher contacted the participant to initiate the 7-day diary portion of the study. The researcher also established a pre-specified nightly phone appointment to complete the daily objective memory assessment. Ideally, the memory testing was scheduled to take place shortly before the time of diary entry. Memory assessments were audio recorded to enable careful scoring after the session. Using the provided envelopes, participants returned each diary entry the following morning. Upon receipt of all completed daily diary questionnaires and additional study materials, participants were compensated according to the previously described schedule.
Results

Data Analysis

All data with at least two of seven potential response opportunities (i.e. participants with two or more diary entries and/or evening telephone calls) were included for statistical analyses yielding a slightly reduced sample size of N=79. For the purposes of this study, both age and level of education were treated as continuous variables. Preliminary data screening was conducted to verify the assumptions required for correlation and regression analyses. Initial data screening by means of visual scatterplot inspection ensured the approximate normality of the data and the linearity between each set of predictor and criterion variables. Using visual inspection of the residuals and VIF values respectively, we ruled out any potential heteroscedasticity or collinearity of the data. All analyses evaluated statistical significance using an alpha level of .05.

To inspect day-to-day variability, we computed bivariate correlations between days on measures of daily mindfulness (range of $r=.35-.68$), memory control beliefs (range of $r=.34-.56$), recall memory (range of $r=.23-.54$), corrected recognition memory (range of $r=.13-.67$) and $A'$ recognition memory (range of $r=.08-.77$). Given the moderate positive associations between days on all measures, scores were averaged across all days of data collection for each participant. All subsequent statistical analyses of daily, domain-specific measures utilized the average value computed across the week-long duration of the study.
Data were analyzed using correlational and hierarchical multiple regression modeling. Aim 1 hypotheses were tested using simple bivariate correlation analyses, as well as hierarchical multiple regression analysis controlling for the potential covarying effects of sex and level of education. Age and dispositional mindfulness were centered to their respective means for the creation of the interaction term. Aim 2 hypotheses similarly employed simple bivariate correlation analyses followed by step-wise hierarchical multiple regression to assess the main and interactive effects of daily mindfulness and memory control beliefs on both recall and recognition memory performance. Daily mindfulness and memory control beliefs were centered to their respective means for the creation of the interaction term. Likewise we controlled for sex, age, and level of education. Our Aim 3 hypotheses predicting memory performance were similarly tested using step-wise hierarchical multiple regression controlling for sex, age, and level of education. Predictors of daily memory performance were input in the following sequence: dispositional mindfulness, general control, and lastly the dispositional mindfulness by general control interaction term. Dispositional mindfulness and general control were centered to their respective means prior to testing the model.

**Results for Aim 1**

*Age and Dispositional Mindfulness*

Correlation analyses did not reveal a significant bivariate relationship between age and dispositional mindfulness ($\rho(78) = .13, p = .25$). Despite testing quadratic and cubic relationships, no distinct pattern arose associating age with dispositional mindfulness (Table 1).

*Age and General Control Beliefs*
As previously found in the literature, hierarchical multiple regression analysis confirmed a negative association between age and general control beliefs (see Lachman, Neupert, & Agrigoroaei, 2011). While controlling for level of education and gender, on average older adults report lower levels of general control beliefs as compared to younger adults ($\beta_{age}=-.02$, $t=-.35$, $p=.001$) (Table 2).

**Dispositional Mindfulness and General Control Beliefs**

Hierarchical multiple regression models confirmed the expected positive relationship between dispositional mindfulness and general control beliefs ($\beta_{\text{Dispositional Mindfulness}}=.60$, $t=4.47$, $p<.001$). Dispositional mindfulness predicts general control over and above level of education, sex, and age ($\Delta R^2=.17$, $\Delta F(1,75)=20.00$, $p<.001$). Those high in dispositional mindfulness reported higher levels of general control beliefs (Table 2).

**Dispositional Mindfulness by Age Interaction**

We tested the interaction effect of age and dispositional mindfulness on general control beliefs by adding the interaction term in the aforementioned model. The age by dispositional mindfulness interaction was not significant ($\beta_{age*\text{Dispositional Mindfulness}}=.01$, $t=.70$, $p=.49$). On average, those higher in dispositional mindfulness reported higher general control regardless of age.

**Results for Aim 2**

**Age and Daily Mindfulness**

Firstly, Pearson-Product Moment Correlation coefficients were calculated to test the relationships among predictor variables (see Table 1). Notably, findings revealed a significant positive relationship between age and average daily mindfulness. The Pearson
Product-Moment Correlation coefficient relating age to daily mindfulness suggested that older adults reported higher levels of daily mindfulness as compared to younger adults \((r(78)=.37, p=.001)\) (Figure 1). We had not originally posited a directional hypothesis of the age-mindfulness relationship, as the analysis was exploratory.

**Age and Memory Control Beliefs**

Simple correlation analyses did not confirm the expected negative relationship between age and memory control beliefs \((r(78)=.14, p=.20)\). Surprisingly, even once controlling for sex and level of education, in multiple regression analyses, age was still not significantly associated with average daily control over memory \((\beta_{age}=.004, t=1.01, p=.32)\).

**Daily Mindfulness and Memory Control Beliefs**

Simple correlation analyses supported the hypothesized positive bivariate relationship between daily mindfulness and memory control beliefs \((r(78)=.32, p=.004)\). Individuals with higher self-reported levels of daily mindfulness reported having a greater sense of control over his or her memory (see Table 1).

**Age and Memory Performance**

Further bivariate analyses revealed a significant negative association between age and recall memory \((r(78)=-.32, p=.01)\) (see Table 1). Moreover, once controlling for sex and level of education, age was still significantly negatively associated with recall memory \((\beta_{age}=-.03, t=-4.15, p<.001)\). There was not a bivariate association between age and either corrected recognition memory \((r(78)=-.17, p=.14)\) or \(A'\) recognition memory \((r(78)=-.08, p=.51)\) (see Table 1), consistent with some previous research (Ratcliff, Thapar, & McKoon, 2004; Ratcliff et al., 2006a, 2007, 2010). Further analysis, however
with hierarchical multiple regression, controlling for sex and level of education, revealed a significant negative relationship between age and corrected recognition memory ($\beta_{age} = -0.02$, $t=-2.43$, $p=.02$), but not between age and $A'$ recognition memory scores ($\beta_{age} = 0.00$, $t=-1.35$, $p=.18$).

**Daily Mindfulness and Memory Performance**

Contrary to predictions, correlational analyses did not show significant bivariate relationships between average daily mindfulness and recall memory ($r(78)=-.09$, $p=.45$), corrected recognition memory ($r(78)=-.10$, $p=.37$), or $A'$ recognition memory ($r(78)=-.02$, $p=.86$) (see Table 1). Likewise, above and beyond age, sex, and education, average daily mindfulness alone was not significantly associated with recall memory ($\beta_{DailyMindfulness}=-.10$, $t=-.60$, $p=.55$), corrected recognition memory ($\beta_{DailyMindfulness}=-.30$, $t=-1.47$, $p=.15$), or $A'$ recognition memory ($\beta_{DailyMindfulness}=-.01$, $t=-.76$, $p=.45$).

**Memory Control Beliefs and Memory Performance**

Contrary to predictions, the bivariate correlations between memory control beliefs and recall memory ($r(78)=.04$, $p=.74$), corrected recognition memory ($r(78)=.09$, $p=.44$), or $A'$ recognition memory ($r(78)=.16$, $p=.17$) were not statistically significant (see Table 1). Even after controlling for age, sex, and education, average memory control beliefs did not significantly predict memory recall ($\beta_{MemoryControl}=.15$, $t=.75$, $p=.46$), corrected recognition ($\beta_{MemoryControl}=.20$, $t=.83$, $p=.41$), or $A'$ recognition memory ($\beta_{MemoryControl}=.01$, $t=1.40$, $p=.17$).

**Daily Mindfulness by Memory Control Beliefs Interaction**

Further hierarchical multiple regression analyses also did not support our hypothesis that daily mindfulness moderates the relationship between memory control
beliefs and memory performance, although there was some suggestive evidence for the $A'$ measure. In predicting recall memory, neither the main effects of daily mindfulness ($\beta_{\text{DailyMindfulness}} = -.14, t = -.81, p = .42$) nor of memory control beliefs ($\beta_{\text{MemoryControl}} = .18, t = .87, p = .39$) were significant. The interaction between daily mindfulness and memory control beliefs was likewise not significant ($\beta_{\text{DailyMindfulness} \times \text{MemoryControl}} = .10, t = .49, p = .63$).

Neither the main effects of daily mindfulness ($\beta_{\text{DailyMindfulness}} = -.38, t = -1.73, p = .09$) nor memory control beliefs ($\beta_{\text{MemoryControl}} = .23, t = 1.11, p = .27$) nor the interaction ($\beta_{\text{DailyMindfulness} \times \text{MemoryControl}} = .32, t = 1.32, p = .19$) significantly predicted corrected recognition memory. Notably, while neither daily mindfulness ($\beta_{\text{DailyMindfulness}} = -.01, t = -1.15, p = .26$) nor memory control beliefs ($\beta_{\text{MemoryControl}} = .01, t = 1.47, p = .15$) alone predicted $A'$ recognition memory, the interactive effect of daily mindfulness and memory control beliefs was closer to significance as compared to other dependent measures ($\beta_{\text{DailyMindfulness} \times \text{MemoryControl}} = .01, t = .16, p = .12$) (see Figure 2). Although not significant, given this strong trend, we further examined the pattern of results. The interaction suggests that individuals high in daily mindfulness and memory control beliefs perform best with regards to $A'$ recognition memory performance. Alternatively, individuals low in daily mindfulness outperform those high in daily mindfulness in the context of preexisting low general control beliefs. Purportedly, in the presence of low daily mindfulness, memory control beliefs contribute little to predicting recognition memory performance (Figure 2).

Results for Aim 3

Dispositional Mindfulness, General Control Beliefs, and Recall Memory
In addition to the aforementioned analyses, we further explored how dispositional measures of mindfulness and general control would relate to memory performance. Hierarchical multiple regression modeling did not suggest a main effect of dispositional mindfulness ($\beta_{\text{DispositionalMindfulness}} = -0.03, t = -0.10, p = 0.92$) or general control ($\beta_{\text{GeneralControl}} = -0.12, t = -0.61, p = 0.55$) on recall memory. Furthermore, the interaction effect between these two dispositional measures did not adequately predict recall memory ($\beta_{\text{DispositionalMindfulness*GeneralControl}} = -0.004, t = -0.02, p = 0.98$).

**Dispositional Mindfulness, General Control Beliefs, and Recognition Memory**

Likewise we found no main effects of dispositional mindfulness ($\beta_{\text{DispositionalMindfulness}} = -0.01, t = -0.56, p = 0.58$) or general control ($\beta_{\text{GeneralControl}} = 0.003, t = -0.39, p = 0.70$) on $A'$ recognition memory nor any main effects of dispositional mindfulness ($\beta_{\text{DispositionalMindfulness}} = -0.24, t = -0.81, p = 0.42$) or general control beliefs ($\beta_{\text{GeneralControl}} = -0.06, t = -0.24, p = 0.81$) on corrected recognition memory. Notably however, the interaction effect between dispositional mindfulness and general control was statistically significant for both $A'$ recognition memory ($\beta_{\text{DispositionalMindfulness*GeneralControl}} = -0.02, t = -0.33, p = 0.002$) (Table 3) and corrected recognition memory ($\beta_{\text{DispositionalMindfulness*GeneralControl}} = -0.59, t = -2.78, p = 0.01$) (Table 4). Dispositional mindfulness moderated the relationship between general control and both $A'$ recognition and corrected recognition memory scores. On average, individuals with high general control beliefs but low dispositional mindfulness demonstrated better recognition memory performance as compared to all other participants. High dispositional mindfulness in the context of low general control was associated with superior $A'$ recognition memory whereas in the context of high general control, mindfulness was associated with inferior $A'$ recognition memory (Figure 3). An
identical pattern surfaced in predicting corrected recognition memory (Figure 4). This unusual finding contrasts our original predictions by suggesting that mindfulness only benefits those with low general control beliefs. Potentially, high levels of dispositional mindfulness or general control beliefs function best in the presence of low general control beliefs or low dispositional mindfulness, respectively. Higher levels of one trait demand lower levels of the alternative trait, indicating that the dispositions themselves might conflict.
Discussion

The present study partially confirmed and added to previous findings relating age, control beliefs, memory, and mindfulness. We also expanded the literature by confirming some novel interactions among these factors. Our findings support previous work (Lachman, 2005; 2006; Krause, 2007; Krause & Shaw, 2003) in that there was a negative association between age and general control beliefs. Furthermore, we found that over and above age, sex, and education, dispositional mindfulness is positively related to a general sense of control. Whereas previous studies have used applied mindfulness practices to enhance perceived control (Kabat-Zinn, 1991), the present study uniquely reveals the association between one’s naturally occurring disposition toward mindful awareness and the individual’s general sense of control over desired outcomes. Furthermore, our research confirmed that the mindfulness-control relationship is both general and domain-specific as measured by average control over memory across a seven-day time frame. To the best of our knowledge, the study of the mindfulness-control relationship has either regarded general control or utilized a state-based measure of mindfulness (Bernier et. al., 2009). We illustrate that dispositional and daily mindfulness relate positively to not only general, but also domain-specific control related to memory.

Contrary to expectations, the association between dispositional mindfulness and general control, or the “mindfulness effect” was not stronger for older adults than it was for younger adults. The generalized nature of the dispositional mindfulness and general
control beliefs measures perhaps attenuated any notable age-related differences in the “mindfulness effect”. Quite possibly, the measures of general control beliefs and dispositional mindfulness reflect individual differences within age groups rather than age differences per se.

The perplexing finding indicating no age-related differences in memory control beliefs contradicts the findings of past studies (Lachman, 2006). However, previous research did not investigate memory control on a daily basis. Thus perhaps when assessing control over memory in the context of daily life, adults of all ages experience similar levels of memory control and lack thereof. Increasing the sample size and using a multi-item assessment of memory control beliefs should each be considered in future studies exploring this relationship further.

Importantly, past research has also suggested the protective roles that memory-aid availability and strategy use play in maintaining a sense of control over memory (Lachman & Andreoletti, 2006). Further research accounting for these factors might reveal the expected and previously confirmed age-related differences in memory control beliefs.

The roles that daily mindfulness and daily memory control beliefs play in individually predicting recall or recognition memory warrant further study. Certain features of our data collection procedures and our statistical methods could underlie our inability to confirm the original hypotheses. Evening self-reports of mindfulness tendencies across the entire day potentially introduced a delay bias in which one might have overestimated or underestimated his or her true experience of moment-to-moment awareness. Furthermore, our chosen statistical approach utilized a between-subjects design, with reports averaged across the seven days of a week. Future research should explore our hypotheses from a within-person perspective, utilizing a multi-level modeling analytic approach. A within-person design might find that on days in
which one is more mindful, one performs better on memory tasks as compared to days on which one is less mindful. We would also predict better recall and recognition memory performance for days on which an individual reports higher control over his or her memory (Amrhein, Bond & Hamilton, 1999). The interaction trend between memory control beliefs and daily mindfulness should prompt further research into the precise nature of the moderating effects of mindfulness on the memory control beliefs-performance relationship. If future research confirms the observed trend, then maintaining a mindful, non-judgmental, and receptive moment-to-moment awareness in the presence of ample memory-control beliefs could offer the most promising outcome for memory maintenance.

The interaction between general control and dispositional mindfulness, although significant, contradicted our directional predictions and deserves particular attention. The cross-over interaction suggests that maintaining an openly flexible, nonjudgmental awareness of the present moment supports the recognition memory of those low in general control, yet impedes the recognition memory of those high in general control. Quite possibly, observance, flexibility, and ultra self-awareness suggests to individuals low in control beliefs that such perceptions are contextual and temporal rather than indeterminate. This unrestricted mindset could protect against undue anxiety that might interfere with the source-monitoring or sensitivity mechanisms relating to recognition memory. Alternatively, awareness of the moment-to-moment variability of controllability might directly threaten individuals with strong foundations of general control beliefs. Ensuing anxiety could actually occupy resources normally available for proper recognition memory performance. Further study should investigate why either version of the mindfulness moderation effect applies only to recognition memory and not to recall memory.
performance. We speculate that the enhanced attentional control associated with mindfulness reduces susceptibility to false decoy memory items, thus minimizing errors associated with recognition memory and inhibition of categorically-related lures. Yet, mindfulness may not facilitate the more demanding task of free recall of newly learned words.

Our exploratory analyses of age as a demographic correlate of mindfulness further contributes unique findings to the study of mindfulness. Older individuals were, on average, more mindful than younger adults, but only as measured on a daily basis. Purportedly, a repeated daily measure is more robust against one’s propensity to overgeneralize his or her mindful or mindless tendencies. Proper evaluation of age differences might demand a more sensitive measure such as that allowed by a day-by-day collection of reported mindfulness. The robust nature of the daily measure as compared with the one-time dispositional measure might offer this advantage.

Whereas previous studies have examined the role of planned mindfulness training in augmenting control beliefs, this study uniquely explored the multi-faceted relationship between naturally occurring mindfulness and both dispositional and daily measures of control beliefs and memory performance. Moreover, to the best of our knowledge, this research is the first to use a daily diary methodology to assess mindfulness. Our study suggests an innovative approach to future exploration of individual variability in mindfulness. Furthermore, the gender, age, and geographic representativeness of the sample permits reasonable generalization to the population as a whole. The external validity of our research is also grounded in previous studies highlighting the efficiency of the 7-day mail in diary method accompanied by a daily reminder (Bolger et al., 2003).
Despite these contributions, we also acknowledge a few noteworthy shortcomings in our study. Most markedly, the nature of our research employs a descriptive, non-experimental methodology. Consequently, we can only draw correlational, non-causal associations. We cannot conclude that mindfulness necessarily leads to higher general or memory control beliefs. In addition, as previously mentioned, our measure of daily memory control was based on a single item. Furthermore, participant reactivity also poses a potential limitation to our findings. Daily diary self-reports are subject to socially-desirable ratings of daily experiences, including those of control and mindfulness.

The aforementioned limitations provide a foundation for directing future research. A logical extension of our research would include analyzing within-person variation in control-beliefs, mindfulness, and memory performance. Furthermore, the theoretical framework of this study could be applied to an experimental design. Such an approach might entail a fully randomized mindfulness intervention accompanied by an immediate state memory control-beliefs assessment and subsequent recall and recognition memory tasks. Lastly, we might suggest exploring alternative demographic correlates of dispositional and daily mindfulness such as socioeconomic status, ethnicity, and religious affiliation. The practical implications of our findings suggest that enhancing memory throughout adulthood demands careful consideration of one’s innate propensity toward mindfulness as well as thorough attention to the relationship between mindful tendencies and underlying control beliefs, both general and domain-specific. Undoubtedly, protecting functional memory abilities demanded by everyday activities is a fundamental indicator of successful aging.
Table 1

Means, standard deviations, and intercorrelations between the study variables

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<th>Free recall</th>
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Notes: SD= standard deviation; Sex: 1=male, 2=female. Education is coded from 1 (some grade school) to 12 (professional degree). **p<.01. *p<.05, 2-tailed.
Table 2

Hierarchical Multiple Regression with General Control as the Dependent Variable

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Notes: Step 1: $R^2=.201$, F(3,76)=6.35, $p<.001$; Step 2 $R^2$ change=.168, $F$ change (1,75)=20.00, $p<.001$; Step 3: $R^2$ change=.004, $F$ change(1,74)=.492, $p=.485$. Sex: 1=male, 2=female. Education is coded from 1 (some grade school) to 12 (professional degree). Age and dispositional mindfulness were centered to the mean. **$p<.01$; *$p<.05$. 

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### Table 3

Hierarchical Multiple Regression with Recognition Memory ($A'$) as the Dependent Variable

<table>
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<th>Step 3</th>
<th>Step 4</th>
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<td>General control</td>
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<td>.01 (.05)</td>
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<td>mindfulness x General control</td>
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</table>

Notes: Step 1: $R^2=.16$, $F(3,74)=4.65$, $p=.005$; Step 2 $R^2$ change=.000, $F$ change (1,73)=.007, $p=.936$; Step 3: $R^2$ change=.035, $F$ change(1,72)=3.126, $p=.081$; Step 4: $R^2$ change=.105, $F$ change(1,71)=10.651, $p=.002$. Sex: 1=male, 2=female. Education is coded from 1 (some grade school) to 12 (professional degree). Dispositional mindfulness and general control were centered to the mean. **$p<.01$; *$p<.05$. 

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Table 4
Hierarchical Multiple Regression with Corrected Recognition as the Dependent Variable

<table>
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<th></th>
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<th>Step 3</th>
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<td>.34 (.15)</td>
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<td>.09 (.49)</td>
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<td>-.02*</td>
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Notes: Step 1: \( R^2 = .23, F(3,74) = 7.23, p < .001 \); Step 2: \( R^2 \) change = .004, \( F \) change(1,73) = .38, \( p = .54 \); Step 3: \( R^2 \) change = .01, \( F \) change(1,72) = .87, \( p = .35 \); Step 4: \( R^2 \) change = .08, \( F \) change(1,71) = 7.74, \( p = .007 \). Sex: 1 = male, 2 = female. Education is coded from 1 (some grade school) to 12 (professional degree). **\( p < .01 \); *\( p < .05 \).
Figure 1. The relationship between age and daily mindfulness
Figure 2. The interaction between memory control beliefs and daily mindfulness in predicting $A'$ recognition memory.
Figure 3. Interaction between general control beliefs and dispositional mindfulness predicting $A'$ recognition memory.
Figure 4. Interaction between general control beliefs and dispositional mindfulness predicting corrected recognition memory.
References


