Memory biases in remitted depression: The role of negative cognitions at explicit and automatic processing levels

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\textbf{A B S T R A C T}

\textbf{Background and objectives;} Cognitive models propose that depression is caused by dysfunctional schemas that endure beyond the depressive episode, representing vulnerability factors for recurrence. However, research testing negative cognitions linked to dysfunctional schemas in formerly depressed individuals is still scarce. Furthermore, negative cognitions are presumed to be linked to biases in recalling negative self-referent information in formerly depressed individuals, but no studies have directly tested this association.

In the present study, we evaluated differences between formerly and never-depressed individuals in several experimental indices of negative cognitions and their associations with the recall of emotional self-referent material.

\textbf{Methods;} Formerly (\(n = 30\)) and never depressed individuals (\(n = 40\)) completed measures of explicit (i.e., scrambled sentence test) and automatic (i.e., lexical decision task) processing to evaluate negative cognitions. Furthermore participants completed a self-referent incidental recall task to evaluate memory biases.

\textbf{Results;} Formerly compared to never depressed individuals showed greater negative cognitions at both explicit and automatic levels of processing. Results also showed greater recall of negative self-referent information in formerly compared to never-depressed individuals. Finally, individual differences in negative cognitions at both explicit and automatic levels of processing predicted greater recall of negative self-referent material in formerly depressed individuals.

\textbf{Limitations;} Analyses of the relationship between explicit and automatic processing indices and memory biases were correlational and the majority of participants in both groups were women.

\textbf{Conclusions;} Our findings provide evidence of negative cognitions in formerly depressed individuals at both automatic and explicit levels of processing that may confer a cognitive vulnerability to depression.

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1. Introduction

Cognitive models of depression (Beck, 1967; Teasdale, 1988) propose that depressed mood states are maintained by biases in cognitive processing in favor of mood-congruent information. Beck’s model (1967) postulates that existing schemas lead individuals to select and remember information congruent with their schemas. This theory proposes that schemas of depressed people include themes of loss, separation, failure, worthlessness, and rejection; consequently, depressed individuals are hypothesized to remember information relevant to and congruent with those schemas. Research has consistently shown that depressed compared to nondepressed individuals are characterized by greater retrieval of negative material (Gotlib & Joormann, 2010; Matt, Vazquez, & Campbell, 1992). Furthermore, this mood-congruent memory bias has been found to be stronger when depressed individuals have to retrieve negative self-referent information (Wisco, 2009).

Dysfunctional schemas and cognitive biases are presumed to endure beyond a depressive episode, representing stable vulnerability factors for depression recurrence (Beck, 1967). Thus, formerly depressed individuals are expected to maintain these biases after the depressive episode remits. Memory biases in remitted depressed samples have been mostly evaluated through the incidental recall of positive and negative adjectives previously presented. Empirical evidence of memory biases in formerly
depressed individuals has been mixed. Some studies have shown that formerly depressed individuals do not differ from never-depressed individuals in their retrieval of negative material (e.g., Bradley & Mathews, 1988; Teasdale & Dent, 1987). Other studies have revealed that formerly compared to never-depressed individuals show memory biases for negative material but only after receiving a negative mood induction (see Scher, Ingram, & Segal, 2005 for review). These findings have been interpreted as dysfunctional schemas might be not stable structures. For instance, Beck’s reformulated model (Beck, 1987; Clark, Beck, & Alford, 1999) proposes that once depression has remitted, dysfunctional schemas are dormant until activated in response to negative stressors. Thus, once a negative mood is experienced in response to stress, dysfunctional schemas in formerly depressed individuals would become more accessible, generating negative memory biases (Gilboa & Gotlib, 1997; Timbremont & Braet, 2004). Furthermore, the differential activation hypothesis (Teasdale, 1988) assumes that during a depressive episode an association between depressed mood and negative thinking patterns is established. According to this model, when depression has remitted, a subsequent depressed mood could re-activate those negative thinking patterns, which in turn would generate memory biases to negative information. In contrast, other current accounts (e.g., Joormann, Yoon, & Zentner, 2007) do not specify that a depressed mood state is required to activate memory biases in formerly depressed. These accounts propose that cognitive biases may operate as a function of the capacity to control for the accessibility of negative cognitions. Thus, memory biases would operate as a function of formerly depressed individuals’ capacity to control or inhibit the activation of negative cognitions in working memory (Joormann, 2010).

A critical issue in clarifying the role of depressive schemas in memory processing once depression has remitted is how negative cognitions have been assessed. Previous studies have mostly employed self-report measures of depressive cognitions, such as the Dysfunctional Attitudes Scale (Weissman, 1979), a scale intended to measure dysfunctional beliefs that are thought to reflect a person’s self-evaluation. Studies using this scale have reported that formerly depressed individuals did not differ from never-depressed individuals in their levels of dysfunctional attitudes (e.g., Miranda, Persons, & Byers, 1990). However, Hedlund and Rude (1995) suggested that the use of self-reported measures may be relatively insensitive to the detection of negative cognitions in remitted individuals. Furthermore, consistently with recent views that propose that cognitive biases depend upon individuals’ available cognitive control (Joormann et al., 2007), some authors have argued that the failure to find evidence of dysfunctional schemas in formerly depressed individuals may be due to effortful mental strategies used to reduce the report of unwanted negative thinking (Wegner, 1994; Wegner & Wenzlaff, 1996). To overcome this issue, researchers have developed experimental tasks to detect depressive cognitions through the assessment of cognitive processes under conditions that interfere with vulnerable individuals’ attempts to control the mind (Wenzlaff & Wegner, 2000). For instance, the scrambled sentence test (SST; Wenzlaff & Bates, 1998) is a task aimed to assess interpretation processes, in which individuals have to use scrambled words to form self-referent statements in a positive or negative way while performing an additional task (e.g., keeping a number in mind) that interferes with cognitive control. Using this approach, research has shown that formerly compared to never depressed individuals form more negative statements (Rude, Covich, Jarrold, Hedlund, & Zentner, 2001; Watkins & Moulds, 2007; Wenzlaff & Bates, 1998). In fact, some studies have found that whereas formerly and never depressed individuals did not differ on the DAS, they did differ on this interpretation measure under reduced cognitive control (e.g., Hedlund & Rude, 1995; Rude et al., 2001).

A more direct approach to detect negative cognitions uninfluenced by cognitive control has involved the use of priming tasks. These tasks assess activation of negative meanings in the absence of conscious information processing (Phillips, Hine, & Thorsteinsson, 2010). For instance, in the lexical decision task (LDT), participants have to identify if verbal stimuli previously presented subliminally represent real words or nonwords. Using this paradigm, studies have shown that depressed compared to nondepressed participants are faster at responding to negative adjectives (Bradley, Mogg, & Millar, 1996; Bradley, Mogg, & Williams, 1995; Scott, Mogg, & Bradley, 2001). These results suggest that automatic activation of negative concepts in depression facilitates the processing of that negative information. However, no studies have used this approach to test if an effect of automatic activation to negative cognitions is also evident once depression has remitted.

Further research is necessary to clarify the presence of negative cognitions in formerly depressed individuals at both automatic and explicit processing levels under reduced cognitive control. The present study was aimed at examining these questions by comparing cognitive processing of formerly and never-depressed individuals. First, as shown by previous research (e.g., Hedlund & Rude, 1995; Rude et al., 2001), we hypothesized that formerly compared to never-depressed individuals would complete more negative sentences in the SST (Wenzlaff & Wegner, 2000), showing negative interpretation biases under reduced cognitive control. Second, we expected that negative cognitions activation would be evident in formerly depressed individuals at an automatic processing level. We hypothesized that formerly compared to never-depressed individuals would show a greater detection of subliminally primed negative words in the LDT.

We also aimed to test how negative cognitions detected by these methods may be linked to memory biases for negative information in formerly depressed individuals. As proposed by Joormann et al. (2007), memory biases to negative information may be not only dependent on negative mood states, as explained by traditional cognitive models of depression (Clark et al., 1999; Teasdale, 1988), but also operate as a function of individuals’ capacity to inhibit negative processing. Consequently, individuals characterized by higher negative processing under reduced cognitive control (i.e., in the SST and the LDT) should be those who would exhibit higher memory for negative material. Thus, we expected that higher negative processing observed under reduced mental control in these tasks would predict individuals’ retrieval of negative self-referent material in a subsequent memory task. Specifically, we expected that higher levels of negative processing in the SST and the LDT would predict greater retrieval of negative self-referent material in formerly depressed individuals.

2. Methods

2.1. Participants

Two hundred eight undergraduate students were initially contacted to complete the Diagnostic Inventory for Depression (DID; Zimmerman, Sheeran, & Young, 2004) and the second edition of the Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996). These instruments were used to divide participants into the formerly and never-depressed groups. The DID was used to diagnose lifetime history of major depression according to DSM-IV criteria. The formerly depressed group comprised participants reporting a past major depressive episode. Participants whose depressive symptoms had been due to physical illness or substance abuse were excluded, and a minimum recovery time of 2 months...
was required to ensure that residual depressive symptoms would not confound results. The never-depressed group comprised participants reporting a lack of lifetime history of depressive episodes.

BDI-II was used to control for group differences in current depressive symptoms and to assure that participants were not currently in a depressed mood. Following criteria used in previous research (e.g., Mackinger, Pachinger, Leibetseder, & Fartacek, 2000), participants in both groups reporting scores of higher than 11 on the BDI-II scale were excluded from the study. According to DID and BDI-II criteria, the formerly depressed group comprised 30 participants and the never-depressed group comprised 40 participants. Thus, the final sample of study participants consisted of 70 undergraduate students (80% female). The mean age was 21.87 years (SD = 1.76).

2.2. Questionnaires

2.2.1. Current depressive symptoms

The BDI-II (Beck et al., 1996), a 21-item self-report measure of the severity of depressive symptoms, was used to determine current depressive symptom levels. Respondents reported how much they have been bothered by each depression symptom on a 4-point scale, ranging from 0 to 3 in severity. This measure has shown excellent reliability and validity (Beck et al., 1996). In the current study, internal consistency was good (α = .84).

2.2.2. Lifetime history of major depression

DID (Zimmerman et al., 2004) is a 38-item self-report scale designed to assess the DSM-IV symptom inclusion criteria for a major depressive episode, psychosocial impairment due to depression, and subjective quality of life at the time of the assessment. Respondents reported how much they have been bothered by each depression symptom during the last 2 weeks on a 5-point scale, ranging from 0 to 4 in severity. Only symptoms reported for more than 2 weeks duration were included in the total score. DID was adapted to assess lifetime history of major depression by asking participants to note how they felt for each item during the period of time in which they felt most depressed in their life. This method to detect past major depressive episodes has been employed in a previous version of the DID instrument, the Inventory to Diagnose Depression, Lifetime Version (IDD; Zimmerman & Coryell, 1987), The DID and IDD have shown excellent reliability in diagnosing past and current major depressive episodes in previous research (e.g., Zimmerman et al., 2004, 2006).

2.3. Experimental tasks

2.3.1. Scramble sentence test

The SST (Wenzlaff & Bates, 1998) is a task aimed to measure interpretation processes. In our study this task served to evaluate negative processing under reduced cognitive control, as employed in previous research (e.g., Rude et al., 2001; Watkins & Moulds, 2007). In this task, 20 different scrambled sentences of six words each were presented (e.g., failure I am generally success). Participants were asked to unscramble five words in each sentence to form a statement, by placing a number over each of five words to indicate the proper order. Scrambled sentences could be unscrambled to form a positive (e.g., I am generally a success) or negative (e.g., I am generally a failure) statement. Participants had to complete as many of the sentences as possible during a 2.5 min period. A negativity score was produced by calculating the ratio of negative sentences to total sentences completed.

Following previous research evaluating vulnerable individuals (e.g., Rude et al., 2001), a cognitive load procedure was used in which participants were required to retain and remember a 6-digit number during the completion of the task.

2.3.2. Lexical decision task

The LDT was used in our study to evaluate automatic activation of negative meanings. This task involves the presentation of a randomly ordered set of 72 words comprising adjectives with different emotional content (24 positive, 24 negative, 24 neutral) and 72 nonwords. Ten additional words were used as stimuli for practice trials. Words were selected from a standardized list of words (Jiménez, Vázquez, & Hernangómez, 1998). According to these criteria, adjective categories showed significant differences in term of emotionality/valence, F(2, 71) = 3214.94, p < .001, but were similar in terms of word length, F(2, 71) = 1.66, p = .20, and frequency of use, F(2, 71) = 2.31, p = .11.

The LDT comprised the random presentation of words and nonwords on a computer screen. For each stimulus, participants were asked to respond as quickly as possible on whether the stimulus was a legitimate word or not by pressing the corresponding key.

There were two conditions: A primed and an unprimed condition that included both word and nonword trials (see Fig. 1). For word trials in the primed condition, a fixation cross was shown for 800 ms followed by the prime word displayed in uppercase. This was replaced by a mask that was a string of letters in uppercase (e.g., YCQVD) matched with the word in length. The stimulus onset asynchrony (SOA) between the prime and mask was 28 ms. The same word used as the prime was then displayed again in lowercase (i.e., target word), and the SOA between the mask and target word was 28 ms. To minimize priming effects due to the superficial physical characteristics of the words (e.g., Bradley et al., 1996), the prime and target words were presented in upper and lower case respectively. The target word remained on the screen until the participant's

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**Fig. 1.** Primed and unprimed conditions in the lexical decision task.
response and then a new trial started, indicated by the appearance of the next fixation cross (i.e., fixation → prime → mask → target). The intertrial interval was 250 ms. For nonword trials in the primed condition, the stimulus sequence was the same except that nonwords were used as prime and target stimuli.

For word and nonword trials in the unprimed condition, the sequence of stimuli was the same as described in the primed condition except that a random letter string was presented instead of a prime word (i.e., fixation → letter string → mask → target, see Fig. 1).

The measure of priming effects was obtained by subtracting lexical decision latencies for primed words from unprimed words for each emotion category (i.e., positive, negative, neutral). Positive scores on these indices denote faster lexical decisions due to priming (e.g., Bradley et al., 1996), indicating the magnitude by which prior activation of automatic self-referent concepts facilitates subsequent processing of that information.

2.3.3. Self-referent incidental recall task

The SRIRT was used to evaluate memory for emotional self-referent material. The task started with the presentation of a randomly ordered set of 36 adjectives (12 positive, 12 negative, 12 neutral). In the self-endorsement part of the task, participants responded by indicating whether each adjective described them or not. Six additional adjectives were used as stimuli for practice trials. Stimulus words were selected from a standardized list of words (Jiménez et al., 1998). According to these criteria adjective categories showed significant differences in terms of emotionality/valence, F(2, 35) = 1127.49, p < .001, but were similar in terms of word length, F(2, 35) = .65, p = .53, and frequency of use, F(2, 35) = 1.81, p = .18. Each trial started with a blank computer screen presented for 500 ms, followed by the appearance of an adjective for 2000 ms in the center of the screen. Participants then indicated if the adjective described them or not by pressing the corresponding yes or no key. An index of self-referent endorsement was computed by dividing the number of self-endorsed adjectives in each emotion category (i.e., positive, negative, neutral) by the total number of self-endorsed adjectives. This index has been employed in previous research in both formerly and currently depressed individuals (e.g., Dozois & Dobson, 2001; Gotlib et al., 2004).

Immediately after completing the self-endorsement task, participants were asked to recall as many of the adjectives presented during 3 min as possible. Indices of retrieval were calculated by dividing the number of self-endorsed and subsequently recalled adjectives from each emotion category by the total number of self-endorsed and recalled adjectives. This index has been employed in previous research (e.g., Gotlib et al., 2004; Joormann, D Kane, & Gotlib, 2006).

3. Procedure

All participants completed the session individually. After providing informed consent, participants were asked to complete the DID and BDI-II. Then, the experimenter scored the DID and BDI-II while participants completed two other tasks. First, participants completed a filler task, a verbal fluency test (Lezak, 1995) in which they were asked to write as many words beginning with the letter s as they could in 7 min. Second, participants completed the SST. After completing those two tasks and being scored on the DID and BDI-II measures, participants who met criteria of presence or absence of past history of depression in the DID, and with BDI-II scores equal to or less than 11, completed the LDT and then the SRIRT. Participants who did not meet participation criteria were not allowed to continue in the study. At the end of the experimental session, participants were thanked and debriefed.

4. Results

4.1. Participant characteristics

Demographic and clinical characteristics of the two participant groups are presented in Table 1. Formerly and never-depressed participants did not significantly differ in age, gender, or current severity of depression.

4.2. Negative processing under reduced cognitive control

We conducted a one-way analysis of covariance (ANCOVA) with group (formerly depressed, never depressed) as the independent variable, and the proportion of negative unscrambled sentences as the dependent variable. Current depressive symptoms were used as a covariate to further control for their influence between groups in the proportion of negative unscrambled sentences. The covariate showed a marginally significant effect, F(1, 67) = 3.05, p = .08, η² = .04. Analyses also revealed a significant group main effect, F(1, 67) = 4.23, p < .05, η² = .06. Formerly depressed participants completed a significantly higher proportion of negative sentences, M = .22, SD = .26, than completed by never-depressed participants, M = .10, SD = .14.

4.3. Negative processing under automatic activation of negative meanings

In accordance with previous studies, trials comprising nonwords and incorrect lexical decisions to words were removed from the analyses (Bradley et al., 1996). To minimize the influence of outlier responses, we excluded reaction times of more than 2.0 standard deviations above or below the mean for each participant (e.g., Carreiras, Mechelli, Estévez, & Price, 2007). The remaining latency data were further inspected using box plots to detect outlier responses (Bradley et al., 1996). The total percentage of invalid trials removed was 3.7%.

Means and standard deviations of lexical decision times and priming scores are presented in Table 2. To test differences between groups in the priming effects in reaction times, we conducted a 2 × 3 mixed design ANCOVA with Group (formerly depressed, never depressed) as a between-subjects factor and Emotion Category (positive, negative, neutral) as a within-subjects factor. Current depressive symptoms were used as a covariate. The covariate did not show a significant effect of emotion category, F(2, 134) = 1.71, n.s., η² = .02. Analysis showed a significant interaction of Group × Emotion Category, F(2, 134) = 3.02, p < .05, η² = .05. Bonferroni tests revealed that formerly and never-depressed participants did not significantly differ inpriming effects in reaction times for positive and neutral words, p = .82 and p = .61, respectively. However, formerly compared to never-depressed participants showed a significantly greater priming effect in reaction times for negative words, p < .01.

Table 1

<table>
<thead>
<tr>
<th>Variables</th>
<th>Formerly depressed (n = 30)</th>
<th>Never depressed (n = 40)</th>
<th>Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>80%</td>
<td>80%</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>20%</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>21.57 (1.43)</td>
<td>22.10 (1.95)</td>
<td>t(68) = 1.26, p = .21</td>
</tr>
<tr>
<td>BDI-II</td>
<td>6.13 (3.39)</td>
<td>4.73 (3.61)</td>
<td>t(68) = 1.65, p = .10</td>
</tr>
</tbody>
</table>

Note. BDI-II = Beck Depression Inventory-II.
Mean proportions and standard deviations of lexical decision latencies.

<table>
<thead>
<tr>
<th></th>
<th>Formerly depressed (n = 30)</th>
<th>Never depressed (n = 40)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>M</strong></td>
<td><strong>SD</strong></td>
<td><strong>M</strong></td>
</tr>
<tr>
<td>Reaction time (ms) for primed words</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>96.59</td>
<td>643.56</td>
</tr>
<tr>
<td>Negative</td>
<td>727.96</td>
<td>691.46</td>
</tr>
<tr>
<td>Neutral</td>
<td>704.72</td>
<td>647.70</td>
</tr>
<tr>
<td>Reaction time (ms) for unprimed words</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>108.18</td>
<td>674.44</td>
</tr>
<tr>
<td>Negative</td>
<td>728.22</td>
<td>700.17</td>
</tr>
<tr>
<td>Neutral</td>
<td>765.67</td>
<td>688.09</td>
</tr>
<tr>
<td>Priming effects (unprimed words – primed words)</td>
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<td></td>
</tr>
<tr>
<td>Positive</td>
<td>31.94</td>
<td>40.86</td>
</tr>
<tr>
<td>Negative</td>
<td>37.71</td>
<td>48.08</td>
</tr>
<tr>
<td>Neutral</td>
<td>39.06</td>
<td>48.08</td>
</tr>
</tbody>
</table>

To assess if group differences reflected a specific priming effect for negative words in formerly depressed participants, priming scores were contrasted against a value of zero using a one-sample t test (a priming score of 0 ms indicates no priming effect; see Bradley et al., 1996). These analyses showed a significant priming effect in reaction times for negative words in the formerly depressed group, t(29) = 5.05, p < .001, whereas the priming effect did not reach significance in the never-depressed group, t(39) = 1.32, p = .19.

4.4. Self-referent endorsement

We examined the self-referential SRIRT encoding data to determine if formerly and never-depressed participants differed in the proportion of self-endorsed adjectives. Mean proportions and standard deviations of self-endorsed adjectives in each emotion category are presented in Table 3. We conducted a 2 x 3 mixed design ANCOVA with Group (formerly depressed, never depressed) as a between-subjects factor and Emotion Category (positive, negative, neutral) as a within-subjects factor, controlling for the influence of current depressive symptoms as a covariate. Current depressive symptoms did not show a significant effect of emotion category, F(2, 134) = .99, n.s., η² = .01. Analysis revealed a significant Group × Emotion Category interaction, F(2, 134) = 4.76, p < .01, η² = .07. Bonferroni tests showed that, within the total number of endorsed and recalled adjectives, formerly compared to never-depressed participants showed a higher proportion of negative adjectives and a lower proportion of positive adjectives, p < .01 and p < .05 respectively. No differences between groups were found in the recall of neutral adjectives, p = .95.

4.5. Memory for emotional self-referent material

Mean proportions and standard deviations of recall of self-endorsed adjectives in each emotion category in the SRIRT are presented in Table 3. We conducted a 2 x 3 mixed design ANCOVA with Group (formerly depressed, never depressed) as a between-subjects factor and Emotion Category (positive, negative, neutral) as a within-subjects factor, controlling for the influence of current depressive symptoms. Main effects of group and the correlation observed between SST scores and LDT priming effects for negative words had a significant positive association with self-endorsed and recalled negative adjectives in the SRIRT, r = .38, p < .01 and r = .37, p < .01, respectively. On the contrary, SST scores and LDT priming effects for negative adjectives did not show a significant correlation, r = .13, p = .27.

To test if negative processing indices predicted the proportion of self-endorsed and recalled negative adjectives, we conducted a series of regression analyses with the standardized proportion of negative self-referent recall as dependent variable, and group and each standardized index of negative processing. Standardized BDI-II scores were entered in the models’ first step to control for the influence of current depressive symptoms. Main effects of group and the corresponding standardized index of negative processing (i.e., SST scores and LDT priming effects for negative words in each regression model respectively) were entered in the second step, followed by their two-way interaction in the third step (see Tables 4 and 5).

As can be seen in Table 4, the relationship observed between SST scores and the proportion of self-endorsed and recalled negative adjectives was accounted by the participants’ group condition. We conducted simple slopes analyses to examine this interaction effect. These analyses indicated that for participants in the never-depressed group, higher negative processing under reduced
cognitive control did not predict the proportion of self-endorsed and recalled negative adjectives, $\Delta R^2 = .01, \beta = -.069, p = .66$. However, higher negative processing under reduced cognitive control in the formerly depressed group did significantly predict the proportion of self-endorsed and recalled negative adjectives, $\Delta R^2 = .14, \beta = .428, p < .05$.

As can be seen in Table 5, the relationship observed between LDT priming effects and the proportion of self-endorsed and recalled negative adjectives was accounted by the participants’ group condition. Simple slopes analyses indicated that for participants in the never-depressed group, automatic activation of negative meanings did not predict the proportion of self-endorsed and recalled negative adjectives, $\Delta R^2 = .01, \beta = .087, p = .58$. However, automatic activation of negative meanings in the formerly depressed group did significantly predict the proportion of self-endorsed and recalled negative adjectives, $\Delta R^2 = .20, \beta = .450, p < .05$.

5. Discussion

Cognitive models propose that depression is caused by dysfunctional schemas that endure beyond the depressive episode, representing vulnerability factors for recurrence (Beck, 1967). However, research using self-report measures of dysfunctional attitudes (Weissman, 1979) has not found differences between formerly and never-depressed individuals in their levels of negative cognitions (e.g., Miranda et al., 1990). It has been argued that negative cognitions in vulnerable individuals may be observed under conditions that interfere with their attempts to reduce unwanted negative thinking (e.g., Watkins & Moulds, 2007; Wenzlaff & Bates, 1998). The present study was aimed at testing this possibility. Congruent with our first hypothesis, analyses on the SST showed that formerly compared to never-depressed individuals unscrambled more negative self-referent sentences while performing an additional secondary task. Our results replicate previous SST findings in vulnerable individuals (e.g., Rude et al., 2001; Watkins & Moulds, 2007). These findings indicate that negative processing in formerly depressed individuals is observable in conditions that interfere with attempts to suppress negative thinking (e.g., Wenzlaff, Rude, Taylor, Stultz, & Sweat, 2001).

Furthermore, we investigated if negative cognitions in vulnerable individuals may also be observed under other conditions uninfluenced by mental control, such as at automatic activation levels. Previous research has shown that currently compared to nondepressed individuals are faster at detecting negative words that have been previously presented subliminally (Phillips et al., 2010). To our knowledge, no studies have evaluated this priming effect in formerly depressed individuals. In our study, we analyzed if activation of subliminal negative words in the absence of conscious processing led to a faster detection of those negative words, as found in clinically depressed samples (e.g., Scott et al., 2001). LDT results revealed that formerly compared to never-depressed individuals showed a greater facilitation effect to detect subliminally primed negative words. This finding confirmed our second hypothesis that, in formerly depressed individuals, negative cognitions are observed not only in conditions with a lowered level of conscious processing but also in conditions where more automatic levels of processing intervene.

These results are congruent with current accounts (i.e., Joormann, 2010) that argue that biases in cognitive processing may operate as a function of the capacity to control for the accessibility of negative cognitions, without needing that those cognitions are activated by stressors as proposed by former cognitive models (e.g., Clark et al., 1999). Our results also support a dual-process theory of cognitive vulnerability to depression (Beever, 2005; Phillips, Hine, & Bhullar, 2012). According to this perspective, cognitive vulnerability to depression involves two modes of information processing. An associative mode implies automatic negative self-referential processing that may provide the foundation for cognitive vulnerability to depression whereas a reflective mode involves controlled and explicit processing. According to this model, cognitive vulnerability occurs when this reflective mode cannot correct negative processing generated at an automatic level. Our results indicate that negative processing in formerly depressed individuals can be observed in both the associative mode of automatic processing and the reflective mode of explicit processing when cognitive resources are depleted.

Cognitive models also postulate that negative cognitions leads individuals to show biases in their cognitive processing, by selecting and remembering information congruent with those negative cognitions (Beck, 1967). It has been well established that currently compared to nondepressed individuals show greater recall for information congruent with their negative schemas (Gotlib & Joormann, 2010). We extended this finding to formerly depressed individuals: In our study, formerly compared to never-depressed participants showed greater recall of negative self-referent adjectives and lower recall of positive self-referent adjectives. This finding is noteworthy given that a number of previous studies have not been able to reveal memory biases in vulnerable individuals (Bradley & Mathews, 1988; Teasdale & Dent, 1987). Previous research has provided more consistent evidence of memory biases following recovery when participants received a negative mood induction (Scher et al., 2005), intended to reactivate negative schemas (Clark et al., 1999; Teasdale, 1988). It should be noted that the index of memory for emotional material used in the present study differs from the index typically used in previous studies that have failed to find memory biases in formerly depressed individuals. Whereas other studies computed the total recall of negative adjectives previously presented, in the present study we calculated the recall of negative adjectives that had been previously encoded as self-referent. This method has shown to be effective in finding memory biases for self-referent information in clinically depressed individuals (Gotlib et al., 2004; Joormann et al., 2006). The present results indicate that, even without manipulating mood, memory biases can be observed in formerly depressed individuals. These

### Table 4
Regression analyses with SST scores.

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<thead>
<tr>
<th>Step</th>
<th>Predictor</th>
<th>$\Delta R^2$</th>
<th>$\beta$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>BDI-II (z)</td>
<td>.082</td>
<td>.287</td>
<td>.016*</td>
</tr>
<tr>
<td>Step 2</td>
<td>Group</td>
<td>.172</td>
<td>.249</td>
<td>.029*</td>
</tr>
<tr>
<td></td>
<td>SST (z)</td>
<td>.301</td>
<td>.301</td>
<td>.011**</td>
</tr>
<tr>
<td>Step 3</td>
<td>Group $\times$ SST (z)</td>
<td>.046</td>
<td>.406</td>
<td>.043*</td>
</tr>
</tbody>
</table>

Note. BDI-II – Beck Depression Inventory-II; SST – Scrambled Sentence Test. * $p < .05$.

### Table 5
Regression analyses with LDT priming effects for negative words.

<table>
<thead>
<tr>
<th>Step</th>
<th>Predictor</th>
<th>$\Delta R^2$</th>
<th>$\beta$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>BDI-II (z)</td>
<td>.082</td>
<td>.287</td>
<td>.016*</td>
</tr>
<tr>
<td>Step 2</td>
<td>Group</td>
<td>.175</td>
<td>.215</td>
<td>.066</td>
</tr>
<tr>
<td></td>
<td>LDT (z)</td>
<td>.300</td>
<td>.300</td>
<td>.010</td>
</tr>
<tr>
<td>Step 3</td>
<td>Group $\times$ LDT (z)</td>
<td>.086</td>
<td>.403</td>
<td>.005**</td>
</tr>
</tbody>
</table>

Note. BDI-II – Beck Depression Inventory-II; LDT – Lexical decision task. * $p < .05$; ** $p < .01$. **
results are consistent with recent research reporting cognitive biases in formerly depressed without using mood induction procedures (Hanking, Gibb, Abela, & Flory, 2010; Joormann & Gotlib, 2007; Sears, Newman, Ference, & Thomas, 2011). For instance, Joormann and Gotlib (2007) and Hanking et al. (2010) found that formerly depressed showed greater attention to sad faces compared to never depressed individuals. Sears et al. (2011) also reported a higher detection of negative images in formerly depressed compared to never depressed individuals using eye movement measures. Our findings extend these results from attention processes by showing that memory biases appear in formerly depressed individuals without using mood manipulations.

Moreover, our results are consistent with results from Alloy, Abramson, Murray, Whitehouse, and Hogan (1997) showing that individuals with higher cognitive vulnerability to depression (as assessed with negative thinking measures) showed lower recall of positive self-referent processing than individuals with lower cognitive vulnerability to depression. These results are consistent with the proposal that memory biases are linked to negative cognitions generated by depressive schemas (Holland & Kensinger, 2010). The present study was aimed at evaluating this association by testing if negative cognitions (assessed by negative processing indices in the SST and the LDT) were associated with memory biases for negative information in formerly depressed individuals. To our knowledge, no previous studies have examined this association in vulnerable individuals. We also confirmed our third hypothesis, showing that greater negative processing at both automatic activation of negative meanings and explicit processing under reduced cognitive control were linked to greater recall of negative self-referent material. Importantly, these associations were specifically found in formerly depressed individuals. This suggests that individual differences in the activation of negative cognitions at both automatic and explicit processing levels may confer vulnerability to depression by facilitating the retrieval of negative self-referent information. Furthermore, our results also suggest that memory biases to negative information may be not only dependent on negative mood states, as explained by traditional cognitive models of depression (Clark et al., 1999; Teasdale, 1988), but also operate as a function of formerly depressed individuals’ capacity to control negative processing (Joormann, 2010).

Interestingly, our results did not reveal significant associations between automatic and explicit measures of negative processing. This result is consistent with previous research evaluating associations between automatic and explicit indicators of self-esteem (e.g., Creemers, Scholte, Engels, Prinstein, & Wier, 2012; Greenwald & Farnham, 2000; Haefeli et al., 2007) that reported weak associations between these factors. However, research on self-esteem has also revealed that both unrelated modes of automatic and explicit processing are implicated in the generation of vulnerability to depression (Haefeli et al., 2007; Phillips et al., 2012). Taken together, these findings suggest that negative processing at automatic and explicit processing levels may reflect different mechanisms by which dysfunctional schemas facilitate the recall of negative self-referent information in vulnerable individuals. However, it should be noted that analyses of the relationship between negative processing indices and memory biases in our study were correlational and that we employed different tasks and stimuli to test the link between negative processing and memory biases. Further research should directly examine the causal links between negative cognitions and accessibility vs. availability biases. This could be implemented, for instance, by experimentally control the encoding of negative stimuli that are part of formerly depressed individuals’ memory representation and then test if differential accessibility for these negative stimuli leads to different patterns of negative retrieval. Further research should also examine if vulnerable individuals’ accessibility to self-referent cognitions and memory processing interact to predict prospective depressive symptomatology. Another limitation in our study was that the majority of participants in both groups were women. Although this is a common characteristic of studies evaluating memory biases in currently and formerly depressed samples (e.g., Dozois & Dobson, 2001; Gotlib et al., 2004), this may limit the generalizability of our results. However, it should be noted that no gender differences were found between groups in the study.

Despite these limitations, the present results have relevant clinical implications. Our findings suggest that negative processing, as detected by the SST and LDT tasks, may lead vulnerable individuals to recall more negative self-referent information in comparison to never depressed individuals. Based on our findings, negative biases observed through both interpretation task (SST) and automatic activation task (LDT) may affect subsequent processing of self-referent material (i.e., memory retrieval). This suggests that manipulating the activation of negative meanings as well as promoting more positive patterns of interpretations may help to reduce negative memory biases, which have been found to be predictive of depressive symptoms over time (e.g., Beene & Arnett, 2008). For instance, recent studies have shown that the manipulation of interpretative bias can result in changes in memory, which suggests a causal relation between both cognitive processes (Salemin, Hertel, & Mackintosh, 2010; Tran, Hertel, & Joormann, 2011). Taken together, these results suggest that it might be possible to reduce cognitive vulnerability to depression by training vulnerable individuals to change rather automatic negative interpretation patterns. Furthermore, modifying negative self-referent aspects at early stages of cognitive processing may also be a potential way of intervention in vulnerable individuals, as this modification might also favor important changes in the later processing of self-referent information, as proposed by current accounts of vulnerability to depression (Reevers, 2005).

6. Conclusion

Our study provides evidence of negative processing in formerly depressed individuals at both automatic and explicit levels of processing under reduced cognitive control. Furthermore, to the best of our knowledge, the present study is the first to demonstrate an association between both modes of negative processing and memory biases for negative self-referent information in formerly depressed individuals. In our opinion, these findings increase our understanding of the processes that intervene in how dysfunctional schemas confer vulnerability to depression.

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