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Emotion Regulation and Mania Risk: Differential Responses to Implicit and Explicit Cues to Regulate

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Abstract

Background and Objectives—People prone to mania use emotion regulation (ER) strategies well when explicitly coached to do so in laboratory settings, but they find these strategies ineffective in daily life. We hypothesized that, compared with control participants, mania-prone people would show ER deficits when they received implicit, but not explicit, cues to use ER.

Methods—Undergraduates ($N = 66$) completed the Hypomanic Personality Scale (HPS) and were randomly assigned to one of three experimental conditions: automatic ER (scrambled sentence primes), deliberate ER (verbal instructions), or control (no priming or instructions to use ER). Then, participants played a videogame designed to evoke anger. Emotion responses were measured with a multi-modal assessment of self-reported affect, psychophysiology, and facial expressions. Respiratory sinus arrhythmia (RSA) was used to index ER.

Results—The videogame effectively elicited subjective anger, angry facial expressions, and heart rate increases when keys malfunctioned. As hypothesized, persons who were more mania prone showed greater RSA increases in the deliberate ER condition than in the automatic or control conditions.

Limitations—One potential limitation is the use of an analog sample.

Conclusions—Findings suggest that those at risk for mania require more explicit instruction to engage ER effectively.

Keywords

mania risk; emotion regulation; implicit emotion regulation; heart rate variability; respiratory sinus arrhythmia

1. Introduction

Emotions can work to one's advantage but can also be dysfunctional when displayed with the wrong intensity, frequency, or in an inappropriate situation. Emotion regulation (ER) is a process by which people alter their responses to emotional situations (Gross & Thompson, 2007). Most ER research has focused on conscious processes, including the effects of explicit instructions to regulate emotions. Explicit instructions to use specific ER strategies

change emotional responses, as measured by self-reported affect, facial affect displays, physiology, and brain scans (Gross, 2007).

Despite the dominant research focus on conscious ER processes, it has been suggested that most ER occurs automatically and outside of conscious awareness (Bargh & Williams, 2007; (Mauss, Bunge, & Gross, 2007). Automatic ER has been found to predict less self-reported anger after an anger provocation task, whether automatic ER is measured implicitly (Mauss, Evers, Wilhelm, & Gross, 2006) or induced by priming (Mauss, Cook, & Gross, 2007).

The distinction between automatic and deliberate ER may shed light on a puzzle in bipolar disorder (BD). Research shows that people diagnosed with BD endorse using ER strategies at least as frequently as do controls (Fletcher, Parker & Manicavasagar, 2013; Green, Cahill, & Malhi, 2007; Gruber, 2008; Gruber, Eidelman, & Harvey, 2008; Gruber, Eidelman, Johnson, Smith, & Harvey, 2011; Gruber, Harvey, & Gross, 2012; Johnson, McKenzie, & McMurrich, 2008; Rowland, Hamilton, Lino et al., 2013; Thomas, Knowles, Tai, & Bentall, 2007). Parallel with this literature in diagnosed persons, persons at high risk for mania, as defined by measures of subsyndromal manic symptoms, also report using ER strategies as frequently as those at low risk (Bentall et al., 2011; Knowles, Tai, Christensen, & Bentall, 2005). Laboratory studies suggest that when explicitly coached to use ER, people diagnosed with BD also modify their affect as successfully as control participants (Green et al., 2011; Gruber, 2008; Gruber et al., 2012; Rowland, Hamilton, Lino et al., 2013). Despite the evidence for people with BD to use ER strategies well and often, the disorder is defined by extreme and persistent affective states that would suggest ER failures may be involved. More specific self-report research indicates that they experience more difficulty with effective ER engagement in the regulation of anger compared to controls (Rucklidge, 2006). We hypothesized that people at high risk for mania would implement ER strategies effectively when explicitly coached to do so, but would fail to implement such strategies in response to implicit cues to regulate, particularly when facing a challenging emotional situation.

To examine the engagement of ER, we chose a videogame designed to evoke anger. Anger was selected because it is difficult to regulate for most people. It is also a core diagnostic criteria for mania, and so may be particularly relevant for understanding the affective disturbance of bipolar disorder. Before playing the videogame, participants were randomly assigned to either 1) receive deliberate instructions to regulate their mood using reappraisal (Gross & Thompson, 2007), 2) receive implicit cues to regulate their mood, or 3) receive an inactive (control) manipulation. ER was assessed with a multimodal battery of subjective affect, psychophysiology, and facial expressivity.

To assess lifetime manic propensities, we used a well-validated measure of subsyndromal manic symptoms. Though analog research has disadvantages, people at risk for bipolar disorder endorse difficulties with intense emotions (Heissler, Kanske, Schonfelder, & Wessa, 2014) and research has shown that they too use ER, parallel to diagnosed samples (Gruber, 2008; Gruber et al., 2012). Use of an analog sample allowed us to test ER without the confound of medication.

2. Methods

2.1 Participants

Participants were undergraduates recruited through a research participation pool. Students receive partial credit in psychology courses for participating in research studies or completing alternative assignments. Students are recruited through a website with brief descriptions of research studies. To ensure effectiveness of the priming task, inclusion criteria specified that students had spoken English for at least 10 years.

Although 86 people were recruited, 66 participants (40 female, age range 18–33, M age = 20.62, $SD = 3.18$) were included in statistical analyses due to responses on a funneled debrief (discussed in results). The sample contained a mix of ethnicities: 27% White, 47% Asian and South American, 3% African American, 15% other or multiple ethnicities, and 8% unidentified.

2.2 Experimental Conditions

Participants were randomly assigned to one of three conditions: automatic ER, deliberate ER, or control. For each condition, participants completed a sentence-unscrambling task (unscramble 10 five-word sentences to create grammatically correct four-word sentences) and received verbal instructions. A previously validated version of sentence-unscrambling task was used to prime ER in the automatic ER group (Mauss, Cook & Gross, 2007; Williams, Bargh, Nocera, & Gray, 2009) by using sentences with words like *analyze*, *perspective*, and *stable* (e.g., “Keep things in perspective”). The sentence-unscrambling task used in the deliberate ER and control conditions contained comparable sentences without ER-relevant words.

After the sentence-unscrambling task, participants received verbal instructions. In the deliberate ER condition, instructions to reappraise included, “... *We’ve found that the best way to do that [perform well] is to adopt a neutral, analytic, and unemotional attitude toward the game. Please try to stay as focused as possible, and try to think about the situation objectively. So, in order to achieve your best performance, remember to think about the game in a way that is not emotionally relevant to you.*”

In contrast, the instructions in the automatic and control conditions focused on engagement and performance, “... *We’ve found that the best way to do that [perform well] is to make sure you attend to what happens in the game. Please try to stay as focused as possible. So, in order to achieve your best performance, try to concentrate on the game and on what you need to accomplish to perform well.*”

2.3 Procedure

After informed consent procedures were completed, psychophysiological sensors were attached by a same-gender experimenter. Participants then viewed videogame instructions on a computer monitor and were informed that they could earn money based on their performance in the game. Participants were given three minutes to practice the game during which they did not earn any money, and then the experimental manipulation — of

unscrambled sentences and verbal instructions — was performed. Participants then played the Retro Runner game for five minutes and completed a mood check. The session ended with removal of sensors, a funneled debrief and an explanation of the deception regarding the broken keys during the game. After the debrief, all participants re-consented for the use of their data.

2.4 Materials

2.4.1 Retro Runner videogame—The Retro Runner videogame was designed to induce anger by engaging participants in an approach-oriented task and then thwarting their performance (Edge, Lwi, & Johnson, 2014), drawing on evidence that similar games induce emotions effectively (Kaiser, Wehrle, & Edwards, 1994). The game has been shown to induce changes in heart rate, angry facial expressions, and subjective anger (Edge, Lwi, & Johnson, 2014). The game was presented on a wall-mounted flat-screen monitor measuring 35 × 19.5 inches. Participants were seated at a table in front of the screen and played the game using a cordless keyboard. Performance was rewarded by a small amount of money (between \$1 and \$6) to encourage engagement in the game.

The game was designed to be simple. Participants were asked to navigate a vehicle along a two-dimensional plane. Forward motion is outside the control of the player — the player uses arrow keys to steer the vehicle left or right. During the game, participants won money by steering to goal-facilitating power-ups and lost money by hitting goal-thwarting obstacles. Collection of power-ups and collision with obstacles were accompanied by sound effects and visual notices informing participants of how much money they had received or lost. At the end of Retro Runner the screen revealed the participant's earnings.

As noted above, participants played a practice round of Retro Runner for three minutes to gain familiarity and provide an index of their skill level. This skill level was used to calibrate the game difficulty for each participant (five difficulty levels were pre-programmed). The speed of the game increased incrementally during the practice only.

After practice, participants played the game for five minutes. To induce anger, the keyboard controls were programmed to stop working temporarily during two 30-second periods beginning at three minutes and again at four minutes 30 seconds. Participants' scores decreased during these periods because they could not steer the vehicle to avoid obstacles. Error messages flashed on the screen to highlight that the participants were losing money.

2.4.2 Physiological measurements—Autonomic physiological responses were measured at a sampling rate of 1 kHz using Mindware Technologies (Gahanna, Ohio). Data was cleaned using MindWare's HR and RSA analysis suite. ECG was collected using a modified Lead II configuration where pre-gelled silver electrodes were attached to the right collarbone, left side of lower ribs, and right side of lower ribs as a ground. A respiration belt was buckled around the chest just under the arms of each participant.

Heart rate (HR) was gathered as an index of activation expected to increase with anger. Respiratory sinus arrhythmia (RSA) a measure of heart rate fluctuations across the respiratory cycle (Denson, Grishan, & Moulds, 2011; Fortunato, Gatzke-Kopp, & Ram,

2014, is generally considered a marker of the control of the parasympathetic nervous system over cardiac arousal. Higher RSA has been interpreted as indexing a capacity for flexible affective reactivity which is empirically linked to ER engagement, whereas lower RSA has been related to low capacity to respond to situational challenges and emotion dysregulation (Butler, Wilhelm, & Gross, 2006; Fortunato, Gatzke-Kopp, & Ram, 2014; Porges, 2007; Thayer & Lane, 2000). BD has been linked to diminished RSA (Henry, Minassian, Paulus, Geyer, & Perry, 2010).

Psychophysiological data was reviewed for outliers by visual inspection in 1-minute intervals using Mindware software. HR was calculated from the R-R intervals in the ECG. RSA was calculated as the natural log of the high frequency power (.12 – .40Hz), a validated method for isolating parasympathetic vagal influence on the heart (Berntson et al., 1997).

Preliminary analyses using repeated-measures ANOVAs indicated that RSA declined from 0–60 seconds of the game but was stable from 61–120 seconds. Parallel findings were obtained for HR. Given this, the two 30-second segments from 61–120 seconds were averaged as a baseline index of HR and RSA before the anger induction.

2.4.3 Facial coding—Participants were video recorded during the Retro Runner task using a camera above the monitor. The Emotional Expressive Behavior system (EEB; Gross & Levenson, 1993), a coding system adapted from the Facial Action Coding System (Ekman & Friesen, 1978), was used to code facial expressions. Raters assign anger codes in each second on the basis of specific facial actions on a scale of 0 (*absent*) to 3 (*strong*).

A female coder was trained by experts in the EEB. After training, the coder consistently achieved reliability (intraclass correlations) of .70 or higher with other trained coders before evaluating study videos. The coder was unaware of participants' experimental condition and scored facial expressions with audio muted. The number and intensity of facial expressions of anger per 30-second segment of the game were summed.

2.4.4 Hypomanic Personality Scale (HPS)—The HPS is a 48-item self-report scale designed to assess risk of bipolar disorders (Eckblad & Chapman, 1986). Items assess lifetime experiences of subsyndromal manic symptoms including heightened positive emotions, energy, and extraverted behavior, and related traits. In a validation study, 78% of people who scored two standard deviations or more above the mean of the HPS met criteria for a diagnosis of bipolar disorder (Eckblad & Chapman, 1986). A 10 to 13-year follow-up study showed that high HPS scores predicted high risk of receiving a bipolar disorder spectrum diagnosis (Kwapil et al., 2000), and the scale has been related to genetic polymorphisms observed in bipolar disorder (Johnson, Carver, Joormann, & Cuccaro, 2014). The scale has good reliability ($\alpha = .87$) and sound test-retest reliability after a 15-week interval ($r = .81$; $\alpha = 0.81$; Eckblad & Chapman, 1986). In the current study, the mean HPS was 17.18 ($SD = 8.954$, range = 0 to 38), internal consistency was good ($\alpha = .88$), and 6 persons obtained scores above the threshold suggested by Eckblad and Chapman (1986) of 1.5 SDs above the mean.

2.4.5 Mood Check—Participants were asked questions regarding their levels of “Anger” (a composite variable of frustration, irritation, and anger mood scores; $\alpha = .64$), and “Excitement” (a composite variable of excitement and enthusiasm mood scores; $\alpha = .91$). Each adjective was rated on a 5-point Likert scale ranging from 1 (*Very slightly or not at all*) to 5 (*A lot*). So as not to cue ER, these items were asked after the game. Participants were asked to rate their current mood, “How are you feeling right now?” and to report on their mood during the game when they were “doing well” versus “doing poorly”.

2.4.6 Debrief—A verbal debrief was used after task completion to assess participants’ awareness of the automatic ER instructions and the anger manipulation (key malfunction during play). Participants were asked, “*Did you notice anything about the game?*” and “*Did you notice anything about the controls?*” Participants also completed a written questionnaire to assess their awareness of the study goals and deception components. Participants were then informed with a scripted debrief that the keys were programmed to stop working and that the scrambled sentences may have contained a prime.

3. Results

Participants were excluded if they indicated an awareness of the purpose of the sentence-unscrambling task ($n = 5$), an awareness of the deception of key malfunction ($n = 9$), or, if they knew the study hypotheses before they were revealed ($n = 8$), yielding 66 participants whose data were analyzed. Missing data due to technological problems yielded the following sample sizes per dependent variable: mood ($n = 65$), RSA ($n = 58$), and facial affect ($n = 54$). Descriptive statistics for dependent variables are presented in Table 1. HPS scores did not differ significantly by condition, $F(2, 55) = 1.24, p = .30$.

3.1 Preliminary Analyses: Did the Retro-Runner Task Induce Anger?

Two dependent means t-tests were performed using the post-game “doing well” versus “doing poorly” ratings for anger and excitement. There was a significant increase in anger scores (M doing well = 1.18, $SD = .45$; M doing poorly = 2.44, $SD = .99$), $t(64) = 10.29, p < .001$, and a significant decrease in excitement scores (M doing well = 3.28, $SD = 1.04$; M doing poorly = 2.05, $SD = .95$), $t(64) = -8.41, p < .001$. Participants’ facial displays of anger increased from baseline to both the first key malfunction, *paired* $t(53) = 2.91, p = .005$, and the second key malfunction, *paired* $t(53) = 3.116, p = .003$.

As an index of arousal, we examined heart rate when keys malfunctioned. Although participants did not experience a significant increase in heart rate during the first 30-second key malfunction period, *dependent* $t(58) = -.724, p = .472$, they did experience a significant increase in heart rate from baseline to the second key malfunction period, *dependent* $t(57) = 2.150, p = .036$, consistent with previous findings with this paradigm (Edge, Lwi, & Johnson, 2014). Speculatively, the first key malfunction period was too early in the game (e.g., before performance was stable enough for participants to notice as clearly) to induce significant physiological reactivity. Given this, we focus on the second key malfunction period in analyses of hypotheses.¹

¹Analyses of group effects for the first period in which the keys failed also did not suggest interactions of the HPS with ER condition.

3.2 Primary Hypothesis: Effects of HPS Score and Automatic ER on Emotion Indices

To examine primary hypotheses, we estimated three separate hierarchical multiple regressions, one for each of three dependent variables: self-rated anger, facial expressions of anger, and RSA. In each regression, the independent variables were baseline state, ER condition (dummy coded to contrast the two ER conditions with the control condition, and to contrast the automatic and deliberate conditions per our hypotheses), HPS score, and interactions of HPS score with the ER condition contrasts. Our main hypotheses concerned the interaction of HPS score with ER condition. For each regression, baseline state was entered in the first block, the two dummy coded contrasts for ER condition in the second block, HPS score in the third block, and interactions of HPS score with the two ER condition contrasts in the fourth block. All terms were entered using forced entry. All β scores reported are final; B's for the specific contrasts of condition are only reported when the overall block for condition was significant.

3.2.1 Self-rated anger—Participants who reported more subjective anger at baseline showed a nonsignificant trend to report more anger when the keys broke, $R^2 = .06$, $p = .06$, $\beta = .29$, $p = .04$. After adjusting for baseline anger, subjective anger when the keys broke was not significantly correlated with ER condition, $R^2 = .006$, $p = .82$, HPS, $R^2 = .000$, $p = .98$, $\beta = -.007$, $p = .96$, nor with the interaction of HPS x ER condition, $R^2 = .026$, $p = .45$. The final model accounted for only 9% of the variance, $F(6, 58) = .92$, $p = .49$.

3.2.2 Facial displays of anger—Participants who displayed more anger on their faces at baseline also displayed more anger when the keys broke, $R^2 = .13$, $p = .006$, $\beta = .35$, $p = .006$. After adjusting for baseline anger displays, there was no evidence that the degree of anger display when the keys broke was related to ER condition, $R^2 = .008$, $p = .79$. Participants with higher HPS scores displayed significantly greater increases in anger displays, $R^2 = .16$, $p = .002$, $\beta = .40$, $p = .002$. The relationship between anger displays and HPS scores did not vary significantly by condition, $R^2 = .05$, $p = .16$. The final model accounted for 35% of the variance in facial anger displays, $F(6, 47) = 4.20$, $p = .002$.

3.2.3 RSA—Before examining RSA, respiratory rate was examined as a potential confound variable. Respiratory rate was not related to HPS, ER condition, nor the interaction of HPS x ER condition, all $R^2 < .05$, all p 's $> .22$

RSA when the keys malfunctioned was significantly correlated with baseline RSA, $R^2 = .38$, $F(1,56) = 34.29$, $p < .001$, $\beta = .64$, $p < .001$. After adjusting for baseline RSA, ER condition did not relate to RSA, $R^2 = .02$, $p = .36$. Final β 's, with all other variables entered, however, were significant: $\beta_{\text{control versus active ER}} = .70$, $p = .008$, $\beta_{\text{automatic versus deliberate ER}} = .70$, $p = .008$. The main effect of HPS was not significant, $R^2 = .003$, $\beta = .063$, $p = .54$. The main effects of ER condition were qualified by a significant interaction of HPS x ER condition, $R^2 = .09$, $p = .01$, with significant β coefficients for the interaction of HPS with ER versus the control condition, $\beta = -.62$, $p = .02$, and for the interaction of HPS with the automatic versus deliberate condition contrast, $\beta = -.76$, $p = .005$. The final model accounted for 50% of the variance, $F(6,51) = 8.526$, $p < .001$. As shown in Figure 1, HPS were unrelated to changes in RSA for those who were assigned to either the control, partial r controlling for

baseline RSA = $-.16$, $p = .48$ or the automatic ER condition, partial $r = -.28$, $p = .27$. In contrast, consistent with the hypothesis that those with high HPS scores would show greater regulatory ability when coached to do so, higher HPS related to higher RSA in the deliberate ER condition, partial $r = .59$, $p = .01$.²

4. Discussion

Previous literature has found that people at risk for mania or diagnosed with bipolar disorder can employ emotion regulation (ER) effectively when coached to do so. Nonetheless, people prone to mania seem to experience failures of ER in their daily life. We theorized that in the absence of structured reminders, those at risk for mania might be less likely to implement ER strategies. Accordingly, we examined the effectiveness of automatic ER among those at risk for bipolar disorder. Our emotion induction successfully induced anger, as shown by self-report, heart rate, and facial expressions. There was also some indication that people with high HPS scores were more reactive, in that HPS scores were correlated with greater increases in facial expressions of anger when the keys broke. This is consistent with previous findings regarding heightened anger expressivity among those diagnosed with bipolar I disorder (Edge, Lwi, & Johnson, 2014).

We hypothesized that mania-prone individuals (those with higher HPS scores) would only display effective ER when deliberately instructed to use strategies like reappraisal. Consistent with this, participants with higher HPS scores showed an increase in RSA only in the deliberate ER condition, and not in the implicit or the control ER conditions. That is, implicit cuing did not appear to be powerful enough to engage increases in RSA for those with high HPS scores. As context for this finding, a growing body of research suggests that most ER in healthy populations may occur through implicit, rather than explicit, processes.

Before considering implications, we acknowledge several limitations. First, facial displays of anger were relatively rare, and this might have contributed to the failure to identify significant differences in facial anger expressions by ER condition. Second, self-ratings of anger were retrospective to avoid cuing participants to regulate their emotions. The failure to capture affect in real time may have interfered with the sensitivity to fluctuations, and indeed, self-rated affect showed no links with either ER condition or HPS scores. Effects may also have been constrained by the limited range of mania risk; a sample with more high risk participants or with a clinically diagnosed group might have yielded stronger effects. Only one (RSA) out of three channels of emotion appeared to be sensitive to the direct effects of the ER condition. Although RSA is arguably the most objective assessment of regulation within this study, the absence of effects of deliberate versus automatic ER manipulations on facial or self-reported affect contrasts with previous studies (Mauss et al., 2006; Mauss, Cook, & Gross, 2007) even though power was adequate for detecting a moderate size effect (Cohen's $d = .38$; Faul, Erdfelder, Lang, & Buchner, 2007). A more powerful anger induction, such as an interpersonal challenge, may be a better test of ER

²To ensure that effects observed were specific to the key malfunction period, separate, parallel regressions examined emotion indices in the period after the key malfunction. There were no significant effects of the ER condition, HPS, or the interactions of HPS and the condition contrasts for anger expression, mood change, or RSA (all $R^2 < .114$, p 's $> .075$). These findings suggest that anger effects were specific to when the keys failed, and that anger was short lived.

manipulations (Mauss et al., 2006; Mauss, Cook, & Gross, 2007); even though 90% of participants reported a subjective increase in anger, most of the increases in self-reported affect were slight, and did not translate into facial expressions of anger. We must acknowledge, however, that there was limited support for the efficacy of automatic emotion regulation in this study, regardless of HPS level.

In sum, current findings provide a replication that a new standardized laboratory paradigm can effectively induce anger (Edge, Lwi, & Johnson, 2014), providing an easily implemented method for studying anger. Our findings support previous research in showing that individuals at high risk for mania effectively increased their RSA response when explicitly instructed to regulate their emotions (Gruber, 2008; Gruber, Harvey, & Gross, 2012). Our findings, though, are novel in showing that those at high risk for mania did not show heightened RSA responses with implicit priming or with no instruction to regulate. Though our study focused on anger, this finding may provide a clue to the difficulty these individuals have in regulating other heightened affective states. If replicated, current findings indicate the importance of offering more directive instructions to cue ER for those at risk for bipolar disorder. The findings also add to a growing body of research suggesting continuity in the emotion problems experienced by those at high risk for bipolar disorders and those diagnosed with bipolar disorders.

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Figure 1.
Effects of HPS score and Experimental Condition on RSA during Broken Key Period,
Controlling for Baseline RSA

Table 1

Descriptive Statistics

Dependent variable	Time	Automatic ER		Deliberate ER		Control	
		<i>n</i>	<i>M (SD)</i>	<i>n</i>	<i>M (SD)</i>	<i>n</i>	<i>M (SD)</i>
Self-rated Anger	Keys working	19	1.11 (0.22)	20	1.12 (0.33)	26	1.28 (0.61)
	Keys malfunctioning	19	2.30 (0.76)	20	2.50 (1.18)	26	2.50 (1.02)
RSA	Baseline	19	5.84 (1.06)	19	5.55 (0.86)	22	5.51 (1.24)
	Broken key period	18	5.97 (1.30)	18	5.56 (1.16)	22	5.67 (1.41)
Facial affect: Anger	Baseline	15	0.60 (0.69)	17	0.56 (0.95)	22	0.47 (0.57)
	Broken key period	15	2.20 (4.43)	17	1.65 (3.60)	22	2.27 (3.63)
Retro Runner Performance		19	3.77 (0.75)	21	3.67 (0.93)	26	3.38 (1.17)

Note: M = mean; SD = standard deviation.