Self-Reported Trait Mindfulness and Affective Reactivity: A Comprehensive Investigation of Valence, Arousal, and Attention to Emotional Pictures
Mindful attention is qualitatively receptive and non-reactive, and is thought to facilitate adaptive emotional responding. Using a multi-method approach, I studied the relationship between individual differences in self-reported trait mindfulness and electrocortical, electromyographic, electrodermal, and self-reported responses to emotional pictures. Specifically, while subjects passively viewed IAPS pictures, electrocortical data, skin conductance, and also electromyographic data were recorded. Afterwards, subjects rated their subjective valence and arousal while viewing the pictures again. If trait mindfulness reduces general emotional responding, then responses from individuals with high mindfulness would be associated with decreased late positive potential amplitudes, decreased skin conductance response, and decreased subjective ratings of valence and arousal to emotional pictures. High mindfulness would also be associated with a decreased emotional modulation of startle eyeblink amplitudes and of startle P3 amplitudes during emotional pictures. Although analysis showed clear effects of emotion on dependent measures, in general, mindfulness did not moderate these effects.
mechanism potentially underlying this relationship, namely that mindfulness decreases
affective reactivity, or one’s reaction in response to affect-relevant events.

This notion has been supported by several studies showing that mindfulness was
associated with decreases in self-reported ratings of emotional intensity (Arch &
Craske, 2006; Ortner, Kilner & Zelado, 2007; Taylor et al., 2011), skin conductance
response (Ortner et al., 2007), and LPP amplitudes to emotional pictures (Brown,
Goodman & Inzlicht, 2013). Although the actual mechanism was not specifically
described in these studies, it has been posited that the decreases in affective reactivity
are the result of mindfulness facilitating disengagement from the affect-relevant
stimulus (Desbordes et al., 2014). An affective response is comprised of several
components, namely: threshold for reactivity, peak amplitude of response, rise time to
peak, and recovery time (Davison, 2003). Paying attention mindfully is proposed to
facilitate disengagement from the emotion-provoking stimulus, leading to attenuated
peak amplitude and faster recovery, thereby decreasing the overall emotional response.
This is in contrast to continued engagement with the stimulus, which may promote
elaborative self-referential processing and rumination, processes which are associated
with psychological distress (Nolen-Hoeksema, 2000). Before considering how
mindfulness might facilitate disengagement, however, it is important to further define
mindfulness.

Defining mindfulness
Mindfulness is a rich concept originating in ancient Buddhist traditions that is difficult
to succinctly and adequately operationalize (Grossman & Van Dam, 2011). Within the
context of Western science, mindfulness is often defined as the awareness generated
through “paying attention in a particular way: on purpose, in the present moment, and
non-judgmentally” (Kabat-Zinn, 1994, p. 4). It is generally agreed upon to consist of
two components: self-regulation of attention, and orientation to one’s current experience
with an attitude of curiosity, acceptance, and openness (Bishop et al., 2004).

Facilitated disengagement through mindful attention
Self-regulation of attention and an attitude of acceptance are thought to work
synergistically to facilitate disengagement from affect-relevant stimuli, leading to
decreased reactivity (Bishop et al., 2004). Self-regulation of attention helps focus
practitioners in the present moment, observing their current experience, including
thoughts, feelings, perceptions, and bodily sensations. As attentional resources are
limited, focusing attention on the current experience naturally inhibits elaboration,
rumination, and other self-referential processes (Bishop et al., 2004). That is not to say
that thoughts/feelings/perceptions are suppressed, but rather they are merely noted as
mental events and not elaborated on further, keeping attention on current experience.
This focus of attention in the present moment might also facilitate disengagement by
increasing awareness of initial reactivity, allowing one to let go and return to the present
moment (Hölzel et al., 2011).

The second component of mindfulness describes a particular orientation of curiosity,
openness, and non-judgmentalness to all experiences. This attitude of acceptance of
current experience, regardless of valence or desirability, is thought to reduce avoidant
behaviors and facilitate decoupling of stimulus-response reactivity through exposure, as
in exposure therapy (Hölzel et al., 2011). In addition, open observation of one’s
experience can create space between the observer and their thoughts, feelings, and
perceptions. Rather than seeing them as accurate judgments or reflections of self, they may be observed as transitory mental events that do not have to be identified with (Bishop et al., 2004). This distance during exposure is likely to facilitate disengagement as it weakens the reaction-inducing traction affect-relevant stimuli generally have. In sum, being mindful may facilitate disengagement by maintaining attention in the present moment, thereby inhibiting elaborative processes, and creating distance between the stimulus and response that weakens habitual reactivity.

**Mindfulness and affective reactivity**

Paying attention in this way, focusing on the present moment and with an attitude of acceptance, is practiced during mindfulness meditation. As the practitioner becomes more adept at attending to their experiences mindfully, the state of mindfulness is thought to facilitate the development of a more trait-like disposition of nonreactivity (Desbordes et al., 2014). Several studies investigating the effects of mindful states or mindfulness interventions have supported the link between mindfulness and decreased reactivity to emotional stimuli (Arch & Craske, 2006; Ortner et al., 2007; Taylor et al., 2011). Arch and Craske (2006) employed a 15-minute focused breathing induction and found that, compared to inductions of worry or unfocused attention, it was associated with decreased self-reported negative affect after passively viewing aversive pictures and greater willingness to engage with unpleasant pictures in a subsequent task. Ortner et al. (2007) conducted a randomized controlled experiment to investigate the effects of a 7-week mindfulness intervention on emotional responding and used an emotional interference task (categorizing tones as high or low), skin conductance response, and self-reported emotional intensity as measures of affective reactivity while participants viewed pleasant, unpleasant, and neutral pictures. Mindfulness training was associated with decreased emotional interference while viewing unpleasant pictures, decreased self-reported emotional intensity while viewing pleasant and unpleasant pictures, and decreased baseline skin conductance and skin conductance response to pleasant and unpleasant pictures. Lastly, Taylor et al. (2011) conducted a functional brain imaging study to investigate mindful attention versus uninstructed attention to pleasant, unpleasant, and neutral pictures in novice and experienced meditators, and used self-reported ratings of emotional intensity after each picture as a measure of affective reactivity. They found that for both novice and experienced meditators, mindful attention decreased self-reported emotional intensity to pleasant, neutral, and unpleasant pictures. Together these findings support the hypothesis that mindfulness is related to decreased affective reactivity while viewing emotional pictures.

However, in the field of psychology, the term mindfulness is currently used to describe a state, as in a mode of awareness entered during mindfulness meditation, a trait, implying a stable quality that differs between individuals, and an intervention, in which participants learn mindfulness meditation. Effects for mindfulness may differ depending on how it is conceptualized. Whereas the studies reviewed above (Arch & Craske, 2006; Ortner et al., 2007; Taylor et al., 2011) provide evidence of the relationship between mindfulness operationalized as a state or intervention and decreased affective reactivity, there is mixed evidence from studies operationalizing mindfulness as a self-reported trait in participants not recruited on the basis of previous meditation experience (Ostafin et al., 2013; Sauer et al., 2011; Brown et al., 2013).

On the one hand, Ostafin et al. (2013) found evidence supporting the relationship between trait mindfulness and reduced affective reactivity. That is, self-reported trait
mindfulness, specifically the Acting with Awareness and Non-judging of Inner Experience facets of the Five Facet Mindfulness Questionnaire (FFMQ; Baer, Smith, Hopkins, Krietemeyer & Toney, 2006), was negatively correlated with self-reported negative affect and accessibility of negative words after a negative emotion induction using aversive pictures. On the other hand, another study (Sauer et al., 2011) using a large sample ($N = 247$), found no significant correlation between self-reported trait mindfulness and ratings of unpleasant and neutral pictures or word ratings after aversive evaluative conditioning. Using evoked brain potentials (the late positive potential; LPP) as a measure of affective reactivity, Brown et al. (2013) found that self-reported trait mindfulness on the Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003) was positively correlated with dampened LPP amplitudes while viewing unpleasant pictures. However, two other studies (Gootjes et al., 2011; Sobolewski et al., 2011) have also measured LPP during passive viewing tasks, comparing meditators and non-meditators directly rather than using self-reported trait mindfulness as an independent measure, and the results did not directly support those from Brown et al. (2013).

Using a group of yogic meditators practicing Sudarshan Kriya traditions, Gootjes et al. (2011) found no difference in LPP amplitudes to emotional pictures between meditators and non-meditators during a passive viewing task. Sobolewski et al. (2011) found experienced Buddhist meditators to have attenuated LPP amplitudes for unpleasant pictures, but the effect was found at left and right frontal electrodes rather than at centro-parietal sites where it is generally reported (Olofsson, Nordin, Sequeira & Polich, 2008). As experienced meditators should ostensibly be more mindful than non-meditators who score high on trait mindfulness scales, these studies suggest that trait mindfulness ought not be related to decreased affective reactivity, at least in terms of LPP responses to emotional pictures. In sum, while mindfulness operationalized as a state or an intervention seems to be associated with decreased affective reactivity, self-reported trait mindfulness has produced mixed results.

The present study
In an effort to reconcile these conflicting results, the aim of the present study was to investigate the relationship between self-reported trait mindfulness and affective reactivity using multiple measures. To that end, participants completed a passive viewing task, looking at pleasant, unpleasant, and neutral pictures, and during the task electroencephalography (EEG), electromyography (EMG), and skin conductance were recorded. While participants were viewing the pictures, they also heard sporadic loud bursts of white noise to induce the startle response. Self-reported ratings of valence and arousal were also collected while participants viewed the pictures a second time. These physiological measures were chosen because they have been shown to be reliably modulated by emotional stimuli, and thus were employed within the same study to comprehensively characterize affective reactivity. I was specifically interested in event-related potentials (ERPs) indexing motivated attention to pictures (LPP) and attention allocated to the startle probes (P3). The startle eyeblink response measured by EMG provided a measure of affect modulation, skin conductance response was used as a measure of sympathetic arousal, and self-reported ratings gave a measure of subjective emotional experience. To investigate the moderating effects of self-reported trait mindfulness, participants also rated trait mindfulness using two commonly used self-report scales, the MAAS (Brown & Ryan, 2003) and FFMQ (Baer et al., 2006). I used both scales as they are thought to measure different aspects of mindfulness and thus was interested in being able to separate the components thought to be related to self-
regulation of attention (MAAS and the Acting with Awareness subscale on the FFMQ) and attitude of acceptance (the subscales of Non-judging of Inner Experience and of Nonreactivity to Inner Experience on the FFMQ).

Dependent measures and hypotheses

Emotion can be conceptualized in terms of discrete categories (e.g. fear, disgust, etc.) or in terms of the motivational dimensions of valence and arousal (Lang & Bradley, 2010). According to the motivational model, unpleasant and pleasant pictures differ in their valence, and both unpleasant and pleasant pictures differ from neutral pictures in their arousal level. Because research has demonstrated clear effects of valence and arousal on different physiological and self-report measures (Lang & Bradley, 2010), the present study adopted a motivational perspective on emotion. Further, because various dependent measures differ in their sensitivity to either valence or arousal (Lang & Bradley, 2010), the predictions and data analyses were focused on either the valence effect (i.e. pleasant vs unpleasant) or the arousal effect (i.e. pleasant + unpleasant combined vs neutral) of emotion. Accordingly, self-reported valence and affect-modulated startle eyeblink response were used as measures of valence effects, and self-reported arousal, skin conductance response, motivated attention to pictures (LPP), and attention to startle probes (P3) were used as measures of arousal effects.

Self-reported valence
An effect of picture valence on self-reported valence was predicted, such that pleasant pictures would be rated more positive than unpleasant pictures (with neutral pictures in between). Self-reported trait mindfulness was expected to moderate this effect with higher mindfulness being associated with a smaller rating difference between pleasant and unpleasant pictures.

Self-reported arousal
An effect of picture arousal on self-reported arousal was expected, such that both pleasant and unpleasant pictures (combined) would be rated more arousing than neutral pictures. Self-reported trait mindfulness was predicted to moderate this effect with higher mindfulness being associated with a relatively smaller difference in arousal ratings between the combined pleasant and unpleasant pictures versus neutral pictures.

Affect-modulated startle eyeblink response (EMG)
The startle response is characterized in humans by muscular contractions in the torso and face, and indexes the activation of the defensive system (Koch, 1999). Startle response amplitude is modulated by one’s affective state and can be conveniently recorded by measuring the amplitude of the eyeblink response to the startle probe. This eyeblink amplitude is potentiated during negative affective states and attenuated during positive affective states, and has been shown to be particularly modulated while viewing highly arousing emotional pictures (Lang & Bradley, 2010). Accordingly, I expected to find an effect of picture valence on startle response with unpleasant pictures eliciting larger startle responses than pleasant pictures (with neutral pictures in between). Self-reported trait mindfulness was hypothesized to moderate the valence effect with higher mindfulness being associated with smaller reactivity scores.
**Sympathetic arousal (SCR)**
Skin conductance response (SCR) is regulated by the autonomic nervous system with sympathetic innervation of the sweat glands producing the skin conductance response (Dawson, Schell & Filion, 2007). As such, SCR is used as a measure of sympathetic arousal and has been shown to be sensitive to affective state (Lang et al., 1993). I expected to find an effect of picture arousal on SCR with both pleasant and unpleasant pictures eliciting greater SCR than neutral pictures. Self-reported trait mindfulness was expected to moderate this arousal effect with higher mindfulness being associated with decreased skin conductance responses to the combined pleasant and unpleasant pictures versus neutral pictures.

**Motivated attention to pictures (LPP)**
The late positive potential (LPP) is a positive deflection of the ERP waveform occurring at centro-parietal sites approximately 400 ms after stimulus onset. The LPP is sensitive to the motivational significance of pictures with larger LPP amplitudes occurring in response to arousing pleasant and unpleasant pictures (Schupp et al., 2000), and thus the LPP will be used as a measure of motivated attention to pictures. I expected to find an effect of picture arousal on LPP amplitudes with greater amplitudes for pleasant and unpleasant pictures with respect to neutral pictures. Self-reported trait mindfulness was predicted to moderate this arousal effect with higher mindfulness being associated with attenuated LPP amplitudes to the combined pleasant and unpleasant pictures versus neutral pictures.

**Attention to startle probes (P3)**
The P3 ERP component, which is a centro-parietal positivity approximately 300 ms after stimulus onset, indexes attention allocation and has been used in affect-modulated startle response paradigms to assess the attention allocated to the startles versus pictures (Schupp, Cuthbert, Bradley, Birbaumer, & Lang, 1997). Specifically, the P3 to startle probes is reduced during viewing of arousing (unpleasant or pleasant) pictures versus neutral pictures. This is consistent with the idea that more attentional resources are drawn to arousing versus neutral pictures and that fewer attentional resources are available to process the additional startle probe. As emotional pictures are salient and readily capture attention (Bradley, Codispoti, Cuthbert & Lang, 2001), I expected to find an effect of picture arousal on P3 amplitudes with smaller P3 amplitudes to startle probes presented on trials where pleasant and unpleasant pictures were shown versus neutral picture presentations. Self-reported trait mindfulness was predicted to be associated with larger P3 amplitudes to startle probes for pleasant and unpleasant pictures, indicating disengagement with the pictures and increased attentional resources available to process the startle probes.

**Methods**

**Participants**
A convenience sample of 56 students and professionals (30 women and 26 men) was recruited via the psychology department at Stockholm University and through an online recruitment website. Two participants were excluded because they reported moderate to severe levels of depression on the Beck Depression Inventory (BDI; Beck, Steer & Carbin, 1988). Three additional participants were excluded due to technical errors ($n = 1$), excessively noisy EEG signal ($n = 1$), and missing survey data ($n = 1$), yielding a
total of 51 participants in the study (25 women, 26 men). Participants were between the ages of 19 and 51 ($M = 25, SD = 6.8$), were not currently being treated for any psychological disorders, and had normal or corrected to normal vision. Seven participants (14%) had some meditation experience, ranging from 1-8 years of regular practice ($M = 3.1$). Mean trait anxiety (STAI-T; Spielberger, Gorsuch, Lushene, Vagg & Jacobs, 1983) was 36.6 ($SD = 7.4$) and mean depression scores (BDI) were 4.6 ($SD = 4.1$). The study was approved by the regional ethics board and was conducted in accordance with the guidelines in the Helsinki Declaration. All participants gave informed consent, were debriefed after the experiment, and were compensated with course credit or 2 movie vouchers.

*Self-reported measures*

**Mindfulness.**

Self-reported trait mindfulness was assessed using two self-report scales: the Mindfulness Awareness Attention Scale (MAAS; Brown & Ryan, 2003) and the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006). The MAAS is a 15-item scale that assesses present-moment awareness, a core facet of mindfulness, as a dispositional trait. An example item is “I could be experiencing some emotion and not be conscious of it until some time later” and answers are scored on a 6-point scale ranging from almost always to almost never. All items are reverse-scored and higher scores indicate higher mindfulness (possible range = 15-90; $\alpha = .85$).

The FFMQ is a 39-item scale measuring five aspects of trait mindfulness. These include: Observing (e.g. “I notice the smells and aromas of things.”), Describing (e.g. “I’m good at finding words to describe my feelings.”), Acting with awareness (e.g. “I am easily distracted.” – reversed item), Non-judging of inner experience (e.g. “I tell myself I shouldn’t be feeling the way I’m feeling.” – reversed item), and Nonreactivity to inner experience (e.g. “I perceive my feelings and emotions without having to react to them.”). Answers are scored using a 5-point scale ranging from never or very rarely true to very often or always true. Higher scores indicate higher mindfulness (possible range = 39-195; entire scale $\alpha = .88$, Observing $\alpha = .71$, Describing $\alpha = .87$, Acting $\alpha = .85$, Non-Judging $\alpha = .85$, Nonreacting $\alpha = .77$).

**Trait Anxiety.**

Trait anxiety was measured using the State-Trait Anxiety Inventory (STAI-T; Spielberger et al., 1983). The STAI-T consists of 20 items measuring trait anxiety and answers are scored on a 4-point scale ranging from not at all to very much so. An example item is “I worry too much over something that really doesn’t matter.” Higher scores indicate higher anxiety (possible range = 20-80; $\alpha = .85$).

**Depression.**

Depression was measured using the Beck Depression Inventory (BDI; Beck, Steer & Carbin, 1988). The BDI is a 21-item questionnaire measuring attitudes and symptoms of depression. Each item is scored with increasing severity of the symptom on a scale from 0-3. An example item is: 0 = I do not feel sad, 1 = I feel sad, 2 = I am sad all the time and can’t snap out of it, 3 = I am so sad and unhappy I can’t stand it. Higher scores indicate higher depression, with scores greater than 21 indicating moderate to severe clinical depression (possible range = 0-63; $\alpha = .75$).
Materials and presentation
Stimuli were 72 pictures from the International Affective Picture System (IAPS; Lang, Bradley & Cuthbert, 2008). The pictures varied in valence and arousal, and emotional pictures (pleasant and unpleasant) were selected to be highly arousing. The pictures included 24 pleasant pictures depicting highly arousing pleasant images (e.g. babies, erotica; valence $M = 7.4, SD = 0.66$, arousal $M = 5.6, SD = 1.1$), 24 unpleasant pictures depicting highly arousing unpleasant images (e.g. mutilation, threat; valence $M = 2.1, SD = 0.57$, arousal $M = 6.3, SD = 0.63$), and 24 neutral pictures (e.g. neutral faces, mushrooms; valence $M = 5.2, SD = 0.38$, arousal $M = 3.4, SD = 0.31$). One-way ANOVAs for normative valence and arousal ratings (with pictures as subjects) showed that each picture category was significantly different from the others (valence and arousal $p < .001$).

Subjective affective experience was measured using the Self-Assessment Manikin (SAM; Bradley & Lang, 1994). This scale consists of two 9-point scales assessing how pleasant/unpleasant and how calm/aroused participants felt while viewing each of the 72 pictures. Higher scores on the valence scale indicated greater positive affect, whereas higher scores on the arousal scale indicated greater arousal.

The pictures were presented on a 21″ View Sonic p227f CRT-screen with a refresh rate of 100 Hz and a resolution of 1024 x 768 pixels. The viewing distance was 70 cm and was maintained with a chin rest. The picture size was 717 x 538 px and the visual angle was 15.4 degrees. The experiment was programmed in Presentation 14.8 (Neurobehavioral Systems, Albany, CA).

Procedure
Before being accepted into the experiment, participants were screened through an online survey, providing information about background and demographic variables, and completed a battery of psychological scales (as described in ‘Self-reported measures’). After survey data was collected and screened, accepted participants came to the lab and participated in the 2-hour psychophysiological experiment. After informed consent was given, EEG, EMG, and skin conductance electrodes were attached. Participants were then instructed to passively view the 72 pleasant, unpleasant, and neutral pictures which were presented in a quasi-random order (no more than 2 pictures of the same valence category in a row) that was generated for each participant. Each picture was displayed at fixation for 6 seconds followed by a randomized interval of 4-12 seconds (i.e. inter-trial interval was 10-18 seconds, $M = 14$ s) during which a fixation cross remained on the screen (cf. Larson, Ruffalo, Nietert & Davidson, 2005). While the participants viewed the pictures, a high amplitude burst of white noise (square wave with a sudden onset at 102 dB for 50 ms) was presented on each trial (1500 ms, 4500 ms, or 7500 ms after picture onset) through headphones to elicit the startle response. The task was divided into 2 blocks (36 trials each) and participants were allowed to take a break between blocks. After the passive viewing task was completed, participants completed another task (not reported here), and then viewed the pictures once again, rating their subjective feelings of pleasantness/unpleasantness and arousal for each picture. Finally participants were debriefed, thanked, and compensated.

Physiological data collection
EEG data were collected from 128 channels using an Active Two BioSemi system (BioSemi, Amsterdam, Netherlands). A BioSemi electrode cap was used with electrodes
placed according to the ABC layout—that is, electrodes were positioned in increasingly larger circles from the vertex (http://www.biosemi.com/download/Cap_coords_all.xls). The electrodes CMS and DRL (approximately at CP1 and CP2) were used as reference and ground electrodes, respectively. Data were sampled at 2048 Hz and filtered with a hardware low-pass filter at 104 Hz. Facial EMG was measured with a pair of 4 mm BioSemi Ag-AgCl electrodes placed on the left orbicularis oculi muscle, according to the guidelines in Blumenthal et al. (2005). Skin conductance was measured with a pair of 1 cm BioSemi Ag-AgCl electrodes placed on the palm of the left hand. All electrodes were filled with electrolyte conductance gel (SIGNAGEL, Parker Laboratories, Inc., Fairfield, NJ, USA). All physiological data was processed offline using MATLAB (version R2013b, The MathWorks Inc., Natick, Massachusetts, www.mathworks.com).

Data reduction

SCR.
The continuous raw data for skin conductance were high-pass filtered at 0.05 Hz with a 4th order Butterworth filter and low-pass filtered at 10 Hz with a 4th order Butterworth filter. After filtering, trials epochs were extracted (between 0 and 7 seconds after stimulus onset) and the data were baseline corrected with a baseline window of 0-900 ms after stimulus onset. Trials were then visually inspected using a response window of 1-4 seconds after stimulus onset and the response onset and peak were selected manually within this window. Trials with no perceptible response or a response less than 0.05 μS were scored as non-responses (zero) but were included when calculating SCR magnitude. Trials with excessive noise were rejected and not included in the magnitude calculation (4.8% of trials were rejected). SCR values were log transformed (log(SCR+1)) to normalize the data and then magnitude scores (the mean across all included trials) were calculated for each condition.

EMG.
Startle eyeblink EMG was processed in accordance with the guidelines outlined in Blumenthal et al. (2005). First, the continuous raw EMG data were high-pass filtered at 28 Hz using a 4th order Butterworth filter and rectified. Next, trial epochs were extracted (between 200 ms before to 200 ms after startle onset) and low-pass filtered at 40 Hz with a 4th order Butterworth filter. The data were then baseline corrected, with a baseline window between 50 and 0 ms before startle onset. The maximum amplitude during the response window (20-150 ms after stimulus onset) was automatically extracted. Trials with a response amplitude greater than 3 times the mean activity during the baseline interval were marked as valid responses. All trials were then visually inspected to ensure that the correct maximum had been selected. Trials were rejected if there was excessive noise in the baseline or activity within the window 0-20 ms after startle onset. Trials with no perceptible response or responses less than 3 times the baseline mean were scored as non-responses (zero) but were included in the analyses. Startle response amplitudes were z-transformed (within participant), and responses greater than 3 SDs from the mean were fenced in and set to ± 3 SDs. Afterwards, these scores were converted to t-scores ($M = 50, SD = 10$) to standardize the scores across participants (cf. Bradley, Codispoti, Cuthbert & Lang, 2001). All participants had more than 50% valid trials total and at least three good responses per cell (Valence x Probe Interval). Notably, some participants ($n = 10$) failed to display a probe-induced eyeblink on at least half of the trials. However, additional analyses showed that results reported below were unaffected whether or not these subjects were excluded. For simplicity, results are reported for all subjects.
The EEG data from the 128 channels were analyzed with the Fieldtrip toolbox in MATLAB (Oostenveld et al., 2011). The channels were visually inspected, and bad channels were excluded (< 8 for 12 subjects). Individual trial epochs were extracted between 200 ms before stimulus onset and 1300 ms after stimulus onset. Data were then downsampled to 250 Hz. An independent component analysis (ICA) with Runica method was used to identify eye-movement related artifacts. The topographies were inspected and those related to vertical or horizontal eye movements were removed from the data. The corrected data were visually inspected to ensure that eye movement artifacts were actually reduced, if not eliminated. Then, channels that were initially excluded were interpolated with spherical splines to obtain 128 channels for each subject. Data were referenced to the average of all 128 electrodes and for each trial, data were baseline corrected with an interval between -100 and 0 ms before stimulus onset. Individual trials were then inspected blindly in reference to their condition in a summary mode that shows the distribution of trials in terms of within trial signal variability and range. Excessive trials were excluded to minimize effects of outliers. Last, event-related potentials (ERPs) were computed by averaging the trials separately for each condition.

To identify the LPP to picture onset, a difference ERP wave was computed across subjects between the ERPs to picture onset for the combined pleasant and unpleasant pictures versus the ERP to picture onset for the neutral pictures. The LPP was apparent between 400 and 800 ms over central-parietal electrodes. The following 11 electrodes were used to extract mean amplitudes between 400 and 800 ms after picture onset: A1, A2, A3, A4, A19, D1, D15, D16, C1, B1, and B2 (see the topography in Figure 2 for the location of these electrodes).

To identify the P3 to startle onset, a grand ERP wave was computed across subjects that combined the ERPs to startle onset for all three picture types (pleasant, neutral, and unpleasant). The P3 was apparent between 300 and 380 ms over central electrodes. The following 3 electrodes were used to extract mean amplitudes between 300 and 380 ms after startle onset: A4, A19, and A20 (see the topography in Figure 3 for the location of these electrodes).

Results

A series of repeated-measures ANOVAs were conducted separately for each dependent measure. For completeness, within-subjects main effects (with multiple df/s) are reported using the Greenhouse-Geisser corrected statistics. Importantly, as described in the introduction, analyses focused on specific contrasts (with 1 df) within the ANOVA to test for specific effects of valence (e.g. pleasant > unpleasant) or arousal (e.g. pleasant/unpleasant > neutral) in accordance with a priori hypotheses for each dependent measure. Self-reported trait mindfulness was used as a continuous covariate in each model, and the MAAS and the three subscales of interest on the FFMQ (Acting with awareness, FFMQ–AWA; Non-judging of inner experience, FFMQ–NJ; and Nonreactivity to inner experience, FFMQ–NR) were analyzed separately. Exact statistics from all contrasts can be found in Table 3. Statistical significance for each analysis was set to $p < .05$, two-tailed. Although the present study involves many comparisons and thus increases the chances of Type I errors associated with multiple
comparisons, these are not specifically corrected for because the focus of the present study is to emphasize effect sizes and their confidence intervals. For example, for each dependent measure, simple effect sizes (i.e. mean differences) together with confidence intervals are shown for both the primary effect (of valence or arousal) and for the group differences (based on a median split) in terms of this primary effect (see Table 3). Because these values are in meaningful units, they can be directly interpreted and compared. This approach matches that of the “new statistics” (Cumming, 2013) that advises against an overemphasis on correction for multiple comparisons at the expense of Type II errors. The means and standard deviations for each scale and the correlation between it and all other scales can be found in Table 1. Means and standard deviations for all dependent measures can be found in Table 2. Gender was also analyzed as a covariate and generated non-significant results for all dependent measures except for self-reported valence, $F(1,49) = 6.6, p < .013, \eta^2 = .119$, with women rating unpleasant pictures as more negative than men. There was no difference between men and women on any measure of trait mindfulness ($ps > .05$).

### Table 1. Correlations between self-reported measures

<table>
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<tr>
<th></th>
<th>MAAS</th>
<th>FFMQ</th>
<th>AWA</th>
<th>NJ</th>
<th>NR</th>
<th>STAI–T</th>
<th>BDI</th>
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<td>.66**</td>
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<td>.34*</td>
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<tr>
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<td>.69**</td>
<td>.32*</td>
<td>.22</td>
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<tr>
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<td>-.52**</td>
<td>-.53**</td>
<td>-.43**</td>
<td>-.32*</td>
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<td>-.23</td>
<td>-.24</td>
<td>-.33*</td>
<td>-.17</td>
<td>.45**</td>
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</table>

*Note. N = 51. MAAS = Mindful Attention Awareness Scale; FFMQ = Five Factor Mindfulness Questionnaire; FFMQ–AWA = Acting with awareness subscale; FFMQ–NJ = Non-judging subscale; FFMQ–NR = Non-reactivity subscale; STAI–T = State–Trait Anxiety Inventory, trait scale; BDI = Beck Depression Inventory.*

* $p < .05$, ** $p < .01$ (2-tailed)

### Table 2. Means for valence and arousal ratings, startle response, sympathetic arousal, motivated attention to pictures, and attention to startle probes

<table>
<thead>
<tr>
<th>Dependent measures</th>
<th>Pleasant pictures</th>
<th>Neutral pictures</th>
<th>Unpleasant pictures</th>
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<td>5.3 (0.5)</td>
<td>2.6 (0.8)</td>
</tr>
<tr>
<td>Startle response: EMG (t-scores)</td>
<td>48.6 (1.5)</td>
<td>50.4 (1.5)</td>
<td>50.7 (1.7)</td>
</tr>
<tr>
<td>Self-reported arousal: Ratings (1-9)</td>
<td>4.8 (1.3)</td>
<td>3.4 (1.3)</td>
<td>5.4 (1.4)</td>
</tr>
<tr>
<td>Sympathetic arousal: SCR log(μS +1)</td>
<td>1.8 (1.1)</td>
<td>1.5 (0.9)</td>
<td>2.2 (1.5)</td>
</tr>
<tr>
<td>Motivated attention to pictures: LPP (µV)</td>
<td>1.3 (2.3)</td>
<td>-0.4 (2.1)</td>
<td>0.8 (2.4)</td>
</tr>
<tr>
<td>Attention to startle probes: P3 (µV)</td>
<td>3.3 (2.7)</td>
<td>3.2 (2.5)</td>
<td>2.9 (2.4)</td>
</tr>
</tbody>
</table>

*Note. N = 49 for SCR and N = 51 for all other measures. Standard deviations are presented in parentheses.*
Self-reported valence: Rating

A one-way ANOVA showed a main effect of picture emotion (pleasant, neutral, unpleasant) on valence ratings ($F(2,98) = 418.1, p < .001, \eta^2_p = .895$). The predicted valence effect of valence ratings was also found ($F(1,49) = 502.5, p < .001, \eta^2_p = .911$).

Pleasant pictures were rated higher than unpleasant pictures (with neutral pictures in

<table>
<thead>
<tr>
<th>Affective Reactivity Measure</th>
<th>Hypothesis</th>
<th>$df$</th>
<th>$F$</th>
<th>$p$</th>
<th>$\eta^2_p$</th>
<th>$M_{diff}$</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-reported valence: Rating</td>
<td>Main effect of emotion</td>
<td>(2, 98)</td>
<td>418.1</td>
<td>.001</td>
<td>.895</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Valence contrast</td>
<td>(1, 49)</td>
<td>502.5</td>
<td>.001</td>
<td>.911</td>
<td>3.95</td>
<td>[3.60, 4.30]</td>
</tr>
<tr>
<td></td>
<td>FFMQ--NR x Valence contrast</td>
<td>(1, 49)</td>
<td>0.1</td>
<td>.707</td>
<td>.003</td>
<td>-0.13</td>
<td>[-0.84, 0.58]</td>
</tr>
</tbody>
</table>

Startle eyeblink response: EMG

Main effect of emotion | (2, 98) | 17.5 | .001 | .263 |
Main effect of interval | (2, 98) | 23.2 | .001 | .321 |
Valence contrast | Neg > Pos | (1, 49) | 26.6 | .001 | .352 | 2.09 | [1.29, 2.90] |
FFMQ--NR x Valence contrast | High < Low | (1, 49) | < 0.1 | .943 | .001 | 0.16 | [-1.47, 1.79] |

Self-reported arousal: Rating

Main effect of emotion | (2, 98) | 86.2 | .001 | .637 |
Arousal contrast | Pos/Neg > Neu | (1, 49) | 140.4 | .001 | .741 | 1.90 | [1.58, 2.22] |
FFMQ--NR x Arousal contrast | High < Low | (1, 49) | < 0.1 | .903 | .001 | -0.12 | [-0.76, 0.53] |

Sympathetic arousal: SCR

Main effect of emotion | (2, 94) | 13.6 | .001 | .225 |
Arousal contrast | Pos/Neg > Neu | (1, 47) | 23.2 | .001 | .330 | 0.54 | [0.31, 0.77] |
FFMQ--NR x Arousal contrast | High < Low | (1, 47) | 1.0 | .319 | .021 | 0.07 | [-0.39, 0.52] |

Motivated attention to pictures: LPP

Main effect of emotion | (2, 98) | 19.9 | .001 | .288 |
Arousal contrast | Pos/Neg > Neu | (1, 49) | 40.4 | .001 | .452 | 1.11 | [0.77, 1.46] |
FFMQ--NR x Arousal contrast | High < Low | (1, 49) | < 0.1 | .812 | .001 | 0.10 | [-0.62, 0.82] |

Attention to startle probes: P3

Main effect of emotion | (2, 98) | 2.2 | .112 | .044 |
Main effect of interval | (2, 98) | 5.8 | .005 | .105 |
Arousal contrast | Neu > Pos/Neg | (1, 49) | 0.3 | .594 | .006 | 0.10 | [-0.27, 0.46] |
FFMQ--NR x Arousal contrast | High > Low | (1, 49) | 1.8 | .181 | .036 | 0.27 | [-0.46, 1.00] |

Note. $N = 49$ for SCR, $N = 51$ for all other measures. $M_{diff}$ refers to the mean difference between conditions/ groups in the specified contrast. Self-reported trait mindfulness was used as a continuous variable in all ANOVAs, but a median split was used to divide scores into high and low groups to calculate mean difference scores and 95% CIs. Statistics reported for self-reported trait mindfulness refer to the nonreactivity subscale of the FFMQ. Scores for all other subscales of interest on the FFMQ (awareness and nonjudging) and the MAAS had p-values > .05. Scales for mean differences and 95% CIs are as follows: Self-reported valence and arousal ratings are on a 9-point scale, EMG is reported as t-scores, SCR is measured in log($\mu$S +1), and LPP and P3 are measured in $\mu$V.

Self-reported valence ratings

A one-way ANOVA showed a main effect of picture emotion (pleasant, neutral, unpleasant) on valence ratings ($F(2,98) = 418.1, p < .001, \eta^2_p = .895$). The predicted valence effect of valence ratings was also found ($F(1,49) = 502.5, p < .001, \eta^2_p = .911$). Pleasant pictures were rated higher than unpleasant pictures (with neutral pictures in
between). In this model the four measures of self-reported trait mindfulness were entered separately as covariates. No main effects of trait mindfulness nor Emotion (pleasant, neutral, unpleasant) x Mindfulness interactions were statistically significant for any of the measures (see Figure 1).

**Affect-modulated startle eyeblink response (EMG)**

A one-way ANOVA revealed a main effect of picture valence on startle response, $F(2,98) = 17.5, p < .001, \eta^2_p = .263$. It also showed the predicted valence effect on EMG startle response, $F(1,49) = 26.6, p < .001, \eta^2_p = .352$. The startle response was greater for unpleasant pictures versus pleasant pictures (with neutral pictures in between). There was also a main effect of probe interval, $F(2, 98) = 23.2, p < .001, \eta^2_p = .321$. This provides a further manipulation check as it replicates previous reports that startle eyeblink response increases with interval. There were no statistically significant main effects of trait mindfulness nor Emotion x Mindfulness interactions (see Figure 1).

**Self-reported arousal ratings**

A main effect of emotion on arousal ratings was found, $F(2, 98) = 86.2, p < .001, \eta^2_p = .637$, as well as the predicted arousal effect, $F(1, 49) = 140.4, p < .001, \eta^2_p = .741$. Pleasant and unpleasant pictures were rated as more arousing than neutral pictures. No statistically significant main effects of trait mindfulness nor Emotion x Mindfulness interactions were found in this model (see Figure 1).

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![Figure 1](image.png)

*Figure 1.* Mean responses for valence ratings, startle EMG, arousal ratings, and skin conductance response across picture type for all participants and for high ($N = 27$) and low ($N = 24$) self-reported trait mindfulness (FFMQ–NR) separately. A median split was used to separate high and low self-reported trait mindfulness. The 95% CI refers to each individual condition mean.
Sympathetic arousal (SCR)
A one-way ANOVA showed a main effect of emotion on skin conductance response, $F(2, 94) = 13.6, p < .001, \eta^2_p = .225$, as well as the expected arousal effect, $F(1, 47) = 23.2, p < .001, \eta^2_p = .330$. As predicted, pleasant and unpleasant pictures elicited greater responses than neutral pictures. There were no statistically significant main effects of trait mindfulness nor Emotion x Mindfulness interactions (see Figure 1).

Motivated attention to pictures (LPP)
A one-way ANOVA revealed a main effect of emotion on LPP amplitude, $F(2, 98) = 19.9, p < .001, \eta^2_p = .288$, and the expected arousal effect as well, $F(1, 49) = 40.4, p < .001, \eta^2_p = .452$. LPP amplitudes to pleasant and unpleasant pictures were greater than to neutral pictures. There were no statistically significant main effects of trait mindfulness nor Emotion x Mindfulness interactions (see Figure 2).

**Figure 2.** Results for the late positive potential (LPP) to picture onset. (A) Grand average waveforms showing the main effect of picture valence on LPP and (B) Valence x Mindfulness (FFMQ–NR) interaction for high and low self-reported trait mindfulness, (D) topographical distributions of the LPP, and (C) graphs depicting the mean amplitudes of the LPP across picture type for all participants and for high ($N = 27$) and low ($N = 24$) self-reported trait mindfulness separately. A median split was used to separate high and low self-reported trait mindfulness. The 95% CI refers to each individual condition mean.

Attention to startle probes (P3)
A one-way ANOVA showed no main effect of emotion, $F(2, 98) = 2.2, p = .112, \eta^2_p = .044$, and the expected arousal effect was not statistically significant, $F(1, 49) = .3, p = .594, \eta^2_p = .006$. Rather than pleasant and unpleasant pictures eliciting the smallest P3 amplitudes as predicted, a valence effect was found with the greatest P3 amplitudes for pleasant pictures, followed by neutral pictures, then unpleasant pictures. There was also a main effect of probe interval, $F(2, 98) = 5.8, p = .005, \eta^2_p = .105$. This provides a

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1 There was a trending main effect of trait mindfulness (FFMQ–NR) on LPP amplitudes, $F(2, 98) = 3.2, p = .078, \eta^2_p = .062$, and a trending Emotion x Mindfulness interaction, $F(2, 98) = 2.6, p = .083, \eta^2_p = .050$. 
manipulation check as it replicates previous reports that P3 increases with interval. A main effect of trait mindfulness (FFMQ–NR) on P3 amplitudes was also found, $F(2, 98) = 4.8, p = .033, \eta_p^2 = .089$, although no Emotion x Mindfulness interactions were statistically significant (see Figure 3). Bivariate correlations showed that trait mindfulness (FFMQ–NR) was negatively correlated with both pleasant, $r(51) = - .336, p = .016$, and unpleasant pictures, $r(51) = - .281, p = .046$.

**Discussion**

The purpose of the present study was to investigate the degree to which self-reported trait mindfulness is related to affective reactivity. To gain a comprehensive understanding of this relationship, I employed multiple measures of affective reactivity, including self-reported ratings of valence and arousal, skin conductance response, startle eyeblink response, motivated attention to pictures (LPP), and attention allocation to the startle probes (P3). Typical effects of picture valence and arousal across subjects were found for all dependent measures except for P3 amplitudes to startle probes. First, participants rated pleasant pictures as more positive than unpleasant pictures (with neutral pictures in between), and pleasant and unpleasant pictures as more arousing than neutral pictures. Second, startle eyeblinks were larger for unpleasant pictures versus pleasant pictures (with neutral pictures in between). Third, skin conductance responses were greater for pleasant and unpleasant pictures with respect to neutral pictures. Fourth, LPP amplitudes were greater for pleasant and unpleasant pictures versus neutral

Figure 3. Results for the P3 to startle probe onset during emotional and neutral pictures. (A) Grand average waveforms showing the main effect of picture valence on P3 and (B) Valence x Mindfulness (FFMQ–NR) interaction for high and low self-reported trait mindfulness, (D) topographical distributions of the P3, and (C) graphs depicting the mean amplitudes of the P3 across picture type for all participants and for high (N = 27) and low (N = 24) self-reported trait mindfulness separately. A median split was used to separate high and low self-reported trait mindfulness. The 95% CI refers to each individual condition mean.
pictures. Contrary to predictions, P3 amplitudes to emotional pictures were smaller than P3 amplitudes to neutral pictures. Taken together, most of the data replicate typical effects of valence and arousal on various measures of affective reactivity. Despite finding these typical effects of picture valence and arousal, self-reported trait mindfulness generally did not moderate these effects.

There are at least five potential explanations for these null findings. The first possible explanation is that our experimental manipulation was unsuccessful. This, however, is unlikely as I found statistically significant moderate to large effects of emotion in predicted directions for all dependent measures other than attention allocation to startle probes (i.e. P3 amplitudes). Participants rated their subjective valence to pleasant pictures as nearly 4 points higher than to unpleasant pictures (on a 9-point scale; 95% CI: 3.60 to 4.30 points), and their subjective arousal to emotional pictures as nearly 2 points higher than to neutral pictures (95% CI: 1.58 to 2.22 points). The difference between startle eyeblink responses to unpleasant pictures versus pleasant pictures was 20% (one-fifth) of a standard deviation (95% CI: 0.129 to 0.290 SD) and skin conductance responses to emotional pictures versus neutral pictures were also larger. LPP amplitudes to emotional versus neutral pictures were approximately 1 microvolt larger (95% CI: 0.77 to 1.46 µV). I had predicted that both pleasant and unpleasant pictures would capture attention and therefore result in smaller P3 amplitudes to the startle probes, but contrasting emotional versus neutral pictures resulted in only a one-tenth of a microvolt difference (95% CI: -0.46 to 1.00 µV). As such, strong conclusions cannot be drawn for this measure. In sum, these measures indicate successful manipulation and thus warrant further examination of the moderating effects of self-reported trait mindfulness.

For all successfully manipulated dependent measures, there were no statistically significant moderation effects of self-reported trait mindfulness and effect sizes of differences in trait mindfulness appeared negligible. Although trait mindfulness was used as a continuous variable in ANOVA analyses, to maximize power in detecting effects, a median split was used to dichotomize the scores. This procedure permitted computation of simple effect sizes for group differences, and these could be readily compared with the simple effect sizes of valence and arousal reported above. Individuals reporting higher trait mindfulness showed only a one-tenth of a point lower mean valence rating (95% CI: -0.85 to 0.58 points) than individuals reporting lower mindfulness, and a similar difference for arousal ratings for emotional versus neutral pictures ($M_{diff} = -0.12$ points, 95% CI: -0.76 to 0.53 points). Higher trait mindfulness versus lower trait mindfulness was also associated with a difference of only two-hundredths of a standard deviation for startle eyeblink responses to positive versus negative pictures (95% CI: -.147 to .179 SD). A similarly small effect was also found for LPP amplitudes ($M_{diff} = 0.10$ µV, 95% CI: -0.62 to 0.82 µV) and skin conductance response.

The second potential explanation is that the scales I employed to measure trait mindfulness were not successfully administered. This is possible as our sample was from a Swedish university and I used the English versions of the MAAS and FFMQ. I chose to use the English versions as they have been validated extensively and the alternative Swedish versions have not. In addition, the Swedish version of the FFMQ has 10 less items and a different factor structure than the English version (Lilja et al., 2011). To attempt to control for this confound, I recruited participants that were fluent
in both Swedish and English and provided the option to reply “I do not understand the question” if the language was unclear. Participants responded to 98% of the items on the FFMQ and 99% on the MAAS, so it does not seem likely that there were issues related to language deficits. It is important to note, however, that the missing items were not evenly distributed on the FFMQ. Of the missing items, 70% (21 out of 30 total) were from the nonreactivity subscale (5.9% missing total). This is also reflected in the lower reliability estimate for this subscale compared to the others (α = .77). The other subscales of interest on the FFMQ and the MAAS, however, did not have this problem (FFMQ–AWA: none missing, FFMQ–NJ: 1.5% missing, MAAS: <1% missing). Interestingly, even with better psychometric properties, the awareness and non-judging subscales on the FFMQ and the MAAS did not moderate any of the observed valence effects. This provides evidence that our measurement of self-reported trait mindfulness was generally successful and that these scores did not moderate affective reactivity to emotional pictures. With successful experimental manipulations and trait mindfulness measurement, the remaining potential explanations are that third, mindfulness in general is not strongly related to decreased affective reactivity, fourth that self-reported trait mindfulness is not sensitive enough to detect this relationship, or fifth, that trait mindfulness is conceptually flawed.

The third explanation does not seems likely, however, as numerous studies operationalizing mindfulness as a state or intervention have found a positive relationship between being mindful and decreased affective reactivity. As reviewed above, these studies showed that mindfulness was associated with decreases in self-reported ratings of emotional intensity (Arch & Craske, 2006; Ortner et al., 2007; Taylor et al., 2011) and skin conductance response (Ortner et al., 2007). Interestingly in the functional brain imaging study by Taylor et al. (2011), during the attend condition, which is similar to the present experimental design, there was no difference between experienced meditators and novices on ratings of emotional intensity. As such, assuming that experienced meditators should have higher trait mindfulness than novices, these findings do not support the idea that trait mindfulness is likely related to affective reactivity to emotional pictures. This is also in accordance with the findings comparing LPP amplitudes from meditators and non-meditators reviewed earlier (Gootjes et al., 2011; Sobolewski et al., 2011). So, whereas being mindful while viewing emotional stimuli or participating in a mindfulness intervention seems to decrease affective reactivity, it may be that trait mindfulness measured by self-report scales is not sensitive enough to detect these effects or that trait mindfulness as a construct is problematic.

Addressing the former possibility, there has been much debate about whether the MAAS and FFMQ are actually measuring mindfulness (Grossman & Van Dam, 2011). The MAAS, for example, consists of 15 items that are all reversed scored and each measures the perceived frequency of inattention or “mindlessness.” While the opposite of perceived inattention may be related to mindfulness, it clearly does not cover other aspects of mindfulness as it is generally operationalized, and recent item response theory analyses have supported this idea (Van Dam, Earlywine & Borders, 2010). The FFMQ suffers from the same problem as the MAAS on awareness subscale, and it has been found to be differentially interpreted by meditators and non-meditators (Van Dam, Earlywine & Danoff-Burg, 2009). In addition, it has been suggested that a certain level of mindfulness is required for people to report mindfulness accurately. If individuals are not aware of their inattention or reactivity, they are unlikely to report it accurately.
(Grossman & Van Dam, 2011). While many of these challenges are not unique to scales purportedly measuring mindfulness per se, they do beg the question of whether they are valid measurements of the construct.

Further, it has been suggested that the entire construct of trait mindfulness is invalid. Grossman & Van Dam (2011) cite Buddhist texts to suggest that mindfulness is better characterized as a state or process, rather than a trait. Desbordes et al. (2014) have also suggested moving beyond mindfulness to focus on the outcomes of mindfulness practice, such as the development of equanimity. The authors define equanimity as “...an even-minded mental state or dispositional tendency toward all experiences or objects, regardless of their affective valence… or source” (Desbordes et al., 2014, p. 2) and propose that this may be a more useful construct than trait mindfulness, as it is indeed a dispositional characteristic and may mediate the relationship between mindfulness and well-being. Further studies should investigate this hypothesis and compare measurements of equanimity and trait mindfulness in the same sample to understand their roles in the relationship between mindfulness and well-being. Future research should also investigate whether equanimity is related to decreased affective reactivity in similar experimental designs as the present study.

**Conclusion**

In summary, the present study employed a multi-method approach to understand the relationship between self-reported trait mindfulness and affective reactivity to emotional pictures, but found that trait mindfulness on the whole did not moderate the effects of picture emotion on dependent measures. Although our study did not show a positive relationship between mindfulness and decreased affective reactivity, it may be due to problems associated with operationalizing mindfulness as a self-reported trait. Future research should investigate this relationship further to determine the validity of self-reported trait mindfulness. Future research should also continue to study the relationship between mindfulness and emotional responding using multiple measures of affective reactivity and investigating both the state-like effects of mindful attention and trait-like quality of equanimity. Using comprehensive experimental paradigms such as the one employed in this study can provide a wealth of information about how different measures of affective reactivity are related and how individual differences in emotional responding are manifested. This information can in turn be used to tailor emotion regulation strategies to different individuals and populations to help promote adaptive emotional responding and improve well-being.

**References**


