Journal of Abnormal Psychology
2001, Vol. 110, No. 2, 282–289

0021-843X/01/$5.00 DOI: 10.1037//0021-843X.110.2.282

Mood-Induced Changes on the Implicit Association Test in Recovered Depressed Patients

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A mood induction paradigm was used to examine dysphoria-related changes in two types of cognitive processing in individuals who had previously experienced depression. Formerly depressed patients (n = 23) and never-depressed controls (n = 27) completed the Dysfunctional Attitudes Scale, a self-report measure of effortful processing, and performed the Implicit Association Test, an automatic–reaction time task that measures evaluative bias, before and after a negative-mood induction. The formerly depressed group showed both an increase in endorsement of dysfunctional attitudes and a more negative evaluative bias for self-relevant information after the induction, relative to controls—however, there was no association between the mood-linked changes observed on these two measures. The shift in evaluative bias shown by the formerly depressed group was similar to that seen in a group of 32 currently depressed individuals. These findings suggest that even a mild negative mood in formerly depressed individuals can reinstate some of the cognitive features observed in depression itself.

The cognitive aspects of acute-phase major depressive disorder (MDD) have been well researched, and the pattern of cognitive distortions, negative thinking style, and increased accessibility of negative information associated with an episode of major depression have been characterized by numerous studies (for a review, see Williams, Watts, MacLeod, & Mathews, 1997). By comparison, our understanding of the cognitive effects that may linger after recovery from an episode of depression is limited, with relatively few studies focusing on this aspect of the disorder. Given that individuals who have recovered from MDD are at a significant risk for future episodes (e.g., Keller, Lavori, Lewis, & Klerman, 1983), it may be that an examination of postrecovery cognitive processes could provide important information as to why recovered individuals are at such an increased risk for recurrence.

One such aftermath that has been noted in those who have recovered from depression is that mild sad moods can produce negative thinking reminiscent of that observed in episode (Ingram, Miranda, & Segal, 1998). Under a normal mood state, formerly depressed individuals perform on most measures of cognitive processing like never-depressed controls. However, a temporary sad mood significantly increases measures of negative thinking in formerly depressed patients, whereas never-depressed controls show no such increase (despite experiencing a similar level of sadness). These findings accord with a self-schema model of depression (Clark, Beck, & Alford, 1999), which postulates that formerly depressed individuals possess negatively biased, depressogenic cognitive structures but that such structures are only activated (and thus influence information processing) when the individual is confronted with certain activating conditions, such as negative affect (Kovacs & Beck, 1978; Miranda & Persons, 1988).

Recently, the link between mood-induced negative thinking and depressive relapse/recurrence has received direct empirical support through a prospective study. Segal, Gemar, and Williams (1999) examined performance on the Dysfunctional Attitudes Scale (DAS), a self-report measure of the degree to which individuals endorse negative or dysfunctional beliefs commonly observed in depression, before and after a negative-mood induction in formerly depressed individuals who were then followed for an average of 30 months. Mood-induced negative thinking, as measured by the degree to which dysfunctional attitudes increased in the face of a mood challenge, significantly predicted the likelihood of reappearance of a depressive episode. These data suggest that changes in cognitive processing arising from the experience of dysphoria can predict future symptom return.

Most studies of mood-linked negative thinking have used a self-report measure, the DAS, as the dependent variable, a reliance that raises a number of difficulties. Being a self-report measure, the DAS is susceptible to the effects of experimental demand, especially when it is readministered in the same study. Furthermore, from a theoretical standpoint, the predominance of this one measure in investigations of mood-linked cognitive changes limits our understanding of the full range of cognitive processes that might be affected by mood induction in recovered individuals.

One way of conceptualizing the possible variety of cognitive processes that might be influenced by mood is suggested by the distinction between effortful and automatic processes. This distinction, following from work in cognitive psychology (e.g., Hasher & Zacks, 1979; Shiffrin & Schneider, 1977), suggests that effortful processes are those that are consciously guided by the

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This research was funded in part by a NARSAD Young Investigator Award, by Medical Research Council Grant MT15367, and by an Ontario Mental Health Foundation Senior Research Fellowship. We acknowledge the generous assistance of Anthony Greenwald for providing both information on the Implicit Association Test and software to run the task.

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individual, that require attention to operate, and that are deliberative in nature. By contrast, automatic processes operate below the level of conscious awareness, do not use attentional resources, and are not controlled by the individual. Although this distinction originated in experimental work on normative cognitive function, it has shown itself to be a valuable heuristic in describing the cognitive processes at play during an acute episode of depression (e.g., Hartlage, Alloy, Vazquez, & Dykman, 1993).[1] Using measures of automatic processing to probe changes in cognition after induced mood would allow us to characterize more precisely the range of cognitive functions affected by induced mood.

There have been a few studies of mood-induced negative thinking that have used tasks involving primarily automatic processes. These studies have focused on the influence of induced mood on the processing of generic valenced material, such as positive and negative adjectives. Results from these investigations involving recovered depressed individuals have been somewhat mixed. Rude, Covich, Jarrold, Hedlund, & Zentner (2001) failed to find mood-linked changes on a Stroop color-naming task (a measure of automatic attentional bias), whereas Ingram and colleagues (Ingram, Bernet, & McLaughlin, 1994; Ingram & Ritter, 2000) used a dichotic listening task to demonstrate mood-related cognitive effects in the form of an attentional bias for negative adjectives. These findings suggest that on balance, individuals who have recovered from depression may exhibit mood-linked changes in automatic processing for general categories of positive and negative information.

Implicit Association Test

In the present study, we used a task recently developed by Greenwald and associates (Greenwald, McGhee, & Schwartz, 1998) that is well suited to examinations of automatic biases in the processing of self and nonself information. The Implicit Association Test (IAT) was originally created to assess beliefs or associations that an individual might want to consciously disavow, such as racism or sexism, and is ideal for use in situations in which automatic cognitive processes may be active. The presumption of the task is that generally speaking, when a task requires the same response (e.g., pressing a particular key) to be used for two associated stimuli, response times should be faster than when the identical response is used for two unrelated stimuli. For example, imagine being presented with a sequence of stimuli, some of faces and some of names. If one were told to press the left key for male names and male faces, and the right key for female names and female faces, one should respond more quickly than if the response mapping were left key to male names and female faces and right key to female names and male faces. The gender association between the two different categories (names and faces) means that when gender is mapped to the same keypress, performance is facilitated relative to the alternate mapping.

As in the Greenwald paradigm, we present two different kinds of judgment tasks to participants, which we term *self* judgments and *adjective* judgments. For the *self* judgments, participants are asked to decide whether ostensibly neutral information presented (such as a first name, a last name, a city) describes them or not. For example, someone born in Toronto would press a key to indicate "Me" if the item *Toronto* was presented and would press a key indicating "Not me" if the item was *Montreal*. For the *adjective* judgments, participants have to judge whether a presented adjective is positive or negative and press the corresponding key. The important feature of this paradigm is that both these judgment tasks use the same two response keys, and the mapping of the responses to the keys used is swapped halfway through the session.

The logic of the paradigm is that by pairing such judgments about possible neutral personal information (*self* judgments) with judgments about the affective tone of adjectives (adjective judgments), the affective tone of ostensibly neutral information about the self can be revealed. For example, if individuals are faster at "Me" responses when the same key is used as with the "Negative" response than when the key pairing is with "Positive," that would suggest that self-information carries a negative connotation. We refer to such preference for responses associated with a particular valence as *evaluative bias*. We examined changes in this evaluative bias when a sad mood is induced. If depression-associated self-information becomes activated by the mood induction, then repeating the IAT after such an induction should shift the evaluative bias more toward the negative in those who have previously been depressed.

In the current study, we compared the responses of formerly depressed individuals and never-depressed controls on both the DAS and IAT before and after a mood induction. To provide a baseline for any dysphoria-related changes in cognitive processing in these two groups, we also test a separate sample of currently depressed patients on the IAT.

Method

Design

The primary study design included one between-subject factor (group: formerly depressed and control) and one within-subject factor (time: preinduction and postinduction) for both the IAT and DAS measures.

Participants

Twenty-three formerly depressed patients were recruited from the Depression Clinic (DC; $N = 16$) and Cognitive Behaviour Therapy Unit (CBTU; $N = 7$) at the Clarke Division of the Centre for Addiction and Mental Health. All patients were assessed with the Structured Clinical Interview for *DSM-IV* Axis I Disorders (SCID; First, Spitzer, Gibbon, & Williams, 1996) upon entry into these clinical services and were diagnosed as meeting diagnostic criteria for MDD. The standard care received by patients at each of these clinics was acute-phase pharmacotherapy for a period of 6 months (DC) or 15 to 18 sessions of cognitive behavior therapy as according to Beck, Rush, Shaw, and Emery (1979; CBTU); no cognitive behavior therapy participants had received pharmacotherapy as well for their last episode. Eligibility for the present study was determined by both

[1]It should be noted that the terms *automatic* and *effortful* in this context refer at best to the relative level of conscious cognitive processes in the myriad processes that collectively determine performance on a task. In the domain of memory, Jacoby (1991) has argued that no task is "process-pure" or involves only one type of processing, and this insight is also applicable to the tasks used in the examination of mood-induced negative thinking. Performance on the measures used involves numerous cognitive processes that are under conscious control to a greater or lesser extent. Thus, use of the terms *automatic* and *effortful* in this context can only refer to tasks that are at relatively different points on a continuum, rather than an absolute dichotomy.

duration and severity criteria (Frank et al., 1991). We used a SCID interview to determine that patients no longer met diagnostic criteria for current MDD and that they had been symptom free for at least 1 month. In addition, all patients met the selection criteria of having a Beck Depression Inventory, Second Edition (BDI-II; Beck, Steer, & Brown, 1996) score of less than 17 and a Hamilton Rating Scale for Depression (HRSD; Hamilton, 1960) score of less than 13.[2]

Twenty-seven never-depressed participants were recruited through media advertisements in Toronto. All control participants were screened with a SCID interview and reported no prior or current history of depression or other psychiatric disorder. Control participants also met criteria of having a BDI-II score of less than 17 and an HRSD score less than 13.

An additional group of 32 currently depressed patients were recruited from those awaiting treatment at the CBTU. All these patients met SCID criteria for current MDD, as well as the selection criteria of having a BDI-II score of greater than 17 and an HRSD score of greater than 13.

Because of the verbal nature of the tasks used, all participants were screened for English language comprehension with the Shipley-Hartford Vocabulary Inventory (Shipley, 1940) to ensure that they met a minimum level of competency (as defined by an adjusted score of 100 on the inventory).

All participants received a payment of $20 at the conclusion of the study session.

Measures

Hamilton Rating Scale for Depression. The HRSD (Hamilton, 1960) is a commonly used, structured interview–based measure of severity of depressive symptomatology, covering a range of affective, behavioral, and somatic symptoms.

Beck Depression Inventory, second edition. The BDI-II (Beck et al., 1996) is a widely used, 21-item, patient-completed inventory used to assess the presence and severity of depressive symptoms.

Visual analogue scale. Subjects rated current mood on a visual analogue scale (VAS) measuring 76 mm from center to each of two endpoints. The descriptor *sad* was located to the left of center, and *happy* was located on the right side, with arrows indicating increasing strength of mood associated with greater distance from center (Grossberg & Grant, 1978).

Dysfunctional Attitudes Scale. This scale (Weissman, 1979) was used to assess endorsement of dysfunctional beliefs that are theorized to guide a person's self-evaluation. These beliefs are important in accounts of cognitive vulnerability because they are presumed to be more enduring than the characteristic negative automatic thinking associated with the depressive episode itself (Kovacs & Beck, 1978). Good internal consistency (alphas ranging from .89 to .93) and the availability of alternative forms of the DAS are also important features of this instrument. In the present study, the 40-item Forms A and B of the DAS were used.

Implicit Association Test. (See Greenwald, McGhee, & Schwartz, 1998.) Before the experimental trials, participants provided 10 specific pieces of personal information that were ostensibly affectively neutral (for example, first name, religion, date of birth, hometown, etc.). This information served as the *me* stimulus items for *self* category judgments. In addition, for each piece of *me* information, individuals chose a corresponding *not me* item from a set list (e.g., if the person's last name was Smith, a possible corresponding *not me* item might have been Jones). These *me* and *not me* items made up the *self* judgment category.

In addition, a set of adjectives describing 20 positive and 20 negative personal attributes, taken from our earlier research (Segal, Gemar, Truchon, Guirguis, & Horowitz, 1995), made up the Positive and Negative stimuli for the adjectives category.

On each trial of the IAT, participants were presented with a stimulus from one of the two category groups (self or adjective), and they indicated which of two values that stimulus had (*me* or *not me* for *self* judgments and *positive* or *negative* for adjective judgments). The two values per pair were mapped to two response keys, one on the left and one on the right, and the person responded by pressing the appropriate key. In the data collection trials, both judgments used the same two keys. To examine the degree of association between two categories, two different sets of data collection trials were performed and compared, one with responses for the two different categories mapped one way (e.g., *me* and *positive* using the left key, *not me* and *negative* using the right key) on one set of trials and the alternate way (*me* with *negative, not me* with *positive*) on the other set of trials.

In the present study, this IAT procedure was used on two separate occasions, once before the mood induction and once after it.

At the start of the task, participants were given (a) 10 practice trials on performing only *self* judgments and (b) 10 practice trials on categorizing only adjectives. After these practice trials, they were given (c) 10 further practice trials in which the two types of stimuli were presented singly in a mixed list, in which the same two response keys (left and right) were used to respond to both category types (self and adjectives).

Once this set of practice trials was completed, participants began (d) the first of two preinduction data collection phases of 40 trials, with the stimuli presented in a mixed list and the response key mappings as they were in the preceding practice trial.

After this set of data collection trials, the response keys used for the adjective judgments were swapped (left and right). Participants then performed (e) a further 10 practice trials for the adjective stimuli under this new response mapping, followed by (f) an additional 10 practice trials with the mixed list of self and adjective stimulus items under the new mapping. After these practice trials, (g) the second set of 40 data collection trials, using this new mapping, took place.

After the second set of data collection trials, the IAT task was interrupted for the mood induction procedure. When participants returned to the task, they performed Steps b–f again, using the same response mappings and same switch in response mappings as they had prior to the induction.

The response keys used for the adjective condition (e.g., left for *positive* or right for *positive*) were counterbalanced across participants and underwent the remapping midway through the procedure. The response keys used for the *self* condition (e.g., left for *me* or left for *not me*) were counterbalanced across participants but remained constant for a given participant.

Scores on the IAT were calculated separately for the *me* and *not me self* judgments by subtracting the response times for these *self* judgments in the two different response-mapping conditions (*positive* and *negative*), which gave a measure of the affective tone with which one perceives ostensibly neutral personal information; to the extent that the two conditions differed, individuals demonstrated either a positive or negative evaluative bias.

Mood Induction

Participants were asked to listen to a piece of music presented on a cassette audiotape recorder and to try and recall a time in their lives when they felt sad. The music came from previous work by Clark and Teasdale (1985) and was the orchestral introduction by Prokofiev entitled "Russia Under the Mongolian Yoke" from the film *Alexander Nevsky.* The taped segment played to participants was remastered at half speed and presented through earphones for approximately 10 minutes. This type of induction, combining elements of music associated with sad mood and autobiographical recall, has been found to be effective in bringing on transient dysphoric mood states that last for several minutes (Martin, 1990).

Procedure

All participants initially completed a demographic information questionnaire, a vocabulary inventory, and a BDI-II. A mood measure was taken,

[2]One CBT-treated patient was entered into the study but was dropped because their pre–mood-induction DAS score was extreme (>2.8 *SD* of the overall mean).

Table 1
Demographic and Clinical History Information for Study Groups

Variable	Formerly depressed (N = 23) M	SD	Controls (N = 27) M	SD
Age[a]	42.8	10.8	32.1	9.2
Sex (female/male)	13/10		17/10	
HRSD	4.4	2.9	1.9	1.9
BDI	6.8	4.2	3.6	2.9
Duration of last episode (weeks) (N = 18)	24.6	23.0		
No. previous episodes (N = 12)	4.3	3.1		
No. previous hospitalizations	0	0		

Note. HRSD = Hamilton Rating Scale for Depression; BDI = Beck Depression Inventory, second edition.
[a] $t(48) = 3.79$, $p < .001$.

participants filled out one version of the DAS, and then the first stage of the IAT, as described above, was performed on a personal computer. After the IAT, participants underwent a mood induction, consisting of recall of a sad personal event while listening to sad music (Segal et al., 1999). Immediately after the induction, individuals completed another mood measure and then repeated the IAT and completed an alternate form of the DAS. Finally, individuals filled out a questionnaire on past psychiatric history and were administered the HRSD.

Results

Demographic information on the two main groups of interest is provided in Table 1. Comparisons between the groups indicated that the only reliable difference was in age. Because of this latter group difference, age was used as a covariate in the following analyses.

Mood Manipulation Check

To confirm that the mood induction was successful in producing a negative shift in mood, we examined the VAS mood measures. The values for the VAS were taken by measuring (in millimeters) how far the mark participants made was from the zero-point center of the scale, with a possible maximum of 76 mm for either positive or negative. Both groups reported a mean positive mood before the mood induction and a large lowering of mood after the mood induction (for the formerly depressed group, the mean VAS score declined from 19.9 immediately before the induction to −4.7 immediately after; for the controls, a similar shift from 25.3 to −6.4 was reported). When examined with Group × Time (preinduction vs. postinduction) ANCOVA, including age as a covariate, these mood induction effects were found to be significant (main effect of time, $F(1, 47) = 9.24$, $p < .005$, with no differences between the two groups (group, $F(1, 47) < 1$) or interactions of group with time, $F(1, 47) < 1$.

Implicit Association Test

The raw reaction time scores for each group and condition are presented in Table 2. For analytic purposes, these scores were converted to evaluative bias scores (subtracting the negative RT from the positive RT in each condition). These bias scores are presented in Figure 1. An analysis of covariance (ANCOVA) was conducted on the evaluative bias scores, with within-subjects factors of judgment type (*me* or *not me*) and time (preinduction or postinduction), a between-subjects factor of group (formerly depressed or control), and with age entered as a covariate. The only main effect to reach significance was judgment type, $F(1, 47) = 7.59$, $p < .01$. As is evident from Figure 1, this main effect reflects the fact that collapsed across groups and time, *me* judgments had a mean positive evaluative bias (judgments were faster when *me* was paired with *positive*), and *not me* judgments had a mean negative evaluative bias (judgments were faster when *not me* was paired with *negative*). However, this main effect was qualified by the significant three-way interaction of Judgment Type × Time × Group, $F(1, 47) = 5.26$, $p < .03$, as would be expected if it was only the *me* judgment type that showed a differential group effect after the mood induction. No other interactions were significant.

Separate ANCOVAs were conducted for the evaluative bias scores of the *me* and *not me* judgment types. For each ANCOVA, time was the within-subject factor, group was the between-subject factor, and age was once again entered as a covariate. For the *not me* judgment type, none of the main effects or interactions reached significance; the negative overall evaluative bias for *not me* did not differ between the two groups, was unaffected by the mood induction, and was not affected by the interaction of these variables.

Table 2
Mean IAT Reaction Times Before and After Mood Induction, "Me," and "Not Me" Judgments

	Formerly depressed				Controls			
	Negative		Positive		Negative		Positive	
Judgment	M	SD	M	SD	M	SD	M	SD
Me								
Preinduction	1,325	298	850	210	1,097	215	769	166
Postinduction	1,127	313	836	230	1,037	218	726	107
Not me								
Preinduction	990	227	1,610	450	965	290	1,377	297
Postinduction	941	353	1,391	286	883	281	1,265	295

Note. IAT = Implicit Association Test.

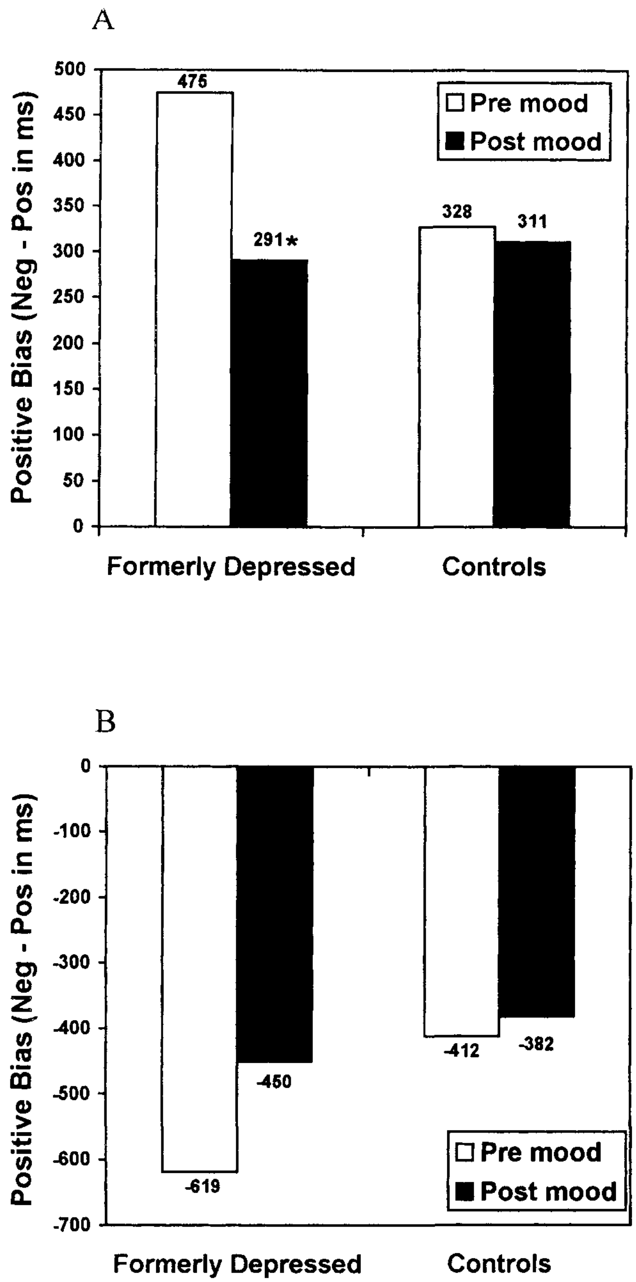

Figure 1. Implicit Association Test (IAT) evaluative bias for *Me* (Panel A) and *Not Me* (Panel B) judgments before and after mood induction, by group. For *Me* judgments, the formerly depressed showed a time main effect: $F(1, 22) = 9.70, p < .005$.

By contrast, the analysis of the *me* judgment type yielded the hypothesized interaction of Group × Time, $F(1, 47) = 5.84, p < .02$. The control group showed no significant effect of the induction on evaluative bias scores. However, the evaluative bias scores for the formerly depressed group were significantly influenced by the mood induction, $F(1, 22) = 9.70, p < .005$.

We next compared the evaluative bias shown by a group of currently depressed patients with the preinduction and postinduction performances of the recovered group. Unlike those in the recovered group, the currently depressed participants received no mood induction and, because of this, could not be entered directly as a third group in the main analysis. The *t* tests showed that, as expected, the *me* evaluative bias of the recovered group before the mood induction ($M = 475.2$ ms, $SD = 275.5$) was more positive relative to that of the currently depressed sample ($M = 366.2$ ms, $SD = 199.6$), $t(53) = 1.70, p < .05$ (one-tailed). However, after the mood induction, the bias shown by the formerly depressed individuals ($M = 291.4$ ms, $SD = 268.8$) had negatively shifted such that it was not reliably different from that found in the group of currently depressed patients, $t(53) = 1.19$, *ns.*

Dysfunctional Attitudes Scale

The scores for the DAS are presented in Figure 2. In the analysis of this measure, group (formerly depressed vs. control), time (before or after the mood induction), and order of form administration (AB or BA) were the independent variables of interest, with age included as a covariate.

The ANCOVA revealed main effects for group, $F(1, 45) = 6.93, p < .02$, and form order, $F(1, 45) = 5.10, p < .03$. However, these effects were qualified by the anticipated interaction of group with time, $F(1, 46) = 4.45, p < .05$. There was also a significant interaction of time with DAS form order, $F(1, 46) = 13.60, p < .005$, with Order AB showing an increase in DAS score after the mood induction (mean A preinduction, 93.8; mean B postinduction, 99.1) and Order BA showing a decrease in score after the induction (mean B preinduction, 116.6; mean A postinduction, 108.3). However, DAS form order did not interact with group, and most important, the main interaction of interest, namely group with time, was not qualified by the order in which the two DAS forms were administered (i.e., the Group × Time × DAS Form Order interaction was not significant).

To explore the group and time interaction, we conducted two separate ANCOVAs using the preinduction and postinduction DAS scores as the dependent variables of interest. In each analysis,

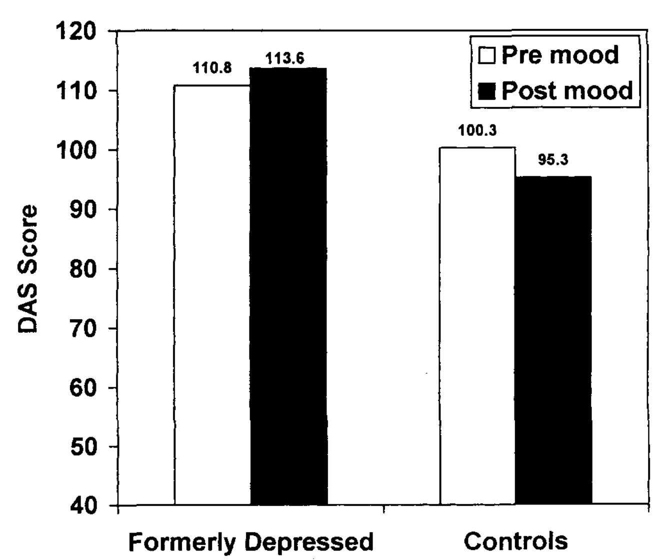

Figure 2. Dysfunctional Attitudes Scale (DAS) scores before and after mood induction, by group.

we included group and DAS form order as independent variables. Age was included as a covariate. The preinduction analysis showed a significant effect for group, $F(1, 45) = 4.07$, $p < .05$, with the formerly depressed patients scoring higher on the DAS than the controls before the mood induction. This analysis also revealed a main effect of DAS form order, $F(1, 46) = 7.19$, $p < .02$, with the B form group scoring higher than the A form group. However, form order did not interact with group.

The postinduction analysis showed a significant effect for group, $F(1, 45) = 8.98$, $p < .005$, with the formerly depressed patients scoring higher on the DAS than the controls after the mood induction. There was no significant main effect of form order and no significant Group × Form Order interaction.

In addition, we examined the above Group × Time interaction by testing the other set of simple main effects by conducting two separate ANCOVAs for each group. In each analysis, we included time and DAS form order as independent variables, and age was again included as a covariate. For the controls, there was a significant effect of form order, $F(1, 24) = 9.32$, $p < .01$, but most important, there was no main effect of time, nor did time interact with form order. By contrast, the formerly depressed group showed a significant Time × Form Order interaction, $F(1, 20) = 14.5$, $p < .01$ (neither of the main effects were significant). This interaction can be seen in examining the means of the different forms of the DAS for the formerly depressed before and after the mood induction. For the A form, there was a large increase from preinduction ($M = 102.8$, $SD = 19.6$) to postinduction ($M = 110.7$, $SD = 36.8$), whereas the B form showed a slight decrease (preinduction $M = 119.5$, $SD = 31.3$; postinduction $M = 116.2$, $SD = 20.5$).

To better quantify the difference in performance of the two groups, we calculated an effect size for the change in DAS score that the two groups showed after the mood induction (preinduction DAS score subtracted from postinduction score). For the difference between the changes for these groups, the effect size measure d was .51, corresponding to a "medium" sized effect (Cohen, 1992).

Relationship Between the Two Main Measures

To address the relationship between our two main measures, we used a linear regression strategy, in which we first calculated the change in DAS score after the mood induction (DAS change) and the difference between the evaluative bias before and after the mood induction (IAT evaluative bias change). We then conducted a linear regression, with DAS change as the dependent measure and with the independent variables of group, DAS form order, and IAT evaluative bias change, as well as the interactions of these variables. As above, age was also entered as a covariate because the two groups differed on this demographic variable.

The order of variable entry and results of this regression are presented in Table 3. The regression confirmed the earlier ANCOVA results of a significant difference between the two groups on the amount of DAS change, as well as a significant effect for order of DAS form administration. However, neither the main effect of IAT evaluative bias change nor the interaction of bias change and group were significant, suggesting that the influences of mood on consciously reported dysfunctional attitudes and automatic self-evaluation were independent in both groups.

Discussion

In the present study, formerly depressed individuals showed a shift toward negative thinking after a sad-mood induction on a measure of automatic cognitive processing, but only for material related to the self. The magnitude of negative thinking on this automatic measure for these recovered individuals under a negative mood was similar to that observed in currently depressed individuals. Never-depressed controls did not show such a negative shift on this automatic measure. Formerly depressed individuals also displayed a greater amount of negative thinking on a more effortful measure of cognition after a mood induction compared with controls, as has been demonstrated in prior studies. However, there were two qualifications to this general finding in that recovered individuals reported more negative thinking before the mood induction and that the negative shift for the formerly depressed participants was most notable on only one version of the effortful measure.

The Importance of Self-Information

This work shows that in the domain of more automatic processing, a mild negative mood seems to have its greatest effect on the cognitive processes surrounding information about the self. Although theoretical approaches to cognition in formerly depressed individuals would predict that self-information should be most

Table 3
Association of Mood-Induced Changes on IAT and DAS: Regression Statistics

Step and variable entered	R^2 change	F change	*df*	β	*t*
Step 1: Age	.000	0.00	1, 48	−.003	−.02
Step 2: DAS Form Order	.197	11.51	1, 47	.447	3.39*
Step 3: Group	.089	5.72	1, 46	.340	2.39*
Step 4: Bias Change	.028	1.82	1, 45	−.178	−1.35
Step 5: Order × Group	.056	3.89	1, 44	.409	1.97
Step 6: Order × Bias Change	.038	2.78	1, 43	−.379	−1.67
Step 7: Group × Bias Change	.050	3.83	1, 42	.339	1.96
Step 8: Order × Group × Bias Change	.003	0.22	1, 41	−.142	−.47

Note. IAT = Implicit Association Test; DAS = Dysfunctional Attitudes Scale.
* $p < .05$.

strongly affected by mood, prior studies using measures of automatic processing have used generic valenced material as their stimuli and thus have been unable to address this question. The present work shows that for those who have recovered from depression, a mild sad mood shifts the connotation of self-information toward the negative, with comparable types of information that are not self-relevant showing no such mood effect. Furthermore, the shift in bias on self-information is similar to the bias seen in currently depressed individuals, suggesting that even a mild negative mood, when experienced by someone with a history of depression, can reinstate some of the cognitive features observed in depression itself.

Relationship Between IAT and Self-Report Measures

In addition, this study addresses, for the first time, the degree of relationship between measures of mood-induced negative thinking that are more automatic and more effortful. The findings from this work suggest that the mood-related changes on the measures used were independent for both of the groups that underwent mood induction. These results were unexpected; we had anticipated that the aftereffects of an episode of depression on the cognitive system would be similar for all formerly depressed patients and thus produce correlated effects on measures of both automatic and effortful processing. It is important to note, though, that our finding of independence is qualified by the finding of preinduction group differences on the effortful measure (DAS) but not on the automatic measure (IAT), with formerly depressed individuals showing more negative thinking on the DAS than the IAT before induction. Because of this initial difference between measures, it may not be surprising that mood-related changes on these tasks demonstrated independence.

Why there might be a difference in the formerly depressed group between the explicit attitudes reported on the DAS and the automatic cognitions tapped by the IAT (as compared against the controls) is not clear. One possible explanation for this independence might be that the two measures not only tap different types of cognitive processing but also target different content domains. As used here, the IAT examines the affective tone of information about the self, whereas the DAS focuses more on attitudes involving self–other relationships. These two areas of concern may operate relatively separately, and it is possible that after recovery from depression, negative attitudes around one's relationship to others might remain slightly negative even after one's view of self has normalized. This is an admittedly speculative explanation of the seeming independence of these measures and one that would have to be explored in further work. Despite this independence, however, it is important to recall that both of these measures do show a negative shift in the face of a sad-mood induction, even though the changes seen on these two measures are independent of each other.

Implications for Modeling Relapse Risk

One of the clinical goals behind the study of mood-linked cognitive changes in recovered depressed patients is to be able to characterize, under controlled conditions, the kind of changes in thinking that occur in response to the negative affect that accompanies environmental provocations. To the extent that these provocations eventuate in a new episode of depression, such cognitive changes may play a role in this recurrence. Prior research has shown that mild negative moods increase endorsement of dysfunctional attitudes in formerly depressed individuals and that such increases significantly predict later relapse (Segal, Gemar, & Williams, 1999). The current work extends these findings by demonstrating that automatic self-evaluative judgements are also influenced by mild sad moods in those who have previously experienced depression. Although this result suggests that risk for future episodes may also be conveyed by such increases in automatic evaluative biases, a direct empirical test of this possibility remains to be done.

If such mood-linked automatic activation of negative self-evaluation were to be empirically related to depressive relapse, there might be important practical implications for the development of prophylactic interventions designed to target risk for depressive relapse. Such processes are, under normal circumstances, beyond conscious control, and thus may serve as a particularly pernicious vulnerability. Effective prophylactic approaches might, therefore, involve attempts to deautomatize such processes, perhaps through the teaching of metacognitive skills that serve to render this type of automatic processing more accessible to effortful reflection. Such treatments may include components that, first, help patients deliberately to monitor and observe their thinking patterns when they feel sad and second, to respond to these thoughts and feelings in a way that allows them to disengage from the cognitive elaboration of their content (Teasdale, Segal, & Williams, 1995). A recently developed intervention created along these principles trains recovered depressed patients to disengage from the cognitive consequences of automatically activated mood-related rumination. Results from a randomized controlled trial of this approach have shown a significant reduction in relapse rates compared with treatment as usual (Teasdale, Segal, Williams, Ridgeway, Soulsby, & Lau, 2000).

One limitation that we encountered in this study was the lack of equivalence between the two forms of the DAS that we used here. Although the use of alternative forms is to be preferred methodologically, especially in studies featuring repeated scale administration, the present two forms of the DAS may not be ideally suited to the purpose (Power et al., 1994). Further work in this area would benefit from the development of alternative forms that are more psychometrically congruent.

Another potential methodological concern in the present study derives from the fact that the IAT was always presented first after the mood induction, raising concerns over whether the effects of the mood induction might not have attenuated by the time the DAS was completed. Because prior research had already shown mood effects on the DAS and our primary interest was in determining whether the IAT would show similar effects, we deliberately chose to maximize possible mood effects for this task. However, in future, a design using counterbalanced ordering of the two tasks might be preferable.

In sum, the results of the current study shed light on the residual cognitive effects of depression and may point to possible cognitive mechanisms that are sensitive to mild dysphoria. The IAT methodology presented here offers a fruitful way of addressing questions of automatic processing in depression and its aftermath.

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Received March 8, 2000
Revision received September 1, 2000
Accepted December 5, 2000 ■