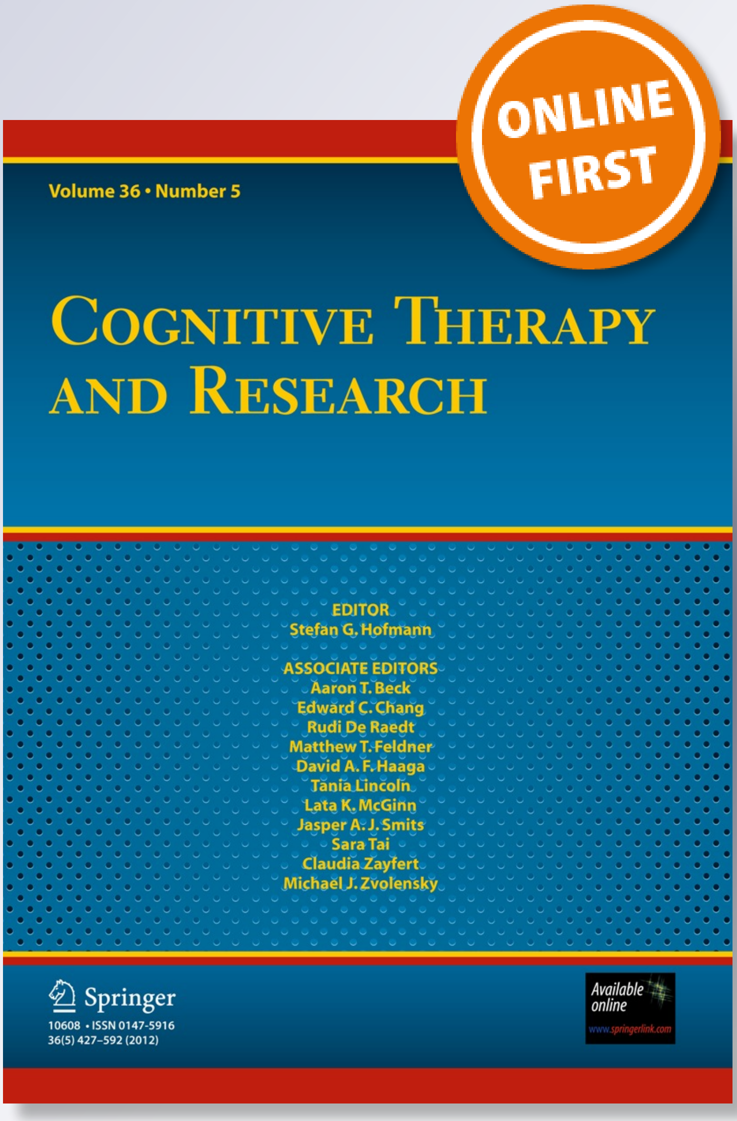
Enhanced Anger Reactivity and Reduced Distress Tolerance in Major Depressive Disorder

Alissa J. Ellis, W. Michael Vanderlind & Christopher G. Beevers

Cognitive Therapy and Research

ISSN 0147-5916

Cogn Ther Res
DOI 10.1007/s10608-012-9494-z



Springer

Cogn Ther Res
DOI 10.1007/s10608-012-9494-z

ORIGINAL ARTICLE

Enhanced Anger Reactivity and Reduced Distress Tolerance in Major Depressive Disorder

Alissa J. Ellis · W. Michael Vanderlind · Christopher G. Beevers

Abstract Difficulty with effective emotion regulation is a central feature of major depressive disorder (MDD). Correlational evidence suggests that people with MDD experience elevated levels of irritability and anger, although few studies have experimentally tested this idea. The current study examined emotional reactivity across self-report (anger ratings), behavioral (task persistence), and physiological (heart rate, skin conductance) domains in response to a standardized, frustrating task in young adults with MDD (n = 74) and without MDD (n = 107). A secondary goal was to determine whether regulating emotional response with reappraisal, acceptance, or no instruction mitigated emotional reactivity across these domains. People with MDD responded with greater self-reported anger, lower galvanic skin conductance, and less task persistence (i.e., lower distress tolerance) than non-MDD individuals. Emotion regulation strategy did not differentially attenuate emotional responses between MDD groups. Instructions to accept emotions increased anger for all participants compared to reappraisal and no strategy instructions. Results confirm that enhanced anger reactivity and poor distress tolerance are present in MDD compared to healthy controls. However, additional work is needed to further develop and implement strategies that help people with MDD manage their emotional reactivity and enhance distress tolerance.

A. J. Ellis (✉)
Semel Institute of Neuroscience and Human Behavior, University of California, Los Angeles, 760 Westwood Plaza, Los Angeles, CA 90095, USA
e-mail: aellis@mednet.ucla.edu

W. M. Vanderlind · C. G. Beevers
The University of Texas at Austin, Austin, TX, USA

Keywords Depression · Anger · Emotion regulation · Distress tolerance

Introduction

Emotion regulation has been defined as a combination of complex processes by which individuals are able to influence, either consciously or unconsciously, the intensity and duration of their emotional experience (Gross 1998, 2007). Emotions can become dysregulated when their experience or expression has either negative psychological (e.g., greater intensity or duration of negative emotion) or physiological (e.g., elevated heart rate and hypertension) consequences (Gross 1998).

Major depressive disorder (MDD), characterized by persistent and severe levels of sadness and anhedonia, has been conceptualized as a disorder of emotion regulation (Campbell-Sills and Barlow 2007; Gross and Muñoz 1995; Kovacs et al. 2008; Kring and Werner 2004). Although sadness is often considered the hallmark emotion experienced during depression, an abundance of literature suggests that anger and irritability is also concomitantly experienced by depressed individuals (e.g., Benazzi 2005; Luutonen 2007; Perlis et al. 2005). Examining anger expression in depression is important because anger has been associated with greater depression severity, increased suicide risk, lowered self-esteem, employment maladjustment, poorer interpersonal relationships, and worsened health outcomes (e.g., Williams et al. 2001; Conner et al. 2004; Perlis et al. 2005). Thus, people with MDD and elevated anger may be at particularly high risk for negative outcomes.

There is evidence that depressed mood may potentiate anger responses. In a naturalistic study where mood/

Published online: 27 October 2012

emotion ratings were collected at random times throughout the day, highly dysphoric individuals displayed greater anger responses to their daily experiences, as well as longer persistence of their negative moods (Wenze et al. 2009). This is consistent with a laboratory study that found stably dysphoric individuals responded with twice as much anger following two different frustrating tasks than non-dysphoric individuals. The dysphoric group also demonstrated lower distress tolerance (i.e., behavioral persistence on the frustrating task) than the non-dysphoric group (Ellis et al. 2010).

Unfortunately, there are no experimental studies specifically examining anger reactivity in clinically depressed individuals. Experimental studies are important because they allow for the assessment of anger reactivity to a standardized stressor—this helps ensure that all participants are responding to a highly similar event and controls for the nature and intensity of the stressor. In addition, no studies to date have examined anger reactivity in MDD across self-report, physiological and behavioral domains. Further, no studies have identified which strategies may be most beneficial to depressed individuals when they are actively regulating their emotional response.

Difficulties with anger reactivity in clinical depression may be due, in part, to an inability to access or effectively utilize adaptive emotion regulation strategies (Gratz and Roemer 2004; Ehring et al. 2010; Aldoa et al. 2010). For example, psychopathology such as MDD has been more strongly associated with the use of maladaptive emotion regulation strategies (e.g., rumination, suppression, worry and avoidance) than adaptive strategies (see Aldoa et al. 2010 for review). Such adaptive strategies include emotional acceptance and cognitive reappraisal, both of which are central features of successful treatments for depression (e.g., Beck 1976; Hayes et al. 1999), and may be potential strategies to reduce anger potentiation and increase distress tolerance in MDD.

Acceptance of emotions involves allowing emotions to occur without judgment and without attempting to alter or suppress them once generated (e.g., Hayes et al. 1999; Segal et al. 2004). Acknowledging, understanding and expressing emotions has demonstrated beneficial effects on emotion responding (i.e., reduction of anxiety and sadness), physiology (e.g., heart rate), and pain tolerance (Low et al. 2008; Stanton et al. 2000; Roche et al. 2007; Hayes et al. 1999; Masedo and Esteve 2007; Pàez-Blarrina et al. 2008). In depressed individuals specifically, acceptance has been shown to demonstrate its salutary effects in reducing negative emotional response following a recovery period, despite initial increases in negative mood following instructions to accept (e.g., Liverant et al. 2008; Campbell-Sills et al. 2006a, 2006b). Further, in recent study using partially remitted depressed individuals, treatment focusing on acceptance of emotions (specifically, Mindfulness Based Cognitive Therapy), resulted in less emotional reactivity compared to a comparison group (Britton et al. 2012). Based on these findings, use of acceptance during an emotionally evocative situation may reduce anger reactivity, decrease physiological response, and increase distress tolerance (i.e., behavioral persistence) for a frustrating task.

Another promising candidate is cognitive reappraisal. Cognitive reappraisal allows for new/different interpretations of the meaning or relevance of an emotionally evocative stimulus or event (Gross 2001; Gross and John 2003). Reappraisal, both when provided as a strategy, as well as when subjectively endorsed as an emotion regulation strategy (i.e., high use of reappraisal on self-report measures), has been found to successfully reduce negative affect, attenuate anger reactivity, and contribute to more adaptive cardiac patterns (Gross and John 2003; Mauss et al. 2007; Memedovic et al. 2010). Finally, reappraisal, compared to acceptance or suppression, was recently shown to increase task persistence and reduce anger response following an anger induction in individuals with moderate levels of state anger (Szasz et al. 2011). Given these results, reappraisal may be a viable strategy for the attenuation of anger reactivity and increasing task persistence in MDD.

The current study primarily sought to examine whether MDD individuals show dysregulated emotion reactivity to a frustrating task across three domains—self-reported emotion reactivity, behavioral persistence, and physiological reactivity to the task. In this study, behavioral persistence is being conceptualized as distress tolerance—an individual's ability to engage and continue in the pursuit of a goal, despite being affectively activated with negative emotions (Roemer et al. 2009; Bornovalova et al. 2012; Brown et al. 2002). We hypothesized that MDD individuals would display greater emotion reactivity and shorter task persistence than non-MDD individuals.

Second, although *both* acceptance and reappraisal influence emotional responses, their direct effects on anger reactivity and task persistence remain unknown in MDD. Further, there have been no direct comparisons of these strategies between MDD and non-disordered individuals to determine usage effectiveness (e.g., Liverant et al. 2008; Campbell-Sills et al. 2006a, b). Given this, the second exploratory aim was to determine whether use of specific emotion regulation strategies helps to mitigate any observed difficulties across the three domains in MDD individuals. We expected that an attempt to regulate emotions using either strategy would be more beneficial than no-strategy in both MDD and non-MDD participants.

Methods

Study Design

MDD and non-MDD individuals were randomly assigned to one of three emotion regulation conditions (acceptance, reappraisal, or no-instruction) prior to completing a frustrating laboratory task, a computerized variant of the Mirror Tracing Persistence Task (MTPT-C; Strong et al. 2003). The MTPT-C has been commonly used in the literature as a behavioral index of distress tolerance and has been demonstrated to increase anger. Change in emotion from baseline to post-task, time to task termination, and physiological changes experienced during the MTPT-C were primary outcome variables. Depression status and emotion regulation strategy condition were included as moderators of outcome.

Participants

Participants (N = 181) were recruited over multiple years from the university community and surrounding area through flyers and the psychology undergraduate research pool. All interested individuals were first screened for presence of high or low levels of depression using the short-form of the Beck Depression Inventory (BDI-SF). Those who scored above a 10 or below a 4 on this measure were invited to the lab to participate. Presence or absence of MDD was confirmed with a diagnostic interview. The MDD group (N = 74) met diagnostic criteria for a current major depressive episode and had no history of bipolar disorder or psychosis. The non-MDD group (N = 107) had no current Axis I pathology, nor a history of bipolar disorder or psychosis, and was considered a healthy control.

MDD groups (i.e., MDD vs. non-MDD) differed in BDI-II total and age but did not differ in gender or ethnicity. However, entering age as a covariate had no substantive impact on our primary outcomes, so its effects are not reported any further. Additionally, within the MDD group, results were not influenced by either the presence of an additional Axis I disorder (present in 58 %) or medication usage (present in 12 %);[1] thus, these analyses are also not reported further. Demographic information is presented in Table 1. Participants recruited from the research pool were compensated with research credit, and individuals from the community were paid $20 for participation.

Materials

Structured Clinical Interview for DSM-IV Diagnoses (SCID)

The Structured Clinical Interview for the DSM-IV Diagnoses—Patient Version (First et al. 1998) was used to determine a primary diagnosis of unipolar depression or no history of depression and diagnoses that would disqualify participants from the study. Diagnosticians were trained with over 30 h of SCID training and involved watching videos, role-playing, and rating previously recorded interviews. Each interview for the current study was audio recorded. Approximately 46 % (30 MDD and 53 non-MDD) of SCID interviews were randomly selected and evaluated by an independent rater who was blind to diagnosis to assess inter-rater reliability. Inter-rater reliability for MDD diagnosis was very good ($\kappa = 0.95$).

Beck Depression Inventory-Short Form (BDI-SF)

This is a shortened version of the BDI with 13 questions and has been shown to have satisfactory reliability in a college sample ($\alpha = 0.78$) (Gould 1982). This assessment was used to screen individuals for depression symptom severity. At the request of our Institutional Review Board, the suicidality item of the BDI-SF for this screening assessment was omitted.

[1] After selecting for individuals in the MDD group, individuals were grouped as yes (n = 26) or no (n = 45) for the presence of an additional Axis I disorder. A 2 (Axis I: yes or no) × 3 (condition) × 2 (time) mixed plot ANOVA was conducted to explore the effects of comorbidities on anger reactivity. Results indicated that individuals who had a comorbid disorder did not differ from those who were exclusively experiencing a major depressive episode in their anger responses over time. Thus, the interaction of Axis I × time was non-significant, (F (1, 65) = 0.01, $p = 0.92$, $\eta^2 = 0.00$). Further, there were no condition effects, and the time × Axis I × condition interaction was also non-significant, (F (2, 65) = 0.30, $p = 0.74$, $\eta^2 = 0.01$). For distress tolerance, the effect of an additional Axis I

Footnote 1 continued
disorder was also non-significant, F (1, 72) = 0.39, $p = 0.53$, $\eta^2 = 0.01$. The interaction of condition × Axis I disorder was also non-significant, F (2, 72) = 0.61, $p = 0.54$, $\eta^2 = 0.02$, indicating that additional Axis I diagnoses did not moderate distress tolerance.

Within the MDD group, individuals were grouped into those who are currently taking anti-depressants (n = 9) and those who are not (n = 62). A 2 (anti-depressant use: yes or no) × 3 (condition) × 2 (time) mixed plot ANOVA was conducted to explore the effects of medication on anger reactivity. Results indicated that individuals who were taking anti-depressants did not differ from those who were not in their anger responses over time. Thus, the interaction of medication use × time was non-significant, (F (1, 66) = 0.12, $p = 0.73$, partial $\eta 2 = 0.00$). Further, there were no condition effects, and the time × medication use × condition interaction was also non-significant, (F (2, 66) = 2.86, $p = 0.10$, partial $\eta 2 = 0.04$). For distress tolerance, the effect of medication use was also non-significant, F (1, 67) = 0.07, $p = 0.79$, partial $\eta 2 = 0.00$. The condition × medication use interaction was also non-significant, F (2, 67) = 0.65, $p = 0.53$, partial $\eta 2 = 0.02$.

Table 1 Demographic information of participants

	MDD	Non-MDD	Significance test
n	74	107	
BDI-II (SD)	31.19 (7.68)	10.07 (7.69)	$F = 269.18$, $p = 0.00$
Age (SD)	22.63 (7.80)	19.00 (3.48)	$F = 17.72$, $p = 0.00$
Gender	66 % Female	65 % Female	$\chi^2 = .09$, $p = 0.30$
Ethnicity			$\chi^2 = 4.91$, $p = 0.96$
Asian (%)	19	24	
African American (%)	8	6	
White (%)	49	45	
Hispanic (%)	18	23	
Other (%)	6	2	

No statistically significant differences between depression groups were observed for gender or ethnicity ($ps > 0.30$). Groups significantly differed ($ps < 0.01$) in BDI-II total and age

Profile of Mood States Short Form (POMS-SF)

The anger-hostility subscale from this measure was utilized for analyses. The subscale included 12 adjectives which participants use a 5-point Likert scale to indicate their current mood state. Examples of adjectives are angry, resentful, annoyed, and furious. The short-form subscales correlate highly with the original POMS (Curran et al. 1995). Internal consistency was good at baseline ($\alpha = 0.88$) and excellent post-task ($\alpha = 0.92$).

Demographics

All participants completed a demographics form that included age, gender, and ethnicity.

Physiological Assessments

Physiology was monitored throughout the duration of the experimental procedures. Data were obtained using a Biopac MP 150 system and processed with Acqknowledge v3.9 software (Biopac Systems Inc., Santa Barbara, CA).

Heart Rate

Electrocardiographic activity (ECG) was recorded with a Biopac ECG100C Electrocardiogram amplifier (Biopac Systems Inc., Santa Barbara, CA). Ag–AgCl electrodes were placed on the right wrist and left ankle. ECG activity was sampled at 1,000 Hz and was averaged during each epoch.

Skin Conductance

Skin conductance levels (SCL), converted to uMho, were obtained using the Biopac GSR100C (Biopac Systems Inc., Santa Barbara, California) electrodermal activity amplifier with Ag–AgCl electrodes placed on the middle segment of the middle and pointer fingers. Signals were digitized at 1,000 Hz and submitted to a 0.05-Hz high-pass filter before analysis.

Outliers

Physiological data from baseline and task completion were initially examined for outliers. Stem-and-leaf plots for heart rate (HR) and skin conductance (SCL) were generated. These plots revealed one significant outlier that was greater than three standard deviations above the mean within the heart rate data. This individual was removed from analyses.

Frustrating Task

Mirror Tracing Persistence Task-Computerized Version (MTPT-C)

Developed by Strong et al. (2003), this computerized version of the Mirror Tracing Persistence task has been shown to be difficult and frustrating (Quinn et al. 1996). Additionally, it has been used in previous research to increase participants' stress level, blood pressure and pulse rate (Matthews and Stoney 1988; Tutoo 1971). People with elevated depressive symptoms respond to this task with greater anger reactivity and lower distress tolerance (Ellis et al. 2010).

The MTPT-C required participants to move a red dot along the lines of different geometric shapes presented on a computer monitor with a computer mouse. The mouse was programmed to move the red dot in the opposite direction of physical movement of the mouse. Moving the computer mouse down and to the left resulted in the red dot moving up and to the right on the computer screen. In this way, the task simulated tracing an object that is viewed in a mirror. During the third and most difficult level of the task, participants are given an unlimited amount of time to trace the shape. Mistakes or tiny deviations off of the line resulted in loud buzzing and having to begin the level again. They are also told that they may discontinue the task by pressing a key on the keyboard. Distress tolerance was measured as time to task termination on the third shape. No incentives were provided to encourage persistence.

In the distress tolerance data, time to termination was examined for outliers. One case was identified as an overly influential outlier in post-estimation plots (i.e., this case was an outlier in a fitted values versus residuals plot and a leverage versus squared residuals plot) and was thus removed from the distress tolerance analyses. Further, given the non-normal distribution (Shapiro–Wilk: $W = 0.64$, $p = 0.00$) of the distress tolerance data, data were log10 transformed. This transformation normalized the distress tolerance data (Shapiro–Wilk: $W = 0.99$, $p = 0.10$). Transformed values were used in analyses.

Emotion Regulation Strategies

Reappraisal (RP)

Consistent with instructions used by Gross (1998), reappraisal instructions encouraged a detached and technical view of the MTPT-C. They were told that the task was being pilot tested for technical changes for an upcoming study. Specifically they were instructed, "Please try to take an unemotional and detached attitude towards the task so that this doesn't bias the feedback you'll give us when you're finished. We'll be soliciting your input on the technical aspects of this task."

Acceptance (AC)

Consistent with Low et al. (2008), participants were told to accept their emotions and experience them without negatively evaluating them or interpreting them as threatening or bad as they completed the MTPT-C. Specifically, they were instructed: "Emotions are normal, healthy and temporary reactions that may cue what is important to you in life. Accept and experience those feelings without judgment or evaluation."

No-Instruction (NI)

Participants received the standard MTPT-C instructions.

Manipulation Check

Strategy utilization and efficacy was assessed using a 2-item author-constructed scale for each active condition. Responses were given for the items using a 5-point Likert scale with anchors of "Not at All" to "Very Well." One item assessed participants' subjective ability to implement their strategy. That is, how well they were able to accept their emotions or to take a detached and technical view of the task. The second item assessed participants' opinion on the perceived effectiveness of the strategy on reducing their emotional response.

Procedure

Participants who successfully completed screening and provided informed consent then participated in a SCID interview to determine current depression status (MDD vs. Non-MDD). Individuals who met study criteria following the interview completed a series of questionnaires. Electrode pads were then fitted to participants and they were given a 10-min acclimation period. They were seated in a comfortable chair, placed in front of a computer monitor with the mouse placed next to their dominant hand, and electrode pads were connected to the recording equipment. A baseline period then began with instructions to clear their mind of all thoughts, feelings, and memories and to relax. This baseline period lasted 5-min and subjective emotion and physiology served as the pre-task assessment. Participants were then randomly assigned to one of three emotion regulation conditions: reappraisal, acceptance, and no strategy. They were then given instructions for the mirror tracing task tailored to their condition. Physiological data were continuously collected throughout the frustrating task. A post-task assessment of subjective emotion was also obtained followed by the manipulation check. Participants were debriefed, thanked, and dismissed from the study. The Internal Review Board at the University of Texas approved all procedures.

Results

Preliminary Analyses

Assessment of Manipulation

Across MDD groups, both the acceptance ($M = 3.40$, $SD = 1.12$) and the reappraisal ($M = 3.27$, $SD = 1.19$) conditions were rated similarly for ease of usage. A univariate analysis of variance was used to explore MDD group differences within each emotion regulation strategy condition. For the acceptance condition, analyses revealed non-significant depression group effects in ability to use acceptance (F (1, 66) $= 0.87$, $p = 0.36$). However, MDD groups differed in effectiveness ratings, F (1, 53) $= 10.21$, $p = 0.00$. Despite being equally able to use acceptance as instructed, depressed individuals rated it less effective than non-depressed individuals. For reappraisal, MDD groups did not differ on ability to remain detached or on the effectiveness for reducing distress, (F (1,51) $= 2.16$, $p = 0.15$ and F (1, 53) $= 0.22$, $p = 0.65$, respectively).

Skill Level

On the MTPT-C, the first two levels are completed under timed conditions. During the second level, participants' skill level was assessed with number of errors (i.e., times dot moved off the line). An ANOVA revealed a non-significant effect for MDD group status on number of errors for the second geometric shape, F (1, 167) = 1.88, $p = 0.17$. Thus, any observed group differences for emotional response or task persistence are unlikely due to differences in skill level.

Primary Analyses

Emotional Reactivity

Anger A 2 (MDD group: MDD, non-MDD) × 3 (condition: no instruction, acceptance, reappraisal) × 2 (time: pre, post) mixed plot ANOVA revealed significant main effects of time, F (1, 171) = 94.91, $p = 0.00$, partial $\eta^2 = 0.36$, MDD group status, F (1, 171) = 31.97, $p = 0.00$, $\eta^2 = 0.16$, and condition, F (2, 171) = 3.20, $p = 0.04$, partial $\eta^2 = 0.04$. In addition, an MDD group × time interaction (F (1, 171) = 5.14, $p = 0.03$, partial $\eta^2 = 0.03$) and condition × time interaction, F (2, 171) = 3.42, $p = 0.04$, partial $\eta^2 = 0.04$, were observed. The time × MDD group × condition interaction was non-significant, F (2, 171) = 1.40, $p = 0.25$, partial $\eta^2 = 0.02$. Means and standard deviations for primary outcomes are listed in Table 2.

To decompose the condition × time interaction, first the effect of condition on anger was examined at each time point. There were no significant differences in anger between emotion regulation conditions pre-task (F (2, 176) = 1.17, $p = 0.31$). However, a significant effect for condition was observed at post-task (F (2, 180) = 3.27, $p = 0.04$). Follow-up comparisons indicated significant differences between the acceptance condition and the no-instruction condition ($p = 0.03$) and between the acceptance condition and the reappraisal condition ($p = 0.02$). Participants in the acceptance condition reported the highest levels of anger compared to the other two conditions. No differences in anger were revealed between the reappraisal condition and the no-instruction condition ($p = 0.77$; see Fig. 1).

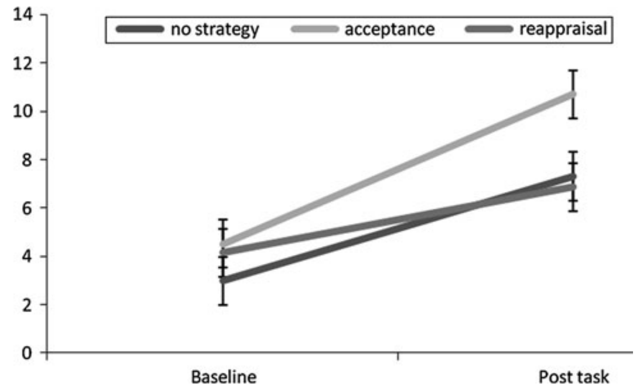


Fig. 1 Mean changes in anger reactivity between the emotion regulation strategies from baseline to post-task. *Error bars* represent standard error

For the MDD × time interaction, the effect of MDD on anger at each time point was first examined. Follow-up comparisons indicated pre-task and post-task MDD group differences in anger (pre: F (1, 175) = 24.36, $p = 0.00$, partial $\eta^2 = 0.12$; post: F (1, 179) = 27.91, $p = 0.00$, partial $\eta^2 = 0.14$). The MDD group had significantly higher anger before and following the mirror tracing task than the non-MDD group. However, even when controlling for pre-task anger, the MDD group reported significantly more post-task anger than the non-MDD group (F (1, 174) = 4.28, $p = 0.04$, partial $\eta^2 = 0.02$). Within each MDD group, follow-up analyses revealed significant effects of time for both the MDD (F (1, 70) = 48.44, $p = 0.00$, partial $\eta^2 = 0.41$) and non-MDD individuals (F (1, 105) = 41.93, $p = 0.00$, partial $\eta^2 = 0.29$), indicating that the mirror tracing task significantly increased anger over time, particularly for the MDD group (see Table 2). In sum, the MDD group reported significantly higher levels of anger following the MTPT-C compared to the non-MDD group, even after controlling for differences in anger prior to the task. Emotion regulation strategy did not differentially affect anger reactivity across MDD groups.

Physiological Emotional Reactivity

To see if the emotion regulation strategies differentially affected the MDD groups' physiological emotional reactivity to the MTPT-C, a 2 (time: baseline, during task) × 2

Table 2 Means (standard deviations) of baseline and post-MTPT-C assessments for MDD groups

	MDD		Non-MDD	
	Baseline	Post	Baseline	Post
Anger	6.31 (7.45)	12.07 (9.97)	2.11 (3.80)	5.49 (6.80)
HR (b/min)	77.01 (11.89)	76.19 (15.00)	77.69 (11.23)	75.41 (11.49)
SCL (uMho)	9.84 (6.80)	12.62 (7.44)	13.82 (8.76)	17.80 (9.96)

(MDD group: MDD, non-MDD) × 3 (condition: control, acceptance, reappraisal) mixed plot ANOVA was conducted for each physiological index (HR and SCL).

Heart Rate For heart rate, a significant effect of time, F (1, 163) = 5.09, $p = 0.03$, partial $\eta^2 = 0.03$, indicated that both groups displayed a significant reduction in HR during the task (see Table 2 for means and standard deviations). A non-significant MDD group status, F (1, 163) = 0.01, $p = 0.94$, partial $\eta^2 = 0.00$, and a non-significant emotion regulation condition status, F (2, 163) = 0.45, $p = 0.64$, partial $\eta^2 = 0.01$, were also observed. The interaction of time × MDD (F (1, 163) = 0.69, $p = 0.41$, partial $\eta^2 = 0.00$), time × condition (F (2, 163) = 0.36, $p = 0.70$, partial $\eta^2 = 0.00$), and time × condition × MDD (F (2, 163) = 0.46, $p = 0.63$, partial $\eta^2 = 0.00$) were all non-significant. Thus, heart rate decreased similarly across all conditions.

Skin Conductance Analyses revealed a significant effect for time, F (1, 163) = 177.90, $p = 0.00$, partial $\eta^2 = 0.52$, with general increases in SCL from baseline during the task. A significant effect for MDD group status, F (1, 163) = 11.76, $p = 0.00$, partial $\eta^2 = 0.07$, and a non-significant effect for emotion regulation condition, F (2, 163) = 0.34, $p = 0.71$, partial $\eta^2 = 0.00$) were observed. Further, a significant interaction between time and MDD group status, F (1, 163) = 5.32, $p = 0.02$, partial $\eta^2 = 0.03$ was also revealed. The time × condition and time × MDD × condition interaction effects were both non-significant (F (2, 163) = 0.19, $p = 0.83$, partial $\eta^2 = 0.00$; F (2, 163) = 1.98, $p = 0.14$, partial $\eta^2 = 0.02$, respectively).

Follow-up analyses of the MDD and time interaction examined the effect of time on skin conductance within each MDD group. Analyses revealed significant effects of time for both the MDD (F (1, 67) = 75.12, $p = 0.00$, partial $\eta^2 = 0.53$) and non-MDD individuals (F (1, 100) = 127.36, $p = 0.00$, partial $\eta^2 = 0.56$), indicating that the mirror tracing task significantly increased SCL across the two MDD groups. Further, follow-up comparisons between MDD groups within each time period indicated pre-task and during-task MDD group differences (pre-task : F (1, 167) = 10.02, $p = 0.00$, partial $\eta^2 = 0.06$; during-task: F (1, 168) = 13.38, $p = 0.00$, partial $\eta^2 = 0.07$). Specifically, the MDD individuals had lower skin conductance pre-task and during the task than non-MDD individuals (see Table 2). This difference in skin conductance during the task remained when controlling for pre-task SCL, (F (1, 168) = 3.68, $p = 0.057$, partial $\eta^2 = 0.02$)0.[2] Thus, the MDD group had lower skin

[2] During task differences between MDD groups also remained when controlling for time to termination ($p = 0.059$).

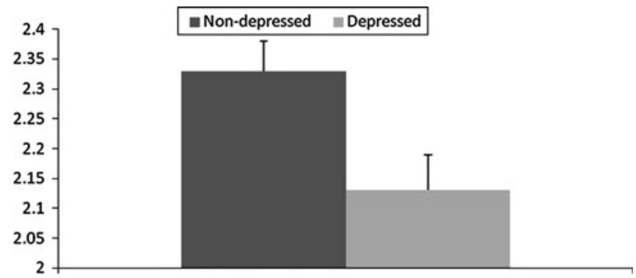


Fig. 2 Mean time to termination (log transformed values and standard errors) during the MTPT-C of depressed and non-depressed individuals

conductance at baseline and showed less change in conductance during the MTPT-C compared to the non-MDD group.

Distress Tolerance

To examine the effects of MDD and emotion regulation strategy on distress tolerance, a 2 (MDD group: MDD, non-MDD) × 3 (condition: control, acceptance, reappraisal) univariate analysis of variance was conducted with time to terminate the MTPT-C task as the dependent variable. Analyses revealed a non-significant effect of condition (F (2, 170) = 1.82, $p = 0.17$, $\eta^2 = 0.02$), a significant effect of MDD status (F (1, 170) = 7.58, $p = 0.01$, $\eta^2 = 0.04$), and a non-significant interaction of condition × MDD status (F (2, 170) = 1.27, $p = 0.28$, $\eta^2 = 0.02$). Thus, the emotion regulation strategies did not differentially affect distress tolerance. However, analyses indicate that the MDD individuals terminated the task more quickly than non-MDD individuals, suggesting lower tolerance for frustration (see Fig. 2).

Effects of MDD and Anger on Distress Tolerance

Linear regression analyses examined the effects of MDD group, anger reactivity (post task minus baseline) and the interaction of MDD group and anger reactivity on task persistence.[3] The results of the entire model explained 10 % of the variance in distress tolerance, $F(3, 172) = 6.04$, $p < 0.001$. The MDD group by anger reactivity interaction was significant ($b = -0.41$, $\beta = -0.44$, $t = -3.51$, $p = 0.001$). Specifically, anger reactivity was strongly inversely associated with persistence on the MTPT-C among the MDD

[3] Although MDD groups did not differ on overall skill level during the MTPT-C, we considered it as an important covariate of our interaction effect (i.e., MDD × anger reactivity) on task persistence. When skill was included in the model, additional variance was explained, ($R^2 = 0.37$, F (4, 168) = 23.7, $p < 0.001$). The MDD group by anger reactivity interaction remained significant ($b = -0.03$, $\beta = -0.30$, $t = -2.81$, $p = 0.01$).

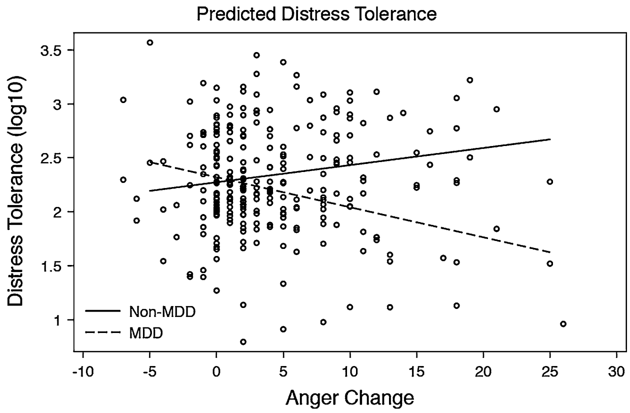


Fig. 3 Predicted values of distress tolerance (with 95 % CIs) across anger change for MDD and non-MDD individuals

group—higher anger reactivity was associated with lower task persistence. In contrast, non-MDD individuals displayed an increase in task persistence as anger increased (Fig. 3).

Discussion

The current study examined anger reactivity, distress tolerance, and physiological reactivity in individuals with and without current MDD. We also assessed the effectiveness of emotion regulation strategies across experiential, physiological and behavioral assessments. Results indicated that MDD individuals responded to the frustrating MTPT-C task with greater anger reactivity and gave up more quickly than non-MDD individuals. Results also revealed smaller changes in skin conductance in response to this task in currently depressed individuals.

This study builds upon prior work in a number of ways. First, prior work revealed greater anger reactivity and lower distress tolerance in a small analog sample of individuals in a stably dysphoric mood (Ellis et al. 2010), whereas the current study included a large number of participants who were diagnosed with MDD. Second, the current study included a physiological level of analysis, which allowed for examination of an additional component of emotional reactivity. Given the importance of replication (e.g., Yong 2012) and that the current study involved a relatively large sample of participants (Maxwell 2004), difficulties with anger reactivity and distress tolerance appear to be a reliable aspect of depression. Confirmation of this finding may be the most important aspect of this study.

These results were partially inconsistent with recent theoretical conceptualizations of emotion reactivity in MDD. The Emotion Context Insensitivity (ECI) hypothesis (e.g., Rottenberg and Gotlib 2004) describes attenuated self-reported emotional responses in depression to both positive and negative stimuli (see Bylsma et al. 2008, for review). However, the current results suggest that heightened anger reactivity, rather than blunted, may be a critical aspect of depression, especially in situations of frustration or stress. In line with this, individuals with MDD have reacted with potentiated negative affect to stressful daily events compared to non-MDD participants (Myin-Germeys et al. 2003). Rottenberg et al. (2005), however, identified several (untested) instances when heightened emotion reactivity may occur and highlighted both anxiety and anger as potentially elevated emotions. Taken together, these findings suggest that the ECI theory may require further modification to accommodate enhanced anger reactivity to frustrating situations in MDD.

Potentiated anger may be particularly important given that the data suggested that increased emotion reactivity affected behavioral responding. In the MDD group, increased anger predicted shorter task persistence indicating that depressed individuals' lack of persistence may be due to difficulties tolerating negative emotions. In fact, the MDD group's pre-task anger was higher than the post-task anger exhibited by the non-MDD group, which further suggests difficulties tolerating intense negative emotions in MDD and may suggest that depressed individuals also have difficulty regulating naturally occurring anger, as shown by differences before the task. Similar associations have been documented in a non-clinical sample between low distress tolerance and anger (Hawkins et al. in press), but this is the first study to document such a strong association in currently depressed individuals.

Further, relative to healthy individuals, MDD individuals displayed an impulsive reaction (i.e., terminating the task) in response to extreme negative emotions, while non-MDD individuals did not. This pattern is consistent with the construct of negative urgency (e.g., Cyders and Smith 2008), which describes the tendency to display rash action in response to negative emotions, and may provide the first evidence of such a style in MDD compared to those without MDD. Taken together, these findings suggest that distress tolerance, especially in MDD, may involve the interplay of (1) the tolerance for negative or distressing emotions (e.g., Simons and Gaher 2005) as well as, (2) the behavioral component of task persistence, in spite of negative affect (e. g., Roemer et al. 2009; Bornovalova et al. 2012; Brown et al. 2002). Future work should aim to measure both of these concepts simultaneously.

Although the MDD group displayed greater anger reactivity than the non-MDD group, physiological reactivity to the MTPT-C appeared to be blunted, which is consistent with ECI. Depressed individuals had lower skin conductance at baseline and had a smaller increase in skin conductance during the task than non-depressed individuals. Depression has often been associated with autonomic nervous system dysregulation with greater sympathetic and weakened parasympathetic responses, especially in cardiac activity (Lahmeyer and Bellur 1987; Lehofer et al. 1997; Byrne et al. 2010; Kibler and Ma 2004; Zuckerman et al. 1968). This suggests that heightened sympathetic responses (i.e., higher heart rate) may be expected in MDD. However, heart rate was similar for individuals with and without MDD. In general, HR decreased during the MTPT-C task. Although seemingly counterintuitive, prior work suggests that as task difficulty increases or as individuals become more focused, heart rate decreases (e.g., Albus et al. 1987; Carroll et al. 2007) implying that participants were actively engaged in the task. Interestingly, despite heart rate decreases, skin conductance levels have been found to increase with task difficulty (e.g., Elliott 1969), as was observed in our sample in both the MDD and non-MDD groups, with smaller change observed in MDD. Future work should explore possible reasons for this physiological dissociation between heart rate and skin conductance reactivity in MDD. Nevertheless, this study is the first to document blunted physiological reactivity to a frustrating task in MDD, in spite of significantly higher subjective arousal.

Emotion Reactivity and Emotion Regulation Strategy Effectiveness

Acceptance, reappraisal, and no-instruction conditions were compared to assess their effectiveness for reducing anger. Emotion regulation strategy was not moderated by MDD status across all outcomes (anger reactivity, physiology, and behavioral task persistence), indicating that there were no differences in strategy effectiveness between MDD and non-MDD individuals. In fact, both groups reported ability to use acceptance and reappraisal "moderately well".

Similar findings have been documented when depression-recovered individuals were compared to never depressed individuals in ability to benefit from an emotion regulation strategy (reappraisal) when shown a sad film clip (Ehring et al. 2010). In that study, both groups had similar emotional reactivity when provided with reappraisal instructions (Ehring et al. 2010). As such, these results support the idea that impairments in depressed and depression vulnerable individuals' emotion regulation may not be due to difficulties *utilizing* emotion regulation strategies that are provided (e.g., Gratz and Roemer 2004). Continued examination of the utilization of emotion regulation strategies, both when provided or when spontaneously used, in MDD is warranted (e.g., Aldoa et al. 2010), as the MDD group reported greater anger reactivity and lower distress tolerance across emotion regulation conditions. Identifying emotion regulation strategies (and how to best implement them) that effectively attenuate these responses is an important future direction for this line of work.

Although no differences emerged between depression groups for the effect of manipulated strategy, significant differences in anger response emerged between strategies. Acceptance was least effective for reducing anger. Both the reappraisal and no-instruction conditions resulted in lower post-task anger than the acceptance condition, which resulted in significantly higher anger after the mirror-tracing task. These results are consistent with recent findings which demonstrated significantly greater anger following a mirror-tracing task in individuals who were instructed to accept their emotions than individuals who were instructed to reappraise their emotions, following an angry mood induction (Szasz et al. 2011). These findings are also in line with work documenting initial increases in negative affect following instructions to accept emotions (e.g., Liverant et al. 2008).

Although there is strong support for acceptance based practices (e.g., Acceptance and Commitment Therapy; Hayes et al. 1999; Mindfulness Based Cognitive Therapy; Teasdale et al. 2000) for treating and preventing psychopathology, the acute effects of acceptance are less consistent. Many of the studies documenting the effectiveness of acceptance are treatment outcome studies with repeated exposure to acceptance-based techniques (e.g., Britton et al. 2012). In the current study, as well as previously noted studies (e.g., Szasz et al. 2011; Liverant et al. 2008), individuals were given a set of instructions only once. This discrepancy suggests that practice may be an integral component to the effectiveness of acceptance, especially because acceptance has been shown to be difficult to manipulate through simple instructions (e.g., Marcks and Woods 2005; Hayes et al. 1999). Additionally, in the current study, the effects of acceptance were only examined immediately following the emotional experience. It is possible that salutary effects of acceptance may have occurred at a later time point (e.g., Liverant et al. 2008).

Further, there were no differences between emotion regulation strategies in task persistence, which is contrary to recent findings indicating that reappraisal was more effective for increasing task persistence than acceptance or suppression following an angry mood induction (Szasz et al. 2011). This may be due to differences in the populations (clinical vs. non-clinical) and conditions (i.e., use of no-strategy in the current study) between the studies. It may also indicate that distress tolerance is a difficult component of emotion regulation to examine in the laboratory. In fact, in a recent review of distress tolerance and psychopathology, Zvolensky et al. (2010) highlighted the paucity of research exploring effective methods to promote change in distress tolerance.

Although our study was one of the first to attempt to identify strategies that increase depressed individuals' tolerance in the moment, the strategies (and the manner in which they were implemented) were ineffective. It may be that altering distress tolerance requires a combination of skills, rather than just one strategy. For example, in a recent randomized control trial, distress tolerance was improved by implementing a treatment consisting of a number of strategies including acceptance, distraction, and interpersonal skills (see Bornovalova et al. 2012). Improvements in distress tolerance may arise from the simultaneous usage of a number of regulation strategies. Future research should continue to investigate these mechanisms of change for distress tolerance given its prevalence in a number of psychopathologies.

Limitations

Several limitations should be noted. First, our observed effect sizes were small, so caution should be employed in interpreting these results. Second, we utilized a convenient student sample for the majority of recruitment. Thus, the generalizability of findings to less educated or older adults is limited; however, all participants completed a carefully administered psychiatric diagnostic assessment, with the MDD group meeting full criteria for a major depressive episode. Next, exclusion criteria for depressed individuals were minimal. We only excluded individuals with a history of bipolar disorder or psychosis and we allowed medication usage. Although this may reduce specificity, it increases the generalizability of the findings. Importantly, analyses suggested that the presence of an additional Axis I disorder and medication did not influence results. Further, individuals with a remitted depression were not excluded from the control group, which may be considered a limitation. The literature, however, has robustly supported a mood-state-dependent view of emotion reactivity difficulties in MDD (e.g., Rottenberg et al. 2005), suggesting that individuals with a history of depression would respond similarly to never depressed individuals, and should be included.

Other important considerations involve the potency of the strategy manipulations and ways to further increase their impact. This is especially essential given the small effect sizes observed in the current study. One possibility involves altering instructions to target the baseline mood state (i.e., pre-frustrating task mood). In the Szasz et al. (2011) study, participants were induced into an angry mood and encouraged to utilize emotion regulation strategy to reduce the induced mood, not the emotions experienced during the task, as was the case in the present study. Instructing participants to reappraise or accept their current baseline mood state (e.g., sad mood in MDD participants) rather than directing them to use these strategies during the frustrating task may have increased the efficacy of these strategies.

Another possibility for increasing strategy potency would be to provide ample time to practice. This may be particularly important for some forms of emotion regulation such as acceptance (Marcks and Woods 2005; Hayes et al. 1999). Further, it may help to have guidance in the process of practicing to increase mastery of these regulation techniques. Implementing such changes would likely increase the potency of these emotion regulation strategies in future research.

In addition to increasing the potency of our manipulations, the current study may have benefitted from gathering subjective information from individuals in the no strategy condition regarding their emotional experience. Specifically, similar to how a manipulation check assessed the usability and perceived effectiveness of each strategy, it would have been interesting to assess both *if* and *how* individuals in the control condition regulated their emotional response. It may be that these individuals used an undefined emotion regulation strategy spontaneously which contributed to the lack of differences between control and the reappraisal conditions. As mentioned previously, it may be differences in the spontaneous use or access of emotion regulation strategies that differentiates depressed from non-depressed individuals.

Finally, although the MTPT-C has been frequently utilized in the literature as a standardized measure of distress tolerance, it does have limitations. First, conceptually, behavioral measures that induce emotional distress may be tapping the construct of frustration tolerance, rather than distress tolerance (e.g., McHugh et al. 2011), which are often used interchangeably and share considerable overlap. Given the frustrating nature of the MTPT-C, the current study may have benefitted from an experimental stressor more relevant to anger, rather than frustration, to increase effects. Second, motivation is critical aspect of persistence, the primary outcome variable in the current study. Future studies should consider manipulating motivational factors (e.g., rewards) for task persistence to examine differences between MDD and non-MDD individuals. Lastly, despite being a standardized assessment, there is a great deal of variability in the MTPT-C. Because participants are able to quit the task when they want, they may quit too early and not experience the same amount of anger as someone who continues. Conversely, they may quit because of the amount of anger being experienced. Although our results point to the latter as more likely, the inherent variability in using the task as both a measure of distress tolerance and an emotional reactivity induction may not be ideal.

Summary

According to Gross's (1998) conceptualization of emotion dysregulation, emotions are dysregulated when their experience or expression has negative consequences psychologically, physiologically or behaviorally. Our results highlight that depressed individuals have difficulties in each of these areas. Specifically, increased anger, blunted physiological arousal, and decreased distress tolerance distinguished depressed and non-depressed individuals. Thus, continued work that identifies strategies that mitigate enhanced anger reactivity observed in MDD, and techniques for how to best implement these strategies, will be critical for reducing maladaptive emotional responses in MDD.

Acknowledgments Preparation for this article was facilitated by the American Fellowship, awarded to Alissa Ellis by the American Association of University Women.

Conflict of interest None.

References

Albus, M., Muller-Spahn, F., Ackenheil, M., & Engel, R. R. (1987). Psychiatric patients and their response to experimental stress. *Stress Medicine, 3*, 233–238.

Aldoa, A., Nolen-Hoeksema, S., & Schweizer, S. (2010). Emotion-regulation strategies across psychopathology: A meta-analytic review. *Clinical Psychology Review, 30*(2), 217–237.

Beck, A. T. (1976). *Cognitive therapy and the emotional disorders*. New York: New American Library.

Benazzi, F. (2005). Possible bipolar nature of irritability in major depressive disorder. *Journal of Clinical Psychiatry, 66*, 1072.

Bornovalova, M. A., Gratz, K. L., Daughters, S. B., Hunt, E. D., & Lejuez, C. W. (2012). Initial RCT of a distress tolerance treatment for individuals with substance use disorders. *Drug and Alcohol Dependence, 122*(1–2), 70–76.

Britton, W. B., Shahar, B., Szepsenwol, O., & Jacobs, W. J. (2012). Mindfulness-based cognitive therapy improves emotional reactivity to social stress: Results from a randomized controlled trial. *Behavior Therapy, 43*, 365–380.

Brown, R. A., Lejuez, C. W., & Kahler, C. W. (2002). Distress tolerance and duration of past smoking cessation attempts. *Journal of Abnormal Psychology, 111*(1), 180–185.

Bylsma, L. M., Morris, B. H., & Rottenberg, J. (2008). A meta-analysis of emotional reactivity in major depressive disorder. *Clinical Psychology Review, 28*(4), 676–691.

Byrne, M. L., Sheeber, L., Simmons, J. G., Davis, B., Shortt, J. W., Katz, L. F., et al. (2010). Autonomic cardiac control in depressed adolescents. *Depression and Anxiety, 27*, 1050–1056.

Campbell-Sills, L., & Barlow, D. H. (2007). *Incorporating emotion regulation into conceptualizations and treatments of anxiety and mood disorders*. New York, NY: Guilford Press.

Campbell-Sills, L., Barlow, D. H., Brown, T. A., & Hofmann, S. G. (2006a). Acceptability and suppression of negative emotion in anxiety and mood disorders. *Emotion, 6*, 587–595.

Campbell-Sills, L., Barlow, D. H., Brown, T. A., & Hofmann, S. G. (2006b). Effects of suppression and acceptance on emotional responses of individuals with anxiety and mood disorders. *Behaviour Research and Therapy, 44*, 1251–1263.

Carroll, D., Phillips, A. C., Hunt, K., & Der, G. (2007). Symptoms of depression and cardiovascular reactions to acute psychological stress: Evidence from a population study. *Biological Psychology, 75*, 68–74.

Conner, K. R., Meldrum, S., Wieczorek, W. F., Duberstein, P. R., & Welte, J. W. (2004). The association of irritability and impulsivity with suicidal ideation among 15- to 20- year-old males. *Suicide Life Threat Behavior, 34*, 363–373.

Curran, M. L., Andrykowski, M. A., & Studts, J. L. (1995). Short form of the profile of mood states (POMS-SF): Psychometric information. *Psychological Assessment, 7*(1), 80–83.

Cyders, M. A., & Smith, G. T. (2008). Emotion-based dispositions to rash action: Positive and negative urgency. *Psychological Bulletin, 134*(6), 807–828.

Ehring, T., Tuschen-Caffier, B., Schnulle, J., Fischer, S., & Gross, J. (2010). Emotion regulation and vulnerability to depression: Spontaneous versus instructed use of emotion suppression and reappraisal. *Emotion, 10*(4), 563–572.

Elliott, R. (1969). Tonic heart rate: Experiments on the effects of collative variables lead to a hypothesis about is motivational significance. *Journal of Personality and Social Psychology, 1969*(12), 211–228.

Ellis, A. J., Fischer, K. M., & Beevers, C. G. (2010). Is dysphoria about being red and blue? Potentiation of anger and reduced distress tolerance among dysphoric individuals. *Cognition and Emotion, 24*(4), 596–608.

First, M. B., Spitzer, R. L., Gibbon, M., & Williams, J. B. W. (1998). Structured clinical interview for DSM-IV-TR axis 1 disorders-patient edition (SCID-I/P, 11/2002 revision). New York: Biometrics Research, New York State Psychiatric Institute.

Gould, J. (1982). A psychometric investigation of the standard and long form beck depression inventory. *Psychological Reports, 51*, 1167–1170.

Gratz, K. L., & Roemer, L. (2004). Multidimensional assessment of emotion regulation and dysregulation: development, factor structure, and initial validation of the difficulties in emotion regulation scale. *Journal of Psychopathology and Behavioral Assessment, 26*, 41–54.

Gross, J. J. (1998). The emerging field of emotion regulation: An integrative review. *Review of General Psychology, 2*(3), 271–299.

Gross, J. J. (2001). Emotion regulation in adulthood: Timing is everything. *Current Directions in Psychological Science, 10*, 214–219.

Gross, J. J. (2007). *The handbook of emotion regulation*. New York: Guilford Press.

Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology, 85*, 348–362.

Gross, J. J., & Muñoz, R. F. (1995). Emotion regulation and mental health. *Clinical Psychology: Science and Practice, 2*, 151–164.

Hawkins, K. A., Macatee, R. J., Guthrie, W., & Cougle, J. R. Concurrent and prospective relations between distress tolerance, life stressors and anger. *Cognitive Therapy and Research.* doi:10.1007/s10608-012-9487-y (in press).

Hayes, S. C., Strosahl, K. D., & Wilson, K. G. (1999). The ACT model of psychopathology and human suffering. In *Acceptance and commitment therapy: An experiential approach to behavior change* (pp. 49–80). New York: Guilford Press.

Kibler, J. L., & Ma, M. (2004). Depressive symptoms and cardiovascular reactivity to laboratory behavioral stress. *International Journal of Behavioural Medicine, 11*, 81–87.

Kovacs, M., Joormann, J., & Gotlib, I. H. (2008). Emotion (dys)regulation and links to depressive disorders. *Child Development Perspectives, 2*, 149–155.

Kring, A. M., & Werner, K. H. (2004). Emotion regulation and psychopathology. In P. Philippot & R. S. Feldman (Eds.), *The regulation of emotion* (pp. 359–385). Mahwah, NJ: Erlbaum.

Lahmeyer, H. W., & Bellur, S. N. (1987). Cardiac regulation and depression. *Journal of Psychiatric Research, 21*, 1–6.

Lehofer, M., Moser, M., Hoehn-Saric, R., McLeod, D., Liebmann, P., Drnovsek, B., et al. (1997). Major depression and cardiac autonomic control. *Biological Psychiatry, 42*, 914–919.

Liverant, G. I., Brown, T. A., Barlow, D. H., & Roemer, L. (2008). Emotion regulation in unipolar depression: The effects of acceptance and suppression of subjective emotional experience on the intensity and duration of sadness and negative affect. *Behaviour Research and Therapy*,. doi:10.1016/j.brat.2008.08.001.

Low, C. A., Stanton, A., & Bower, J. (2008). Effects of acceptance-oriented versus evaluative emotional processing on heart rate recovery and habituation. *Emotion, 8*(3), 419–424.

Luutonen, S. (2007). Anger and depression—Theoretical and clinical considerations. *Nordic Journal of Psychiatry, 61*(4), 246–251.

Marcks, B. A., & Woods, D. W. (2005). A comparison of thought suppression to an acceptance-based technique in the management of personal intrusive thoughts: A controlled evaluation. *Behaviour Research and Therapy, 43*, 433–445.

Masedo, A. I., & Esteve, M. R. (2007). Effects of suppression, acceptance and spontaneous coping on pain tolerance, pain intensity and distress. *Behaviour Research and Therapy, 45*(2), 199–209.

Matthews, K. A., & Stoney, C. M. (1988). Influences of sex and age on cardiovascular responses during stress. *Psychosomatic Medicine, 50*, 46–56.

Mauss, I. B., Cook, C. L., Cheng, J. Y. J., & Gross, J. J. (2007). Individual differences in cognitive reappraisal: Experiential and physiological responses to an anger provocation. *International Journal of Psychophysiology, 66*, 116–124.

Maxwell, J. A. (2004). Using qualitative methods for causal explanation. *Field Methods, 16*(3), 243–264.

McHugh, R. K., Hearon, B. A., Halperin, D. M., & Otto, M. W. (2011). A novel method for assessing distress intolerance: Adaptation of a measure of willingness to pay. *Journal of Behavior Therapy and Experimental Psychiatry, 42*, 440–446.

Memedovic, S., Grisham, J. R., Denson, T. F., & Moulds, M. L. (2010). The effects of trait reappraisal and suppression on anger and blood pressure in response to provocation. *Journal of Research in Personality, 44*, 540–543.

Myin-Germeys, I., Peeters, F., Havermans, R., Nicolson, N. A., Delespaul, P., deVries, M., et al. (2003). Emotional reactivity to daily life stress in psychosis and affective disorder: An experience sampling study. *Acta Psychiatrica Scandinavica, 107*, 124–131.

Pàez-Blarrina, M., Luciano, C., Gutiérrez-Martínez, O., Valdivia, S., Rodríguez-Valverde, M., & Ortega, J. (2008). Coping with pain in the motivational context of values: Comparison between an acceptance-based and a cognitive control based protocol. *Behavior Modification, 32*, 403.

Perlis, R. H., Fraguas, R., Fava, M., Trivedi, M. H., Luther, J. F., Wisniewski, S. R., et al. (2005). Prevalence and clinical correlates of irritability in major depressive disorder: A preliminary report from the sequenced treatment alternatives to relieve depression study. *Journal of Clinical Psychiatry, 66*, 159–166.

Quinn, E. P., Brandon, T. H., & Copeland, A. L. (1996). Is task persistence related to smoking and substance abuse? Applying learned industriousness theory to addictive behaviors. *Experimental and Clinical Psychopharmacology, 4*, 186–190.

Roche, B., Forsyth, J. P., & Maher, E. (2007). The impact of demand characteristics on brief acceptance- and control-based interventions for pain tolerance. *Cognitive and Behavioral Practice, 14*(4), 381–393.

Roemer, L., Lee, J. K., Salters-Pedneault, K., Erisman, S. M., Orsillo, S. M., & Mennin, D. S. (2009). Mindfulness and emotion regulation difficulties in generalized anxiety disorder: Preliminary evidence for independent and overlapping contributions. *Behavior Therapy, 40*, 142–154.

Rottenberg, J. M., & Gotlib, I. H. (2004). Socioemotional functioning in depression. In M. Power (Ed.), *Mood disorders: A handbook of science and practice* (pp. 61–77). New York: Wiley.

Rottenberg, J. M., Gross, J. J., & Gotlib, I. H. (2005). Emotion context insensitivity in major depressive disorder. *Journal of Abnormal Psychology, 114*(4), 627–639.

Segal, Z. V., Teasdale, J. D., & Williams, J. M. G. (2004). Mindfulness-based cognitive therapy: Theoretical rationale and empirical status. In S. Hayes, V. Follette, & M. Linehan (Eds.), *Mindfulness and acceptance: Expanding the cognitive behavioral tradition*. New York: Guilford Press.

Simons, J. S., & Gaher, R. M. (2005). The distress tolerance scale: Development and validation of a self-report measure. *Motivation and Emotion, 29*(2), 83–102.

Stanton, A. L., Kirk, S. B., Cameron, C. L., & Danoff-Burg, S. (2000). Coping through emotion approach: Scale construction and validation. *Journal of Personality and Social Psychology, 78*(6), 1150–1169.

Strong, D. R., Lejuez, C. W., Daughters, S., Marinello, M., Kahler, C. W., & Brown, R. A. (2003). *The computerized mirror tracing task, version 1* (unpublished manual).

Szasz, P. L., Szentagotai, A., & Hofmann, S. G. (2011). The effect of emotion regulation strategies on anger. *Behaviour Research and Therapy, 49*, 114–119.

Teasdale, J. D., Segal, Z., Williams, J. M. G., Ridgeway, V. A., Soulsby, J. M., & Lau, M. A. (2000). Prevention of relapse/recurrence in major depression by mindfulness-based cognitive therapy. *Journal of Consulting and Clinical Psychology, 68*, 615–623.

Tutoo, D. N. (1971). Psychodiagnostic applications of the mirror tracing test. *Indian Educational Review, 6*, 293–303.

Wenze, S. J., Gunthert, K. C., Forand, N. R., & Laurenceau, J. P. (2009). The influence of dysphoria on reactivity to naturalistic fluctuations in anger. *Journal of Personality, 77*(3), 795–824.

Williams, J. E., Nieto, F. J., Sanford, C. P., & Tyroler, H. A. (2001). Effects of an angry temperament on coronary heart disease risk: The Atherosclerosis Risk in Communities Study. *American Journal of Epidemiology, 154*, 230–235.

Yong, E. (2012). Replication studies: Bad copy. *Nature, 485*(17), 298–300.

Zuckerman, M., Persky, H., & Curtis, G. C. (1968). Relationships among anxiety, depression, hostility and autonomic variables. *Journal of Nervous and Mental Disease, 146*(6), 481–487.

Zvolensky, M. J., Vujanovic, A. A., Bernstein, A., & Leyro, T. (2010). Distress tolerance: Theory, measurement, and relations to psychopathology. *Current Directions in Psychological Science, 19*, 406.