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When Mental Inflexibility Facilitates Executive Control: Beneficial Side Effects of Ruminative Tendencies on Goal Maintenance

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Abstract

Although previous research suggests that depressive ruminators tend to become stuck in a particular mind-set, this mental inflexibility may not always be disadvantageous; in some cases, it may facilitate active maintenance of a single task goal in the face of distraction. To evaluate this hypothesis, we tested 98 college students, who differed in ruminative tendencies and dysphoria levels, on two executive-control tasks. One task emphasized fast-paced shifting between goals (letter naming), and one emphasized active goal maintenance (modified Stroop). Higher ruminative tendencies predicted more errors on the goal-shifting task but fewer errors on the goal-maintenance task; these results demonstrated that ruminative tendencies have both detrimental and beneficial effects. Moreover, although ruminative tendencies and dysphoria levels were moderately correlated (r = .42), higher dysphoria levels predicted more errors on the goal-maintenance task; this finding indicates that rumination and dysphoria can have opposing effects on executive control. Overall, these results suggest that depressive rumination reflects a trait associated with more stability (goal maintenance) than flexibility (goal shifting).

Keywords

cognitive control; goal neglect; rumination; depression; executive functions; cognitive style

Successful everyday functioning requires balancing two opposing needs: maintaining the current goal to avoid distraction and flexibly shifting from one goal to another (Goschke, 2000). Overfocusing on a single goal makes switching to a new, potentially important goal difficult, whereas being always ready to shift goals makes it hard to concentrate and complete the task at hand. Although ever-changing environments require constant adjustments between these opposing needs, we propose that individuals differ systematically in the degree to which their mental balance tilts toward goal maintenance or goal shifting and that depressive rumination is one trait that captures such systematic variation. We support this claim by demonstrating differential effects of ruminative tendencies on two

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executive-control tasks, one emphasizing goal maintenance and one emphasizing goal shifting.

Depressive rumination involves having recurrent thoughts focused on the causes, meanings, and implications of a depressed mood (Nolen-Hoeksema, 1991). Ruminators become stuck in a set of recurring thoughts with a common, often emotionally charged theme and have trouble switching to a new train of thought. Ruminative tendencies have been established as a stable individual characteristic with serious negative consequences: Higher ruminative tendencies lead to reduced motivation and initiative and increasingly severe and numerous bouts of depression (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Although many studies have examined rumination in emotionally charged contexts, the tendency of ruminators to become stuck in a certain mind-set—mental inflexibility—can also be observed on emotionally neutral tasks. For example, individuals with higher ruminative tendencies (hereafter, trait ruminators) make more perseverative errors on the Wisconsin Card Sorting Test (Davis & Nolen-Hoeksema, 2000) and have greater difficulty inhibiting no-longer-relevant task sets in a task-switching paradigm (Whitmer & Banich, 2007).

These findings suggest that mental inflexibility is a stable characteristic of trait ruminators that affects their thought and action in various situations. In fact, recurring thoughts experienced by trait ruminators could be a manifestation of this underlying mental inflexibility (Davis & Nolen-Hoeksema, 2000). Once certain thoughts (e.g., negative thoughts or task goals) are established in working memory, they are not easily removed; this impedes trait ruminators from switching to more positive thoughts or other goals. If there is no negative mood on which to ruminate, an emotionally neutral goal lingers in working memory even when that goal becomes no longer relevant.

This characterization of the cognitive profile of trait ruminators (hereafter, the trait-inflexibility view) leads to a counterintuitive prediction: Although mental inflexibility is often disadvantageous (especially when the situation calls for rapidly shifting between goals), it can be advantageous when successful performance requires active maintenance of a particular goal despite distracting stimuli or competing goals. In such situations, trait ruminators' mental "stickiness" may help prevent that goal from easily slipping out of working memory.

We tested this novel implication of the trait-inflexibility view by comparing people's performance on two tasks designed to elicit goal neglect, a phenomenon in which individuals know yet fail to execute a task goal. The letter-naming task (Duncan, Emslie, Williams, Johnson, & Freer, 1996) requires fast-paced letter reading from one side of a pair of letters (left or right), followed by a quick cue interpretation to determine which side of the remaining letters to read from. This task necessitates rapid switching from letter naming to cue interpretation and back to letter naming. The modified Stroop task (Kane & Engle, 2003), like the regular Stroop task (Stroop, 1935), requires subjects to view color words (e.g., *red, blue*) and identify the actual color in which each word is displayed. In the modified version, however, incongruent trials (25% of the total trials), in which the word and color do not match, are randomly intermixed with congruent trials (75% of the total trials), in which the word and color do match. This setup makes it easy to erroneously slip

into word-reading mode on rare incongruent trials unless the color-naming goal is actively maintained.

The trait-inflexibility view predicts a negative correlation between ruminative tendency and performance on the letter-naming task but a positive correlation between ruminative tendency and performance on the modified Stroop task. If once-established goals tend to linger, trait ruminators should have difficulty rapidly switching goals during the letter-naming task. In contrast, trait ruminators' mental stickiness should facilitate maintenance of the color-naming goal in the modified Stroop task and make them less error prone.

This prediction can be contrasted with the predictions of alternative views that attribute trait ruminators' executive-control difficulties to other sources. One such account posits that trait ruminators may occasionally engage in ruminative thinking, even in emotionally neutral settings. Task-irrelevant ruminations could then consume limited working memory resources, thereby disrupting flexible regulation of thought and action (Watkins & Brown, 2002). Unlike the trait-inflexibility view, this ongoing-rumination view predicts negative correlations between ruminative tendency and performance on both goal-neglect tasks. This is because task-irrelevant ruminative thoughts should impair effective management of goals regardless of whether the task requires goal shifting or goal maintenance. The current study tested these contrasting predictions.

Method

Subjects

Ninety-eight undergraduate students (33 females and 65 males) participated for course credit.

Materials and procedure

Questionnaires—We assessed depressive rumination with the 10-item Ruminative Responses Scale (RRS; Treynor, Gonzalez, & Nolen-Hoeksema, 2003). Because the two RRS subscales (Reflection and Brooding) showed the same patterns of correlations as the overall RRS scores, only overall scores are reported. We assessed dysphoria levels (non-clinical-level depressed mood) with the Beck Depression Inventory (BDI; Beck & Steer, 1987).

Letter-naming task—As illustrated in Figure 1a, in the letter-naming task, letter pairs and number pairs flashed in rapid succession on the monitor. Subjects attended to letters only and read them aloud. An initial cue ("LEFT" or "RIGHT") specified which side of the letter pairs to read. After 10 pairs, a secondary cue indicated which side of the remaining pairs subjects should read ("+" meant "left" and "–" meant "right"). Each trial began with a "READY" sign, and then a 1,000-ms blank screen that was followed by the initial cue, presented for 1,000 ms. After another 1,000-ms blank screen, the letter pairs and number pairs appeared. Each pair (and the secondary cue) flashed for 200 ms and was followed by a 200-ms blank screen.

Subjects completed one block of 16 trials, each of which contained 15 pairs of numbers or letters. The first 10 pairs were randomly ordered but evenly divided between number pairs and letter pairs. The first pair after the secondary cue was always a number pair, but the remaining 4 pairs were randomly ordered and evenly split between letter pairs and number pairs. The dependent measure was the proportion of trials with no errors or omissions, and this measure was scored separately for pairs that preceded the secondary cue (precue pairs) and pairs that followed the secondary cue (postcue pairs).

Modified Stroop task—As illustrated in Figure 1b, on the modified Stroop task, the words *RED*, *BLUE*, and *GREEN* appeared on the monitor in the colors red, blue, and green, but word and color did not always match. Subjects were instructed to ignore the words' meaning and name the color of the word as quickly and as accurately as possible. After a practice block of neutral color-naming trials (in which "XXX" appeared on the screen instead of the color word), subjects completed four blocks of 48 randomly ordered trials each. Every block consisted of 25% incongruent trials (i.e., the colors did not match the words) and 75% congruent trials (i.e., the colors matched the words).

Each trial began with a 750-ms black screen followed by a 250-ms central fixation cross. After a 500-ms black screen, the target stimulus appeared; it remained on the screen until the subject vocally responded. Reaction times (RTs) were measured by voice key. Because this task was optimized for inducing goal-neglect errors (Kane & Engle, 2003), the primary dependent measure was accuracy, though we also examined RTs. Voice-key errors and RTs outside the range of 150 ms to 3,000 ms or more than 3 standard deviations from the subject's mean were removed from analysis; these criteria affected 2.3% of trials.

Results

Descriptive statistics are summarized in Table 1. BDI scores were low in this restricted nonclinical sample, but still correlated moderately with RRS scores, $r(96) = .42$, $p < .001$.

Letter-naming task

Following Duncan et al. (1996), we excluded from analysis 10 subjects who failed to correctly recall the task requirements after completing the task. Among the remaining 88 subjects, precue letter-naming accuracy was uniformly high ($M = .89$) and unrelated to RRS scores, $r(86) = –.13$, $p = .215$. Consistent with both the trait-inflexibility view and the ongoing-rumination view, the data indicated that postcue letter-naming accuracy ($M = .66$) was negatively correlated with RRS scores, $r(86) = –.30$, $p = .005$; this correlation suggests that ruminators were worse than nonruminators at goal shifting.

To distinguish the effects of rumination and dysphoria, we conducted semipartial-correlation analyses. As shown in Figure 2, controlling for BDI, RRS scores still predicted post-cue accuracy, $r(85) = –.26$, $p = .016$. In contrast, a small non-significant correlation between BDI and postcue accuracy, $r(86) = –.15$, $p = .159$, completely vanished after controlling for RRS, $r(85) = –.03$, $p = .785$; this result suggests that rumi-native tendencies, not dysphoria levels, affected postcue accuracy.

Modified Stroop task

Congruent-trial accuracy was at ceiling (*M* = .995) and unrelated to RRS scores, r(96) = .01, *p* = .956. Accuracy on the rare, incongruent trials (*M* = .84), however, was positively correlated with RRS scores, *r*(96) = .30, *p* = .003; this correlation suggests that ruminators performed better than nonruminators on this task, as predicted by the trait-inflexibility view but not the ongoing-rumination view. This tendency became even stronger after controlling for BDI scores, *r*(95) = .38, *p* = .0001 (see Fig. 2). It is interesting to note that although BDI scores were uncorrelated with incongruent-trial accuracy, *r*(96) = –.11, *p* = .293, they showed a significant negative correlation after partialing out RRS scores, *r*(95) = –.26, *p* = .011 (see Fig. 2). These results suggest that ruminative tendencies and dysphoria levels have opposing effects on this task and that the former is the primary source for the positive correlation for incongruent-trial accuracy.

If trait ruminators indeed maintained the color-naming goal, then they should have responded more slowly than nonruminators on the frequent, congruent trials because they were still naming colors rather than reading words. Consistent with this prediction, RRS scores showed a near-significant correlation with congruent-trial RTs, *r*(96) = .19, *p* = .064. This correlation became significant after controlling for BDI, *r*(95) = .23, *p* = .023.

Trait inflexibility or conservative responding?

These results support the trait-inflexibility view, but one alternative explanation is that, compared with nonruminators, trait ruminators report fewer letters in the letter-naming task and produce fewer word-reading errors on the modified Stroop task because they are more cautious responders, favoring accuracy over speed. Contrary to this account, the positive correlation between ruminative tendencies and color-naming accuracy on incongruent trials of the modified Stroop task was still significant even after controlling for congruent-trial RTs, *r*(95) = .25, *p* = .012, or incongruent-trial RTs, *r*(95) = .29, *p* = .004. Similarly, the negative correlation between ruminative tendencies and postcue accuracy on the letter-naming task remained significant after controlling for congruent-trial RTs, *r*(85) = –.27, *p* = .011, or incongruent-trial RTs, *r*(85) = –.27, *p* = .010, on the modified Stroop task. Thus, response-criterion conservativeness, at least as measured by RTs on the modified Stroop task, cannot fully explain the results.

Discussion

The current study produced a striking dissociation between two goal-neglect tasks. On a task emphasizing rapid goal shifting (letter naming), higher ruminative tendencies predicted lower accuracy. Yet on a task emphasizing goal maintenance (modified Stroop), higher ruminative tendencies predicted higher accuracy on rare, incongruent trials. These results support the trait-inflexibility view because they suggest that trait ruminators may indeed have “sticky” minds and that their cognitive processing may inherently be geared more toward goal maintenance than toward goal shifting.

The correlational dissociation reported here is surprising for two reasons. First, theoretical accounts of rumination have focused on the negative consequences of ruminative thinking

(Nolen-Hoeksema, 1991; Nolen-Hoeksema et al., 2008). Although increasingly more attention is being given to the potential benefits of ruminative thoughts (Watkins, 2008), research documenting specific advantages is still rare (Smallwood et al., 2003; Verhaeghen, Joormann, & Khan, 2005). The current study contributes to this literature by suggesting that active goal maintenance may be an important cognitive benefit of trait rumination.

Second, better performance on these goal-neglect tasks has been linked to higher fluid intelligence in the case of the letter-naming task (Duncan et al., 1996, 2008) and larger working memory capacity in the case of the modified Stroop task (Kane & Engle, 2003).[1] Given that fluid intelligence and working memory capacity are closely related (Conway, Kane, & Engle, 2003), there is good reason to expect these tasks to show similar patterns of correlations. The observed dissociation, however, suggests that the critical processes underlying successful performance on these two tasks are different and that goal neglect may be a nonunitary, multifaceted construct.

The current results have two important implications for rumination research and depression research. First, the demonstration that trait ruminators' executive-control difficulties during emotionally neutral tasks are not necessarily due to ongoing ruminative thinking highlights a need for caution when researchers examine the effects of rumination by experimentally inducing ruminative thoughts. This approach has been used widely to examine the causal effect of ruminative thinking (see Nolen-Hoeksema et al., 2008, for a review). Although such investigation can provide information about how ongoing ruminative thinking affects cognitive or emotional processing, it may not reveal the effect of individual differences in ruminative tendencies that seem present even in the absence of negative moods or ruminative thinking. Together with the notion that recurring ruminative thoughts may be a manifestation of general mental inflexibility in trait ruminators (Davis & Nolen-Hoeksema, 2000; Whitmer & Banich, 2007), the current results highlight the importance of not equating the effects of experimentally induced rumination with the effects of naturally occurring trait rumination.

Second, the dissociation between ruminative tendencies and dysphoria levels observed for the modified Stroop task indicates that, though they are closely related and often show similar patterns of correlations, ruminative tendencies and dysphoria levels have distinct, or even opposing, influences on cognitive processing (see also Smallwood et al., 2003; Whitmer & Banich, 2010). Indeed, the current results suggest that higher ruminative tendencies are associated with better goal maintenance, whereas higher levels of dysphoria are associated with worse goal maintenance. It is interesting to note that this pattern is consistent with previous observations that higher ruminative tendencies were associated with fewer task-unrelated thoughts, whereas higher dysphoria levels were associated with more task-unrelated thoughts (Smallwood et al., 2003; Smallwood, O'Connor, & Heim, 2005). Such dissociations help specify the distinct effects of trait rumination and dysphoria

[1]Although this study did not administer working memory and intelligence tests, existing evidence suggests that ruminative tendencies are unrelated to working memory capacity (Davis & Nolen-Hoeksema, 2000) and general fluid intelligence (Altamirano, Friedman, & Miyake, 2010).

and suggest that studying circumstances in which active maintenance of a single goal is required despite distraction may be revealing.

Although the current study provides new insights into the cognitive basis of individual differences in ruminative tendencies, it also has two limitations. First, because we used an undergraduate sample, generalizability to clinical populations (e.g., severely depressed individuals) remains to be seen. Second, although these goal-neglect tasks were selected on the basis of existing evidence and key task requirements (goal shifting vs. goal maintenance), the two tasks differed in many ways. Although it is unlikely that the current results are attributable solely to simple differences between the two tasks (such as average accuracy levels),[2] it is nevertheless important to further test the mental-inflexibility view using other goal-neglect or executive-control tasks that have varying difficulty levels and require different levels of goal shifting versus goal maintenance.

In conclusion, this study provides evidence that depressive rumination is a trait that captures a dimension of individual differences that has not been thoroughly examined before: the degree to which people's cognitive processing is geared toward flexibility (goal shifting) or stability (goal maintenance). Studying ruminative tendencies from this flexibility-stability perspective holds great promise for elucidating not only maladaptive but also adaptive properties of ruminative thinking. Moreover, current efforts to understand the neural and genetic underpinnings of ruminative tendencies (Nolen-Hoeksema et al., 2008) should help uncover the biological mechanisms underlying trait differences between people with an inclination toward mental flexibility and people with an inclination toward mental stability.

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[2]Mean accuracies for the two goal-neglect tasks may seem substantially different (*M* = .66 for postcue letter naming and *M* = .84 for incongruent-trial Stroop), but these numbers are not directly comparable because there are multiple ways to score letter-naming accuracy. Although the main dependent measure was the proportion of trials with no errors or omissions, more lenient methods that yielded higher mean accuracies more comparable to that of the modified Stroop task (e.g., the proportion of correctly named letters, *M* = .75, or of trials with at least one correctly named letter, *M* = .87) still produced robust negative correlations with RRS scores. Thus, differences in mean accuracies cannot explain the correlational dissociation between the letter-naming and modified Stroop tasks.

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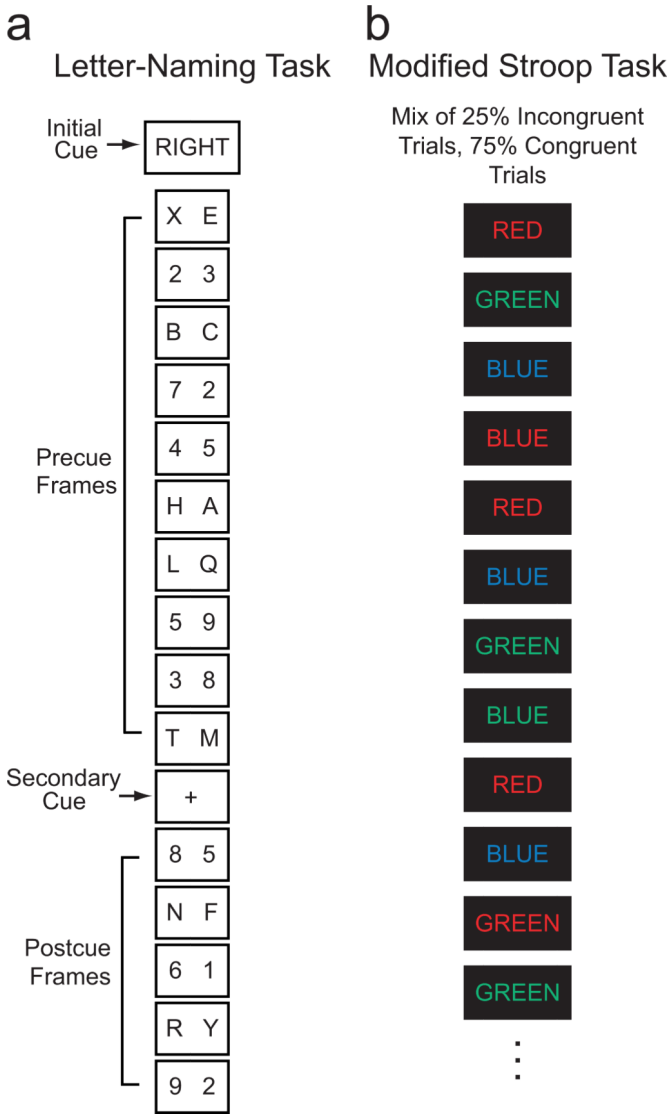

Fig. 1.

Sample trial structure for the two tasks in the study. In the letter-naming task (a), an initial cue ("LEFT" or "RIGHT") specified which side of the letter pairs subjects should read aloud from in the following 10 pairs of numbers and letters. A secondary cue ("+" meant "left" and "–" meant "right") indicated which side subjects should read from in the next 5 pairs. In the modified Stroop task (b), subjects were instructed to name the color of the word on the screen and ignore the meaning of the word; 25% of the trials were incongruent (i.e., the colors did not match the words), and 75% were congruent (i.e., the colors matched the words).

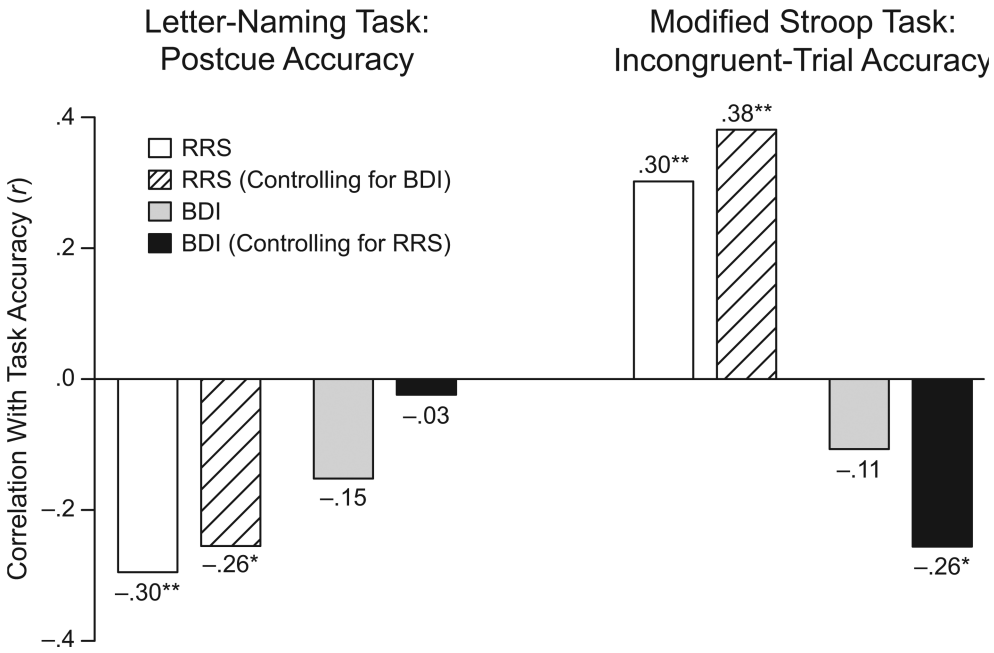

Fig. 2.

Correlation between performance on each goal-neglect task and scores on the Ruminative Responses Scale (RRS) and the Beck Depression Inventory (BDI). Semipartial-correlation analyses were used to control for RRS or BDI where indicated. Asterisks indicate correlations significantly different from zero (*$p < .05$, **$p < .01$).

Table 1

Descriptive Statistics for the Measures Used in the Study

Task and measure	Mean	SD	Range	Skewness	Kurtosis	Reliability
Questionnaires (n = 98)						
Depressive rumination (RRS)	19.8	5.2	10–32	0.29	–0.73	.75
Dysphoria level (BDI)	7.5	5.4	0–23	1.00	0.55	.90
Letter-naming task (n = 88)						
Precue accuracy	.89	.09	.56–1.00	0.33	–0.80	.24
Postcue accuracy	.66	.19	.19–1.00	0.46	0.58	.82
Modified Stroop task (n = 98)						
Incongruent-trial accuracy	.84	.13	.21–1.00	–0.31	1.66	.91
Congruent-trial accuracy	.995	.01	.94–1.00	–1.76	1.60	–.04
Incongruent-trial RT (ms)	780	122	508–1,102	0.29	0.27	.93
Congruent-trial RT (ms)	601	86	409–864	0.41	0.55	.96

Note: Scores for the Ruminative Responses Scale (RRS; Treynor, Gonzalez, & Nolen-Hoeksema, 2003) and the Beck Depression Inventory (BDI; Beck & Steer, 1987) were calculated by summing across all responses within each questionnaire. Higher RRS scores indicate more ruminative tendencies, and higher BDI scores indicate higher levels of dysphoria. Skewness, kurtosis, and reliability were calculated with arcsine-transformed accuracies. It was not necessary to transform the response time (RT) data. Reliability estimates are split-half correlations adjusted with the Spearman-Brown prophecy formula. Ten participants failed to correctly recall task rules after completing the letter-naming task and were excluded from all analyses involving this task. Descriptive statistics for the questionnaires and modified Stroop task are reported here for all subjects, but were unchanged when we included only the 88 participants included in the analysis of the letter-naming task.