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The role of expectancy and proactive control in stress regulation: A neurocognitive framework for regulation expectation

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HIGHLIGHTS

- Low expectancy to deal with stressful events may result in less initiation of proactive control. Anticipation is related to specific neurocircuits and the ability to deal with stressors
- Our approach can be used to develop and fine-tune interventions to facilitate proactive control.

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ABSTRACT

When confronted with stressful or emotionally arousing situations, regulatory abilities should allow us to adaptively cope. However, depressed individuals often have a low sense of perceived control and are characterized by a negative expectation bias regarding their ability to deal with future stressful events. Low expectancy concerning the ability to deal with future stressful events may result in less initiation of proactive control, a crucial mechanism of cognitive control reflecting sustained and anticipatory maintenance of goal-relevant information in the dorsolateral prefrontal cortex to optimize cognitive performance. In this theoretical review we integrate a diverse body of literature. We argue that the expectancy of an individual's regulatory abilities prior to the presentation of an arousing event or stressful task will be related to anticipation and proactive up- or downregulation of specific neurocircuits *before* the actual encounter with the stressful event occurs, in a manner that can be either adaptive or maladaptive. Moreover, we discuss the important role of self-esteem as well as the ability to accept the situation when coping is not possible. Our approach has implications for a broad range of disorders and conditions in which stress regulation plays a role, and can be used to guide the use of recently developed clinical interventions, as well as to fine-tune interventions to facilitate proactive control.

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When we are confronted with situations or thoughts perceived as unpleasant, aversive or threatening, a series of biological and psychological processes is activated, generating a coordinated response. This so-called stress response is triggered when an individual's well-being or health is threatened. Relational or financial problems, unpredictability, an acute threat, or a challenging situation such as a job interview are examples of stressful situations or stressors that can initiate a stress response. Regulatory abilities, which we call *stress regulation*, generally allow us to cope with these situations in an adaptive way. However, there are large individual differences in how well people handle life stressors. Indeed, problems with *stress regulation* are thought to play a central role in the development and clinical course of depression (Hooley, Orley, & Teasdale, 1986; Hankin, 2008; Morris, Ciesla, & Garber, 2010). It has also been suggested that, over time, depressive episodes can be triggered by progressively milder and milder stressors (Monroe & Harkness, 2005; but see also Anderson, Monroe, Rohde, & Lewinsohn, 2016).

Research shows the important role of *stress regulation* in the development of different forms of psychopathology, such as depression, where psychosocial stressors are strongly implicated in the triggering of new episodes (Kendler, Thornton, & Gardner, 2000). Understanding the role of stressors in depression requires consideration of the interaction between biological, cognitive and environmental factors (De Raedt & Koster, 2010). Vulnerability to the effects of stressful events can be conceptualized as a trait-like latent endogenous process related to genetic, as well as other biological and psychological variables (Gotlib, Joormann, Minor, & Hallmayer, 2008; Ingram & Siegle, 2009).

Cognitive control, which is a crucial concept related to resilience to stressors, refers to processes that allow adaptive changes in information processing and behavior to current goals. Numerous studies have documented the role of prefrontal circuits in cognitive control (i.e., regulation) over stressful events (e.g., Baeken et al., 2014), as well as negative emotions (e.g., Leyman, De Raedt, Vanderhasselt, & Baeken, 2011) and painful physical stimuli (e.g., Strigo, Simmons, Matthews, Craig, & Paulus, 2008). However, our ability to deal with stressful events goes far beyond dealing with stressors that occur in the moment. Anticipation of future stressful events is an important component of emotion processing (Phillips, Drevets, Rauch, & Lane, 2003). It also influences acute emotional experiences (Kirsch, 1985). Simply knowing that we have an adaptive response to the stressor available can reduce aversiveness, decrease anxiety prior to exposure to the stressful event and reduce anticipatory physiological arousal (Gatchel & Proctor, 1976).

In this theoretical review we start from depression but take an essentially transdiagnostic approach and seek to integrate a diverse body of literature. Braver (2012) has recently developed a cognitive control framework distinguishing between proactive and reactive modes of control (the Dual Mechanisms of Control Framework). Proactive control occurs before the onset of a stimulus and involves preparatory processes that serve to enhance coping with conflict or challenge when it is presented. It is a crucial mechanism of cognitive control reflecting sustained and anticipatory maintenance of goal-relevant information in the dorsolateral prefrontal cortex (DLPFC) to optimize cognitive performance. Reactive control, in contrast, can be thought of as a corrective mechanism. Reactive control involves recruiting processing resources to resolve conflict when that conflict is actually occurring (Braver, 2012). Building on this perspective, we suggest that if depressed (or other vulnerable) individuals have negative expectations concerning their ability to deal with future stressful events, this may result in less initiation of proactive control. That is, the expectancy of an individual's regulatory abilities prior to the presentation of an arousing event or stressful task will be related to the anticipation and proactive up- or downregulation of specific neurocircuits *before* the actual encounter with the stressful event occurs. This will influence the actual regulatory response and will also have implications for the development of a balanced self-esteem. In other words, we argue that *expectations* about an upcoming stressful event shape the subsequent neuro-regulatory response in a manner that can be either adaptive or maladaptive. Although we will mainly focus on depression, this approach has also implications for a broad range of disorders and conditions in which stress regulation is considered to play a role. It may also provide a framework that can also be used to develop and fine-tune clinical interventions to facilitate proactive control.

Our review is not intended to be an exhaustive consideration of all the literature in the areas we discuss. Rather, our goal is to provide a framework within which several distinct and diverse literatures might be integrated. We begin by providing a step-by step overview of all the building blocks of our neurocognitive framework, starting with the role of cognitive control and perceived control in emotion reactivity and emotional adjustment to stressful experiences. We then explain the role of expectancy, anticipation and proactive control in the person's ability to regulate stress, and consider the neural substrates of these processes. We also further clarify the relationship of expectancy, anticipation and proactive control in emotion regulation and highlight how inter-individual differences such as self-esteem (actual and ideal self-esteem) and the tendency to accept (or resign oneself to the situation) when coping is not possible are related to regulatory control. Finally, we propose our integrated model and emphasize its clinical implications.

1. Cognitive control and emotion reactivity

A functional balance between ventral (ventral anterior cingulate cortex (ACC)) and dorsal compartments in the brain (dorsal ACC, DLPFC) is thought to be necessary to maintain homeostatic control over emotion arousing stimuli (for an overview, see Ochsner & Gross, 2005). Negative information is more personally relevant for depressed people (increased bottom-up reactivity), who show impairments (decreased top-down control) in their abilities to exert cognitive control over negative thinking (De Raedt & Koster, 2010). It has further been proposed that decreased regulatory control leads to increased rumination and sustained negative affect (Koster, De Lissnyder, Derakshan, & De Raedt, 2011). Consistent with this, neural systems that are dysfunctional in depression include circuitries related to emotional reactivity, cognitive control and rumination.

Results from a large meta-analysis of neuroimaging studies reveal that, compared to healthy individuals, people diagnosed with major depression have higher baseline activity in the pulvinar, a large nucleus in the thalamus (Hamilton et al., 2012). Moreover, when exposed to negative stimuli, depressed people demonstrate greater responses in the amygdala, insula, and dorsal ACC, and lower responses in the dorsal striatum and DLPFC than do healthy comparison participants. Based on the role of the pulvinar nucleus in emotional attention and awareness as well as its connectivity with amygdala, insula and dorsal ACC, Hamilton and colleagues proposed that elevated baseline pulvinar activity could potentiate the brain's salience network to respond negative information.

It is also possible that some of these neurocognitive characteristics might reflect trait vulnerability for depression. For example, Hooley and coworkers (Hooley, Gruber, Scott, Hiller, & Yurgelun-Todd, 2005; Hooley et al., 2009) have demonstrated that, relative to healthy controls, symptom free formerly depressed individuals responded to criticism