

INVITED SPECIAL SECTION

Capitalizing on Appraisal Processes to Improve Affective Responses to Social Stress

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Abstract

Regulating affective responses to acute stress has the potential to improve health, performance, and well-being outcomes. Using the biopsychosocial (BPS) model of challenge and threat as an organizing framework, we review how appraisals inform affective responses and highlight research that demonstrates how appraisals can be used as regulatory tools. *Arousal reappraisal*, specifically, instructs individuals on the adaptive benefits of stress arousal so that arousal is conceptualized as a coping resource. By reframing the meaning of signs of arousal that accompany stress (e.g., racing heart), it is possible to break the link between stressful situations, and malignant physiological responses and experiences of negative affect. Applications of arousal reappraisal for academic contexts and clinical science, and directions for future research are discussed.

Keywords

appraisal, biopsychosocial, challenge, threat

Cognitive appraisal processes have been at the forefront of affective science for over a quarter century. For instance, Lazarus's classic *appraisal theory of emotion* defined appraisals as the personal significance of an encounter for well-being and a proximal determinant of emotion generation (Lazarus & Smith, 1988), and Gross's *process model of emotion regulation* emphasizes that changing antecedent appraisals directly alters affective responses. Building on these models, the *biopsychosocial (BPS) model of challenge and threat* provides a process-focused model for understanding how cognitive appraisal processes can impact affective, physiological, and behavioral responses in motivated-performance situations that present acute task demands and require instrumental responding (Blascovich, 1992; Blascovich & Mendes, 2010).

In this review we first highlight appraisal models of emotion with an emphasis on how these informed the development of challenge and threat theory. Then, we outline the appraisal and

physiological processes underlying challenge and threat responses. Finally, using challenge and threat theory as an organizing framework, we suggest how manipulating appraisals can shape affective responses and be used to optimize responses in acutely stressful situations.

Appraisal Models of Emotion

Extending back to the roots of psychological science, William James (1884) theorized that perceptions of bodily states have a direct impact on emotional experiences. Neo-Jamesian researchers, such as Stanley Schachter and Jerome Singer (1962), specified that individuals perceive internal bodily states and that these perceptions are contextually grounded. Subsequent work on the *appraisal theory of emotion* introduced notions of “challenge” and “threat” affective states that are experienced in stressful contexts (see Lazarus, 1991, for a review). Importantly,

this model pioneered the idea that no single process—psychological, biological, or situational—undergirded emotions. Instead, the appraisal theory of emotion argued for multiple processes derived from bodily sensations, past experience, and situational factors, to name a few, that contributed to emotional experiences (e.g., Lazarus, DeLongis, Folkman, & Gruen, 1985). Central to the model is the malleability of emotions rooted in cognitive appraisal processes. That is, affective responses differ (or can be altered) by changing how individuals perceive internal and external cues.

Lazarus's (1991) appraisal model of emotion specified multiple levels of appraisals: primary and secondary. Primary appraisals assess (consciously and/or unconsciously) whether situations are emotionally relevant (benign or stressful) or irrelevant. Irrelevant situations are those that do not require instrumental responding or impact health/well-being. Emotionally relevant situations that are appraised as benign-positive *only* signal positive outcomes. Stressful primary appraisals, however, are further subdivided into “threat” and “challenge.” Threatening situations involve potential for harm or loss, whereas challenging situations refer to opportunities for growth, mastery, or gain (Lazarus, 1991). Primary appraisals alone, however, are not sufficient to determine affective responses. Secondary appraisals inform emotion by evaluating (again, consciously and/or unconsciously) available coping resources and available response options (Folkman & Lazarus, 1985).

Primary appraisals are not “primary” because they always come first in the temporal sequence, but rather they are primary because they confer personal relevance and signal the situation has the *potential* to elicit emotional responses (Lazarus & Smith, 1988). Moreover, primary and secondary appraisals can be interdependent (Folkman & Lazarus, 1980). For example, primary appraisals might suggest a threatening situation with the potential for harm, such as staring down a steep, icy ski slope with no other way off the mountain than plunging down the dangerous trail. However, if secondary appraisals indicate one can cope with the threat, such as skiing expertise and experience, threat is diminished. Alternatively, challenging situations can become threatening if coping resources are not sufficient to meet perceived situational demands. For instance, consider a high-achieving student about to take a final exam in a course. Because of her/his high level of prior performance throughout the semester, this situation may be initially appraised as challenging. However, s/he did not study at all for this particular exam. So, during the test, secondary appraisal processes indicate that the student does not have the requisite knowledge to perform well, eliciting threat.

Lazarus's (1991) appraisal theory remains highly influential in the emotion, stress, and coping literatures. Importantly, by establishing challenge and threat profiles across levels of appraisals, this model directly informed the development of prominent biopsychosocial models in multiple domains, including affective science, psychophysiology, and social psychology.

The Biopsychosocial (BPS) Model of Challenge and Threat: Appraisal Processes

Building on the appraisal theory of emotion, researchers sought to map the biological underpinnings of affective responses, upstream appraisal processes, and downstream health, behavior, and decision outcomes. In one line of theoretical development, the *biopsychosocial (BPS) model of challenge and threat* sought to explain acute stress responses in motivated-performance situations. A fundamental principle of the BPS model of challenge and threat is the idea that appraisals of demands (i.e., perceptions of uncertainty, danger, and required effort) and resources (i.e., perceptions of familiarity, knowledge, skills/ability, dispositional factors, and social support) interact to elicit challenge- and threat-type responses in motivated-performance contexts when individuals are engaged (see Blascovich & Mendes, 2010; Mendes & Park, 2014; Seery, 2011, for reviews; see Table 1 for a summary).

The conceptualization of “demands” and “resources” in the BPS model is multidimensional. For instance, demands may consist of appraisals of uncertainty, danger, and effort. These different facets of demand appraisals can be independent, but are often intertwined. For instance, consider an unfamiliar situation in which there is a potential source of danger, such as a firefighter entering a burning building s/he has never been in before. In this context the firefighter does not know the layout of the building (i.e., is uncertain) and thus could have difficulty quickly locating and assessing potential dangers, such as a falling beam. Similarly, perceptions of familiarity, knowledge, skills/ability, dispositional factors, and social support (facets of resource appraisals in the BPS model) can also be related. For example, familiarity and support could play important roles in an athlete's perceived resources during a competition. To illustrate, a (American) football player competing in his/her home venue would be more familiar with the field and its orientation, but playing at home is also tied to social support provided by the home crowd. This multifaceted conceptualization of demands and resources is consistent with Lazarus and colleagues' previous theorizing regarding the content of appraisals when they argue,

By considering the system as a whole, one can see what it means to speak of stress as a rubric rather than as a variable and can recognize that none of the variables [i.e., resource and demand components] individually is capable of explaining the emotional response. (Lazarus et al., 1985, p. 777)

It is also important to indicate that the specific content of resource and demand appraisals will vary substantially across situations and people. Moreover, appraisals of resources can fluctuate independently from appraisals of demands. That is, resource and demand appraisals may be ontologically distinct. For instance, resources include perceptions of knowledge, ability, or skills that are independent of perceptions of demands such as danger, difficulty, or effort. Alternatively, resource and demand appraisals can also index bipolar factors with relevance for both processes. To illustrate, familiarity/uncertainty or safety/danger are dimensions that impact resources and demands

Table 1. Overview of challenge threat response patterns.

Challenge	Threat
<i>Appraisals:</i> Coping resources > situational demands	<i>Appraisals:</i> Coping resources < demands
<i>Motivation:</i> approach / appetitive	<i>Motivation:</i> avoidance / defensive
<i>Affect:</i> pride / excitement / ↑ self-esteem	<i>Affect:</i> anxiety / shame / ↓ self-esteem
<i>Neuroendocrine reactivity:</i>	<i>Neuroendocrine reactivity:</i>
↔ or ↑ cortisol	↑ Cortisol
↑ DHEA	↓ or ↔ DHEA
↑ Testosterone	↓ Testosterone
<i>Autonomic reactivity:</i>	<i>Autonomic reactivity:</i>
Large ↑ in SNS activation (↑ HR; ↓ PEP; ↑ SC)	Immediate ↓ SNS, delayed moderate ↑ in SNS
↑ Cardiac output (CO)	↓ or ↔ CO
↓ Total peripheral resistance (TPR)	↑ TPR
<i>Recovery:</i> Fast. Return to baseline quickly after stress	<i>Recovery:</i> Slow. Stress responses linger
<i>Performance:</i> Facilitated cognitive performance	<i>Performance:</i> Debilitated cognitive performance

Note. Challenge and threat are presented as distinct patterns for clarity; however, challenge and threat correspond to endpoints on a single continuum of response (i.e., challenge and threat are not dichotomous states). DHEA = dehydroepiandrosterone; SNS = sympathetic nervous system; HR = heart rate; PEP = pre-ejection period; SC = skin conductance.

simultaneously: As familiarity increases (relative to uncertainty) resources may be appraised as increasing and demands appraised as decreasing (Blascovich, 2008).

Because demand and resource appraisals are comprised of variable, multiple components, a hallmark of BPS-based appraisal research is a preference for experimentally manipulating demands (e.g., perceived effort, uncertainty, danger, etc.) and/or resources (e.g., knowledge, training, skills, etc.; Blascovich, 2000; Blascovich & Mendes, 2000; Blascovich, Mendes, Tomaka, Salomon, & Seery, 2003). This approach requires experimental control to isolate the specific factors being studied, and thus can provide important mechanistic data. Moreover, manipulating features of the situation or resources avoids inherent limitations in self-reports of appraisals—although self-reports may be used as types of manipulation checks when either resources or demands are specifically targeted (for an example of this approach, see Jamieson, Peters, Greenwood, & Altose, 2016). That is, individuals process information consciously *and* unconsciously/automatically. Thus, they may or may not have access to the full array of processes undergirding appraisals when completing explicit self-reports, necessitating implicit measurement.

Rather than separating primary and secondary appraisals, the BPS model of challenge and threat considers appraisals more holistically (see Blascovich et al., 2003, for a review). For instance, many immediate, automatic appraisals classified as “primary” in Lazarus’s (1991) model may be represented in the engagement stage in the BPS model. A prerequisite to experiencing challenge and threat affective states is engagement in a motivated-performance context. Engagement requires attention and reflects goal relevance (though additional research is needed to better specify the interplay between goals, appraisals, and physiological responses; e.g., Jamieson, in press; Yeager, Lee, & Jamieson, 2016). Challenge and threat responses are then determined by resource and demand appraisals. Individuals experience challenge when coping resources are appraised as

exceeding perceived situational demands. Alternatively, threat manifests when perceived demands are appraised as exceeding resources. Note, however, that challenge and threat are best conceptualized as anchors along a continuum of possible stress responses rather than as dichotomous states. That is, individuals do not *only* experience either “challenge” or “threat,” but rather can experience a multitude of stress responses that fall anywhere along the continuum from challenge to threat. As the ratio of perceived resources to demands shifts, individuals may move along the continuum.

The BPS Model of Challenge and Threat: Physiological Processes

In the BPS model of challenge and threat, appraisals are associated with patterns of physiological responding (for a biologically oriented review, see Mendes & Park, 2014). Dienstbier’s (1989) classic work on *physiological toughness* provided the organization for the physiological response patterns delineated by challenge and threat theory. Specifically, challenge and threat derive from activation of the sympathetic-adrenal-medullary (SAM) and hypothalamic-pituitary-adrenal (HPA) axes, which function to mobilize resources that enable individuals to respond to stressors.

In the BPS model both challenge- and threat-type responses are accompanied by SAM activation, which leads to the synthesis and secretion of catecholamines, particularly epinephrine (or adrenaline) and norepinephrine. More downstream, catecholamines increase ventricular contractility (decrease pre-ejection period and increase heart rate), constrict veins (which facilitates return of blood to the heart), and dilate blood vessels (via the binding of epinephrine to beta-2 receptors; Brownley, Hurwitz, & Schneiderman, 2000). Challenge-type responses, which are dominated by SAM activation, are thus characterized by increased cardiac output (CO)—the volume of blood pumped by the heart across a given period of time (usually 1 min)—and

decreased resistance in the peripheral vasculature (TPR). Challenge-type responses also allow for a rapid onset and offset of responses: resources are mobilized rapidly and individuals return to homeostasis quickly after stress offset. Moreover, in Dienstbier's model physiologically "tough" individuals are those who exhibit relatively greater SAM relative to HPA activation when faced with acute stressors, and these individuals also appraise stressful situations more positively (Dienstbier, 1989).

In addition to activating the SAM axis the experience of threat also strongly activates the HPA axis, which is most often assessed by measuring its end-product: cortisol. Given the shorter half-lives of catecholamines relative to catabolic hormones such as cortisol (e.g., a few min vs. 1+ hr, respectively), activation of the HPA axis produces a more prolonged stress response as cortisol lingers after stress offset. HPA activation tempers effects of the SAM axis and results in reduced (or little change in) CO and increased TPR downstream in the cardiovascular system (see Table 1; for reviews see Blascovich, 2013; Blascovich & Mendes, 2010; Seery, 2011). Thus, the end consequences of the cardiovascular changes accompanying challenge- and threat-type affective responses is that challenge results in more blood (and hence more oxygen) being delivered to peripheral sites, such as the brain, whereas blood is centered in the core of the body when individuals experience threat.

Other physiologically based models compatible with the BPS model of challenge and threat have emphasized the interaction of hormones (i.e., dual hormone hypotheses), particularly the ratio of cortisol to testosterone (T-C ratio; Mehta & Josephs, 2010), and the ratio of cortisol to DHEA (anabolic balance; Southwick, Vythilingam, & Charney, 2005). More tightly integrating these models with challenge and threat theory has the potential to increase theoretical precision regarding the neurobiology underlying affective and motivational responses in motivated-performance situations.

Although challenge/threat response patterns are often indexed using physiological responses (see previous lines), it is important to remember that the physiological responses in challenge and threat theory are manifestations of psychological processes, which also have consequences for decisions, behavior, and performance. For instance, challenge and threat states are accompanied by changes in motivational orientation. Like other affective states (e.g., anxiety = avoidance; anger = approach), challenge and threat states are associated with motivational orientations. Challenge is generally associated with approach motivation and threat with avoidance motivation (e.g., Jamieson & Mendes, 2016; Jamieson, Nock, & Mendes, 2013; Jamieson, Valdesolo, & Peters, 2014). Moreover, whereas challenge typically is associated with positive behavioral and performance outcomes (e.g., Blascovich, Mendes, Hunter, & Salomon, 1999; Dienstbier, 1989; Jamieson, Mendes, Blackstock, & Schmader, 2010), threat impairs decision making in the short term and in the long term is associated with accelerated "brain aging," cognitive decline, and cardiovascular disease (Jefferson et al., 2010; Matthews, Gump, Block, & Allen, 1997). In fact, endogenously generated catecholamines resulting from SAM activation (i.e., a challenge-oriented response) demonstrate a positive, *linear* relationship with

performance (Dienstbier, 1989). Researchers have yet to identify levels that are "too high" to facilitate cognitive performance.

Given the overall benefits of experiencing challenge relative to threat, developing regulatory methods that promote challenge responses has been a primary application of BPS research. As noted before, challenge/threat affective states stem from appraisals. Thus, manipulating or modifying appraisals has the potential to improve stress responses and subsequent physiological, behavioral, and health outcomes.

Arousal Reappraisal

Recent studies provide initial support for the idea that affective responses to stress can be improved by manipulating appraisals (e.g., Beltzer, Nock, Peters, & Jamieson, 2014; Jamieson et al., 2010; Jamieson, Mendes, & Nock, 2013; Jamieson, Nock, & Mendes, 2012, 2013; John-Henderson, Rheinschmidt, & Mendoza-Denton, 2015). In that line of research, the arousal experienced during stressful situations is presented as a functional *coping resource* that aids performance. That is, signs of stress arousal are interpreted as coping tools, which facilitate challenge appraisals to affect subsequent physiological, affective, and motivational processes (see Figure 1).

To date, research has utilized two general forms of this *arousal reappraisal* manipulation: (a) A ~10-min reading exercise comprised of summaries of scientific articles on the adaptive benefits of stress responses (e.g., Jamieson, Mendes, & Nock, 2013; Jamieson et al., 2016; Jamieson et al., 2012; materials are freely available for download at <http://socialstresslab.wixsite.com/urochester/research>); and (b) a "short form," single paragraph instruction, which is presented next (e.g., Jamieson et al., 2010; John-Henderson et al., 2015). For instance, Jamieson and colleagues used the following short-form instructions to manipulate appraisals prior to participants completing a standardized test,

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.

Presenting stress arousal (or even subsequent negative affective experiences of anxiety) as a coping resource stands in stark contrast to how people typically appraise stress. That is, as shown in Figure 1, a strong link exists between the experience of stress and negative affect such that when individuals perceive increases in stress arousal they expect (and thus construct) negative states like anxiety, fear, or threat. Even stress researchers developing scales consider stress a negative experience. For instance, the widely used Daily Inventory of Stressful Events (DISE; Almeida, Wethington, & Kessler, 2002) includes seven items, six of which equate stress with "bad" events and one that is nonvalenced (asking the incidence of "a stressful event at work or school").

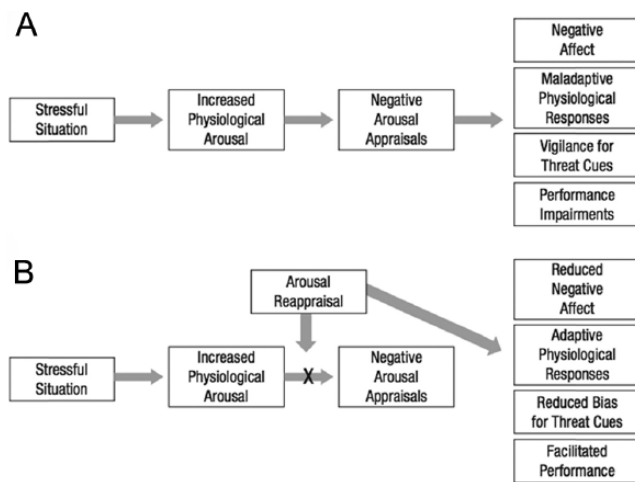


Figure 1. In panel A, stressful situations elicit physiological arousal, which is typically appraised negatively. These negative appraisals feed forward to produce negative outcomes. In panel B, arousal (re)appraisal manipulations break the association between stress-based arousal and negative appraisals. By severing this link, arousal reappraisal techniques help shift negative acute stress states (threat) to more positive ones (challenge), leading to a reduction in negative affect, more adaptive patterns of physiological reactivity, reduced attentional bias for threat cues, and improved performance.

Note. Adapted from Jamieson, Mendes, et al. (2013).

Given typical “stress-is-bad” perspectives, the classic emotion regulation literature has often (but not always) sought to encourage individuals to reappraise (i.e., change typical appraisal patterns) external cues in order to attenuate sympathetic arousal in passive situations (e.g., Gross, 2002). For example, an individual might reinterpret the meaning of emotionally relevant videos. No instrumental responding is needed when watching a movie, however. Thus, emotion paradigms that include viewing tasks are “passive receiving” situations, not motivated-performance situations, and thus fall outside the bounds of the BPS model of challenge and threat. Similarly, reappraisal processes in clinical psychological science typically either seek to decrease arousal (e.g., mindfulness meditation; Cincotta, Gehrman, Gooneratne, & Baime, 2011) or encourage individuals to accept heightened arousal in acute stress situations (e.g., interoceptive exposure; Levitt, Brown, Orsillo, & Barlow, 2004). Again, situational factors are important to consider. In clinically relevant samples/situations, the arousal experienced is often not matched to the situation. For instance, an individual with posttraumatic stress disorder may experience a stress response in situations which are not acutely demanding but include trauma-inducing cues, such as a veteran responding to hearing a car backfire because it resembles the noise of a gunshot. Thus, attenuating stress arousal can be highly beneficial in these situations/samples because arousal is not needed to marshal resources to actively address acute task demands.

Acutely stressful situations, however, necessitate instrumental responding where *increased* sympathetic arousal can be functional. Notably, arousal reappraisal provides a method for regulating affective responses in demanding situations because

it is not aimed at eliminating or dampening stress arousal (i.e., it does not encourage calmness or relaxation), but instead focuses on changing the *type* of stress response experienced (see Brooks, 2014; Crum, Salovey, & Achor, 2013, for related approaches). Notably, this approach runs counter to lay appraisals regarding stress responses in demanding situations. To demonstrate, during World War II the British Ministry of Information encouraged their citizens to “keep calm and carry on” to boost morale in the face of war. Armchair psychologists have adopted this mantra as a reminder to stay calm/relaxed in acutely stressful situations to optimize outcomes. However, in contexts of acute social stress if individuals do not experience stress, they cannot reap the adaptive benefits of sympathetic arousal (e.g., Dienstbier, 1989). To illustrate, recent research highlights the advantages of being excited (a high arousal stress state) versus calm (a low arousal state) in evaluative performance situations (Brooks, 2014). Participants instructed to “get excited” outperformed those instructed to “remain calm” on performance measures across multiple domains. Thus, techniques aimed at improving performance under stress should seek to maintain (or even increase) sympathetic arousal.

The focal mechanism of stress reappraisal is the resource component of demand/resource appraisals as defined by the BPS model of challenge and threat. This approach does not seek to convince individuals that stressful situations are not demanding or manipulate attributes of the situation itself—the focus is not on decreasing the perceived effort it takes to complete tasks or decreasing uncertainty regarding performance outcomes. Rather, stress reappraisal focuses on defining stress itself as a coping resource. That is, research on arousal reappraisal finds that individuals taught the adaptive benefits of stress report possessing more abilities to cope with acute social stressors (e.g., Jamieson et al., 2016). The tight focus of the manipulation on appraisals of resources is an important mechanistic distinction when individuals encounter acutely stressful situations that cannot be avoided or mitigated. For example, students frequently must take exams (i.e., engage in effortful responding), and the relevance of exams for grades/placements/applications (i.e., uncertainty processes) are difficult to attenuate without changing the structure of the broader educational system. However, students who reframe their stress response as a “skill” that maximizes performance can exhibit a more challenge-type response because of increased resource relative to demand appraisals.

Laboratory studies of reappraising stress arousal have provided initial evidence that experimentally manipulating arousal appraisals can improve online stress responses and downstream outcomes. One study examined how reappraising arousal altered responses to a well-controlled, laboratory evaluation task (Jamieson et al., 2012). After a resting baseline, participants were informed that they were going to complete a public-speaking task (the Trier Social Stress Test; Kirschbaum, Pirke, & Hellhammer, 1993). Prior to the task, one third of the participants were randomly assigned to an arousal reappraisal condition; another third received the “placebo” materials (“ignore stress”); and the remaining third were given no instructions. During the stressful social evaluative task, reappraisal participants exhibited a more challenge-type cardiovascular (CV) pro-

file as indexed by less vascular resistance and greater cardiac output, compared with participants assigned to the other conditions. Moreover, immediately after the public-speaking task, attentional bias for emotionally negative cues was assessed using an emotional Stroop task (e.g., Williams, Mathews, & MacLeod, 1996). Reappraisal participants exhibited less vigilance for potentially threatening cues than did participants assigned to the other two groups.

Arousal Reappraisal: Academic Achievement Applications

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 in the laboratory and provided saliva samples which were assayed for salivary alpha amylase (sAA), a protein that tracks adrenergic activity and has been suggested to index catecholamine levels in acute social stress situations (e.g., Nater et al., 2006; Thoma, Kirschbaum, Wolf, & Rohleder, 2012; van Stegeren, Rohleder, Everaerd, & Wolf, 2006). Participants were randomly assigned to receive arousal reappraisal instructions (see short-form instructions in the previous lines) or no instructions prior to their tests. Reappraisal participants exhibited elevated sAA levels compared to controls and outperformed controls on the quantitative section of the GRE. Then, 1–3 months after the initial laboratory session, participants provided score reports from the actual GRE. Again, reappraisal participants outperformed controls on the quantitative section of the real test without any boosters delivered after the laboratory session. 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 levels of an immune marker of inflammation (interleukin-6) relative to a no instruction control condition (John-Henderson et al., 2015).

Extending quantitative performance findings to a classroom setting, a double-blind randomized field study demonstrated that teaching community college students to appraise their stress arousal as a coping tool immediately before math exams reduced test anxiety and improved performance. Preliminary mediation analyses suggested arousal reappraisal improved academic performance by increasing students' appraisals of their ability to cope with the stressful testing situation (Jamieson et al., 2016). Arousal reappraisal is not only relevant for academic performance contexts, but rather may help advance theory and inform interventions across myriad domains in which stressful social situations are common, including clinical science.

Arousal Reappraisal: Clinical Applications

Consistent with research on arousal reappraisal, cognitive behavioral therapy (CBT) programs include modules designed to encourage patients to reappraise threat cues, which is also the focus of arousal reappraisal (see Barlow, 2004; Smits, Julian,

Rosenfield, & Powers, 2012, for reviews). One may even consider reappraisal as a centerpiece of CBT methods. Particularly relevant for research on arousal reappraisal, some CBT methods include giving individuals information about the evolutionary antecedents and adaptive functions of biological responses, as is evident in patient workbooks for anxiety and panic (e.g., Barlow, Craske, & Meadows, 2000). In fact, clinical science greatly informed the development of the “long form” arousal reappraisal instructions (e.g., Jamieson et al., 2012; Jamieson, Nock, et al., 2013; to download materials, see <http://socialstresslab.wixsite.com/urochester/research/>).

Although arousal reappraisal techniques were informed by clinical science, this regulation manipulation may also add to reappraisal-based CBT methods. Specifically, reappraising stress arousal may encourage the development of intervention components that not only educate people about the functionality of stress, but also encourage the maintenance of adaptive levels of sympathetic arousal during acute stress situations. As such, arousal reappraisal is best applied to psychopathology that is directly tied to stressful experiences for which sympathetic activation is needed for coping, such as evaluative experiences and social anxiety disorder (SAD).

Along these lines, a recent clinical extension of arousal reappraisal explored the affective and physiological reactions to social evaluation in SAD patients, and examined the efficacy of arousal reappraisal in altering CV reactivity and affective responses (Jamieson, Nock, et al., 2013). In Experiment 1 socially anxious individuals' CV responses to a social evaluative threat situation were similar to those of nonclinically anxious individuals, but socially anxious participants exhibited increased vigilance for threat cues and self-reported more anxiety compared to nonanxious participants. Experiment 2 then tested the efficacy of the arousal reappraisal manipulation. Socially anxious participants assigned to reappraise arousal as a coping resource appraised more resources to cope with evaluation than those provided no instruction and this fed-forward to positively impact their physiological responses and decreased vigilance for threat cues relative to a no instruction control group. This research provided preliminary evidence that arousal reappraisal can benefit those with SAD, but neither the long-term clinical effects of the manipulation nor the generalizability to other mental health problems have been explored.

More broadly, translational research on arousal reappraisal could have myriad benefits, including assisting clinical scientists in identifying mechanisms of change in CBT, providing guidance to organizational and sports psychologists on improving performance, helping educators facilitate learning, and more. Rather than targeting symptoms or outcomes (a common approach in intervention research) arousal reappraisal is process-focused. It was developed based on evidence from an established, well-validated model—in this case the BPS model of challenge and threat—and targets mechanisms (e.g., resource appraisals in the case of arousal reappraisal). Process-focused interventions are much preferred to outcome-focused approaches (e.g., the counterproductive but widely used outcome-focused Drug Abuse Resistance Education (DARE) Program; Lilienfeld, 2007). The importance of taking a process-focused approach for

intervention development is shared by the recent Research Domain Criteria (RDoC) initiative undertaken at National Institute of Mental Health (NIMH), which advocates for first identifying mechanisms of mental health problems and then developing diagnostic methods and treatments to target those mechanisms (e.g., Franklin, Jamieson, Glenn, & Nock, 2015; Insel et al., 2010).

Summary and Future Directions

The BPS model of challenge and threat is based on classic work on the appraisal theory of emotion (e.g., Lazarus & Folkman, 1991) and physiological toughness (Dienstbier, 1989), and specifies a multitude of possible stress responses anchored by *challenge* and *threat*. Physiological responses associated with approach-oriented challenge states are considered benign compared to avoidance-oriented threat states because challenge state have higher levels of anabolic (DHEA) relative to catabolic (cortisol) hormones (e.g., Mendes, Gray, Mendoza-Denton, Major, & Epel, 2007), dilation in the peripheral vasculature and increased cardiac output (e.g., Dienstbier, 1989), and rapid recovery to homeostasis after stress offset (e.g., Dienstbier, 1989; Jamieson et al., 2014). Challenge/threat response patterns follow directly from multidimensional cognitive appraisal processes that assess demands and resources (Blascovich, 1992; Blascovich & Tomaka, 1996). Challenge manifests when an individual appraises that s/he has the resources to successfully meet demands, whereas threat is marked by the opposite pattern: demands perceived as exceeding resources.

Although research frequently conceptualizes physiological and motivational responses that accompany challenge (approach) and threat (avoidance) as positive and negative, respectively, it is important to note that the approach/avoidance motivations are not necessarily valenced. An example of this can be observed in research on acute responses associated with the experience of anger. Although anger does exhibit some different physiological consequences than challenge, such as a slower return to homeostasis after stress offset, anger is clearly approach motivated. When one examines the upstream resource and demand appraisal processes and downstream physiological responses of individuals experiencing anger, these may appear similar to responses in individuals who are “excited” or challenged because of the concordance in motivational orientation (e.g., Jamieson, Koslov, Nock, & Mendes, 2013).

The motivational concordance between challenge and anger, however, does not imply that challenge and anger would be expected to influence health outcomes similarly. For example, challenge responses are typically associated with benign outcomes (e.g., Blascovich & Mendes, 2010; Mendes & Park, 2014). Alternatively, although trait anger has rarely emerged as a unique predictor of heart disease when considering anxiety and depression (see Suls, 2018), anger predicts increased anxiety and depression longitudinally (Stewart, Fitzgerald, & Kamarck, 2010). That is, anger may influence attention, social-relational processes, and decisions in ways distinct from challenge. For example, individuals high in trait anger (or hostility)

might perceive ambiguous cues as “challenging,” necessitating an approach-motivated anger response (e.g., Wilkowski & Robinson, 2010). Repeatedly responding with (often inappropriate) anger to slight provocations can increase allostatic load (McEwen, 1998), negatively impact relationships (e.g., Simpson, Collins, Tran, & Haydon, 2007), and promote risky decisions (e.g., Jamieson, Koslov, et al., 2013), which then may directly promote feelings of loneliness, anxiety, and depression and contribute to poor health.

The motivational emphasis of the BPS model of challenge and threat, however, makes it ideal for extension to emotion regulation processes captured by the *extended process model of emotion regulation* (Gross, 2015). Such integrations can help inform future work on the BPS model by capturing the dynamic nature of challenge/threat appraisals across situations and people. To illustrate, challenge/threat appraisals fit well with the conceptualization of the “valuation” process in the extended process model. Explicitly incorporating facets of challenge/threat appraisals into the valuation process has the potential to better explicate how appraisals feed-forward to exert potent, long-lasting effects. 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 influence on emotions, behaviors, and health outcomes. For instance, trait-affects may influence situation-specific appraisals, which in turn, determine future affective responses and health outcomes.

Appraisal processes in the context of the BPS model are not usually general, but instead tend to be situation specific. That is, appraisals of demands and resources will necessarily vary from situation to situation and across domains. For instance, one may consider oneself an adept skier. Presented with a demanding trail (e.g., steep, icy, and narrow), the expert skier may perceive her/his coping resources (ability, skills, familiarity, etc.) to exceed task demands. However, when the same expert skier is placed in a mathematics achievement context, such as taking an important standardized test, s/he may perceive the demands (high difficulty of problems, uncertainty processes, etc.) as exceeding ability to cope (poor math knowledge, little experience, etc.). So, whereas the demanding skiing situation produced challenge, the demanding math situation produced threat, and the two contexts and patterns of responding are independent of each other.

Regulatory methods or psychosocial intervention approaches often emphasize more general processes instead of situationally grounded processes. For instance, emerging research on *stress mindsets*—general beliefs about stress not specifically tied to appraisals—indicates that changing mindsets can produce similar health and performance benefits as reappraising stress arousal in vivo (e.g., Brooks, 2014; Crum et al., 2013). Similar to stress mindset research, implicit theories (see Dweck & Leggett, 1988, for a review) place perceptual processes (i.e., belief systems) at a more general level relative to BPS-derived appraisal processes. Implicit theories are broadly organized into one of two types: *entity* and *incremental* theories. An individual holding an entity theory endorses the belief that personality, intelligence, etcetera, are fixed and immutable. For instance, an

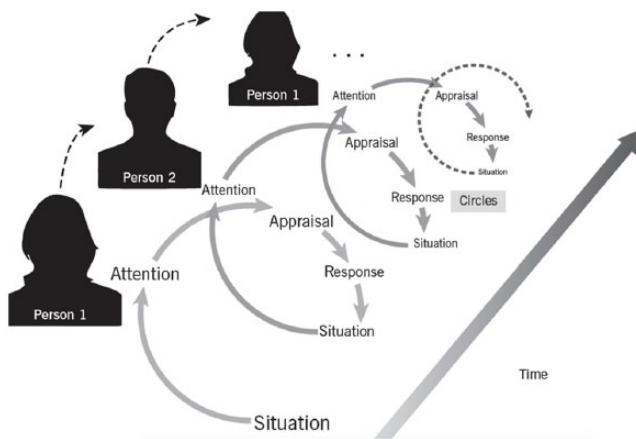


Figure 2. Dyadic model of affect regulation: Cycles operate between people and across time such that attention and appraisal processes enacted by Person 1 at Cycle 1 can feed-forward to impact Person 2 at Cycle 1, which can then produce effects in Person 1 at Cycle 2, and so on.

entity theorist believes that people are innately intelligent or not. S/he would not endorse the belief that one's intellectual ability can grow across the lifespan with study and hard work. Rather, an individual who believes in the potential for growth and change in traits, such as intelligence, would hold an incremental theory.

To illustrate how a potential integration of the BPS model of challenge and threat and implicit theories might manifest, if one perceives ability (i.e., resources) as fixed in a given domain—an entity theory in that domain—then challenge/threat appraisals will be particularly sensitive to perceptions of demands because perception of certain resources (e.g., intelligence, ability, personality traits, etc.) may be static (e.g., Yeager et al., 2016). Furthermore, appraisal-based interventions that target resource appraisals, such as the arousal reappraisal method highlighted here, may be moderated by implicit theories. That is, the manipulation may be less effective for those holding an entity theory.

Another potentially generative area for future research is exploring appraisal processes in longitudinal and/or dyadic designs to elucidate questions of affective dynamics. To date, no research has tested long-term effects of arousal reappraisal. Initial studies of arousal reappraisal examined appraisals in cross-sectional experimental designs constrained to specific acute stress contexts, but challenge/threat appraisals are not encapsulated to specific situations or even within individuals. Rather, as depicted in Figure 2, prior appraisals influence future appraisals in subsequent similar (or even unfamiliar) situations (e.g., Gross, 2015), and affective processes in one person (including appraisals) can have important effects on their interaction partners (e.g., Peters, Hammond, Reis, & Jamieson, 2016; Peters & Jamieson, 2016).

Along these lines, incorporating processes from challenge and threat theory and the extended process model of emotion regulation with research on *coregulation*—the reciprocal maintenance of physiological response patterns (Sbarra & Hazan, 2008)—has the potential to better specify how appraisals and

subsequent physiological responses help maintain healthy relationships and promote adaptive behaviors (e.g., responsiveness; Reis, Clark, & Holmes, 2004). For instance, in this special issue, Sbarra and Coan (2018) propose collecting ambulatory physiological measures in conjunction with ecological momentary assessment methods to gain insight into coregulation and partner effects on one's own physiology (for a similar lab-based approach, see Peters et al., 2016). To further advance research in this area and explore potential differential effects of *types* of interdependent physiological responses, it may be informative to also collect measures diagnostic of challenge and threat. That is, do positive relationship or partner effects result if partners experience interdependent negative, threat-type physiological responses? Moreover, interactions among physiological responses, relationship processes, and context are also important to consider. For example, it may be beneficial for both partners to coexperience threat or other negative affects when grieving (i.e., response and context are matched in valence), but not in more positive situations. Or, individuals with dominant partners may be particularly motivated to “tune” (regulate) their emotional responses to match those of their partners (Peters et al., 2016). Pursuing research along these lines has the potential to inform theories of interpersonal relationships, emotion regulation, and affective dynamics.

Conclusion

Since the introduction of the BPS model of challenge and threat (e.g., Blascovich, 1992), it has been applied to diverse and important domains ranging from stereotyping, prejudice and discrimination, academic and athletic performance, and affective science, to name a few. Here, we emphasize the importance of appraisal processes for optimizing affective responses in acutely stressful situations. Future inquiries into the dynamics of challenge/threat appraisal processes and affective responses are needed to help inform the development and refinement of process-focused interventions to improve health, performance, and well-being, and extend theories relevant to emotion and emotion regulation.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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