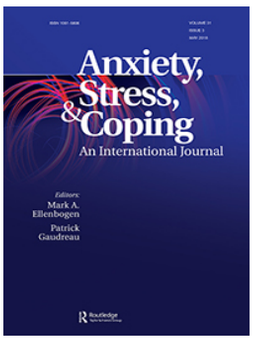

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Big Ideas Series

Optimizing stress responses with reappraisal and mindset interventions: an integrated model

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ABSTRACT

Background: The dominant perspective in society is that stress has negative consequences, and not surprisingly, the vast majority of interventions for coping with stress focus on reducing the frequency or severity of stressors. However, the effectiveness of stress attenuation is limited because it is often not possible to avoid stressors, and avoiding or minimizing stress can lead individuals to miss opportunities for performance and growth. Thus, during stressful situations, a more efficacious approach is to optimize stress responses (i.e., promote adaptive, approach-motivated responses).

Objectives and Conclusions: In this review, we demonstrate how stress appraisals (e.g., [Jamieson, J. P., Nock, M. K., & Mendes, W. B. (2012). Mind over matter: reappraising arousal improves cardiovascular and cognitive responses to stress. *Journal of Experimental Psychology: General*, *141*(3), 417–422. doi:10.1037/a0025719]) and stress mindsets (e.g., [Crum, A. J., Salovey, P., & Achor, S. (2013). Rethinking stress: The role of mindsets in determining the stress response. *Journal of Personality and Social Psychology*, *104*(4), 716–733. doi:10.1037/a0031201]) can be used as regulatory tools to optimize stress responses, facilitate performance, and promote active coping. Respectively, these interventions invite individuals to (a) perceive stress responses as functional and adaptive, and (b) see the opportunity inherent in stress. We then propose a novel integration of reappraisal and mindset models to maximize the utility and effectiveness of stress optimization. Additionally, we discuss future directions with regard to how stress responses unfold over time and between people to impact outcomes in the domains of education, organizations, and clinical science.

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Complete freedom from stress is death – Hans Seyle

Stress – the nonspecific response of the body to any demand for change (Selye, 1936) – is ubiquitous in daily life. Any internal or external factor, positive or negative, can disrupt homeostasis and elicit sympathetic activation: "A painful blow and a passionate kiss can be equally stressful" (Selye, 1974, p. 137). Although stress is unavoidable, stress is not wholly negative or something to be unilaterally avoided. Stress can facilitate performance, promote active coping, and protect against damaging effects of catabolic hormones (e.g., Dienstbier, 1989; Jamieson, Hangen, Lee, & Yeager, 2017; Mendes, Gray, Mendoza-Denton, Major, & Epel, 2007). This multifaceted conceptualization of stress, however, is not typically represented in lay theories of stress. That is, the possible adaptive benefits of stress are not considered; rather, people tend to equate stress with distress. In fact,

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when asked to choose the best advice for performing in an upcoming evaluative stress scenario, 91% of people indicated that remaining calm and relaxed (i.e., trying to reduce/eliminate stress) was the best option (Brooks, 2014). Moreover, self-report scales developed to measure perceived stress are overwhelmingly constructed of negatively valenced items, which implicitly present stress as a negative state (e.g., Cohen, Kamarck, & Mermelstein, 1983). The result is that people believe that efforts to cope with stress should focus on eliminating stress rather than seeking to optimize stress responses. That is, stress is a problem to be solved rather than an opportunity to be harnessed.

The research reviewed here is rooted in the idea that the processes associated with stress are multifaceted and psychobiological, and can result in adaptive or maladaptive outcomes depending on myriad factors including context, duration (e.g., acute vs. chronic), and upstream psychological factors (e.g., appraisals and mindsets). Notably, the current review seeks to stimulate future research by integrating two theoretical models that have, to date, been explored relatively independently in the literature: the biopsychosocial (BPS) model of challenge and threat and implicit theories of stress. First, we review the BPS model and an intervention approach based on processes derived from that model: *stress reappraisal*. Second, we review implicit theories and mindsets, and a mindset-based stress intervention: *stress-as-enhancing mindset*. Then, a novel integration of stress reappraisal and stress mindset is proposed and future directions are discussed.

Biopsychosocial model of challenge and threat

Classic research on the appraisal theory of emotion argues that processes derived from bodily sensations, past experiences, and situational factors – to name a few – contribute to emotional experiences (e.g., Lazarus, DeLongis, Folkman, & Gruen, 1985). Central to the model is the notion that affective processes are malleable, and cognitive appraisals play a central role in the generation and regulation of affective states, including stress states. That is, stress responses differ (or can be altered) by changing how individuals perceive internal and external cues. For instance, even the experience of anxiety – typically considered a negative emotion – can be perceived as debilitative *or* facilitative (Jones & Hanton, 1996).

Building on the appraisal theory of emotion (Lazarus, 1991) and the theory of constructed emotion (Barrett, 2006), researchers have sought to map biological underpinnings or "components" of affective responses, upstream appraisal processes, and downstream health, behavior, and decision outcomes. One pioneering theory, the *BPS model of challenge and threat* (for reviews, see Blascovich & Mendes, 2010; Jamieson, 2017; Seery, 2011) sought to elucidate stress responses in motivated performance situations that require instrumental cognitive responses and often involve social evaluation (Blascovich & Mendes, 2000).

Appraisal processes

A fundamental principle of the BPS model of challenge and threat is the idea that cognitive appraisals of demands and resources interact to elicit challenge- and threat-type stress responses in motivated performance contexts (Blascovich & Mendes, 2010; Mendes & Park, 2014; Seery, 2011). The conceptualization of "demands" and "resources" in the BPS model is multidimensional. To illustrate, demand appraisals can consist of uncertainty, danger, and effort, which may be orthogonal or (as is often the case) intertwined. Similarly, facets of resource appraisals such as familiarity, knowledge, skills/ability, dispositional factors, and social support can also be related. For instance, consider preparing for an exam in a difficult course. Studying the material can act on multiple components of both resource and demand appraisals in the exam situation. More preparation is likely to be associated with increases in perceptions of knowledge and skills (resources), and decreases in perceptions of uncertainty and effort (demands) during the exam.

It is also important to specify that the content of stress appraisals tend to vary substantially across time, situations, and people. For example, although the student in the example above might exhibit

higher resource appraisals from extensively studying an exam, studying for a particular exam in one course may not impact resource appraisals in other courses. Moreover, resource and demand appraisals can fluctuate independently of each other (i.e., ontologically distinct), or resource and demand appraisals can index bipolar factors with relevance for both processes. To illustrate, familiarity/uncertainty or safety/danger are dimensions that impact resources and demands simultaneously: as familiarity increases (relative to uncertainty), resources may be appraised as increasing and demands appraised as decreasing (Blascovich, 2008). Importantly for research on improving acute stress responses, a prerequisite to experiencing challenge and threat affective states is that individuals need to be actively engaged in the stressful situation. Engagement requires attention and reflects goal relevance (though additional research is needed to better specify the interplay between goals and appraisals: Jamieson & Elliot, 2018; Yeager, Lee, & Jamieson, 2016). Thus, challenge and threat theory is inherently a model focused on understanding stress responses. Challenge and threat stress responses are determined by resource and demand appraisals. Individuals experience challenge when resources are appraised as exceeding perceived situational demands. Alternatively, threat manifests when perceived demands are appraised as exceeding resources.

Although the psychological states of challenge and threat are often discussed as distinct, they are conceptualized as anchors on a continuum of possible responses rather than as dichotomous states. That is, individuals do not *only* experience either "full blown" challenge or threat, but rather can experience a multitude of responses that fall anywhere along the continuum from challenge to threat depending on the weighing of resources vs. demands. Thus by definition, promoting challenge would also reduce threat. As the ratio of perceived resources to demands increases, individuals move along the continuum from threat to challenge.

Physiological processes

Challenge and threat appraisals are associated with specific patterns of physiological responding (see Mendes & Park, 2014 for a review) derived from activation of the sympathetic-adrenal-medullary (SAM) and hypothalamic–pituitary–adrenal (HPA) axes. Both challenge and threat physiological responses are accompanied by SAM activation, leading to the synthesis and secretion of catecholamines (e.g., epinephrine and norepinephrine), which act to increase ventricular contractility (i.e., increase heart rate) and dilate blood vessels (Brownley, Hurwitz, & Schneiderman, 2000). In other words, since the BPS model focuses on motivated performance situations, one would expect sympathetic responses (e.g., elevated heart rate indicating SAM activation) to accompany both challenge and threat appraisals. However, with challenge physiological responses, SAM activation is heightened, and thus challenge is characterized by increased cardiac output – a volumetric measure of blood pumped by the heart across time – and decreased total peripheral vascular resistance. Challenge physiological responses also allow for a rapid onset and offset of physiological reactivity: resources are mobilized rapidly and individuals return to homeostasis quickly after offset. Threat physiological responses, however, not only elicit SAM activation, but also strongly activate the HPA axis, which produces a prolonged stress response relative to challenge due to the longer half-life of cortisol (the end product of HPA activation). That is, HPA activation tempers SAM effects and results in reduced (or little change in) cardiac output and increased resistance in the peripheral vasculature (for reviews see Blascovich, 2013; Blascovich & Mendes, 2010; Jamieson et al., 2017).

Researching challenge and threat responses

Because the appraisals that give rise to challenge and threat physiological responses are comprised of multiple components that vary across people and contexts, experimental methods have often been used to elucidate processes derived from the BPS model. That is, researchers seek to manipulate dimensions of demands and/or resources (e.g., Blascovich & Mendes, 2000; Blascovich, Mendes, Tomaka, Salomon, & Seery, 2003; Jamieson, Nock, & Mendes, 2012). For instance, studies have

manipulated stigmatized status of an interaction partner to induce uncertainty (Blascovich, Mendes, Hunter, Lickel, & Kowai-Bell, 2001), or have manipulated valence (positive vs. negative) feedback during a public speech to vary perceived skill levels (Kassam, Koslov, & Mendes, 2009).

Experimental manipulation has been necessary to isolate factors that produce psychological and biological effects and provide mechanistic data. Manipulating features of the situation or individuals' levels of resources/demands also avoids inherent limitations in self-reports of stress processes, although self-reports are often used to inform subjective appraisal processes (e.g., Jamieson, Peters, Greenwood, & Altose, 2016). In other words, individuals process information consciously *and* unconsciously or automatically. Thus, they may or may not have access to the full array of processes undergirding appraisals when completing explicit self-reports, often necessitating implicit measurement.

Taken together, the BPS model highlights the physiological responses that accompany challenge and threat appraisals, and demonstrates the multiplicity of stress responses in motivated performance situations. Notably, physiological stress responses (e.g., challenge and threat) differentially impact motivation, cognitions, performance, and behavior. For instance, whereas threat is associated with avoidance motivation and debilitated cognitive performance, challenge is approach motivated and facilitates performance (e.g., Blascovich, Mendes, Hunter, & Salomon, 1999). Therefore, by demonstrating that cognitive appraisals have direct consequences for downstream biological, psychological, and behavioral responses, the BPS model of challenge and threat has stimulated the development of a new class of interventions that influence how people experience and respond to stress by seeking to modify attributes of their cognitive appraisal processes. Along these lines, the following section focuses on one such intervention approach: stress reappraisal.

Stress reappraisal

Generally, experiencing challenge responses as opposed to threat responses in stressful situations can result in improved performance, as well as benefits in short-term health outcomes. Thus, developing regulatory methods that promote challenge responses has been a primary application of the BPS model of challenge and threat. As noted previously, challenge and threat physiological responses stem from cognitive appraisal processes of situational demands and personal resources. Thus, manipulating or modifying appraisals upstream has the potential to improve physiological stress responses and outcomes downstream. Here, we provide a description of stress reappraisal techniques, and highlight empirical data that demonstrate the effects of this affect regulation approach.

Research on stress reappraisal has specifically focused on manipulating appraisal processes – primarily resource appraisals – to optimize acute stress responses (e.g., Beltzer, Nock, Peters, & Jamieson, 2014; Jamieson, Mendes, Blackstock, & Schmader, 2010; Jamieson, Mendes, & Nock, 2013; Jamieson et al., 2012, 2013, 2016; John-Henderson, Rheinschmidt, & Mendoza-Denton, 2015; Moore, Vine, Wilson, & Freeman, 2015; Sammy et al., 2017). In this line of research the arousal that individuals experience during stressful situations is conceptualized as a functional *resource* that can benefit psychological, biological, and performance and behavioral outcomes.

To date, research has primarily utilized two types of reappraisal manipulations: (a) a ~10-min reading/Q&A exercise comprised of summaries of scientific articles on the adaptive benefits of stress responses (e.g., Jamieson, Mendes, et al., 2013; Jamieson et al., 2012, 2016; materials available at: http://socialstresslab.wixsite.com/urochester/research), and (b) a "short form," paragraph length instruction (e.g., Jamieson et al., 2010; John-Henderson et al., 2015; Jones & Hanton, 1996), one of which is presented below. For instance, Jamieson et al. (2010) used the following short-form instructions to manipulate appraisals prior to a standardized test (the Graduate Record Examination),

> People think that feeling anxious while taking a standardized test will make them do poorly on the test. However, recent research suggests that arousal doesn't hurt performance on these tests and can even help performance … people who feel "anxious" during a test might actually do better. This means that you shouldn't feel concerned if you do feel anxious while taking today's GRE test. If you find yourself feeling anxious, simply remind yourself that your arousal could be helping you do well.

Mechanisms and outcomes

Stress reappraisal is not aimed at eliminating or dampening stress arousal – it does not encourage relaxation or reduction of sympathetic arousal – but instead focuses on changing the *type* of stress response experienced (threat → challenge). Thus, this approach posits that maintaining, not decreasing, adaptive levels of sympathetic arousal is needed to optimize performance and active coping in acute stress situations. In fact, approach-oriented challenge states tend to be associated with *higher* levels of "stress arousal" (sympathetic nervous system activation) compared to avoidance-oriented threat states (Jamieson, Mendes, et al., 2013).

The focal psychological mechanism of stress reappraisal is the resource component of stress appraisals as defined by challenge and threat theory. The stress response itself is presented as an active coping resource (e.g., Jamieson, 2017). The focus of stress reappraisal manipulations on resource appraisals is an important mechanistic distinction when individuals encounter acutely stressful situations that cannot be avoided or mitigated. For example, in the American educational system students frequently must take evaluative exams (i.e., a stressful situation), and the relevance of exams for outcomes such as course grades, placements, and applications are difficult to attenuate without changing the structure of the educational system. However, students who reframe stress responses as functional can experience stress as a "skill," which helps optimize performance on exams (e.g., Jamieson et al., 2016).

Laboratory studies of stress reappraisal provide evidence that manipulating stress appraisals directly improves acute stress responses. One study examined how reappraising arousal altered responses to a social evaluation task in the laboratory (Jamieson et al., 2012). After a resting baseline, participants completed the Trier Social Stress Test (Kirschbaum, Pirke, & Hellhammer, 1993). Prior to the task, some participants were randomly assigned to reappraise stress, whereas others received either placebo materials (i.e., ignore stress and stay calm) or were given no instructions. Reappraisal participants exhibited a cardiovascular profile consistent with challenge, as indexed by less vascular resistance and greater cardiac output, compared to participants assigned to the other conditions during the evaluative task. Moreover, following the speech task, attentional bias for emotionally-negative cues was assessed (Emotional Stroop: Williams, Mathews, & MacLeod, 1996). Reappraisal participants exhibited less vigilance for threatening cues than others.

Some benefits of reappraising arousal have been observed in academic contexts. In one study, Graduate Record Examination (GRE) performance was examined (Jamieson et al., 2010). Participants first completed a practice test and provided saliva samples which were assayed for salivary alpha amylase, a protein that tracks andregenic activity and catecholamine levels in stressful situations (e.g., Nater et al., 2006; Thoma, Kirschbaum, Wolf, & Rohleder, 2012). Participants were randomly assigned to receive stress reappraisal or no instructions prior to practice tests. Reappraisal participants exhibited elevated alpha amylase levels and outperformed controls on the quantitative section. Participants then provided their actual GRE score reports one to three months after the laboratory visit. Again, reappraisal participants outperformed controls on the quantitative section.

Subsequently, research using the same instruction materials as Jamieson et al. (2010) replicated quantitative performance effects in a stereotype threat context, and also demonstrated that arousal reappraisal reduced acute levels of an immune marker of inflammation (interleukin-6) relative to controls (John-Henderson et al., 2015). Extending to classroom settings, a double-blind randomized field study demonstrated that instructing students to appraise stress as a functional tool immediately before math exams reduced evaluation anxiety and improved exam performance by increasing resource appraisals (Jamieson et al., 2016).

Research on stress reappraisal is rooted in the BPS model of challenge and threat. Stress reappraisal was developed to harness the power of appraisals to improve responses to acute evaluative stress. Although stress reappraisal has yielded promising findings, appraisals are not the only cognitive process that plays an important role in determining stress responses. Notably, implicit theories and mindsets also play prominent roles. In the following section, we highlight how

mindsets can impact stress responses and review an intervention program centered on mindset processes.

Implicit theories and stress mindset theory

Stress appraisals, as conceptualized by challenge and threat theory, tend to target perceived demands and resources related to a specific stressor or stressful situation (i.e., a motivated performance situation). That is, appraisals of demands and resources can, and typically do, vary from situation to situation and across domains. However, optimizing stress responses may also be achieved by targeting "domain general," higher-level belief systems. Along these lines, research on implicit theories of stress or *stress mindsets* – beliefs about the nature of stress in general, not specifically tied to situational appraisals – indicates that changing mindsets can produce similar benefits as reappraising stress arousal *in vivo* (e.g., Crum, Salovey, & Achor, 2013). Before reviewing how stress mindsets can be harnessed to improve outcomes, we first highlight basic mechanisms involved in how mindsets operate to impact processes relevant to the experience of stress.

The theory of stress mindset was inspired by a large corpus of research on implicit theories (see Dweck & Leggett, 1988; Yeager & Dweck, 2012, for reviews). Early research on implicit theories focused on the core assumptions people have about the malleability of personally relevant qualities (Blackwell, Trzesniewski, & Dweck, 2007; Dweck, Chiu, & Hong, 1995; Dweck & Leggett, 1988; Molden & Dweck, 2006; Yeager, Trzesniewski, & Dweck, 2013; Yeager et al., 2014, 2016). An individual holding an entity theory about a particular domain endorses the belief that personality, intelligence, and psychological resources are fixed and immutable. On the other hand, an individual holding an incremental theory believes that people can develop personality, intelligence, and psychological resources over time. Decades of research on entity and incremental theories (often referred to as *fixed* and *growth* mindsets, respectively) show that the implicit theories people adopt have consequences on motivation and behavior (e.g., Burnette, O'Boyle, VanEpps, Pollack, & Finkel, 2013). Similar to stress reappraisals, growth mindset has been shown to facilitate challenge seeking (Dweck, 2000; Yeager & Dweck, 2012) and academic performance (Blackwell et al., 2007; Yeager, Romero, et al., 2016).

Implicit theories were originally labeled "implicit" because the underlying belief systems are not necessarily explicitly activated or consciously processed. They were labeled "theories" because, like any scientific theory, beliefs and mindsets create a lens through which hypotheses are made about possible treatment or outcomes in a situation or environment, and ensuing events are interpreted as evidence in confirmation of these hypotheses. Moreover, implicit theories are sometimes referred to as naïve or "lay" theories because, unlike scientific theories based on the accumulation of empirical evidence, implicit theories refer to "commonsense" explanations for daily situations and social relationships (Dweck, 2000; Molden & Dweck, 2006; Yeager & Dweck, 2012). In more recent years, the term mindset has been preferred over the term implicit theory, because interventions that focus on changing implicit theories often provide evidence to support one theory over another. Thus, these interventions can make implicit theories explicitly accessible. In the current implicit theories intervention literature, mindsets are operationalized as a "lens" or "frame of mind" that orients individuals to particular sets of associations and expectations. These positive expectancy effects then serve to make positive outcomes more likely (Crum et al., 2013; Dweck, 2006).

Importantly, implicit theories or mindsets are not only applicable to intra-individual domains, such as intelligence (Aronson, Fried, & Good, 2002; Blackwell et al., 2007) or personality (Yeager et al., 2013), and they do not necessarily reflect perceptions of malleability or stability. For example, people can hold mindsets about the potential of groups to change (e.g., Goldenberg et al., 2018). Moreover, mindsets can reflect a broad range of cognitive associations. For example, people can hold mindsets about the effects of failure (e.g., Haimovitz & Dweck, 2016), the qualities of healthy food (e.g., Turnwald, Boles, & Crum, 2017), the meaning of sufficient exercise (e.g., Zhart & Crum, 2017), and, as we discuss next, the nature of stress.

Stress mindset

Stress mindsets are mindsets about how one perceives the experience of stress: Whether stress is believed to have enhancing or debilitating consequences (Crum et al., 2013). A "stress-is-enhancing mindset" refers to the tendency to believe that stress has enhancing effects of performance, health, and wellbeing, whereas a "stress-is-debilitating mindset" refers to the tendency to believe that stress has debilitating effects on performance, health, and wellbeing. Although the true nature of stress is complex and has the potential to have either or both enhancing and debilitating effects, stress mindsets serve as simplifying systems which orient individuals to a corresponding set of expectations and motivations that are useful for increasing the likelihood that an individual will experience the enhancing effects of stress.

Mindsets are typically measured by self-reports asking participants the extent to which they agree or disagree with statements about the nature of stress (e.g., The Stress Mindset Measure: Crum et al., 2013). For example, some items focus on the enhancing effects of stress (e.g., "experiencing stress improves health and vitality"), while others focus on the debilitating effects of stress (e.g., "experiencing stress inhibits learning and growth"). Existing research on stress mindset has been varied in its methodology. Some studies have explored the correlation or predictive value of stress mindset on outcomes such as performance, wellbeing, and health; others have experimentally manipulated stress mindset and measured corresponding effects.

To date, interventions for altering stress mindset have taken two forms. Early research focused on providing participants with selected information on the effects of stress in the form of videos that presented research, anecdotes, and examples about the effects of stress on various outcomes including health, performance, and wellbeing. The content of the videos was accurate, albeit selectively unbalanced to present either only enhancing or debilitating information. For example, in the "stress debilitates health" video participants are given research on the number of stress related diseases (e.g., Herbert & Cohen, 1993; Sapolsky, 1996), whereas the "stress enhances health" video presents research depicting how stress responses can promote physiological toughening (Dienstbier, 1989). Moreover, the content was tailored to the needs of various studies. For instance, Crum et al. (2013) altered stress mindset by having participants watch three 3-minute videos on how stress affects performance, health, and wellbeing broadly. Crum, Akinola, Martin, and Fath (2017), however, altered stress mindset with just one 3-minute video on how stress affects cognitive performance specifically.[1]

Although the stress mindset manipulation videos have proven useful and effective in experimental research, presenting unbalanced research poses potential ethical and practical challenges. First, presenting biased information to people could be viewed as ethically questionable. Second, the durability of mindset changes derived from interventions relying on incomplete or biased information may be limited: People will inevitably encounter oppositional evidence that stress is debilitating. As a result, researchers have tested a second approach to altering stress mindset. Whereas the aforementioned stress mindset manipulation are inherently biased, recent research shows that mindsets can also be changed by presenting more balanced information on both the enhancing and debilitating nature of stress, while also teaching participants about the power of mindset and a stress-is-enhancing mindset (Crum et al., 2018). This more complex, yet less biased, approach (referred to as stress mindset training) has been delivered in a live two-hour training as well as in the form of online modules.[2]

Mechanisms and outcomes

Correlational research has demonstrated myriad benefits of a stress-is-enhancing mindset. In a sample of 388 employees at a large financial institution, higher levels of dispositional stress-is-enhancing mindset predicted increased life satisfaction, reduced anxiety and depressive symptoms, and higher dispositional resources such as optimism, resilience, and mindfulness (Crum et al., 2013). In

a sample of university students, a stress-is-enhancing mindset predicted adaptive physiological and behavioral responses during an evaluative stressor (modified trier social stress test [TSST] embedded in a class). Specifically, students who had a stress-is-enhancing mindset exhibited more moderate cortisol reactivity and a greater desire for feedback from peer and professor evaluators (Crum et al., 2013). Research on a large sample of 8th grade adolescents ($N = 1,383$) has shown that relationships between adverse life events, and perceived distress and lack of control were weakened for those who held a stress-is-enhancing mindset (Park et al., 2017). Furthermore, a daily diary study of employees showed that a stress-is-enhancing mindset increased approach motivation when anticipating high workload, which in turn increased engagement and performance (Casper, Sonnentag, & Tremmel, 2017).

Similarly, experimental research indicates that stress mindset interventions can improve physiological responding, performance, affective responses, and health outcomes. In a longitudinal field study, employees who watched three 3-minute video clips about the enhancing nature of stress over the course of 1-week had greater self-reported improvements in work performance and general health compared to employees who watched videos about the debilitating effects of stress and compared to employees who did not watch any videos (Crum et al., 2013). Other studies examining the effects of stress mindset training have shown that the benefits of instilling a stress-is-enhancing mindset may persist, impacting individuals for weeks or possibly even years. For instance, finance employees who attended a two-hour stress-mindset training reported improvements in health and wellbeing 3–4 weeks after the intervention was delivered (Crum et al., 2018). Building on this research, a recent field experiment among college students suggests that a stress-is-enhancing mindset intervention delivered in the summer prior to college matriculation predicted high levels of reported positive affect during spring-semester exams over freshman and sophomore years (Goyer, Akinola, Grunberg, & Crum, 2018).

In summary, although additional research is needed to reveal precise mechanisms through which stress mindset improves outcomes, the extant research indicates that stress mindset can influence physiological, attentional, motivational, and affective processes. That is, stress-is-enhancing mindset is associated with more optimal neuroendocrine responses, positive affect, reduced bias for negative faces, improved cognitive flexibility, increased desire for social feedback, and greater self-control (e.g., Crum et al., 2013, 2017; Goyer et al., 2018; Park et al., 2017).

Distinguishing stress mindsets and BPS stress appraisals

A critical distinction between research on stress mindsets and stress reappraisal is that mindsets do not focus on manipulating or altering appraisals of demands or resources in stressful situations. Rather, the foci of stress mindsets are more general beliefs about the *nature* of stress (i.e., whether stressful experiences are enhancing or debilitating). That is, stress mindsets are meta-cognitive processes that can shape stress responses independent of how demands and resources are appraised in specific stressful situations. Consequently, it is possible for a stress-is-enhancing mindset to benefit stress-relevant outcomes in a wider variety of stressful situations (e.g., Crum et al., 2017). For example, consider a novice skier staring down a steep, icy slope with no other way off the mountain than plunging down the trail (i.e., a stressful situation). This skier may (and would likely) experience this stressful situation as threatening (situational demands outweigh available resources), but if the individual also possessed a stress-is-enhancing mindset, she may potentially expect (or at least hope) the stressful skiing experience will result in a positive outcome (e.g., pushing skill boundaries to learn to be a better skier). On the other hand, if the same skier possessed a stress-is-debilitating mindset, she might expect the stressful skiing experience to result in negative outcomes (e.g., loss of control, falling, and ultimately embarrassment or injury). In both instances, the novice skier is not equipped to handle the difficult trail – resources (training and skill) are not sufficient to meet the high demands (steepness of the trail, icy conditions). Thus, situation specific appraisals would likely indicate the experience of threat. However, if the skier possessed a stress-is-enhancing mindset, she might

exhibit more adaptive behaviors and experience less negative downstream outcomes relative to a stress-is-debilitating mindset.

Taken together, research on the aforementioned stress reappraisal and stress mindsets demonstrates the potential for people to be active agents in constructing their affective responses to stressors. Neither approach, however, should be considered a "magic bullet" for improving stress responses. Rather, additional work is needed to develop integrated interventions for optimizing responses in stressful situations. Along these lines, the following section highlights one example for how the two existing intervention approaches might be integrated.

Integrating stress reappraisal and stress-as-enhancing mindset

An important direction for future research on optimizing stress responses will be to integrate existing theoretical models and intervention approaches to maximize collective benefits. For instance, some initial work has begun integrating the BPS model of challenge and threat and implicit theories of personality to better understand mechanisms of interventions targeting adolescents' responses to negative social stressors (Yeager et al., 2016). In that research, an incremental theory of personality – the belief that people have the potential for change – attenuated the link between daily negative stressors, threat appraisals, and cortisol levels. However, for the most part, mindset- and appraisal-based interventions have been explored relatively independently in the literature and yielded independent empirical results.

To date, only one study has explored stress appraisals and stress mindsets in the same paradigm (Crum et al., 2018). In that research, a stress-is enhancing mindset improved outcomes in a negative social evaluation condition that was shown to elicit threat appraisals relative to a stress-is-debilitating mindset. The best outcomes, though, were observed when participants both had a stress-is-enhancing mindset *and* when they received positive social evaluation, which elicited challenge appraisals. However, BPS and mindsets concepts were not integrated. In fact, to date, no research has directly integrated stress reappraisal and stress mindsets methods. Towards this end, we posit that the effectiveness of reappraisal and mindset-based stress optimization approaches can be enhanced by a theoretical and applied integration of the two.

Stress optimization integration

The two stress interventions reviewed here – stress reappraisal and stress mindset – are rooted in the concept that stressful experiences can lead to physiological and psychological thriving, and improve performance and wellbeing when stressors are perceived as opportunities for growth and stress responses are appraised as functional and adaptive. These interventions invite individuals to (a) perceive stress responses as functional and adaptive, and (b) see opportunities inherent in stress. Although stress reappraisal and stress mindset target distinct mechanisms at different levels (i.e., domain specific and domain general, respectively), a common theme underlying reappraisal and mindset research is that changing interpretations of situational and intrapsychic factors can produce downstream psychological and physiological benefits, which, in turn, promote active coping and thriving under adversity.

We propose that an integrated intervention should not explicitly deny the negative realities of stress, but instead focus on promoting the enhancing properties of stress by incorporating stress reappraisal themes into a three-step process: (a) acknowledging stress, (b) approaching stressful situations, and (c) optimizing stress responses. This integration has the potential to improve upon observed benefits of both the interventions reviewed here. For instance, including content that does not deny negative aspects of stress adds flexibility and nuance to stress reappraisal messages that present stress as functional and adaptive. Increased flexibility is important if an individual experiences difficulties after seeking to reappraise stress in a particular context. Consider a student who is provided with stress reappraisal intervention materials prior to taking an exam. This student may seek

to appraise their stress as a resource during the exam, but if the student subsequently receives a low score, s/he may denounce reappraisal as not useful and not apply the message to other domains. Not denying negative aspects of stress discourages individuals from overgeneralizing a negative experience in a particular performance context to all performance contexts.

Alternatively, the stress-is-enhancing mindset approach does not directly target performance contexts and associated appraisal processes, but rather seeks to shape meta-level beliefs about the nature of stress. That is, an individual completing a stress mindset intervention could adopt a mindset that stress is enhancing, but have difficulties efficiently implementing this belief system to improve performance and functioning. Incorporating stress reappraisal themes has the potential to assist people in applying meta-level stress mindsets to specific performance contexts by presenting stress responses as resources. That is, mindsets adopted at a general level can direct responses in specific contexts via appraisal processes (the primary targets of stress reappraisal; for a similar approach see, Yeager et al., 2016).

Distinguishing stress optimization from traditional stress intervention approaches

Considering stress and stress responses as functional and adaptive stands in stark contrast with the typical negative conceptualizations of stress espoused in the media and some research literatures. For instance, a strong link exists between physiological stress responses and negative affective states like anxiety, fear, or threat (e.g., Franklin, Jamieson, Glenn, & Nock, 2015). Even scientists researching stress have considered physiological stress responses and the affective responses associated with stress as negative when developing self-report measures to index "amounts" of stress. For instance, the Daily Inventory of Stressful Events (Almeida, Wethington, & Kessler, 2002) includes seven items, six of which equate stress with "bad" events, and one that is non-valenced (asking about the incidence of "a stressful event at work or school"). Similarly, the widely used Perceived Stress Scale (Cohen et al., 1983) equates general stress with perceptions of high demands (e.g., *how often have you felt difficulties were piling up so high that you could not overcome them?*), and reverse-scored (i.e., low) resources (e.g., *how often have you felt confident about your ability to handle your personal problems?*). Moreover, as noted previously, the vast majority of people believe that it is optimal to relax and avoid being stressed when seeking to perform well in a stressful evaluative situation (Brooks, 2014). Given these (negative) lay conceptualizations of stress, it is thus not surprising that traditional stress intervention approaches have focused on reducing the frequency or severity of stress (e.g., Bränström, Kvillemo, Brandberg, & Moskowitz, 2010; Hembree, 1988; Holmes & Rahe, 1967).

Along similar lines, reappraisal processes in clinical psychological science typically either seek to decrease stress arousal (e.g., mindfulness meditation; Cincotta, Gehrman, Gooneratne, & Baime, 2011) or encourage individuals to accept heightened stress responses (e.g., interoceptive exposure; Levitt, Brown, Orsillo, & Barlow, 2004). In clinically relevant samples, stress arousal is often not matched to the situation. For instance, an individual with post-traumatic stress disorder may experience stress responses in non-demanding situations that include trauma-inducing cues, such as a combat veteran responding to a car backfiring because it resembles the noise of a gunshot. In these instances attenuating stress and arousal can be beneficial because arousal is not needed to address demands. Acutely stressful situations (i.e., motivated performance contexts), however, typically require instrumental responding, and *increased* sympathetic arousal can be functional.

Traditional stress reduction and relaxation interventions have high face validity because of negative lay theories surrounding stress, but the effectiveness of such approaches for optimizing responses is limited (e.g., Hembree, 1990; Rumbold, Fletcher, & Daniels, 2012; Taylor et al., 2003). First, it is often not possible to avoid stress, especially when pursuing goals. In fact, stress is ubiquitous throughout the lifespan. For instance, social evaluative pressures manifest at all levels of the educational system (e.g., testing, grades, etc.) and extend into workplace environments (e.g., job interviews, performance reviews, etc.). Second, avoiding or minimizing stress can lead individuals to miss opportunities for advancing goals. That is, stress frequently emerges when people are pursuing

goals that are important to them (Park & Helgeson, 2006; Tedeschi & Calhoun, 2004). Stress encountered during the pursuit of valued goals can thus be pivotal opportunities for achieving growth and higher levels of competence. Finally, traditional "stress reduction" or "relaxation" approaches reinforce the counterproductive stress-is-debilitating mindset. In fact, instructing individuals to avoid or reduce stress could potentially increase the accumulation of stress over the long-term via ironic processes (e.g., Wegner, 1994). Thus, several stress reduction techniques may create negative stress when they are seen as additional demands. Integrating research on stress reappraisal and stress mindsets to develop novel, active coping intervention approaches seeks to change the dominant narrative that stress is harmful and should be avoided. Integrated stress optimization approaches will help to enable individuals to overcome adversity, perform better under pressure, and thrive during times of uncertainty.

To date no empirical research has tested the efficacy of an intervention that integrates processes from the reappraisal and mindset literatures. Towards this end, we advocate for future empirical research that integrates theories to provide a fundamentally different approach to optimizing stress, rather than struggling to avoid stress. A single, comprehensive "stress optimization" (SO) intervention may allow participants to reap (potentially additive) benefits of both a stress-is-enhancing mindset and challenge type stress appraisals on cognitive, psychological, physiological, and behavioral outcomes (see Figure 1 for a hypothesized model). Moreover, it will be important for future research to explore moderators. As of now, the extant research on stress reappraisal and stress mindsets has observed effects at the group level with experimental paradigms (i.e., as a main effect), but moderators remain largely unspecified. It is very likely that the effectiveness of an integrated SO intervention will vary as a function of psychological and demographic factors. Notably, an integrated SO intervention that focuses on the adaptive benefits of stress has the potential to disrupt self-reinforcing processes that can emerge between stress, threat, and negative outcomes (for a similar intervention targeting recursive processes see Cohen, Garcia, Purdie-Vaughns, Apfel, & Brzustoski, 2009).

Future directions in stress optimization dynamics

Focusing on changing recursive processes to produce long-term change fits well with current models of emotion regulation, and the *extended process model of emotion regulation*, in particular (Gross, 2015).

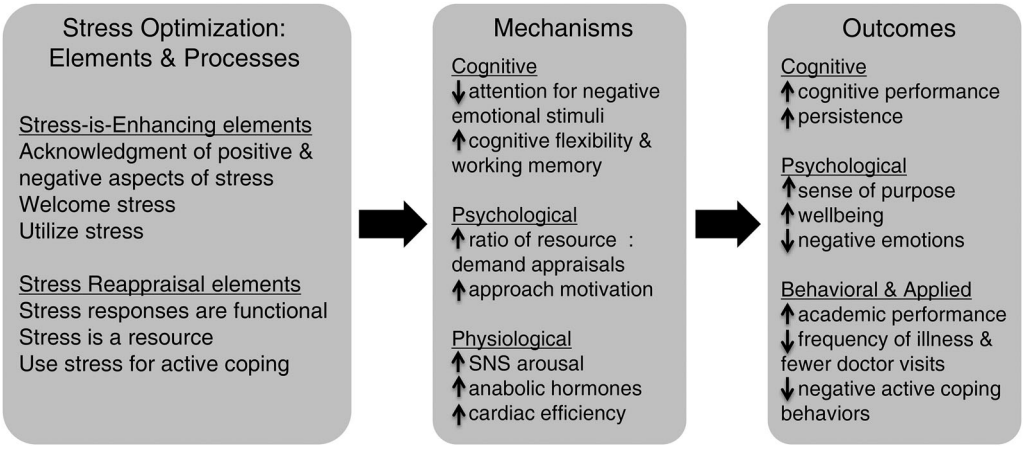

Figure 1. Hypothesized theory of change process model for an integrated stress reappraisal and stress-is-enhancing mindset SO intervention. The first step depicts the integration of elements and processes derived from existing manipulations. These are predicted to impact mechanisms, which are then hypothesized to feed-forward to improve outcomes. Note that the processes depicted in the model should not be considered exhaustive. The hypothesized model focuses on mechanisms and outcomes that have previously been shown to vary as a function of stress reappraisal and stress mindset interventions in the extant literature. SNS, sympathetic nervous system.

Directing future stress optimization research on capturing the dynamic nature of stress appraisals and mindsets across situations and people has the potential to both advance theory and yield substantial applied benefits.

Stress appraisals, for example, fit within the conceptualization of the "valuation" process in the extended process model. That is, a valuation system in the extended process model is conceptualized as aspects of the social and external environment, perceptions of internal and external states, valuations of perceptions, and goal directed actions (Gross, 2015). Stress appraisals and mindsets may be considered perceptual processes that inform valuations with the goal of modifying actions (stress responses) within the context of the broader valuation system. Importantly for informing future work on the dynamics of stress optimization, multiple valuation systems may be active simultaneously, each sensitive to different aspects of a situation or psychological factors. Thus, valuation systems can (and likely do) interact with one another. Modifying a valuation system by targeting stress responses and one's placement in a stressful situation using stress optimization tools also has the potential to impact valuation systems directed at social feedback under stress, performance monitoring/self-evaluation, or emotional experiences, to name a few. Explicitly incorporating facets of stress appraisals and mindsets into the valuation process has the potential to better explicate how appraisals and mindsets could feed-forward to exert potent, long-lasting effects within and across stressful situations. Research along these lines may also help inform future development of the extended process model by emphasizing physiological and motivational underpinnings for how valuations exert influences on emotional experiences, behaviors and performance, and health outcomes.

Another potentially generative area for future research on stress optimization dynamics is utilizing dyadic designs to elucidate questions of the interpersonal communication and regulation of stress processes. To date, research on stress reappraisal and stress mindsets has primarily focused on intra-individual effects. However, recent research has demonstrated that stress appraisals and stress responses in one person can have direct effects on the stress responses of interaction partners (e.g., Peters, Hammond, Reis, & Jamieson, 2016; Peters & Jamieson, 2016; Peters, Reis, & Jamieson, 2018). Along these lines, incorporating stress optimization research with research on *coregulation* – the reciprocal maintenance of physiological response patterns between interaction partners (Sbarra & Hazan, 2008) – has the potential to better specify how stress appraisals and mindsets help maintain healthy relationships and promote adaptive behaviors (e.g., responsiveness, Reis, Clark, & Holmes, 2004).

Extending interpersonal dynamics processes beyond dyads, individual-level interventions that improve stress responses may also potentially exert effects at group levels. For instance, it is possible that a stress optimization intervention delivered in a classroom setting may not only impact the students completing the intervention, but also benefit other students in class. Along these lines, prior research has demonstrated exactly such an effect for a self-affirmation intervention targeting minority students (Powers et al., 2016). In that research, the number of students completing the intervention in a classroom (i.e., density) directly and independently predicted academic achievement of classmates, regardless of whether they completed the intervention or not. Thus, the benefits of self-affirmation were not isolated to the individual. Individuals who experienced alterations in important psychological factors then impacted their social environment. Future research on stress optimization should consider the possibility that helping individuals better cope with stressors may have benefits for others in their social networks or immediate social environment.

Summary and conclusion

This review advocates for an integrative science approach to advancing research on understanding stress and facilitating active coping in stressful situations. Toward this end, we started with specifying stress reappraisal research derived from the BPS model of challenge and threat, and then reviewed stress mindset research derived from implicit theories. The research reviewed here provides empirical

evidence for the adaptive benefits of reappraisal and mindset interventions in acute stress contexts. However, prolonged exposure to stress or repeated activation of stress systems (i.e., chronic stress) has the potential to cause allostatic load and elicit negative health outcomes (Juster, McEwen, & Lupien, 2010). To date, potential effects of stress reappraisal and mindset interventions on chronic stress processes are relatively unknown because neither has been extensively tested in longitudinal paradigms. However, as research in stress optimization progresses, there exists the potential for these types of interventions to alter the experience of chronic stress processes through recursive and reciprocal processes.

Our review of the extant research on stress reappraisal and stress mindsets, coupled with our proposed an integration of these approaches in a unified SO model, were intended to broaden researchers' understanding of the dynamics of stress and interventions for improving stress responses. It is our hope that this review was not only informative from the perspective of elucidating links that bridge these independent models and interventions (showing how they draw on common themes at different levels of analysis), but we also believe this and similar integrative scientific approaches can be highly generative for psychological science. Exploring how theories may be connected and bridged has the potential to stimulate new research ideas and offer novel perspectives through which to understand stress, health, and intervention approaches.

We emphasize, however, that integrating stress reappraisal and stress-is-enhancing mindset interventions should not be considered some special or unique hub for *all* integrations of psychological interventions for optimizing stress responses. Rather, this review represents an exercise into how such integrations might be done using two approaches that share the same underlying spirit – that stress is not inherently negative for performance, health, and wellbeing, but can be utilized as a resource for goal achievement. Finally, once sufficient research has accumulated on the synthesis of particular theories or intervention approaches, it may then be possible to "integrate the integrations" to create general or universal programs for facilitating active stress coping. Such an approach would be similar to conducting mega-analysis, and has potential to inform policy decisions.

Notes

1. Mindset manipulation videos can be found at https://mbl.stanford.edu/instruments/stress-mindset-manipulation-videos.
2. Additional information on this mindset intervention can be found at https://mbl.stanford.edu/interventions/rethink-stress.

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