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Review

Modeling the onset of a depressive episode: A self-regulation perspective

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Abstract

Major depression is an episodic disorder which, for many individuals, has its onset in a distinct change of emotional state which then persists over time. The present article explores the utility of combining a dynamical systems approach to depression, focusing specifically on the change of state associated with episode onset, with a self-regulation perspective, which operationalizes how feedback received in the ongoing process of goal pursuit influences affect, motivation, and behavior, for understanding how a depressive episode begins. The goals of this review are to survey the recent literature modeling the onset of a depressive episode and to illustrate how a self-regulation perspective can provide a conceptual framework and testable hypotheses regarding episode onset within a dynamical systems model of depression.

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Introduction

Major depression continues to pose a substantial public health challenge, in terms of mortality, morbidity/co-morbidity, and societal costs [1]. Yet, as new perspectives on psychopathology emerge, their application to specific disorders can lead to insights for diagnosis, treatment, and prevention [2,3]. Dynamical systems and network models of psychiatric disorders provide a rich context for mechanism-focused experimental research, with the dual purpose of increasing our understanding of each disorder and then translating new findings into effective interventions [4,5]. The goals of this brief review are to survey the recent literature modeling the onset of a depressive episode and to illustrate how a self-regulation perspective can provide a conceptual framework and testable hypotheses regarding episode onset within a dynamical systems model of depression. With increased availability of experience sampling and neuroimaging data in addition to behavioral, self-report, and clinician assessments, it may be possible to advance our understanding of depression through application of models and data analytics technologies that can account for both linear and nonlinear/reciprocal causal influences [6,7].

Dynamical systems and network models of depression

The episodic nature of depression requires an approach to etiology that can account for the qualitative change in state that individuals experience as they move into (and out of) a depressive episode [8], ideally so that intervention can be provided before that transition occurs [9]. Dynamical systems and network models of psychopathology emphasize that psychiatric disorders can be construed as organized collections or networks of elements or symptoms that, once instantiated, tend to maintain themselves [10,11]. These models characterize mental disorders not as collections of symptoms per se, but as dynamic patterns of associations among symptoms that have both a logical and temporal structure [12]. Networks characteristically maintain a coherent and stable state, and some energy or disruption is required to cause a shift into a different (and also potentially stable) state [13]. Thus, the conceptual challenge is to identify the factors that lead to a change in state culminating in a depressive episode — specifically, from euthymic to dysthymic [14,15]. In traditional models of etiology, some combination of diatheses and stressors causes a disorder called depression, which then causes symptoms. From a systems perspective, stressors trigger reactions and symptoms that in turn activate other symptoms, potentially leading to a change in state that itself is the disorder [16].

Epidemiological and experimental data consistently show that a majority of individuals who have met diagnostic criteria for a depressive episode experienced a relatively discontinuous change in mood, motivation, and behavior as an episode begins [17]. This pattern, in

turn, suggests the possibility of a state transition within a dynamic system. Such a system is composed of multiple interacting nodes or elements, the associations of which vary in strength and direction of influence over time. The system becomes vulnerable to a transition from a stable adaptive state to a stable dysphoric/maladaptive state after sufficient perturbation from one or more stressors [18,19]. There also is evidence that response to treatment for depression often follows a similar discontinuous transition pattern [20]. However, this depressive-onset-as-phase-transition hypothesis has been challenging to test experimentally, in part because doing so requires clear operationalization of a target brain/behavior system within which to observe such transitions, as well as controlled manipulations that approximate cumulative or catastrophic stress [21].

Recent applications of dynamical systems and network theories to depression suggest that human brain/behavior systems, particularly those involved in motivation and mood regulation, are characteristically stable but can become less so under chronic or intense stress [22]. This principle is illustrated by the familiar notion of a tipping point [23]. In the context of depression, brain—behavior systems, when exposed to a gradual increase in stress over time, may undergo a relatively abrupt shift into a qualitatively distinct state in which mood and motivation stabilize at a dysfunctional level (dysphoric mood, inadequate approach motivation) [24]. This shift from a euthymic to a dysthymic state, termed 'critical slowing down,' is both descriptive (denoting a clinical presentation in which the individual manifests greater dysphoric affect, reduced goal pursuit, lower energy level, and so on) and technical (hypothesizing that the system's capacity for adjustment to perturbation is diminished and the correlations among system elements/symptoms are increased) [25]. As was originally hypothesized five decades ago, depression can be construed as a functional disorder in which the behavioral, experiential, and neural mechanisms associated with reward sensitivity and reinforcement become hypoactive [26]. Given that these systems phenomena derive from properties of feedback loops, feedback-based theories of mood regulation and vulnerability may offer ways to operationalize key concepts and conduct robust experimental tests of the critical slowing down phenomenon in depression [27,28].

Depression and self-regulation

The concept of 'self-regulation' is used in psychology and related disciplines to describe the processes by which people initiate, maintain, and control their own thoughts, behaviors, or emotions, with the intention of producing a desired outcome or avoiding an undesired outcome [29]. Self-regulation incorporates both genetically based and learning-based mechanisms and operates in the pursuit of motivationally significant goals, notably approach and avoidance goals that lead to nurturance and security [30]. Regulatory focus theory (RFT) is a well-validated theory of human self-regulation that proposes two brain/behavior systems for goal pursuit, the promotion and prevention systems, which operate to maximize positive outcomes and minimize negative outcomes, respectively [31]. Both behavioral and neuroimaging data support the assertion that the two systems are functionally discriminable and nonredundant with temperament-based systems for spatiotemporal approach and avoidance [32—34]. RFT has been applied to conceptualizing a broad range of self-regulation failures, including depression and related forms of internalizing psychopathology such as generalized anxiety disorder [35].

The construct of self-regulation offers a powerful conceptual basis for testing basic and translational hypotheses about psychopathology [36]. Although self-regulation models of depression are not always cast in dynamical systems terms, there are multiple correspondences that indicate the value of doing so [37]. For example, self-regulatory failure can be gradual/degenerative or abrupt/catastrophic, can be system wide, and can occur across multiple types of adaptive functions [38]. A recently proposed self-regulation perspective on depression [39] offered four hypotheses regarding the disorder, drawing upon related feedback loop models [40—43]: (a) depression results from cumulative or catastrophic failure of the individual's neurobiological and psychological capacity for goal pursuit (specifically, promotion/'making good things happen'), (b) an initial episode of depression is a functional state resulting from a downward spiral of failure to make progress toward valued positive outcomes, (c) core symptoms of depression reflect dysregulation of approach/promotion (e.g. mood, appetite, anhedonia, energy, concentration, worthlessness, hopelessness, low self-esteem) or dysregulation of reciprocal inhibition between approach/promotion and avoidance/prevention (e.g. sleep disturbance, guilt, agitation/anxiety, hypothalamic—pituitary—adrenal (HPA) dysfunction), and (d) as episodes of depression accumulate, self-regulatory neural mechanisms may be permanently altered.

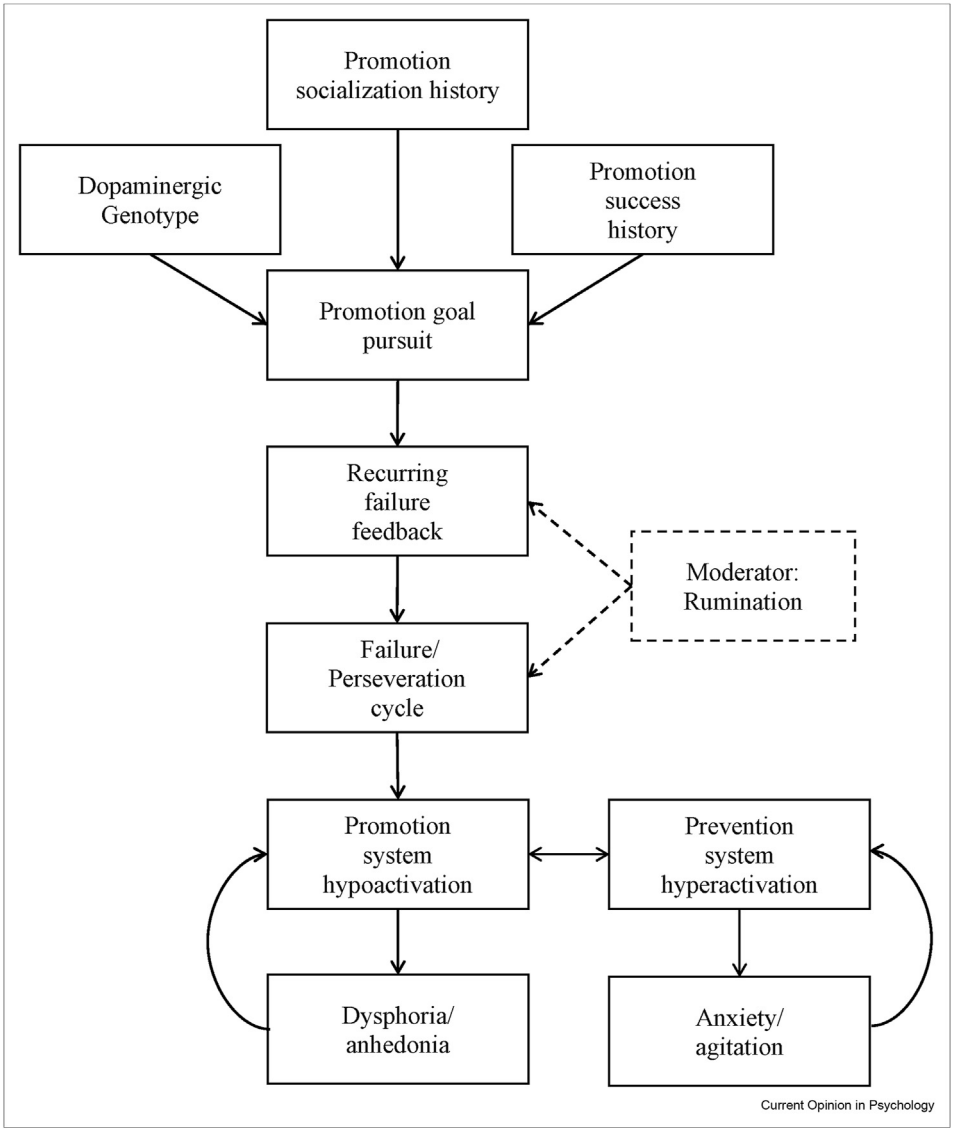
There is now substantial evidence linking self-regulatory dysfunction and depression. Research based on self-discrepancy theory indicates that when individuals experience chronic failure to attain a promotion ('ideal') or prevention ('ought') goal, they manifest a specific type of distress — dysphoria vs. anxiety, respectively [44,45]. Similarly, research based on RFT indicates that clinically significant dysphoric and

anxious states are associated with reliably identifiable dysfunctions within those motivational systems [46,47]. This research on RFT as an explanatory framework for depression has been extended into a model describing an etiological pathway to depression based on dysfunction of the promotion and prevention systems [48]. Specifically, for vulnerable individuals, chronic or catastrophic failure to make progress toward motivationally significant promotion goals (signified by recurring failure feedback) is hypothesized to induce a perseverative behavioral cycle that continues to engage the individual with failure feedback, ultimately leading to a change of state in the promotion system from active to hypoactive. Figure 1 depicts a model for promotion system–mediated depressive vulnerability as a specific etiological pathway to a depressive episode. Based on the RFT postulate that the promotion and prevention systems operate in a mutually inhibitory manner, chronic downregulation of promotion also is hypothesized to increase vulnerability to prevention system hyperactivation, which is in turn seen as a contributory factor for comorbid anxiety.

A self-regulation perspective on depressive episode onset

If chronic or catastrophic promotion goal pursuit failure represents a pathway to depression for individuals with specific premorbid characteristics (i.e. strong history of

Figure 1



A model for self-regulation as a contributory causal factor in the onset of unipolar depression (Strauman, 2017, [48]).

promotion goal pursuit socialization and success plus a dopaminergic genotype biasing reward sensitivity toward perseveration), what might trigger or influence the hypothesized change in state of the promotion system from active to hypoactive? Research based on expectancy theory indicates that as the individual's expectation of a positive outcome approaches zero (or some critical minimum value determined by current or historical contingencies), effort and persistence decrease precipitously [49]. Cognitive behavioral therapy for depression incorporates this insight by focusing the client on the role of expectancies in both the onset and maintenance of a depressive episode [50]. Behavioral experimental research using RFT to explore the dynamics of promotion-based behavior leads to the prediction that continuous failure feedback should result in an initial increase in goal pursuit effort (while the system anticipates a sufficient likelihood of a positive outcome) followed by abrupt discontinuation of goal pursuit (when the individual's expectancy goes below a critical threshold for the minimum required likelihood of a positive outcome) [51,52]. From this perspective, repeated assessment of an individual's expectancy of a positive outcome for her/his promotion goal pursuit efforts may provide a readout of the extent to which the promotion system is shifting in the direction of a phase transition.

The hypothesized link from 'Failure/perseveration cycle' to 'Promotion system hypoactivation' seen in Figure 1 incorporates the general notion of a state change from feedback-based perseverative promotion goal pursuit efforts to hypoactivation/shutdown of goal pursuit. Can this hypothesized transition be experimentally manipulated? And does it represent an ecologically valid model for the onset of a depressive episode? Although the specific dynamics of that process are yet to be explored experimentally in analog or clinical samples, there is evidence in the behavioral literature that continued failure feedback leads to discontinuation of promotion goal pursuit [53,54]. There also is evidence in the psychotherapy literature that interventions targeting promotion system hypoactivation may be efficacious in the treatment of depression [55–57]. If the model in Figure 1 is valid, it should be possible (a) acutely, to intervene therapeutically before the failure feedback/perseverative goal pursuit cycle triggers a state transition to promotion system hypoactivation and the accompanying dysphoric symptoms and (b) from a preventive intervention standpoint, to identify individuals at heightened risk of this hypothesized etiological pathway and provide them with cognitive and motivational skills to maintain adaptive promotion system function and avoid critical slowing down within that system.

A proof-of-concept study by Goetz et al [58] illustrates an experimental paradigm in which the critical slowing down phenomenon might be detectable within the context of promotion system response to continuing failure feedback. Those authors used a probabilistic reward task [59] to examine the interaction between individual differences in strength of promotion and prevention orientation and a common functional genetic polymorphism impacting prefrontal dopamine signaling (COMT rs4680). They observed that having a strong promotion system predicted total response bias, but only for individuals with the COMT genotype (Val/Val) associated with relatively increased phasic dopamine signaling and cognitive flexibility. The experimental parameters of that study were not tuned to provide consistent failure feedback, or to shift from consistent success to consistent failure (as an approximation of life circumstances in which individuals who are accustomed to successful goal pursuit efforts begin to encounter greater difficulty). However, the same basic task and design could easily be adapted to incorporate all three of the premorbid characteristics hypothesized to predispose to promotion system–mediated depression (dominant promotion system, high expectancy of success based on the individual's reinforcement history, dopaminergic genotype biasing goal pursuit toward perseveration) and then observe the effects of shifting over multiple trials from initial success to increasing probability of failure.

Conclusion

The goals of this brief review were to survey the recent literature modeling the onset of a depressive episode and to illustrate how a self-regulation perspective can provide a conceptual framework and testable hypotheses within a dynamical systems model of depression. Improved modeling of depressive episode onset can set the stage for better prediction, earlier and more effective intervention, and, ultimately, more broadly available preventive intervention strategies. As noted, the systems/network approach to depression already has demonstrated substantial implications for treatment, including the frequency with which response to psychological or pharmacologic interventions itself may be abrupt and nonlinear [60,61]. Self-regulation models of depression do not necessarily apply to all instances of unipolar depression, which is known to be highly heterogeneous in etiology and clinical presentation. Nonetheless, self-regulation represents a critical proximal locus for the effects of more distal risk factors on mood, motivation, and behavior [62]. Experimentally testable hypotheses such as those offered here may help to advance our understanding of depression's origins, its dynamics, and its amelioration.

Conflict of interest statement

Nothing declared.

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