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>> Version of Record - Nov 13, 2012

OnlineFirst Version of Record - Oct 15, 2012

What is This?

# Feeling Blue or Turquoise? Emotional Differentiation in Major Depressive Disorder

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## Abstract

Some individuals have very specific and differentiated emotional experiences, such as anger, shame, excitement, and happiness, whereas others have more general affective experiences of pleasure or discomfort that are not as highly differentiated. Considering that individuals with major depressive disorder (MDD) have cognitive deficits for negative information, we predicted that people with MDD would have less differentiated negative emotional experiences than would healthy people. To test this hypothesis, we assessed participants' emotional experiences using a 7-day experience-sampling protocol. Depression was assessed using structured clinical interviews and the Beck Depression Inventory-II. As predicted, individuals with MDD had less differentiated emotional experiences than did healthy participants, but only for negative emotions. These differences were above and beyond the effects of emotional intensity and variability.

Imagine yourself at the funeral of a friend from high school. You might be filled with an intense feeling of *sorrow*. You might also feel *happy* that he lived a fulfilling life. And you might feel *awed* by the large crowd that has gathered to honor him. Perhaps you also feel *surprised* to see acquaintances and friends that you have not seen in some time, along with *frustration* about losing someone close to you, but also *determination* to make the most of every moment of every day that follows.

At every waking moment, people have access to exteroceptive information from their senses, interoceptive information from their muscles and internal organs, and conceptual information about the past, the present, and the future. Emotional processes combine these pieces of information, allowing a person to experience discrete states of happiness, sadness, anger, elation, and a variety of other emotional states (Barrett, Mesquita, Ochsner, & Gross, 2007; Ellsworth & Scherer, 2003; Frijda, 1986). Thus, during daily events, people often experience a changing stream of emotions. Moreover, the situations encountered during daily life are often multidimensional, with elements that can lead a person to feel both happiness and sadness at the same moment.

Sometimes the emotions people experience are discrete and highly specific, as in this funeral example. But another person in the same situation might feel a general gnawing unpleasantness or deep despair with no distinguishing features. The more differentiated people's emotional reactions, the better able they are to calibrate their behavioral responses to the demands of specific situations (Barrett, Gross, Christensen, & Benvenuto, 2001). For instance, whether one feels undifferentiated anger or anger laced with shame and guilt determines the course of action one will take in response to a specific situation (Ellsworth & Tong, 2006). Previous research has conceptualized and

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quantified the differentiation among emotions (Barrett, 2004; Barrett & Bliss-Moreau, 2009). Furthermore, investigators have shown that people differ in their degree of emotional differentiation (e.g., Barrett, 2004; Kashdan, Ferssizidis, Collins, & Muraven, 2010). In this article, we report an investigation of whether people diagnosed with major depressive disorder (MDD) experience less differentiated emotions in daily life than do healthy people. We use our results to ground a discussion of how the ability to differentiate a variety of emotional experiences plays an adaptive role in dealing with life stressors.

MDD is a common and debilitating psychiatric condition. Approximately one in six people in the United States experience MDD during their lifetime. The cost of medical treatment and lost productivity is approximately $85 billion each year (Greenberg et al., 2003). Depressed people are 30 times more likely to commit suicide than are healthy individuals (Joiner, 2010) and 5 times more likely to abuse drugs. They are twice as likely to take sick days and 7 times more likely to be unemployed (Lerner et al., 2004). Depression also aggravates the course of cardiovascular conditions; it is linked to obesity, osteoporosis, arthritis, type 2 diabetes, certain cancers, periodontal disease, and frailty. Moreover, depression downregulates immune responses, and makes it more difficult to quit smoking.

A primary reason for the widespread and cascading adverse effects of depression is that this mood disorder fundamentally alters the way in which the self is situated in the physical and social world. People with depression have overly general autobiographical memory (Williams & Scott, 1988). Compared with healthy individuals, they have greater difficulty removing irrelevant information from short-term memory (Joormann, Nee, Berman, Jonides, & Gotlib, 2010); are less able to perceive contrasts in the visual world (Bubl, Kern, Ebert, Bach, & Ludger, 2010); are less sensitive to context in emotional processing (Rottenberg, Gross, & Gotlib, 2005); and are impaired in executive functioning (Joormann, 2005). The common theme among these findings is that depression is associated with a diminished ability to differentiate elements of information from one another, whether at the level of perception, memorial processing, or executive functioning. Each of these elements is thought to be associated with momentary emotional experience (Barrett, 2006b). Accordingly, we hypothesized that people with depression have less differentiated emotional experiences in their daily lives than do healthy people.

When people experience a discrete emotional state, such as anger or sadness or fear, they attend to certain features of the stimulus field and ignore others. People's states of pleasure and arousal become meaningfully conceptualized, so that it is possible to make reasonable inferences about these states, to predict what to do to resolve or enhance them, and to communicate these experiences to other people (e.g., Barrett, 2006b). For instance, consider two situations that typically provoke anger. When healthy people miss an appointment because of not waking up on time, they usually feel angry with themselves (Ellsworth & Tong, 2006); that is, they experience anger directed at the self rather than the world. In contrast, when a driver disregards a stop sign and crashes into another person's car, a healthy victim's experience of anger does not have elements of shame and guilt; rather, the referent of the experience of anger is the driver who disregarded the stop sign. To ameliorate these situations, healthy people would take actions that are appropriate to their specific emotional experience of anger directed at the self or the other person, respectively. People who lack the ability to differentiate these particular emotional states from each other or from a general feeling of unpleasantness might choose actions that are not appropriate to the current context and might exacerbate the problem.

Studying the experience of emotion presents a challenge to researchers because it is difficult to study subjective experience objectively. Reviews of the literature indicate that there is no essential signature within the brain or body that is specific to a particular emotion as humans experience it (Barrett, 2006a; Mauss & Robinson, 2009)—much as a particular wavelength of light is assigned to different color categories by different people (Barrett, 2006b; Berlin & Kay, 1969). Furthermore, extensive research suggests that people make biased responses when asked to evaluate their emotional lives (Dunning, Heath, & Suls, 2004); therefore, it is not possible to obtain an accurate measure of emotional differentiation simply by asking individuals how differentiated they feel their emotions are (although this might be useful information for understanding meta-emotional processes). One of the best ways to study subjective experiences in a more objective way is to use experience sampling to assess the richness of momentary emotional experience as it is lived (Barrett & Barrett, 2001; Larsen & Csikszentmihalyi, 1983). With this procedure, individuals are probed at various times throughout the day and are asked to characterize their momentary experience using a set of emotion adjectives.

We used this method to measure participants' emotional experiences over the course of a week. The ratings were later analyzed to reveal the extent to which people reported differentiated versus global emotional feelings (Barrett & Bliss-Moreau, 2009). Specifically, the patterns of correlation in the reports provide an objective estimate of emotional differentiation. For example, if temporal fluctuations in anger are highly correlated with temporal fluctuations in sadness across situations, then from a statistical standpoint, "anger" and "sadness" describe the same state (i.e., negative emotion), and these emotions are not well differentiated (e.g., Barrett, 2004). The less related changes in the two emotions are over time, the higher an individual's emotional differentiation.

We predicted that people with MDD would experience less differentiated emotions than would demographically matched healthy individuals. Given that the cognitive biases exhibited by individuals diagnosed with MDD appear to be stronger for the processing of negative than of positive information, we hypothesized that the reduction in emotional differentiation would be limited to negative emotional experiences. We

predicted further that emotional differentiation is unique from other emotional constructs implicated in MDD, such as emotional intensity or variability (an association between depression and alterations of the latter constructs within the same sample used in the present study has been described in Thompson et al., 2012). We did not have specific predictions about whether emotional differentiation would be related to average emotional intensity; however, given that previous work has shown that lower clarity of emotion is related to higher emotional variability (Thompson, Dizén, & Berenbaum, 2009), we did expect to find an inverse relation between differentiation and emotional variance throughout the experience-sampling period.

# Method
## *Participants*

One hundred six participants between the ages of 18 and 40 ($M = 27.8$ years, $SD = 6.5$ years) were recruited for the current study, which was part of a larger project (see Mata et al., 2012; Thompson et al., 2011; Thompson et al., 2012). All of the participants were native English speakers. Individuals were eligible to participate in the control group ($n = 53$; 71.7% women, 28.3% men) if they had no current or past history of any mental health disorders and scored below 9 on the Beck Depression Inventory-II (BDI; Beck, Steer, & Brown, 1996). To be eligible for the depressed group ($n = 53$; 67.9% women, 32.1% men), individuals had to have a current diagnosis of MDD, as assessed by the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I; First, Spitzer, Gibbon, & Williams, 1997), and a BDI-II score above 13; in addition, they could not have (a) a history of alcohol or drug dependence in the past 6 months, (b) a Bipolar I or II diagnosis, or (c) any psychotic disorders. The MDD and control groups did not differ in years of education, gender, or race and ethnicity composition; however, depressed participants ($M = 28.2$, $SD = 6.4$) were on average 3 years older than healthy participants ($M = 25.4$, $SD = 6.4$), $t(104) = -2.19$, $p = .03$. Including age as a covariate in the analyses did not influence any of the reported results.

Participants were recruited from the communities surrounding the University of Michigan in Ann Arbor, Michigan, and Stanford University in Stanford, California. Advertisements were posted online (e.g., Craigslist) and at local agencies and businesses (e.g., bulletin boards). Approximately equivalent numbers of participants were recruited in the two locations. Participants recruited at the two sites differed in gender composition, $\chi^2(1, N = 106) = 11.77$, $p < .01$, with the Michigan sample having more men (44.6% men) than the Stanford sample (14.0 % men). There was also a significant difference in years of education between the two sites, $\chi^2(3, N = 106) = 9.67$, $p < .05$: Whereas the majority of the Michigan sample (55.4%) reported having completed "some college," the majority of the Stanford sample (66%) reported having earned a bachelor's degree or a professional degree. This difference in education status is also reflected in an age difference: The Michigan sample ($M = 24.2$ years, $SD = 5.5$ years) was younger than the Stanford sample ($M = 29.7$ years, $SD = 6.5$ years), $t(104) = 4.69$, $p < .01$. The two sites did not differ in ethnic and racial distribution, $\chi^2(5, N = 106) = 4.78$, or in depression status, $\chi^2(1, N = 106) = 1.00$, both $ps > .1$. Because the samples did not differ on central variables of interest (i.e., emotion ratings), we combined the two samples for the remaining analyses (see Table S1 in the Supplemental Material available online for detailed demographic information).

## *Materials and procedure*

Participants were administered the SCID-I and BDI prior to the experience-sampling period. If more than 2 weeks had passed since the administration of the SCID-I, participants' diagnostic status was reassessed with another SCID-I to ensure eligibility. Participants were provided with handheld electronic devices (Palm Pilot Z22), were individually instructed on the experience-sampling protocol, and completed a full practice trial. The handheld devices were programmed using the Experience Sampling Program, Version 4.0 (Barrett & Barrett, 2001). Participants were prompted (via a tone signal) eight times per day between 10 a.m. and 10 p.m. The majority of the participants carried the device for 7 to 8 days. Prompts (trials) occurred at random times within eight 90-min windows per day; thus, prompts could occur from as little as 2 min apart to almost 180 min apart. After participants were prompted for a given trial, they had 3 min to respond to the initial question on the Palm Pilot; otherwise, the device switched to hibernation until the next prompt, and the data for that trial were recorded as missing. Up to 56 trials of data were recorded for each participant. The depressed and control participants did not differ in the number of completed trials. Participants provided informed consent and were compensated for their participation in the study; they received an extra incentive for responding to more than 90% of the prompts.

On each trial, participants were asked to use a 4-point scale (*not at all* = 1, *little* = 2, *much* = 3, *a great deal* = 4) to indicate the degree to which each of 11 emotion adjectives described their current emotional state. There were 7 negative-emotion adjectives (*sad, anxious, angry, frustrated, ashamed, disgusted*, and *guilty*) and 4 positive-emotion adjectives (*happy, excited, alert*, and *active*). The adjectives were drawn from various sources, such as the Positive and Negative Affect Schedule (Watson, Clark, & Tellegen, 1988) and previous studies (e.g., Ekman, Friesen, & Ellsworth, 1972).

## *Calculation of emotion differentiation, intensity, and variability*

To quantify emotional differentiation, we calculated for each participant the Pearson's correlations between all possible pairs of negative emotions ($r_{sad,anxious}$, $r_{sad,angry}$, $r_{sad,frustrated}$, $\cdots$) and all possible pairs of positive emotions ($r_{happy,excited}$, $r_{happy,alert}$, $r_{happy,active}$, . . .; Tugade, Fredrickson, & Barrett, 2004). The average of the Fisher's $z$-transformed correlations was used to

quantify positive and negative emotional differentiation for each participant. The larger the average correlation, the less the person distinguished between various categories of emotional experience when describing his or her feelings. We then transformed the scores by subtracting them from 1, such that larger values indicate higher differentiation.

Emotional intensity was measured by averaging the emotion ratings at each prompt, separately for the seven negative and four positive emotions. Then, we obtained one negative and one positive intensity score for each participant by calculating the mean for each set of adjectives across the entire sampling period. Higher scores indicated that the individual experienced emotions with higher intensity.

Temporal variability was measured by calculating the variance of the intensity of each emotion over the sampling period, again separately for the negative and positive emotions. Higher scores indicated that the individual experienced emotions with greater variability. Emotions with zero temporal variance were pruned from the correlation-based differentiation analyses. Considering that four positive and seven negative emotions were used in this study, we excluded from the analyses participants with three or more positive emotions with zero temporal variance (1 MDD participant) and participants with six or more negative emotions with zero temporal variance (5 control participants) because correlations could not be calculated with such data (see Bootstrap Analyses in the Supplemental Material for a description of the robustness of our analyses to excluding these participants). In order to investigate the effect of differentiation above and beyond the effects of emotional intensity and variability, we included intensity and variability as covariates in our analyses.

## Results

### Emotional differentiation

As predicted, people with MDD had less differentiated negative emotions (Table 1) than did healthy participants, $F(1, 98) = 7.18$, $p < .01$, $d = −0.54$. Also as predicted, there was no difference between the MDD and control participants in differentiation of positive emotions. A two-way analysis of variance (ANOVA) yielded no significant main effects of participant group or valence, but did yield a significant interaction of participant group and valence, $F(1, 196) = 6.60$, $p = .01$, suggesting that the differences in differentiation between people with MDD and control participants was limited to negative emotions. Negative and positive emotional differentiation were not correlated for people in either group, which suggests that differentiation of positive and negative emotions depends on different psychological mechanisms (see Table S2 in the Supplemental Material for differentiation scores for individual emotion pairs).

An examination of the mean levels of differentiation of emotion for men and women led us to investigate the role of gender. Although we had no a priori hypotheses concerning gender differences in emotion differentiation in MDD, we conducted an exploratory three-way ANOVA on emotion differentiation including gender as the third factor (with valence and group). The three-way interaction was not significant, $F(1, 192) = 2.32$, $p ≤ .13$; thus, gender was not a significant moderator of the relation between depression and emotional differentiation (see Table S3 in the Supplemental Material for results broken down by gender and for a description of additional bootstrapping analyses that explain and confirm this finding).

### Emotional differentiation versus emotional intensity and variability

It was possible that the observed differences in differentiation were due to group differences in emotional intensity or variability. In fact, in previous research examining the same data, we found that the MDD and control groups differed in emotional intensity (Mata et al., 2012) and variability (Thompson et al., 2012). To test whether group differences in intensity (Table 1) and variability (Table 1) were linked to group differences in emotional differentiation, we used two multiple regression models, one predicting changes in positive emotional differentiation and one predicting changes in negative emotional differentiation. Predictors were depression as a nominal variable and intensity and variability as continuous predictors. After we controlled for intensity and variability, depression remained a significant predictor of low differentiation only for negative emotions, $F(1, 96) = 7.51$, $p < .01$; thus, between-group differences in negative differentiation were not due to differences in intensity and variability. Emotional variability remained a significant predictor of both negative emotional differentiation, $F(1, 96) = 6.53$, $p < .02$, and positive emotional differentiation, $F(1, 96) = 5.21$, $p < .03$, whereas

**Table 1.** Mean Emotion Differentiation, Intensity, and Variability Scores

| Measure | Positive emotions | | Negative emotions | |
| --- | --- | --- | --- | --- |
| | Participants with MDD | Control participants | Participants with MDD | Control participants |
| Differentiation | 0.57 (0.21) | 0.54 (0.18) | 0.51 (0.22) | 0.64 (0.27) |
| Intensity | 1.68 (0.39) | 2.17 (0.45) | 1.88 (0.53) | 1.15 (0.17) |
| Variability | 0.51 (0.24) | 0.50 (0.27) | 0.59 (0.29) | 0.14 (0.13) |

Note: Standard deviations are in parentheses. MDD = major depressive disorder.

emotional intensity was a significant predictor of only positive emotional differentiation, $F(1, 96) = 4.25$, $p < .05$.

Positive emotional intensity was modestly negatively correlated with emotional differentiation for both people with MDD, $r(50) = -0.19$, $p < .09$, and control participants, $r(46) = -0.21$, $p < .08$; that is, individuals who experienced positive emotions with higher intensity tended to have less differentiated positive emotional experiences. There was no significant relation between negative emotional intensity and differentiation for either group (see Table 2).

For people with MDD, emotional variability was negatively correlated with both positive emotional differentiation, $r(50) = -.35$, $p < .005$, and negative emotional differentiation, $r(50) = -.27$ $p < .03$. Similarly, control participants exhibited a tendency for emotional variability to be negatively correlated with both positive emotional differentiation, $r(46) = -.22$, $p < .07$, and negative emotional differentiation, $r(46) = -.21$, $p < .08$. These results suggest that individuals whose emotional experiences were more variable across time had less differentiated experiences of positive and negative emotions (see Table 2; also see Tables S3, S4, and S5 in the Supplemental Material for adjusted mean differentiation scores; for differentiation, intensity, and variability scores by gender; and for correlations of intensity and variability with differentiation by gender).

## Discussion

The present study is the first to show that people diagnosed with MDD experience negative emotions with less differentiation in their daily lives than do healthy individuals. We found that the relation between emotional differentiation and depression could not be accounted for by emotional intensity or variability. This finding suggests a fundamental way in which the emotional lives of individuals diagnosed with MDD are altered independently of increased negative emotional intensity and emotional variability.

Earlier research supporting the affect-as-information perspective has shown that specific emotional states (e.g., anger, sadness, and fear) have more adaptive value than do global affective states (e.g., pleasant and unpleasant states). This is because specific and differentiated negative emotional experiences are less subject to misattribution errors (Schwarz & Clore, 1996). One of the important distinguishing features of discrete emotional states is that specific emotions are generally associated with a causal object, whereas undifferentiated,

global affective states are not (Russell & Barrett, 1999). It is important to identify the source and cause of an emotional state in order to generate an adaptive response. In fact, earlier research has shown that negative emotional differentiation is correlated with emotion regulation (Barrett et al., 2001). Accordingly, decreased differentiation might lead people with MDD to regulate their emotions less frequently than healthy people do. Future research should specifically test this hypothesis.

It is important to note that people with MDD did not differ from control participants in positive emotional differentiation. First, this finding suggests that the psychological mechanisms underlying emotional differentiation can be selectively altered for negative emotions, as one might expect to be the case in individuals with MDD. Second, given that participants with MDD experienced positive emotions with decreased intensity (see Table 1) but exhibited unaltered differentiation, this finding further supports the claim that emotional differentiation, intensity, and variability are independent constructs. It could be that people with MDD use differentiated positive emotional experiences as a buffer against life stressors (Tugade et al., 2004), and this may be one of the reasons that they retain differentiation among positive emotions. It could also be that the high-arousal positive emotions that we sampled are not representative of the domains in which people with MDD might experience alterations in emotional differentiation. In future studies, we plan to use a larger number of positive emotions, including such emotions as compassion and calmness.

Previous research has shown that depression is associated with alexithymia (Honkalampi, Hintikka, Tanskannen, Lehtonn, & Vilnamaki, 2000), defined as the inability to recognize and verbalize emotions. Alexithymia is often associated with emptiness of feelings, poverty of imagination, difficulty in communicating with other people, lack of positive emotions, and high prevalence of negative emotion. The major difficulty in interpreting this body of research is its reliance on people's self-reports of their ability to differentiate emotions (Dunning et al., 2004). Earlier research suggests that people make flawed, biased responses when asked to evaluate their abilities globally, and that global abilities are best captured using skill-based measurements. Therefore, it is important to measure individuals' subjective emotional experiences and to quantify their degree of emotional differentiation. This is especially important if one wants to understand the mechanisms of emotional experience in healthy and depressed populations.

**Table 2.** Correlations of Emotional Differentiation With Emotional Intensity and Variability

| | Positive emotions | | Negative emotions | |
|---|---|---|---|---|
| Measure | Participants with MDD | Control participants | Participants with MDD | Control participants |
| Intensity | −0.19, $p < .09$ | −0.21, $p < .08$ | 0.12, $p > .19$ | −0.13, $p > .17$ |
| Variability | −0.35, $p < .005$ | −0.22, $p < .07$ | −0.27, $p < .03$ | −0.21, $p < .08$ |

Note: MDD = major depressive disorder.

Despite some success in developing empirically validated diagnoses and interventions for depression and other mental health disorders, the mechanisms of even the most successful treatments are still unclear. For example, in a recent summary of the literature on mechanisms of change in psychotherapy research, Kazdin (2007) concluded, "After decades of psychotherapy research, we cannot provide an evidence based explanation for how or why even our most well studied interventions produce change, that is, the mechanism(s) through which they operate" (p. 1). This noted lack of progress may be due, in part, to how researchers measure emotional states in various psychopathologies. The present results indicate that the use of momentary experience sampling, coupled with techniques that extract relations among emotions, may be helpful in increasing understanding of the structure and dynamics of emotional experience in depression (Palmier-Claus et al., 2011; Peeters, Nicolson, Berkhof, Delespaul, & deVries, 2003; Wichers et al., 2012) because experience sampling goes beyond retrospective self-report, which is influenced by beliefs and attitudes. Experience sampling should allow a broader perspective in examinations of other mental illnesses as well, by making it possible to study not only what individuals report feeling in the past, but also what they feel on a moment-to-moment basis in the present (which may not be the same; Robinson & Clore, 2002). Greater breadth of perspective and assessment of momentary experience may inform the development of improved diagnostic criteria, which should play a crucial role in the development and validation of more effective treatments.

## Supplemental Material

Additional supporting information may be found at http://pss.sagepub.com/content/by/supplemental-data

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<u>Bootstrap Analyses</u>
In the main manuscript, we reported results indicating that people with MDD have less differentiated unpleasant emotional experiences than do their healthy peers. We reached this conclusion by calculating the correlations among a set of 4 pleasant and 7 unpleasant emotion adjectives that participants used to rate their momentary emotional experience. In order to show that our results are not due simply to the difference in the number of pleasant and unpleasant emotion adjectives, we conducted a bootstrap analysis. In this analysis, we conducted t-tests comparing people with depression and healthy controls for all possible 4-adjective subsets of the 7 emotion adjectives. 97.1% of the t-tests yielded p-values <0.05, indicating that the difference in emotional differentiation between people with depression and healthy controls is robust across various emotion adjectives, and that it is not an epiphenomenon of the larger number of unpleasant emotion adjectives. We also provide Table S3, which shows the degree to which individual emotion adjectives are differentiated from one another. This table also shows that the difference in differentiation between people with depression and healthy controls is pervasive across all emotion adjectives.

Furthermore, in our study, there was one person with depression who had 3 pleasant emotion adjectives with zero temporal variance and 5 healthy controls with 6 unpleasant emotion adjectives with zero temporal variance. We excluded these participants from analyses in the manuscript because emotion differentiation scores could not be calculated for them. In order to ensure that pruning these individuals from our participant pool did not lead to differences between groups in emotion differentiation, we conducted a separate bootstrap analysis. In this analysis, 1 healthy control and 5 people with depression were randomly selected to be pruned from the participant pool. Then the emotion differentiation calculations were computed for the remainder of the participants. This random selection procedure was carried out 1000 times. Of these 1000 instances, 973 yielded a significant difference in emotion differentiation between people with depression and healthy controls. This shows that our findings are robust (97.3%) and not epiphenomenally linked to the between-group differences in the likelihood to report nonzero values for the emotion ratings.

In order to ensure the robustness of our findings, we took the bootstrap analyses a step further. In this set of bootstrap analyses we carried out a more refined matching process. For every $i$ number of healthy controls who had zero temporal variance for $j$ emotion ratings, we randomly selected $i$ people with depression and randomly excluded $j$ of their emotion ratings. This procedure was carried out to ensure that the healthy controls and people with depression were matched in psychometric properties that could confound the results. The random selection process was executed 1000 times, and for 964 of the instances, people with MDD had less differentiated unpleasant emotional experiences than did their healthy peers. This further shows that our findings are robust (>96%) and that they are not epiphenomenally linked to between group-differences in emotion reporting behavior.

*Table S1. Demographic Characteristics of Participants with MDD and Control Participants*

| | *Participants with MDD* (n=53) | *Control Participants* (n=53) | Statistics |
|---|---|---|---|
| BDI score, M(SD) | 32.2 (8.6) | 1.7 (2.3) | t(104) = -24.86, p<.001 |
| Age, M(SD) | 28.2 (6.4) | 25.4 (6.4) | t(104) = -2.19, p=0.03 |
| Ethnicity (*n*) | | | $c^2(5)$ = 7.79, p=0.17 |
|     African American | 3 | 5 | |
|     Asian | 2 | 9 | |
|     Caucasian | 39 | 33 | |
|     Hispanic | 2 | 1 | |
|     Multiracial | 5 | 5 | |
|     Other | 2 | 0 | |
| Education (*n*) | | | $c^2(3)$ = 6.67, p=0.08 |
|     High school | 6 | 0 | |
|     Some college | 20 | 25 | |
|     Bachelor's | 23 | 23 | |
|     Master's | 4 | 5 | |
| Gender (*n*) | | | $c^2(1)$ = 0.18, p=0.83 |
|     Female | 38 | 36 | |
|     Male | 15 | 17 | |
| # of completed prompts, M(SD) | 44.0 (7.6) | 42.4(7.8) | t(104) = 1.08, p=0.29 |
| Mean PA over the week, M(SD) | 1.7(0.4) | 2.2(0.5) | t(104) = 5.54, p<0.001 |
| Mean NA over the week, M(SD) | 1.9 (0.5) | 1.1(0.2) | t(104) = 9.98, p<0.001 |

Note:

MDD = Major Depressive Disorder

BDI = Beck Depression Inventory – II;

PA = Positive Affect (Average of the pleasant emotion adjectives);

NA = Negative Affect (Average of the unpleasant emotion adjective)

*Table S2*. Differentiation (1- ρ) scores for all pairs of emotion adjectives

|  | Participants with MDD | | Control Participants | |
|---|---|---|---|---|
| **Pleasant** | Mean | SD | Mean | SD |
| ρ(Happy, Excited) | 0.49 | 0.22 | 0.46 | 0.16 |
| ρ(Happy, Alert) | 0.70 | 0.23 | 0.65 | 0.25 |
| ρ(Happy, Active) | 0.71 | 0.24 | 0.67 | 0.23 |
| ρ(Excited, Alert) | 0.60 | 0.20 | 0.60 | 0.18 |
| ρ(Excited, Active) | 0.61 | 0.23 | 0.59 | 0.18 |
| ρ(Alert, Active) | 0.52 | 0.22 | 0.53 | 0.23 |
|  |  |  |  |  |
| **Unpleasant** |  |  |  |  |
| ρ(Sad, Anxious) | 0.56 | 0.27 | 0.69 | 0.27 |
| ρ(Sad, Angry) | 0.55 | 0.26 | 0.62 | 0.32 |
| ρ(Sad, Frustrated) | 0.57 | 0.23 | 0.61 | 0.31 |
| ρ(Sad, Ashamed) | 0.53 | 0.25 | 0.73 | 0.35 |
| ρ(Sad, Disgusted) | 0.51 | 0.25 | 0.53 | 0.36 |
| ρ(Sad, Guilty) | 0.55 | 0.24 | 0.66 | 0.32 |
| ρ(Anxious, Angry) | 0.67 | 0.27 | 0.64 | 0.27 |
| ρ(Anxious, Frustrated) | 0.58 | 0.24 | 0.73 | 0.25 |
| ρ(Anxious, Ashamed) | 0.66 | 0.26 | 0.78 | 0.29 |
| ρ(Anxious, Disgusted) | 0.63 | 0.25 | 0.70 | 0.28 |
| ρ(Anxious, Guilty) | 0.61 | 0.26 | 0.75 | 0.28 |
| ρ(Angry, Frustrated) | 0.48 | 0.22 | 0.51 | 0.24 |
| ρ(Angry, Ashamed) | 0.59 | 0.26 | 0.73 | 0.30 |
| ρ(Angry, Disgusted) | 0.58 | 0.26 | 0.60 | 0.34 |
| ρ(Angry, Guilty) | 0.60 | 0.25 | 0.71 | 0.30 |
| ρ(Frustrated, Ashamed) | 0.62 | 0.22 | 0.83 | 0.27 |
| ρ(Frustrated, Disgusted) | 0.63 | 0.26 | 0.72 | 0.29 |
| ρ(Frustrated, Guilty) | 0.62 | 0.22 | 0.82 | 0.27 |
| ρ(Ashamed, Disgusted) | 0.45 | 0.18 | 0.51 | 0.39 |
| ρ(Ashamed, Guilty) | 0.35 | 0.22 | 0.43 | 0.33 |
| ρ(Disgusted, Guilty) | 0.44 | 0.22 | 0.47 | 0.35 |

Note: MDD   = Major Depressive Disorder

*Table S3*. Emotion differentiation, intensity and variability for male and female participants.

| | Positive Emotions | | | | Negative Emotions | | | |
|---|---|---|---|---|---|---|---|---|
| | *Participants with MDD* | | *Control Participants* | | *Participants with MDD* | | *Control Participants* | |
| | Male | Female | Male | Female | Male | Female | Male | Female |
| Differentiation | 0.52 (0.19) | 0.59 (0.22) | 0.54 (0.20) | 0.55 (0.18) | 0.55 (0.16) | 0.50 (0.24) | 0.54 (0.33) | 0.69 (0.23) |
| Intensity | 1.75 (0.54) | 1.67 (0.32) | 2.08 (0.43) | 2.21 (0.46) | 1.62 (0.33) | 1.98 (0.55) | 1.21 (0.27) | 1.13 (0.10) |
| Variability | 0.55 (0.34) | 0.48 (0.24) | 0.53 (0.20) | 0.51 (0.26) | 0.48 (0.34) | 0.63 (0.26) | 0.19 (0.22) | 0.12 (0.08) |

Note: MDD    = Major Depressive Disorder

To investigate the role of gender in the relation between MDD and emotional differentiation, we conducted a three-way analysis of variance (ANOVA) with the independent variables of gender, participant group, and valence, and the dependent variable of emotional differentiation. The three-way interaction of gender, participant group, and valence was not significant, $F(1,192) = 2.32$, $p<0.13$. The two-way interaction of participant group and valence, however, was still significant, $F(1,192) = 6.70$, $p<0.01$.

Because this study was designed to investigate MDD, and because females constitute nearly 2/3 of the population of people with MDD, we matched the number of male and female participants in this study to reflect this proportion. Accordingly, we have nearly 2.5 times as many females as males in our sample (32 vs 74) (see Table S1 for demographics). Therefore, the male group had less power than did the female group. Furthermore, in two additional bootstrapping analyses, we determined that the three-way interaction remained nonsignificant.  First, we randomly selected (without replacement) 32 participants from the 74 female participants, ensuring an equal number of people with MDD and healthy controls. There are roughly $10^{20}$ such random samples. From this, we took 10000 random samples and evaluated the results of the three-way ANOVA described above for each of them. In 9632 of these analyses, the interaction remained non-significant, giving us confidence about the robustness of our finding regarding the absence of a moderating effect of gender. In the second analysis, we randomly selected (with replacement) 74 male participants from our sample, again ensuring an equal number of people with MDD and healthy controls. There are roughly $10^{90}$ such random samples. Therefore, we took 100000 random samples and evaluated the results of the three-way ANOVA described above for each one of them. In 96735 of these analyses the interaction remained nonsignificant, again giving us confidence about the robustness of our finding regarding the absence of a moderating effect of gender. In addition to the fact that there was no strong theoretical reason for hypothesizing a gender difference in emotional differentiation, these findings indicate that the absence of gender differences should be treated with caution until it is replicated by future work.

*Table S4*. Original and adjusted emotion differentiation scores.

| | Positive Emotions | | Negative Emotions | |
|---|---|---|---|---|
| | *Participants with MDD* | *Control Participants* | *Participants with MDD* | *Control Participants* |
| Differentiation | 0.57 (0.21) | 0.54 (0.18) | 0.51 (0.22) | 0.64 (0.27) |
| Differentiation (adjusted) | 0.65 (0.15) | 0.68 (0.14) | 0.39 (0.21) | 0.55 (0.16) |

Note: Adjusted scores indicate levels of emotion differentiation after controlling for intensity and temporal variability.
MDD   = Major Depressive Disorder

*Table S5*. Correlations among emotional intensity, variability and differentiation.

| | Positive Emotions | | | | Negative Emotions | | | |
|---|---|---|---|---|---|---|---|---|
| | *Participants with MDD* | | *Control Participants* | | *Participants with MDD* | | *Control Participants* | |
| | Male | Female | Male | Female | Male | Female | Male | Female |
| Intensity | -0.33 p=0.12 | -0.12 p=0.23 | 0.04 p=0.44 | -0.34 p<0.03 | 0.08 p=0.39 | 0.14 p=0.20 | -0.19 p=0.24 | 0.10 p=0.30 |
| Variability | -0.51 p<0.03 | -0.28 p<0.05 | 0.16 p=0.28 | -0.37 p<0.02 | -0.23 p=0.21 | -0.28 p<0.05 | -0.26 p=0.18 | 0.01 p=0.48 |

Note: MDD  = Major Depressive Disorder