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Testing a "content meets process" model of depression vulnerability and rumination: Exploring the moderating role of set-shifting deficits

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Abstract

Background and objectives: MacCoon and Newman's (2006) "content meets process" model posits that deficits in cognitive control make it difficult to disengage from negative cognitions caused by a negative cognitive style (NCS). The present study examined if the interactive effect of cognitive set-shifting abilities and NCS predicts rumination and past history of depression.

Methods: Participants were 90 previously depressed individuals and 95 never depressed individuals. We administered three laboratory tasks that assess set-shifting: the Wisconsin Card-Sorting Task, the Emotional Card-Sorting Task, and the Internal Switch Task, and self-report measures of NCS and rumination.

Results: Shifting ability in the context of emotional distractors moderated the association between NCS and depressive rumination. Although previously depressed individuals had more NCS and higher trait rumination relative to never depressed individuals, shifting ability did not moderate the association between NCS and depression history.

Limitations: The cross-sectional correlational design cannot address the causal direction of effects. It is also not clear whether findings will generalize beyond college students.

Conclusions: NCS was elevated in previously depressed individuals consistent with its theoretical role as trait vulnerability to the disorder. Furthermore, NCS may be particularly likely to trigger rumination among individuals with poor capacity for cognitive control in the context of emotional distraction.

Keywords

Depression; Rumination; Cognitive control; Set-shifting; Negative cognitive content; Negative cognitive style

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1. Introduction

According to the hopelessness theory of depression, negative cognitive style (NCS) entails attributing negative events to causes that are stable (i.e., enduring over time) and global (i.e., affecting many life domains), thinking that these events will lead to other negative consequences, and that these events imply negative characteristics of the self (Abramson, Metalsky, & Alloy, 1989). Numerous studies have found that NCS retrospectively and prospectively predicts both depressive symptoms and episodes, suggesting that it functions as a trait vulnerability to depression (e.g., Abela, Brozina, & Seligman, 2004; Alloy et al., 2000; Hankin & Abramson, 2002). However, while there is a robust association between NCS and risk for depression, not all individuals with a NCS develop depression. This phenomenon has led researchers to postulate the conditions by which NCS confers risk for depression.

The degree to which individuals are able to control and disengage from negative cognitions may be critical. MacCoon, Wallace, and Newman (2004) distinguish between dominant cognitions, which are well rehearsed responses in interpreting the environment, and non-dominant cognitions, which are only sporadically used responses. They posit that executive control processes are required to shift from automatically deployed dominant cognitions to less practiced non-dominant cognitions. Their “content meets process” model (MacCoon & Newman, 2006) further posits that depression prone individuals have relatively limited cognitive control, which makes it difficult for them to switch attentional focus to non-dominant content when dominant content has been activated. Given the presence of NCS among depression prone individuals, it is likely that they perseverate on negative content. This perseveration and difficulty disengaging from negative cognitions would likely take the form of depressive rumination, and would further fuel depressive symptomatology.

Depressive rumination is a repetitive self-focus on negative aspects of the self (Nolen-Hoeksema, 1991), and is a robust correlate of depression. There is a great deal of research that has shown that rumination maintains negative affect, precedes depressive episodes, and leads to longer depressive episodes (see Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008 and Smith & Alloy, 2009 for reviews). Several researchers have proposed that a NCS leads to depression because depression prone individual tend to ruminate on this content (e.g., Abramson et al., 2002; Alloy & Abramson, 2007; Lo, Ho, & Hollan, 2008; Spasojevic & Alloy, 2001). In addition, consistent with MacCoon and Newman’s (2006) hypothesis, impairments in cognitive control are associated with rumination and depression (see Gotlib & Joormann, 2010 for a review). In short, there is support for the claims that both rumination and depression are products of NCS and impaired cognitive control. From a content meets process perspective it can be hypothesized that deficits in cognitive control amplify the effect of a NCS to produce rumination, and in turn depression. However, it is empirically unknown if the potential synergistic effect of NCS and cognitive control exerts a direct risk for depression or indirect risk via rumination, or both. Thus, the current study will examine the influence of NCS and cognitive control on both rumination and depression history.

However, it is important to recognize that cognitive control is a multifaceted construct that refers to several higher order abilities (e.g., Miyake et al., 2000), and that the content meets process model posits set-shifting to be the most relevant executive process in the etiology of depression. In line with this framework, there is evidence to suggest that rumination (Davis & Nolen-Hoeksema, 2000) and current depression (e.g., Grant, Thase, & Sweeney, 2001; Harvey et al., 2004; Merriam, Thase, Haas, Keshayan, & Sweeney, 1999) are associated with set-shifting deficits as measured by the Wisconsin Card Sorting Task (WCST). However, these studies examined the concurrent association between set-shifting and both depression and rumination, and therefore do not address the issue of whether set-shifting deficits are trait vulnerabilities to depression or simply a consequence of a depressive state. Studies that used a remission-design (which compare previously depressed individuals with never depressed individuals) have not found performance differences on the WCST (Biringer et al., 2005; Nakano et al., 2008). Together, these findings suggest that set-shifting deficits may be a state dependent effect of current depression rather than a trait vulnerability.

In efforts to clarify the role of cognitive control in the etiology of depression, some researchers have argued that vulnerability to depression involves set-shifting deficits in the context of emotional information (e.g., De Lissnyder, Koster, Derakshan, & De Raedt, 2010; Deveney & Deldin, 2006). Because the WCST only presents neutral stimuli, a new generation of set-shifting tasks, including the Emotional Card Sorting Task (ECST) and the Internal Shift Task (IST), have been developed to investigate the role of set-shifting ability in the context of valenced information (De Lissnyder, Koster, & De Raedt, 2012; Deveney & Deldin, 2006). The ECST functions very similarly to the WCST, but assesses the degree of perseveration in the presence of negatively, positively, or neutrally valenced distracting stimuli. In contrast, the IST assesses how quickly individuals can update and switch between both emotion and non-emotion mental sets that are held in working memory.

In the one previous study using the ECST, Deveney and Deldin (2006) found that currently depressed individuals made more perseverative errors relative to healthy controls during the presence of negative distractors, but not during positive or neutral distractors. However, to our knowledge no previous studies have examined whether rumination or depression vulnerability are associated with poor set-shifting specific to the presence of negative information using the ECST. Using the IST De Lissnyder et al. (2012) found that difficulty updating and switching between (from or towards) emotion mental sets held in working memory was associated with rumination, but not concurrent depressive symptoms. However, in a sample of previously depressed individuals, impairments in updating and switching between emotion mental sets held in working memory were found to prospectively predict rumination and depressive symptoms (Demeyer, De Lissnyder, Koster, & De Raedt, 2012). Importantly, past research has not investigated if set-shifting deficits specific to the presence of negative information or difficulty updating and switching between emotionally valenced stimuli amplify the impact of negative cognitive content on the development of rumination and risk for depression.

The goal of the current study was to examine the association between different types of set-shifting and both rumination and depression history. Furthermore, we investigated if the interactive effect of NCS and set-shifting was associated with rumination and depression

history. We hypothesized that perseverative errors during the negative block of the ECST (but not during the positive or neutral blocks) would predict rumination and the likelihood of having a previous depressive episode. Similarly, we expected that IST emotion switch costs (but not non-emotion switch costs) would predict rumination and likelihood of having a previous depressive episode. We posited that NCS would be more strongly associated with rumination and probability of having a past history of depression among individuals with greater ECST perseverative errors during the negative block (but not during the positive and neutral blocks) and higher IST emotion switch costs (but not non-emotional switch costs). Lastly, to compare the current sample to previous studies we administered the WCST. In line with past research that did not select participants based on rumination or current depression we did not expect the WCST to yield significant effects.

2. Method

2.1. Participant overview

Participants were 185 (81 male) undergraduate students enrolled in an introductory psychology course at a large public university in the Northeastern United States. The majority self-identified as Caucasian (72.0%), 8% as Hispanic, 6.5%, as African American, 6.5% as other (e.g., multiracial), 6% as Asian, and 1% as American Indian. Participants received course credit in partial fulfillment of a course requirement.

2.2. Measures

2.2.1. Depression screen—The Patient Health Questionnaire-9 current and lifetime (PHQ and PHQ-L; Cannon et al., 2007; Spitzer, Kroenke, & Williams, 1999) are self-report measures that assess symptoms of Major Depressive Disorder (MDD) consistent with DSM-IV diagnostic criteria. These measures have good agreement with diagnoses made by mental-health professionals using clinical interviews. For example, the PHQ has shown sensitivity of .75 and specificity of .90 (Spitzer et al., 1999), whereas the PHQ-L has shown sensitivity of .71 and specificity of .84 (Cannon et al., 2007).

2.2.2. Depressive symptoms—The depression subscale of the Depression Anxiety Stress Scale (DASS-21; Lovibond & Lovibond, 1995) includes a 7-item subscale that assess depressive affective symptoms with a 4-point Likert scale ranging from 0 “did not apply to me at all” to 3 “applied to me very much”. The DASS-21 has demonstrated good reliability (α = .94; Antony, Bieling, Cox, Enns, & Swinson, 1998) and good convergent and discriminant validity (Henry & Crawford, 2005). In the present study the internal consistency of the depression subscale was α = .81.

2.2.3. Depression diagnosis—The mood disorder and psychosis modules from the Structured Clinical Interview for DSM-IV (SCID; First, Spitzer, Gibbon, & Williams, 1996) was conducted to confirm diagnostic status and determine participant eligibility. The SCID is a clinician-administered semi-structured interview used to make clinical diagnoses according to the DSM-IV criteria. The diagnostic team consisted of six advanced graduate students who received extensive training in administering these modules, and supervision led by a Ph.D. level psychologist. All SCID-I interviews were video recorded to allow

for inter-rater reliability assessment and supervision. In the present study the inter-rater reliability was *Fleiss K* = .92.

2.2.4. Negative cognitive style—The Cognitive Styles Questionnaire (CSQ; Alloy et al., 2000) was used to assess NCS. In this measure participants are presented with 12 hypothetical negative events, and rate the extent to which they: (a) attribute each situation as being caused by something with stable and global characteristics; (b) believe the situation will cause other negative consequences; and (c) view the self as worthless for experiencing the situation on 7-point Likert scales. This measure has good internal consistency and 1-year test re-test reliability (r = .80; Alloy et al., 2000). In the present study the internal consistency was α = .95.

2.2.5. Rumination—The Ruminative Response Scale (RRS; Nolen-Hoeksema & Morrow, 1991) is a 22-item self-report measure used to assess rumination. Using a 4-point Likert scale ranging from almost never to almost always, participants indicate the extent to which they ruminate on negative content when feeling sad, blue, or depressed. The RRS has shown to have good internalconsistency (r = .89; Nolen-Hoeksema & Morrow, 1991) and predictive validity (Just & Alloy, 1997). In the present study the internal consistency was α = .94.

2.2.6. Cognitive control: set-shifting—Each of the computerized tasks described below to assess cognitive control were programmed and administered using the Psychology Experiment Building Language (PEBL; Mueller, 2012).

The Wisconsin Card Sorting Test (WCST; Heaton, Chelune, Talley, Kay, & Curtiss, 1993) was administered to assess non-valenced set-shifting ability. In this task a target card must be sorted with one of four key cards that differ in form (crosses, circles, triangles, or stars), color (red, blue, yellow, or green), and number (one, two, three, or four). Participants must sort these cards by choosing the correct sorting criteria (i.e., sort by form, color, or number) without prior knowledge of the correct sorting rule. Participants receive immediate feedback regarding whether or not the selected sorting principle is correct. The sorting rule changes throughout the task without notice and participants are required to *switch* their selected sorting principle. The present study focused on the number of perseverative errors (continuing to sort cards according to a sorting principle that is no longer correct).

The Emotional Card Sorting Test (ECST; Deveney & Deldin; 2006) was administered to assess set-shifting abilities in the presence of negative, positive and neutral distractors. There a 4 key cards and one target card, which must be sorted with the correct key card. Each of the 4 key cards have the word “item” printed on it and the features of the word “item” vary in color, form (font type instead of geometric shape as in the WCST), and number of times the word “item” appears. The target card, which needs to be sorted with one of the 4 key cards, contains a stimulus word that varies in valence (positive, negative, or neutral), as well as color, form, and number. For example, a target card may contain the stimulus word “festive”, “agony”, or “cabinet.” Participants must sort the target card based on color, form, or number of times the stimulus word appears on the target card. The valence of the stimulus word is not used as a sorting criteria, but instead the word on the target card

serves as a distractor stimulus. Participants must identify the correct sorting rule and they are provided immediate feedback whether their response is correct or incorrect. The sorting rule changes spontaneously and without notice and participants must *switch* their selected sorting principle. A failure to switch sorting rules (continuing to sort cards according to a sorting principle that is no longer correct) is called a perseverative error. Percent perseverative errors (i.e., the amount of perseverance on an inaccurate sorting rule) are calculated separately for blocks in which the distractor stimuli are negatively, positively, or neutrally valenced, and these different blocks are counterbalanced within the task.

The Internal Shift Task (IST; De Lissnyder et al., 2012) was administered to assess how quickly individuals can update and switch between negative and neutral information. The IST has two types of blocks which are counterbalanced. In the emotional block, participants are given instructions to keep a mental count of the number of angry and the number of neutral faces that are presented on the computer screen. Thus, in this condition the "target" feature of the faces is the emotional expression. In the non-emotional block, participants are given instructions to keep a mental count of the number of female faces and the number of male faces that are presented on the computer screen. Thus, in this condition the "target" characteristic of the faces is gender. Both the emotional and non-emotional blocks present the same face stimuli. There are a total of 24 blocks (12 emotional blocks and 12 non-emotional blocks) with a random set of 10–14 face stimuli presentations. On each trial participants are instructed to press the space bar as soon as they have updated their count according to the instruction of the specific block. Within each condition participants are presented with "switch" and "non-switch" trials. Switch trials occur when two different types of stimuli are presented back to back and participants must switch their mental set to perform an update of their mental count (e.g., angry to neutral, or female to male). Non-switch trials occur when the same type of stimuli are presented back to back and participants do not need to switch their mental set to perform an update of their mental count (e.g., angry to angry, or female to female). The reaction time latency between the presentation of the face stimuli and participant's pressing of the space bar (indicating they have updated their mental count) is the measure used to calculate our variables of interest. From this reaction time latency two types of "switch costs" are calculated: emotion switch costs, and non-emotional switch costs. Switch costs represent the difference score between the reaction time latency of participants when updating their mental counts in switch trials relative to non-switch trials. In line with De Lissnyder et al. (2010; 2012) the emotion switch cost is the median reaction time difference score between all of the switch and non-switch trials during the emotional block. The non-emotion switch cost is the median reaction time difference score between all of the switch and non-switch trials during the non-emotional block. Greater switch costs are indicative of poor set-shifting.

2.3. Participant eligibility criteria and verification procedures

Eligibility criteria required participants to be native English speakers, be between 18 and 30 years old, and to either have no lifetime history of depression or to have met criteria for at least one previous depressive episode. Participants were excluded if they met criteria for a current depressive episode or had a lifetime history of hypomania, mania, or psychosis.

We screened a total of 2272 individuals, and invited 302 individuals who screened negative for both current and past depressive episodes and 230 individuals who screened negative for a current depressive episode, but positive for past depressive episode. Of the 532 participants who were invited to the laboratory, a total of 346 participants underwent the SCID. Of these participants, 95 were confirmed to have never met for previous depressive episode and 90 were confirmed to have met for a previous depressive episode, but were currently not in a depressive episode. To insure that these individuals were fully recovered they were required to have experienced at least 8 consecutive well weeks with no more than 2 current depressive symptoms. Our final sample consisted of 185 participants. We attempted to match participants on gender, race, and age. See Table 1 for summary of the sample characteristics.

2.4. Procedure

Eligible participants were invited to complete two separate laboratory sessions: 1) a first session where set-shifting tasks were administered, and 2) a second session where self-report measures were administered. The first laboratory session occurred within one week from the diagnostic interview session and the second laboratory session occurred within one week from the first laboratory session. Retention rates across the 1st and 2nd laboratory sessions were 99.5% and 98.4%, respectively.

3. Data analytic plan

Analyses were conducted using R 3.1.0 (R Foundation for Statistical Computing, 2014).

Demographic variables that were significantly associated with the dependent variables were treated as covariates. Rumination, depressive symptoms, the WSCT and the ECST cognitive control variables were significantly skewed and kurtotic, thus, these variables were log transformed.

We conducted separate step-wise regression models for each of the six cognitive shifting variables (i.e., perseverative errors during the negative, positive, and neutral blocks in the ECST, perseverative errors during the WSCT, and switch costs during the emotion and non-emotion blocks on the IST). Furthermore, separate models were run for the two dependent variables (rumination and depression history; see Tables 3 and 4 for examples of how the models were conducted). In Step 1 we entered the respective covariates for the model (i.e., any relevant demographic variables). We entered NCS and the relevant cognitive control variable in Step 2. Finally, we entered the relevant two-way interaction terms in Step 3 to examine the interactive effects of NCS and cognitive control predicting rumination and depression history. Significant interaction terms were probed by conditioning the moderator (cognitive control) at 1 standard deviation above and below the mean.

4. Results

4.1. Preliminary analyses

Rumination was associated with race/ethnicity, $t(180) = 2.0$, $p < .05$, such that non-Caucasians reported higher levels of rumination (*mean* = 47.7) relative to Caucasians (*mean* = 43.3). Likewise, rumination was positively associated with depressive symptoms, $r = .51$,

$p < .01$, but not, age, $r = .12$, $p > .05$, or gender, $t(180) = 1.5$, $p > .05$. We included race and current depressive symptoms as covariates in all models that treated rumination as the dependent variable.

In terms of depression history, there were no statistically significant differences on gender, $\chi 2$ (1, N = 185) = .74, $p > .05$, or ethnicity/race (Caucasians compared to all other racial groups), $\chi 2$ (1, $N = 185$) = .00, $p > .05$, between the two diagnostic groups (see Table 1), suggesting that matching was successful on these variables. However, previously depressed individuals reported higher current depressive symptoms, $t(180) = 3.66$, $p < .05$, $M = 1.7$ vs. 3.1, higher rumination, $t(175) = 8.65$, $p < .05$, $M = 37.0$ vs. 52.4, and were older, $t(142) = 2.32$, $p < .05$, $M = 18.7$ vs. 19.2, than never depressed individuals. On the DASS-21 depression subscale scores between 0 and 4 are considered to represent minimal depressive symptoms. Thus, both the previously and never depressed participants had mean depression scores in the minimal range, albeit, the previously depressed group were slightly more symptomatic. We included age and current depressive symptoms as covariates in all models that treated depression history as the dependent variable.

As shown in Table 2 NCS was moderately correlated with depressive symptoms and rumination, suggesting that these are related but separate constructs. NCS was not correlated with any cognitive control variables. Perseverative errors during the negative and neutral blocks on the ECST were weakly correlated with rumination, and perseverative errors during the positive block on the ECST were marginally correlated with rumination. As expected all three blocks on the ECST were strongly correlated with the WCST. The statistically non-significant correlations between the ECST and the IST, and the WCST and the IST are consistent with previous research that generally finds a lack of association across different measures of cognitive control and aligns to the view of cognitive control as “fractionable” (e.g., Miyake et al., 2000).

4.2. Regression models with rumination as the dependent variable

Consistent with our hypotheses, perseverative errors during the negative block on the ECST were positively associated with rumination (see Table 3), whereas perseverative errors during the positive and neutral blocks and during the WSCT were not statistically significant. Furthermore, NCS was positively associated with rumination. Although falling short of conventional levels of significance, there was a marginally significant NCS × Perseverative Errors interaction during the negative block on the ECST, $p = .07$, such that NCS positively predicted rumination at high perseverative errors, $\beta = .34$, $p < .01$, but not at low perseverative errors, $\beta = .13$, $p > .05$. Similarly, there was a marginally significant NCS × Perseverative Errors interaction during the positive block on the ECST, $p = .05$, such that NCS positively predicted rumination at high perseverative errors, $\beta = .36$, $p < .01$, but not at low perseverative errors, $\beta = .14$, $p > .05$. Consistent with our hypotheses, the NCS × Perseverative Errors interaction during the neutral block on the ECST and during the WSCT were not significant, $p's > .05$.

Given that the NCS × ECST Perseverative Errors interactions were marginally significant in the case of both positively and negatively valenced blocks and that these interactions were similar in form, post-hoc analysis were conducted in which the two valenced conditions

were combined to test if the synergistic effect would be observed across both positive and negative stimuli. Results indicated that valenced perseverative errors on the ECST were positively associated with rumination, $\beta = .15$, $p < .05$. Furthermore, there was a significant NCS × Valenced Perseverative Errors interaction on the ECST, $\beta = .14$, $p < .05$, such that NCS positively predicted rumination at high perseverative errors, $\beta = .39$, $p < .01$, but not at low perseverative errors, $\beta = .10$, $p > .05$.[1]

Finally, IST switch costs in both the emotion and non-emotion condition did not predict rumination, either on their own or in interaction with NCS.

4.3. Logistic regression models with depression history as the dependent variable

All step-wise logistic regression models followed the same framework as the step-wise linear regression models reported above except that our covariates were age and depressive symptoms (see Table 4). Although NCS significantly predicted depression history, $p < .05$, contrary to hypotheses, none of the cognitive control variables predicted depression history either on their own or in interaction with NCS, all p's > .33. We exponentiated the NCS coefficients to interpret the odds-ratio and found that for a one unit increase in NCS the odds of having a history of depression increased by a factor of 1.8.

5. Discussion

The aim of the current study was to provide an initial test of the content meets process model of depression. We examined the relationships between set-shifting ability and NCS with both depressive rumination and depression history. Furthermore, we tested if the association between NCS and both rumination and history of depression varied as a function of set-shifting ability.

Our results show that difficulties in set-shifting in the presence of distracting emotional information are associated with elevations in depressive rumination. This finding adds to a growing body of literature suggesting that deficits in cognitive control may be an underlying mechanism that produces rumination (Koster, De Lissnyder, Derakshan, & De Raedt, 2011; Whitmer & Gotlib, 2013). Furthermore, we found that set-shifting in the presence of distracting emotional information moderated the relationship between NCS and depressive rumination. NCS was more strongly associated with elevated levels of depressive rumination among individuals with poor set-shifting in the presence of distracting emotional information (both negative and positive). In contrast, our results suggest that set-shifting in the context of neutrally valenced distractors, set-shifting in the absence of any distractors, and set-shifting between negative and neutral emotional information in working memory were not associated with rumination either on their own or in interaction with NCS.

[1]Some researchers have proposed that there are two facets of rumination: brooding and reflection (also referred to as pondering) that can be derived from a subset of items on the RRS (Treynor, Gonzalez, & Nolen-Hoeksema et al., 2003). While the objective of the current study was to examine correlates of the full rumination construct, in light of this research we tested whether the NCS × ECST (combined across both positively and negatively valenced blocks) interaction predicted each of these forms of rumination. Although this interaction marginally predicted reflection/pondering, $t = 1.8$, $\beta = .12$, $p = .07$, such that NCS positively predicted reflection/pondering at high errors, $\beta = .25$, $p > .05$, but not at low errors, $\beta = .00$ $p = .96$, the interaction was not a statistically significant predictor of brooding, $t = 1.5$, $\beta = .09$, $p = .13$

Carver and Scheier (1998) argue that it is adaptive for individuals to focus their attention on negative events or problems in order to solve the issue. However, individuals with NCS tend to repetitively focus on this information (i.e., ruminate) instead of switching between possible solutions (see Martin, Shrira, & Startup, 2004 for a theoretical account of this view). Abramson et al. (2002) propose that because negative events are perceived to be caused by stable and global characteristics, and to lead to other negative consequences, there is “spreading activation” of more negative information. Our findings are consistent with the possibility that such spreading activation is most likely among individuals who have shifting difficulties in the presence of valenced stimuli, and that this spreading activation of negative content takes the form of depressive rumination. In contrast, individuals with better shifting abilities seem to be able to disengage from this process even if they have a NCS.

Although our study provides preliminary support for the content meets process model in terms of rumination, several specifications regarding the type and context under which cognitive control deficits contribute to the development of rumination need to be made. First, our results suggest the role of specific deficits related to shifting difficulties in the presence of emotional information rather than general deficits in set-shifting. Our a priori hypothesis was that these effects would be specific to difficulties shifting attention in the presence of negative emotional stimuli, and it was therefore surprising to find that difficulties shifting in the presence of either negatively or positively valenced distractors predicted greater rumination among individuals with NCS. It may be that individuals with a NCS respond to both negatively and positively valenced emotional distractors with the activation of negative cognition. For example, among individuals with a NCS the distractor word “success” might trigger cognitions related to goal failure (i.e., lack of being successful), triggering spreading activation of negative content. However, this is a speculative post-hoc explanation.

Second, although both the ECST and IST involve set-shifting in working memory across different emotional valences, our results suggest specificity to the ECST. In contrast to the IST, the ECST involves shifting between different rules in the context of task-irrelevant emotional content. Our results suggest that difficulties detecting and flexibly responding to changes in rules in the context of emotional distraction exacerbates the effect of NCS on rumination, whereas set shifting that does not involve changing rules (as assessed by the IST) or set shifting in the absence of emotional distractors does not have this effect. In other words, our results suggest that the interactive effect of NCS and set-shifting on rumination is specific to difficulties shifting rules when the context involves potentially distracting emotional stimuli. These results are consistent with the possibility that either the tendency to get ‘stuck’ in a given way of thinking (rule) amplifies the effect of NCS in the generation of ruminative thoughts or that individuals who are prone to thinking about their experiences in a negative manner (high NCS) have difficulty flexibly responding to shifting rules when they are ruminating. However, actively using emotionally valenced information in working memory (as assessed by switch costs in the IST) was not associated with rumination even among individuals with a NCS. With these specifications in mind, our study is the first to provide empirical support for the content meets process model showing that NCS and cognitive control deficits synergistically predict rumination.

Although previously depressed individuals reported greater rumination and a more NCS than their never depressed counterparts, none of the set-shifting measures were associated with depression history either on their own or in interaction with NCS. Our results fit with previous studies that failed to show that deficits in cognitive control function as a trait-like vulnerability to depression (Biringer et al., 2005; Nakano et al., 2008). Moving beyond past research, the present study found that previously depressed individuals did not differ from never depressed controls on set-shifting in the context of emotional distractors or on set-shifting between negative and neutral emotional information in working memory. Furthermore, there was no evidence that the synergistic effect between NCS and set-shifting was associated with having a past history of depression. However, in line with previous research our results indicated that previously depressed individuals reported greater NCS (e.g., Abela, Stolow, Zhang, & McWhinnie, 2012; Alloy et al., 2000) and elevated rumination (Roberts et al., 1997) compared to never depressed individuals. Importantly, we matched individuals based on gender, age, and race between the two diagnostic groups, which helps address potential confounds in the interpretation of the current findings. These results provide support for the notion that NCS (Abela et al., 2012; Alloy et al., 2000) and rumination (Roberts et al., 1997) confer risk for depression.

The cross-sectional nature of our study requires caution in the interpretation of our results. We cannot infer that rumination was caused by either NCS or cognitive set-shifting. It is possible that a transactional relationship is occurring such that impaired set-shifting in the context of emotional distractors contributes to the development of depressive rumination, and rumination in turn leads to more impairment in set-shifting. Future prospective designs or experimental manipulations of rumination are needed to clarify the causal direction of these effects. Additionally, future studies may benefit from measuring state rumination in the natural environment (e.g., via ecological momentary assessment), and/or stress-reactive rumination. Previous research suggest that brooding is the maladaptive form of repetitive thinking (versus reflection). We did not find that NCS interacted with cognitive control to predict brooding (reported in Footnote 1). This may be mean that cognitive control (at least as assessed by the ECST) does not differentiate between types of repetitive thinking; however, replication of these surprising results is warranted. Furthermore, while college students represent a population with an increasingly high prevalence of diagnosable depression (American College Health Association, 2009) and we over-sampled individuals with a bonafide previous depressive episode, this population may represent a group of individuals with above average cognitive control (which could have masked some of the possible associations). Thus, future studies may benefit from utilizing community and clinical samples. Finally, we acknowledge that our measures of set-shifting are not “process pure” and likely assessing set-shifting, as well as other facets of cognitive control.

Despite these limitations this study found preliminary support for the content meets process model as applied to depressive rumination. Although set-shifting failed to predict depression history, our findings are consistent with a recent theoretical movement suggesting that rumination accounts for the association between cognitive control deficits and depression (Koster et al., 2011; Levens, Muhtadie, & Gotlib, 2009). That is, rumination is conceptualized as a mediator of more distal predictors of depression, such as cognitive control (e.g., Demeyer et al., 2012).Koster et al. (2011) argue that if poor cognitive control

contributes to ruminative thinking, which in turn fuels depression, then treatments that only focus on the content of maladaptive thinking (such as traditional cognitive therapy) may be insufficient. Our findings lend support for the argument that advancement in the treatment of depression may benefit from targeting cognitive control (e.g., Koster et al., 2011; Siegle, Ghinassi, & Thase, 2007).

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Table 1

Sample characteristics by diagnostic group.

	No depression history	Previous major depressive episode
N	95	90
Age (mean and SD)	18.7 (1.0)	19.2 (1.7)
Gender ratio (male/female)	45/50	36/54
Depressive symptoms (mean and SD)	1.7 (2.3)	3.1 (3.2)
Rumination (mean and SD)	37.0 (9.3)	52.4 (14.2)

Note: depressive symptoms assessed with the Depression and Anxiety Stress Scale (DASS-21: Lovibond & Lovibond, 1995) depression subscale; rumination assessed with the full Ruminative Response Scale (RRS; Nolen-Hoeksema & Morrow, 1991).

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Table 2

Means, standard deviations, and correlation matrix.

		Mean	SD	1	2	3	4	5	6	7	8	9
1	Depressive symptoms	2.4	2.8	1.00	.34**	.51**	.07	.06	.05	.00	−.01	.09
2	NCS	3.8	1.0		1.00	.39**	.06	−.03	.01	.02	−.03	−.01
3	Rumination	44.6	14.2			1.00	.23**	.13+	.15*	.05	.02	.04
4	ECST: negative	9.5	4.9				1.00	.52**	.51**	.36**	.02	−.11
5	ECST: positive	8.5	4.8					1.00	.67**	.56**	−.04	.00
6	ECST: neutral	8.2	4.6						1.00	.89**	.06	.04
7	WCST	7.8	3.1							1.00	.02	−.02
8	IST: emotion	481.8	278.7								1.00	.51**
9	IST: non-emotion	478.0	279.8									1.00

Notes: ECST = Emotional Card Sorting Task, IST = Internal Shift Task, WCST = Wisconsin Card Sorting Task;

+ =.09

* <.05

** <.01.

Table 3

Step-wise regression results (dependent variable = depressive rumination).

Regression model	ECST: negative β (*SE*)	ECST: positive β (*SE*)	ECST: neutral β (*SE*)	WCST: neutral β (*SE*)	IST: emotion β (*SE*)	IST: non-emotion β (*SE*)
Step 1	R^2 = .25, p < .01	R^2 = .25, p < .01	R^2 = .25, p < .01	R^2 = .25, p < .01	R^2 = .25, p < .01	R^2 = .25, p < .01
Race	.29 (.14) *	.29 (.14) *	.29 (.14) *	.29 (.14) *	.29 (.14) *	.29 (.14) *
Depressive symptoms	.48 (.07) **	.48 (.07) **	.48 (.07) **	.48 (.07) **	.48 (.07) **	.48 (.07) **
Step 2	ΔR^2 = .08, p < .01	ΔR^2 = .05, p < .01	ΔR^2 = .06, p < .01	ΔR^2 = .05, p < .01	ΔR^2 = .05, p < .01	ΔR^2 = .05, p < .01
NCS	.24 (.07) **	.25 (.07) **	.25 (.07) **	.24 (.07) **	.25 (.07) **	.24 (.07) **
Cognitive control	.17 (.06) **	.06 (.06)	.11 (.06) +++	.03 (.06)	.04 (.07)	−.01 (.07)
Step 3	ΔR^2 = .01, p = .07	ΔR^2 = .02, p = .05	ΔR^2 = .01, p > .10	ΔR^2 = .00, p > .10	ΔR^2 = .00, p > .10	ΔR^2 = .00, p > .10
NCS × cognitive control	.11 (.06) ++	.11 (.06) +	.09 (.06)	.06 (.06)	.06 (.07)	.01 (.07)

Notes: ECST = Emotional Card Sorting Task, IST = Internal Shift Task, WCST = Wisconsin Card Sorting Task.

+++ =.095

++ =.07

+ =.05

* <.05

** <.01.

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Table 4

Step-wise logistic regression results (dependent variable = depression history).

Regression Model	ECST: negative coefficient (*SE*)	ECST: positive coefficient (*SE*)	ECST: neutral coefficient (*SE*)	WCST: neutral coefficient (*SE*)	IST: emotion coefficient (*SE*)	IST: non-emotion coefficient (*SE*)
Step 1	PR^2 = .09, p < .05	PR^2 = .09, p < .05	PR^2 = .09, p < .05	PR^2 = .09, p < .05	PR^2 = .09, p < .05	PR^2 = .09, p < .05
Age	.39 (.17)*	.39 (.17)*	.39 (.17)*	.39 (.17)*	.39 (.17)*	.39 (.17)*
Depressive symptoms	.57 (.16) **	.57 (.16) **	.57 (.16) **	.57 (.16) **	.57 (.16) **	.57 (.16) **
Step 2	ΔPR^2 = .06, p < .05	ΔPR^2 = .06, p < .05	ΔPR^2 = .06, p < .05	ΔPR^2 = .06, p < .05	ΔPR^2 = .06, p < .05	ΔPR^2 = .06, p < .05
NCS	.58 (.19) **	.60 (.19) **	.58 (.19) **	.59 (.19) **	.59 (.19) **	.57 (.19) **
Cognitive control	.14 (.17)	.09 (.16)	−.00 (.16)	−.07 (.16)	.00 (.16)	−.16 (.17)
Step 3	ΔPR^2 = .00, p > .05	ΔPR^2 = .00, p > .05	ΔPR^2 = .00, p > .05	ΔPR^2 = .00, p > .05	ΔPR^2 = .00, p > .05	ΔPR^2 = .00, p > .05
NCS × cognitive control	.01 (.17)	.11 (.17)	−.01 (.17)	−.10 (.17)	.00 (.17)	−.09 (.19)

Notes: ECST = Emotional Card Sorting Task, IST = Internal Shift Task, WCST = Wisconsin Card Sorting Task. PR^2 = *McFadden Pseudo R-squared.*

** <.05

*** <.01.