Effects of Mindfulness Meditation on Emotional Reactivity and Self-Association with Emotional Stimuli

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1. Introduction

1.1 Self-Referential Processing

An integral part of human experience is the feeling of "self" – a sense of awareness of one's own being. Various philosophical and religious traditions have given different descriptions of the true nature of the self. One view claims the existence of an eternal, unchanging "soul" that is carried throughout one's life (Goetz & Taliferro 2011). Another view claims the existence of no inherent self – rather just a constant flux of impersonal psychological and physical processes that we mistakenly identify with (Ho 1995).

Behavioral scientists have defined various experiences of "self." One type of experience is characterized as relatively stable and continuous across time, and consists of a narrative of one's life with past experiences and future expectations being woven together into one cohesive framework. This is known as "narrative" self-reference (Farb 2007) or conceptual self-view (Goldin 2009). Another experience is characterized by moment-to-moment awareness of one's physical and mental states. Known as momentary self-reference (Farb 2007), one's attention is centered in the contents of present moment experience.

1.1.2 "Narrative" Self-Reference

Neuroscientists have found several regions mediating "narrative" self-reference experience – stringing disparate experiences together to create a coherent narrative - located in the cortical midline structures in the frontal medial area of the cortex (Northoff 2006). These regions, specifically the ventral and dorsal medial prefrontal cortices (mPFC) and a region spanning from the posterior cingulate cortex to the precuneus (Goldin 2009) are considered responsible for this type of self-view

Positive and negative consequences have been identified in association with adopting a "narrative" mode of self-reference. Positives include higher-order executive functions responsible for the sophisticated cognition of the human species, as well as complex social cognitive functions such as mentalizing (Farb 2007) and forming theories of minds. However, it has been argued that narrative self-view contributes to negative emotional reactivity and deficits in the cognitive regulation of emotion (Goldin 2009).

Another negative consequence of a "narrative" mode of self-reference concerns the default-mode network (DMN). This is a network of brain regions that is active when we are awake but not focused on a specific task. A default-mode of brain activity is correlated with mind-wandering (Brewer 2011) and lower levels of happiness (Killingsworth & Gilbert 2010). Interestingly, cortical regions implicated in the DMN overlap with CMS structures associated with "narrative" self-referential processing, including the medial prefrontal and posterior cingulate cortices (Brewer 2011). One could speculate that adopting a narrative view of self is a default tendency of the brain and mind.

1.1.3 "Moment-to-moment" self-reference

Momentary self-reference is characterized by present-moment awareness of thoughts and bodily sensations. Rather than connecting temporally disparate events, this type of self-awareness consists of keeping a conscious perception of each moment as it arises and passes. The neural correlates of this self-referential mode are a right lateralized network including the lateral prefrontal cortex, insula, secondary somatosensory cortex, and inferior parietal lobule (Farb 2007). In addition, a study by Farb 2007 looking at the neural correlates of this type of self-awareness found task-related suppression of midline cortical representations, very similar to those supporting the default-mode network and "narrative" self-focus.

1.1.4 Measuring SRP

Self-referential processing is difficult to measure since it is subjective. There a number of domains through which SRP can be measured indirectly. A study conducted by Goldin et al. in 2009 looked at self-referential processing in the verbal domain for individuals diagnosed with Social Anxiety Disorder. Before and after MBSR (mindfulness-based stress reduction) training, individuals were given trait adjectives and asked to rate how much these described themselves. Results showed that after MBSR, less negative trait adjectives and more positive trait adjectives were self-endorsed. However, the authors of this study stated a more ecologically valid method of measuring self-referential processing is needed.

Another domain in which SRP can be measured is the emotional domain. A fMRI study conducted by Phan et al. in 2004 involved participants being presented a sequence of emotional pictures from the International Affective Picture System (IAPS) and asked to

make two judgments: 1) how unpleasant or pleasant each picture makes them feel and 2) the extent to which they relate or associate themselves with each picture. The goal was to determine the brain areas active when making judgments of valence and self-association. The authors found that activity in the CMS (vmPFC, posterior anterior cingulate cortex, and dmPFC) varied directly with the extent of self-association towards the pictures. Interestingly, the authors found that regions active during emotional valence ratings were mostly distinct from regions active during self-association ratings. Emotions are considered integral to the experience of the self; this finding suggests that emotions can exist independently without a "self" associating with the emotion.

Asking participants to make self-referential judgments on emotional pictures can be argued to be more ecologically valid than making judgments on words. Viewing a picture is analogous to having an experience (which can vary with current emotional state), while reading a word activates a specific semantic meaning that has been pre-encoded.

1.2 Mindfulness Meditation

Mindfulness meditation is a technique aimed at developing present moment awareness and non-reactivity to all types of experience. There are a variety of different forms of mindfulness teachings (Vipassana, Zen, MBSR, etc.), however all techniques share the common goal of cultivating present-moment, non-judgmental awareness and non-reactivity. This is accomplished by learning to concentrate one's attention in the present-moment using some type of object (usually by focusing on the natural breath), and then to switch one's attention to thoughts and body sensations and learn to not react. Overall, mindfulness techniques increase awareness and decrease reactivity.

Mindfulness practices are predicted to cause a shift in the experience of self of individuals – moving from a "narrative" experience and into one centered into the present moment. Examining the neural, physiological, and behavioral effects of this training could provide a window into the repercussions of adopting various modes of self-view.

1.2.1 Mindfulness-Based Stress Reduction (MBSR)

Mindfulness-based stress reduction (MBSR) is a program incorporating mindfulness meditation to increase physical and emotional well-being, and is offered in many health

clinics throughout the world (Kabat-Zinn 1990). MBSR is offered in an 8-week course format, with progressive instructions given on each class. Instructions are given on various types of mindfulness meditation, including focused attention to an object of concentration and open awareness to the contents of one's experience. MBSR enrollees are instructed to practice the techniques they learn at home daily. In addition, there is a one-day silent retreat led by the class teacher that occurs towards the end of the course.

1.3 Present Study

This study aims to elucidate some of the repercussions of a shift in experience of "I". In addition, the purpose of this study is to validate potential beneficial effects of mindfulness meditation. The specific mindfulness practice targeted in this study is MBSR.

There are three main questions asked in this study. The first is how mindfulness meditation, specifically MBSR, affects emotional reactivity to a variety of experiences ranging from pleasant to unpleasant. This will be assessed by presenting meditators with emotional pictures from the International Affective Picture System and asking them to rate how unpleasant or pleasant the picture makes them feel on a Likert scale from 1-100. Participants will complete this task before and after an 8-week MBSR course.

It is hypothesized that after the course, participants will rate the pictures less strongly (both positive and negative), and increasingly neutral. The mindfulness program teaches participants to attempt to maintain non-judgmental awareness of the present moment. Participants are trained to maintain equanimity to a variety of experiences. This may manifest as less strongly valenced emotional reactions after the course than before the course. In addition, it is hypothesized that after the course, participants will have increasingly positive ratings given the emotional content of the pictures. MBSR increases positive outlook; this would manifest as increased ratings after the course.

In a study conducted by Phan and colleagues in 2004, normal individuals were given a similar task under fMRI. They found that activity in the amygdala was associated with judgments of emotional valence, with more activity found for more strongly valenced reactions (both positive and negative). However, they speculated that this activity could be modulated by top-down influences through conscious processing of stimuli. Thus, MBSR

may teach participants indirect techniques to access this top-down control of emotional reactivity mediated by the amygdala by consciously being aware, yet non-reactive.

The second question explored in this study is how mindfulness training changes self-association with emotional experiences. This will be assessed by presenting MBSR participants with IAPS emotional pictures and asking them to rate how much they relate or associate with the picture. This same question was posed to participants in the Phan 2004a study (although the participants in that experiment were not meditators). The researchers found that cortical midline structures implicated in "narrative" self processing had activation proportional to the amount of self-association perceived; the more self-relevance the picture had for the participant, the more activation was found in these regions.

MBSR training has been shown to shift self-referential processing. A study by Farb et al. in 2007 compared brain activity of novices and MBSR-trained individuals when engaging in different modes of self-focus – either a "narrative" (NF) or "momentary" (EF) self-concept. The researchers found the novices had a reduction in CMS activity when engaging in EF, but that MBSR-trained individuals had significantly greater reduction in these regions. Goldin and colleagues also found a reduction in CMS activity implicated in conceptual self-view after MBSR training, suggesting a shift from narrative self-referential processing to a more experiential, visceral mode. In the Farb et al. 2007 study, certain right lateralized regions associated with "momentary" self-reference were activated in MBSR-trained but not novice participants (engaging in EF) (right lateralized prefrontal cortical structures, insular cortex, secondary somatosensory area, angular gyrus, and posterior viscerosomatic representations).

Since MBSR training has been shown to reduce activity in cortical midline structures implicated in "narrative" self-view, it is predicted that after the 8-week course, subjects will rate less self-association with the pictures than before.

The main question explored in this study is to what extent changes in self-association with emotional experiences are correlated with changes in emotional reactivity. The hypothesis is that the mechanism of control over strong emotional reactions is a reduction in self-association with these experiences. A reduction in self-association potentially caused by MBSR training may allow participants to gain a more objective, detached perspective of the emotional pictures, thus causing an attenuated reaction.

Previous studies indicate that mindfulness training may shift functional connectivity between key brain networks to allow for a self-detached perspective on events. In the Farb study, novices were found to have functional connectivity between the right insula and cortical midline structures, suggesting that by default, viscerosomatic signals are associated with activation in the vmPFC. One could speculate that this connection is the substance of the narrative sense of self; responsible for disparate viscerosomatic signals being woven together into a cohesive framework. Interestingly, in MBSR-trained participants, no connectivity was found between these regions. Rather, functional connectivity occurred between the right insula and right lateralized dorsolateral prefrontal cortices. This provides evidence for a shift in self-referential processing that occurs after MBSR training. Farb et al. speculate that MBSR may afford greater access to distinct modes of self-focus by a shifting viewing viscerosomatic activity thru the "lens" of the mPFC to viewing this activity through the lateral prefrontal cortices. The insula – lateral prefrontal cortex connection may correlate to a self-detached and objective analysis of sensory events (rather than one that is incorporates these events into a created sense of self), a non-linguistic based awareness of the psychological present, and inhibiting the default tendency towards narrative self-reference (Farb 2007**)**. Increased activity in the right insula, secondary somatosensory cortex, and inferior parietal lobule in MBSR-trained individuals may reflect the contents of present-focused awareness. The authors speculate that mindfulness training allows for thoughts, feelings, and sensations to not be viewed as good, bad, or integral to the self (vmPFC), but as transient mental events that can simply be observed. A shift in self-referential processing accompanied by mindfulness training may be the mechanism for non-reactivity.

If the hypothesis is shown to be true, it will yield interesting implications. Many individuals seek control over emotions; and keeping the balance of one's mind is key for productivity and efficiency in the modern world. Discovering that the mechanism for this control is reducing self-association with experiences will highlight a fundamental way to control emotional reactivity, and may lead to increased interest in mindfulness meditation for practical benefits.

2. Methods

2.1 Participants

Participants included 12 (11 female) MBSR enrollees and 10 UCSD undergraduates (6 females) as controls**.** Upon further screening, 6 MBSR participants were dropped as well as 1 control subject, resulting in 6 MBSR (6 female) participants and 9 control subjects (6 female). The reasons for screening are discussed below. All participants provided informed consent to act as an adult research subject in accordance with an approved University of California, San Diego Human Research Protections Program consent form.

2.2 Recruiting Procedure

2.2.1 MBSR Participants

MBSR participants were drawn from the UCSD Center for Mindfulness, which conducts 8-week MBSR courses approximately every 3 months. Five 8-week courses started in mid-March 2014 and ran thru early May 2014. Participants in this study came from four of the five courses (two from the March 11th – April 29th course (course #1), one from the March 18th – May 6th course (course #2), two from the March 19th – May 7th course (course #3), and seven from the March 20th – May 8th course (course #4)).

Enrolled participants were emailed at the beginning of March 2014 and then again on March 10th, 2014 asking if they would be interested in participating in research. Interested participants were followed-up with by the primary researcher to set up an appointment to conduct the experiment. Through email, 5 participants were recruited (two from course #1 and three from course #4). The primary researcher in person recruited an additional 7 participants on the first day of the MBSR courses (one from course #2, two from course #3, and four from course #4).

Each of the MBSR participants was run twice, once before the start of the course (pre-test) and once after the course concluded (post-test). However, only pre-tests for the 5 email recruited participants were run at least a day before the course started. For the 7 participants recruited in person, 1 of the pre-tests was conducted immediately preceding

the first class, 5 were conducted immediately following the first class, and 1 was conducted the day after the first class. All 12 post-tests were conducted after the courses concluded; 6 immediately after the last class (the same 6 that had the pre-test immediately preceding/following the first class) and 6 a day or more after the last class.

Subsequent data analysis revealed that there was a significant difference in pre-test scores between participants completing the task before and after the 1st class. Namely, the 6 participants who took the pre-test after their 1st class already showed effects of training which skewed the pre to post-MBSR results. As a result, these 6 were dropped leaving 6 subjects who truly took the pre-test prior to the MBSR course.

All participants were new to MBSR. For compensation for participating in research, $10-$20 was given as well as a $50 discount towards the next course taken at the UCSD Center for Mindfulness (courtesy of the center program director).

2.2.2 Controls

Controls were recruited from the UCSD undergraduate student body. The pre- and post-tests for the control group were separated by 8 weeks, exactly the amount of the time that pre- and post- tests were separated for the MBSR group. Controls were not practicing sanctioned mindfulness meditation techniques during the 8-week period. One control subject was dropped due to intoxicant-induced differences in mental state while taking the pre- and post-test. For compensation for participating in research, $10-$20 or SONA credit was given after the post-test.

2.3 Task

Before and after an 8-week MBSR course, participants viewed one of two sets of 30 IAPS (International Affective Picture System) emotional pictures. For each picture, participants were asked to make two ratings on a Likert scale from 1 to 100: 1) How does this picture make you feel? (1 = very unpleasant, 25 = somewhat unpleasant, 50 = neutral, 75 = somewhat pleasant, and 100 = very pleasant) and 2) How much do you associate with or relate to this picture? (1 = not at all, 50 = somewhat, 100 = a lot). Each set of pictures had a widely distributed sample of valence. Participants viewed different sets before and

after the 8-week course (in the case of controls, before and after the 8-week period), so as to reduce any effect familiarity with the pictures may have on self-association. During the task, subjects viewed rated the pictures at their own pace, with no specified time limit for rating each pictures.

The procedure to create the picture sets was as follows. The IAPS pictures were ordered from lowest to highest mean valence rating using an excel spreadsheet (the mean valence value for each picture was determined based on ratings of the pictures over a 13-year span (Lang 2005)). All pictures were chosen with an arousal rating below 6; pictures above this value were considered too gruesome (especially for the negatively valenced pictures). The range of valence values that the pictures were selected from was from a rating of 1.78 (lowest) to 7.87 (highest) on a scale from 1 – 9. This range value was divided equally into 30 intervals. Two pictures were chosen from each interval of similar themes (nature, snakes, food, etc.); one was put in the first slide set and the other was put in the second slide set. The similarly themed pictures in both slide sets were in the same order so as to minimize the effect of the sequence of pictures shown influencing emotional state. The mean ratings for each picture were converted from a 1-9 scale to a 1-100 scale. Participants that viewed one slide set in the pre session viewed the other slide set in the post session, so that the familiarity of the pictures will not influence their judgments.

2.4 Data Collection

Subjects recorded the two judgments (valence and self-association) for each of the 30 pictures on a sheet of paper provided. Ratings were subsequently entered systematically into an excel spreadsheet, from which further analysis was conducted.

2.5 Data Analysis

2.5.1 Valence

This study looked at whether MBSR training led to less extremely valenced reactions (both positive and negative). In the data recorded, this manifests as less judgments towards 1 and 100, and more towards 50. As such, the valence scores between 1 and 100 for each participant were converted to an emotional intensity scale (scale of 1-

50) by taking the raw valence each participant recorded, subtracting 50, and taking the absolute value. Thus, raw scores of both 1 (extremely negative) and 100 (extremely positive) were both 50 on the new scale (most emotionally reactive), while a raw score of 50 equaled 0 on the new scale (least emotionally reactive).

The emotional intensity scores were made more ecologically valid by taking the standardized IAPS mean intensity (formed through ratings of the pictures over a 13 year span) of each picture into account. For each judgment, the emotional intensity was divided by the square root of the standardized IAPS emotional intensity of the picture the judgment was made on. The emotional intensity of the IAPS picture was found by taking the raw mean provided in the picture package (between 1-100), subtracting 50, and taking the absolute value. The formula for normalized emotional intensity is as follows for each picture:

$$ABS(Raw\ Score - 50)/(\sqrt{ABS(Raw\ IAPS\ Mean - 50)} + 1)$$

The numerator is the intensity of each score given by a participant for each picture, and the denominator is a normalization factor consisting of the standardized intensity of the IAPS picture. The + 1 in the denominator was to ensure that the denominator did not equal 0. This formula was applied to each valence rating a subject made (6 MBSR x 30 pictures + 9 control x 30 pictures). A graph giving a conceptual understanding of how the pictures were transformed is shown below:

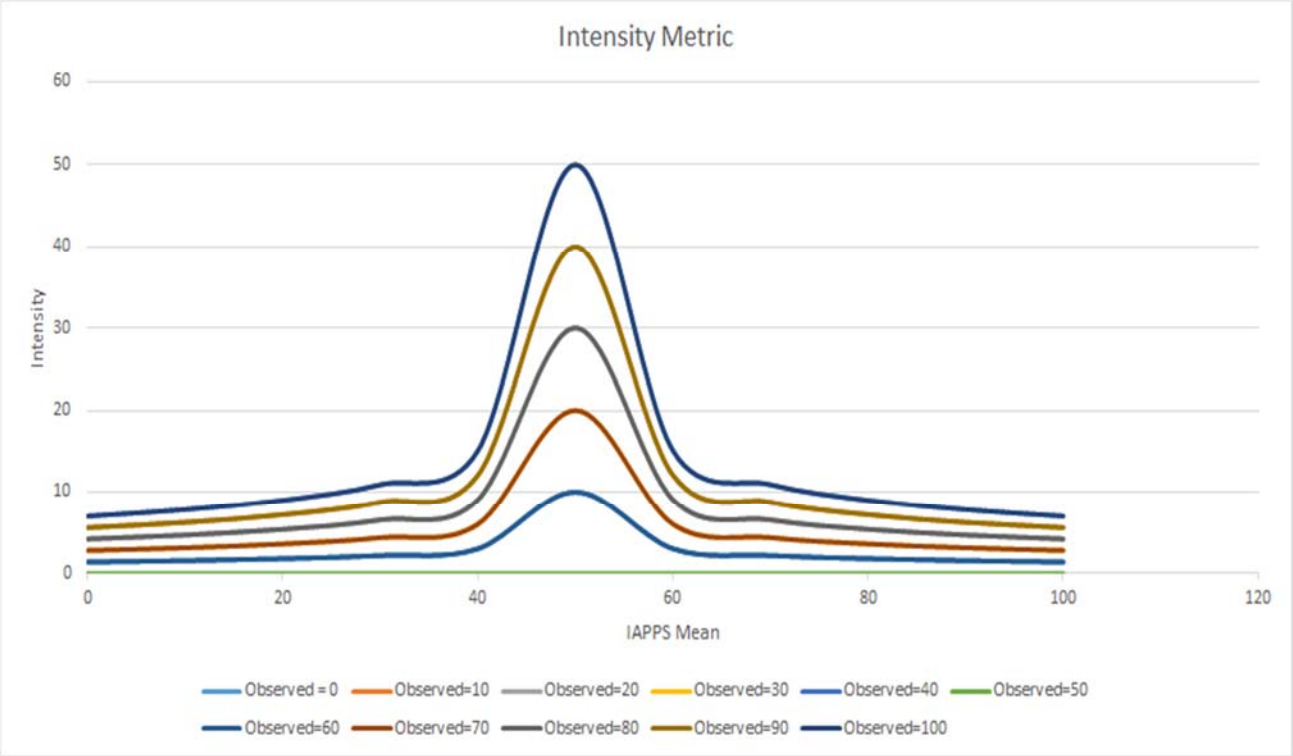

Figure 1: Normalized Emotional Intensity Metric

This makes each rating of valence more ecologically valid because it gives weight to a valence judgment based on the situation in which that judgment was made. For example, if a subject judged a picture that had an IAPS mean near 50 (relatively neutral picture) as extremely emotionally intense (either 1 – negative or 100 – positive), then this would be a very intense reaction based on the relatively neutral situation (the lumps in the middle). However, if a subject gave had a strong emotional reaction of an IAPS picture that was already intense, this would be normalized as much less intense (the ends of the curves). Neutral reactions to intense IAPS pictures are rewarded the most under this scale. With the new scale, two equal raw ratings given by a subject are not necessarily equal in intensity; it depends on the situation the rating was made under. This eliminates the confounding factor of participants habitually putting numbers down because they are trying to finish the questionnaire as quickly as possible. It also determines how neutral subjects are *based on the situation*, not just overall. Thus, the normalized emotional intensity rewards awareness to the situation yet neutrality based on that situation. It eliminates overall neutrality (a subject habitually putting 50) that may be due to wanting to get the test over with or a dull, inattentive mood.

The 30 normalized emotional intensity scores (corresponding to 30 pictures) for each subject were averaged. This resulted in 6 average normalized emotional intensity scores for MBSR participants before and after, and 9 such scores for control subjects before and after. The corresponding before and after scores were compared for significant shifts using a paired, one-tailed t-test in both the MBSR and control group.

This study also seeked to determine whether MBSR led to increased positive reactivity given a situation after an 8-week course. To determine this, a similar procedure of normalization was carried out using the following equation:

$$Raw\ score/\sqrt{Raw\ IAPS\ mean}$$

The resulting product can be considered the "total" valence in that it acknowledges differences along the positive/negative scale (unlike the intensity). A conceptual understanding of the normalization of total valence is provided in the metric below:

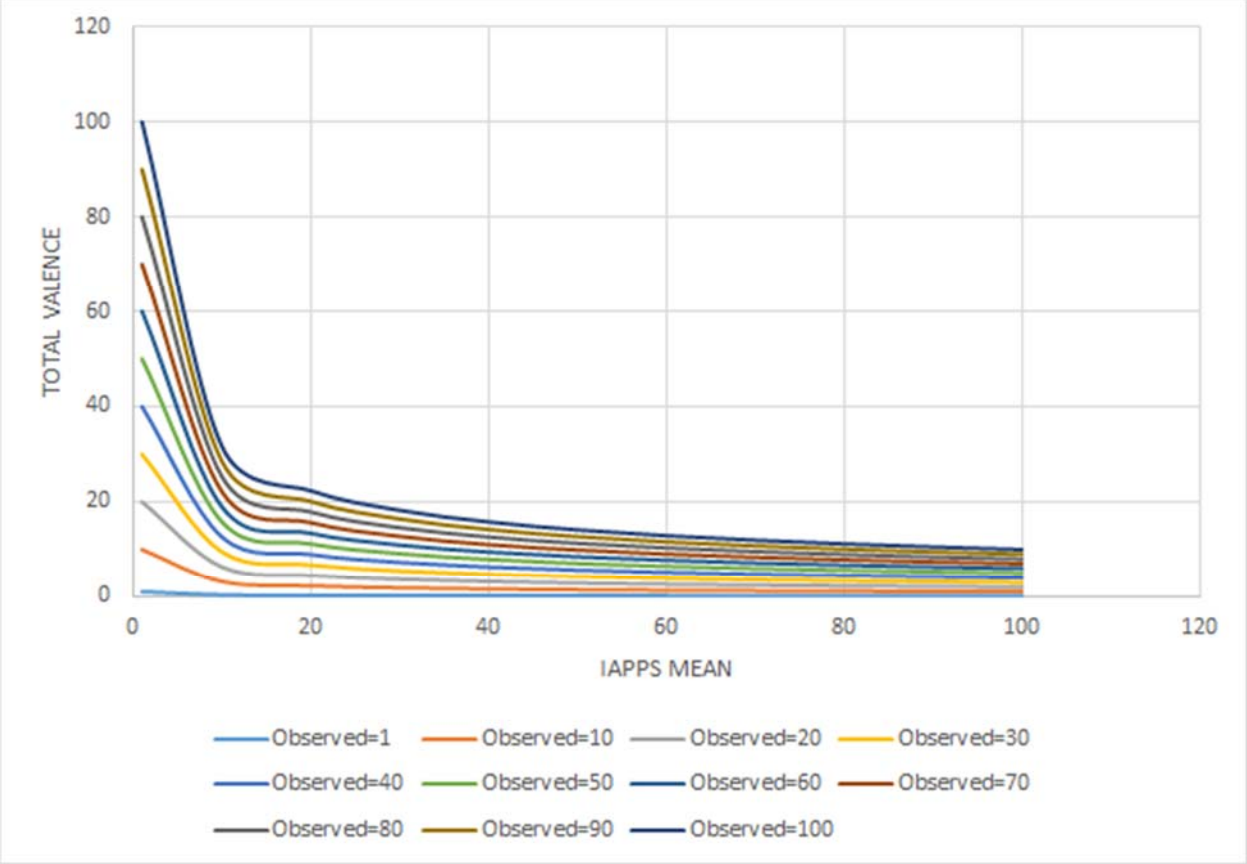

Figure 2: Normalized Total Valence Metric

Again, this transformation makes each judgment of total valence more ecologically valid. Positive reactions to negative situations are given more weight than positive or negative reactions to positive pictures. This is congruent with societal expectations – maintaining positivity in the face of negativity is highly cherished in most cultures, while being exceedingly positive in an already positive situation is less strongly valued. This normalization eliminated the possibility seemingly significant changes in total valence being due to positivity with disregard for the situation at hand. It rewards positivity that is realistic.

2.5.2 Self-Association

The self-association scores were averaged for each subject in their raw form (scale of 1-100), and compared before and after using a paired, one-tailed t-test for both the MBSR and control groups.

2.5.3 Relationship Between Emotional Reactivity and Self-Association

To test the hypothesis of whether there was a relationship between intensity of emotional reaction and self-association with experiences, the correlation coefficient was calculated for each participant. This was calculated using Excel, by pitting the 30 normalized emotional intensity ratings against the 30 self-association ratings made by each participant for each of the 30 pictures before and after the 8-week gap. The correlation coefficients were averaged across participants, giving one value before and one value after, which were compared for both the MBSR and control groups.

The same procedure was conducted to determine whether there was a relationship between total valence of emotional reaction and self-association with the experience.

3. Results

3.1 Emotional Reactivity

Comparing MBSR normalized emotional intensity ratings before and after the course, a significant decrease in intensity of reactions based on the situation (at about 90% confidence) was found.

Table 1: MBSR Intensity

T Test: Two Paired Samples

SUMMARY			Alpha	0.101		Hyp Mean Diff	0	
Groups	*Count*	*Mean*	*Std Dev*	*Std Err*	*t*	*df*	*Cohen d*	*Effect r*
Pre	6	6.705319188	1.02575202					
Post	6	5.820998637	2.034123413					
Difference	6	0.884320552	1.474616224	0.602009553	1.468947707	5	0.656933385	0.549055609

T TEST

	p-value	*t-crit*	*lower*	*upper*	*sig*
One Tail	0.100893676	1.468126392			yes
Two Tail	0.201787351	2.007251683	-0.324064136	2.092705239	no

Comparing normalized emotional intensity reactions before and after 8 weeks for controls, there was not a significant change in intensity of reactions before and after, even at 80% confidence.

Table 2: Control Intensity

T Test: Two Paired Samples

SUMMARY			Alpha	0.2		Hyp Mean Diff	0	
Groups	*Count*	*Mean*	*Std Dev*	*Std Err*	*t*	*df*	*Cohen d*	*Effect r*
Pre	9	6.198764184	1.61949389					
Post	9	5.69106084	2.051995462					
Difference	9	0.507703344	2.040043718	0.680014573	0.746606565	8	0.263965283	0.255223316

T TEST

	p-value	*t-crit*	*lower*	*upper*	*sig*
One Tail	0.238333414	0.888889518			no
Two Tail	0.476666827	1.39681531	-0.442151421	1.45755811	no

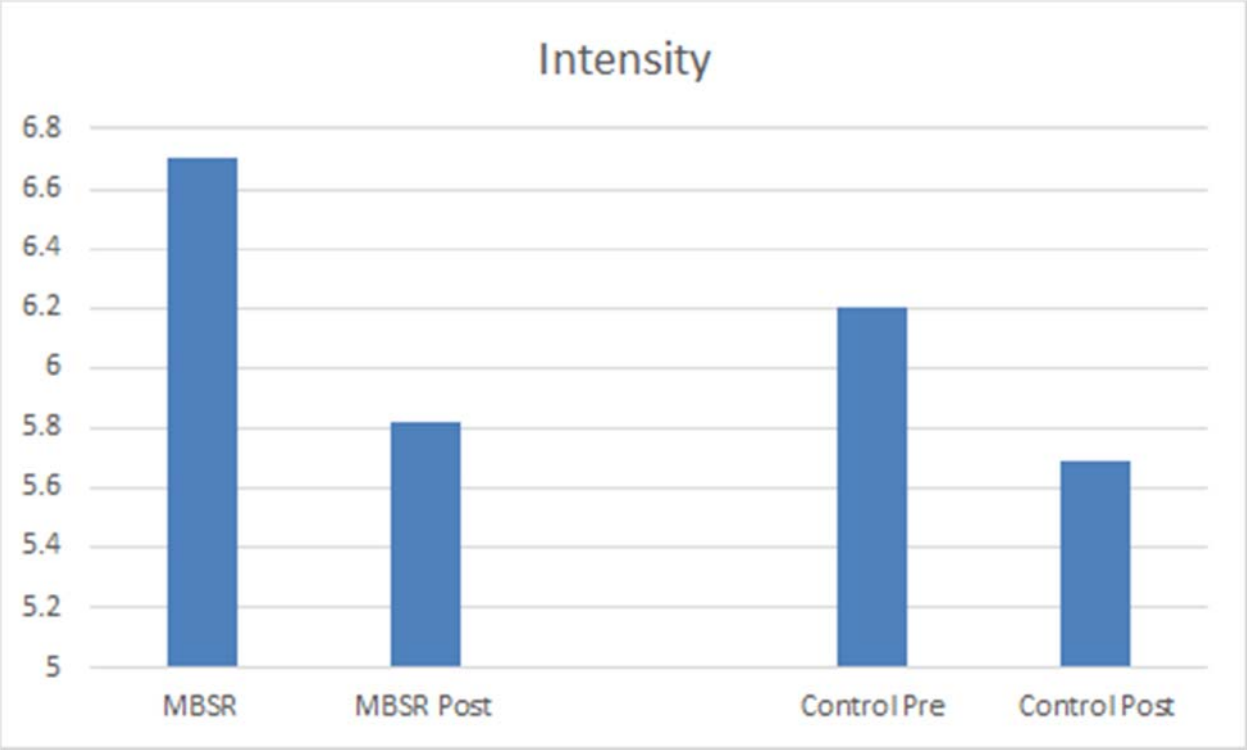

Figure 3: Pre- to Post- Emotional Intensity

The total valence for MBSR participants went up significantly (using an 83% confidence interval) after the course, while for controls this went down.

Table 3: MBSR Total Valence

T Test: Two Paired Samples

SUMMARY			Alpha	0.17		Hyp Mean Diff	0	
Groups	*Count*	*Mean*	*Std Dev*	*Std Err*	*t*	*df*	*Cohen d*	*Effect r*
Pre	6	5.713040285	0.413268412					
Post	6	6.20081264	1.157011129					
Difference	6	-0.487772355	1.120104781	0.457280862	-1.066680011	5	0.477033803	0.43055394

T TEST

	p-value	*t-crit*	*lower*	*upper*	*sig*
One Tail	0.167444927	1.054309099			yes
Two Tail	0.334889854	1.602257993	-1.220454271	0.244909561	no

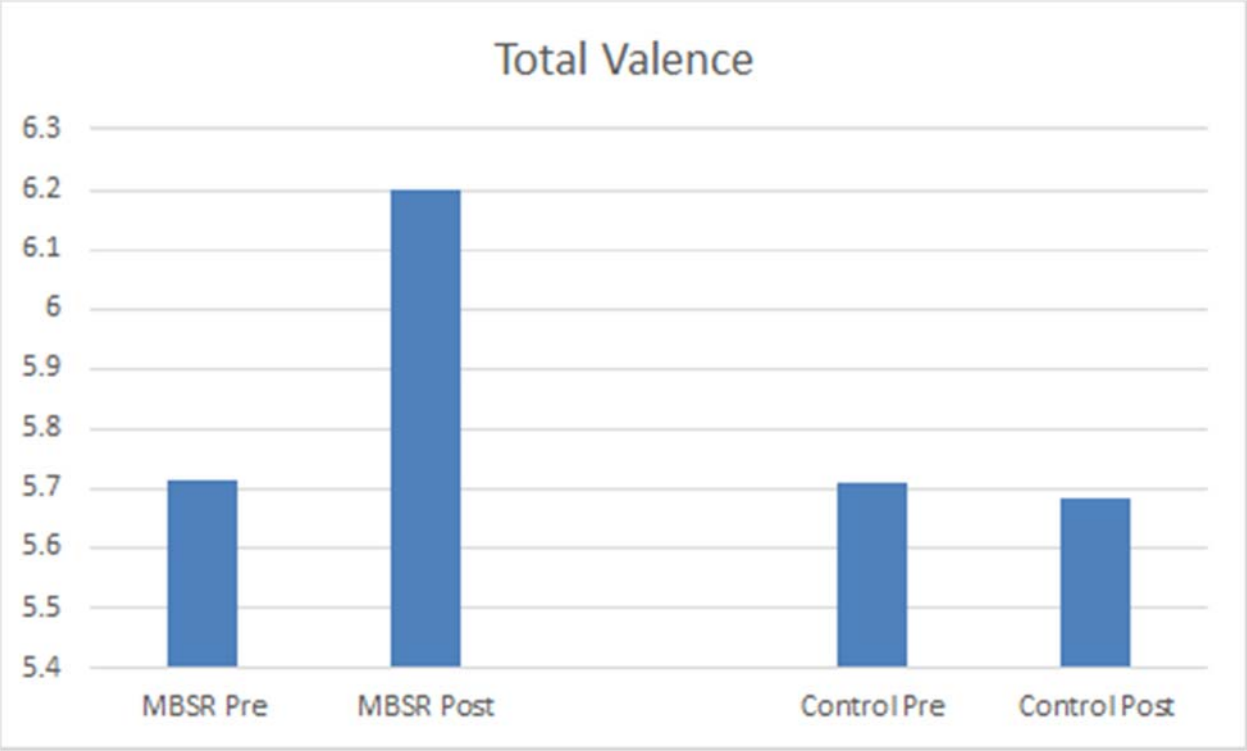

Figure 4: Pre- to Post- Total Valence Ratings

3.2 Self-Association

For the MBSR group, there was a significant *increase* in self-association with an 85% confidence interval.

Table 4: MBSR Association

T Test: Two Paired Samples

SUMMARY			Alpha	0.15		Hyp Mean Diff	0	
Groups	*Count*	*Mean*	*Std Dev*	*Std Err*	*t*	*df*	*Cohen d*	*Effect r*
Pre	6	42.93333335	14.11841979					
Post	6	47.72222222	5.991203419					

Difference	6	-4.788888872	9.964819582	4.068120559	-1.177174767	5	0.52644856	0.46583843

T TEST

	p-value	*t-crit*	*lower*	*upper*	*sig*
One Tail	0.146052625	1.155767343			yes

For the control group, there was a significant *increase* in self-association using an 80% confidence interval.

Table 5: Control Association

T Test: Two Paired Samples

SUMMARY				Alpha	0.2		Hyp Mean Diff	0
Groups	*Count*	*Mean*	*Std Dev*	*Std Err*	*t*	*df*	*Cohen d*	*Effect r*
Pre	9	40.44074072	13.1673183					
Post	9	42.23703702	10.85613554					
Difference	9	-1.7962963	5.639184425	1.879728142	-0.955614942	8	0.337860903	0.320085579

T TEST

	p-value	*t-crit*	*lower*	*upper*	*sig*
One Tail	0.183623992	0.888889518			yes
Two Tail	0.367247984	1.39681531	-4.421929347	0.829336747	no

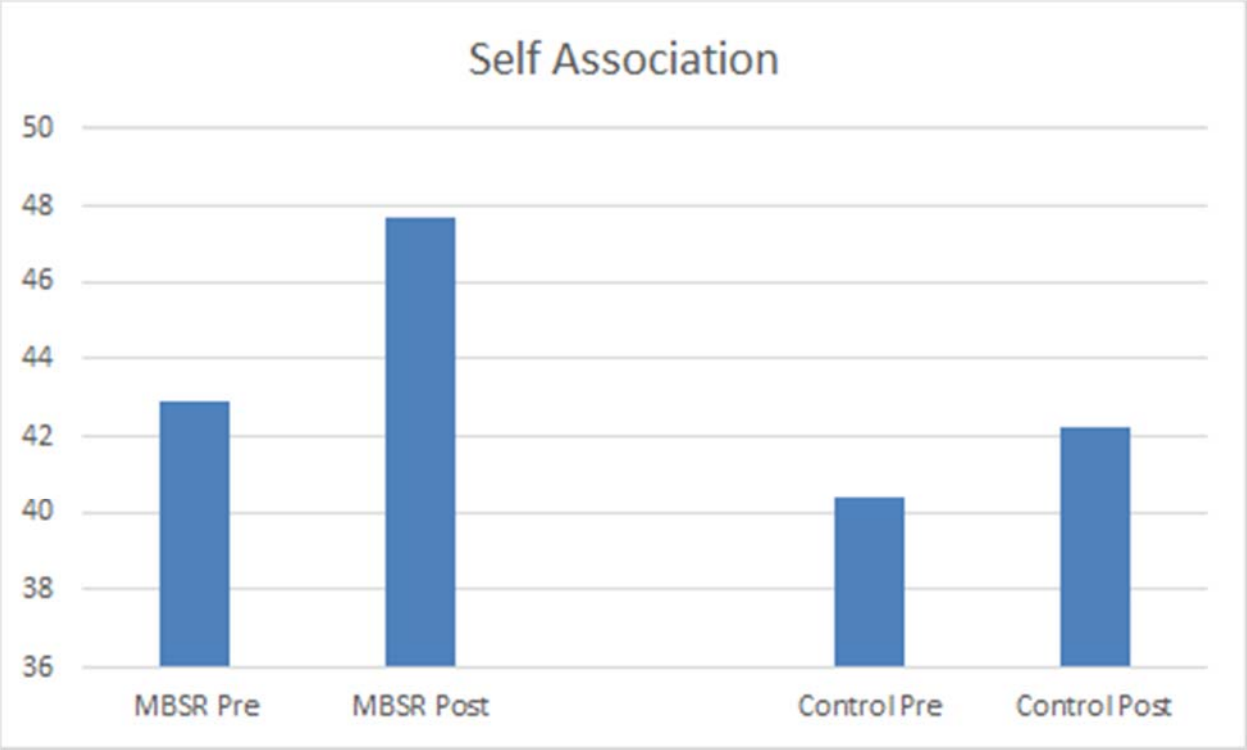

Figure 5: Pre- to Post- Self-Association

3.3 Relationship between Emotional Reactivity and Self-Association

For the MBSR group, the correlation constant between self-association and intensity of emotional reaction averaged across subjects was 0.1968. After MBSR, the correlation constant between these two measures increased to 0.2434.

For the control group, the correlation constant between the two measures was 0.0963. After 8 weeks, the correlation constant between the two ratings went down to 0.0162.

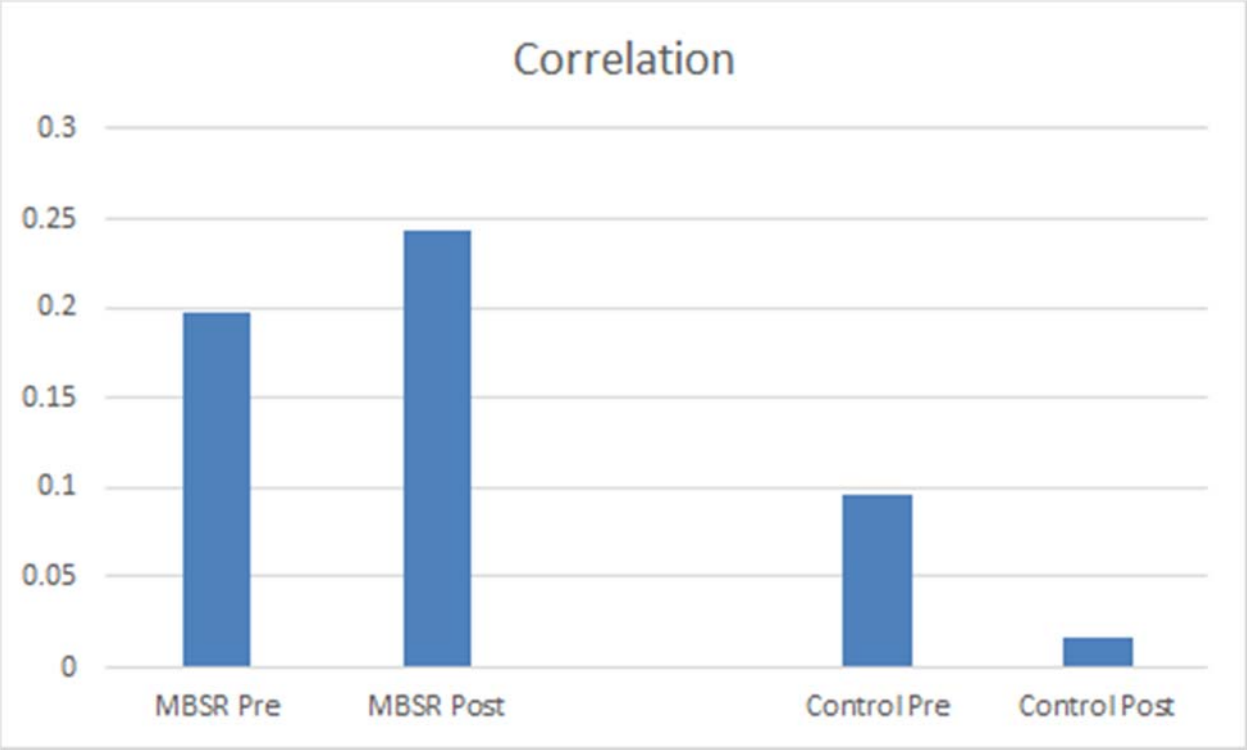

Figure 6: Pre- to Post- Correlation between Emotional Intensity and Self-Association

With regards to total valence, the correlation constant between raw valence rating and self-association for MBSR subjects increased from 0.3388 to 0.4501, a significant increase using an ~85% confidence interval. For controls the correlation constant before and after the 8-week gap decreased.

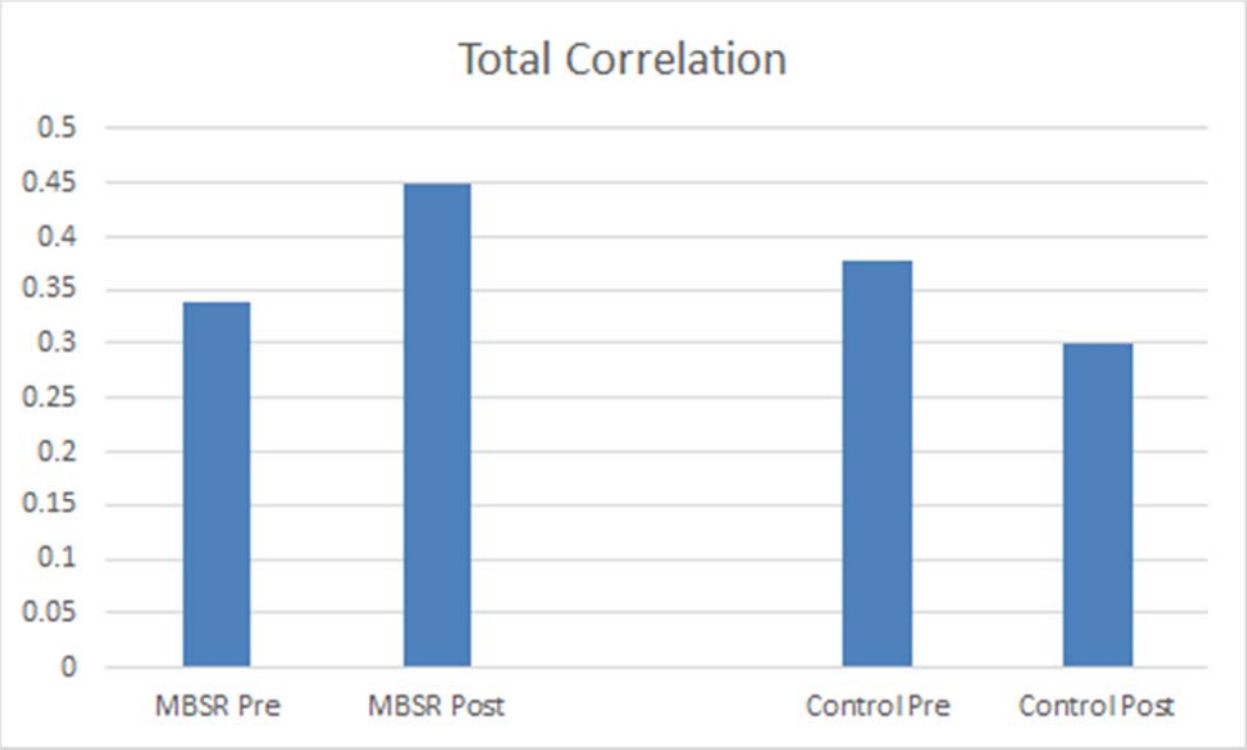

Figure 7: Pre- to Post- Correlation between Total Valence and Self-Association

4. Discussion

The very purpose of meditation is to discipline the mind and reduce afflictive emotions.

-- Tenzin Gyatso, the 14th Dalai Lama

This study aimed to elucidate repercussions in a shift in the experience of "I" on emotional reactivity. In addition this study aimed to reveal concrete benefits of mindfulness meditation practice, specifically MBSR.

The first question addressed in this study is how mindfulness meditation affected emotional reactivity to a variety of pictures ranging from unpleasant to pleasant. Results indicate that after MBSR training, participants gave significantly (90% confidence) less emotionally intense evaluations (both positive and negative) to pictures, taking into account the inherent emotional valence of the picture. The control group did not show nearly as significant (less than 80% confidence) a decrease in emotional intensity after 8

weeks of non-meditation activity (or at the very least, not structured meditation as in the MBSR group). In addition, MBSR participants had significantly (83% confidence) more positive emotional reactions given the inherent emotional quality of the picture, while the control group decreased in this regard. Thus, one can draw the conclusion that mindfulness training, specifically MBSR, leads to less emotional reactivity and increased positive reactivity based on the situation.

The finding that MBSR participants showed decreased intensity of reaction and increased positivity based on the situation reveals a concrete benefit of meditation practice. Keeping the balance of one's mind, maintaining a positive outlook, and not getting overwhelmed by emotions is an essential skill in being optimally productive in today's fast-paced world. This is not to say that mindfulness dulls emotional life altogether, that they were more neutral and unaffected overall, or that they were blindly positive without being aware of the situation at hand. Rather, this study indicated that given a negative or positive situation, participants who went through MBSR training reacted less strongly and more positively *based on the situation* than they did before. One could conclude that this shows that they were aware of the intense feeling elicited by the pictures, but did not let that feeling overwhelm them and instead kept a balanced, positive mind as best as possible. Increasing awareness of feelings yet maintaining non-reactivity is a key aspect of mindfulness training; this data provides evidence to back up the efficacy of that effort.

One can speculate as to what might be occurring in the brains of MBSR participants that manifests itself as less emotional intensity. Phan 2004a found that the amygdala responds more strongly to increasing intensity of a stimulus, regardless of valence. However, the authors stated that activity in the amygdala could be modulated via top-down control. Assuming that activity in the amygdala corresponded to ratings of emotional intensity in this study (which is a plausible assumption since Phan 2004a used the same task), the cause of attenuated intensity in the post-MBSR group may have been mindfulness cognitive regulation strategy of being aware, but not reactive of emotional experiences. This is one theory of why MBSR participants showed less intense emotional reactions to a given situation after their course.

The second question posed in this study is to what extent self-association with the pictures changed after the MBSR course. The prediction was that self-association would go

down for MBSR participants since brain areas mediating high self-association ratings have been shown to have less activity with MBSR training. Surprisingly, the results turned out counter to that. MBSR participants seemed to have *higher* self-association with the pictures after the 8-week course, albeit at an 85% confidence interval. This is most likely not an effect of MBSR, as the control group also showed an increase in self-association after the 8-week interval.

One explanation for this phenomenon is that participants became more familiar with the pictures the second time they did the task. Even though they viewed different sets of pictures each time, the sets had similar sequences, similar subject matters, and similar standardized valence ratings. The first time participants completed the task, they may have subconsciously stored the memories of the picture and partially incorporated it into their self-schema, since they are somewhat emotionally evocative. Then, the second time around, participants may have felt they associated more because they had a vague familiarity with the picture.

The question arises as to why MBSR participants did not have less self-association since MBSR training has been shown to decrease activity in cortical midline structures and shift modes of self-referential processing. As stated in the introduction, self-referential processing is tricky to measure. Viewing the pictures may have had nothing to do with their experience of self. Indeed, even if they viewed a picture while they were in a momentary self-reference, the picture may have caused the recall of strong memory which snapped them back into narrative processing.

Another explanation for the lack of decrease in MBSR association is that the MBSR 8-week course is a relatively light form of mindfulness meditation training. More intense forms include 10-day intensive retreats where one is shut off completely from all distractions and focuses exclusively on the mediation technique. This would be more conducive to a more pronounced shift in the sense of self. In addition, any form of mindfulness practiced may not lead immediately to shift in the fundamental sense of one's being. Therefore, one cannot say for certain whether a different group of participants that had more experience and were practicing a more intensive form of the training would show different results on this task. One cannot conclude that mindfulness *does not* shift self-association with emotional pictures from this task alone.

Another question posed in this study is to what extent intensity of emotional reaction towards the pictures is related to self-association. The hypothesis was that the mechanism of control over emotional reactivity is a detaching of "self" with the emotional experience, manifesting as a decrease in narrative self-view. Results of this study indicate that there is a weak positive correlation between emotional reactivity and self-association as measured in this study. This weak correlation appeared in both the MBSR and control groups previous to their 8-week tasks.

An interesting finding is that after MBSR training, the strength of correlation between emotional reactivity and self-association increased. Conversely, in the control group, there was actually a decrease in correlation between the two measures after the 8-week gap. An immediate interpretation of this finding is that MBSR somehow links emotional reactivity with self-association. Previous to any sort of mindfulness training, one may have a variety of superfluous ways to control one's emotions. However, mindfulness meditation offers a direct strategy to control one's emotions – detaching one's "self" from the emotional experience and observing it objectively. This strategy manifests in different forms of meditation trainings in a variety of ways, from objectively observing bodily sensations corresponding to emotions or by objectively observing one's thoughts. Regardless of the specific technique implemented, all forms of mindfulness stress objective observation of phenomena as they are. After mindfulness training, one learns to detach one's "narrative" self from emotional experiences by decreasing "narrative" self-referential processing and increasing "moment-to-moment" self processing. One could speculate that the reduction in intensity of emotional reactions found in this study could be a result of this strategy, and the increased correlation between self-association and intensity of emotional reaction suggests that this new strategy may have been adopted to control reactivity.

The final question posed in this study is to what extent changes in overall emotional reactivity were related to changes in self-association. Results showed that after MBSR, there was an increased correlation between normalized total valence and self-association ratings, which was relatively significant (85% confidence interval). This means that positive reactions were increasingly correlated with higher ratings of self-association after MBSR, suggesting that MBSR participants had an increasingly positive self-view. This effect of MBSR has been documented before with self-endorsement of trait adjectives (Goldin

2009), however this is the first time this effect has appeared with the endorsement of emotional pictures, suggesting that the increase in positive self-view endowed by MBSR practice spreads across measurement domains.

5. Limitations/Future Directions

The sample size of MBSR participants used in this study was quite small. A larger sample size would be more conducive to drawing bolder conclusions. In addition, studying participants from a more intensive mindfulness technique, such as a Zen or Vipassana retreat, may provide a clearer window into the effects of mindfulness on self-view.

The control group and MBSR group had participants with significantly different demographics. This study would have benefitted from using a control group that was more similar in age and gender to the MBSR group.

In retrospect, the scale of 1-100 that subjects made judgments was much too large a scale, which made for a wide variance of responses and clusters of responses around certain landmark numbers (50, 25, etc.) Rarely does someone have enough subtlety of insight into his or her emotional states to distinguish from negative to positive on a 100-point scale. As such, this experiment would have benefitted from using a standard 0-9 or 1-10 Likert scale. Subjects may have responded more favorably to such a scale, without being daunted by the large range of possible responses, and therefore the results may have been different or more prominent.

A better way of distinguishing narrative vs. momentary self-referential processing is needed. One possibility is to utilize various brain imaging techniques while performing this task to determine if MBSR causes different modes of SRP to appear while performing this task. Another possibility is to present subjects with another task entirely that elucidates repercussions of different forms of self-view.

A future study could investigate different types of cognitive regulation/meditation techniques (compassion cultivation, cognitive behavioral therapy, etc.) to see what kind of effects those have on emotional reactivity and/or self-referential processing.

An interesting finding from this study was that MBSR participants that took the pre-test immediately after their first class already showed an effect of the meditation training

on emotional intensity. A future study could aim to elucidate the time window of the effects of MBSR training (and mindfulness meditation in general). Is there a specific time period after each weekly class where emotional reactivity and/or self-association are significantly decreased/significantly more correlated? Do the effects after the 8-week course wear off after some time, with emotional reactivity coming back to the levels it was before the course? How much mindfulness practice is needed to sustain the effects of decreased emotional intensity? All of these questions would make for interesting future studies.

In conclusion, a significant finding from this study is that MBSR training significantly reduces emotionally intense reactions (both highly positive and highly negative) based on the situation, and relatively increases positive reactions. This suggests that after MBSR, participants are able to be more equanimous to variety of emotional experiences and not react as strongly as they previously did, while reacting more positively than before. This finding has practical value. Having balanced and positive reactions to emotions is conducive to increased efficiency in all aspects of life. MBSR participants were not found to have less intense reactions independent of situation, which would suggest a sense of aloofness or possibly even suppression of emotions. Rather, this finding is highly ecologically valid in that the significant reduction in emotional intensity and increased positivity is based on the situation at hand; implying that MBSR helped participants develop the noble characteristics of awareness and non-reactivity to emotionally intense experiences, and positivity in the face of relatively negative situations. In other words, after MBSR, participants still feel the emotions, but react differently to that feeling.

There was not a significant decrease in self-association for MBSR participants found in this study as predicted, and this could be due to the fact that all the participants were novices and getting to the depth of self-concept requires more intensive and longer meditation experience.

Finally, this study showed that there is a positive, albeit weak, correlation between intensity of emotional reactivity/overall valence and self-association, which increases after an 8-week MBSR course. This suggests that emotional reactivity is intrinsically related to self-association with an experience, and that MBSR may offer a regulation strategy over reactions to emotions by detaching one's "narrative" self-concept from the evocative

experience. In addition, it suggests that MBSR participants gain increasingly positive self-view after training, which has benefits in many facets of experience.

A major question left unanswered is whether regulation of emotion endowed by mindfulness occurs because of a shift in self-view. This is definitely possible, and future studies could aim at elucidating the mechanism of emotional regulation.

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References

1. Brewer, J.A. et al. (2011). Meditation experience is associated with differences in default mode network activity and connectivity. *Proc. Natl. Acad. Sci. USA, 108,* 1-6.

2. Farb, N.A. et al. (2007). Attending to the present: Mindfulness meditation reveals distinct neural modes of self-reference. *Social Cognitive and Affective Neuroscience, 2,* 313-322.

3. Goetz & Taliferro (2011). A Brief History of the Soul. *Wiley-Blackwell.*

4. Goldin, P.R. (2009). Mindfulness meditation training and self-referential processing in social anxiety disorder: behavioral and neural effects. *Journal of Cognitive Psychotherapy, 23,* 242-256.

5. Ho, D.Y.F. (1995). Selfhood and Idenitity in Confucianism, Taoism, Buddhism, and Hinduism: Contrasts With the West. *Journal for the Theory of Social Behavior, 29,* 115-139.

6. Kabat-Zinn, J. (1990). Full Catastrophe Living: Using the Wisdom of Your Body and Mind to Face Stress, Pain, and Illness.

7. Killingsworth & Gilbert (2010). A wandering mind is an unhappy mind. *Science, 330,* 932.

8. Lang, P.J. et al. (2005). International Affective Picture System (IAPS). *NIMH Center for the Study of Emotion and Attention.*

9. Northoff, G. et al. (2006). Self-referential processing in our brain – A meta-analysis of imaging studies of the self. *Neuroimage.*

10. Phan, K.L. (2004a). Neural correlates of individual ratings of emotional salience: a trial-related fMRI study. *Neuroimage, 21,* 768-780.