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An Examination of Associations among Components of Mindfulness and Women's Attention Bias to Sad Faces

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AN EXAMINATION OF ASSOCIATIONS AMONG COMPONENTS OF MINDFULNESS AND WOMEN'S ATTENTION BIAS TO SAD FACES

by

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ABSTRACT

Mindfulness, a set of techniques for engaging with stimuli in the present-moment environment, has recently received considerable attention in the literature. Mindfulness is drawn from Eastern, Buddhist traditions and has been integrated into contemporary psychology, in part, as a technique for improving the ability to respond skillfully to emotionally distressing stimuli and processes (Bishop, et al., 2004). However, the boundaries of the mindfulness construct have yet to be solidly established; a variety of definitions exist and are used inconsistently in the literature. Clarifying how engaging attentional control processes in response to emotionally-charged stimuli, such as sad faces, relates to precisely-articulated models of mindfulness could constitute a useful first step toward better understanding the construct of mindfulness. One widely-referenced, viable model of mindfulness, developed by Bishop and colleagues (2004) suggests that mindfulness is composed of two components: attention and acceptance. It is unclear whether and how these proposed components of mindfulness relate to individual variations in behavior patterns on measures of attention bias for sad stimuli.

The current study, therefore, aims to examine associations among two components of mindfulness (Bishop, et al., 2004) and performance on a widely-used measure that elicits attention bias for emotional cues. It was hypothesized that scores on self-reported measures of attention and acceptance components of mindfulness would show negative and moderate associations with attention bias for sad faces and positive and moderate associations with attention bias for happy faces, indexed both by bias scores based on reaction times and patterns of visual gaze toward sad and happy faces. One hundred twenty-three college students were asked to complete demographic measures, the Philadelphia Mindfulness Scale (PHLMS), and the dot-probe attention bias paradigm (which yielded both behavioral and eye movement measures). Complete behavioral attention bias data were acquired for 104 participants and complete eye tracking data were acquired for 88 participants. Results suggest no significant relationships of either component of mindfulness with either measure of attention bias to emotional stimuli. The discussion explores factors that may have contributed to the outcome and ideas for future research that might further clarify mindfulness.

INDEX WORDS: Mindfulness, Attention, Acceptance, Attention Bias

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DEDICATION

This dissertation is dedicated to my family: Joshua, Matthias, and Elizabeth Garn. Because of your support and love I was able to stay “mindful” of what was most important to me throughout this whole process—you.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

1.1 The Construct of Mindfulness

Mindfulness, a set of techniques for engaging with stimuli in the present-moment environment (Shapiro, Carlson, Astin, & Freedman, 2006; Wenk-Sormaz, 2005), has recently received considerable attention in the literature. Historically, mindfulness-based psychological interventions have drawn from Eastern, Buddhist traditions, which developed mindfulness meditation with the aim of fostering insight into internal stimuli, as a way to lead to the cessation of personal suffering, even in the context of objectively painful experiences (Anderson, Lau, Segal, & Bishop, 2007; Bishop et al., 2004; Grossman, 2011; Kabat-Zinn, 2003; Kumar, 2002; Silananda, 1990; Thera, 1962). From this traditional perspective, mindfulness integrated an attitude of acceptance or non-judgment with either an attentive awareness of everything in one's environment or sustained attention toward one stimulus (Anderson, Lau, Segal, & Bishop, 2007; Goleman, 1977; Gunaratana, 1992; Hart, 1987; Langer, 1989).

Jon Kabat-Zinn formally integrated the concept of mindfulness into Western mental and physical health treatment in the 1980s (Kabat-Zinn, 1982). Most subsequent conceptualizations of mindfulness within the psychology literature have been based on Kabat-Zinn's definition of the term, which suggests that mindfulness is "the awareness that emerges through paying attention on purpose, in the present moment, and non-judgmentally to the unfolding of experience moment by moment" (2003, p. 145). Kabat-Zinn's interpretation of the concept "mindfulness" has been adopted in contemporary psychology, in part, as a technique for improving the ability to respond skillfully to emotionally distressing stimuli and processes (Bishop, et al., 2004).

When examining relationships among mindfulness and other variables, researchers do not always adhere strictly to Kabat-Zinn's definition. Indeed, they disagree considerably about the structure and boundaries of the mindfulness construct. This lack of a uniformly-accepted definition makes it difficult to interpret findings from research on relationships between mindfulness and putative correlates, such as attentional patterns for emotional stimuli (Bergomi Tschacher, & Kupper, 2013; Bishop, 2002).

There is some agreement that mindfulness may comprise multiple components. However, consensus is lacking regarding these components. Definitions include different combinations of intention (or purpose; Shapiro, Carlson, Astin, & Freedman, 2006; Shapiro & Schwartz, 2000), non-reactivity (Baer, et al., 2008), creativity (Langer, 1989), describing (Baer, Smith, & Allen, 2004; Baer et al., 2008), emotion regulation (Tang, Hölzel, & Posner, 2015), observing (Baer, Smith, & Allen, 2004; Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006; Baer et al., 2008), acting with awareness (Baer, Smith, & Allen, 2004; Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006; Baer et al., 2008), acceptance or non-judgment (Baer, Smith, & Allen, 2004; Baer, et al., 2008; Bishop, et al., 2004; Langer, 1989; Shapiro, Carlson, Astin, & Freedman, 2006; Tang, Hölzel, & Posner, 2015), and attention (Baer, Smith, & Allen, 2004; Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006; Baer et al., 2008; Bishop, et al., 2004; Brown & Ryan, 2003; Langer, 1989; Shapiro, Carlson, Astin, & Freedman, 2006; Tang, Hölzel, & Posner, 2015).

Several concerns have been raised about some of these proposed components of mindfulness. For example, some putative components (e.g., observe and describe, describe and act with awareness, and non-judging and non-reactivity; Baer, Smith, & Allen, 2004; Coffey, Hartman, and Fredrickson, 2010) moderately correlate with each other, which may suggest that they are not wholly distinct (Baer, Smith, & Allen, 2004; Baer, et al., 2008; Cardaciotto, Herbert, Forman, Moitra, & Farrow, 2008). Further, it is not clear whether some proposed components (such as non-reactivity, creativity, and emotion regulation) might instead be outcomes or consequences of mindfulness rather than aspects of mindfulness itself (Bishop, et al., 2004; Coffey, Hartman, & Fredrickson, 2010).

In contrast, two other putative components, attention and acceptance, emerge with notable consistency across definitions (Baer, Smith, & Allen, 2004; Baer et al., 2008; Bishop, et al., 2004; Brown

& Ryan, 2003; Langer, 1989; Shapiro, Carlson, Astin, & Freedman, 2006). These two components are deeply rooted in Buddhist tradition (Anderson, Lau, Segal, & Bishop, 2007; Gunaratana, 1992; Hanh, 1987) and have met with fewer questions, in part because they appear to be distinct from each other (Cardaciotto et al., 2008; Coffey, Hartmann, & Fredrickson, 2010).

Mindful attention is generally thought to comprise awareness and attentional control, although there is not always consistency in how these components are defined. In the attention literature, awareness is considered to be a stimulus-driven or bottom-up attentional process and attentional control is a separate top-down set of attentional processes that includes sustained attention, inhibition, and attention switching (Anderson, Lau, Segal, & Bishop, 2007; Jha, et al., 2007; Posner & Peterson, 1990; Washburn, Latzman, Schultz, & Bramlett, 2015). In the mindfulness literature, however, awareness is generally defined as "the background 'radar' of consciousness, continually monitoring the inner and outer environment" (Brown & Ryan, 2003, p. 822). To focus awareness, an individual must engage attentional control processes to bring salient aspects of the inner and outer environments into the foreground (Bishop, et al., 2004). Attentional control skills are also necessary skill for maintaining awareness of relevant stimuli over time (sustained attention), preventing elaborative processes that are irrelevant to stimuli in the present environment (inhibition), and facilitating shifts in focus as new details become salient (attention switching; Bishop et al., 2004; Brown & Ryan, 2003; Gunaratana, 1992; Kabat-Zinn, 2003). Therefore, in mindfulness top-down and bottom-up attentional processes may work in concert to cause an intentional, monitored awareness of internal and external stimuli in the present-moment environment.

Mindful acceptance is also frequently identified in theoretical (Baer, Smith, & Allen, 2004; Baer, et al., 2008; Bishop, et al., 2004; Langer, 1989; Shapiro, Carlson, Astin, & Freedman, 2006) and empirical (Cardaciotto, et al., 2008; Coffey, Hartman, & Fredrickson, 2010) accounts as a necessary component in mindfulness. Mindful acceptance has been defined as an orientation of one's attention such that one is curious about, open to, and nonjudgmental of stimuli in the environment (Bishop et al., 2004; Langer, 1989; Roemer & Orsillo, 2002).

This definition of mindfulness as composed of two distinct and necessary components—attention and acceptance (Bishop et al., 2004; Cardaciotto et al., 2008; Coffey, Hartman, and Fredrickson, 2010; Kabat-Zinn, 2003)—allows for several possible patterns of association between mindfulness and patterns of attention to emotional stimuli. First, mindfulness may facilitate effective and intentional deployment of attention processes in response to potentially emotionally-dysregulating cues (i.e., emotional stimuli that may trigger emotion dysregulation; Bishop et al., 2004) that enter awareness. Second, mindfulness may facilitate a receptive and accepting, rather than mood-congruent (e.g., sadness, grief, or rejection; Beck, 1967; Teasdale, 1988), pattern of emotional response to such cues (Bishop et al., 2004). It is also possible that one component is more strongly correlated with attention patterns for emotional stimuli than is the other or that both are equally and independently correlated with attention patterns to emotional stimuli.

However, few researchers have examined hypothetical relationships among these two proposed components of mindfulness and attention patterns to emotional stimuli. In order to do so, it is necessary to identify attention patterns that are amenable to measurement and that have been linked to emotional dysregulation. The present study is focused on attention bias for sad cues, or a behavioral tendency to preferentially attend to a sad stimulus set (Macleod, Mathews, & Tata, 1986), as a first step toward understanding relationships among components of mindfulness and patterns of attention for emotional stimuli. The next section discusses the literature on attention biases.

1.2 Attention Bias to Sad Faces

Numerous cognitive and behavioral patterns have been suggested as possible targets in investigations of cognitive, particularly attentional, disruptions that occur in the context of emotional dysregulation (e.g., memory dysfunction [Fossati, Coyette, Ergis, & Allilaire, 2002; Lang, Moulds, & Holmes, 2009;

Williams, Teasdale, Segal, & Soulsby, 2000], rumination [Nolen-Hoeksema, 1991; Nolen-Hoeksema, Wisco, & Lynbomirsky, 2008; Treynor, Gonzalez, & Nolen-Hoeksema, 2009], and visual attention biases [Hallion & Ruscio, 2011; Joormann, 2009; MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002; Wells & Beevers, 2010]). One in particular—attention bias toward emotional stimuli, which has been well-documented as a correlate and predictor of anxious (Bantin, Stevens, Gerlach, & Hermann, 2016; Eldar, Ricon, & Bar-Haim, 2008; Mathews & MacLeod, 2002; Taylor, Cross, & Amir, 2016) and depressive symptoms (Hallion & Ruscio, 2011; MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002; Wells & Beevers, 2010)—appears to be especially well suited for use in research on mindfulness, conceptualized as comprising attention and acceptance.

In the present study, I focus on a specific type of attention bias—bias to attend preferentially to sad cues—that has been associated with increased emotional distress responses and depressive symptoms (Baert et al., 2010; Hallion & Ruscio, 2011; MacLeod et al., 2002; Wells & Beevers, 2010). I selected this focus for several reasons. First, attention biases are measured behaviorally rather than via self-report, which is consistent with recommendations for assessing components of mindfulness (Bishop, 2002). Second, measures of attention bias to emotional stimuli yield indices that researchers have interpreted as signaling regulated (or dysregulated) implementation of sustained attention and inhibition for emotional stimuli that enter awareness (Eizenman et al., 2003; Gotlib, Krasnoperova, et al., 2004; Joormann, 2004; Joormann & Gotlib, 2007). These indices thus appear to reflect processes that resemble those engaged in mindfulness. The apparent overlap between attention bias tasks and mindful behavior—both demand engagement of attentional control processes (sustained attention and inhibition)—makes attention bias measures particularly relevant tools for research on mindfulness. Finally, correlational studies have found a relationship between the experience of and risk for depressive symptoms and attention bias toward sad faces; depression and vulnerability to depression thus appear to be associated with an emotionally dysregulated or mood congruent pattern of attentional response (Appendix

A, Table 1; Gotlib, Kasch et al., 2004; Gotlib, Krasnoperova, et al., 2004; Joormann & Gotlib, 2007; Kujawa, et al., 2011). Correlational studies have also found evidence that healthy controls, relative to depressed individuals, show attention biases toward happy faces, which may reflect a more emotionally regulated pattern of attentional response (Joormann & Gotlib, 2007; Joormann, Talbot, & Gotlib, 2007; Leyman, De Raedt, Vaeyens, & Philippaerts, 2011; Surguladze, et al., 2004).

Such attention biases for emotional stimuli are commonly assessed with behavioral reaction time measures. Bias scores can be calculated by examining differences in reaction time for cues that follow different types of stimuli; if an individual responds more quickly, on average, to cues that replace briefly displayed emotionally-charged stimuli (e.g., sad faces) than to those that replace briefly displayed neutral stimuli, that person is considered to show a bias to attend preferentially to emotional cues. If, in contrast, an individual tends to respond faster to cues that are distant from emotionally-charged stimuli, that individual is identified as demonstrating a bias to preferentially avoid emotional cues.

To augment the information that behavioral reaction time studies can provide, some researchers also collect data via eye tracking regarding the number of times an individual gazes at a stimulus (i.e., number of fixations) and the length of time spent looking at a stimulus (i.e., gaze duration) during an attention bias task (Duque & Vázquez, 2015; Hermans, Vansteenwegen, & Eelen, 1999; Isaacowitz, Wadlinger, Goren, & Wilson, 2006; Kellough, Beevers, Ellis, & Wells, 2008). Eye tracking data are limited in that they do not capture attention shifts that are not accompanied by a measurable shift of gaze; however, in light of evidence that there is a necessary shift of attention immediately preceding the time of a gaze shift (Kowler, Anderson, Dosher, & Blaser, 1995), it is likely that these data do capture at least a sizable subset of attentional changes. Eye tracking attention bias research findings suggest that individuals with mood dysregulation, compared to healthy controls, look for longer periods of time at sad scenes (Caseras, Garner, Bradley, & Mogg, 2007; Eizenman et al., 2003; Kellough, Beevers, Ellis, & Wells, 2008; Matthews & Antes, 1992) and faces (Duque & Vázquez, 2015; Leyman, De Raedt, Vaeyens, & Philippaerts, 2011; Appendix A, Table 2), compared to other emotional stimuli.

By gathering both behavioral reaction time and gaze duration data during a dot-probe attention task, it may be possible to obtain a particularly rich set of data about attention patterns for emotional cues that reflect heightened risk for mental illnesses, including depression. Evidence that mindfulness is associated inversely with one or more indices of attention bias could suggest that such attention patterns constitute at least one path through which individuals with higher self-reported mindfulness respond to emotionally-charged stimuli. To date, little is known about how patterns of attention bias for any type of emotional cue relate to mindfulness and its components. There is evidence, however, that self-reported mindful attention, along with self-reported mindful acceptance, does relate to performance on behavioral measures that tap such aspects of attention control as sustained focus and inhibition. In the next section, I review this literature briefly and use it as a foundation for hypotheses about relationships among mindful attention, mindful acceptance, and attention bias to sad faces.

1.3 Relationship between Mindfulness and Attention Processes

A number of studies, using both correlational and intervention designs, have examined associations between self-reported mindfulness or changes in mindfulness levels following interventions designed to increase mindful behavior and performance on measures of awareness and cognitive attention processes (including sustained attention, inhibition, and attention switching). Complicating efforts to summarize this research, different studies measure mindfulness in different ways, using a variety of self-report instruments. For example, several studies used measures that focus on a single component of mindfulness, typically mindful attention (assessed through the Mindful Attention Awareness Scale [MAAS; Brown & Ryan, 2003]; Chambers, Lo, & Allen, 2008; Deng, Li, & Tang, 2014; De Raedt, et al., 2012; Jensen, Vangkilds, Frokjaer, & Hasselbalch, 2011) although mindful acceptance was measured in one study (the Toronto Mindfulness Scale [TMS; Lau et al., 2006]; Anderson, Lau, Segal, & Bishop, 2007).

Other studies employed composite measures that combine items tapping multiple hypothetical components to yield a single mindfulness score (such as the Cognitive and Affective Mindfulness Scale, Revised [CAMS-R; Feldman, Hayes, Kumar, Greeson, & Laurenceau, 2007], the Five Factor Mindfulness Questionnaire [FFMQ; Baer, et al., 2008], and the Kentucky Inventory of Mindfulness Skills [KIMS; Baer, Smith, & Allen, 2004]; Moore & Malinowski, 2009; Schmertz, Anderson, & Robins, 2009). Finally, another group of studies compared attention task performance measured pre- and post-mindfulness training to assess effects that mindfulness interventions might have on attention processes (Anderson, Lau, Segal, & Bishop, 2007; Chambers, Lo, & Allen 2008; De Raedt, et al., 2012; Heeren, Van Broeck, & Philippot, 2009; Jensen, Vangkilde, Frokjaer, & Hasselbalch, 2012; Jha, Krompinger, & Baime, 2007; MacLean, et al., 2010; Moore & Malinowski, 2009; Semple, 2010; Tang et al., 2007; Teper & Inzlicht, 2013; Vega et al., 2014; Valentine & Sweet, 1999; Wenk-Sormaz, 2005; Zeidan et al., 2010). Broadly, although not uniformly, results from this small emerging literature indicate that mindfulness correlates positively with well-regulated attention and that mindfulness training can contribute to improvements in attention regulation (Table 1).

Researchers have found that mindful attention (as measured by the MAAS) is positively correlated with performance on multiple measures of sustained attention (Chambers, Lo, & Allen, 2008; Deng, Li, & Tang, 2014; De Raedt, et al., 2012; Jensen, Vangkilds, Frokjaer, & Hasselbalch, 2011) and inhibition (De Raedt et al., 2012; Jensen, Vangkilde, & Frokjaer, 2012). Findings regarding the relationship between mindful attention and attention switching, however, have been mixed, with one study showing improvement in attention switching following mindfulness training (Jensen, Vangkilde, Frokjaer, & Hasselbalch, 2012) and another showing no significant improvement in attention switching after a similar intervention (Chambers, Lo, & Allen, 2008). In general, findings consistently suggest a positive relationship between mindful attention—a single component of mindfulness—and performance on some

Table 1. Studies of Mindfulness and Attention

Author	N	Dx	Age	Groups	Mindfulness Measure	Task and Stimuli	Analysis	General Results
Correlational studies examining relationships between individuals components of mindfulness and attention processes								
Chambers et al., 2008	20	HC	33.7	10 day Vipassana intervention	MAAS	Digit span backwards and Internal Switching Task (IST) with both neutral and affective stimuli.	Group x testing time x stimulus emotion	Post-training MAAS scores were positively and moderately correlated with sustained attention. Intervention led to moderate improvements in sustained attention, particularly toward emotional, personally relevant stimuli. Attention switching processes were not influenced by mindfulness training.
	20		31.9	Waitlist Control				
Deng et al., 2014	23	HC	21.9		MAAS	Sustained Attention Response Task (SART)	Pearson's Corr	Mindfulness was negatively and moderately correlated with error rates, suggesting individuals with higher levels of mindfulness had better sustained attention.
De Raedt et al., 2012	45	MDD	45.2	8 week MBCT intervention	MAAS	Negative Affective Priming with emotional face stimuli	Group x testing time x stimulus emotion	Post-training MAAS scores were positively and moderately correlated with sustained attention. Dysfunction in sustained attention and inhibition found at pre-training disappeared in post-training performance.
	26		45.0	Waitlist control				
Jensen et al., 2012	16	HC		8 week MBSR intervention	MAAS	Dual Attention to Response Task, Spatial and Temporal Attention Network, Stroop task, d2 Test of Attention, and combiTVA.	Group x testing time	Post-training MAAS scores were positively and strongly correlated with sustained attention and inhibition. Intervention led to significant improvement in sustained attention and attention switching on one task (d2), but not on another task (DART) compared to those in the non-mindfulness intervention.
	16			8 week non-mindfulness intervention				
	16			Waitlist Control				
Anderson et al, 2007	39	HC	37	8 week MBSR intervention	TMS	Vigil Continuous Performance Task, Stroop task, and an object detection task	Group x testing time x stimulus condition	Changes in TMS scores (calculated from pre- and post-training measurement) did not predict improvements in sustained attention, inhibition, and attention switching. Mindfulness intervention was also not related to sustained attention, inhibition, and attention switching. Mindfulness intervention led to improvements in performance on an awareness task.

Correlational studies examining relationships between a composite measure of mindfulness and attention processes								
Schmertz, Anderson, & Robins, 2009	50	HC	20.3		MAAS, KIMS, and CAMS-R	Connors' CPT-2 and Paced auditory serial addition test	Regress	Greater self-reported mindfulness on the MAAS and CAMS-R was moderately correlated with better sustained attention (CPT-2). KIMS *Act with awareness* was not related to performance on either task.
Moore & Malinowski, 2009	25	HC	28	Buddhist mindfulness meditators	KIMS	Stroop task and d2 Test of Attention	Corr and Regress	Mindfulness was positively, related to sustained attention and inhibition (moderate to large effects). *Act with awareness* and *observe* on the KIMS best predicted better inhibition performance on the Stroop task.
	25		27.5	non-meditators				
Intervention studies examining the effects of mindfulness training on attention processes								
Wenk-Sormaz, 2005	120	HC	19.4	20 minutes of Zen mindfulness	None	Stroop with neutral stimuli	Group	Mindfulness meditation, compared to other interventions and control, led to improved inhibition (moderate effect size).
				20 minute Attention task				
				20 minute Rest				
Zeidan et al., 2010	24	HC	22	4 day mindfulness training	FMI	n-back task	Group x testing time	Participants enrolled in brief mindfulness training, compared to controls, showed improvements in sustained attention over time.
Tang et al., 2007	40	HC		5 day integrative body-mind training	None	ANT with neutral stimuli	Group x testing time	Participants enrolled in mindfulness intervention were related to improvements in inhibition (large effect sizes)
	40			Relaxation control				
Semple, 2010	45	HC	40.2	4 week 2x/daily meditation practice	None	Conners' CPT-2 and Stroop Task	Group x testing time	Participants in the mindfulness group improved sustained attention over time compared to relaxation and waitlist controls (moderate effects). All participants improved on the Stroop task over time.
				Progressive Muscle Relaxation				
				Waitlist				
Heeren et al, 2009	18	HC	54.3	8 week intervention	None	Hayling Task; Trail Making A & B; GoStop paradigm	Group x testing time	Participants enrolled in the mindfulness intervention showed improved inhibition on the Hayling task after mindfulness training (small to moderate effects). No differences were seen in other tasks.
	18		54.7	Waitlist control				

Jha et al., 2007	17	HC	24	8 week MBSR intervention	None	Attention Network Task (ANT) with neutral stimuli	Group x testing time	Participants from both mindfulness groups showed improved inhibition when compared to controls. The retreat participants showed greater awareness.
	17		35	1 month retreat				
	17		22	Waitlist control				
Vega et al., 2014	58	HC	29.6	8 week MBSR intervention	MAAS	CPT-2; Stroop task	Linear mixed models	Mindfulness training led to improved sustained attention (CPT-2) and improved inhibition (Stroop) over time (moderate effect sizes).
	43		28.4	Waitlist				
MacLean et al., 2010	30	HC	49	Zen meditation retreat	None	Sustained attention task with line stimuli	Hierarchical Linear Regression	Mindfulness training led to improvement in sustained attention (moderate effects).
	30		46	Waitlist				
Teper & Inzlicht, 2013	20	HC	33.0	> 1 year of previous experience	PHLMS	Stroop task	Group x mindful component	In general, meditators made fewer errors (better inhibition). Mindful acceptance was negatively moderately correlated with errors on the Stroop task, suggesting that mindful attention is related to improved inhibition.
	18		37.5	No previous experience				
Valentine & Sweet, 1999	19	HC	32.9	Buddhist meditators	None	Wilkins' counting test	t-test	Mindfulness meditators had better sustained attention than non-meditators (moderate to large effect sizes).
	24		22	No previous experience				

* HC = Healthy Control; MDD = Major Depressive Disorder; TMS = Toronto Mindfulness Scale (Lau et al., 2006); MAAS = Mindful Attention Awareness Scale (Brown & Ryan, 2003); KIMS = Kentucky Inventory of Mindfulness Skills (Baer et al, 2004); CAMS-R = Cognitive and Affective Mindfulness Scale-Revised (Feldman et al., 2007); PHLMS = Philadelphia Mindfulness Scale (Cardaciotto et al., 2008); FMI = Freiburg Mindfulness Inventory (Walach, et al., 2006)

attention control tasks, particularly those that measure sustained attention and inhibition. Findings are less consistent with regard to performance on attention switching tasks.

I was only able to identity one published study that examined the relationship between behavior patterns on attention measures and self-reported mindful acceptance. Findings from that study showed that higher self-reported mindful acceptance, following an 8-week-long mindfulness intervention (Mindfulness-Based Stress Reduction; MBSR), did not significantly predict performance on a variety of measures assessing sustained attention, attention switching, and inhibition (Anderson, Lau, Segal, & Bishop, 2007). This finding, taken together with evidence of a positive correlation between mindful attention and attention task performance, could indicate distinct patterns of association between performance on measures of attention control processes and mindful attention and mindful acceptance, respectively. However, such a conclusion is necessarily speculative, given the dearth of studies assessing mindful acceptance and attention task performance.

Research has also shown positive associations between attention processes and mindfulness as captured via composite self-report measures, which do not distinguish among possible components of the mindfulness construct. Within studies that have examined such associations, scores on composite measures of mindfulness have been positively correlated with performance on measures of sustained attention (Schmertz, Anderson, & Robins, 2009), and negatively correlated with error rates on measures of inhibition (suggesting better inhibitory performance; Moore & Malinowski, 2009). Taken together, findings from all studies examining relationships between mindfulness and attention control processes suggest that self-reported mindfulness (assessed either as a composite measure or a single component measure) is positively related to better performance on measures of sustained attention and inhibition. Little evidence has emerged, in contrast, in support of associations between mindfulness and attention switching.

Consistent with the majority of correlational study findings, mindfulness intervention studies also yield evidence that mindfulness is related to improvement on measures of attention. In nine studies, researchers compared pre- and post-training performance differences on measures of sustained attention between healthy control participants who did not receive mindfulness training and healthy participants who completed either 4-10 days of mindfulness practice (Chambers, Lo, & Allen 2008; Tang et al., 2007, Zeidan, Johnson, Diamond, David, & Goolkasian, 2010), a four week daily mindfulness practice (MacLean, et al., 2010; Semple, 2010), or an eight week MBSR course (Heeren, Van Broeck, & Philippot, 2009; Jensen, Vangkilde, Frokjaer, & Hasselbalch, 2012; Jha, Krompinger, & Baime, 2007; Vega et al., 2014). Generally, results across studies suggest a significant positive relationship between mindfulness training and performance on sustained attention tasks (Chambers, Lo, & Allen, 2008; Heeren, Van Broeck, & Philippot, 2009; Jha, Krompinger, & Baime, 2007; MacLean, et al., 2010; Semple, 2010; Tang, et al., 2007; Vega, et al., 2014; Zeidan, Johnson, Diamond, David, & Goolkasian, 2010). Additionally, one study compared attention performance changes among a group that received mindfulness training, a group that received a non-mindfulness stress reduction training, and a waitlist group. Findings from this study are mixed, but do suggest that even though both intervention groups showed improvement in sustained attention, the mindfulness training group improved significantly more on one measure of sustained attention than the non-mindfulness stress reduction group (Jensen, Vangkilde, Frokjaer, & Hasselbalch, 2012).

Similar positive findings have emerged in studies comparing performance on tasks measuring inhibition (in addition to sustained attention) between groups that received mindfulness intervention and groups that did not. In one example, Wenk-Sormaz (2005) had three groups of healthy participants—one that completed a brief 20 minute mindfulness exercise, one that completed a cognitive learning task, and one that was simply asked to wait—complete the Stroop task (Stroop, 1935). Those who completed the mindfulness exercise, compared to other groups, showed better inhibition (i.e., fewer errors in incongruent trials on the Stroop task). Additionally, one study found that formerly depressed adults who completed mindfulness training showed more improvement in inhibition and sustained attention than did healthy controls who did not receive training (De Raedt, et al., 2012). Findings from all mindfulness intervention studies suggest that mindfulness training leads to improvements in sustained attention and inhibition in non-clinical samples and samples at risk for future depressive episodes (Chambers, Lo, & Allen 2008; De Raedt, et al., 2012; Heeren, Van Broeck, & Philippot, 2009; Jensen, Vangkilde, Frokjaer, & Hasselbalch, 2012; Jha, Krompinger, & Baime, 2007; MacLean, et al., 2010; Semple, 2010; Tang et al., 2007; Wenk-Sormaz, 2005; Vega et al., 2014; Zeidan, Johnson, Diamond, David, & Goolkasian, 2010).

Finally, two studies have examined differences in attentional task performance between individuals who practice mindfulness regularly (e.g., via mindfulness meditation) and those who have never practiced mindfulness. In healthy populations, mindfulness practitioners, compared to non-practitioners, made fewer errors on the Stroop task (suggesting better inhibition among practitioners; Teper & Inzlicht, 2013) and performed more accurately on a measure of sustained attention (Wilkins' Counting Test, Wilkins et al., 1987; Valentine & Sweet, 1999). Findings from these studies provide further support for the idea that mindfulness interventions lead to improved performance on measures of attention control processes in non-clinical samples.

Not all intervention studies, however, yield consistent findings. Inconsistencies are even apparent across studies that use the same measures of attention. Specifically, some studies show evidence of improved performance on the Stroop task after receiving mindfulness interventions (Moore & Malinowski, 2009; Vega et al., 2014; Wenk-Sormaz, 2005), but others do not (Anderson, Lau, Segal, & Bishop, 2007; Semple, 2010) or only show a trend toward statistical significance (Teper & Inzlicht, 2013). It is unclear why divergent results emerged from these studies, but sample sizes in these studies were small, potentially leaving the studies under-powered and therefore vulnerable to both Type I and Type II errors (Button, et al., 2013).

Further, the mindfulness interventions used varies across studies on several parameters, including content and length, which makes it difficult to make sense of differences in findings across intervention studies. Specifically, some studies found significant differences in attention task performance between healthy controls and groups who received one 20-minute mindfulness exercise, six weeks of training in Buddhist meditation, or eight weeks of Mindfulness-Based Stress Reduction (MBSR) courses (Moore & Malinowski, 2009; Vega et al., 2014; Wenk-Sormaz, 2005). However, studies implementing similar interventions, including mindfulness training with four weeks of daily meditation, eight weeks of MBSR, or meditators who had practiced for at least one year, failed to find significant differences between groups (Anderson, Lau, Segal, & Bishop, 2007; Semple, 2010; Teper & Inzlicht, 2013).

There is thus an emerging, albeit not always consistent, literature suggesting that self-reported mindfulness and mindfulness interventions show significant relationships with better performance on at least some attention control tasks. Although there are a few studies that failed to find significant relationships, the majority of studies have found that measures of mindfulness and mindfulness intervention are related to attention control processes, particularly sustained attention and inhibition. Findings are weaker with regard to associations between mindfulness and attention switching.

1.4 Current Gaps in the Literature

Although a number of studies have examined relationships between mindfulness and attention, yielding interesting, if complicated, findings, there remain gaps in the current literature. First, the studies in this small body of work have typically used emotionally-neutral attention tasks that do not allow examination of the impact of emotionally-charged stimuli on patterns of attention. There may be particular value in using emotionally-charged stimuli in research aimed at ultimately identifying mechanisms by which mindfulness alleviates distress and regulates emotions. For example, if mindfulness decreases emotional dysregulation by introducing attentional flexibility that disrupts depressed people's tendency to ruminate or dwell on negative cues (Beck, 1967; Teasdale, 1988), then examining whether and how mindfulness, or distinct components of mindfulness, relates to performance on tasks engaging attention control processes in the context of emotionally-negative cues could provide a first step toward understanding the mindfulness construct.

Only two studies have considered the relationship between mindfulness and behavior patterns of attention in the context of positively or negatively emotionally-charged cues. Each study involved mindfulness training (either a 10 day mindfulness meditation retreat or eight week Mindfulness-Based Cognitive Therapy [MBCT]) and analyses compared pre- and post-training performance on tasks designed to measure sustained attention, inhibition, and attention switching in response to emotionally-charged stimuli (Chambers, Lo, & Allen, 2008; De Raedt et al., 2012). Findings suggest that mindfulness training led to improvements in sustained attention and inhibition in healthy (Chambers et al., 2008) and previously depressed individuals (De Raedt et al., 2012) when participants were presented with emotionally-charged cues.

Not only have researchers focused on mindfulness and attention largely neglected emotion as a salient variable, but they have also typically conceptualized mindfulness as a single, broad construct or focused exclusively on a single component. Surprisingly few studies have attempted to more fully capture the mindfulness construct by examining relationships among cognitive attention processes and multiple, distinct components of mindfulness. Examining relationships among components of mindfulness and attention processes allows for more precise examination of and potentially greater clarity of the mindfulness construct.

Only two studies have examined relationships among multiple components of mindfulness and attention processes. First, Teper and Inzlicht (2013) evaluated associations between attention task performance and a two-component model of mindfulness by correlating self-reported levels of two mindfulness components—attention and acceptance—with participant performance on a Stroop inhibition task (Stroop, 1935) that used emotionally-neutral stimuli. They found that although self-reported mindful attention was not significantly related to any aspect of Stroop task performance, self-reported mindful acceptance was significantly, moderately, and negatively associated with error rates, which can serve as a measure of inhibition (higher error rates indicate poorer inhibition).

Moore and Malinowski (2009) examined associations between self-reported mindfulness components and performance on a pencil and paper version of the Stroop task (administered to assess inhibition; Stroop, 1935), and the d2 concentration and endurance task (administered to assess sustained attention and inhibition; Brickenkamp & Zillmer, 1998). Mindfulness was measured with the KIMS, which assesses four components of mindfulness: observing, describing, acting with awareness, accepting without judgement (Baer, Smith, & Allen, 2004). Findings suggested that three of the components—acting with awareness, observing, and accepting without judgement—were significantly and moderately correlated with better performance on measures of inhibition (on the Stroop and the d2 concentration and endurance test) and sustained attention (on the d2 concentration and endurance test; Moore & Malinowski, 2009). Further analysis of components of mindfulness revealed that only two mindful attention factors on the KIMS (i.e., acting with awareness and observing) accounted for significant amounts of variance in error rate on the Stroop test (Moore & Malinowski, 2009). Overall, their results suggest that mindful attention, more than mindful acceptance, may predict performance on measures of attention control processes.

Moore and Malinowski's (2009) and Teper and Inzlicht's (2013) findings suggest the possibility that mindful attention and mindful acceptance may both have distinct and important relationships with attention control processes. However, it is difficult to consider these studies' findings in an integrated way, as they defined mindfulness differently. Moore and Malinowski (2009) used a definition of mindfulness that proposes four components (observing, describing, acting with awareness, and accepting; Baer, Smith, & Allen, 2004). Although these components ostensibly overlap, at least partially, with the two-component model used by Teper and Inzlicht (2013) and discussed in the present paper, no research to date has examined whether and how well these two- and four-component models of mindfulness align with each other. Results from these two studies (Moore & Malinowski, 2009; Teper & Inzlicht, 2013), despite differences in findings, provide a foundation for hypotheses about relationships among individual components of mindfulness and attention control with emotionally-charged stimuli.

1.5 Summary and Hypothesis

One potentially useful way to extend previous research findings that could facilitate future work exploring mindfulness would be to examine relationships among two components of mindfulness and attention processes using attention measures that incorporate emotionally-charged facial expressions. Attention bias measures, for example, which often include emotional faces as stimuli, may be good candidates for such work, as they yield indices of behavioral patterns linked to attention control processes in the context of potentially emotionally-dysregulating stimuli.

Therefore, the current study aims to take a small step that could move us closer to understanding how mindfulness works by examining, in a healthy sample, the two-component model of mindfulness and its relation to patterns of attention bias. Attention biases will be measured through both behavioral reaction times and eye movements during a computerized dot-probe task. Mindfulness will be measured using the Philadelphia Mindfulness Scale (PHLMS; Cardaciotto et al., 2008), a self-report measure based on a two-component (attention and acceptance) model of mindfulness. Thus, I aim to investigate common and distinct associations between scores on the PHLMS attention and acceptance subscales and behavioral reaction time and eye tracking performance on a measure of attention bias for sad and happy faces.

Although no research to date has examined relationships among attention bias and components of mindfulness in this way, several researchers have considered relationships between mindfulness and attention control processes that suggest potential hypotheses. A review of the current literature shows a few findings of small and statistically nonsignificant relationships between mindfulness and attention processes (Anderson, Lau, Segal, & Bishop, 2007; Semple, 2010); however, the majority of study findings suggests that mindfulness, generally, is significantly, positively, and moderately correlated with performance on measures of sustained attention and inhibition (Deng, et al., 2014; Heeren, Van Broeck, & Philippot, 2009; Jensen, et al., 2012; Jha, et al., 2007; MacLean, et al., 2010; Moore & Malinowski, 2009; Schmertz, Anderson, & Robins, 2009; Semple, 2010; Tang, et al., 2007; Teper & Inzlicht, 2013; Valentine & Sweet, 1999; Vega, et al., 2014; Wenk-Sormaz, et al., 2005; Zeidan, Johnson, Diamond, David, & Goolkasian, 2010). Additionally, Chambers and colleagues (2008) and De Raedt and colleagues (2012) found evidence that mindfulness is related to performance on measures of attention when tasks incorporate positively and negatively emotionally-charged stimuli.

Further, there is emerging evidence that attention and acceptance components of mindfulness may have distinct relationships with performance on behavioral measures of cognitive attention processes (Moore & Malinowski, 2009; Teper & Inzlicht, 2013). In particular, both attention and acceptance have shown significant positive relationships with inhibition. Clarifying whether and how each mindfulness component relates to attentional patterns to emotionally-charged stimuli is a next step toward the larger goal of clarifying the mindfulness construct.

Based on evidence that mindful attention (Moore & Malinowski, 2009) and mindful acceptance (Teper & Inzlicht, 2013) both relate positively and moderately to performance on measures of attention performance, I expected that scores on self-report measures of two components of mindfulness—attention and acceptance—would both be negatively associated with attention bias for sad faces and positively associated with attention bias for happy faces. Further, I predicted that moderate associations between each mindfulness component and attention bias would remain significant, even when the other component was included as a covariate in analyses.

2 METHODS

2.1 Participants

One-hundred twenty-three female college students between the ages of 18-24 provided informed consent to participate in this study, which was approved by the Georgia State University Institutional Review Board. Focusing exclusively on female participants removed a potential confounding variable associated with sex differences in attention control processes as there is some evidence of sex differences in performance on behavioral measures of attention (Bayliss, di Pellegrino, & Tipper, 2005; Merritt et al., 2007; Smith & Waterman, 2005). Additionally, only individuals between the ages of 18-24 were included in order to remove potential confounds associated with developmental differences (as some evidence suggests that youths and older adults may show different patterns of attention bias for emotional stimuli; Isaacowitz, Toner, Goren, & Wilson, 2008; Isaacowitz, Wadlinger, Goren, & Wilson, 2006; Rubia, Hyde, Halari, Giampietro, & Smith, 2010). The average age of the participants was 19.74 (Median = 19; Standard Deviation = 1.74). The participants were racially and ethnically diverse (see Table 2 for demographic details).

Table 2. Demographic Variables

		Whole Sample (*N* = 123)	**Attention Bias Sample** (*N* = 104)	**Eye Tracking Sample** (*N* = 86)
N		123	104	86
Age	**Mean (SD)**	19.74 (1.73)	19.78 (1.75)	19.71 (1.72)
	Median	19	19	19
Race	**African American**	49.59%	49.04%	50.00%
	Caucasian American	30.57%	33.65%	29.07%
	Asian American	13.22%	10.58%	15.12%
	Other	6.61%	6.73%	5.81%
Ethnicity	**Hispanic/Latino**	12.5%	13.46%	12.79%

Complete behavioral data were obtained for 104 participants and usable eye movement data were collected for 88 participants. Data loss resulted from both human and computer errors. Initial inspection of the data revealed two participants who looked minimally (limited gaze duration) at the faces displayed during dot-probe trials; their data were thus excluded from eye tracking analysis, reducing the sample size for eye tracking participants to 86. Demographic characteristics of the subgroups of participants with behavioral data and/or eye tracking data did not differ significantly from those of the sample as a whole (see Table 2).

2.2 Procedure

Participants completed all study procedures, which comprised self-report questionnaires and a computerized attention bias task during which eye movements were recorded, in a university lab space after providing informed consent. Order of presentation for self-report measures and the task was counterbalanced, such that half of the participants completed measures before the task and the other half completed the task before the measures. Full participation took less than one hour.

2.3 Measures

2.3.1 Demographic information.

Participants completed a brief questionnaire regarding their demographic information, including information about participant age, ethnicity, and race (Appendix B).

2.3.2 Measure of mindfulness.

Designed to be a concise measure of the two-component construct of mindfulness, the Philadelphia Mindfulness Scale (PHLMS; Appendix C), includes items that tap acceptance and items that tap awareness/attention (Cardaciotto, Herbert, Forman, Moitra, & Farrow, 2008). Participants rated the frequency with which they experienced each item in the past week using a 5-point Likert-type scale (1 = never, 2 = rarely, 3 = sometimes, 4 = often, and 5 = very often). To obtain the Awareness subscale score, all odd-numbered items were totaled; higher scores reflect higher levels of awareness. To obtain the Acceptance subscale, all even-numbered items were reverse scored and totaled; higher scores reflect higher levels of acceptance. Cardaciotto and colleagues (2008) found small correlations (ranging from -.02 to -.13) between the PHLMS Awareness and Acceptance subscales in two non-clinical and two clinical samples, which they interpreted as suggesting that the subscales measure relatively distinct aspects of the mindfulness construct.

Cardaciotto and colleagues (2008) found evidence that the PHLMS is psychometrically reliable. In their study, the PHLMS exhibited high internal consistency reliability (Cronbach's alpha coefficients of .81 for awareness and .85 for acceptance). Corrected item-subscale total correlations ranged from .43 to .60 for awareness and .47 to .67 for acceptance. Cardaciotto et al. (2008) also found evidence of convergent and discriminant validity for the two PHLMS subscales. Specifically, scores on the Awareness scale of the PHLMS correlated moderately with scores on another measure of mindful attention (MAAS, $r = .21$) and the Reflection subscale of the Rumination Reflection Questionnaire (RRQ; $r = .36$). The Acceptance scale of the PHLMS was highly correlated with other measures of acceptance (Acceptance and Action Questionnaire, $r = .54$; the White Bear Suppression Inventory, $r = -.52$) and moderately correlated with separate measure of mindful attention (MAAS, $r = .32$) and the Rumination scale of the RRQ ($r = -.40$). Scores on the Acceptance scale of the PHLMS were not significantly related to scores on the reflection scale of the RRQ ($r = -.02$; Cardaciotto et al., 2008).

2.4 Attention Bias Task

During each of the 84 trials that constitute this computer-based measure of attention bias toward emotional cues, participants viewed an initial fixation cross (a plus sign) for 500 ms, followed by a face pair (happy/neutral, sad/neutral, angry/neutral, neutral/neutral, with one face on the right and one on the left of the screen) that remained on the screen for 3000 ms (Figure 1). This presentation time is con-

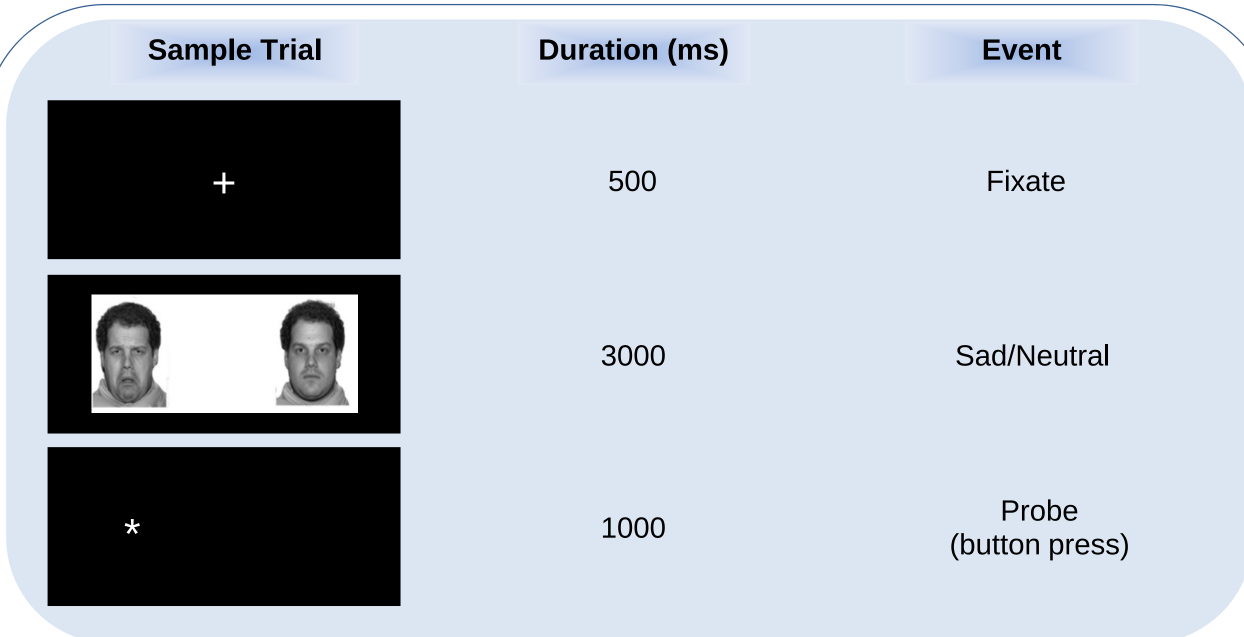

Figure 1. Attention Bias Task

sistent with previous eye tracking studies (Caseras, Garner, Bradley, & Mogg, 2007; Sears Newman, Ference, & Thomas, 2011) and has been shown to be reliable for measurement of attention bias using eye tracking (Waechter, Nelson, Wright, Hyatt, & Oakman, 2014). After a face pair was presented, an asterisk appeared in the position previously occupied by one face and participants were asked to indicate the asterisk's location by pressing the "1" key on the computer keyboard to indicate the left side and pressing "2" to indicate the right side of the screen. The asterisk appeared on each side of the screen an equal number of times and replaced emotional and neutral faces an equal number of times.

Stimuli were presented against a black background, consistent with previous presentations of this measure (Mogg, Bradley, Dixon, Fisher, Twelftree, & McWilliams, 2000). Each emotional expression (happy, sad, and angry) was paired with a neutral expression, resulting in 24 sad/neutral pairs, 24 happy/neutral pairs, 24 angry/neutral pairs, and 12 neutral/neutral pairs (see Appendix D for examples of face pairs). Total task time was 18 minutes.

Visual stimuli used in this task consisted of 84 black and white pictures of faces with sad, happy, angry, or neutral expressions (Caseras, Garner, Bradley, & Mogg, 2007; Eizenman et al., 2003; Gotlib, Kasch, et al., 2004; Gotlib, Krasnoperova, et al., 2004; Joormann & Gotlib, 2007; Kellough, et al., 2008; Kujawa et al., 2011; Leyman, De Raedt, Vaeyens, & Philippaerts, 2011; Mathews & Antes, 1992). Facial expressions were selected from a pool that comprised four sets of validated images: the NimStim set (Tottenham et al., 2009), the Productive Aging Laboratory set (Minear & Park, 2004), images used by Bradley and colleagues (1997) in a widely-used dot-probe task version, and the GSU Diverse Faces set (Schmidt, Davis, & Tone, 2012). The 84 images used in the present dot-probe task were selected as good exemplars of different expressions based on undergraduate students' ratings of how well they represented the emotion they were intended to convey and how distinct they were from other emotional expressions (Schmidt & Tone, 2014).

2.5 Behavioral Reaction Time

Based on prior attention bias research (Gotlib, Kasch, et al., 2004; Gotlib, Krasnoperova, et al., 2004; Joormann & Gotlib, 2007; Kujawa et al., 2011; MacLeod, Mathews, & Tata, 1986), attention bias scores were computed separately for each emotional expression using the following equation:

Attention bias = ½[(RaLe – RaRe) + (LaRe – LaLe)]

Within this equation, 'R' represented the right position, 'L' represented the left position, 'a' represented the asterisk, and 'e' represented the emotional expression. For example, RaLe represented the mean reaction time when the asterisk was in the right position and the emotional expression (sad, angry, or happy) was in the left position. Positive scores indicated an attentional bias toward the spatial locations of emotional expressions relative to matched neutral faces, and negative values indicated a bias to direct attention away from the spatial locations of emotional expressions. Attention bias scores for sad faces and for happy faces served as dependent variables in this study.

Only response time data from correct responses (when the key press corresponded accurately with the probe position) were included in bias score calculations. The error rate was less than 1% of all data (consistent with published error rates; Gotlib, Krasnoperova, et al., 2004; Joormann & Gotlib, 2007).

2.6 Eye Tracking

2.6.1 Eye movement recording.

Eye tracking measurements were gathered in addition to behavioral reaction times, as researchers have expressed uncertainty about the degree to which behavioral reaction times reflect attention as opposed to fine motor ability (Caseras, Garner, Bradley, & Mogg, 2007; Nummenmaa et al., 2006). Measuring total gaze fixation, or the amount of time that gaze is directed toward a visual target, provides complementary information about attention that depends on fewer intervening motor processes than manual reaction time measures (Leyman, De Raedt, Vaeyens, & Philippaerts, 2011). Gaze fixation measures of attention bias have also been shown to be reliable across trials and participants (Waechter, Nelson, Wright, Hyatt, & Oakman, 2014).

In the present study, eye movement was recorded using an Applied Science Laboratories (ASL) Model 504 eye tracker, equipped with remote pan and tilt optic. After initial gaze calibration, eye movements were measured via continuous recording with high-resolution infrared oculography of points of gaze on a stationary object in the environment (in this case, a computer screen; Applied Science Laboratories [ASL] Model 504, Boston). The tracker sampled eye position at a rate of 120 Hz, with precision that is better, according to the manual, than .5°visual angle, and spatial error of less than one degree. Points of gaze were determined by continually calculating the relationship between the corneal reflection of a near infrared beam that was projected to the eye and the center of the illuminated pupil as the eye rotated. The possibility of artifacts due to head movement was minimized through use of an autofocusing lens and a chin rest (eye-screen distance was 19 inches for all participants).

2.6.2 Eye Movement data processing.

Raw eye movement data were processed with the Eyenal Data Analysis Program (ASL supplied software). This program calculated gazes based on an algorithm that accounts for the distance from the eye to the screen, which was kept uniform across participants. Fixation location was defined by comparing the point-of-gaze cursor with a grid of coordinates that corresponded to positions on the computer screen. Consistent with the literature (Caseras, Garner, Mogg, & Bradley, 2006; Waechter et al., 2014) and the program's default algorithm, a fixation was defined as a condition in which the eye remained within fixed coordinates for a period equal to or in excess of 100 milliseconds (ms). Fixations on two regions of the computer screen (the left third and the right third) were used in analyses as indices of attention to the left or right image in a pair.

Total duration of gaze at each face in a pair was calculated by summing the duration of all fixations on the side of the screen where the face appeared. These data were then exported to SPSS and gaze fixations were summed across trials to yield total scores for each participant that represented time spent focusing attention at each type of emotional expression (sad, happy, angry, and neutral). Total gaze duration for sad faces and total gaze duration for happy faces served as dependent variables in the present study.

2.7 Power Analysis

Sample size was determined prior beginning the study and was based on power analyses conducted using G*Power (Faul, Erdfelder, Lang, & Buchner, 2007) utilizing analysis for a linear regression with two tested components of mindfulness: attention and acceptance. Alpha error probability was set at .05 and power was set at 80%. Two power analyses were completed to assess necessary sample size for behavioral reaction time analyses. First, because Teper and Inzlicht (2013) have been the only researchers to assess the contributions of both hypothesized components of mindfulness to performance on attention measures, power analysis was completed based on their findings, which yielded an effect size of f^2 = .11. Results of this analysis suggest that a sample size of 88 participants is necessary to detect significant associations. Second, Moore and Malinowski (2009) also considered effects of specific components of mindfulness on performance on attention measures. Power analysis based on their findings, which yielded effect sizes of f^2 =.78 and f^2 = 1.33, resulting in sample sizes of 16 and 11, respectively.

Finally, a separate power analysis was completed for eye tracking analyses. Because Caseras and colleagues (2007) completed an eye tracking attention bias study with emotional stimuli presented for three seconds; power analysis was completed based on their findings, which yielded an effect size of f^2 = .33. Results of this analysis suggest that a sample size of 76 participants would be necessary to detect significant associations. Based on all analyses, our final sample size was large enough to maximize power and reduce the potential for Type II error.

3 RESULTS

3.1 Descriptive Statistics

The final sample consisted of 104 participants with complete dot-probe data and 86 participants with complete eye tracking data. Before conducting correlational and regression analyses, descriptive statistics were calculated. Descriptive statistics were calculated separately for participants with complete behavioral data and those with complete eye tracking data (Tables 3 and 4).

Table 3. Descriptive Statistics for the Behavioral Dot-probe Data (*N*=104)

Variable	Mean	Range		Variance	Standard Deviation	Skew	Kurtosis
		Min	Max				
Age	19.78	18	24	3.05	1.75	1.18	.62
PHLMS Attention	38.94	26	50	26.81	5.18	-.02	-.40
PHLMS Acceptance	25.22	10	40	45.94	6.78	-.13	-.59
Attention Bias to Sad Faces	-2.62	-92.94	87.55	1133.00	33.66	.37	.31
Attention Bias to Happy Faces	6.03	-102.45	91.41	915.18	30.25	-.23	1.12

Table 4. Descriptive Statistics for Gaze Duration Data (*N*=86)

Variable	Mean	Range		Variance	Standard Deviation	Skew	Kurtosis
		Min	Max				
Age	19.71	18	24	2.94	1.71	1.17	.56
PHLMS Attention	38.91	25	49	31.57	5.62	-.18	.52
PHLMS Acceptance	25.14	10	40	48.67	6.98	-.12	-.71
Gaze Duration for Sad Faces	39.82	4.12	65.28	242.40	15.57	-.89	.04
Gaze Duration for Happy Faces	39.56	3.77	63.63	247.33	15.73	-.82	-.19

All four of the dependent variables—reaction-time based sad and happy attention bias scores and gaze durations for sad and happy faces—met the majority of assumptions for linear regression (see

Appendix E). However, gaze duration variables of attention bias for happy and sad faces showed a significant negative skew. Therefore, these variables were transformed using a square transformation to normalize data. Descriptive statistics with these transformed variables are given below (Table 5).

Table 5. Descriptive Statistics for Gaze Duration Following a Square Transformation (*N*=86)

Variable	Mean	Range		Variance	Standard Deviation	Skew	Kurtosis
		Min	Max				
Age	19.71	18	24	2.94	1.71	1.17	.56
PHLMS Attention	38.91	25	49	31.57	5.62	-.18	.52
PHLMS Acceptance	25.14	10	40	48.67	6.98	-.12	-.71
Gaze Duration for Sad Faces	1809.09	14.25	4049.29	1163683.60	1078.74	-.05	-.84
Gaze Duration for Happy Faces	1825.09	17.00	4260.83	1126981.22	1061.59	-.05	-.55

The square transformation minimized the skewness of the gaze duration variables. As expected, the square transformation also impacted the kurtosis of the data; however, the resulting values were inside normal or acceptable ranges. Therefore, the transformed gaze duration variables were used in subsequent analyses.

3.2 Philadelphia Mindfulness Scale

The psychometric properties of the PHLMS were assessed in the present sample. The PHLMS showed high internal consistency reliability (Cronbach's alpha coefficient of α = .79 overall, α = .75 for awareness and α = .84 for acceptance). The subscales of the PHLMS were also minimally correlated with each other (r = .09, p = .32).

3.3 Preliminary Analyses

Bivariate correlations were computed among age, mindfulness subscale scores (PHLMS-awareness and PHLMS-acceptance), attention bias scores, and total gaze fixation times for happy and sad faces. Age was significantly, and positively associated with PHLMS Acceptance score ($p < .05$). No other correlations were statistically significant (Table 6 and 7).

Table 6. Bivariate Correlations among Age, PHLMS, and Attention Bias Dot-probe Responses (*N*=104)

	Age	PHLMS Attention	PHLMS Acceptance	Bias to Sad Faces	Bias to Happy Face
Age		-.01	.36*	-.01	.16
PHLMS Attention			-.03	-.02	-.05
PHLMS Acceptance				.00	.09
Bias to Sad Faces					-.17
Bias to Happy Faces					

* indicates a significant correlation at $p < .05$

Table 7. Bivariate Correlations among Age, PHLMS, and Gaze Durations (*N*=86)

	Age	PHLMS Attention	PHLMS Accept	Bias to Sad Faces	Bias to Happy Face	Gaze Duration Sad Faces	Gaze Duration Happy Faces
Age		-.01	.31*	.05	.15	-.12	-.06
PHLMS Attention			-.03	.00	-.10	.04	.03
PHLMS Acceptance				.04	.08	.13	.09
Bias to Sad Faces					-.25*	-.08	-.11
Bias to Happy Faces						.10	.17
Gaze Duration for Sad Faces							.91*
Gaze Duration for Happy Faces							

* indicates a significant correlation at $p < .05$

Behavioral reaction times were not significantly correlated with gaze fixation durations for different emotional expression types. Specifically, attention bias reaction times and gaze fixation times were not significantly correlated for sad faces ($r = -.08$, $p = .49$) or for happy faces ($r = .17$, $p = .14$).

Analyses of variance (ANOVA) yielded evidence that scores on the PHLMS acceptance subscale differed across racial groups in both the sample with complete dot-probe data, $F(3, 100)=3.0$, $p < .05$ and the sample with complete eye tracking data, $F(3, 81) = 2.78$, $p = .05$. T-tests also indicated differences between participants who identified as Hispanic and those who identified as non-Hispanic, in both the reaction time data sample, $t(102) = 2.02$, p < .05, and the eye tracking data sample, $t(84) = 2.30$, p <

.05. ANOVAs and t-tests comparing racial and ethnic groups on the PHLMS awareness subscale and on attention bias measures and total gaze duration measures produced nonsignificant results (all *p*'s > .05; see Appendix F).

3.4 Regression Analysis

Linear regression analyses were conducted using SPSS (PASW Statistics 18) to assess relationships between components of mindfulness, operationalized as PHLMS Attention and Acceptance scores, and attention bias. Four models were tested in order to assess associations among mindful attention (PHLMS Awareness) and mindful acceptance (PHLMS Acceptance) and each of the four dependent variables, which comprised attention bias scores for happy faces and for sad faces, as well as total gaze fixation on sad faces and on happy faces. Linear regression assumptions were probed to determine if linear regression analysis was appropriate; data met assumptions of independence and normality (see Appendix E).

Results from the first regression analysis predicting performance on the dot-probe attention bias task for sad faces were not significant, $F(2,101) = .01$, $p = .99$. Neither mindful attention (β = -.02, $p = .87$), nor mindful acceptance (β = .00, $p = 1.00$), accounted for significant proportions of the variance in sad bias scores ($R^2 = .00$; Table 8). Similar results emerged from the second regression model, predicting happy attention bias, $F(2,101) = .57$, $p = .57$; neither mindful attention (β = -.05, $p = .63$) nor mindful acceptance (β = .09, $p = .35$) accounted for significant proportions of the variance in happy bias scores ($R^2 = .01$; Table 9).

Table 8. Linear Regression Analysis for Relationships among Components of Mindfulness and Attention Bias to Sad Faces (Dot-probe, *N* = 104).

Model	Unstandardized Coefficients		Standardized Coefficients	t	Significance
	B	Std. Error	β		
Constant	1.54	30.25		.05	.96
Attention	-.11	.65	-.02	-.17	.87
Acceptance	.00	.49	.00	-.01	1.00

Table 9. Linear Regression Analysis for Relationships among Components of Mindfulness and Attention Bias to Happy Faces (Dot-probe, *N* = 104).

Model	Unstandardized Coefficients		Standardized Coefficients	t	Significance
	B	Std. Error	β		
Constant	31.26	27.04		1.16	.25
Attention	-.28	.58	-.05	-.48	.63
Acceptance	.41	.44	.09	.93	.35

Results from the third regression analysis predicting performance on the eye tracking attention bias task for sad faces were non-significant, $F(2,82) = .82$, $p = .44$. Neither mindful attention (β = .05, p = .68) nor mindful acceptance (β = .13, p = .22), accounted for significant proportions of the variance in gaze durations for sad faces (R^2 = .02; Table 10). Similar results emerged from the fourth regression model, predicting happy attention bias, $F(2,82) = .40$, $p = .67$; neither mindful attention (β = .04, p = .76) nor mindful acceptance (β = .09, p = .40) accounted for significant proportions of the variance in gaze durations for happy faces (R^2 = .01; Table 11).

Table 10. Linear Regression Analysis for Relationships among Components of Mindfulness and Attention Bias to Sad Faces (Eye Tracking, *N* = 86).

Model	Unstandardized Coefficients		Standardized Coefficients	t	Significance
	B	Std. Error	β		
Constant	2196.48	977.389		2.25	.03
Attention	8.60	20.55	.05	.42	.68
Acceptance	20.26	16.55	.13	1.22	.22

Table 11. Linear Regression Analysis for Relationships among Components of Mindfulness and Attention Bias to Happy Faces (Eye Tracking, *N* = 86).

Model	Unstandardized Coefficients		Standardized Coefficients	t	Significance
	B	Std. Error	β		
Constant	2051.22	998.34		2.06	.04
Attention	6.62	21.06	.04	.32	.75
Acceptance	14.38	17.02	.09	.85	.40

4 Discussion

The current study was designed to examine associations between two components of mindfulness—attention and acceptance—and patterns of performance on measures of attention bias to emotional stimuli. Several researchers have suggested that attention bias tasks place demands on the attention control processes of sustained attention and inhibition (Eizenman et al., 2003; Gotlib, Krasnoperova, et al., 2004; Joormann, 2004; Joormann & Gotlib, 2007), both of which have been linked to mindfulness in prior research. Further, attention bias tasks often include emotional images or words as distractors; this characteristic makes them particularly relevant for research on mindfulness, which is often used to facilitate tolerance and acceptance of emotions that are strong or uncomfortable.

Specifically, I predicted that scores on self-report measures of both components of mindfulness would be negatively and moderately associated with attention bias for sad faces and would be positively and moderately associated with attention bias for happy faces. Further, I predicted that each mindfulness component would independently account for a significant portion of variance in attention bias scores, even when the other component was covaried. Such findings would suggest that each component of mindfulness has a distinct and necessary role in attention patterns that emerge in response to emotionally-dysregulating stimuli.

Findings from the present study did not support study hypotheses. Specifically, self-reported mindful attention and mindful acceptance were not significantly associated with reaction time or gaze duration measures of attention bias for sad or happy faces.   These findings could suggest that self-perceived mindful attention and mindful acceptance are not related to objectively measured patterns of biased attention for emotional cues in a college sample. However, this conceptualization is not consistent with evidence from previous studies, the majority of which have found significant relationships generally between mindfulness and performance on attention tasks involving sustained attention

(Chambers, Lo, & Allen, 2008; Deng, Li, & Tang, 2014; De Raedt, et al., 2012; Heeren, Van Broeck, & Philippot, 2009; Jensen, Vangkilds, Frokjaer, & Hasselbalch, 2011; Jha, Krompinger, & Baime, 2007; MacLean, et al., 2010; Moore & Malinowski, 2009; Schmertz, Anderson, & Robins, 2009; Semple, 2010; Tang et al., 2007; Valentine & Sweet, 1999; Vega et al., 2014; Wenk-Sormaz, 2005; Zeidan, Johnson, Diamond, David, & Goolkasian, 2010), inhibition (De Raedt et al., 2012; Jensen, Vangkilde, Frokjaer, & Hasselbalch, 2012; Moore & Malinowski, 2009; Vega et al., 2014; Wenk-Sormaz, 2005), and, in one case, attention switching (Jensen, Vangkilde, Frokjaer, & Hasselbalch, 2012).

This study, however, is not the first to fail to find significant associations between measures of attention processes and mindfulness. For example, Anderson, Lau, Segal and Bishop (2007) found that mindfulness training did not affect performance on several measures of attention control processes (including measures of sustained attention, inhibition, and attention switching). Additionally, two other studies found that a mindfulness intervention did not significantly improve performance on a measure of inhibition (Semple, 2010; Teper & Inzlicht, 2013) and one study failed to find a significant relationship between performance on a measure of attention switching and self-reported mindfulness (Chambers, Lo, & Allen, 2008).

Some inconsistencies between the present study and prior work could reflect differences in the ways that mindfulness is conceptualized across studies. However, the present findings are also inconsistent with those from the two studies that used a comparable multi-component model of mindfulness. These studies found evidence that mindful attention (Moore & Malinowski, 2009) and mindful acceptance (Moore & Malinowski, 2009; Teper & Inzlicht, 2013) were each related to inhibition, as indexed by number of errors on the Stroop task. Additionally, Moore and Malinowski (2009) found evidence that sustained attention was correlated with multiple components of mindfulness, which included attention and acceptance components of mindfulness. In light of the present study and these previous studies, further research is needed to clarify the relationships among mindful attention, mindful acceptance, sustained attention, and inhibition.

In the following sections, I attempt to make sense of these inconsistencies, drawing on relevant empirical and theoretical literatures. In addition, I review limitations of the present study that may have contributed to the failure to detect predicted associations and identify future directions that could improve our understanding of the mindfulness construct.

4.1 Alternative Understanding of Attention Processes in Attention Biases

4.1.1 Alternate Mechanisms of Attention Biases

Although several researchers have suggested that the dot-probe measure of attention bias for sad stimuli engages sustained attention and inhibition (Eizenman et al., 2003; Gotlib, Krasnoperova, et al., 2004; Joormann, 2004; Joormann & Gotlib, 2007), there is also some suggestion that alternative attentional control processes are engaged in the dot-probe task. Specifically, some researchers suggest that the dot-probe attention bias task measures the ability to disengage from negative or threatening stimuli (Amir, Bomyea, & Beard, 2010; Koster, Crombez, Verschuere, Van Damme, & Wiersema, 2006; Koster, De Raedt, Goeleven, Franck, & Crombez, 2005). From an attentional control perspective, such disengagement would require the ability to inhibit and shift focus away from specific stimuli, rather than the ability to sustain attention toward those stimuli. In this conceptualization, then, attention biases toward emotional stimuli would be driven by difficulties with inhibition and attention switching and not necessarily sustained attention.

If it is true that the dot-probe attention bias task assesses inhibition and attention switching, then the results of the present study could be interpreted as consistent with previous research. As noted previously, the literature is mixed regarding whether or not mindfulness significantly correlates with performance on inhibition (Anderson, Lau, Segal, & Bishop, 2007; Moore & Malinowski, 2009; Semple, 2010; Teper & Inzlicht, 2013; Vega et al., 2014; Wenk-Sormaz, 2005) and attention switching measures (Chambers, Lo, & Allen, 2008; Jensen, Vangkilde, Frokjaer, & Hasselbalch, 2012). Therefore, the present study could provide evidence that aligns with other findings that mindfulness is not significantly related to the attention processes of inhibition and attention switching.

This conceptualization, however, leaves open the possibility that mindfulness may work through the ability to sustain attention toward selected stimuli, and not inhibition of or switching from emotional stimuli in the internal and external environment. Therefore, if this alternative explanation is correct, further research is needed to assess relationships among components of mindfulness and sustained attention toward potentially emotionally-dysregulating stimuli.

4.1.2 Alternate Mechanisms of Mindfulness

It is possible that there are additional conceptualizations of the results that may explain the lack of significant findings in the present study that might also support hypothesized relationships among components of mindfulness and attention bias to sad faces. It is possible that components of mindfulness could help people to engage with emotional stimuli in ways that are not reflected on measures of visual attention biases. Specifically, Bishop and colleagues (2004) suggest that mindfulness, and particularly mindful attention, directs focus to the present moment and inhibits the elaboration of mood-congruent cognitions. For example, mindfulness could disrupt internal cognitive attention biases in ways that interrupt rumination and other sustained patterns of negative thinking (Beck, 1976; Joormann, 2009; Nolen-Hoeksema, 1991; Nolen-Hoeksema, Wisco, & Lynbomirsky, 2008; Treynor, Gonzalez, & Nolen-Hoeksema, 2003; Williams, Watts, MacLeod, & Mathews, 1997). This conceptualization of mindfulness could suggest that components of mindfulness could contribute to mental health by disrupting cognitive attention biases, such as rumination, rather than visual attention biases. Testing this hypothetical pattern of relationships could be another useful step toward understanding mindfulness and how it works.

4.2 Methodological Differences and Limitations

Additionally, methodological factors may have contributed to inconsistencies between the present findings and those from prior research. In particular, the focus in the present research on attention biases for emotional cues, measured via both reaction time and eye movements, rather than on performance on general measures of attention processes sets the present study apart from earlier work. In addition, studies have varied considerably in the measures that they have selected to tap mindfulness. I discuss both of these issues in detail below.

4.2.1 Attention bias versus other attention measures.

The present study revolved around a measure of one very specific type of attentional pattern—attention bias for sad cues. There is considerable evidence that the dot-probe is a valid measure of attention biases in both healthy and populations at risk for mental illness (Eizenman et al., 2003; Gotlib, Krasnoperova, et al., 2004; Joormann, 2004; Joormann & Gotlib, 2007). Further, attention bias for sad cues, measured using dot-probe tasks, has been suggested to index sustained attention and inhibition (Eizenman et al., 2003; Gotlib, Krasnoperova, et al., 2004; Joormann, 2004; Joormann & Gotlib, 2007). Surprisingly, although attention bias seems like a viable target for examining mindfulness, there do not appear to be other published studies to date that have used dot-probe or comparable tasks in the context of research on mindfulness and how it relates to other constructs.

Differences from other studies in terms of the attention measures used complicates comparisons of the present results with those from earlier research, as this study is the first to have examined relationships among components of mindfulness and attention biases to emotionally-charged stimuli.

This focus sets it apart from the majority of previous studies in the literature on mindfulness and attention, each of which had participants complete various other attention tasks. These tasks included the Stroop task (Stroop, 1935), a continuous performance task (e.g., Conners' CPT-II; Conners, 2000), the d2 Test of Attention (Brickenkamp, 2002; Brickenkamp & Zillmer, 1998), the Attention Network Task (Fan, McCandliss, Sommer, Raz, & Posner, 2002), and other attention processing measures.

Whether and how attention biases relate to performance on other types of attentional control (e.g., sustained attention, inhibition, or attention switching) tasks remains unclear. I was unable to locate research that examined associations between attention biases and performance on the Stroop task (Stroop, 1935), the d2 Test of Attention (Brickenkamp, 2002; Brickenkamp, & Zillmer, 1998), or other measures of attention. Additionally, only a few previous studies have included emotionally-charged stimuli (Chambers, Lo, & Allen, 2008; De Raedt, et al., 2012) that may capture attention particularly strongly for individuals with or at risk for mood dysregulation (Macleod, Mathews, & Tata, 1986). It is possible, therefore, that differences in tasks may account for some of the differences in findings across studies.

Further, issues with the reliability of dot-probe tasks, particularly in non-clinical, healthy populations, may also have contributed to the unexpected pattern of findings in the current sample. Research into the reliability of dot-probe task versions that use angry/threatening words, scenes (Schmukle, 2005), and faces (Staugaard, 2009) as attentional cues has led some researchers to express concerns about the psychometric properties of such measures. For example, findings suggest that the temporal stability of dot-probe task performance, as reflected in indices derived from reaction times, may be limited. Although Schmukle (2005) found some evidence of test-retest reliability for a version of the dot-probe that used physical threat words (r = .32), other published reliability estimates have been small and statistically nonsignificant (Schmukle, 2005; Staugaard, 2009). In addition, one recent study examined the test-retest reliability of various ways of measuring attention bias via the dot-probe task and found moderate reliability ratings in clinically anxious adult populations (interclass correlation coefficients [ICC] ranging between .49 and .55) and healthy pediatric populations (ICC of .53) when attention bias scores were calculated for trials only when the probe was placed on the bottom of the screen rather than on top (stimulus pairs were arranged vertically rather than horizontally, as in the present study; Price, et al., 2015). The relevance of these reliability estimates to the current measure is unclear; all of these reliability studies examined angry/threatening, rather than sad, stimuli and presented those stimuli for shorter durations (100-675 ms) than the 3000 ms duration used in the present study.

Examinations of the dot-probe task's internal consistency have also generally yielded minimal and nonsignificant results. Internal consistency ratings for attention bias tasks with threat words, scenes and faces are small and nonsignificant (Cronbach's α ranging between .00 and .28 for words and scenes [Schmukle, 2005] and -.52 and .04 for faces [Staugaard, 2009]; split-half reliabilities ranging between -.19 and .03 for words and scenes [Schmukle, 2005] and -.29 and .17 for faces [Staugaard, 2009]). Additionally, Bar-Haim and colleagues (2007) obtained significant and moderate split-half reliability estimates (r = .45) for the dot-probe paradigm in non-clinical samples of individuals living near the Gaza Strip who experienced high levels of daily anxiety (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007).

Two studies to date have assessed the reliability of eye tracking measures of attention bias. One study examined reliabilities for stimuli displayed at each 500 ms interval between 0 and 5,000 ms (Waechter, Nelson, Wright, Hyatt, & Oakman, 2014). The authors note that at shorter presentation times (between 0 and 2,500 ms) reliability estimates for the eye tracking attention bias task were non-significant and low to moderate (between r = -1.06 and r = .55; Cronbach's α between α = -1.55 and α = 0.55); however, for task versions that presented stimuli for 3,000 ms or longer, the authors suggest that internal consistency measured as split-half reliability (between r = .60 and r = .68) and Cronbach's α reliability (between α = .50 and α = .63) were significant and moderate (Waechter, Nelson, Wright, Hyatt, &

Oakman, 2014). Another study examined the reliability of eye tracking measures of attention bias and found moderate to good reliability ratings when eye tracking measures were averaged across all trials (rather than looking individually at each trial) in clinically anxious adult populations (ICC ranging between .69 and .96) and healthy pediatric populations (ICC of .68; Price, et al., 2015).

Notably, the present study yielded little evidence that reaction time attention bias scores related to gaze durations for either sad faces or happy faces. It may thus be worth considering the possibility that reaction time-based bias scores and gaze duration indices reflect different constructs (e.g., motor behavior, eye moment behavior, or different facets of attention). It is also possible that participants are initially attentive (e.g., bottom-up processing) to sad faces but avoid gazing at them (e.g., top-down processing such as inhibition), which would affect both reaction time and gaze duration attention bias scores. More precisely documenting how participant responses unfold over the course of a trial for both measures may help elucidate the failure to detect an association between the two measures of bias used in this study.

Finally, it is possible that individuals shifted gaze frequently (e.g., top-down processes such as attention switching) between the two stimuli presented as a pair during each trial. Specifically, switching gaze frequently between emotional and neutral stimuli could lead to inconsistent attention bias and gaze duration scores. Such a variable pattern of attention could contribute to a lack of relationship between reactions to a probe and total length of time participants gazed at stimuli.

4.2.2 Measure of mindfulness concerns

The approach to conceptualizing and measuring mindfulness used in the present study may also have contributed to the failure to detect significant effects. First, the PHLMS mindful attention subscale, like other widely used mindfulness self-report measures (e.g., the Mindful Attentive Awareness Scale; Brown & Ryan, 2003), includes items that reflect awareness and attention control processes, which the theoretical and empirical literature typically present as orthogonally related (Brown & Ryan, 2003; 2004;

De Raedt et al., 2012; Fan, McCandliss, Fossella, Flombaum, & Posner, 2005; Posner & Peterson, 1990; Washburn, Latzman, Schultz, & Bramlett, 2015). Additionally, other authors suggest that awareness (which is a bottom-up attention process) and attentional control (which is a top-down attention process) may either work together or compete for attentional resources (Washburn, Latzman, Schultz, & Bramlett, 2015). The combination of these two attention factors within a single measure of mindful attention may have influenced results. Specifically, it is possible that only one attention factor is related to attention biases or that both were related in opposite directions. Both of these possibilities could have led to the small and nonsignificant relationship between mindful attention and attention bias to sad faces.

Second, Bergomi and colleagues (2013) have raised questions about whether the PHLMS acceptance subscale is appropriately titled. They suggest that the subscale may "capture experiential avoidance" (p. 195), while failing to tap positive acceptance, non-reactivity, and non-judgment. Although these concepts may sound as if they are inversely related to each other, Bergomi and colleagues' (2013) observation serves as a reminder that they may show other patterns of association. The PHLMS acceptance subscale, therefore, may not fully capture mindful acceptance. Therefore, results may suggest that experiential avoidance is not related to attention bias to sad or happy faces, which does not clarify relationships between mindful acceptance and attention biases.

4.3 Future Research

There are a number of directions that future research might take in order to clarify the lack of significant findings from the present study and to more effectively examine whether and how the two-component model of mindfulness relates to attention bias for emotional stimuli. First, there is evidence that attention biases for sad stimuli are commonly observed in the context of depression (Gotlib, Kasch et al., 2004; Gotlib, Krasnoperova, et al., 2004; Joormann & Gotlib, 2007; Kujawa et al., 2011) and that more depressed individuals tend to show stronger biases (Gotlib, Kasch, et al., 2004; Gotlib, Krasnoperova, et al., 2004; Joormann, 2004). Therefore, there may be value in replicating the present study in a clinically depressed sample, or in a sample that includes both clinical and non-clinical participant, as such a samples could allow a larger range of individual variability in all measures (PHLMS attention, PHLMS acceptance, and reaction times and gaze fixations for attention biases). This larger range in scores could potentially lead to more clearly identified relationships among variables that could help clarify the construct of mindfulness. Although such work was beyond the scope of the present study, results of exploratory analyses on data from a small subsample of participants who endorsed high levels of depressive symptoms raise the possibility that mindful attention (as measured by the PHLMS Awareness scale) may relate positively with attention bias to sad faces in people who are experiencing depression (see Appendix G), even if no significant association is observed in a healthy sample.

Second, mindfulness may protect against mental illness by modulating additional cognitive and behavioral processes besides attention bias for sad cues. For example, there is evidence that cognitive biases in response to emotionally-charged stimuli could be measured by evaluating rumination (Joormann, 2009; Nolen-Hoeksema, Wisco, & Lynbomirsky, 2008; Treynor, Gonzalez, & Nolen-Hoeksema, 2003). Such patterns of rumination can be measured using the Rumination Response Scale (RRS; Treynor, Gonzalez, & Nolen-Hoeksema, 2003), which was designed to assess cognitive attention biases in thought patterns. Therefore, mindfulness could change how people engage with emotionally-charged stimuli by normalizing cognitive and behavioral patterns, including rumination. Research examining relationships among components of mindfulness and these cognitive patterns would be a useful future direction for efforts to better understand the mindfulness construct.

Other measures of visual attention bias to emotional cues may also be useful in examining components of mindfulness. Examples of such tasks include the emotional Stroop paradigm (Paelecke-Habermann, Pohl, & Leplow, 2005), the Attention Network Task (Fan et al., 2002; 2005), and the Negative Affective Priming Task (see De Raedt, et al., 2012). Each of these measures examines cognitive attention processes in response to emotionally-charged stimuli and, therefore, could be used to assess relationships among components of mindfulness and visual attention biases and further clarify the mindfulness construct.

Third, there may be alternate ways to measure biased attention that involve neither eye movement tracking nor response time measures, each of which has limitations (Caseras, Garner, Bradley, & Mogg, 2007; Kellough, Beevers, Ellis, & Wells, 2008; Kowler, Anderson, Dosher, & Blaser, 1995; Leyman, De Raedt, Vaeyens, & Philippaerts, 2011). Functional neuroimaging research, for example, has yielded evidence that mindfulness is correlated with activation in the anterior cingulate cortex (Hölzel, et al., 2007; Gard, et al., 2012) and the dorsolateral prefrontal cortex (Allen, et al., 2012). Activation in such areas is also related to attentional control processes (such as sustained attention, inhibition, and attention switching; Cahn & Polich, 2006; Hölzel, et al., 2007; Tang & Posner, 2014; Tang, Tang, & Posner, 2013). Examination of the relationships among components of mindfulness and patterns of frontal neural activation in response to emotional stimuli could provide further insight into the construct of mindfulness.

Fourth, it is possible that the construct of the two component model of mindfulness was not measured appropriately and it may be possible to better examine mindful attention and mindful acceptance through other measures of mindfulness. For example, mindful attention can also be measured by subscales of mindfulness measures (such as observe and/or describe from the Kentucky Inventory of Mindfulness [KIMS; Baer, Smith, & Allen, 2004] or Five Factor Mindfulness Questionnaire [FFMQ; Baer, et al., 2008]) or the Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003), which have been developed and validated as measures of mindful attention. Some concerns have also been noted with these measures in the literature (Cardaciotto, et al., 2008; Coffey, Hartman, & Fredrickson, 2010). In addition, components of mindful acceptance could also be assessed from specific acceptance subscales from either the KIMS (Baer, Smith & Allen, 2004) or FFMQ, or mindful acceptance can be measured by the Toronto Mindfulness Scale (TMS; Lau, et al., 2006), which is a psychometrically validated measure that has been shown to measure mindful acceptance. It is possible that using multiple measures of these two components of mindfulness in relation to measures assessing attentional processes to emotional stimuli may help to clarify the construct of mindfulness.

4.4 Conclusions

The present study examined relationships among a proposed two component definition of mindfulness—attention and acceptance—and attention bias to sad faces in order to clarify the mindfulness construct. Findings from the present study suggest no significant relationships among the variables of interest, which is inconsistent with previous research showing relationships between mindfulness and measures of sustained attention and inhibition (Chambers, Lo, & Allen, 2008; Deng, Li, & Tang, 2014; De Raedt, et al., 2011; Heeren, Van Broek, & Philippot, 2009; Jha, Krompinger, & Baime, 2007; Moore & Malinowski, 2009; Schmertz, Anderson, & Robins, 2009; Short, Mazmanian, Oinonen, & Mushquash, 2015; Tang et al., 2007; Teper & Inzlicht, 2013; Valentine & Sweet, 1999; Vega, et al., 2014; Wenk-Sormaz, 2005; Semple, 2010). It is possible, however, that mindfulness, defined as mindful attention and mindful acceptance, may relate to patterns of cognitive rather than behavioral biases. Additionally, given the lack of relationship between reaction time attention bias scores and eye tracking gaze durations, it is possible that these measures assess different attention constructs and may not be a true measure of attention control in the moment.

The inconsistency between present findings and previous research could also be affected by limitations with the present study. First, the attention bias measures may not be measuring the same attention constructs as attention measures used in previous studies and the dot-probe attention bias task is not as reliable as other measures of attention processes. Second, it is unclear exactly what the subscales of the Philadelphia Mindfulness Scale measure, making it difficult to clarify the construct of mindfulness, particularly in relation to mental health.

The results from this study do not conclude the examination and exploration of the mindfulness construct and, specifically, the two component model of mindfulness. Future research is needed to further explore mindfulness, mindfulness components, and relationships among components of mindfulness and measures of attentional processes in response to emotionally-charged stimuli. Such further research could lead to greater clarity in the construct of mindfulness.

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APPENDICES

Appendix A. Behavioral studies correlating depression and attention bias

Behavioral Studies Correlating Depression and Attention Bias

Authors	N	Diagnosis	Age	Stimuli	Comparison	General Results
Gotlib, Kasch, et al., 2004	88	Major Depressive Disorder (MDD)	34.5	Sad, angry, happy, and neutral faces	Group x Face emotion	No main effects of group or emotion, but the interaction was significant. Patients with MDD, compared HC, showed bias toward sad faces more than any other expressions.
	55	Healthy Control (HC)	33.6			
Gotlib, Krasnoperova, et al., 2004	19	MDD		Sad, angry, and happy faces	MDD compared to controls.	Participants with MDD showed significant attention bias for sad faces than did HC, and participants with MDD showed no significant bias for happy faces.
	16	HC				
Joormann & Gotlib, 2007	26	MDD	35.0	Sad, happy, and neutral faces	Group x Face emotion	Both participants with MDD and with remitted MDD had significantly greater attention bias to sad faces than did HC. HC, compared to other participants, showed greater attention bias for happy faces.
	23	MDD, remitted	36.1			
	19	HC	46.4			
Kujawa, et al., 2011	15	Females at risk for MDD	6.15	Sad, happy, and neutral faces	Group x Face emotion	Females at risk for MDD, compared to HC and males at risk for MDD, showed an attention bias to sad faces. Authors suggest that such attention biases may be a vulnerability marker for MDD. No significant differences between groups were found in attention biases toward happy faces.
	27	Female HC	6.10			
	21	Males at risk for MDD	6.21			
	36	Male HC	6.19			

Behavioral Eye Tracking Studies Correlating Depression and Attention Bias

Authors	N	Diagnosis	Age	Stimuli	Eye-tracking	Comparison	General Results
Caseras et al., 2007	23	Dysphoric	22.6	Negative, positive and neutral scenes	Orientation time & gaze duration	Group x Scene emotion	Dysphoric individuals, compared to nondysphoric individuals, gazed longer at negative scenes. No significant group differences on measures of initial orienting.
	20	Non-dysphoric	22.1				
Duque & Vázquez, 2015	16	MDD	26.3	Sad, happy, angry, and neutral faces	First fixation & gaze duration	Group x Face emotion	Individuals with MDD looked first and longer (gaze duration) toward sad faces and spent slightly less time viewing happy faces.
	34	HC	27.0				
Eizenman et al., 2003	8	MDD	36.9	Dysphoric (sad/loss), threatening, social, and neutral scenes.	Gaze duration	Group x Scene emotion	Individuals with MDD gazed longer at dysphoric scenes compared to HC.
	9	HC	27				
Kellough, Beevers, Ellis, & Wells, 2008	15	MDD		Dysphoric (sad/loss), threatening, social, and neutral scenes	Orientation time & gaze duration	Group x Scene emotion	Individuals with MDD had longer total gaze durations at dysphoric stimuli compared to the never depressed HC. All participants tended to initially orient toward threat and positive stimuli over dysphoric stimuli.
	45	HC					
Leyman et al., 2011	19	Dysphoric		Sad, angry, happy, and neutral faces	Gaze duration	Group x Face emotion	Dysphoric individuals had longer gaze durations at sad and neutral faces than nondysphoric individuals; nondysphoric individuals had longer gaze durations for happy faces than dysphoric individuals. Authors argue that gaze duration is the most straight forward measure of sustained attention.
	20	Non-dysphoric					
Matthews & Antes, 1992	20	Dysphoric		Sad, happy and neutral scenes	Orientation time & gaze duration	Group x Scene emotion	Dysphoric individuals had longer gaze durations to sad scenes compared to nondysphoric individuals. Both dysphoric and nondysphoric participants initially quickly oriented toward happy scenes compared to sad scenes.
	20	Non-dysphoric					

Appendix B. Demographic Survey

Date of Birth: _______/_______/_______

Age: _______

Date of Survey Completion: _______/_______/_______

Gender:

- ☐ Female
- ☐ Male

Ethnicity:

- ☐ Hispanic or Latino
- ☐ Not Hispanic or Latino

Race:

- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☐ White
- ☐ Other ______________________________

Current Year in College:

- ☐ Freshman
- ☐ Sophomore
- ☐ Junior
- ☐ Senior
- ☐ Other: ______________________________

Major:

- ☐ Psychology
- ☐ Other: ______________________________

Appendix C. The Philadelphia Mindfulness Scale

Philadelphia Mindfulness Scale (PHLMS)

Instructions: Please circle how often you experienced each of the following statements *within the past week.*

1. I am aware of what thoughts are passing through my mind.

1	2	3	4	5
Never	Rarely	Sometimes	Often	Very Often

2. I try to distract myself when I feel unpleasant emotions.

1	2	3	4	5
Never	Rarely	Sometimes	Often	Very Often

3. When talking with other people, I am aware of their facial and body expressions.

1	2	3	4	5
Never	Rarely	Sometimes	Often	Very Often

4. There are aspects of myself I don't want to think about.

1	2	3	4	5
Never	Rarely	Sometimes	Often	Very Often

5. When I shower, I am aware of how the water is running over my body.

1	2	3	4	5
Never	Rarely	Sometimes	Often	Very Often

6. I try to stay busy to keep thoughts or feelings from coming to mind.

1	2	3	4	5
Never	Rarely	Sometimes	Often	Very Often

7. When I am startled, I notice what is going on inside my body.

1	2	3	4	5
Never	Rarely	Sometimes	Often	Very Often

8. I wish I could control my emotions more easily.

1	2	3	4	5
Never	Rarely	Sometimes	Often	Very Often

9. When I walk outside, I am aware of smells or how the air feels against my face.

1	2	3	4	5
Never	Rarely	Sometimes	Often	Very Often

10. I tell myself that I shouldn't have certain thoughts.

1	2	3	4	5
Never	Rarely	Sometimes	Often	Very Often

11. When someone asks how I am feeling, I can identify my emotions easily.

1	2	3	4	5
Never	Rarely	Sometimes	Often	Very Often

12. There are things I try not to think about.

1	2	3	4	5
Never	Rarely	Sometimes	Often	Very Often

13. I am aware of thoughts I'm having when my mood changes.

1	2	3	4	5
Never	Rarely	Sometimes	Often	Very Often

14. I tell myself that I shouldn't feel sad.

1	2	3	4	5
Never	Rarely	Sometimes	Often	Very Often

15. I notice changes inside my body, like my heart beating faster or my muscles getting tense.

1	2	3	4	5
Never	Rarely	Sometimes	Often	Very Often

16. If there is something I don't want to think about, I'll try many things to get it out of my mind.

1	2	3	4	5
Never	Rarely	Sometimes	Often	Very Often

17. Whenever my emotions change, I am conscious of them immediately.

1	2	3	4	5
Never	Rarely	Sometimes	Often	Very Often

18. I try to put my problems out of mind.

1	2	3	4	5
Never	Rarely	Sometimes	Often	Very Often

19. When talking with other people, I am aware of the emotions I am experiencing.

1	2	3	4	5
Never	Rarely	Sometimes	Often	Very Often

20. When I have a bad memory, I try to distract myself to make it go away.

1	2	3	4	5
Never	Rarely	Sometimes	Often	Very Often

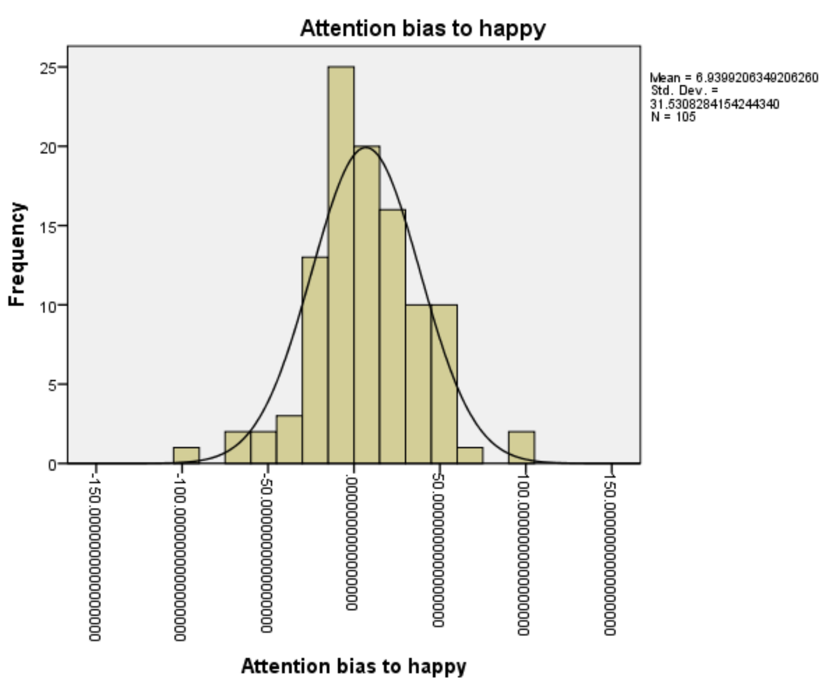
Appendix D. Sample Images from the Dot-Probe Attention Bias paradigm

Appendix E. Linear Regression assumptions

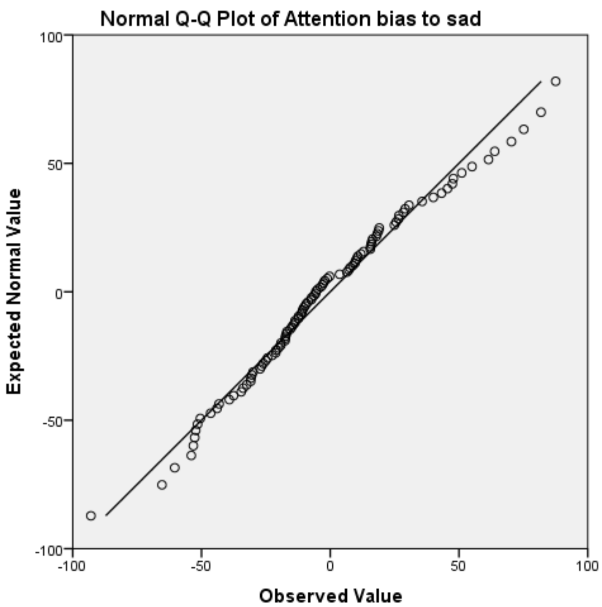
Linear regression assumptions were probed for each of the four dependent variables. Transformations were implemented in order to meet assumptions as needed and as noted in the document.

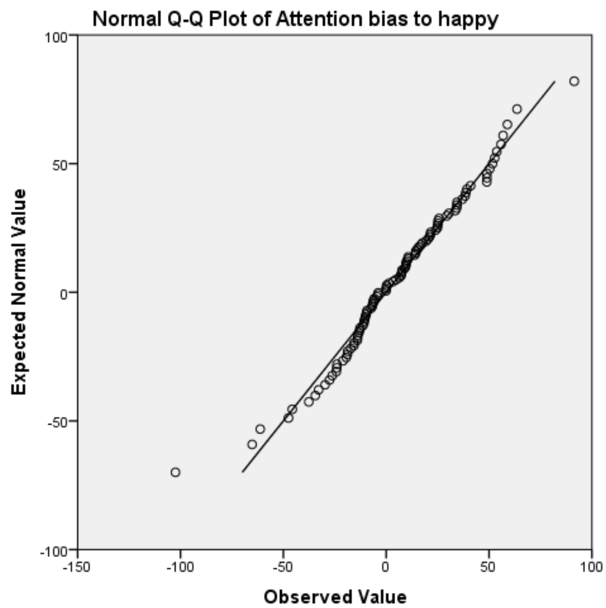
The Behavioral Reaction Time Data

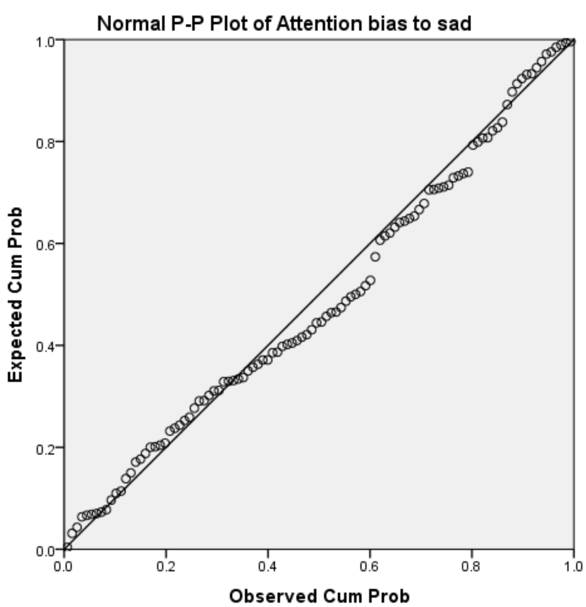
First, normality assumptions were probed for both behavioral reaction time dependent variables, which showed very little skewness and kurtosis. Specifically, attention bias to sad faces data showed a skew of .369, with a standard error of skewness of .236, and a kurtosis of .330, with a standard error of kurtosis of .467. The attention bias to happy faces data showed almost no skew as the analysis suggests a skew of -.009 with a standard error of skewness of .236. This data is slightly leptokurtis, as analysis showed a kurtosis of 1.311 and a standard error of kurtosis of .467; however, this is not outside the acceptable ranges of normality. Therefore, the behavioral reaction time data met normality assumptions.

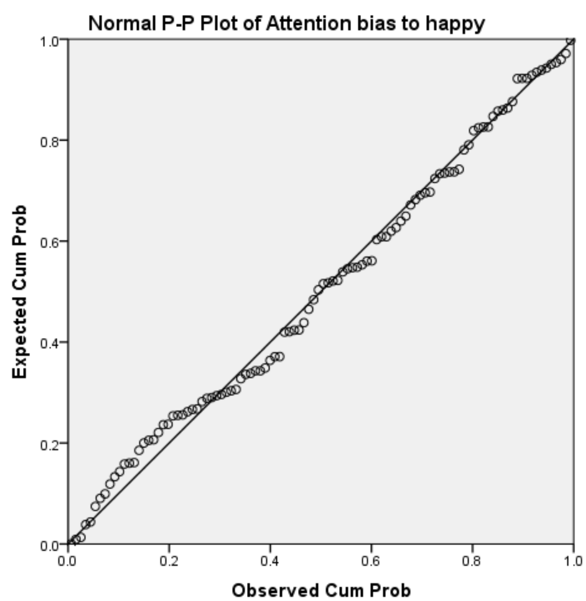


Additionally, the residuals of the variables appear to be normal and linear, as shown on both the q-q and p-p plots.

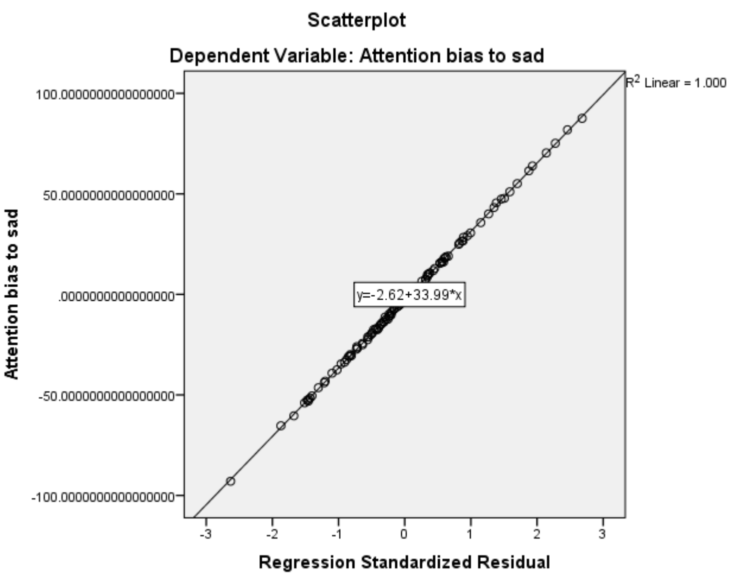


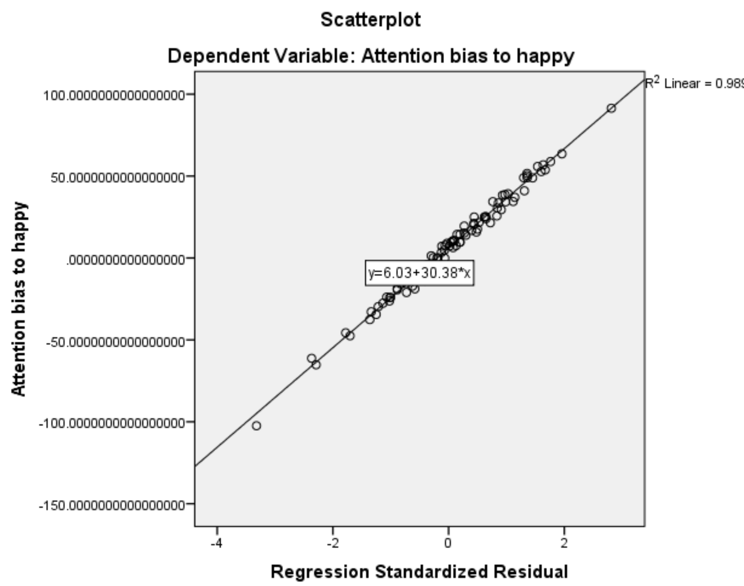






There is also homoscedasticity for both dependent variables.

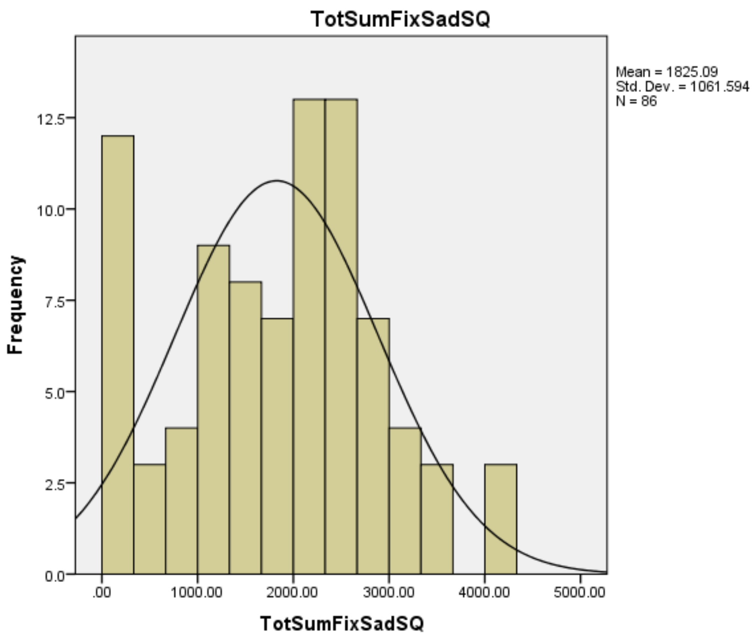


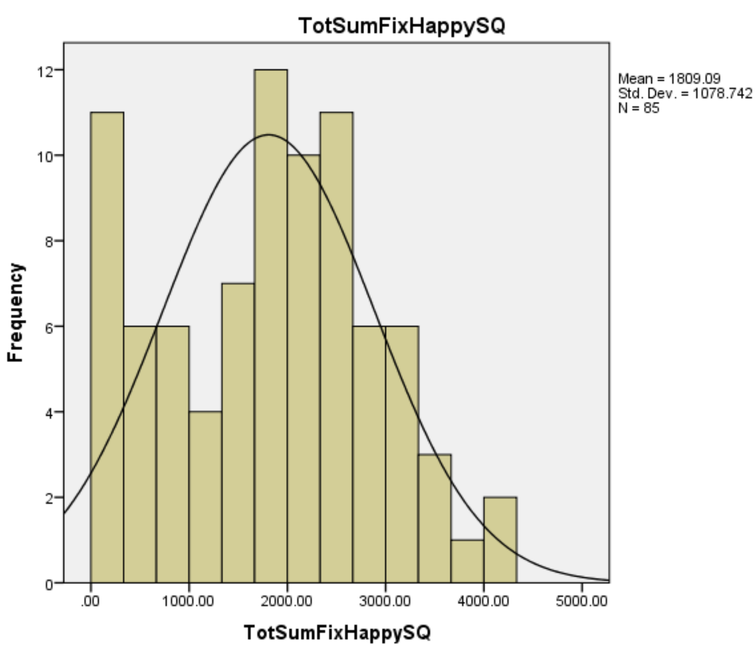


Finally, both independent variables showed no multicollinearity within regression analysis for attention bias to sad faces (PHLMS Awareness: VIF = 1.001; PHLMS Acceptance: VIF = 1.001) or happy faces (PHLMS Awareness: VIF = 1.001; PHLMS Acceptance: VIF = 1.001).

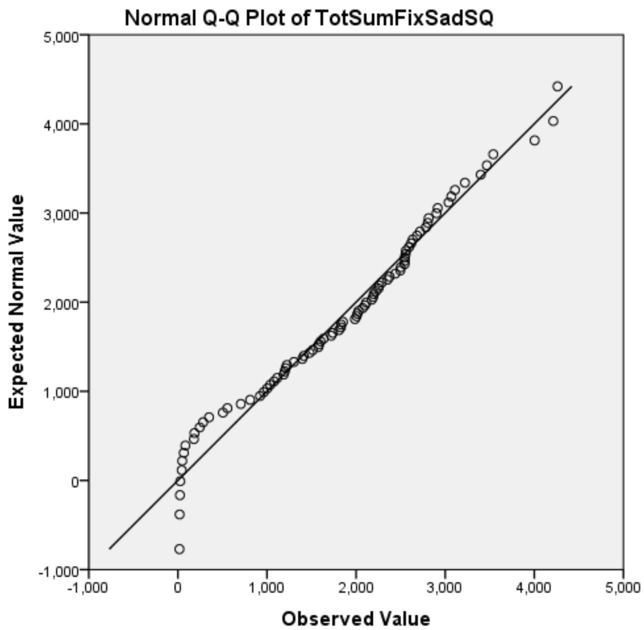
The Eye Tracking Gaze Fixation Data

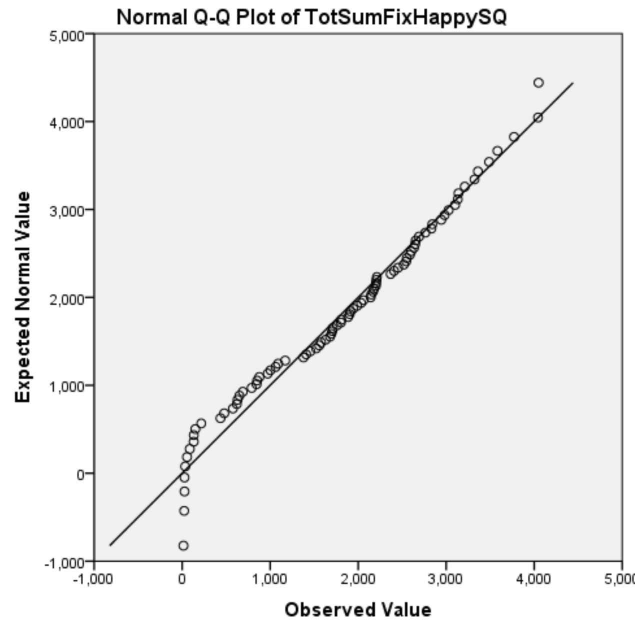
First, normality assumptions were probed for both eye tracking gaze fixation dependent variables. Although neither gaze fixation for both sad (kurtosis = .036) or happy faces (kurtosis = -.188) showed problems with kurtosis, both displayed a left skew (gaze fixation for sad faces: skew = -.893; gaze fixation for happy faces: skew = -.816). Therefore, the data were transformed using a square transformation. After transformation, both skewness (gaze fixation for sad faces: skew = -.053; gaze fixation for happy faces: skew = -.045) and kurtosis (gaze fixation for sad faces: kurtosis = -.843; gaze fixation for happy faces: skew = -.549) suggested normality of the data.

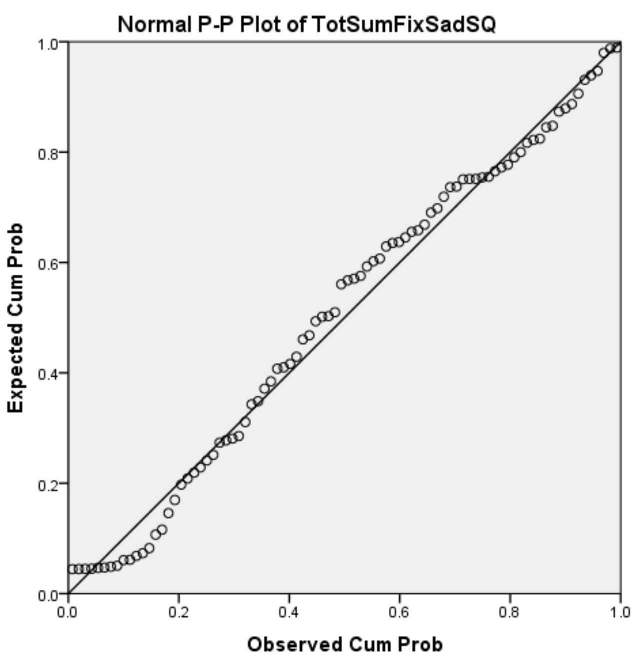


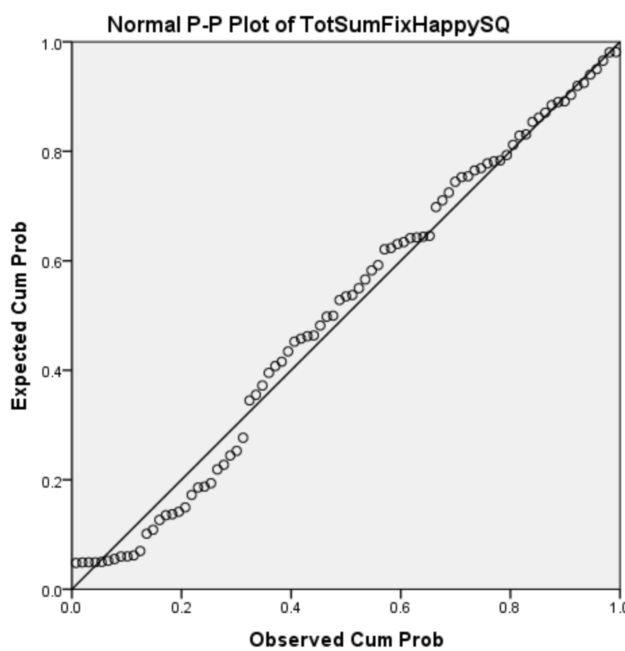


Additionally, the residuals of the variables (of the transformed data) appear to be normal and linear, as shown on both the q-q and p-p plots.

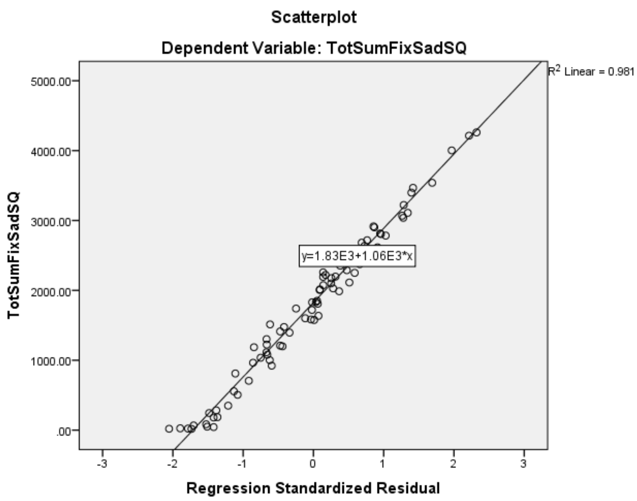

Normal Q-Q Plot of TotSumFixSadSQ
Expected Normal Value
Observed Value
5,000
4,000
3,000
2,000
1,000
0
-1,000
-1,000
0
1,000
2,000
3,000
4,000
5,000

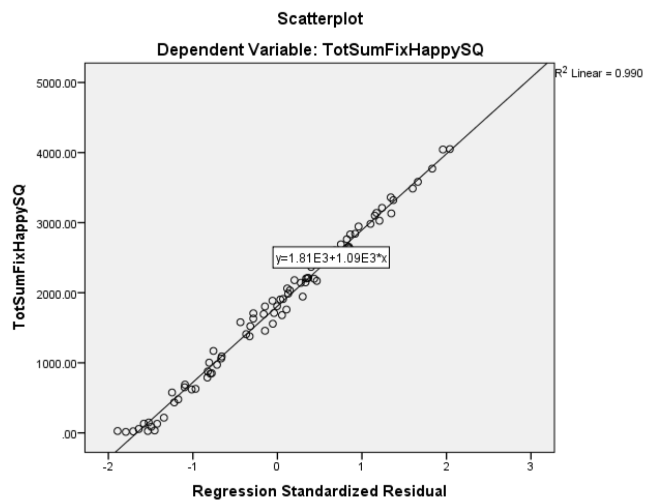

Normal Q-Q Plot of TotSumFixHappySQ
Expected Normal Value
Observed Value
5,000
4,000
3,000
2,000
1,000
0
-1,000
-1,000
0
1,000
2,000
3,000
4,000
5,000


Normal P-P Plot of TotSumFixSadSQ
Expected Cum Prob
Observed Cum Prob
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0


Normal P-P Plot of TotSumFixHappySQ
Expected Cum Prob
Observed Cum Prob
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0

There appears to be homoscedasticity for both dependent variables.





Finally, both independent variables showed no multicollinearity within regression analysis for attention bias to sad faces (PHLMS Awareness: VIF = 1.001; PHLMS Acceptance: VIF = 1.001) or happy faces (PHLMS Awareness: VIF = 1.002; PHLMS Acceptance: VIF = 1.002).

Appendix F. Further Analysis of demographic variables.

T-tests for Ethnicity Differences on the PHLMS Subscales and Dot-probe Data.

	Degrees of Freedom	*t*	*p*	95% Confidence Interval of the Difference	
				Lower	Upper
PHLMS Attention	102	-1.18	.24	-4.70	1.20
PHLMS Acceptance	102	2.02	.05	.07	7.68
Attention Bias to Sad Faces	102	.72	.48	-12.30	26.16
Attention Bias to Happy Faces	102	-.50	.62	-21.65	12.95

T-test for Ethnicity Differences on the PHLMS Subscales and Attention Bias Tasks (Eye Tracking Data).

	Degrees of Freedom	*t*	*p*	95% Confidence Interval of the Difference	
				Lower	Upper
PHLMS Attention	84	-.23	.82	-4.04	3.21
PHLMS Acceptance	84	2.30	.02	.68	9.42
Attention Bias to Sad Faces	84	-1.71	.09	-1274.94	96.10
Attention Bias to Happy Faces	84	-1.63	.11	-1226.92	123.30

ANOVA Between Race Group Differences on the PHLMS Attention Subscale (Dot-probe Data).

	Degrees of Freedom	Mean Square	F	Significance
Intercept	1	85154.90	3205.52	.00
Race	3	35.05	1.32	.27
Error	100	26.57		
Total	104			

ANOVA Between Race Group Differences on the PHLMS Acceptance Subscale (Dot-probe Data).

	Degrees of Freedom	Mean Square	F	Significance
Intercept	1	36014.12	829.65	.00
Race	3	130.35	3.00	.03
Error	100	43.41		
Total	104			

ANOVA Between Race Group Differences in Attention bias to sad faces (Dot-probe Data).

	Degrees of Freedom	Mean Square	F	Significance
Intercept	1	27.00	.02	.88
Race	3	1428.38	1.27	.30
Error	100	1124.14		
Total	104			

ANOVA Between Race Group Differences in Attention bias to Happy Faces (Dot-probe Data).

	Degrees of Freedom	Mean Square	F	Significance
Intercept	1	8405.53	9.40	.00
Race	3	1612.96	1.80	.15
Error	100	894.24		
Total	104			

ANOVA Between Race Group Differences on the PHLMS Attention Subscale (Eye Tracking Data).

	Degrees of Freedom	Mean Square	F	Significance
Intercept	1	72291.20	2312.06	.00
Race	3	39.79	1.27	.29
Error	82	31.27		
Total	86			

ANOVA Between Race Group Differences on the PHLMS Acceptance Subscale (Eye Tracking Data).

	Degrees of Freedom	Mean Square	F	Significance
Intercept	1	31886.72	696.31	.00
Race	3	127.07	2.78	.05
Error	82	45.79		
Total	86			

ANOVA Between Group Differences in Total Gaze Duration for Sad Faces (Eye Tracking Data).

	Degrees of Freedom	Mean Square	F	Significance
Intercept	1	168462310.52	146.18	.00
Race	3	431608.17	.38	.77
Error	82	1152421.70		
Total	86			

ANOVA Between Group Differences in Total Gaze Duration for Happy Faces (Eye Tracking Data).

	Degrees of Freedom	Mean Square	F	Significance
Intercept	1	166212833.07	138.62	.00
Race	3	207436.60	.17	.91
Error	82	1199100.15		
Total	86			

Appendix G. The Inventory of Depression and Anxiety Symptoms Scale

The Inventory of Depression and Anxiety Symptoms (IDAS) is a self-report inventory designed to assess depressive and anxious symptoms. The IDAS was developed through factor analyses on data sampled from three populations (Watson, et al., 2007) and consists of 99 items addressing common feelings, thoughts, and experiences related to both anxiety and depression. The 20 item General Depression scale, therefore, includes statements related more specifically to the experience of depression. Within a college sample, the General Depression scale of the IDAS has been shown to be internally consistent ($\alpha = .89$ with an average internal correlation of .30), highly correlated with the Beck Depression Inventory-II (BDI-II; $r = .83$, $p < .01$), and moderately correlated with the Beck Anxiety Inventory (BAI; $r = .69$, $p < .01$). Within a broader sample (which included high school students, college students, young adults, psychiatric patients, postpartum women) the IDAS General Depression Scale continued to be internally consistent ($\alpha = .88$-.92 with an average internal correlation of .27-.36), highly reliable (retest correlations at one week were $r = .84$), and was correlated with the BDI-II ($r = .83$) and the Hamilton Rating Scale for Depression (HRSD; $r = .67$, $p < .01$). Specifically, within the adolescent sample IDAS General Depression Scale was correlated with the Reynolds Adolescent Depression Scale ($r = .86$), and, within the postpartum women sample, the IDAS General Depression Scale was correlated with the Edinburgh Postnatal Depression Scale ($r = .83$).

For exploratory analysis, the present study was also assessed considering only the data from those individuals who scored in the fourth quartile of the IDAS General Depression Scale. The output for the behavioral reaction time data is given below.

Statistics									
		Age	Ethnicity	Race	IDAS-Dep	PHLMS Awareness	PHLMS Acceptance	Attention bias to sad	Attention bias to happy
N	Valid	23	23	23	23	23	23	23	23
	Missing	0	0	0	0	0	0	0	0
Mean		19.52	.9565	1.7391	67.30	38.00	39.04	-5.265	11.602
Median		19.00	1.0000	2.0000	63.00	38.00	39.00	-14.405	17.628
Mode		19	1.00	2.00	60[a]	39[a]	39	-65.344[a]	-102.446[a]
Std. Deviation		1.755	.20851	.81002	8.901	3.943	6.026	38.935	39.561
Variance		3.079	.043	.656	79.221	15.545	36.316	1515.938	1565.059
Skewness		1.591	-4.796	-.590	1.284	.361	-.462	.745	-.861
Std. Error of Skewness		.481	.481	.481	.481	.481	.481	.481	.481
Kurtosis		2.121	23.000	.349	.394	.537	-.854	.381	2.155
Std. Error of Kurtosis		.935	.935	.935	.935	.935	.935	.935	.935
Minimum		18	.00	.00	60	31	26	-65.344	-102.446
Maximum		24	1.00	3.00	89	48	47	87.545	91.406
a. Multiple modes exist. The smallest value is shown									

Correlations							
		Age	IDAS-Dep	PHLMS Awareness	PHLMS Acceptance	Attention bias to sad	Attention bias to happy
Age	Correlation	1	-.200	.013	-.458*	-.272	.183
	Sig. (2-tailed)		.361	.953	.028	.209	.403
	N	23	23	23	23	23	23
IDAS-Dep	Correlation	-.200	1	-.052	.276	.142	.062
	Sig. (2-tailed)	.361		.814	.202	.518	.780
	N	23	23	23	23	23	23
PHLMS Awareness	Correlation	.013	-.052	1	.082	.415*	-.404
	Sig. (2-tailed)	.953	.814		.709	.049	.056
	N	23	23	23	23	23	23
PHLMS Acceptance	Correlation	-.458*	.276	.082	1	.106	-.137
	Sig. (2-tailed)	.028	.202	.709		.631	.533
	N	23	23	23	23	23	23
Attention bias to sad	Correlation	-.272	.142	**.415***	.106	1	-.506*
	Sig. (2-tailed)	.209	.518	**.049**	.631		.014
	N	23	23	**23**	23	23	23
Attention bias to happy	Correlation	.183	.062	**-.404**	-.137	-.506*	1
	Sig. (2-tailed)	.403	.780	**.056**	.533	.014	
	N	23	23	**23**	23	23	23
*. Correlation is significant at the .05 level (2-tailed).							

Closer examination of the data revealed one data point as an outlier. When this data was re-moved, the correlations were no longer significant; however, there is still some suggestion that mindful attention may be a slightly related to attention bias to sad faces in this small clinical sample.

Correlations							
		Age	IDAS-Dep	PHLMS-Awareness	PHLMS-Acceptance	Attention bias to sad	Attention bias to happy
Age	Correlation	1	-.208	.059	-.460*	-.280	.184
	Sig. (2-tailed)		.352	.795	.031	.208	.414
	N	22	22	22	22	22	22
IDAS-Dep	Correlation	-.208	1	.008	.322	.232	-.006
	Sig. (2-tailed)	.352		.972	.144	.300	.979
	N	22	22	22	22	22	22
PHLMS-Awareness	Correlation	.059	.008	1	-.096	.180	-.087
	Sig. (2-tailed)	.795	.972		.670	.424	.700
	N	22	22	22	22	22	22
PHLMS-Acceptance	Correlation	-.460*	.322	-.096	1	-.054	.059
	Sig. (2-tailed)	.031	.144	.670		.813	.794
	N	22	22	22	22	22	22
Attention bias to sad	Correlation	-.280	.232	**.180**	-.054	1	-.270
	Sig. (2-tailed)	.208	.300	**.424**	.813		.224
	N	22	22	**22**	22	22	22
Attention bias to happy	Correlation	.184	-.006	**-.087**	.059	-.270	1
	Sig. (2-tailed)	.414	.979	**.700**	.794	.224	
	N	22	22	**22**	22	22	22

*. Correlation is significant at the .05 level (2-tailed).

Similar analyses were completed for the eye tracking gaze fixation data of individuals who scored in the fourth quartile of the IDAS General Depression scale. The output for this data is giving below.

Statistics											
		Age	Ethnicity	Race	IDAS-Dep	PHLMS Awareness	PHLMS Acceptance	Attention bias to sad	Attention bias to happy	Gaze Fixation Happy (Squared)	Gaze Fixation Sad (Squared)
N	Valid	21	21	21	21	21	21	20	20	21	21
	Miss-ing	1	1	1	1	1	1	2	2	1	1
Mean		19.29	.9524	1.952	66.81	37.86	39.71	-2.90	13.23	1492.194	1347.356
Median		19.00	1.000	2.000	63.00	38.00	40.00	-10.87	21.25	1378.488	1476.327
Mode		19	1.00	2.00	63	39[a]	39	-65[a]	-102[a]	26.85[a]	48.43[a]
Std. Deviation		1.521	.2182	.740	8.959	4.028	5.866	40.092	41.641	1213.074	1017.406
Variance		2.314	.048	.548	80.262	16.229	34.414	1607.364	1733.991	1471550.147	1035115.876
Skewness		1.818	-4.583	-.741	1.546	.501	-.733	.699	-.961	.565	.371
Std. Error of Skewness		.501	.501	.501	.501	.501	.501	.512	.512	.501	.501
Kurtosis		3.765	21.000	1.405	1.034	.646	-.243	.217	2.123	-.689	-.593
Std. Error of Kur-tosis		.972	.972	.972	.972	.972	.972	.992	.992	.972	.972
Minimum		18	.00	.00	60	31	26	-65	-102	26.85	48.43
Maximum		24	1.00	3.00	89	48	47	88	91	4043.31	3539.66
a. Multiple modes exist. The smallest value is shown											

Correlations

		Age	IDAS-Dep	PHLMS Awareness	PHLMS Acceptance	Attention bias to sad	Attention bias to happy	Gaze Fixation Happy (Squared)	Gaze Fixation Sad (Squared)
Age	Correlation	1	-.139	-.107	-.360	-.145	.275	-.060	-.114
	Sig. (2-tailed)		.548	.644	.109	.542	.240	.797	.624
	N	21	21	21	21	20	20	21	21
IDAS-Dep	Correlation	-.139	1	.005	.311	.117	.097	.347	.382
	Sig. (2-tailed)	.548		.984	.170	.622	.684	.123	.088
	N	21	21	21	21	20	20	21	21
PHLMS Awareness	Correlation	-.107	.005	1	.159	.522*	-.400	-.013	-.022
	Sig. (2-tailed)	.644	.984		.491	.018	.081	.954	.925
	N	21	21	21	21	20	20	21	21
PHLMS Acceptance	Correlation	-.360	.311	.159	1	.009	-.213	-.186	-.200
	Sig. (2-tailed)	.109	.170	.491		.971	.368	.420	.384
	N	21	21	21	21	20	20	21	21
Attention bias to sad	Correlation	-.145	.117	.522*	.009	1	-.576**	-.171	-.195
	Sig. (2-tailed)	.542	.622	.018	.971		.008	.471	.409
	N	20	20	20	20	20	20	20	20
Attention bias to happy	Correlation	.275	.097	-.400	-.213	-.576**	1	.258	.175
	Sig. (2-tailed)	.240	.684	.081	.368	.008		.272	.459
	N	20	20	20	20	20	20	20	20
Gaze Fixation Happy (Squared)	Correlation	-.060	.347	-.013	-.186	-.171	.258	1	.930**
	Sig. (2-tailed)	.797	.123	.954	.420	.471	.272		.000
	N	21	21	21	21	20	20	21	21
Gaze Fixation Sad (Squared)	Correlation	-.114	.382	-.022	-.200	-.195	.175	.930**	1
	Sig. (2-tailed)	.624	.088	.925	.384	.409	.459	.000	
	N	21	21	21	21	20	20	21	21

*. Correlation is significant at the .05 level (2-tailed).

**. Correlation is significant at the .01 level (2-tailed).