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Exploring the Relationships Among Mindfulness, Attention and Interpretation Bias, and Depressive Symptoms in Emerging Adults

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EXPLORING THE RELATIONSHIPS AMONG MINDFULNESS, ATTENTION AND INTERPRETATION BIAS, AND DEPRESSIVE SYMPTOMS IN EMERGING ADULTS

by

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Under the Direction of Laura G. McKee, Ph.D.

ABSTRACT

Theoretical and empirical work suggesting associations between (1) mindfulness and depression and (2) cognitive biases (CBs) and depression lay the groundwork for novel questions about how to model mindfulness, how mindfulness and CBs are linked, how CBs are associated with one another, and how CBs may explain the association between mindfulness and depression. The present study derived a model of mindfulness, from which a structural model was built to explore relationships among factors in the model, including attention bias (AB), interpretation bias (IB), and depressive symptoms in a sample of emerging adults. Findings suggested a bi-factor Exploratory Structural Equation Model best fit the data. Results showed mindful non-judgment (but not attention) was related to depression through IB, but not through AB. AB was not related to depression or IB in any model. Implications for the construct of mindfulness and the role of cognitive biases in the mindfulness-depression link are considered.

INDEX WORDS: Mindfulness, Attention bias, Interpretation bias, Cognitive biases, Depression, Emerging adults, Exploratory structural equation modeling

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LIST OF ABBREVIATIONS

AB = Attention bias

AC = The acceptance factor of mindfulness

ATT = The attention factor of mindfulness

CFA = Confirmatory factor analysis

EA = Emerging Adulthood

EAs = Emerging Adults

ER = Emotion Regulation

ESEM = Exploratory structural equation model

IB = Interpretation bias

MDD = Major Depressive Disorder

NJ = The non-judgment factor of mindfulness

NJAC = The non-judgmental acceptance factor of mindfulness

SEM = Structural equation model

1 INTRODUCTION

1.1 Mindfulness – A call for research

The practice of mindfulness is rooted in religious traditions thousands of years old. Buddhism, specifically, proliferated the intentional practice of being mindful as a way to calm and control the mind (Kabat-Zinn, 2003). Recent empirical interest in mindfulness as it relates to well-being is evident in the surge of publications in the past 25 years, climbing from around 2000 instances in 1990 to 32,000 in 2015 (Van Dam et al., 2017). Despite the abundance of research on mindfulness, several problems have plagued the topic of study. For example, there has been a lack of consensus on mindfulness as a construct, along with questionably rigorous methodology. In addition, the field has perhaps rushed to apply knowledge to intervention programs before the science is sound. As a result, many mindfulness-based interventions exist in the absence of strong evidence to support their effectiveness. In response to these critiques of the literature, there has been a call for research to focus on the multi-dimensional "mental states, processes, and functions" (Van Dam et al., 2017, p. 41) that comprise the construct.

1.2 Defining mindfulness

One of the most oft-quoted definitions of mindfulness comes from Kabat-Zinn (2003); he defines mindfulness as "the awareness that emerges through paying attention on purpose, in the present moment, and nonjudgmentally to the unfolding of experience moment by moment" (p. 145). Despite this widely accepted theoretical conceptualization, researchers have used mindfulness as an umbrella term to encompass a range of concepts and practices. For instance, the mindfulness literature includes research on mindfulness as a trait, as a state, and as an active ingredient in interventions that incorporate a variety of meditation and mindfulness-informed practices (e.g. meditation, yoga, tai chi, etc.). The lack of a consensus definition is reflected in

the myriad measurement tools utilized, variable factor structures identified, and range of methods for operationalizing the construct (Van Dam et al., 2017). As of 2016, the research canon included 11 different self-report questionnaires measuring mindfulness, 9 of which were reviewed by Van Dam et al. (2017). While theoretical discourse often uses the term "mindfulness" to reference a cohesive construct consisting of attention and acceptance, there is inconsistency in the factor structure of mindfulness across questionnaires. Only three of the nine included in Van Dam et al.'s review found support for a two-factor structure (PHLMS, TMS, SMS), one of which reflected the two separate factors of attention and acceptance (PHLMS). To add to the confusion, there was great variability in whether mindfulness was modeled as a latent, overarching factor. In sum, although mindfulness is often talked about in a similar way (attention to the present moment without judgement), there is no consensus in the research canon about how to model or measure it.

To address some of the questions about the construct of mindfulness, Coffey et al. (2010) built on previous work by Baer et al. (2006) to derive a measure of mindfulness empirically. This work specifically examined dispositional mindfulness, which has been shown to exist in varying amounts in all people (Gilbert & Christopher, 2010). Baer et al. developed the Five Factor Mindfulness Questionnaire (FFMQ) to test and confirm the factor structure of mindfulness by conducting a series of factor analyses that included items from multiple mindfulness measures. Coffey and colleagues built upon Baer's work and used a series of exploratory, confirmatory, and path analyses to create "a revised model for mindfulness' mechanisms of action that accounts for the multi-faceted nature of the construct" (p. 238). Their empirically-derived model includes two main factors – attention and acceptance – but not an overarching latent mindfulness construct. Attention can be understood as present moment focus on emotions, physical

sensations, and experience of the external environment. Non-judgmental acceptance is defined as the opposite of judgmental, self-critical, non-acceptance of internal experiences that are unpleasant. Coffey et al.'s findings support the conceptualization of attention and acceptance as multi-dimensional indicators of mindfulness and point to the importance of testing specific effects of these factors as separate dimensions in future models.

These findings are in line with Bishop et al.'s (2004) theory, which proposes that mindfulness includes multiple multi-dimensional processes, namely attention and acceptance. However, while Coffey and colleagues (2010) identified mindfulness as collectively consisting of these two factors, they relied on subscales from existing measures to indicate them, rather than deriving their own subscales using all available items. In other words, the attention factor was indicated by the pre-identified attention subscale, and the two subscales of acceptance and non-judgement were used to indicate a non-judgmental acceptance factor. Further, they did not test an overarching (latent) mindfulness factor. In fact, they found that the attention and non-judgmental acceptance factors were uncorrelated. They did, however, suggest an overarching factor visually by grouping the attention and acceptance factors together in a single box labeled "mindfulness" (p. 243). The current study draws from the foundational work of Coffey et al. (2010) and takes a different approach to explore the factor structure of mindfulness. Namely, we utilized all items from the potential scales to explore the factor structure of mindfulness. In doing so, we assessed their conceptualization of mindfulness as consisting of two multi-dimensional "attention" and "non-judgmental acceptance" factors while also exploring the possible existence of a higher order mindfulness factor.

1.3 Mindfulness and depression

Dispositional mindfulness has been associated with a range of positive outcomes, including global mental health, and has also been negatively associated with psychopathology. Specifically, trait mindfulness has been found to negatively relate to depression (Jimenez, Niles, & Park, 2010; Way, Creswell, Eisenberger, & Lieberman, 2010), a chronic, episodic condition involving negative mood as well as physical and cognitive symptoms associated with severe impairment (American Psychiatric Association, 2013). A meta-analysis examining mindfulness training on depression revealed large effect sizes (Hofmann, Sawyer, Witt, & Oh, 2010), and mindfulness interventions have demonstrated reduced risk for relapse of major depressive disorder through randomized control trials (Creswell, 2015). As Coffey et al. (2010) point out, these important findings frame the study of dispositional mindfulness as worthwhile, in that it will advance understanding about both the construct of mindfulness and the mechanisms by which it is associated with mental health broadly, and depression, specifically.

Studies designed to delineate the mechanisms involved in the association between mindfulness and depression have identified (1) the generation of positive emotions, (2) belief in one's ability to regulate emotions and repair mood, (3) self-acceptance, and (4) rumination, as some of the significant mediators of the relationship (Jimenez et al., 2010; Petrocchi & Ottaviani, 2016). Other studies have shown that dispositional mindfulness is related to the ability to regulate negative affect via mediating variables such as clarity about internal experience and being able to see that happiness does not depend on the external world (Coffey et al., 2010). However, research exploring the role of cognitive biases, like attention and interpretation biases, in the relationship between mindfulness and mental health is lacking. This is significant in light of the robust association between cognitive biases, which can be defined broadly as mental

mistakes or systematic errors in cognition (Beck, 2008; Kahneman & Tversky, 1973), and depression. The current study begins to fill this gap in the literaure by investigating the relations among mindfulness, cognitive biases (i.e., attention and interpretation biases), and depression. This approach may also add value to the mindfulness research canon by identifying cognitive processes associated with mindfulness that do not rely on the self-report format of the mindfulness assessments typically employed (Quickel, Johnson, & David, 2014).

1.4 Depression in emerging adulthood

As the second most prevalent mental illness, depression is a serious public health concern. Depression ranks as the 19th most common disease worldwide, and it is estimated that 16% of people will experience an episode of Major Depressive Disorder (MDD) in their lifetime (Kessler et al., 2005). In addition to being prevalent, MDD has a negative impact on individual suffering and mortality, families, and society. In fact, individuals with depression are 20-27% more likely to commit suicide and twice as likely to die prematurely from all causes compared to their healthy counterparts (Lépine, 2011). Furthermore, depression is second only to back pain as the leading cause of disability worldwide (Kessler et al., 2015) and is predicted by the World Health Organization to be the leading cause of disease burden by 2030 (Lépine, 2011). In addition to increases in suffering and mortality, the functional and social impairments resulting from depression impact job stability and overall income. Alarmingly, work absence or impaired performance resulting from depression is estimated to cost the US $36.6 billion dollars every year.

The impact of depression is arguably even larger during emerging adulthood (EA), a key period of development from around ages 18 to 30 (Arnett, Žukauskiene, & Sugimura, 2014), during which depression often emerges (De Girolamo, Dagani, Purcell, Cocchi, & McGorry,

2012). Specifically, the prevalence of depression is estimated at 30.6% in university students (Ibrahim, Kelly, Adams, & Glazebrook, 2013), almost twice that of the general population. Further, the number of undergraduate and graduate students reporting depressive symptoms severe enough to impair functioning is on the rise, from 14.8% in 2008 to 18.8% in 2018 (American College Health Association, 2009, 2018). Given the recurrent and chronic nature of depression (Gotlib & Joormann, 2010), its potential to impact emerging adults (EAs) is especially significant, as depression during this important developmental period can lead to a life-long cascade of negative events interfering with social relationships, academic and career success, and emotional and physical health (Bruffaerts et al., 2018; Ibrahim et al., 2013). For example, depression has been found to negatively predict exam performance in university students (Wilding, Andrews, & Wilding, 2016), and students with mood disorders have been found 2.9 times more likely to fail out of college compared to students without a mood disorder (Kessler, Foster, Saunders, & Stang, 1995). As is clear from these recent statistics, this developmental period of EA, characterized by identity exploration, self-focus, instability, and "in-between-ness" (Arnett et al., 2014), deserves focused attention with respect to mental health, broadly, and depression, specifically.

The high rate and cost of depression in EAs suggest that efforts aimed at better understanding factors that influence vulnerability, such as cognitive biases, are imperative. Doing so at this point of developmental transition where depression can impact trajectories makes this endeavor especially worthy of pursuit. Equally important is research that uncovers factors associated with lower depression risk, or depression resilience factors. Beginning in the 1960's, researchers began exploring resilience, and the field saw such studies proliferate during the 70's and 80's, followed by subsequent waves of resilience research that have led to a shift

away from frameworks based solely on risk factors towards those based on strengths (Masten & Monn, 2015). This transformation in theory, research, and practice demonstrates the value of such exploration and speaks to the need for continuing research on resilience.

In line with this call to uncover factors that confer vulnerability to depression as well as factors that may act to protect or inoculate individuals from experiencing the symptoms, the present study (1) explores mindfulness, one potential depression resilience factor that has received much attention in the literature, (2) as it relates to cognitive bias, a well-documented vulnerability factor, (3) in a model predicting depressive symptoms in EAs. In the following sections, theoretical and empirical work suggesting the associations between (1) mindfulness and depression and (2) cognitive biases and depression lay the groundwork for novel questions: what is the empirical structure of mindfulness? how are mindfulness and cognitive biases linked? how are cognitive biases associated with one another? and how might cognitive biases explain the association between mindfulness and depression? The current study explores the possibility of an overarching mindfulness factor that consists of sub-factors and proposes that these sub-factors differentially relate to cognitive biases and depression. Further, the cognitive biases of attention and interpretation are proposed to indirectly affect the relationship between mindfulness and depression in EAs. While robust findings support the connections between mindfulness and depression, and separately, attention and interpretation biases and depression, there is limited research on the relationship between mindfulness and attention and interpretation biases, and support is even more scarce when considering how this relationship may be associated with depression.

1.4 Cognitive biases in depression

1.4.1 History and theory of cognitive biases in depression

Over the past several decades, researchers exploring the etiology of depression have focused on the role of cognition, proposing that a key contributing factor to depression development, maintenance, and relapse is the biased processing of emotional information that results in sustained negative attention and emotion dysregulation (Hilland et al., 2018). Cognitive theories of depression have a long history, and two of the most common cognitive mechanisms found to be atypical in people with depression are biases in the types of information that is attended to (attention biases) and how that information is interpreted (interpretation biases).

Cognitive models of depression purport that the onset and maintenance of depressive symptoms are causally connected to distorted thoughts and biased information processing. Such models operate within a diathesis-stress framework, wherein depression results from negative affective states that stem from the activation of maladaptive underlying schemas, which are triggered by stressful life events or negative moods (Joormann, Talbot, & Gotlib, 2007b). Such an approach prioritizes the role of information processing in maladaptive emotional responses, and has grown largely from Beck's Cognitive Schema Theory (Beck, 1967), along with Bower's Associative Network Theory (1981; De Raedt & Koster, 2010), and the more recent dual-process models proposed by Sheppard and Teasdale (2000) and Beevers (2005; Beck, 2008). All in all, cognitive theories of depression emphasize the role of biased attention, interpretation, and memory. This section will briefly explore cognitive models of depression vulnerability in order to expose the reasons that mindfulness and cognitive biases may be associated.

1.4.1.1 Beck's cognitive model for depression. Incorporating previous theories of depression vulnerability, Beck (2008) described an expanded, comprehensive cognitive model for depression. According to Beck's re-formulation, cognitive vulnerability to depression originates with early negative life events that contribute to the development of dysfunctional

attitudes, which are organized in negative cognitive schemas reflecting themes of worthlessness, loss, and failure (Beck, 2008; Beevers, 2005). These maladaptive schemas, when triggered by activating events or moods, are thought to bias how information is attended to, interpreted, and remembered (Beck, 2008; De Raedt & Koster, 2010). Influenced by Bower's (1981) Associative Network Model of Learning and Memory, Beck describes how the negative schemas become further organized into a "depressive mode" once they have been activated time and again. This depressive mode also includes schemas around behavior and motivation, in addition to mood. If a negative event is powerful enough (or enough small negative events accumulate), this depressive mode takes over information processing, making it happen automatically and reflect negative attentional and interpretation biases, while any cognitive control that could correct these biases is suppressed. Depression ensues, the symptoms of which are then similarly evaluated through a negative lens, thereby fueling a negative feedback loop (Beck, 2008).

1.4.1.2 Dual-process models. While the initial activation of information processing networks is thought to contribute to depression vulnerability and severity, the way an individual responds to initial activation is also thought to be important and sheds light on depression in the context of dual processes. Dual process models originated in the fields of social and personality psychology, where they were used to describe cognition according to two distinct but interrelated modes by which humans process information. Fast, automatic processing that relies on solidified network associations, as described above, is the work of the associative mode. The reflective mode on the other hand, is slow and requires deliberate effort, intentionally activated in the face of violated expectancies (Beevers, 2005). Only recently have dual process models been more widely extended to clinical frameworks (Beck, 2008). Sheppard and Teasdale (2000), for instance, postulated that maladaptive thoughts in depression stemmed both from heightened

access to negative schemas, which would fit within the associative processing mode, and from a decreased awareness of the resulting thoughts and feelings, which can be understood as a failure of the reflective mode, or what they referred to as metacognitive monitoring (De Raedt & Koster, 2010). A similar two-process framework of depression was more recently put forth by Beevers (2005), who proposed that the failure of reflective processing to correct negatively biased associative information processing is specifically what contributes to depression vulnerability (Beck, 2008). Cognitive vulnerability to depression, therefore, stems from associative processing of attention, interpretation, and memory that biases self-referential processing negatively. Reflective processing has the potential ability to correct this negative processing by intentionally shifting attention to unrelated positive networks, but left uncorrected, negatively biased self-referent processing can cascade into depression (Beevers, 2005).

1.4.2 Research support for cognitive biases in depression

Several decades of research have instantiated various aspects of biased information processing theorized across these cognitive models of depression (Gotlib & Joormann, 2010). Initial studies provided evidence that the content of thoughts differed between people with and without depression (Gotlib & Joorman, 2010). Specifically, research has revealed stronger ties to self-referential and general information processing of a negative valence in depressed people. The strength of this bias corresponds to depression chronicity and persists despite symptom remission (Beevers, 2005; Mathews and McCloud, 2005). More recently, research has tested Beck's proposal that maladaptive automatic information processes implicated in depression would reveal themselves through cognitive biases seen in attention, memory, and interpretation (Gotlib et al., 2004). Research has demonstrated that, indeed, biases towards attending to negative content, negative automatic thoughts, a tendency to remember negative events more

than positive ones, and a trend towards interpreting neutral events negatively are all implicated in the onset and maintenance of depression (Fritzsche et al., 2010; Gotlib & Joorman, 2010; Mathews & MacLeod 2005). Further, these biases have also been found in children who have a mother with depression, before any of their own symptoms emerge (Joormann et al., 2007b), suggesting they may play a causal role in depression etiology.

1.4.2.1 Research support for attention biases in depression. When specifically considering the role of attention biases in depresion, a recent meta-analysis confirms that people with depressive symptoms demonstrate skewed attention favoring negative content (Everaert, Koster, & Derakshan, 2012). Other research has demonstrated that negatively biased attention in depressed individuals results from increased difficulty inhibiting attention toward negative information (Everaert et al., 2012). Thus, some research suggests that people with depression preferentially focus their attention on negative stimuli, while other research shows that depressed individuals may not initially attend to negative information more often than controls, but do have difficulty disengaging from it once their attention is captured (Gotlib & Joormann, 2010). In eye tracking studies, for example, depressed participants didn't detect negative information more readily than non-depressed controls, but they did look at pictures depicting negative emotions (loss, sadness) significantly longer (Gotlib & Joormann, 2010). In addition to attention biases resulting from difficulty disengaging from negative information, depressed individuals have also been found to avoid positive content (Peckham, McHugh, & Otto, 2010), which is in opposition to healthy controls, who not only demonstrate a lack of negatively biased attention but actually exhibit attention biases towards positive information (Joormann, Talbot, & Gotlib, 2007a).

1.4.2.2. Research support for interpretation biases in depression. Along with biases in attention, the literature supports Beck's hypothesis that depressed individuals demonstrate biases

in how they interpret stimuli. While some discrepancies exist, findings largely hold that people with depression tend to interpret ambiguous situations negatively, compared to non-depressed controls (Bisson & Sears, 2007). For instance, participants with clinically elevated depressive symptoms have been found to favor negatively-biased reactions to hypothetical situations, and dysphoric participants have shown more agreement with negative self-relevant feedback than controls (Wisco, 2009).

Although promising, findings such as these have been criticized for relying solely on self-report methods, with critics noting that negative response choices may reflect a response bias and not an interpretation bias per say. In other words, it is possible that depressed participants may differ from non-depressed participants according to the responses they *report*, with depressed participants reporting more negative interpretations, which may or may not accurately reflect initial processing (Mogg, Bradbury, & Bradley, 2006). However, negative interpretation biases have also been identified in depressed individuals using experimental methods designed to address this shortcoming. For example, the scrambled sentences task (SST) was developed to test the hypothesis that depressed individuals are more inclined to demonstrate a negative automatic interpretation bias under cognitive load (Hindash & Amir, 2012). In this task, 20 sentences with scrambled words are presented, and the participant must arrange the words in order to create a grammatically correct sentence. Negative and neutral sentences are both possible outcomes, and negative bias is determined by the number of negative sentences constructed during the allotted time (Hindash & Amir, 2012). Research employing the SST has identified negative interpretation biases in currently and formerly depressed individuals (Hindash & Amir, 2012) and shown them to predict future depressive symptoms. Dearing and Gotlib (2009) used a similar task consistent of self-relevant ambiguous scenarios and found a negative interpretation bias in never-depressed

high-risk daughters of mothers with depression, supporting the causal role that negative interpretation may play in depression (Hindash & Amir, 2012). Using another experimental paradigm employing images of faces that morphed from ambiguous to either happy or sad expressions, Beevers et al. (2009) found that dysphoric participants were more inclined to interpret mixed happy-sad emotions as sad compared to non-dysphoric controls. Taken together, it is clear that negative interpretation biases are evident in depression, though additional research using robust experimental paradigms is needed.

1.4.2.3 The combined cognitive bias hypothesis. Although attention and interpretation biases have both been identified independently in currently depressed and at-risk participants, only recently have scientists begun to theorize and test how these biases are related to each other. The Combined Cognitive Bias (CCB) Hypothesis (Hirsch, Clark, & Mathews, 2006) proposes that cognitive biases interact and reciprocally influence each other, and that collective biases impact depression more than any individual isolated bias. Specifically, the CCB Hypothesis posits that the challenge of disengaging from negative stimuli, exhibited as negative attention bias in depression, informs how those stimuli are interpreted, and in turn, remembered. Empirical tests of the CCB hypothesis demonstrate that in sub-clinical samples, negative attention biases are associated with higher negative interpretation biases and, in turn, more negatively biased memory (Sanchez, Duque, Romero, & Vazquez, 2017). Furthermore, Everaert, Tierens, Uzieblo, and Koster (2013) have shown that attention bias influences memory bias indirectly through interpretation bias. Interestingly, in this study, interpretation and memory biases related to depression, but attention biases did not, suggesting that even when some cognitive mechanisms are not directly related to depression, they can impact other levels of processing that are. However, a more recent study found all three biases related to depression severity, as well as to

each other (Sanchez et al., 2017). This same study advanced the understanding of CCB models by comparing two potential models of attention, interpretation, and memory biases as they relate to depression. Findings suggest that negative interpretation bias plays a key role in depression severity, and the model in which negative attention bias predicted interpretation bias was the most robust (Sanchez et al., 2017). While such findings advance an understanding of the relationships among cognitive biases and depression, additional research is needed to (1) clarify discrepancies about the relationship between cognitive biases and depression, and (2) further explore whether attention bias precedes interpretation bias (as was suggested by Sanchez et al., 2017), vice versa, or whether they occur simultaneously or through other information processes. Regardless of nuances in the mechanisms, it is clear that biases in both attention and interpretation are in some way associated with the etiology and maintenance of depression. The study at hand offers additional clarification on the nuances of these relationships.

1.5 Mindfulness, cognitive biases, and depression

While research demonstrates that cognitive biases and mindfulness both relate to depression, there are different potential models that may explain associations (1) between mindfulness and cognitive biases, and (2) among mindfulness, cognitive biases, and depression. Despite clear theoretical ties between mindfulness and cognition, there is a dearth of empirical work examining the cognitive underpinnings of mindfulness, especially relative to studies of cognitive biases and depression that have accumulated over several decades. Furthermore, how these variables interact with each other in relation to depression is almost entirely unexplored.

1.5.1 Mindfulness and cognitive biases

As mentioned above, mindfulness, as operationalized by Bishop et al. (2004), is grounded in self-regulating attention and awareness of experience through an accepting and open lens,

which are both mechanisms of cognition (De Raedt et al., 2012). This conceptualization is consistent with Mayer et al.'s (2018) discussion of mindfulness using the term "Beginner's Mind," referencing the capacity to perceive each experience as novel, without biases. Some evidence supporting the relationship between mindfulness and cognitive biases comes from examining cross-sectional relations, while other evidence comes from testing changes in information processing among individuals who have engaged in mindfulness training. For example, mindfulness interventions, such as Mindfulness Based Stress Reduction (MBSR), have demonstrated reductions in negative cognitions and dysfunctional attitudes for intervention participants relative to controls (De Raedt et al., 2012; Desrosiers, Vine, Klemanski, & Nolen-Hoeksema, 2013). Relatedly, an inverse association between mindfulness and negative cognitions has been documented, along with a positive association between mindfulness and openness to positive information (De Raedt et al., 2012).

1.5.2 Mindfulness, cognitive biases, and depression

We have some evidence, cited above, that mindfulness and general cognitive biases are associated. We now turn to more theoretical perspectives that make the case that the facets of mindfulness (present-moment attention and non-judgmental acceptance) are almost, by definition, interwoven with the cognitive processes of interest (attention and interpretation), and thus, may impact depression via these cognitive biases.

1.5.2.3 Present-moment attention and depression. Present-moment attention, in the context of mindfulness, is defined as attending to external and internal stimuli as they rise and fade away. This means focusing attention on present internal and external sensory experiences (i.e., thoughts, emotions, physical sensations), and learning to retrain one's attention to stay focused rather than allowing the mind to wander or fixate (De Raedt et al., 2012). Studies have in

fact shown that present-moment attention is related to fewer thoughts about the past and future (Brown, Ryan, & Creswell, 2007; Xu, Purdon, Seli, & Smilek, 2017); as such, mindfulness may be inversely associated with depression via reduced reliance on biased self-schemas and self-concepts that are built on historical influences (Gilbert & Christopher, 2010). Such attention further allows one to be present to and notice the experience of all sensations and emotions (positive, negative, and neutral) as they arise and fade away. It is plausible then, that greater levels of mindfulness may relate to lower levels of depression through less biased attention.

1.5.2.4 Present-moment attention, non-judgmental acceptance, and depression. Some theory suggests that for present moment attention to be beneficial, it must be paired with non-judgmental acceptance, which inhibits attachment to stimuli brought into the field of awareness, allowing them to pass, and creating space for other stimuli to enter. In fact, present moment attention may actually be harmful for people who are not able to respond non-judgmentally (Desrosiers et al., 2014). Consider, then, that it is not just noticing internal and external stimuli that makes a difference, but the non-reactive stance that emerges in response to that noticing (Coffey et al., 2010). As Desrosiers et al. (2014) explain, "it matters not only whether individuals tend to observe their experiences, but also the way in which they observe" (p. 32). Consider that the acceptance of emotions and stimuli brought into awareness may lead people to be more acutely aware of shifting affective indicators, including errors and affective responses to errors, better equipping them to respond with action (Teper, Segal, & Inzlicht, 2013). A wider awareness of initial sensory information reveals a greater range of possible interpretations of the given situation, but it is the non-judgmental awareness factor that produces un-biased interpretations. In this way, mindfulness may serve as a mechanism for reflective processing or cognitive control that corrects automatic processing biases, according to Beck

(2008) and Beevers' (2005) dual-process cognitive model of depression. Evidence supporting this demonstrates how it is only for people who are highly reactive (signaling low non-judgmental awareness) that observing is associated with depressive symptoms (Desrosiers et al., 2014).

1.5.2.5 How attention and non-judgmental awareness interrupt cognitive biases. The essential nature of the non-judgmental awareness dimension of mindfulness in the interplay between cognition and depression is supported by a study that found higher trait mindfulness to be associated with making fewer cognitive errors, above and beyond what attention accounted for (Herndon, 2008). This signifies cognitive errors as important to consider when trying to understanding how mindfulness may be related to depression, and further indicates the importance of non-judgmental awareness, which facilitates an open-minded and curious approach to experiences, regardless of whether or not they are unpleasant (Cameron & Fredrickson, 2015). In this way, mindful attention and non-judgmental awareness expand the landscape of information to be processed, which allows all information equal "weight" for interpretation, thus reducing cognitive biases. Gilbert and Christopher (2010), indeed, discovered that a significant relationship between negative cognitions and depression was only present in individuals low in mindfulness. Further support comes from research showing that attention significantly predicts depression via an increase in the cognitive bias of rumination, but only for highly-reactive people (those low in non-judgmental awareness; Desrosiers et al., 2014). In other words, mindful attention and non-judgmental awareness short-circuit restricted attentional focus that impairs cognitive performance and triggers conditioned patterns of behavior that lead to habitual identification with and reinforcement of negative emotions (Chambers, Gullone, & Allen, 2009). Put another way, mindful attention and nonjudgmental acceptance together

interrupt the cognitive processes that predict depression (Gilbert & Christopher, 2010). The current study, therefore, explores mindfulness as a construct reflecting both attention and non-judgmental awareness, which is hypothesized to be related to depression, via biased attention and interpretation.

1.5.2.1 Mindfulness, attention bias, and depression. What empirical evidence links specific cognitive biases (i.e., attention, interpretation) with mindfulness and depression? Although very little research has examined mindfulness, attention bias *and depression*, one study (Gilbert & Christopher, 2010) found a significant relationship between negative cognitions and depression only in participants with low levels of mindful attention; in other words, those high in mindful attention were protected from depression. Similarly, De Raedt et al. (2012) demonstrate that lower levels of mindfulness are related to greater attention towards negative stimuli and higher levels of depression severity. Higher mindfulness, alternatively, is associated with a reduction in the inhibition of positive information. Second, mindfulness practices have been found to reduce habitual responding and decrease rumination (Kiken & Shook, 2011), which is a kind of negative attention bias common in depression. People who are higher in mindfulness have lower levels of depression because they ruminate less (Desrosiers et al., 2013).

1.5.2.2 Mindfulness, interpretation bias, and depression. The relationship between interpretation bias and mindfulness has even more limited support in the literature. Kiken and Shook (2011) conducted a randomized control trial that found participants in the brief mindfulness intervention condition demonstrated more accurate categorization of positive and negative stimuli than controls. Interestingly, this resulted from more accurate classification of positive stimuli, which corresponded to a unique increase in optimism. These findings suggest that mindfulness is indeed associated with more accurate and less negatively biased

interpretations. The indirect effects of interpretation bias on the association between mindfulness and depression have been the subject of only one study to date (Mayer et al., 2018). In this study, the authors modeled interpretation bias as indirectly impacting (mediating) the relationship between mindfulness and depression. They found a significant negative relationship between mindfulness and interpretation bias, and a positive relationship between interpretation bias and depression. When interpretation bias was included in the model, there was a reduction in the strength of the direct relationship between mindfulness and depression, which provided support for the role of interpretation bias as a partial mediator of the mindfulness-depression relationship. The current study seeks to replicate these findings using an empirically-derived measure of mindfulness, while simultaneously considering attention bias.

1.5.3 Mindful attention and non-judgmental acceptance may relate to depression through distinct cognitive biases

One question addressed in the current project is whether mindfulness is best modeled as (1) a unitary, multidimensional construct (i.e., a latent variable indicated by mindful attention and non-judgmental acceptance) or (2) two separate, but related constructs. Some theory suggests that attention and non-judgmental awareness may achieve their greatest impact on the association between cognitive biases and depression by existing together as a unified mechanism, but other data suggest a likelihood that mindful attention and non-judgmental acceptance will each impact this association differentially, potentially even through specific cognitive biases. In support of a unified model, consider that non-judgmental acceptance leads to un-biased interpretations, but only in response to a broadened awareness of initial stimuli resulting from mindful attention, that increases the breadth of interpretation possibilities. Other evidence, however, suggests that mindfulness is best modeled by distinct, potentially unrelated,

components. For example, some work demonstrates that these separate components of attention and non-judgment work through different neural pathways: attention operates bottom-up in the brain and non-judgmental awareness works top down, apparent in mirrored physiological functioning, suggesting that the two factors of mindfulness may predict depression differentially through different cognitive biases (Chiesa, 2013; Creswell & Lindsay, 2014). In predicting depression then, it may be specifically through attention bias that mindful attention has an impact, whereas non-judgmental acceptance may impact depression more strongly through interpretation bias stemming from less biased initial attention. For instance, Mayer et al. (2018) found that the non-judgmental awareness subscale of the Five Factor Mindfulness Questionnaire (FFMQ) correlated with interpretation bias and depression, but the Observe (mindful attention) subscale did not. Further, interpretation bias was found to be a partial mediator of the relationship between non-judgmental awareness and depression, but not between depression and observation (Mayer et al., 2018). Furthermore, at least one attempt to model mindfulness has suggested that mindful attention and non-judgmental acceptance best remain separate, unrelated dimensions (i.e., Coffey et al., 2010). The study at hand therefore proposes both (1) to uncover the factor structure best supported by the data and (2) to test the hypothesis that the multiple dimensions of mindfulness relate differentially to depression through different cognitive biases.

1.6 The present study

Mindfulness interventions are receiving increasing attention in pop-culture and intervention development, but questions remain regarding how best to model mindfulness. Furthermore, although dispositional mindfulness is related to lower levels of depression, a significant problem during EA, little is known about the mechanisms that explain the association, which could provide insight into prevention and treatment efforts. Theory, along with limited

research, support the idea that mindfulness relates to depression indirectly via attention and interpretation biases, but only one study has examined such a model, and then only with interpretation bias. Given that attention and interpretation biases both relate to depression and have been shown to relate to one another temporally (attention bias is associated with interpretation bias, which is in turn associated with depression; Sanchez et al., 2017), the current study proposes to examine the indirect effects of attention and interpretation biases on the relationship between mindfulness and depression. Further, the present study proposes to examine whether the attention and non-judgmental awareness factors of mindfulness relate differently to attention and interpretation biases, or if a unified mindfulness factor consisting of both achieves a greater effect.

1.6.1 Aim 1

Theory suggests that both mindful attention and non-judgmental acceptance are integral to the construct of mindfulness (Bishop et al., 2004), however the existence of these two factors of mindfulness and the existence of mindfulness as a latent construct need more empirical attention. Aim 1 will use advanced statistical modeling techniques to uncover the factor structure of mindfulness as it best fits with the current data. The structure of mindfulness identified by Coffey et al. (2010) that indicates the existence of separate attention and non-judgmental acceptance factors will be more thoroughly assessed using the full scale of items. Further, the existence of a unified mindfulness factor will be tested.

1.6.2 Aim 2

Using the model generated from Aim 1, Aim 2 will examine the relationships among mindfulness, the cognitive biases of attention and interpretation, and depression; no prior studies have considered the indirect effects of both attention and interpretation biases on the

mindfulness-depression link. As such, the current study will examine separate models exploring the order of attention and interpretation biases in the pathway between the factors of mindfulness and depression. Broadly, it is hypothesized that a model with mindfulness (using the factor structure identified in Aim 1) predicting attention bias followed by interpretation bias, and in turn depressive symptoms, will fit better than a model where interpretation bias precedes attention bias in mediating the mindfulness-depression link.

1.6.3 Aim 3

The third aim of the present study is exploratory in nature. In Aim 1, the structure of mindfulness will be identified and utilized in Aim 2 to test the directional relationship between positive and negative attention and interpretation biases in the context of mindfulness and depression. Depending on what emerges from analyses in Aim 1 (i.e., if a unified mindfulness construct is indicated), it may be necessary to use the separate the dimensions of mindfulness, rather than a latent mindfulness variable, to facilitate exploration of the specific differential associations between the facets of mindfulness and the two cognitive biases. Namely, we will investigate the specificity of the associations between the individual facets of mindfulness and depression via their unique contributions to attention and interpretation biases. We propose that mindful attention will be more strongly associated with attention bias, and non-judgmental acceptance more strongly associated with biased interpretation. Again, in light of previous research revealing different results with negative and positive cognitive biases, the present study will consider models examining positive and negative biases separately.

2 METHODS

2.1 Participant sample and recruitment

Archival data from the Picture This! randomized control trial, designed to assess the

efficacy of a technology-based positive psychology intervention, were utilized. A sample of 258 EAs, including undergraduate and graduate students, was recruited between 2013 and 2015from a northeastern university and the surrounding area, using the psychology subject pool, flyers, and online advertisements. Participants with mental health concerns were targeted via flyer placement at the university counseling center. Eligibility requirements for the study included (1) being at least 18 years of age, (2) enrollment in a local college or university, (3) possession of a smartphone with daily internet access, (4) willing to participate for the duration of 21 days, and (5) capable of returning 4-5 weeks after baseline assessment to complete a follow-up visit.

2.2 Procedure

Eligible participants provided informed consent prior to completing approximately 1.5 hours of baseline questionnaires and computerized assessments. As part of the larger trial, participants also completed online surveys daily for 21 days, and returned approximately 30 days post baseline to complete follow-up questionnaires and computer assessments. Only data collected during the baseline assessment were used in the present study.

2.3 Measures

2.3.1 Demographics and mental health history

A self-report questionnaire created for this study was used to collect information about participant sex, age, and race/ethnicity.

Table 1 Demographic characteristics of sample (n = 258)

Variable	Mean	SD	Percent
Age (years)	19.85	2.31	
Female (%)			75.2
Race/Ethnicity			
Caucasian			74.8
African-American			3.1
Latino			8.1
Other			14.0

2.3.2 Mindfulness

Mindfulness was measured using the Carolina Empirically Derived Mindfulness Inventory (CEDMI; Coffey, Hartman, & Fredrickson, 2010). This measure consists of thirty-two self-report items reflecting three subscales. Items are scored on a Likert scale from 1, "never or rarely true," to 5, "very often or always true" and items on two of the scales are reverse coded so that higher levels of mindfulness are indicated by higher sum scores. In the development of the CEDMI, Coffey et al. (2010) identified eight items from the Non-judgmental Acceptance subscale of the FFMQ (e.g., "I tell myself that I shouldn't be thinking the way I'm thinking" [reverse-scored]), and six items from the Acceptance subscale of the Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004; e.g., "When I'm upset, I become embarrassed for feeling that way" [reverse scored]) to indicate a latent factor reflecting non-judgmental acceptance, understood as reflecting one's ability to non-judgmentally accept their thoughts, emotions, and surroundings. They additionally identified a present moment attention factor using eight items from the Observe subscale of the Five Facet Mindfulness Questionnaire, capturing awareness of sensations in the body, stimuli in the environment, and emotions (FFMQ; Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006; e.g., "I notice how foods and drinks affect my thoughts, bodily sensations, and emotions"). The CEDMI has been found to have Cronbach's alphas ranging from .84 - .94 (Cameron & Fredrickson, 2015; Catalino, Algoe, & Fredrickson, 2014). In the current study, the Cronbach's alpha was .89.

2.3.3 Cognitive biases

2.3.3.1 Attention bias. Attention bias was assessed using the computerized dot probe task, originally developed by MacLeod, Mathews, and Tata (1986). Biased attending to positive (happy) and negative (sad) stimuli was assessed using images of emotional faces chosen from the

Pictures of Facial Affect (Ekman & Friesen, 1976). Following a practice trial during which computerized feedback was provided to ensure task understanding, participants completed 34 trials. Each trial consisted of an initial fixation cross that appeared in the middle of the screen, followed by an adjacent pair of faces that remained on the screen for 500ms. Each pair included one face with a neutral expression, and another face expressing either happy *or* sad emotion. Following the presentation of the images, participants were asked to respond to a subsequent probe on the right or left side of a black screen, in place of either the neutral or affective face. Average response times were calculated according to the placement of the probe behind the neutral, sad, or happy faces independently, reflecting attention allocation (Gotlib & Joormann, 2010). Response latencies greater than 2.5 SD from the mean of each individual were discarded on the basis of assuming distraction rather than exceptionally long response time and guessing or accidental button pressing rather than especially fast response times. Trials for which the incorrect button was pressed were also discarded. Attention bias towards happy and sad faces was indicated by positive scores, reflecting longer response times to the probe when it appears on the opposite side of the screen than the emotional stimuli (incongruent), compared to when it appears on the same side (congruent). Attention bias away from happy and sad faces was evidenced by longer response latencies on congruent versus incongruent trials, and indicated by negative scores (Kujawa et al., 2011). Scores around 0 reflect a lack of bias in either direction. Attention bias scores were calculated for happy and sad valences separately. Internal consistency values for the dot probe task were consistent with those reported in the literature.

2.3.3.2 Interpretation bias. Interpretation bias was assessed with the Scrambled Sentence Task developed by Wenzlaff and Bates (1998). Participants were presented twenty-five sets of six scrambled words and asked to use five of the words to form a complete sentence by

placing a number over each of the five words indicating their order. For example:

4 1 3 5 2

born I loser a winner am

Each set could be unscrambled to make a positively or negatively valenced sentence. Participants were instructed to work as quickly as possible, move on in the instance of mistakes, and choose only one solution. They had three minutes to complete the task. In order to induce cognitive load, participants were told to remember a six-digit number immediately prior to beginning the task, which they were asked to recall at the end of the three minutes. This requires mental capacity, which has been demonstrated to impair one's ability to control the suppression of negative cognitions, therefore increasing the likelihood that existing negative biases will become apparent (Van der Does, W., 2010). Only logical unscrambled sentences using exactly five words were scored. Each sentence was scored as a positive or negative interpretation. Interpretation bias scores were derived for positive and negative valences separately by calculating a ratio of the number of sentences unscrambled with each valence to the total number of unscrambled sentences. Previous studies using the Scrambled Sentence Task report adequate internal consistency (Van der Does, W., 2010). Cronbach's alpha for the current study was .79.

2.3.4 Depressive symptomatology

The Beck Depression Inventory (BDI-II; Beck, Steer, & Brown, 1996) was utilized to assess depressive symptoms with 20 self-report items. An item measuring suicide risk on the original scale was not administered. Participants indicated the degree to which each symptom (sadness, loss of interest and pleasure, tiredness and fatigue, changes in sleep and appetite, irritability, indecisiveness and concentration difficulty, and worthlessness) was experienced over the prior two week period. Response options for each item ranged from zero to three, with higher

scores representing more severe symptomatology. A sum score was computed for the scale. Total scores ranging from 0 to 12 indicate no depression, scores 13 to 19 signal mild depression or dysthymia, and scores 20 and above indicate that clinically significant dysthymia or MDD is likely (Dozois, Dobson, & Ahnberg, 1998). The BDI-II has been validated for use with emerging adults (Whisman & Perez, 2000). Reported Cronbach's alphas for the BDI-II ranged from .74-.90 in recent studies (Storch, Roberti, & Roth, 2004), and was .88 for the current sample.

2.4 Data analysis

Analyses were conducted in Mplus, version 8.1 (Muthén & Muthén, 2012). Missing data and violations of multivariate non-normality and independence were accounted for by the use of Maximum Likelihood estimation with Robust standard errors (MLR; Kwok, Cheung, Jak, Ryu, & Wu, 2018; Muthén & Muthén, 2012). Fit for each model was assessed using multiple fit indices to account for their variable strengths and weaknesses. The chi-square test was used to evaluate model accuracy, with good fit signified by a non-significant value, indicating the lack of difference between the hypothesized model and the true model in the data. Since the chi square test can be sensitive to sample size, Root Mean Squared Error (RMSEA; Browne & Cudeck, 1993), which is not, was also examined to evaluate the reproducibility of the model. RMSEA values less than .06 are generally accepted to indicate good fit (Hu & Bentler, 1999). The Comparative Fit Index (CFI; Bentler, 1990) and the Tucker-Lewis index (TLI; Tucker & Lewis, 1973) were also used, with values greater than 0.95 and 0.90, respectively, indicating good fit. Lastly, the standardized root mean square residual (SRMR) was used to supplement the RMSEA, CFI, and TLI measures, with values below .08 signifying acceptable fit (Hu & Bentler, 1999).

In models demonstrating good fit, standardized path coefficients were used to evaluate the strength of relationships between variables, with coefficients with values less than .10

representing a small effect, 0.30 or greater a medium effect, and 0.50 or higher a large effect. A bootstrapping technique with 1,000 replications was used to generate confidence intervals for hypothesized indirect effects, in order to correct for non-normality typically present in most estimates of the like (Preacher & Hayes, 2008). Effects were determined as significant based on an alpha of 0.05.

2.4.1 Analysis for Aim 1

A series of Confirmatory Factor (CFA) analyses and Exploratory Structural Equation (ESEM) Models were used to test the factor structure of the data collected with the CEDMI and to attempt to model an overarching mindfulness factor (see Figures 1-6 below). CFAs allow researchers to test pre-specified models, but in CFA models, all items are forced to load on only one predicted factor and are not allowed to loading on any other factors. While this approach is the multivariate technique most widely used, it can be overly restrictive and frequently fails to result in models that meet acceptable measurement standards (Marsh, Morin, Parker, & Kaur, 2014). Historically, the alternative approach has been Exploratory Factor Analysis (EFA), which identifies patterns of latent variables in the data that the researcher then interprets. EFAs are often criticized for their lack of guiding a priori theory. It is also difficult to incorporate latent EFA factors into additional analyses. Recently, ESEM has been developed as an alternative approach to model identification that incorporates the ideal aspects of CFA and EFA. ESEM is less restrictive than CFA, and unlike EFA, maintains the ability to test pre-specified models and makes it easy to use identified factors in subsequent analyses (Marsh et al., 2014). ESEM accomplishes this by using target rotation to confirm a priori factor structures, while also allowing variables to cross-load onto other factors (Asparouhov & Muthén, 2009; Morin, Arens,

& Marsh, 2015). Finally, it still produces traditional fit indices to allow for estimation of model fit.

In the current study, six separate models using CFA and ESEM to test the factor structure of the thirty-two items on the CEDMI were compared (Coffey et al., 2010). The first model used CFA to indicate (1) an attention factor comprised of items identified by the CEDMI to be on the attention subscale, (2) a non-judgment factor consisting of non-judgment subscale items, (3) an acceptance factor made up of items from the acceptance subscale, (4) a second order non-judgmental acceptance factor (non-judgmental acceptance – NJAC) made up of the separate non-judgment and acceptance lower order factors, and (5) a hierarchal mindfulness factor comprised of the second order non-judgmental acceptance factor and the lower order attention factor (Figure 1). Second, to mirror the structure proposed to exist in the CEDMI, a second CFA was run to test the same structure from the first model, but without the hierarchical mindfulness factor (Figure 2). Third, using the three factors indicated by the CEDMI subscales, we ran a CFA to test the existence of (1) a hierarchical mindfulness factor, (2) indicated by the three separate subscales (Figure 3). Fourth, an ESEM was conducted to test a lower-level structure whereby the three factors of attention, non-judgment, and acceptance were indicated by the items on their respective CEDMI subscales, while allowing items from other subscales to load freely where they fit best (Figure 4). Fifth, a bi-factor CFA used CEDMI items to indicate the three separate subscale factors and simultaneously an overarching non-judgmental acceptance bi-factor using all items from the CEDMI non-judgment and acceptance subscales (Figure 5). Finally, ESEM was used to test a similar bi-factor model, while allowing more freedom for the true factor structure to emerge, including the possibility for the bi-factor to be indicated by items from all three CEDMI subscales, including attention (Figure 6).

Model fit was determined by the criteria outlined above. Since maximum likelihood estimation was used to account for potential non-normality, the chi-square comparison test traditionally used to compare models was not appropriate since the distribution of the data may not be chi-square distributed. To account for this, models were compared using the Satorra-Bentler scaled chi-square test, which uses a corrected chi-square value to compare nested models (Satorra & Bentler, 2010).

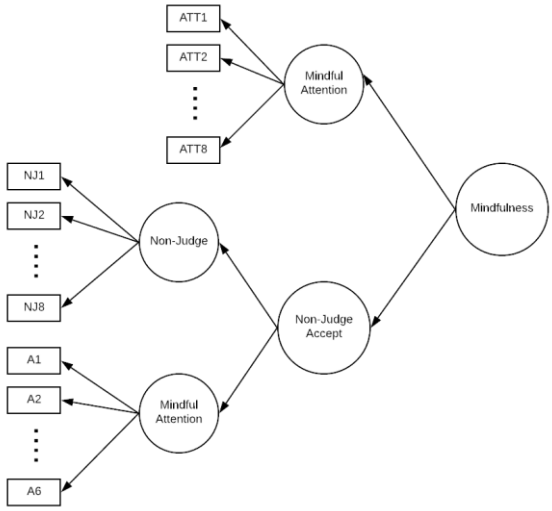


Figure 1

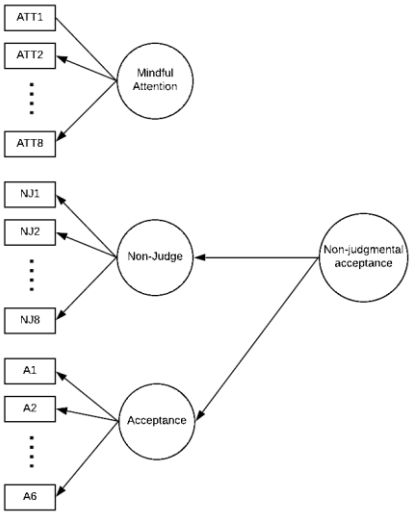


Figure 2

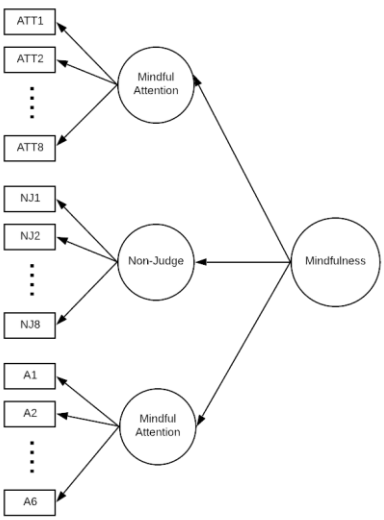
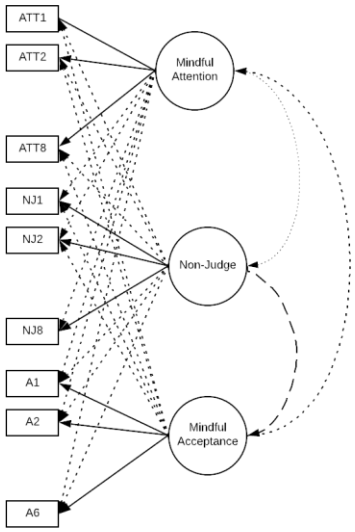


Figure 3



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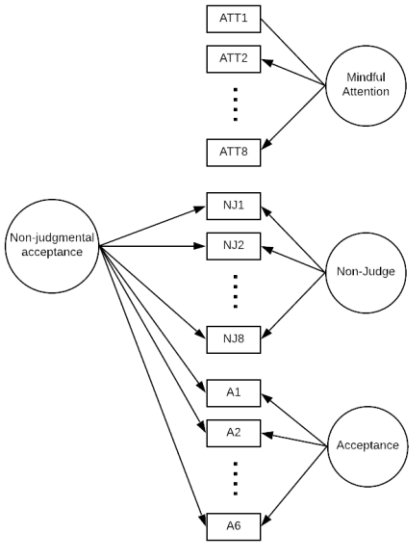

Figure 5

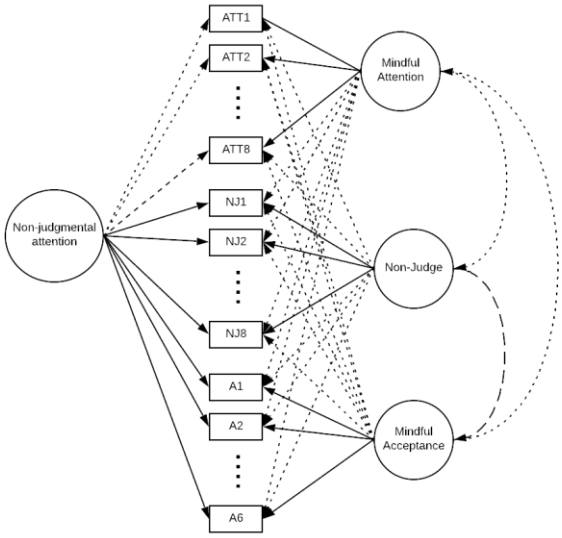

Figure 6

2.4.2 Analysis for Aim 2

Using the best fitting model from Aim 1, structural Equation Modeling (SEM) was used to examine the direct and indirect effects of mindfulness on attention bias, interpretation bias, and depression, as well as the direct and indirect effects of attention bias on interpretation bias and depression (Figure 7). Two models were tested, one for negative attention and interpretation biases and a second for positive biases. Two additional models for positive and negative biases were analyzed to test the direction of cognitive biases, such that in the second set of models, mindfulness predicted interpretation bias, which in turn predicted attention bias, followed by depression (Figure 8). Model fit was then compared for the two sets of models according to differences in Akaike Information Criteria (AIC) values, with the smallest AIC value indicating the best fit, and a difference of 10 or greater preferred (Burnham & Anderson, 2004).

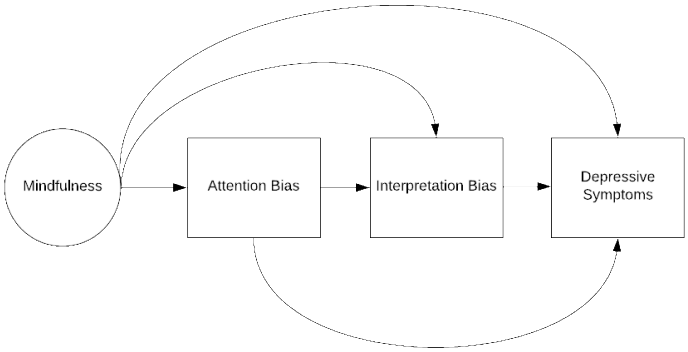

Figure 7 The indirect effects on the relationship between mindfulness and depressive symptoms via attention bias to interpretation bias, run separately for positive and negative biases.

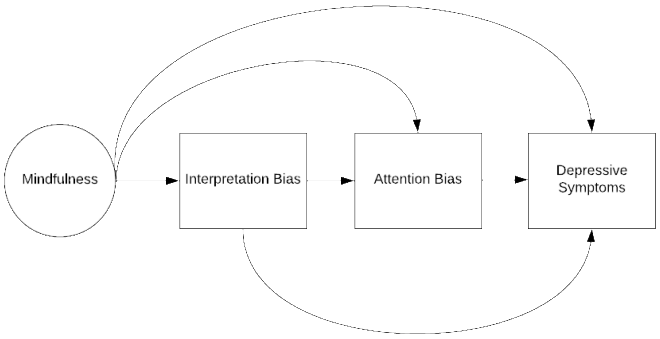

Figure 8 The indirect effects on the relationship between mindfulness and depressive symptoms via interpretation bias to attention bias, run separately for positive and negative biases.

2.4.3 Analysis for Aim 3

The third aim of the present study was exploratory in nature. In Aim 1, the best fitting model of mindfulness was identified. Aim 2 utilized this model to test the directional relationship between attention and interpretation biases in the context of mindfulness and depression. In Aim 3, we used the same models from Aim 2 to explore the differential associations between the factors of mindfulness and the two cognitive biases in the model predicting depression. To explore the specificity of these relationships, we compared the differential direct and indirect effects between each of the mindfulness factors and attention, interpretation bias, and depression. This was done separately for negative and positive biases.

2.4.3 Sample size and statistical power considerations.

According to guidelines by Bentler and Chou (1987), to achieve sufficient power, SEM models should use a sample size consisting of 5 or 10 observations per parameter. Along with the minimum sample size of 100 to 200 suggested by Boomsma (1985), a sample size of at least 200 was expected to account for the 12 parameters in the largest model and to be sufficient to achieve power of .80 at an alpha of .05. Therefore, the current sample of 258 participants should have sufficient power.

3 RESULTS

3.1 Preliminary analyses

Missing data ranged from 1% to 19%, which was accounted for with the use of Maximum Likelihood estimation with Robust standard errors in subsequent analyses (MLR; Kwok, Cheung, Jak, Ryu, & Wu, 2018; Muthén & Muthén, 2012). On the BDI-II, 14.3% of participants had a sum score of 20 or above, indicating they likely had clinically significant dysthymia or depression; 19.2% of participants had scores between 13 and 19, signifying mild depression or dysthymia; and 66.5% of participants fell in the normative range with scores of 12 or below. None of the model variables differed based on demographic characteristics (i.e., sex); as a result, demographic variables were not included as controls in subsequent models.

3.2 Results for Aim 1

3.2.1 Identifying the best fitting measurement model

A total of six models of mindfulness were run (Figures 1-6). One model was not identified and was therefore discarded (Figure 1). The remaining five models were compared according to their model fit, using the Satorra-Bentler chi square difference test, due to the nested nature of the models. A nested model is one that is more restricted than the model from

which it was created. CFA models are nested in ESEM models, and hierarchical models are nested in bi-factor models (Chen et al., 2006). With this in mind, model 3 was nested in model 2, and was the first model comparison. Since model 3 demonstrated better fit, it was then compared to model 4, since it was nested in model 4. Model 4 was evidenced to be better fitting, and since it was nested in model 5, that comparison followed. The fit of model 5 was proven to be superior. Since model 2 was also nested in model 5, that comparison was made and confirmed model 5 was the better fit. Finally, models 3, 4, and 5 were all nested within each other and thus compared, revealing model 6, the bi-factor ESEM, to have the best fit overall (Figure 6; $\chi 2$ (149) = 307.12, p = <0.001, *CFI* = 0.94, *TLI* = 0.905, *RMSEA [90% CI]* = 0.064 [0.054, 0.075], *SRMR* = 0.031). Table 2 details the model fit for all six models and comparisons between them. Model 6 was used in subsequent SEM models to simultaneously test Aims 2 and 3. The correlations among factors in this model and all other variables in the SEM models in Aims 2 and 3 are provided in Table 3.

Table 2 Model Fit for Mindfulness Measurement Models Tested in Aim 1

Model fit statistics										
Model/figure	**χ2**	**P**	**df**	**CFI**	**TLI**	**RMSEA [90% CI]**	**SRMR**	**AIC**	**BIC**	**Scaling Correction**
(1) hCFA with ATT, NJAC, and higher mindfulness factor	Model did not converge									
(2) hCFA with NJAC factor	485.65	<.001	206	0.89	0.878	0.073 [0.064, 0.081]	0.073	15136	15380	1.13
(3) hCFA with ATT, NJ, AC, and higher mindfulness factor	642.57	<.001	207	0.83	0.811	0.091 [0.083, 0.099]	0.350	15312	15553	1.13
(4) lower-order 3-factor ESEM	356.07	<.001	168	0.93	0.900	0.066 [0.057, 0.076]	0.036	15064	15443	1.12
(5) Bi-factor CFA	414.67	<.001	192	0.91	0.896	0.067 [0.058, 0.076]	0.067	15068	15363	1.09
(6) Bi-factor ESEM	307.12	<.001	149	0.94	0.905	0.064 [0.054, 0.075]	0.031	15018	15464	1.02

Chi-Square Difference Test			
Δdf	**Δχ2**	**p**	**Satorra-Bentler χ^2 Difference Comparison**
1	156.92	<.001	Model 2 vs. model 3*
39	279.75	<.001	Model 3 vs. model 4*
24	60.45	<.001	Model 4 vs. model 5*
14	57.61	<.001	Model 2 vs. model 5*
58	295.2	<.001	Model 3 vs. model 6*
19	45.09	<.001	Model 4 vs. model 6*
43	76.89	<.001	Model 5 vs. model 6**

Notes. hCFA = Hierarchical Confirmatory Factor Analysis; ATT = Attention; NJAC = Non-judgmental Acceptance; NJ = Non-judgment; AC = Acceptance; ESEM = Exploratory Structural Equation Model; CFI = Comparative Factor Index; TLI = Tucker Lewis Index; RMSEA = Root Mean Squared Error of Approximation; Standardized Root Mean Square Residual; AIC = Aikake Information Criteria; BIC = Bayesian Information Criteria; *indicates better fitting model in the comparison; ** indicates best fitting of all models

Table 3 Correlations between study variables

	M (SD)	1	2	3	4	5	6	7	8
1. Mindful attention	-	-	-	-	-	-	-	-	-
2. Mindful non-judgment	-	0.098	-	-	-	-	-	-	-
3. Mindful acceptance	-	0.000	0.277†	-	-	-	-	-	-
4. Mindful non-judgmental acceptance	-	-	-	-	-	-	-	-	-
5. Negative attention bias	-1.12 (19.83)	0.152*	-0.080	0.064	0.095	-	-	-	-
6. Positive attention bias	2.42 (23.19)	-0.130*	-0.064	0.002	-0.013	-0.057	-	-	-
7. Negative interpretation bias	0.17 (0.18)	-0.072	-0.323*	-0.262*	-0.334*	-0.022	0.081	-	-
8. Positive interpretation bias	0.73 (0.22)	0.150*	0.339*	0.244†	0.288*	-0.062	-0.043	-0.807**	-
9. Depressive symptoms	10.89 (8.11)	-0.098	-0.272*	-0.264*	-0.535**	-0.044	0.016	0.584**	-0.543**

** p <.01, * p < .05, † p < .1

Notes. Means are not included for variables 1-4, as they are latent variables and their means are not interpretable. Mindful non-judgmental acceptance (4) is the bi-factor, and therefore orthogonal to all other factors.

3.2.2 The factors of mindfulness

The best fitting model identified a bi-factor made up of all items from the NJ and AC items (NJAC), with marginal contributions from the ATT items, as well as additional group factors over and above the bi-factor for attention (ATT), non-judgment (NJ), and acceptance (AC) (see Figure 9 and Table 4). A single mindfulness factor that encompasses attention, acceptance, and non-judgment did not emerge. The NJAC bi-factor is mathematically orthogonal to the other factors and therefore not correlated with them. While the group factors were allowed to correlate with each other, only NJ and AC came close to correlating in a positive direction, but the relationship did not reach significance (see Table 3).

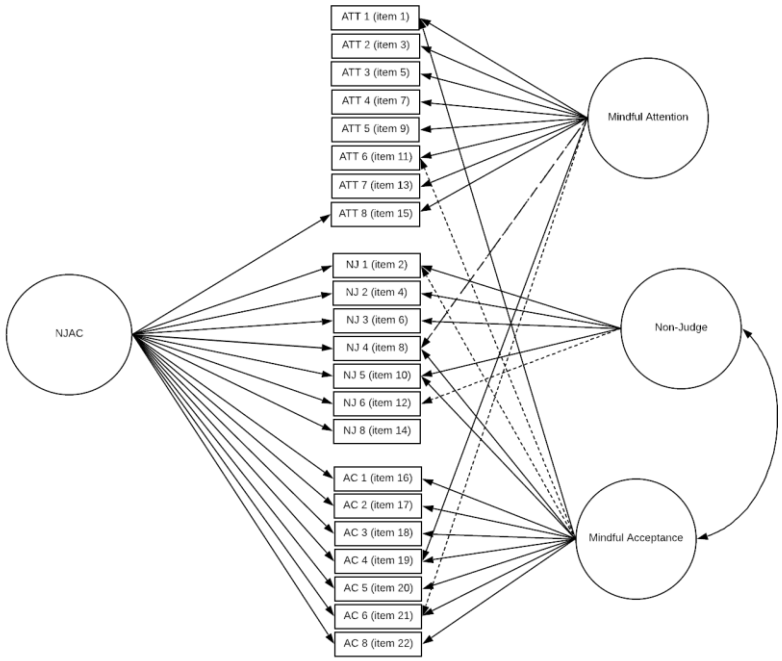

Figure 9 Best Fitting Mindfulness Measurement Model: A Bi-factor ESEM

Notes. ESEM = Exploratory Structure Equation Model; NJAC = Non-judgmental Acceptance; ATT = Attention; NJ = Non-judgment; AC = Acceptance; solid line = significant positive association; dashed line = significant negative association; dotted line = trending association. Item numbers and subscales from the Carolina Empirically Derived Mindfulness Inventory (CEDMI) are shown in the center. Only significant pathways are depicted. See Table 4 for standardized estimates of factor loadings and their standard errors.

Table 4 Factor Loadings for Best Fitting Mindfulness Measurement Model

CEDMI sub-scale (CEDMI item)	Mindfulness Factors from Bi-Factor ESEM											
	Attention (ATT)			Non-judgment (NJ)			Acceptance (AC)			Non-judgmental acceptance bi-factor (NJAC)		
	β	SE	p	β	SE	p	β	SE	p	β	SE	p
ATT (1)	0.567**	0.067	0.000	-0.072	0.115	0.528	-0.184*	0.060	0.002	-0.053	0.098	0.588
ATT (3)	0.572**	0.070	0.000	-0.053	0.125	0.674	-0.095	0.071	0.181	-0.100	0.094	0.289
ATT (5)	0.521**	0.055	0.000	-0.136	0.084	0.104	0.004	0.074	0.961	-0.081	0.088	0.356
ATT (7)	0.785**	0.039	0.000	0.094	0.079	0.236	0.020	0.056	0.725	-0.028	0.087	0.752
ATT (9)	0.636**	0.056	0.000	0.085	0.088	0.332	0.099	0.063	0.113	-0.100	0.099	0.311
ATT (11)	0.630**	0.070	0.000	0.059	0.133	0.659	0.142	0.074	0.053	-0.103	0.122	0.399
ATT (13)	0.624**	0.061	0.000	0.094	0.111	0.399	-0.005	0.066	0.943	-0.068	0.103	0.512
ATT (15)	0.458**	0.055	0.000	-0.141	0.091	0.120	-0.046	0.064	0.467	-0.204*	0.084	0.016
NJ (2)	-0.068	0.042	0.107	0.530**	0.106	0.000	0.117†	0.061	0.056	0.602**	0.113	0.000
NJ (4)	0.043	0.038	0.266	0.617**	0.140	0.000	0.004	0.067	0.952	0.639**	0.135	0.000
NJ (6)	0.068	0.048	0.155	0.377*	0.175	0.031	-0.040	0.074	0.591	0.707**	0.100	0.000
NJ (8)	-0.197**	0.047	0.000	0.159	0.231	0.491	-0.146*	0.066	0.028	0.772**	0.073	0.000
NJ (10)	0.037	0.036	0.309	0.481*	0.190	0.012	-0.128*	0.049	0.009	0.755**	0.110	0.000
NJ (12)	0.048	0.035	0.166	0.363†	0.194	0.062	-0.031	0.050	0.532	0.764**	0.091	0.000
NJ (14)	0.014	0.055	0.798	0.020	0.211	0.926	0.089	0.097	0.357	0.733**	0.083	0.000
AC (16)	-0.002	0.053	0.967	0.168	0.150	0.262	0.198*	0.069	0.004	0.602**	0.094	0.000
AC (17)	-0.019	0.043	0.655	0.075	0.112	0.503	0.597**	0.080	0.000	0.508**	0.098	0.000
AC (18)	-0.047	0.041	0.245	-0.102	0.083	0.221	0.611**	0.101	0.000	0.524**	0.102	0.000
AC (19)	0.095*	0.044	0.031	-0.049	0.083	0.553	0.470**	0.130	0.000	0.684**	0.093	0.000
AC (20)	-0.021	0.051	0.674	0.125	0.086	0.144	0.408**	0.075	0.000	0.442**	0.091	0.000
AC (21)	0.065†	0.036	0.069	-0.065	0.085	0.442	0.460**	0.118	0.000	0.726**	0.090	0.000
AC (22)	-0.061	0.039	0.122	0.040	0.077	0.603	0.624**	0.069	0.000	0.398**	0.091	0.000

** p <.01, * p < .05, † p < .1

Notes. CEDMI = Carolina Empirically Derived Mindfulness Inventory; ESEM = Exploratory Structural Equation Model; Standardized regression coefficients (β) and their standard errors (SE) are displayed for the association between each item on the CEDMI and each mindfulness factor.

3.3. Results for Aim 2

Aim 1 demonstrated that there was not an overarching, latent mindfulness factor. With this in mind, analyses for Aims 2 and 3 were run in the same four models using the bi-factor ESEM model (Figure 9), which was the best fitting. To test Aim 2's hypothesis about the directional effects of the relationship between attention and interpretation bias, four total models were run. Two models, one for positive and one for negative biases, had each of the four mindfulness factors (including the bi-factor) predicting attention bias, which predicted interpretation bias, which predicted depression (Figures 10 and 12). A second set of models were run, separately for positive and negative biases, with each of the mindfulness factors predicting interpretation bias, to attention bias, to depression (Figures 11 and 13).

For models with both happy and sad biases, fit was better when interpretation bias preceded attention bias in predicting depressive symptoms (see Table 5; sad biases, Figure 11: χ^2 (207) =394.52, p = <0.000, *CFI* = 0.933, *TLI* = 0.903, *RMSEA [90% CI]* = 0.059 [0.058, 0.068], *SRMR* = *0.038;* happy biases, Figure 13: χ^2 (207) = 378.85, p = <0.000, *CFI* = 0.939, *TLI* = 0.911, *RMSEA [90% CI]* = 0.057 [0.048, 0.066], *SRMR* = 0.036), than when attention bias preceded interpretation bias (sad biases, Figure 10: χ^2 (207) = 438.03 , p = <0.000, *CFI* = 0.918, *TLI* = 0.881, *RMSEA [90% CI]* = 0.066 [0.057, 0.074], *SRMR* = 0.080; happy biases, Figure 12: χ^2 (207) = 427.49, p = <0.000, *CFI* = 0.921, *TLI* 0.886, *RMSEA [90% CI]* = 0.064 [0.056, 0.073], *SRMR* = 0.075). Additionally, comparison based on differences between AIC and BIC values also indicated that for both positive and negative biases, models predicting depressive symptoms with interpretation bias preceding attention bias (Figures 11 and 13) fit better than those where attention bias preceded interpretation bias (Figures 10 and 12; see Table 5).

Table 5 Model fit for SEM models

Valence of biases	Figure	χ2	P	df	CFI	TLI	RMSEA [90% CI]	SRMR	AIC	BIC
Sad / negative	10	438.03	<0.000	207	0.918	0.881	0.066 [0.057, 0.074]	0.080	18612	19120
	11	394.52	<0.000	207	0.933	0.903	0.059 [0.050, 0.068]	0.038	18562	19070
Happy / positive	12	427.49	<0.000	207	0.921	0.886	0.064 [0.056, 0.073]	0.075	18777	19285
	13	378.85	<0.000	207	0.939	0.911	0.057 [0.048, 0.066]	0.036	18728	19236

Notes. Figures with even numbers (10 and 12) refer to those where attention bias precedes interpretation bias in predicting depressive symptoms. Figures with odd numbers (11 and 13) refer to those where interpretation bias precedes attention bias in predicting depressive symptoms. CFI = Comparative Factor Index; TLI = Tucker Lewis Index; RMSEA = Root Mean Squared Error of Approximation; Standardized Root Mean Square Residual; AIC = Aikake Information Criteria; BIC = Bayesian Information Criteria;

3.4 Results for Aim 3

Aim 3 examined the direct and indirect effects of the relationships between variables in the same four models used in Aim 2 above. Specifically, the hypothesized relationships between ATT and attention bias, and NJAC and interpretation bias, in the context of depression, were examined.

3.4.1 Direct effects

The direct effects between all study variables are presented in Table 6. While the values of direct effects were different depending on valence of bias (negative versus positive) and order of biases, all models revealed similar patterns.

Each model tested the direct effects from the factors of mindfulness to depressive symptoms. Across all four models, neither the attention nor non-judgment factors of mindfulness significantly predicted depressive symptoms. The acceptance factor, however, always significantly predicted depression in a negative direction (Figure 10: β = -0.150, p = 0.032; Figure 11: β = -0.136, p = 0.037; Figure 12: β = -0.160, p = 0.025; Figure 13: β = -0.154, p = 0.021), though the effect was small. Additionally, across all four models, the non-judgmental acceptance bi-factor more strongly negatively predicted depression compared to the acceptance

factor, with a medium effect size (Figure 10: β = -0.468, p = 0.000; Figure 11: β = -0.410, p = 0.000; Figure 12: β = *-0.491*, p = 0.000; Figure 13: β = -0.440, p = 0.000).

Direct effects were only tested from the mindfulness factors to either interpretation bias or attention bias, depending on which bias came first in the model. In other words, for models with interpretation bias preceding attention bias, only the relationships between the factors of mindfulness and interpretation bias were examined, and in models when attention bias preceded interpretation bias, the mindfulness factors were only examined in relation to attention bias.

For models examining attention bias followed by interpretation bias, neither the non-judgment (NJ), acceptance (AC), nor non-judgmental acceptance (NJAC) factors significantly predicted attention bias, regardless of whether the biases were positive or negative. However, the relationship between the attention factor (ATT) and attention bias was close to significant for positive biases (Figure 12: β = -0.123, p = 0.055), and fully reached significance for negative biases (Figure 10: β = 0.162, p = 0.028), though the effect was small.

In models when interpretation bias came before attention bias, the relationship between the attention mindfulness factor (ATT) and interpretation bias was not significant in the model with negative biases but was trending in the context of biases that were positive (Figure 13: β = 0.127, p = 0.071). The non-judgment factor (NJ) significantly predicted interpretation bias in the model with positive biases (Figure 13: β = 0.283, p = 0.038), and that relationship was close to reaching significance in the model with negative bias (Figure 11: β = - 0.270, p = 0.051), though the effects of both were small. The opposite pattern was apparent for the relationship between the acceptance factor (AC) and interpretation bias. AC significantly predicted interpretation bias in the model with negative biases (Figure 11: β = - 0.191, p = 0.035), and was close to significance for positive biases (Figure 13: β = 0.163, p = 0.062). The effects were again small. In models

with both happy and sad biases, the non-judgmental bi-factor (NJAC) had a significant medium effect on interpretation bias (Figure 11: β = - 0.328, p = 0.011; Figure 13: β = 0.283, p = 0.027).

None of the models revealed a significant direct effect between attention bias and interpretation bias, or attention bias and depressive symptoms. On the other hand, interpretation bias significantly predicted depression in all four models. Negative interpretation bias had a medium positive effect on depressive symptoms (Figure 10: β = 0.393, p = 0.000; Figure 11: β = 0.373, p = 0.000), and positive interpretation bias had a medium negative effect on depression (Figure 12: β = -0.351, p = 0.000; Figure 13: β = -0.334, p = 0.000).

In considering how much depression, attention bias, and interpretation bias effected the models, all models with both negative/sad biases and positive/happy biases had a significant R^2 for depression (Figure 10: R^2 = 0.428, p = 0.000; Figure 11: R^2 = 0.510, p = 0.000; Figure 12: R^2 = 0.421, p = 0.000; Figure 13: R^2 = 0.491, p = 0.000). Attention bias did not have a significant effect on any model. Interpretation bias, however, did significantly affect the models for both sad and happy biases, but only when it preceded attention bias in predicting depressive symptoms (Figure 11: R^2 = 0.251, p = 0.000; Figure 13: R^2 = 0.236, p = 0.002;). Based on guidelines by Cohen (1992) these results demonstrate that for both positive and negative biases, depression had a large effect on all models, while interpretation bias had a medium to large effect on the models in which it came before attention bias.

Taken together, the results show that attention bias did not significantly predict depression for positive or negative biases, but interpretation bias did for both negative and positive biases. The relationship between attention bias and interpretation bias never reached significance. Looking at mindfulness, ATT and NJ never predicted depression, while AC and NJAC always did, regardless of what valence the biases were. The only mindfulness factor that

significantly predicted attention bias was ATT for negative biases, though the direction of the relationship was unexpected; it was positive, indicating that greater levels of ATT predicted higher levels of negative attention bias. ATT for positive biases was trending in relationship to attention bias and was also opposite to expectations in that higher levels of ATT predicted lower levels of attention bias to positive stimuli. The picture is even more nuanced when considering the relationship between mindfulness and interpretation bias. The NJAC mindfulness factor was the only one that fully reached significance in predicting interpretation bias for both positive and negative biases, though the relationship between AC and interpretation bias was significant for sad biases, and nearing significance for happy biases, and the NJ-interpretation bias effect was significant for happy biases and close in sad. ATT was trending towards significantly predicting interpretation biases for positive biases, but not for negative ones. In other words, the only mindfulness factor that did not come close to significantly predicting interpretation bias was ATT in models with negative biases.

Table 6 Standardized results for direct associations between bifactor mindfulness ESEM factors and outcomes

			Direct Effects								
			Depression			Attention Bias			Interpretation Bias		
Predictor	**Valence of bias**	**Figure**	**β**	**SE**	**p**	**β**	**SE**	**p**	**β**	**SE**	**p**
Attention (ATT)	Sad / negative	10	-0.073	0.058	0.211	0.162*	0.074	0.028	-	-	-
		11	-0.063	0.054	0.244	-	-	-	-0.049	0.075	0.517
	Happy / positive	12	-0.049	0.056	0.384	-0.123†	0.064	0.055	-	-	-
		13	-0.038	0.053	0.469	-	-	-	0.127†	0.070	0.071
Non-judgment (NJ)	Sad / negative	10	-0.124	0.110	0.262	-0.120	0.101	0.237	-	-	-
		11	-0.111	0.102	0.275	-	-	-	-0.270†	0.138	0.051
	Happy / positive	12	-0.130	0.116	0.260	-0.063	0.099	0.525	-	-	-
		13	-0.113	0.103	0.272	-	-	-	0.283*	0.137	0.038
Acceptance (AC)	Sad / negative	10	-0.150*	0.070	0.032	0.100	0.081	0.219	-	-	-
		11	-0.136*	0.065	0.037	-	-	-	-0.191*	0.091	0.035
	Happy / positive	12	-0.160*	0.071	0.025	0.014	0.085	0.871	-	-	-
		13	-0.154*	0.066	0.021	-	-	-	0.163†	0.087	0.062
Non-judgmental acceptance (NJAC)	Sad / negative	10	-0.468**	0.074	0.000	0.098	0.080	0.220	-	-	-
		11	-0.410**	0.070	0.000	-	-	-	-0.328*	0.129	0.011
	Happy / positive	12	-0.491**	0.070	0.000	-0.010	0.088	0.909	-	-	-
		13	-0.440**	0.066	0.000	-	-	-	0.283*	0.128	0.027
Interpretation bias (IB)	Sad / negative	10	0.393**	0.075	0.000	-	-	-	-	-	-
		11	0.373**	0.069	0.000	-0.027	0.072	0.705	-	-	-
	Happy / positive	12	-0.351**	0.066	0.000	-	-	-	-	-	-
		13	-0.334*	0.062	0.000	-0.042	0.060	0.489	-	-	-
Attention Bias (AB)	Sad / negative	10	0.017	0.057	0.761	-	-	-	-0.033	0.076	0.660
		11	0.011	0.051	0.830	-	-	-	-	-	-
	Happy / positive	12	-0.017	0.050	0.731	-	-	-	-0.046	0.062	0.460
		13	-0.014	0.045	0.748	-	-	-	-	-	
R^2	Sad / negative	10	0.428**	0.043	0.000	0.050	0.037	0.175	0.001	0.005	0.826
		11	0.510**	0.047	0.000	0.001	0.004	0.850	0.251**	0.071	0.000
	Happy / positive	12	0.421**	0.042	0.000	0.020	0.020	0.307	0.002	0.006	0.712
		13	0.046	0.000	0.002	0.005	0.729		0.078	0.002	

** p <.01, * p < .05, † p < .1

Notes. Figures with even numbers (10 and 12) refer to those where attention bias precedes interpretation bias in predicting depressive symptoms. Figures with odd numbers (11 and 13) refer to those where interpretation bias precedes attention bias in predicting depressive symptoms; Standardized regression coefficients (β) and their standard errors (SE) are displayed for each outcome/predictor combination; proportions of variance explained (R^2) and their standard errors (SE) are displayed for each predictor overall.

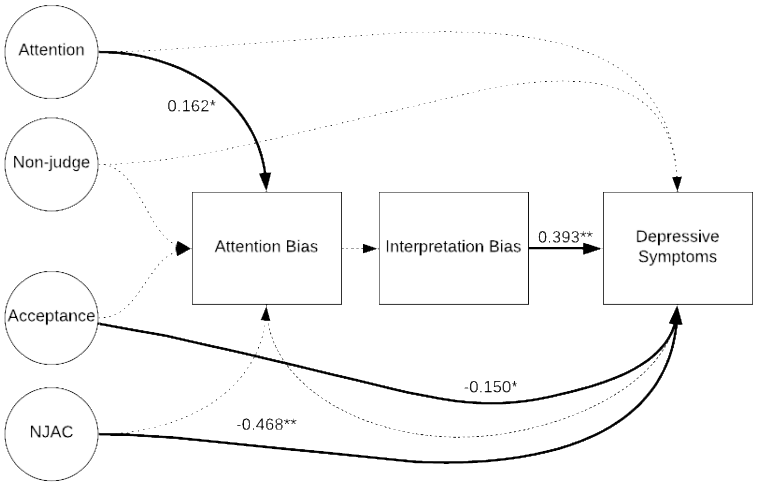

Figure 10 Standardized direct effects in model with mindfulness factors predicting depressive symptoms via attention bias followed by interpretation bias for negative/sad biases

*** p <.01, * p < .05, † p < .1*

Notes. Figures with even numbers (10 and 12) refer to those where attention bias precedes interpretation bias in predicting depressive symptoms. Figures with odd numbers (11 and 13) refer to those where interpretation bias precedes attention bias in predicting depressive symptoms; standardized direct effects are only indicated for significant paths.

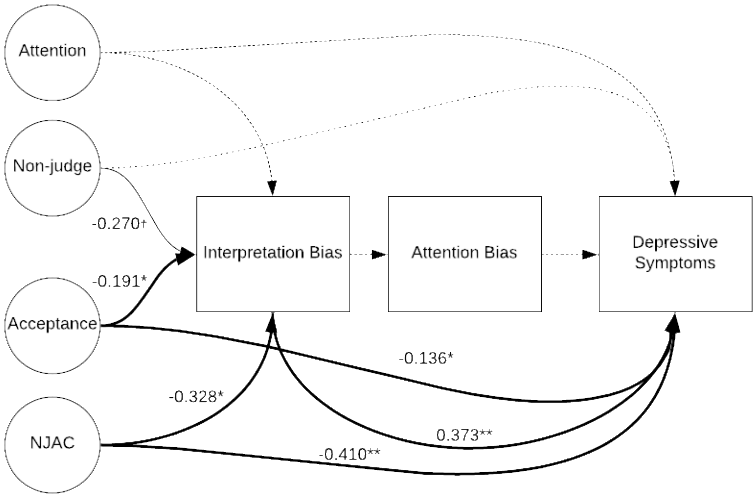

Figure 11 Standardized direct effects in model with mindfulness factors predicting depressive symptoms via interpretation bias followed by attention bias for negative/sad biases

** p <.01, * p < .05, † p < .1

Notes. Figures with even numbers (10 and 12) refer to those where attention bias precedes interpretation bias in predicting depressive symptoms. Figures with odd numbers (11 and 13) refer to those where interpretation bias precedes attention bias in predicting depressive symptoms; standardized direct effects are only indicated for significant paths.

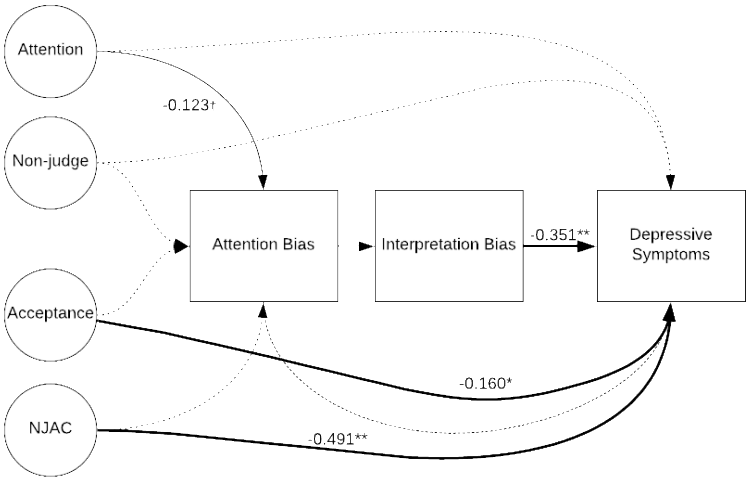

Figure 12 Standardized direct effects in model with mindfulness factors predicting depressive symptoms via attention bias followed by interpretation bias for positive/happy biases

** p <.01, * p < .05, † p < .1

Notes. Figures with even numbers (10 and 12) refer to those where attention bias precedes interpretation bias in predicting depressive symptoms. Figures with odd numbers (11 and 13) refer to those where interpretation bias precedes attention bias in predicting depressive symptoms; standardized direct effects are only indicated for significant paths.

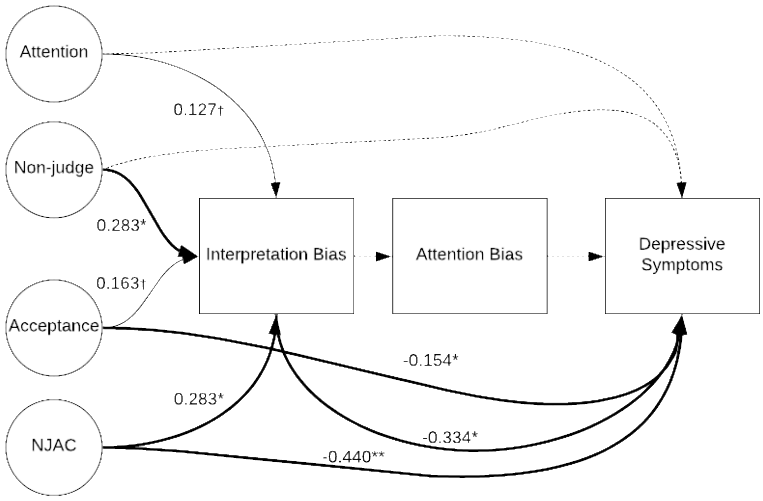

Figure 13 Standardized direct effects in model with mindfulness factors predicting depressive symptoms via interpretation bias followed by attention bias for positive/happy biases
** p <.01, * p < .05, † p < .1
Notes. Figures with even numbers (10 and 12) refer to those where attention bias precedes interpretation bias in predicting depressive symptoms. Figures with odd numbers (11 and 13) refer to those where interpretation bias precedes attention bias in predicting depressive symptoms; standardized direct effects are only indicated for significant paths.

3.4.2 Indirect effects

The indirect effects from each of the four mindfulness factors to depression through attention bias to interpretation bias (Figures 10 and 12), and through interpretation bias to attention bias (Figures 11 and 13) are detailed for positive and negative biases in Table 7. None of the indirect paths from any of the four mindfulness factors to depressive symptoms via attention and interpretation biases, regardless of their order, were significant. However, when only the path from mindfulness to depression through interpretation bias was examined (i.e., not including attention bias) significant indirect effects from NJAC to depressive symptoms through interpretation bias for both positive (β = -0.095, p = 0.038) and negative biases (β = -0.125, p = 0.011) emerged.

Table 7 Standardized results for indirect pathways from bifactor mindfulness ESEM factors to depressive symptoms through attention and interpretation bias

			Indirect Effects					
			AB > IB > Depression			IB > AB > Depression		
Predictor	**Valence of bias**	**Figure**	**β**	**SE**	**p**	**β**	**SE**	**p**
Attention (ATT)	Sad / negative	10	-0.002	0.005	0.664	-	-	-
		11	-	-	-	0.000	0.000	0.855
	Happy / positive	12	-0.002	0.003	0.524	-	-	-
		13	-	-	-	0.000	0.000	0.759
Non-judgment (NJ)	Sad / negative	10	0.002	0.003	0.642	-	-	-
		11	-	-	-	0.000	0.000	0.838
	Happy / positive	12	-0.001	0.002	0.680	-	-	-
		13	-	-	-	0.000	0.001	0.757
Acceptance (AC)	Sad / negative	10	-0.001	0.003	0.699	-	-	-
		11	-	-	-	0.000	0.000	0.839
	Happy / positive	12	0.000	0.001	0.866	-	-	-
		13	-	-	-	0.000	0.000	0.755
Non-judgmental acceptance (NJAC)	Sad / negative	10	-0.001	0.003	0.707	-	-	-
		11	-	-	-	0.000	0.000	0.841
	Happy / positive	12	0.000	0.001	0.914	-	-	-
		13	-	-	-	0.000	0.001	0.756

** p <.01, * p < .05, † p < .1

Notes. Figures with even numbers (10 and 12) refer to those where attention bias precedes interpretation bias in predicting depressive symptoms. Figures with odd numbers (11 and 13) refer to those where interpretation bias precedes attention bias in predicting depressive symptoms; Standardized regression coefficients (β) and their standard errors (SE) are displayed for each outcome/predictor combination; AB = Attention Bias; IB = Interpretation Bias. Standardized regression coefficients (β) and their standard errors (SE) are displayed for each outcome/predictor combination.

4 DISCUSSION

With the proliferation of mindfulness-based interventions, there is a need for evidence-based research to better understand the construct and measurement of mindfulness as well as the mechanisms through which it may influence mental health. Depression, one of the most common mental illnesses in EA, has been the target of many mindfulness-based interventions. However, little is known about how mindfulness may operate to influence this growing public health concern. One potential mechanism through which mindfulness may relate to depression is through cognitive biases. Much previous research has considered the roles of cognitive biases,

like attention and interpretation bias, in relation to depression, but investigation of how such biases are associated with mindfulness is almost non-existent. Nonetheless, there is an abundance of theory that outlines why these constructs may be related. Further, little work has examined the potential interplay of these specific biases. With this in mind, the current study sought to contribute to the literature by 1) testing a measurement model of mindfulness to better understand the construct and how it may be operating, 2) examining the indirect effects of both positive and negative attention and interpretation biases in the mindfulness-depression relationship, and 3) exploring the nuanced relationships between the factors of mindfulness and distinct cognitive biases.

4.1 The Structure of mindfulness

Aim 1 of the current study sought to elucidate the empirical structure of mindfulness in a sample of EAs. Exploratory structural equation modeling (ESEM) was used to discover and confirm a more accurate factor structure than is possible when using EFA or CFA alone, as it predicts which items will load on certain factors, but simultaneously allows all items to contribute to all factors. Comparison of ESEM and CFA models revealed the best fitting model of mindfulness to consist of four factors. A non-judgmental acceptance (NJAC) bi-factor was indicated, which was collectively composed of items primarily from the non-judgment (NJ) and acceptance (AC) scales (1 item was from the ATT scale). Three factors were also determined to represent attention, acceptance, and non-judgment, above and beyond the NJAC bi-factor.

In contradiction to the hypothesis of Aim 1, an over-arching (i.e., latent) mindfulness factor was not found. Rather, the factor structure confirms some previous assertions that present-moment attention to one's experiences and a non-judgmental approach to interpreting them should be considered as distinct components of mindfulness that do not necessarily indicate a

latent mindfulness construct and that may influence independent mechanisms and outcomes. In fact, the present study replicated Coffey et al.'s (2010) findings that suggest mindfulness is composed of two factors reflecting attention and acceptance (non-judgment), without an overarching mindfulness construct. Current findings also support Bishop et al.'s (2004) theory that proposes a two-component structure of mindfulness, reflecting the different, but equally important, dimensions of attention and non-judgment. Almost all definitions of mindfulness include these dual-components but lack clarity on whether they are underlying indicators of a latent mindfulness construct or are best modeled as distinct, even unrelated, components. The replication of Coffey et al.'s (2010) model adds one additional piece of evidence to the literature base (Mayer et al., 2018). Of course, it should be noted that we used the measure developed by Coffey and colleagues and focused on an EA sample as they did, so future research should continue to explore the structure of mindfulness and the possibility of a latent mindfulness factor with other measures in other samples.

While the acceptance factor in Coffey et al.'s (2010) model was indicated by two separate scales reflecting non-judgment and acceptance, they did not consider these components as independent factors. In contrast, our model confirmed the existence of acceptance and non-judgment as two different factors reflecting additional dimensions of mindfulness above and beyond the combined non-judgmental acceptance (NJAC) bi-factor. By confirming acceptance and non-judgment as separate factors, we were then able to explore their unique interactions with other variables in subsequent models, in addition to examining their combined impact.

Interestingly, the attention factor did not correlate with either the non-judgment or acceptance factor. While this is consistent with some previous research failing to find a significant association between attention and non-judgment (Baer at al., 2006; Coffey et al.,

2010), it is counter to other work that has found a significant negative correlation between the factors (Baer et al., 2004). One possible reason for the discrepancy may be explained by differences between novice and experienced meditators (Baer at al., 2006). Coffey et al., for example, reported a significant negative correlation between the two factors in a sub-sample of their participants who reported no regular meditation practice. They did not find a significant association between attention and acceptance for frequent meditators (defined as at least once a week over the previous six months). Unfortunately, frequency of meditation practice was not collected for the current sample, so this moderation could not be examined. Future studies should be intentional about examining how varying levels of meditation experience may influence the structure of mindfulness as well as how it relates to other constructs.

In sum, the best fitting model resultant from analyses in Aim 1 did not support a single latent mindfulness factor but rather highlights the importance of evaluating present-moment attention, non-judgment, acceptance, and non-judgmental acceptance as separate dimensions. With this in mind, these four factors found in Aim 1 (attention, acceptance, non-judgment, and non-judgmental acceptance) were used as the starting point for Aim 2 and 3 analyses, which were conducted simultaneously in the same four models. Since the factor structure of mindfulness found in Aim 1 identified discrete factors, it was not necessary to separate them for the intentional purpose of exploring specific relationships.

4.2 Considering the direction and combined effects of attention and interpretation biases in the relationship between mindfulness and depressive symptoms

In light of little extant research about 1) the relationship between attention bias and interpretation bias, and 2) the relationship between these cognitive biases and mindfulness, Aims 2 and 3 used the measurement model found to be the best fit from Aim 1 to simultaneously test

the directional effects of attention bias and interpretation bias in the relationship between mindfulness and depressive symptoms, as well as the specificity of the relationships between the factors of mindfulness, attention bias and interpretations bias, and depressive symptoms.

To test the directional effects of the cognitive biases, models with mindfulness predicting depressive symptoms via attention bias, followed by interpretation bias, were compared to models with interpretation bias preceding attention bias in the mindfulness-depression relationship. Models considered positive and negative biases separately for a total of four models. Comparison of the models revealed that for both happy and sad biases, model fit was better when interpretation bias preceded attention bias, rather than when attention bias preceded interpretation bias. In fact, only one of the models with attention bias followed by interpretation bias reached an acceptable fit threshold for any of the indices, and the other model only just met the fit threshold for SRMR (SRMR was 0.075, with suggested cutoff under 0.08). Although findings confirmed the general hypothesis that cognitive biases play a role in the mindfulness-depression relationship, results ran counter to our specific hypotheses about the direction of effects. Namely, we expected that mindfulness would more strongly influence depression by *first* broadening one's attention to stimuli outside the narrow range informed by negative information processing networks and longstanding negative self-schemas (as reflected in decreased negative attention bias and increased positive attention bias), which would then inform interpretation biases, and finally fewer depressive symptoms. However, this hypothesized model was not the best fitting. Rather, the model with the mindfulness factors predicting depressive symptoms through interpretation bias followed by attention bias demonstrated relatively better fit. It is important to note that examination of specific variable relationships (relevant to Aim 3) revealed that attention bias was not significantly related to interpretation bias or depressive symptoms for

models of positive or negative biases. Further, the only significant relation between the dimensions of mindfulness and attention bias was between the ATT factor of mindfulness and attention bias, but as discussed below (see section 4.2.2), this relationship was in the opposite direction expected. Together, these results suggest that a model without attention bias altogether may be more valid.

While these findings failed to support the hypothesis that attention bias would have a significant impact on the model, there is conflicting evidence about the relationship between attention bias and depression in the literature (Gotlib & Joormann, 2010). Studies examining depression and attention biases have produced varying results depending on the specifics of the methodology. It has largely been found that mood induction before an experimental task, use of depression-relevant pictorial stimuli, and longer presentation of the stimulus (≥ 500 ms) may be required to capture attention bias as it manifests in depressed, at-risk, and remitted individuals (Gotlib & Joormann, 2010). While we did present pictorial stimuli that are relevant to depression during the dot probe task, we did not include a mood induction beforehand, and only exposed the stimuli for 500 ms. This may explain while we failed to find an association between attention bias and depression in the current sample.

It is possible to interpret the lack of association between attention bias and depression in the current sample as either (1) a lack of direct association between the two, and/or (2) the product of methodological limitations; however, our consideration of multiple biases at the same time may have also had an impact. Very little research has examined the combined impact of multiple biases at the same time, especially in the context of depression. Some theory suggests that when multiple cognitive biases are considered at the same time, only one of them may predict depression (Everaert et al, 2012). Everaert et al. (2013), for example, found that

interpretation bias was related to depression but attention bias was not. To explain their finding, they conjectured that some cognitive mechanisms may not be related to depression directly but could be associated with other levels of processing that are. Perhaps attention bias and depression are connected through a cognitive process other than interpretation bias, such as memory. Support for this idea comes from a study that evidenced a direct relationship between prolonged attention to negative words and negative memory bias (Everaert & Koster, 2020). Unfortunately, we did not have data on memory biases available for the current study and were thus unable to consider this possibility. Future research should explore the independent relationship between mindfulness and attention bias, and the role of attention bias in the mindfulness-depression link. Specific recommendations would be to create models that incorporate cognitive biases other than interpretation bias, such as memory or rumination.

The current results demonstrate that attention bias does not directly relate to depression, but that interpretation bias does. This replication of the role of interpretation bias in Everaert et al. (2013) highlights interpretation bias as a key mechanism in depression. Indeed, the literature demonstrates more robust evidence for an association between interpretation bias and depression than between attention bias and depression (Beevers et al., 2009; Bisson & Sears, 2007; Hindash & Amir, 2012). Further, cognitive bias modification has been demonstrated to reduce depressive symptoms in part through a reduction in interpretation bias (Mayer et al., 2018). Additional insight comes from studies that have found robust support for the contribution of interpretation bias to a reduction of depressive symptoms in the context of mindfulness-based interventions (Mayer et al., 2018). Taken together, these data point to the importance of the relations among mindfulness, interpretation bias, and depression. The current results offer additional support by replicating findings by Mayer et al. (2018), indicating that interpretation bias was directly related

to both mindfulness and depression and also that positive, in addition to negative, interpretation bias was a significant mediator of dispositional mindfulness and depression.

4.3 Exploring specificity in the relationships between the factors of mindfulness, cognitive biases, and depression

4.3.1 Considering mindful attention

Aim 3 proposed that the attention factor of mindfulness (ATT) would significantly predict attention bias in the model predicting depression. As mentioned above, the relationship between ATT and attention bias was significant for negative biases, but in a positive direction, whereby people who had higher levels of ATT had more negative attention bias. This was opposite from what was hypothesized; it was expected that higher levels of ATT would be related to less negatively biased attention. However, in light of the cross-sectional nature of the data, this finding may reflect that mindful ATT perpetuates a pre-existing negative attention bias. In other words, perhaps people with negative attention biases are initially more attentive to present-moment stimuli in their environments, which is reflected in higher levels of ATT. Due to activated negative schemas, however, they may have difficulty disengaging from negative stimuli, which reinforces negatively biased attention (Beck, 2008), reflected in the positive correlation between ATT and attention bias here. As this is the first study to examine the relationship between mindfulness and attention bias, future research should continue to explore this association, particularly in longitudinal studies.

4.3.2 Attention can be dangerous without non-judgmental acceptance

The positive relationship between mindful ATT and negative attention bias in the current study may suggest that, on its own, without non-judgmental acceptance (NJAC), attention can be detrimental. This suggestion was also made by Desrosiers and colleagues (2014), although they

were considering the potential negative impact of attention on depressive symptoms (rather than on attention bias). In their study, attention was positively associated with depression, but only in the absence of acceptance/non-judgment.

Coffey and colleagues (2010) also have data that may help contextualize the current associations between ATT and negative attention bias. They showed that mindful ATT and NJAC may be best conceptualized as operating in sequence, with greater levels of NJAC *following* from heightened present-moment ATT. In this sense, someone with present-moment attention alone may have a negative attention bias, but when non-judgmental acceptance is present as a mediator, that person may be able to more easily disengage from negative stimuli and expand their awareness to a wider range of positive stimuli, in which case negative attention bias would not manifest in negative mental health outcomes. In sum, the current findings add a suggestion to the literature that in the absence of non-judgment or acceptance, mindful attention and negative attention biases may be positively related. Future research should continue to explore whether non-judgmental acceptance is equally impactful in isolation from present-moment attention, above and beyond present-moment attention, or as a potential mediator of the relationship between present-moment attention and other outcomes such as attention bias and depressive symptoms.

4.3.3 Non-judgmental acceptance is important without attention

While mindful ATT can be detrimental without NJAC, NJAC may still be positively impactful without ATT. The current findings revealed that at least one of three factors in our mindfulness model (NJAC, AC, NJ) was significantly related to the cognitive biases, or depression, or both, in every model. Across models where attention bias was followed by interpretation bias, NJAC was never associated with attention bias, although the significant

negative relation between NJAC and depression remained. In the models when interpretation biases preceded attention bias, NJAC was significantly associated with interpretation bias (predicting fewer negative biases and more positive biases) and negatively associated with depression. Even when the positive connection between ATT and attention bias was present, NJAC still predicted fewer depression symptoms.

These findings suggest that non-judgmental acceptance of one's experience is key to mindfulness, regardless of whether attention reflects expanded present-moment awareness or a negative bias. In other words, even without present moment-attention, or with negative attention bias, non-judgmental acceptance appears to be impactful. Research has demonstrated that the non-judgmental acceptance dimension of mindfulness independently predicts mental health outcomes, including depression, above and beyond attention, highlighting the primary role of this mindfulness factor (Coffey et al., 2010; Mayer et al., 2018). In considering cognitive biases, research by Herndon and colleagues (2008) showed that making fewer cognitive errors was associated with mindfulness, above and beyond attention, and Mayer and colleagues found that non-judgmental awareness mediated the association between interpretation bias and depression, but mindful attention did not. In sum, our findings add further support to the literature that it is indeed the non-reactive, open-minded way in which one observes that is associated with fewer symptoms of depression through promoting less biased interpretations, regardless of the whether the observations are good or bad (Cameron & Fredrickson, 2015; Coffey et al., 2010; Desrosiers et al., 2014; Mayer et al., 2018).

4.3.4 The nuances of mindful non-judgment, acceptance, and non-judgmental acceptance

Based on the current findings and consistent with prior literature, non-judgmental acceptance is proposed to be essential to mindfulness. However, throughout the literature, non-

judgment (NJ) and acceptance (AC) are sometimes separated, depending on the measure used, and thus may have a differential impact on outcomes. In our model, mindfulness reflects the multiple factors of NJ and AC, in addition to a combined bi-factor representing non-judgmental acceptance (NJAC). We were thus able to explore the nuances of how these separate dimensions of mindful AC and NJ may differentially impact interpretation bias and depression. NJ can be conceptualized as different from AC, in that AC refers to one's ability to be present with all aspects of immediate experience, especially negative thoughts and feelings, without trying to change or suppress them. NJ, on the other hand, refers to refraining from self-focused ruminative judgment in response to thoughts and emotions that arise from experience, which is important for staying present to experience as it arises, and may inform one's acceptance of that experience (and desire to change it), but does not necessitate desire for such change. The combined non-judgmental acceptance bi-factor can then be understood to reflect an attitude of openness to experience that stems from refraining from self-judgment of thoughts and emotions that arise in response to experience *as well as* accepting whatever thoughts and feeling arise, without trying to alter them.

In the current study, higher levels of NJ were significantly associated with more positive interpretation biases and were approaching significance in relation to lower negative interpretation bias. AC was negatively associated with negative interpretation bias and was approaching significance in relation to positively predicting positive interpretation bias. The more significant relationship between high levels of NJ and more positive interpretation bias emphasize the positive self-compassionate nature of NJ and suggests that NJ allows one to consider positive interpretations of the thoughts and feelings one experiences. That higher levels of AC are more significantly associated with less negative interpretation biases suggests that the

acceptance of whatever thoughts and feelings that emerge without trying to change them may help one more easily disengage from negative stimuli. Depression was not associated with NJ in any of the four models but was significantly negatively associated with AC in all of them. This supports the idea that the ability to disengage from negative stimuli, as reflected in the negative relationship between AC and negative interpretation biases, plays a more important role in preventing depression than the ability to acquire positive interpretations. However, the combined NJAC factor in the current study positively predicted positive interpretation bias, and negatively predicted negative interpretation bias and depression. This highlights the combined importance of both the AC and NJ dimensions in relation to depression. The processes of accepting experience as it arises while withholding judgment of that experience are likely overlapping and collectively promote disengagement from negative stimuli in order to allow for more positively biased interpretations, and less depression. Previous findings suggest that mindfulness negatively relates to psychological distress through promoting non-attachment to negatively self-oriented information (Coffey et al., 2010). Further, prior research has reflected that depressed participants have difficulty disengaging from negative stimuli *and* lack a positive bias that is present in non-depressed participants. NJAC indeed demonstrated a greater impact in our findings than either NJ or AC alone.

4.3.6 The importance of positive information processing

While the focus of the literature review for this study was primarily negative processing biases, given their salience in the clinical literature, positive processing biases were also considered in light of evidence suggesting that biases towards positive information are found in non-depressed people. The points made above about negative biases don’t just signify that present-moment attention may only be helpful in tandem with mindful non-judgmental

acceptance, but they also highlight the value of present-moment attention in extending awareness to positive information. It may be that present-moment attention broadens the range of stimuli likely to be attended to (Everaert, 2012). As a result, one gains heightened awareness of positive information that contradicts negative self-oriented schemas and inhibits the cascading activation of negative associative networks that lead to negatively biased interpretations. More positively biased interpretations may in turn relate to fewer symptoms of depression. Mindfulness has been found not only to inversely relate to negative cognitions, but also to be positively associated with expanded awareness of positive information (De Raedt et al., 2012). Findings from the current study further support this by demonstrating a near significant correlation between present-moment attention and positive, but not negative, interpretation bias, and a significant negative relationship between positive interpretation bias and depressive symptoms. The present findings also showed that non-judgment was associated with positive, but not negative interpretation bias. In this way, the current study adds support to the importance of positive information processing in the relationship between mindfulness and depression. The current study builds on the work of work of both Mayer et al. (2018) and Sanchez and colleagues (2017) to emphasize the important role positive interpretation biases may play in the mindfulness-depression link.

4.4 Conclusion

The abundance of theory and empirical support discussed above can be boiled down into several key take-aways: (1) The construct of mindfulness best reflected the factors of present-moment attention, acceptance, non-judgment, as well as a non-judgmental acceptance (NJAC) bi-factor, without an overarching latent mindfulness factor; (2) the attention factor did not relate to depression or interpretation biases, while some evidence suggested an unexpected relationship between mindful attention and attention bias that should be further explored; (3) the NJAC factor

appeared to capitalize on the combination of the non-judgment and acceptance factors, in that it significantly predicted depression and positive and negative interpretation biases in the expected directions; (4) interpretation bias significantly predicted depression but attention bias did not; (5) attention bias was not related to interpretation bias or mindful non-judgmental acceptance, and (6) both negative and positive interpretation biases appeared important in the relationship between mindfulness and depression via NJAC.

These findings add support to mindfulness as a tool for depression prevention and intervention and offer additional insight into the mechanism underlying its effect. Specifically, interpretation bias appears to be an important means through which mindfulness is associated with depression, and the non-judgmental acceptance dimension of mindfulness appears to be the most impactful. This pattern of associations may be especially important to during the transitional period of EA. More work is needed to elucidate how cognitive biases do and can change over the course of development, but there is research to suggest that the developmental trajectory of some biases are sensitive to change (Scherf & Scott, 2012). Information processing biases in the context of relationships, for example, change across EA and have been associated with meaningful mental health outcomes (Finn et al, 2014). In addition, face processing biases have been demonstrated to shift during periods of transition and instability (Sherf & Scott). Such in-between-ness characterizes EA and suggests that the presumed plasticity of information processing during this period may make it an important time for intervention aimed at reducing negative processing biases and increasing positive ones. Lastly, the strengthening of self-concept that occurs during this important period of transition suggests that changes made in biased information processing during EA have the potential to impact depression across adulthood. Together then, mindfulness, and especially non-judgmental acceptance, may be an especially

salient tool for intervention during the sensitive period of EA that could greatly impact negative and positive information processing biases, and, in turn, the course of depression across the adulthood, reducing the public health impact of this mental illness.

4.5 Limitations and future directions

There are several limitations that should be kept in mind when considering the present findings and conducting future research. Primarily, the analyses were conducted on a cross-sectional sample. Thus, any claims about causality are not supported. While important information can be gleaned about the pieces of the mindfulness-combined cognitive bias-depression relationship, future research will ideally explore longitudinal relationships among these variables.

Additionally, the sample was relatively homogenous in terms of race/ethnicity. The data were also collected from a community sample, and thus did not reflect clinical levels of depression. While the variability in depressive symptoms was of particular interest in this study, results may differ with a clinically depressed sample. The current study did not control for demographic variables, in line with suggestions by Jaccard et al. (2006) and Spector and Brannick (2010), who advise against doing so in some circumstances due to a reduction in power for the sake of a small potential increase in the precision of an already evident effect, and at the risk of distorting the estimates. Future research should, however, explore measurement invariance based on demographic distinctions such as gender, age, race, socioeconomic status, and primary language, as important differences may become apparent that would improve our understanding about how mindfulness, cognitive biases, and depression may function differently across diverse sectors.

In addition to potential limitations associated with the sample, methodological limitations are also likely. Specifically, the study did not find an association between attention bias and depression, which may call into question pre-existing concerns about the reliability of the dot probe task. Our lack of mood induction prior to the task and the stimulus presentation of only 500 ms may also be limitations. Researchers are developing alternative ways to calculate dot-probe data, such as work by Zvielli et al., 2015 that produces multiple indices of attention bias by calculating trial level bias scores according to the time series of congruent-incongruent trials. However, when data from this method were used in additional models not presented here, the results remained largely the same, which may provide further support for our findings. Researchers should continue to pursue alternative methods of calculating attention bias from the dot probe task and alternative paradigms with which to measure attention bias.

It is important to note the non-judgmental acceptance (NJAC) bi-factor indicated in the best fitting measurement may indeed represent an additional non-judgmental acceptance factor distinct from either of the independent non-judgment or acceptance factors, but it is also possible that this bi-factor simply represents items that were negatively worded on the scale. In other words, it is possible that this bi-factor could be a methodological artifact reflecting nothing more than all items that were worded negatively. However, it has been suggested that if the factor does *not* merely reflect the shared wording of items, that it will predict outcomes differentially (Marsh et al., 2010). As seen in the results from our SEM models, this was indeed the case. Theory and prior research indicating a similar factor structure to the current model also lend support to the validity of the NJAC bi-factor as reflecting the inter-relationship of acceptance and non-judgment above and beyond the factors of attention and acceptance and non-judgment separately. In order to better account for this issue in the future, however, researchers modeling

mindfulness with data collected from the CEDMI should consider including an orthogonal method factor to account for construct-irrelevant variance from negatively worded items.

It was unfortunate that we were unable to examine the role of memory bias in the models. In light of evidence testing the combined cognitive bias hypothesis, memory bias may help further explain relationships in the models. Perhaps with the inclusion of memory bias, a significant pathway from attention bias to the other variables in the model would become apparent. In addition to considering the trifecta of attention, interpretation, *and* memory biases in future studies examining cognitive biases as mediators in the mindfulness-depression link, alternative models whereby mindfulness mediates the relationship between cognitive biases and depression should also be explored. It was also unfortunate that we were unable to examine the impact of meditation experience in our models, as prior research has suggested such experience is relevant and may indeed provide further insight into the mechanisms at hand.

Despite several limitations, the current study is enhanced through the use of an empirically-derived mindfulness scale, which is important in light of the many different scales that claim to measure mindfulness. Additionally, measures of interpretation bias, as well as attention bias, were resistant to reporting biases common with self-report measures. Further, powerful, cutting-edge statistical techniques were used to empirically determine the most valid factor structure of mindfulness, and to subsequently test the relationships between the factors of mindfulness, attention and interpretation biases, and depression.

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APPENDICES

Appendix A: Self-Report Measures

Demographics

1) What is your sex ___1 Male ____ 0 Female

2) How many years of education have you completed

___1 Completed High School (or GED)

___2 Completed First Year of College

___3 Completed Second Year of College

___4 Completed Third Year of College

___5 Completed Fourth Year of College

___6 Earned Bachelor's Degree

___7 Completed Graduate work (how many years? ___)

3) Are you currently in a romantic relationship?

__ ____ No, I am currently single

__ ____Yes, I am dating at least one person casually

__ ____Yes, I am in an exclusive relationship

__ ____Yes, I am engaged to be married

__ ____Yes, I am married or in a life-long, committed partnership

4) Are you of Hispanic/Latino origin?

___1 Yes

___0 No

5) Which race or ethnicity do you consider yourself to be?

___1 White/Caucasian

___2 Black/ African-American

___3 East Asian (i.e. Chinese, Japanese, Vietnamese)

___4 South Asian (i.e. Indian, Pakistani, Burmese)

___5 American Indian or Alaskan Native

___6 Pacific Islander or Native Hawaiian

___7 Other (please specify _____)

6) Is English your primary language?

___1 Yes

___0No (please specify _____)

7) Where were you born?

___1 United States

___0 Not United States

8) Where did you (primarily) grow up?

___1 United States

___0 Not United States

9) How would you describe the economic situation of your household when you were in high school? [Check one]

___We had barely enough to get by

___We had enough to get by but not more

___We were solidly middle class

___We had plenty of "extras"

___We had plenty of "luxuries."

10) What is your age? ____

11) Have you ever been diagnosed with the following psychiatric disorders?

Major Depression ___Yes ___No

Bipolar Depression ___Yes ___No

Generalized Anxiety Disorder ___Yes ___No

Post-Traumatic Stress Disorder ___Yes ___No

Social Phobia ___Yes ___No

Specific Phobia (e.g., fear of heights, crowds, dogs, etc.) ___Yes ___No

Eating Disorder ___Yes ___No

Schizophrenia ___Yes ___No

Alcohol / Substance Abuse or Dependence ___Yes ___No

12) Have you ever received psychiatric treatment for any of the following psychiatric disorders?

Major Depression ___Yes ___No

Bipolar Depression ___Yes ___No

Generalized Anxiety Disorder ___Yes ___No

Post-Traumatic Stress Disorder ___Yes ___No

Social Phobia ___Yes ___No

Specific Phobia (e.g., fear of heights, crowds, dogs, etc.) ___Yes ___No

Eating Disorder ___Yes ___No

Schizophrenia ___Yes ___No

Alcohol / Substance Abuse or Dependence ___Yes ___No

13) Are you currently receiving treatment for any psychiatric disorders? ___Yes ___No

If so, what are you currently receiving treatment for?_____

14) Please specify which (if any) family member(s) has experienced each psychiatric disorder. Please circle all that apply. For instance, if both your mother and grandmother experience Major Depression, you would circle both "Mother" and "Grandparent."

Major Depression

Mother Father Sibling Grandparent Aunt/Uncle None

Bipolar Depression

Mother Father Sibling Grandparent Aunt/Uncle None

Generalized Anxiety Disorder

Mother Father Sibling Grandparent Aunt/Uncle None

Post-Traumatic Stress Disorder

Mother Father Sibling Grandparent Aunt/Uncle None

Social Phobia

Mother Father Sibling Grandparent Aunt/Uncle None

Specific Phobia (e.g., fear of heights, crowds, dogs, etc.)

Mother Father Sibling Grandparent Aunt/Uncle None

Eating Disorder

Mother Father Sibling Grandparent Aunt/Uncle None

Alcohol / Substance Abuse or Dependence

Mother Father Sibling Grandparent Aunt/Uncle None

BDI-II

Instructions: This questionnaire consists of 20 groups of statements. Please read each group of statements carefully, and then pick out the **one statement** in each group that best describes the way you have been feeling during the **past two weeks, including today.** Circle the number beside the statement you have picked. If several statements in the group seem to apply equally well, circle the highest number for that group. Be sure that you do not choose more than one statement for any group, including Item 15 (Changes in Sleeping Pattern) or Item 17 (Changes in Appetite).

1. **Sadness**

0 I do not feel sad.

1 I feel sad much of the time.

2 I am sad all the time.

3 I am so sad or unhappy that I can't stand it.

2. **Pessimism**

0 I am not discouraged about my future.

1 I feel more discouraged about my future than I used to be.

2 I do not expect things to work out for me.

3 I feel my future is hopeless and will only get worse.

3. Past Failure

0 I do not feel like a failure.

1 I have failed more than I should have.

2 As I look back, I see a lot of failures.

3 I feel I am a total failure as a person.

4. Loss of Pleasure

0 I get as much pleasure as I ever did from the things I enjoy.

1 I don't enjoy things as much as I used to.

2 I get very little pleasure from the things I used enjoy.

3 I can't get any pleasure from the things I used to enjoy.

5. Guilty Feelings

0 I don't feel particularly guilty.

1 I feel guilty over many things I have done or should have done.

2 I feel quite guilty most of the time.

3 I feel guilty all the time.

6. Punishment Feelings

0 I don't feel I am being punished.

1 I feel I may be punished.

2 I expect to be punished.

3 I feel I am being punished.

7. Self-Dislike

0 I feel the same about myself as ever.

1 I have lost confidence in myself.

2 I am disappointed in myself.

3 I dislike myself.

8. Self-Criticalness

0 I don't criticize or blame myself more than usual.

1 I am more critical of myself than I used to be.

2 I criticize myself for all of my faults.

3 I blame myself for everything bad that happens.

9. Crying

0 I don't cry any more than I used to.

1 I cry more than I used to.

2 I cry over every little thing.

3 I feel like crying, but I can't.

10. Agitation

0 I am no more restless or wound up than usual.

1 I feel more restless or wound up than usual.

2 I am so restless or agitated that it's hard to stay still.

3 I am so restless or agitated that I have to keep moving or doing something.

11. Loss of Interest

0 I have not lost interest in other people or activities.

1 I am less interested in other people or things than before.

2 I have lost most of my interest in other people or things.

3 It's hard to get interested in anything.

12. Indecisiveness

1 I make decisions about as well as ever.

2 I find it more difficult to make decisions than usual.

3 I have much greater difficulty in making decisions than I used to.

4 I have trouble making any decisions.

13. Worthiness

0 I do not feel like I am worthless.

1 I don't consider myself as worthwhile and useful as I used to.

2 I feel more worthless as compared to other people.

3 I feel utterly worthless.

14. Loss of Energy

0 I have as much energy as ever.

1 I have less energy than I used to have.

2 I don't have enough energy to do very much.

3 I don't have enough energy to do anything.

15. Changes in Sleeping Pattern

0 I have not experienced any change in my sleeping pattern.

1a I sleep somewhat more than usual.

1b I sleep somewhat less than usual.

2a I sleep a lot more than usual.

2b I sleep a lot less than usual.

3a I sleep most of the day.

3b I wake up 1-2 hours early and can't get back to sleep

16. Irritability

0 I am no more irritable than usual.

1 I am more irritable than usual.

2 I am much more irritable than usual.

3 I am irritable all the time.

17. Changes in Appetite

0 I have not experienced any change in appetite

1a My appetite is somewhat less than usual.

1b My appetite is somewhat greater than usual.

2a My appetite is much less than before.

2b My appetite is much greater than usual.

3a I have no appetite at all.

3b I crave food all the time.

18. Concentration Difficulty

0 I can concentrate as well as ever.

1 I can't concentrate as well as usual.

2 It's hard to keep my mind on anything for very long.

3 I find I can't concentrate on anything.

19. Tiredness or Fatigue

0 I am no more tired or fatigued than usual.

1 I get more tired or fatigued more easily than usual.

2 I am too tired or fatigued to do a lot of things I used to do.

3 I am too tired or fatigued to do most of the things I used to do.

20. Loss of Interest in Sex

0 I have not noticed any recent change in my interest in sex.

1 I am less interested in sex than I used to be.

2 I am much less interested in sex now.

3 I have lost interest in sex completely.

CEDMI

Please indicate below how often the following items are true for you:

	Never or very rarely true	**Rarely true**	**Sometimes true**	**Often true**	**Very often or always true**
When I'm walking, I deliberately notice the sensations of my body moving.	1	2	3	4	5
I criticize myself for having irrational or inappropriate emotions.	1	2	3	4	5
When I take a shower or bath, I stay alert to the sensations of water on my body.	1	2	3	4	5
I tell myself I shouldn't be feeling the way I'm feeling.	1	2	3	4	5
I notice how foods and drinks affect my thoughts, bodily sensations, and emotions.	1	2	3	4	5

I believe some of my thoughts are abnormal or bad and I shouldn't think that way.	1	2	3	4	5
I pay attention to sensations, such as the wind in my hair or sun on my face.	1	2	3	4	5
I make judgments about whether my thoughts are good or bad.	1	2	3	4	5
I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing.	1	2	3	4	5
I tell myself that I shouldn't be thinking the way I'm thinking.	1	2	3	4	5
I notice the smells and aromas of things.	1	2	3	4	5
I think some of my emotions are bad or inappropriate and I shouldn't feel them.	1	2	3	4	5
I notice visual elements in art or nature, such as colors, shapes, textures, or patterns of light and shadow.	1	2	3	4	5

I notice visual elements in art or nature, such as colors, shapes, textures, or patterns of light and shadow.	1	2	3	4	5
When I have distressing thoughts or images, I judge myself as good or bad, depending what the thought/image is about.	1	2	3	4	5
I pay attention to how my emotions affect my thoughts and behavior.	1	2	3	4	5
I disapprove of myself when I have irrational ideas.	1	2	3	4	5
When I'm upset, I become angry with myself for feeling that way.	1	2	3	4	5
When I'm upset, I become embarrassed for feeling that way.	1	2	3	4	5
When I'm upset, I feel ashamed for feeling that way.	1	2	3	4	5
When I'm upset, I feel like I am weak.	1	2	3	4	5

When I'm upset, I feel guilty for feeling that way.	1	2	3	4	5
When I'm upset, I become irritated with myself for feeling that way.	1	2	3	4	5

Scrambled Sentence Task

Condition: CL NoCL

For this section you will be asked to unscramble sentences to form statements. Each of the scrambled sentences contains six words. Unscramble five words in each sentence by placing a number over each of five words indicating the proper order. For example:

3 2 1 5 4

has green child the eyes blue

Unscramble the sentences to form statements, not questions. Each sentence can be unscrambled into more than one statement, but you should choose only one statement to unscramble. You can unscramble the sentences to form whatever statement comes to mind first. Work as quickly as you can because your time will be limited. Do not correct errors. If you make a mistake simply move on to the next item.

1. looks the future bright very dismal

2. interesting life my boring generally is

3. usually like people not me do

4. equal am others I inferior to

5. living life not worth is well

6. worthwhile I worthless am a person

7. failure I a am generally success

8. love I others' don't deserve generally

9. about do care people me don't

10. have I my friends lost helped

11. is impossible to happiness possible attain

12. is appearance physical my unchanged worsening

13. well me people of poorly think

14. not college is worth well it

15. me people understand do not usually

16. am I ruining life improving my

17. person an am inadequate I adequate

18. others' cannot I can meet expectations

19. I little offer to have much

20. my wasted I utilized have opportunities

21. have life succeeded failed I at

22. happy miserable be I expect to

23. curious I person bad a am

24. will goals I cannot achieve my

25. me to is life cruel good

Please STOP HERE.

ALERT RESEARCHER THAT YOU HAVE COMPLETED THE SENTENCES.

Condition: CL NoCL

For this section you will be asked to unscramble sentences to form statements. Each of the scrambled sentences contains six words. Unscramble five words in each sentence by placing a number over each of five words indicating the proper order. For example:

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Unscramble the sentences to form statements, not questions. Each sentence can be unscrambled into more than one statement, but you should choose only one statement to unscramble. You can unscramble the sentences to form whatever statement comes to mind first. Work as quickly as you can because your time will be limited. Do not correct errors. If you make a mistake simply move on to the next item.

26. disappointed have I friends pleased my

27. trying keep to stop want I

28. good feel very bad I usually

29. myself in disappointed am confident I

30. life makes good nothing me feel

31. time I alone enjoy my dislike

32. I fail will once succeed more

33. something I give nothing to have

34. forever want sleep I live to

35. usually feel I energetic tired very

36. who I dislike I am like

37. good mostly memories my sad are

38. is nothing me something with wrong

39. is stressful life interesting my very

40. personal satisfying my disappointing relationships are

41. things can't I get can together

42. born I loser a winner am

43. decisions problems making I confidence have

44. quite generally incapable I capable am

45. happen bad seem good to things

46. person good a am defective I

47. my boring is interesting life usually

48. concentration worse now my is better

49. often crying like I laughing feel

50. seldom death often of think I

#_____