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Cognitive vulnerability to depression: examining cognitive control and emotion regulation

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Disordered affect is a key feature of depression. Basic research on emotion and emotion regulation, therefore, promises to increase our understanding of depression vulnerability. Recent studies that examine cognitive processes that may underlie the ability to regulate emotion effectively have shown that depression is associated with deficits in cognitive control and that these deficits are related to difficulties in emotion regulation. This article reviews recent empirical evidence for these deficits in cognitive control, focusing on updating, shifting, and inhibition, and their relation to emotion dysregulation in depression. The review puts special emphasis on studies that examine neural correlates of cognitive control difficulties in this disorder and discusses future directions and treatment implications of this line of research.

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Major depressive disorder (MDD) is among the most prevalent of all psychiatric disorders affecting almost 20% of the American population at some point in their lives [1]. Given the high prevalence and the substantial personal and societal costs of depression, efforts to identify risk factors and underlying mechanisms as well as effective intervention strategies are particularly pressing. A hallmark feature of depression is disordered affect. MDD is defined by sustained negative affect and difficulties experiencing positive affect [2]. A closer look at the concept of emotion regulation and at mechanisms that allow us to understand individual differences in the important ability to regulate affective states may therefore help us better understand vulnerability to depression and thereby improve our treatment approaches.

Theories of depression vulnerability have emphasized the role of cognition and the role of emotion regulation but only recently have researchers explicitly examined the relation between these two constructs [3]. Emotion regulation is defined as strategic and automatic processes that influence the occurrence, magnitude, duration and expression of an emotional response [4]. Many forms of effective emotion regulation require high levels of cognitive control. Negative mood is generally associated with the activation of mood-congruent representations in working memory [5]. Working memory (WM) is a limited-capacity system that reflects the focus of attention and the temporary activation of representations that are the content of awareness. The ability to exert cognitive control, that is, to control the contents of working memory, might therefore play an important role in recovery from negative affect [6]. Cognitive control, for example, increases people's ability to use reappraisal, which requires the re-interpretation of the emotion-eliciting event [7] and has been identified as an adaptive emotion regulation strategy. At the same time, deficits in cognitive control may increase the risk for rumination, a particularly maladaptive emotion regulation strategy that has been linked to risk for depression and other forms of psychopathology [8].

Cognitive control is not a unitary construct but subsumes a variety of executive control processes including updating, switching, and inhibition [9]. It has been proposed that deficits in all of these aspects of cognitive control are linked with emotion dysregulation and studies have begun to emerge that examine the role of these different components in emotion regulation and psychopathology [10]. Deficits in updating may, for example, make it difficult to discard mood-congruent content from working memory, thus keeping attention focused on the emotion-eliciting aspects and the initial appraisals of the event. The following sections review recent research on the functioning of these aspects of cognitive control in depression. Table 1 gives brief descriptions of select tasks that have been used to examine these different components.

Updating

Updating concerns the monitoring and manipulation (i.e. addition or removal) of the contents of working memory [9]. The ability to flexibly and efficiently update working memory could help individuals avoid perseverative thinking, such as rumination, by allowing them to remove negative, no longer goal-relevant content from working memory. Interestingly, recent studies have shown that depressed individuals have greater difficulty manipulating

Table 1

Common tasks for investigating components of cognitive control.

Name	Cognitive control domain	Description	Example
Working memory manipulation task	Updating	Participants are shown lists of three words on a screen and are instructed to remember those words either in the order presented (forward trials) or in the reverse order (backward trials). Then, they are presented with a probe word and required to indicate whether that word was first, second, or third in the list, counting in the order in which they were instructed to memorize (forward or backward). The cost of updating is measured as differences in response times between forward and backward trials.	Joormann, Levens and Gotlib, 2011 [13]
Emotional n-back task	Updating	Faces are presented on the screen, and participants are required to indicate whether the emotional expression of the current faces matches that of the face that appeared two trials ago. This tests participants' ability to continuously update working memory with emotional information.	Levens and Gotlib, 2010 [16••]
Affective inflexibility task	Shifting	Participants are required to categorize pictures either on the basis of an affective rule (i.e. whether they are positive or negative) or a non-affective rule (i.e. the number of people in them). Each trial consists of the picture and a cue signaling which categorization rule to apply. The cognitive cost of switching is calculated as the difference in reaction times between trials preceded by a trial employing the same rule and trials preceded by a trial employing the other rule.	Genet, Malooly, and Siemer, 2012 [21]
Internal shift task	Shifting	Participants are instructed to count the number of angry and neutral faces (or, in the neutral condition, male and female faces) presented throughout a block of trials. They press a button to indicate that they have updated their count after each face presentation. The cognitive cost of switching is calculated as the change in reaction time on trials where the preceding trial featured a different face category than the current trial.	De Lissnyder *et al.*, 2012 [19]
Cued emotional conflict task	Inhibition	On each trial, participants are instructed to respond to the upcoming presentation of a face by identifying the emotion it is displaying, identifying the opposite emotion, or pressing an unrelated button. Examining performance on trials when participants are required to respond by identifying the opposite emotion allows for the investigation of emotional conflict.	Vanderhasselt *et al.*, 2012 [35]
Emotion-word Stroop task	Inhibition	In addition to blocks of trials with color and meaning conflict (e.g. 'red' written in yellow), some blocks of trials require participants to identify the color when a negative emotion word is presented (e.g. 'fail' written in red).	Compton *et al.*, 2011 [43]

material in working memory compared to control participants, especially when that material is negative (see Table 1) [11]. Functional magnetic resonance imaging (fMRI) work has found that depressed participants show greater activation of the dorsal anterior cingulate and parietal and bilateral insular cortices when removing negative, but not positive, words from working memory, compared to maintaining them [12]. Healthy participants show the same pattern of activation for positive, but not negative, words. These regions are thought to subserve cognitive control; thus greater activation in these areas suggests that depressed individuals have difficulty manipulating negative material in working memory. Other work has demonstrated that, when required to memorize two lists of words and then ignore one of them, participants with MDD compared to participants with social anxiety disorder or healthy controls had greater difficulty removing emotional words from working memory [13]. Participants with MDD, compared to healthy controls, have also been found to be slower to discard sad faces and faster to discard happy faces from WM in an emotional n-back task (see Table 1) [14]. Similarly, patients with MDD exhibited difficulty updating working memory with relevant task instructions [15]. In healthy participants, updating ability was found to moderate the effects of reappraisal and rumination on high arousal negative emotions [16••]. Among those with high updating ability, reappraisal was associated with decreased experience of these emotions, while there was no association among those with low updating ability. Similarly, rumination was associated with greater experience of high arousal negative emotions, but only among those with low updating ability. Overall, several studies have shown that updating is impaired in depressed individuals in the context of