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BRIEF REPORTS

Does Processing of Emotional Stimuli Predict Symptomatic Improvement and Diagnostic Recovery From Major Depression?

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This study was designed to examine whether processing of emotional stimuli predicts both symptomatic improvement and recovery from depression. Participants diagnosed with Major Depressive Disorder (MDD) ($N = 63$) completed information-processing tasks to assess attention to and memory for sad, physically threatening, socially threatening, and happy stimuli. At a follow-up session an average of nine months later, participants were reassessed to determine diagnostic status and depression severity. None of the measure of attention or memory predicted diagnostic status at follow-up. Those depressed participants who remembered a higher proportion of positive words that they had endorsed as self-descriptive exhibited greater symptomatic improvement. After controlling for memory of positive self-referential words, attentional measures did not predict symptomatic change. These results are consistent with a growing literature highlighting the importance of emotionally relevant memory processes for understanding the course of major depression.

Keywords: depression, recovery, information processing, memory, attention

Cognitive models propose that depression is associated with biases in cognitive processes—in particular, in attention to, interpretation of, and recall of positive and negative stimuli (Beck, 1967). Indeed, considerable research suggests that depressed individuals demonstrate negative biases in memory (e.g., Mathews & MacLeod, 2005). Although biases in attention were initially difficult to demonstrate in depression, studies using tasks with longer stimulus durations have documented negative biases in attention (e.g., Gotlib et al., 2004). Early findings suggested that biases in memory and attention diminish as depressive symptoms remit (e.g., Gotlib & Cane, 1987); more recent investigations, however, that have included a priming strategy such as a negative mood induction have demonstrated that cognitive biases can be activated even after recovery from depression, suggesting that cognitive biases are not merely symptoms of a depressive episode (e.g., Timbremont & Braet, 2004).

While there is now relatively consistent evidence that depression is associated with cognitive biases, whether these processes predict the course of depression is less clear. Several studies have found cognitive biases predict changes in depressive symptoms in non-clinical samples (cf. Rude, Wenzlaff, Gibbs, Vane, & Whitney, 2002). Bellew and Hill (1991), for example, found that recalling relatively more negative than positive self-referential words on a self-referent encoding task during pregnancy predicted depressive symptoms after childbirth.

Less empirical attention has been paid to whether cognitive processes serve to maintain depression among individuals who are already depressed (e.g., Teasdale, 1988). Most investigations examining this issue have focused on overgeneral recall of positive or negative autobiographical memories (Brittlebank, Scott, Williams, & Ferrier, 1993). Fewer studies have examined whether attention to and memory for experimenter-presented emotional stimuli are associated with the maintenance of depression, and available studies have focused on seasonal affective disorder (Dalgleish et al., 2004) or have used a single measure of information processing (Dent & Teasdale, 1988). The present investigation examined the ability of measures of attention and recall of emotionally relevant stimuli to predict symptomatic improvement and diagnostic recovery from Major Depressive Disorder (MDD). More specifically, we examined whether responses to the dot-probe task (assessing selective attention to negative and positive facial expressions) and the self-referent encoding task (SRET; assessing recall of positive- and negative-content adjectives) predict subsequent change in symptoms and diagnostic status.

Beck (1967) postulated that themes of loss, rejection, and disappointment characterize schemas of people diagnosed with depression, whereas themes of social and physical threat characterize schemas of patients diagnosed with anxiety disorders. Although this differentiation has mixed empirical support (see Beck &

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Perkins, 2001), there are few studies of content specificity in information processing. Because of the high comorbidity of these two disorders and because cognitive biases appear to operate in social anxiety and panic disorder (Mathews & MacLeod, 2005), we excluded depressed individuals with comorbid diagnoses of social phobia or panic disorder. We assessed responses of individuals diagnosed with MDD to stimuli with sad, physically threatening, socially threatening, and happy content. We hypothesized that the course of depression would be predicted by measures of attention and memory for sad and happy, but not for physically or socially threatening stimuli. In sum, the current study was designed to examine whether attention and recall indices predict the maintenance of depression, beyond the variance accounted for by initial depression levels.

Method

Cross-sectional analyses of this dataset were published previously. Those analyses revealed that, compared to participants with social anxiety and never depressed controls, participants with MDD endorsed more negative and fewer positive words as self-referential, remembered more of the negative and fewer of the positive words that they endorsed, and attended selectively to sad faces on the emotion-faces dot-probe task (Gotlib et al., 2004). The present paper focuses on prospective analyses, which were not previously reported.

Participants

Participants were 63 individuals (67.8% female) diagnosed with MDD. About half of participants were recruited through advertisements and flyers and the others were referred from two outpatient psychiatry clinics at Stanford University. All participants were between 18 and 60 years of age, able to complete assessments in English, reported no history of brain injury, and were not developmentally disabled. Diagnoses were made using the Structured Clinical Interview for *DSM–IV* (SCID; First, Spitzer, Gibbon, & Williams, 1996). Participants met *DSM–IV* criteria for current MDD and did not meet criteria for current comorbid panic disorder, social phobia, for alcohol or psychoactive substance abuse or dependence in the past six months, or for lifetime mania, hypomania, or primary psychosis.

Measures

Diagnosis. At Time 1 (T1), advanced psychology graduate students and post-baccalaureate research assistants with extensive psychiatric interviewing experience administered the SCID. Interviewers completed extensive SCID training. A trained rater evaluated 15 randomly selected audiotapes and obtained diagnoses that matched the original diagnosis, $\kappa = 1.00$, although the SCID "skip out" strategy reduces opportunities for raters to disagree.

At Time 2 (T2), approximately nine months after T1, the depression module of the SCID (modified to assess depression since T1) was administered to determine whether participants met criteria for recovery from depression, using guidelines recommended by the National Institute of Mental Health (NIMH) Collaborative Program on the Psychobiology of Depression (e.g., Keller et al., 1992): eight consecutive weeks with no more than two mild symptoms (i.e., minimal symptoms) and no impairment. Participants were categorized "fully recovered" if they met these strict recovery criteria; as "partially recovered" if they did not meet these criteria, but no longer met criteria for MDD; and as "not recovered" if they continued to meet criteria for current MDD.

Hamilton Depression Inventory (HDI; Kobak & Reynolds, 2000). The HDI is a self-report scale with probes parallel to the interview-based Hamilton Rating Scale for Depression (HRSD; Hamilton, 1960). The HDI has demonstrated excellent reliability and validity (Kobak & Reynolds, 2000). We used the version of the HDI designed to correspond to the 17-item HRSD and obtained adequate internal consistency, $\alpha = .75$.

Beck Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988). The BAI is a widely used 21-item self-report scale designed to assess the severity of subsyndromal anxiety symptoms and to differentiate symptoms of anxiety from depression. It has been shown to have robust internal consistency and convergent validity (Beck, Epstein, Brown, & Steer, 1988).

Shipley Institute of Living Scale (Shipley, 1940). The Shipley test is a self-administered vocabulary test that correlates highly with other measures of verbal intelligence (Weiss & Schell, 1991).

Stimuli for the Information-Processing Tasks

Self-referent encoding and incidental recall task (SRET). To increase reliability, we used more than the 10 words per category typically used in previous studies (e.g., Timbremont & Braet, 2004). Thus, we used 22 depressotypic, 22 socially threatening, and 22 physically threatening words. To balance the number of negative and positive words, we used 50 positive words. Details of word selection and tests for equivalence across emotion categories in length, intensity, and frequency are described elsewhere (Gotlib et al., 2004). Examples of the words include "loving" for the positive category, "sad" for the sad emotion category, "teased" for the social threat category, and "choking" for the physical threat category.

Emotion face dot-probe task. Drawing on evidence for the importance of interpersonal factors in depression (Gotlib & Hammen, 2002) and on previous research using visual probe tasks in the anxiety disorders (e.g., Bradley, Mogg, & Lee, 1997; Mogg & Bradley, 1999), we developed an emotion face version of the dot-probe task. Previous publications describe how stimuli were compiled and rated to ensure that relatively pure emotions were displayed and that the mean intensity of the emotion displayed did not differ across emotion categories (Gotlib et al., 2004). Pairs of emotional and neutral photographs of the same person were presented to participants. There were 20 picture pairs (10 male, 10 female) of each emotion type (happy, sad, and angry), for a total of 60 pairs.

Procedure

Of the participants screened by telephone, approximately 35% met screening criteria and were scheduled for a visit to complete informed consent procedures, the diagnostic interview, and self-report questionnaires. Approximately 65% of those interviewed in person met study criteria. Participants were invited to complete additional questionnaires and information-processing tasks 3–7

days later. To reduce the possibility of interference on the incidental recall task, the SRET and the incidental recall task were administered first, followed by the emotion face dot-probe task. (The Emotion Stroop task was administered last, but given concerns about fatigue effects, results of the Stroop task are not discussed in this paper). Tasks were presented on an IBM-compatible computer and a Dell 15-inch color monitor using Micro Experimental Laboratory 2.0 software (Schneider, 1995). A response box with microphone was used to record responses and response latencies. For all information-processing tasks, the experimenter left the room after practice trials.

Because of scheduling problems and difficulty reaching participants, there was variability in the follow-up interval. The median interval between T1 and T2 was 260 days (M = 279.65 days; SD = 85.36 days). In the T2 session the depression module of the SCID, modified to assess depression since the last interview and to assess recovery according to the NIMH criteria, was administered to each participant. Participants were paid $25 per hour.

Information-Processing Tasks: Measures

SRET. On each trial, the words "Describes me?" appeared on the screen for 500 msec, followed by a 250-msec screen with a fixation cross, followed by one of the stimulus words presented in capital letters. Participants were instructed to respond by pressing computer keys labeled "yes" or "no." The stimulus word disappeared as soon as participants responded. The inter-trial interval was 1000 msec. Stimulus words were presented in random order. After the SRET, participants were instructed to work on the digit-symbol subtest of the Wechsler Adult Intelligence Scale as a distracter task. After three minutes, participants completed an incidental recall measure. That is, they were asked to recall as many of the words from the SRET as they could, regardless of whether they had endorsed the words as self-descriptive. Participants were given three minutes to write down words. To control for individual differences in endorsement, recall scores were calculated as the proportion of words that participants recalled from the words that were endorsed within each emotion category. Thus, a sad recall score of 0.50 indicated that the participant recalled 50 percent of the sad words that s/he initially endorsed.

Emotion face dot-probe task. Each trial began with a white fixation cross that appeared mid-screen for 500ms. After the cross, a face pair was displayed for 1000 msec. The offset of the face pair was followed immediately by a small gray dot centered where one of the faces had been displayed. Participants were instructed to respond as quickly and accurately as possible when they detected the dot by pressing a key labeled "L" or "R" to indicate if the dot appeared on the left or right side of the screen. The dot disappeared immediately after participants responded. The inter-trial interval was 1000 msec. Four practice trials were presented using a simplified version of the task, in which a dot was presented on either the left or right side of the screen without any face stimuli. In these practice trials, participants were asked to respond as quickly and as accurately as possible when they detected the dot. In the next 12 practice trials, intervening neutral face stimuli were included, and participants were told to continue to respond only to the location of the dot. The computer generated a 500-msec beep after incorrect responses for the practice trials. Each picture was approximately 9×10 cm when displayed. The centers of the pictures in each pair were approximately 13 cm apart. Each of the 60 picture pairs was presented in each of four blocks (total of 240 trials). The side of the emotion face and the side of the dot presentation display were counterbalanced across the four presentations of each picture pair. Each participant viewed the 60 trials within each block in a new, randomized order.

Attentional scores were computed for each facial expression (sad, angry, happy) using the following equation (Mogg, Bradley, & Williams, 1995):

$$\text{Attentional score} = 1/2\,[(\text{RpLe} - \text{RpRe}) + (\text{LpRe} - \text{LpLe})],$$

where R = right position, L = left position, p = probe, and e = emotional face. That is, RpLe corresponds to the mean latency when the probe is in the right position and the emotional face is in the left position. This equation calculates the "attention capturing" quality of emotional faces by subtracting the mean probe detection times for probes appearing in the same position as the emotional face from the mean probe detection times for probes appearing in a different position than the emotional face. Positive values of this score indicate attention towards the location of emotional faces relative to neutral faces, and negative values indicate a shift of attention away from the location of emotional faces relative to neutral faces.

Results

Twenty-five of the 88 initially enrolled depressed individuals did not complete the second assessment; most had disconnected telephone numbers, expired email addresses, or had moved. Completers and noncompleters did not differ with respect to baseline HDI scores, history of recurrence, number of psychiatric hospitalizations, Shipley scores, or any information-processing measures. Further, completers and non-completers did not differ on the number of psychotropic or nonpsychotropic medications at T1 or the presence of SSRIs, other antidepressants, anticonvulsant medications, beta blockers, or benzodiazapenes.

The following analyses were conducted on the 63 participants who completed both the T1 and T2 assessments. Demographic and clinical characteristics of the sample are presented in Table 1. Overall, 46 participants were Caucasian. Only 17.5% reported that this was their first major depressive episode (MDE), whereas 50.3% reported at least three previous episodes and 19% reported at least one previous hospitalization for depression. At T1, 23 people reported taking at least one psychiatric medication (each including at least one antidepressant), and of these nine reported taking an SSRI. Only three people were receiving CBT. During the follow-up period, 48% of the sample reported taking psychotropic medication and 59% received at least some psychotherapy. At baseline, 10% of the participants met criteria for GAD, an additional 4% met criteria for other current anxiety disorders, 14% met criteria for an eating disorder, and 19% met criteria for comorbid dysthymia.

HDI scores were significantly lower at T2 than at T1, $t(59) = 4.74$, $p < .001$. With respect to diagnostic status at T2, 44% participants remained fully depressed, 38% were partially recovered, and 17% were fully recovered according to the NIMH collaborative study criteria for recovery. Because few participants achieved full recovery, analyses focused on differentiating full

Table 1
Demographic and Clinical Characteristics of the Sample by Recovery Status at Time 2

	Depressed at Time 2		Partially or fully recovered at Time 2	
	M	*SD*	*M*	*SD*
Age	37.54	12.25	32.91	11.13
Education[a]	6.79	1.47	6.49	1.44
Income[b]	3.09	1.54	3.09	1.63
Shipley Verbal IQ score	35.61	4.13	34.97	2.60
Number of lifetime episodes of major depression	3.72	4.30	4.56	6.03
Number of psychiatric hospitalizations	.69	1.31	.26	.98
HDI baseline	28.62	7.76	27.72	6.53
HDI follow-up***	28.78	8.76	16.48	6.63

Note. HDI = Hamilton Depression Inventory score.
[a] Education was assessed on an 8-point scale, with higher numbers representing more education—a score of 6 reflects some college education. [b] Income was assessed on a 6-point scale, with higher numbers representing more income—a score of 3 reflects an annual income of $25,000–$50,000.
*** $p < .001$.

depression from partial or full recovery. Diagnostic status at T2 was unrelated to HDI score at T1, $t(61) < 1$.

Descriptive statistics for the information-processing variables are presented in Table 2. These variables were normally distributed, except the dot-probe indices, which had significant kurtosis and skew.[1]

Predictors of Diagnostic Status at Follow-up

A discriminant function analysis was conducted to examine whether performance on the information-processing measures at T1 predicted recovery status at T2 (fully depressed versus partial or full recovery). Predictors were T1 HDI score, attentional scores from the faces dot probe task (sad, happy, and angry), and the recall scores from the SRET (depression, physical threat, social threat, and positive scores). No variable was significantly related to diagnostic status, and 68.6% of the cases were correctly classified (sensitivity to depression: 65%; specificity: 71%), Wilk's Lambda (7) = .81.

Predictors of Change in Symptom Severity From T1 to T2

To assess the unique contribution of cognitive variables to change in HDI scores, a hierarchical multivariate linear regression analysis was conducted with T2 HDI scores as the dependent variable and T1 HDI scores entered in block one.[2] Forward selection was then used in block 2 to examine whether T2 HDI scores were predicted by the three attentional scores from the faces dot probe task and the four SRET recall scores. All predictors were *z*-transformed, and tolerance coefficients were above .78 for all variables. After controlling for depression scores at T1, r^2_{change} (1, 48) = .04, ns, only the proportion of the endorsed positive words that were recalled on the SRET was significantly related to HDI scores at T2, r^2_{change} (1, 45) = .16, $p < .01$: depressed participants who recalled a greater proportion of their endorsed positive words at T1 had lower depression scores at T2.[3] No other information-processing variables predicted T2 HDI scores after controlling for HDI scores. The overall model was significant, $r^2_{total} = .20$, $F(2, 45) = 5.61$, $p < .01$.[4]

Potential Confounds

We examined the potential confounding effects of number of days between T1 and T2, age, education, income, gender, Shipley Verbal IQ score, number of lifetime MDEs, presence of a comorbid anxiety diagnosis, GAD diagnosis, eating disorder diagnosis, history of psychiatric hospitalization, BAI scores, number of psychotropic and nonpsychotropic medications at T1, and presence of SSRIs, other antidepressants, anticonvulsant medications, beta blockers, or benzodiazapenes. We also examined medication and psychotherapy use between T1 and T2. A set of partial correlations controlling for T1 HDI scores indicated that none of these variables was significantly correlated with HDI scores at T2. Similarly, *t*-tests indicated that none of these variables was related to

[1] Although correlational analyses are generally robust to deviations from the normal distribution, we conducted parallel analyses using square root transformations of the faces dot-probe variables. Results were comparable to those obtained using non-transformed distributions. Given the parallel findings, we present analyses based on non-transformed distributions.

[2] We also conducted bivariate correlations of cognitive measures with T2 depression and partial correlations of cognitive measures with T2 depression controlling for T1 depression. Using alpha = .01 due to the large number of analyses, these findings were entirely consistent with the regression findings in that the only significant predictor of recovery was the proportion of self-referential positive words recalled.

[3] Although previous reports have tended to focus on negative recall, current findings suggest that positive recall is important. To assess whether positive recall was significantly stronger than negative recall, we calculated h' to determine the level of positive self-referential recall adjusted for negative self-referential recall (Matt, Vazquez, & Campbell, 1992). h' was equal to .49, $t(53) = 4.77$, $p < .01$, indicating that participants recalled significantly more positive than negative self-referential words.

[4] Because differences in the number of words endorsed in each emotion category (M positive words = 25; M sad words = 4.62) could explain the stronger findings for positive than for specific types of negative words, regression analyses were repeated with recall of all negative self-referential words combined. As above, only recall of positive words predicted T2 HDI scores.

Table 2
Descriptive Statistics for the Cognitive Variables

Variable	*M*	*SD*
Bias Scores on the Emotion Face Dot-Probe Task (in msec)		
Sad faces	8.70	29.78
Angry faces	4.18	28.33
Happy faces	−4.61	25.71
SRET: Proportion of words endorsed in each category		
Sad words	0.21	0.07
Physical threat words	0.12	0.06
Social threat words	0.17	0.07
Positive words	0.50	0.15
SRET: Proportion of endorsed words recalled in each category		
Sad words	0.25	0.14
Physical threat words	0.14	0.16
Social threat words	0.16	0.16
Positive words	0.45	0.20

Note. SRET = Self-Referent Encoding Task.

follow-up diagnostic status. Bivariate correlations indicated that the recall of positive words was significantly related only to gender. After controlling for gender and HDI scores at T1, recall of positive words remained a significant predictor of T2 HDI scores, r^2_{change} (1,44) = .16, $p < .01$.

Discussion

This study was designed to examine whether recovery from depression is predicted by attention toward and recall of emotionally relevant stimuli. The present findings extend the results of the few studies that have found autobiographical recall and cognitive processes to predict subsequent depressive symptoms (e.g., Brittlebank et al., 1993; Mackinger & Svaldi, 2004). This investigation has the strengths of examining reliably diagnosed depressed participants, of excluding participants with comorbid current anxiety diagnoses of social phobia or panic disorder, and of following participants to predict diagnostic status at a nine-month assessment. Only greater recall of positive words uniquely predicted a decrease in depressive symptoms.

Importantly, none of the cognitive variables predicted diagnostic recovery from depression. Other information-processing assessment procedures, such as tasks that increase cognitive load (see Rude et al., 2002), might yield stronger results, as might a larger sample. With 63 participants, our power was limited in detecting small effects (i.e., correlations of less than .3) and even more limited in examining complex multivariate relationships and categorical outcomes such as recovery (Cohen, 1992).

After controlling for recall of positive self-referential words, no other cognitive variable added to the prediction of depression recovery, suggesting that memory processes have the most enduring consequences for symptom maintenance. This finding is consistent with previous theories positing that depression is more closely associated with memory and cognitive processes involving elaboration of stimuli than with attention processes (Williams, Watts, MacLeod, & Mathews, 1997). It is important to note, however, that whereas the memory task involved semantic stimuli, the attention task used facial stimuli. Fatigue may have limited findings with the dot-probe task, which was administered after the recall task, although there were nevertheless group differences obtained on this task (Gotlib et al., 2004). Thus, future research should replicate these findings with a memory task involving both semantic and facial stimuli, and should vary task order.

Symptomatic improvement among depressed persons was predicted in the present study by better memory for positive self-referential stimuli. Although some investigators have reported that recall of negative self-referential stimuli predicted worsening symptoms among undergraduates (e.g., Reilly-Harrington, Alloy, Fresco, & Whitehouse, 1999), the present findings are consistent both with the tripartite model, in which depression is differentiated from anxiety by low positive affect (Clark, Watson, & Mineka, 1994), and with findings that positive attributional style predicts recovery from depression (e.g., Johnson, Han, Douglas, Johannet, & Russell, 1998). We did use more happy than sad words in the SRET task, and it is possible that this contributed to our results, although we obtained comparable results with the larger combined list of negative words.

In sum, although performance on measures of information processing did not predict diagnostic recovery from major depression, the ability to remember positive self-referential information predicted improvement in depressive symptoms. These findings underscore the importance of cognitive processes in affecting the course of depression. It is important that future studies use larger samples to examine more systematically the mechanisms underlying the relation between memory for emotional material and change in depressive symptoms.

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