Challenge and Threat Appraisals

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Extending back to the formative years of psychology as a science, William James and Wilhelm Wundt believed mental processes were rooted in bodily processes. Thus, scientists have long theorized that the mind and body are not ontologically distinct, but changes in one directly affect the other. Many major advances in psychological theory and treatment research over the past 50+ years are predicated on a belief in mind-body monism. For instance, the idea that the mind and body operate in concert to produce psychological states is evident in modern models of emotion. Specifically, Conceptual Act Theory argues that appraisal processes transform internal states into emotional experiences by integrating bodily changes with external sensory information and knowledge of the situation (see Barrett, 2014, for a review). Along similar lines, empirically based cognitive-behavioral therapies are predicated on the belief that changing cognitive appraisals are often sufficient to improve downstream mental (and physical) health outcomes (see Hofmann, Asnaani, Vonk, Sawyer, & Fang, 2012, for a review).

The research presented in this chapter builds on ideas of monism and mind-body processes to understand how cognitive appraisal processes interact with situational factors to determine motivational, physiological, and behavioral responses, with the goal of informing future avenues of exploration. More specifically, the work presented here relies on the *biopsychosocial model of challenge and threat* (e.g., Blascovich & Mendes, 2010) as an organizing framework though which to understand how cognitive appraisal processes can produce affective, physiological, and behavioral responses in motivated-performance situations, and how altering appraisals can be used to optimize responses to acute social stressors.

Appraisal Theory of Stress and Coping

Schachter and Singer (1962) pioneered the idea that appraisals are contextually grounded. Specifically, their seminal research suggests perceptions of bodily states can shape emotional experiences. To illustrate, participants who were injected with epinephrine (adrenaline) but led to believe the injection would have no impact on their stress arousal, labeled their affective states consistent with situational cues. Subsequent appraisal models of emotional experience were based on the idea that situational and cognitive processes interact to determine emotions.

In classic work on the *appraisal theory of emotion*, Lazarus and colleagues introduced notions of "challenge" and "threat" states experienced in stressful situations (see Lazarus, 1991, for a review). The notion was that no single process – psychological, biological, or situational – undergirded stress responses. 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 stress appraisals and subsequent emotional experiences (e.g., Lazarus, DeLongis, Folkman, & Gruen, 1985). Considering stress responses as a *system* required categorizing responses into general rubrics, rather than using single processes to define stress. Central to the model is the malleability of stress responses rooted in cognitive appraisal processes. That is, stress responses can be altered by changing how individuals perceive stressors.

Lazarus' model specified two levels or stages of cognitive appraisal processes: primary and secondary. Primary appraisals addresses whether a situation is relevant to well-being and emotion. For instance, primary appraisal processes assess whether situations are irrelevant, benign, or stressful. Irrelevant situations are those that do not require instrumental responding

and have no impact on well-being or health outcomes. Benign-positive situations *only* signal positive outcomes with relatively low involvement (i.e. no instrumental action is needed to obtain good outcomes). The stressful type of primary appraisal, however, is further subdivided into “threat” and “challenge.” Threatening situations are those that involve potential for harm/ loss, whereas challenging situations refer to opportunities for growth, mastery, or gain (Lazarus, 1991). Primary appraisal processes alone, however, are not sufficient to determine affective responses. Secondary appraisals inform affective responses by evaluating available coping resources and response options available. Essentially, secondary appraisals seek to establish how to address or cope with stressors (e.g., Folkman & Lazarus, 1985).

Primary appraisals are not "primary" because these necessarily come first in the temporal sequence (though they usually do). Primary appraisals are primary because these appraisals confer personal relevance and have the potential to elicit emotional responses (Lazarus & Smith, 1988). Similarly, primary and secondary appraisals can be interdependent (e.g., Folkman & Lazarus, 1980). For example, primary appraisals might suggest a threatening situation with the potential for harm, such as the sudden escalation of an interpersonal conflict in which one is in danger of being physically assaulted. However, if secondary appraisals indicate one can cope with the threat, such as martial arts training in the example above, the experience of threat is diminished. Alternatively, challenging situations can become threatening if coping resources are not sufficient to meet perceived situational demands. To illustrate, a highly achieving student is about to take an important exam. Because of her high level of prior performance, this situation is initially appraised as challenging. However, she has not studied at all for this particular exam.

So, during the test her secondary appraisal processes indicate that she does not have the requisite knowledge to perform well on this particular test, causing her to experience threat.

In sum, the appraisal theory of stress and coping established challenge and threat profiles across two levels of appraisals – primary and secondary. Building on this model, researchers sought to refine the appraisal processes and ground *challenge* and *threat* predictions in physiological systems. This led to the development of the biopsychosocial (BPS) model of challenge and threat (e.g., Blascovich, 1992; Blascovich & Tomaka, 1996; Tomaka, Blascovich, Kelsey, & Leitten, 1993).

The Biopsychosocial Model of Challenge and Threat

A fundamental principle of the BPS model of challenge threat is the idea that appraisals of situational demands and coping resources interact to elicit challenge- and threat-type responses in motivated-performance contexts – those that present acute demands that require instrumental responding (see Mendes & Park, 2014, for a review). In Lazarus's appraisal model, challenge and threat referred to types of primary appraisals rooted in perceptions of gain (challenge) and loss (threat) potential. Then, secondary appraisal processes acted on this information by assessing one's capacity to cope and delineating response options. The BPS model of challenge and threat integrates primary and second appraisal levels such that an individual appraises situational demands and available coping resources in concert. Appraisals of resources and demands then produce challenge or threat responses – note, challenge/threat responses represent anchors along a continuum in the context of the BPS model of challenge and threat (e.g., Jamieson, Koslov, Nock, & Mendes, 2013).

In the BPS model (as well as Lazarus's appraisal theory), *challenge* and *threat* are experienced during motivated-performance situations, but differ in antecedent appraisals and downstream motivational and physiological processes. Individuals experience challenge when appraisals of personal coping resources exceed situational demands. Alternatively, threat manifests when perceived demands exceed resources. To demonstrate, consider a skier staring down a steep, narrow, icy slope lined with imposing trees. There is no other way off the mountain other than navigating this treacherous trail. Regardless of one's affinity for skiing, this situation is acutely stressful. There is an immediate demand (the difficult trail) that requires instrumental responding (navigating down it). Expert skiers might appraise the situation as challenging, believing that their skill, training, and experience (i.e. resources) allows them to handle the demands of the difficult trail, whereas novices are be more likely to experience threat because the difficulty of the trail is appraised as outweighing their (low) skill level. Thus, the general increase in stress arousal experienced by skiers standing at the top of the slope is semantically and psychologically fuzzy (Blascovich, 1992) – arousal is simply the consequence of engagement within a motivated-performance situation. The form the arousal takes – threat or challenge – depends on appraisals of situational demands in relation to coping resources.

An important advance the BPS model of challenge and threat made beyond existing appraisal theories was the grounding of challenge and threat predictions and psychological states in physiology. Theoretical physiological underpinnings were based on models of *physiological toughness* (Dienstbier, 1989), which targeted primary stress systems active in motivated-performance (i.e. stressful) situations: the sympathetic-adrenal-medullary (SAM) and hypothalamic-pituitary-adrenal cortical (HPA) (aka, pituitary-adreno-cortical: PAC) axes.

Broadly, the SAM system can be conceived as reflecting general sympathetic nervous system activation (e.g., “fight or flight” response). The HPA system, on the other hand, is more conservative, coming online after longer exposures to (usually more negative) stressors.

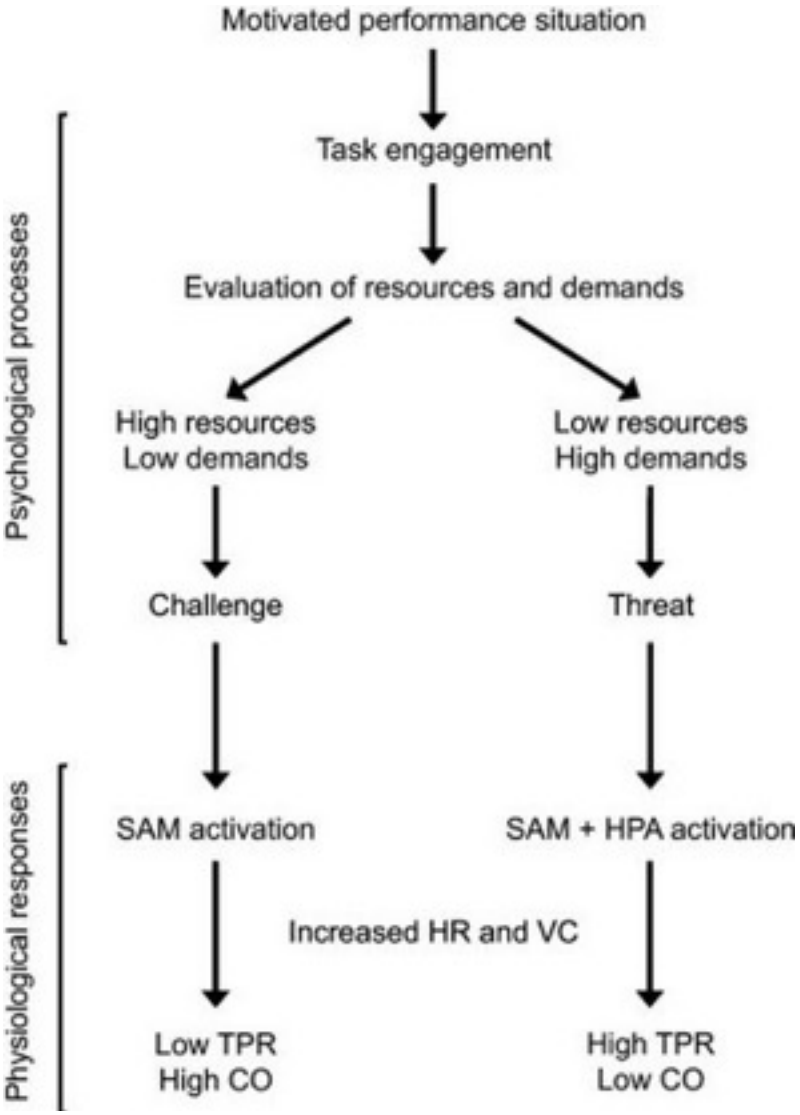
Activation of the SAM system stimulates release of epinephrine (aka, adrenaline) from the adrenal medulla, which produces important changes relevant for challenge/threat responding. For example, epinephrine increases heart rate, dilates blood vessels, and stimulates release of glucose from the liver. HPA activation results in the release of cortisol from the *zona fasciculata* of the adrenal gland. Given the chemical signaling sequence of the HPA axis – the hypothalamus releases corticotropin, which triggers the pituitary gland to release adrenocortiotropin, which then travels through bloodstream to the adrenal glands to stimulate cortisol release – levels of cortisol typically peak 15-20 min after the onset of stress (e.g., Dickerson & Kemeny, 2004). Challenge *and* threat appraisals are hypothesized to each activate the SAM, but only threat is also accompanied by HPA activation, thus inhibiting vasodilation (see Blascovich, 2013, for a review).

More downstream, the physiological consequences of challenge and threat appraisals can be clearly observed in differential patterns of cardiovascular (CV) responding. The BPS model of challenge and threat originally focused on stress axes (SAM and HPA), but has evolved and been refined to include CV as means to assess task engagement and differentiate challenge and threat states (e.g., Blascovich, Mendes, Hunter, & Salomon, 1999; Jamieson, Valdesolo, & Peters, 2014; Seery, Weisbuch, & Blascovich, 2009). The most common CV measures used to index task engagement are heart rate (HR) and pre-ejection period (PEP). HR is simply the rate of left ventricle contraction. Increases in task engagement produce increases in HR primarily through

increased sympathetic tone, but vagal withdrawal (decrease parasympathetic tone) can also contribute to increases in HR observed under situations involving cognitive effort (e.g., Appelhans, & Luecken, 2006). PEP assesses time from left ventricle contraction to the opening of the aortic valve, and is thus an index of ventricular contractility (VC) or the contractile force of the left ventricle. More forceful contractions yield shorter PEP intervals.

To differentiate challenge and threat responses following from appraisals of situational demands and coping resources, research has most frequently focused on cardiac output (CO) and total peripheral resistance (TPR) (see Seery, 2001 for a review). CO is a measure of cardiac efficiency that reflects the amount of blood pumped per minute (usually in liters) and is calculated by first estimating stroke volume (SV), which is the amount of blood ejected during each beat, and multiplying SV by HR. Challenge states are marked by an increase in CO resulting from increases in cardiac activity combined with vasodilation, whereas CO either declines or exhibits little change in threat states as cardiac activity increases but is not accompanied by dilation of the vasculature. To directly assess net resistance in peripheral vasculature, researchers use total peripheral resistance (TPR), which is often calculated using the following validated formula: TPR = (mean arterial pressure / CO) *80 (see Sherwood et al., 1990). When threatened, vascular resistance increases, limiting blood flow to the periphery and producing high TPR scores. On the other hand, vasodilation (i.e., reduced TPR) accompanies challenge states so as to facilitate delivery of oxygenated blood to the brain and periphery. See Figure 1 for a diagram for how challenge/threat responses unfold in the context of the BPS model of challenge and threat.

Figure 1. Summary of the BPS model of challenge and threat. Note that the parallel paths (i.e. challenge and threat) represent endpoints along a continuum, rather than discreet, dichotomous states (adapted from Seery, 2011).



As highlighted above, the BPS model of challenge and threat is an appraisal-based model that has clear physiological underpinnings, but it should be noted that challenge/threat are *psychological* states encompassing appraisals, physiology, motivation, and behavior. Although challenge/threat response patterns are often indexed using physiological responses, it is

important to remember that the physiological response is a manifestation of the psychological state.

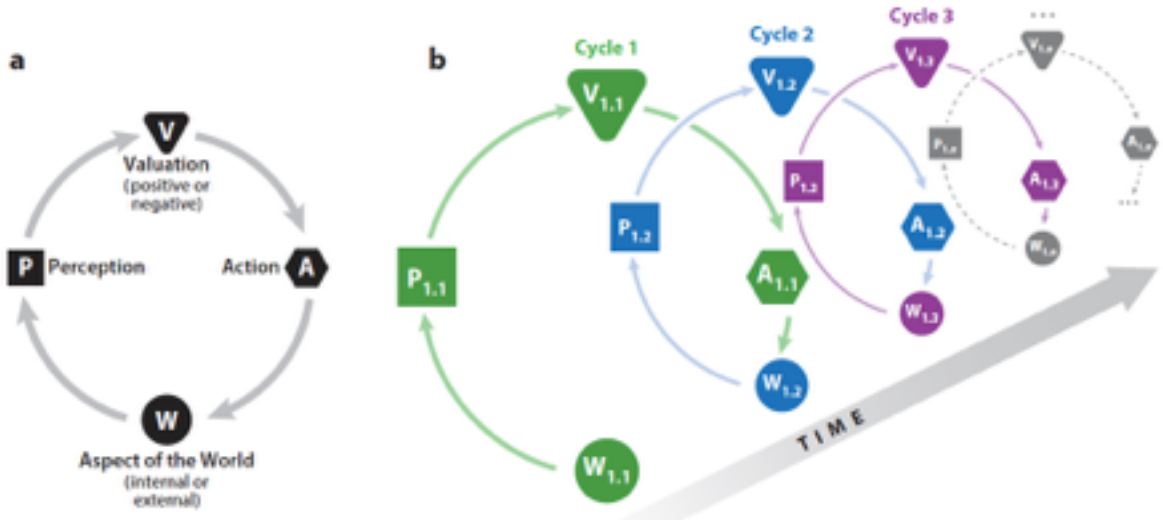
The breadth of challenge and threat states can be seen in research examining the motivational and behavioral consequences of these processes. For instance, and importantly for research on competence and motivation, challenge and threat states direct motivational orientation (e.g., Jamieson, Nock, & Mendes, 2013). When challenged, resource appraisals are sufficient to meet demands (i.e., "I can handle this") and the body enacts changes (e.g., vasodilation increases delivery of blood and oxygen to the brain) to enable people to actively address stressors. Thus, challenge predicts approach motivation. Threat, on the other hand, is rooted in demand appraisals exceeding resources (i.e. "I can't handle this") and prepares the body for damage or social defeat. This signals an avoidance orientation (Mendes, Blascovich, Hunter, Lickel, & Jost, 2007). Whereas challenge typically is associated with positive behavioral and performance outcomes (e.g., Blascovich et al., 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).

Appraisal Dynamics

Challenge and threat appraisals and responses are not constrained to a single point in time or to within-individual processes only. Appraisals operate dynamically to shape responses to future situations (e.g. Jamieson et al., 2010) and to influence cognitions and responses in those with whom we interact (e.g., Mendes et al., 2007). Along these lines, the *extended process model of emotion regulation* emphasizes the temporal dynamics of appraisal processes for determining

affective or emotional responses (Gross, 2015; Ochsner & Gross, 2014; Sheppes, Suri, & Gross, 2015). Central to this update to Gross's (1998) process model of emotion regulation is the notion that a valuation system – which includes appraisal processes – can be activated for extended periods of time (Oschner & Gross, 2014). To demonstrate, as shown below in Figure 2, attributes of the external environment ("the World" in the extended process model) necessitate engagement of Perceptual processes (or selective attention mechanisms). Perceptions then trigger the Valuation system, which produce Action outputs (behaviors, decisions, physiological responses, etc.). Targets of Actions are attributes of "the World," and the resulting change in situational or external factors directly leads to a second cycle that is Perceived, Valued, and Acted upon (e.g., Sheppes et al., 2015). This cyclical process then repeats itself in a dynamical nature over time and across situations. For instance, a Valuation process at cycle 1 can feed-forward and "snowball" to influence situations, attentional processes, valuations, and actions in future cycles. Such a regulatory system helps explain how appraisal-based cognitive behavioral therapies can have long-lasting benefits (e.g., Barrett, Duffy, & Dadds, 2001).

Figure 2. (a) The World (W) (notably, motivated-performance situations), give rise to Perception (P) processes. Valuations (V) based on perceptions give rise to Actions (A) that alter situational factors (i.e., "the World"). (b) Valuation processes, which include appraisals, take place over time (see cycles 1, 2, 3, etc.), as shown in this spiral depiction (figure adapted from Gross, 2015; Oschner & Gross, 2014; Sheppes et al., 2015).



Valuations in the extended process model of emotion regulation may be consider similar to, albeit more general than, appraisal processes in the BPS model of challenge and threat because valuations are appraisals that involve integrating perceptions of internal and situational processes to determine the functional utility of situations. That is, values, like challenge/threat appraisals, are based on weighting perceived costs and benefits derived from prior experience and perceptions of demands versus resources to inform approach or avoid actions. Slightly different from challenge/threat appraisal processes in BPS models, however, the feed-forward effect of valuations is emphasized by the extended process model. As shown in Figure 2, the physiological, behavioral, and experiential output of the valuation system at cycle 1 can activate a second cycle. This requires valuation processes at cycle 2 to act on the outputs of the first cycle. Thus, targets of valuations can be previous valuations. In current conceptualizations of the BPS model of challenge and threat, challenge/threat appraisals are situation-specific. Although BPS researchers would certainly agree that appraisals produce outcomes which influence subsequent appraisal processes and behaviors (e.g., Jamieson et al., 2010), the appraisal

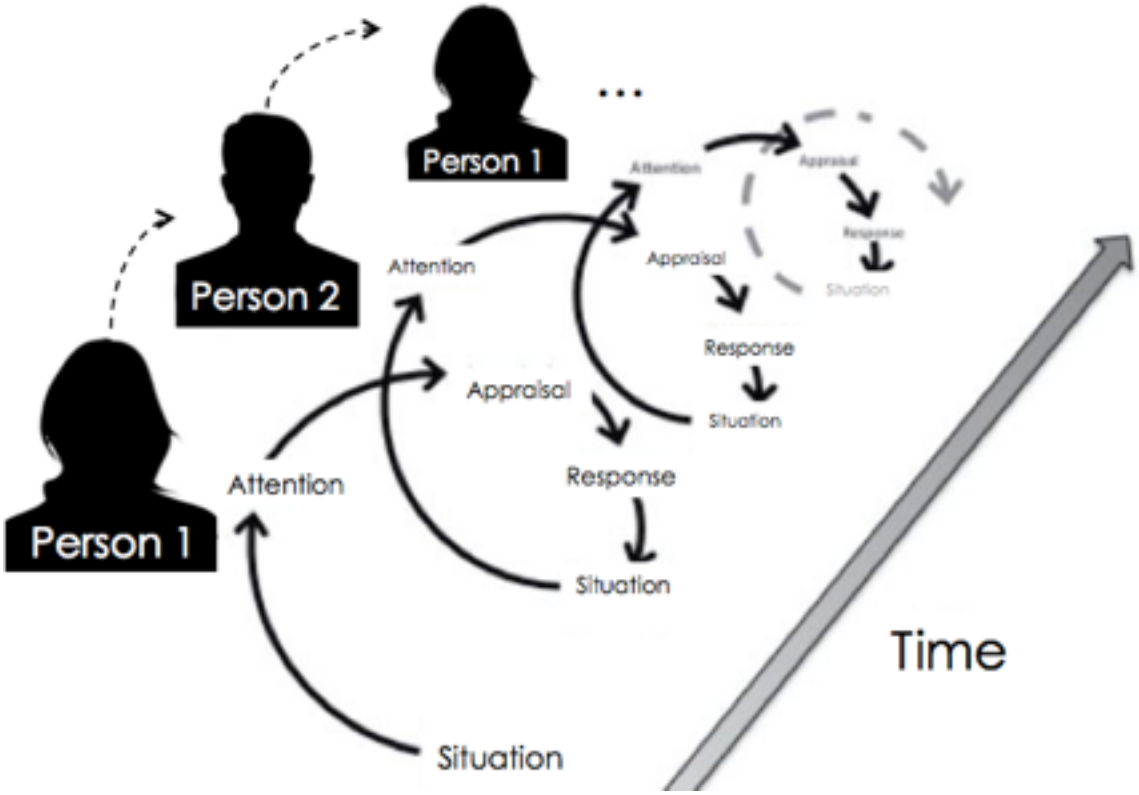
processes themselves are tied to specific situations, as resources to cope are considered in the context of situational demands.

To fully consider the role of appraisals in producing challenge and threat states in a dynamical nature, one must also integrate interpersonal processes. Valuations and challenge/threat appraisals are often conceptualized as intrapsychic processes that interact with external factors. However, appraisal processes have direct interpersonal consequences. Not only do appraisals of demands and resources affect one's own physiological responses and behaviors, but appraisals and physiology can feed-forward to impact those with whom one interacts. The dyadic effects of challenge/threat appraisals and responses are highlighted in recent research that measured interpersonal effects of expressive suppression online during interactions (Peters, Overall, & Jamieson, 2014). More specifically, an emotion regulation paradigm that required unacquainted dyads to watch a film and discuss their emotional responses (see Butler et al., 2003, for a full description) was utilized to study the transmission of challenge/threat processes between individuals. Prior to the emotional conversation, one member of the dyad was given additional instructions – either to normally express affective displays or to suppress affective displays – whereas the other member of the dyad was given no instructions and was unaware of the instructions their partner received. Physiological, affective, and behavioral responses were measured to assess partner effects of suppressing affective displays. That is, the research sought to demonstrate how regulatory processes enacted in one person can impact naïve interaction partners. Suppression is an effortful regulatory process, thus creating task demands (and threat) for the regulator (e.g., Gross & Levenson, 1997; Gross, 1998; Peters et al., 2014; see also English, John, & Gross, 2013 and Gross, 2002 for reviews). Physiological responses associated

with the experience of threat also "spilled over" to impact interaction partners of expressive regulators (Peters et al., 2014). These data demonstrates that dynamical appraisal/valuation processes can operate at the interpersonal level.

Thus, the "cycles" captured in the extended process model of emotion may not only operate within a person across time, but also *between* people *and* across time. For example, as suggested in Figure 3 below, in cycle 1, Person 1's appraisal processes (or attentional allocation) produce physiological and behavioral responses (e.g., suppression of affective displays elicits threat responses). The downstream responses of these appraisals (e.g., challenge/threat responses) can then "spill over" to directly impact Person 2's appraisals/valuations and subsequent responses in what could be considered their cycle 1. Then, the outcomes/behavior of Person 2 might feedback to influence Person 1 in cycle 2, and so on.

Figure 3. Dyadic process model of emotion 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.



Challenge and Threat Reappraisal

Recent advances in emotion regulation dynamics (see also Koole & Veenstra, 2015) indicate that appraisal processes can exert long-lasting effects on individuals and those with whom they interact. A pertinent question then becomes, can appraisal processes be manipulated to optimize outcomes? This is a particularly important question in the context of acutely stressful motivated-performance situations. Building on research from emotion (e.g., Barrett, 2006), emotion regulation (e.g., Gross, 2015), and the BPS model of challenge and threat (e.g., Mendes & Park, 2014), this section presents a method for improving appraisal processes during acute stress: reappraising arousal.

Upstream, the BPS model of challenge and threat argues that appraisals of demands and resources determine physiological and behavioral responses in motivated-performance situations. Recall, however, BPS theory is consistent with beliefs in mind-body monism (Blascovich & Mendes, 2010). Thus, signals from the body can feedback and influence appraisal processes (Gross, 2015). That is, physiological responses to motivated-performance situations can influence challenge/threat appraisal processes that determine subsequent response patterns.

Using the BPS model of challenge and threat as a framework, recent studies have sought to optimize responses in motivated-performance situations by altering appraisals of bodily states (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 this 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 reinterpreted as coping tools, which facilitate challenge appraisals that have effects on subsequent physiological, affective, and motivational processes.

Research on reappraising stress arousal extended seminal work on emotion regulation (Gross, 1998, 2002, 2015) and cognitive behavioral therapy (CBT; Hofmann & Smits, 2008). Underpinning these theories is that changing cognitive appraisal processes can alter downstream affective responding, and improve mental and physical health outcomes. To provide context, reappraisal, as specified by emotion-regulation models, typically involves the reinterpretation of the affective meaning of contextual cues, which can include physical stimuli, attributes of situations, and actions/words of other people to name a few. In other words, emotionally charged stimuli are presented, and participants are instructed to reinterpret those stimuli (e.g., “The

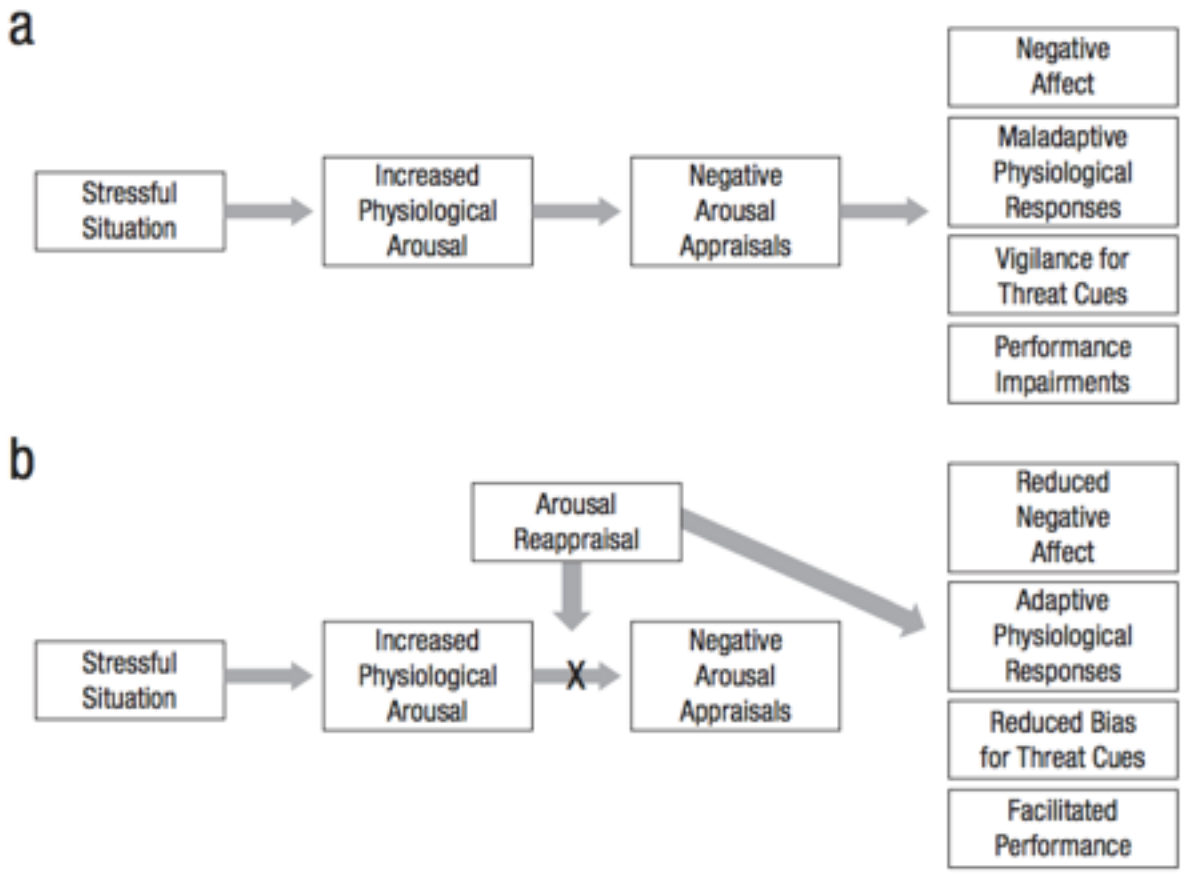
disturbing movie I'm watching is fake") or distance themselves from the stimuli (e.g., by adopting a third-person perspective; Kross & Ayduk, 2011; Ochsner & Gross, 2008). Clinical researchers developed CBT to help improve patient outcomes by modifying faulty affective responses and cognitions (Barlow, 2004). For instance, depressive patients are taught to identify errors in thinking (e.g., "Everyone hates me and always will") and replace them with more rational thoughts.

In the "classic" emotion-regulation literature, reappraisal has often (but not always) centered on decreasing sympathetic arousal in passive situations (e.g., Gross, 2002). For example, an individual might reinterpret the meaning of affective videos. No instrumental responding is needed when watching a movie. It is a "passive receiving" situation, not a motivated-performance one, and thus falls 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). Across these approaches, decreased arousal should be construed as adaptive when no instrumental cognitive or physical responses are required. However, motivated-performance situations necessitate instrumental responding and *increased* sympathetic arousal can be functional. As touched on before, a hallmark of challenge and threat type responses is activation of the SAM axis and increased cardiac activity. Harkening back to Dienstbier's (1989) physiological toughness model, SAM axis activation can facilitate mobilization of oxygenated blood to the brain and periphery via dilation of the vasculature, thereby improving performance under challenge states. Thus,

contrary to popular beliefs, stress arousal itself is not harmful for performance nor does it signal a negative affective state during motivated-performance situations.

Arousal reappraisal narrows in on situations of acute stress that require active responding and identifies bodily responses, specifically signs of sympathetic arousal (e.g., racing heart or "butterflies in my stomach," as coping tools. That is, stress reappraisal seeks to alter cognitive construal of bodily signals to promote adaptive, challenge type responses during acute social stress (Dienstbier, 1989; Mendes & Jamieson, 2011). Stress reappraisal is not aimed at eliminating or dampening stress arousal but instead focuses on changing the *type* of acute stress response (see also, Brooks, 2014; Crum, Salovey, & Achor, 2013). As can be seen below in Figure 4, arousal reappraisal operates after the instantiation of stress (i.e. engagement), but severs the (almost automatic) tie between acute stress and negative appraisal processes. People taught to reinterpret the meaning of stress and their body's response to stressors no longer experience stressful situations as negative. Stress becomes a coping resource, not a demand to be eliminated.

Figure 4. In panel (a), stressful situations elicit physiological arousal, which is typically construed negatively. These negative appraisals feed-forward to produce negative outcomes. In panel (b), arousal-reappraisal 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 (adapted from Jamieson et al., 2013).



Laboratory studies of reappraising stress arousal provide mechanistic evidence for how appraisals shape downstream performance outcomes. To demonstrate, one study examined how reappraising arousal might alter 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). Just prior to the task, one third of the participants were randomly assigned to a stress 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 CV profile, 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 negative information 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. This has important implications for how changing appraisals processes in response to one situation can feed-forward to positively impact affective, physiological, and behavioral responses in future situations (i.e. a positive "snowball" effect in the extended process model of emotion regulation; Gross, 2015).

Importantly for research on competence and achievement motivation, benefits of reappraising arousal have been observed in academic contexts. For instance, a double-blind randomized field study conducted in community college classrooms demonstrated that teaching students to appraise their stress arousal as a coping tool reduced test anxiety and improved exam performance. Mediation analyses indicated reappraisal improved academic performance by increasing students' perceptions of their ability to cope with the stressful testing situation (Peters, De Jong, Altose, Greenwood, & Jamieson, in revision). In other words, the stress reappraisal materials increased challenge appraisals by specifically targeting the resource, not the demand, side of the appraisal process.

Benefits of arousal reappraisal have also been shown to improve long(er)-term academic achievement outcomes. To demonstrate, the first empirical test of arousal reappraisal examined potential benefits of the approach for students preparing to take the Graduate Record Examination (GRE) – a standardized test used to assess applicants to graduate school (Jamieson et al., 2010). The research included laboratory and "field" components. First, students preparing

to take the GRE reported to the lab for a practice GRE study, where they were randomly assigned to read arousal reappraisal materials or no instructions prior to taking a practice test. Reappraisal students outperformed no instruction controls on the quantitative section of the practice GRE. Participants then completed the GRE within three months of the lab session and reported back to the lab after completing their "real" tests. Similar to the pattern observed in the lab, participants who reappraised stress as a coping resource scored higher on the quantitative section of the actual GRE. This performance effect was achieved without the delivery of any intervention "boosters" after the lab session.

How, then, did a laboratory reappraisal manipulation operate to improve GRE scores up to three months later? Although daily diaries (or similar event sampling methods) were not used to track psychological processes leading up to the "real" exams, self-reported psychological experiences of the GRE testing experience indicated that the reappraisal participants were less concerned with being anxious, believed arousal aided performance, and were more sure of themselves compared to no instruction controls. Building on the recent work on appraisal dynamics, these findings might suggest that the reappraisal materials delivered in the lab fed-forward to impact test-takers' future appraisal and attention processes (perceptions and valuations) in a future academic performance situation. However, it should be emphasized that no direct evidence has demonstrated *how* arousal reappraisal feeds-forward to operate within the context of the extended process model of emotion regulation. In fact, this endeavor would be an interesting area of future research on this topic.

Integration and Future Directions

The previous sections delineated how appraisal processes operate in the context of the BPS model of challenge and threat, explicated the dynamical nature of appraisal processes, and highlighted a method for optimizing appraisals and subsequent responses in acutely stressful situations. The following section explores avenues for integrating BPS-derived work on challenge/threat appraisals with other prominent theories from the social psychological literature on competence and motivation.

In the context of the BPS model of challenge and threat, an individual appraises situational demands and personal coping resources in motivated-performance situations. Because challenge and threat responses are thought to follow from a ratio of perceive demands and resources, these appraisals should operate in parallel or at nearly the same cognitive stage. Appraisal processes then predict patterns of challenge/threat response patterns with important implication for motivation (challenge = approach, threat = avoidance), physiological responses, and behavioral outcomes.

Broadly, appraisals in the context of the BPS model can be conceived of as situation specific. Situational demands versus personal resources are appraised in a motivated-performance context and are unique to that context because demands necessarily vary situation-to-situation and assessments of coping resources vary 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 his coping resources (ability, training, experience, 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, he may perceive the demands as exceeding his abilities to successfully cope in this domain (math knowledge, experience, etc).

So, whereas the demanding skiing situation produced challenge appraisals, the demanding math situation produced threat appraisals, and the two are independent of each other. Multiple other cognitive processes, however, can operate on appraisal processes to influence or moderate patterns of responding.

Little research, though, has sought to explicate how more meta-level cognitive processes interact with, shape, and are shaped by proximal challenge/threat appraisals. Even less research, actually none as of this writing, has integrated work on appraisal dynamics with proximal and distal influences on situation-specific challenge/threat appraisal processes. Two promising lines of research ripe for integration with BPS-derived challenge/threat appraisal processes in motivated-performance situations are achievement goals (Elliot, 1999; Elliot & Thrash, 2001; Pekrun, Elliot, & Maier, 2009) and implicit theories (Dweck, 1996; Dweck, Chiu, & Hong, 1995; Yeager, Johnson, Spitzer, Trzesniewski, Powers, & Dweck, 2014).

Similar to the BPS model of challenge and threat, achievement goal theory is rooted in concepts of approach and avoidance (see Elliot, 1999 for a review). This may not be surprising given a fundamental, evolved process observed across all organisms is the ability to assess the adaptive significance of environmental stimuli (via myriad sensory mechanisms) and to respond accordingly (e.g., Orians & Heerwagen, 1992). Even amoebas will avoid harmful stimuli (Schneirla, 1959). In humans, and in the context of BPS models, appraisal processes function to assess demands/resources and direct behavioral outputs. Assessment and direction of behavior can also be achieved via other cognitive processes. Prominently, achievement goal models place an emphasis on goals for assessment of the situation and one's ability to cope (i.e. competence, see Elliot & Hulleman, Chapter 4, for a review).

Achievement goals vary along two dimensions: valance and definition (or evaluative standard). Goals may either focus on approaching positive outcomes or avoiding negative outcomes, and are evaluated using mastery or normative/performance standards (Elliot & McGregor, 2001). For instance, a performance-avoidance goal might manifest as a student trying to avoid performing poorly on an exam relative to the rest of the class. Or a mastery-approach goal could result from a student learning course material purely to increase knowledge in the domain. Whereas performance goals require evaluative standards – performance either meets the goal or falls short – mastery goals do not necessarily involve evaluation. In the example above, the student striving to learn could do so without setting a standard to assess her learning progress. Given the greater evaluative demands that accompany performance-based goals relative to mastery-based goals, performance-based goals are more easily integrated with appraisal processes derived from the BPS model of challenge and threat.

Similar to challenge/threat appraisals, performance-approach and performance-avoidance goals are determined by situational and cognitive factors and produce downstream responses and behaviors (Elliot & McGregor, 2001). The antecedent factors that give rise to challenge/threat appraisals and performance-approach/avoidance goals may also likely overlap in many cases. For instance, higher assessments of competence can predict performance-approach goals (e.g., Elliot & Church, 1997: Urdan & Schoenfelder, 2006), and competence can also be construed as a coping resource, which elicits challenge. However, do goals give rise to appraisals, appraisals give rise to goals, or do the two processes operate independently (or dependently) in parallel? For instance, high perceptions of competence could prompt performance-approach goal adoption, which is predictive of proximal resource/demand appraisals (Elliot & Reis, 2003). Or

competence could be appraised as a coping resource, predicting a challenge response that includes the pursuit of performance-based goals.

Given the structure and function of achievement goal and BPS models, it may be more likely that appraisals function more upstream from task-specific goals. Appraisals in the context of the BPS model are situation-specific, but general. Challenge and threat responses stem from broad-based resource/demand assessments. For example, "resources" include myriad factors such as individual resources (e.g., competence, ability/knowledge, or experience), social resources (i.e. others to help, network of people to tap), or even institutional resources (e.g., equipment/tools). Similarly, task demands can encompass multiple domains from perceptions of difficulty to time/evaluative pressure to concurrent tasks, to name a few. Performance-based goals, too, are context bound. Goals based on performance standards require an evaluative situation in which to apply the goal. Slightly different from BPS conceptualizations of challenge/ threat appraisals, though, performance-based goals are more specific in their focus and application. For example, a performance-approach goal in an academic achievement context might take the form of trying to surpass a specific score or trying to outperform one's classmates on an exam. To summarize, antecedent factors, such perceived competence, might *cause* goal adoption, whereas these antecedent factors are *part of* (not separate from) challenge/threat appraisal processes. Alternatively, BPS researchers have specifically stated that achievement motivation "may capture motivational underpinnings of the demand-to-resource ratio" (Blascovich, Mendes, Tomaka, Salomon, & Seery, 2003, pg. 239). So, instead of appraisals predicting goals, goals may operate as factors (like competence assessments) that give rise to challenge/threat appraisals.

As highlighted above, interesting avenues for future research could seek to explicate how appraisal processes shape and are shaped by goal adoption, or whether these processes might unfold independently in parallel. To date, however, few studies have sought to examine temporal relationships between achievement goals and BPS-derived challenge/threat appraisals. What little research on this topic that exists has focused on athletics. For example, theories of athlete performance have sought to link achievement goals to physiological response patterns associated with challenge and threat states (Jones, Meijen, McCarthy, & Sheffield, 2009). Along similar lines, an imagery intervention for athletes sought to promote approach goals and challenge responses (Williams, Cumming, & Balanos, 2010), but did not provide direct insight into temporal associations between the goals and appraisals in athletes. Future studies on achievement goals and challenge/threat appraisals are relevant for advancing theories of competition, emotion regulation, and close relationships.

Whereas goals may, at least at times, be more specific than BPS-derived challenge/threat appraisals, other processes likely consistently operate at a more general level than situation-specific appraisals. Implicit theories, specifically, warrant consideration for integration with concepts of challenge and threat (see Dweck & Leggett, 1988, for a review). Dweck's model broadly organizes implicit theories into one of two types: *entity* and *incremental* theories. An individual holding an entity theory endorses the belief that traits, intelligence, etc. are fixed and immutable. For instance, an *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, intelligence, etc. would hold an *incremental* theory.

A large corpus of research indicates that individuals who endorse an incremental theory of intelligence and ability are more resilient, have better social interactions, and demonstrate improved academic performance relative to individuals holding an entity theory (see Burnette, O'Boyle, Van Epps, Pollack, & Finkel, 2013; Yeager & Walton, 2011, for reviews). Importantly for integrating implicit theories with work on challenge/threat appraisals, entity or incremental beliefs may be conceptualized as operating at the "global belief" level, which is more broad and general than situation-specific appraisal processes. Whereas challenge/threat appraisals vary substantially from situation to situation, within domains (e.g., social processes) implicit theories are more likely to be stable across situations. If one believes in an entity theory of intelligence, he is also likely to endorse an entity theory of personality (e.g., morality), for instance (see Dweck et al., 1995, for a review).

Implicit theories may be conceptualized as a "lens" that focuses situation-specific challenge/threat appraisal processes. To illustrate, if one perceives ability (i.e. resources) as fixed in a given domain, then challenge/threat appraisals will be particularly sensitive to perceptions of demands. That is, the "action" in challenge/threat response patterns will be rooted in the demand side of the resource-to-demand ratio. Similarly, appraisal-based interventions that target resource appraisals, such as the arousal reappraisal method highlighted earlier, will be less effective for those holding an entity theory.

Fortunately, global belief systems are not "set for life." Methods have been developed to modify implicit theories so as to maximize the instantiation of an incremental theory. For example, a brief (20 min) intervention teaches individuals to endorse incremental theory through educational material and written "endorsements." Experimental research demonstrates that

incremental theory interventions can exert long-lasting and powerful benefits for individuals randomly assigned to complete those materials (e.g., Yeager et al., 2014). Building on these previous implicit theories intervention studies, recent research has begun to explore the interplay between belief-level implicit theories and situation-level challenge/threat appraisals (Yeager, Lee, & Jamieson, in prep). More specifically, high school students were taught an incremental theory or control message prior to completing a stressful evaluative laboratory task – an age-modified Trier Social Stress Test (Kirschbaum et al., 1993). Prior to beginning the TSST, but after intervention materials, adolescents completed challenge/threat appraisal measures. Then, physiological responses were tracked online during task performance. Adolescents assigned to complete incremental theory materials reported greater challenge appraisals relative to those who completed control materials. Moreover, the incremental theory intervention also produced improvements in physiological indexes of challenge and threat – cortisol, cardiac output, and total peripheral resistance – compared to controls. These data demonstrate that instantiating a global belief in the capacity for growth and change can directly impact situation-specific appraisal processes relevant to challenge/threat response patterns. Additional research, however, is needed to elucidate *how* changing global beliefs functions to alter situation-specific appraisals, and the generalizability of effects across different types of situations. For instance, altering global beliefs could possibly impact performance situations more strongly than social situations.

Summary and Conclusion

The BPS model of challenge and threat is based on classic work on appraisal processes (Lazarus & Folkman, 1991) and delineates two *types* of organized responses to motivated-performance situations: challenge and threat, which have clear physiological underpinnings (e.g.,

Dienstbier, 1989). Physiological responses associated with approach-oriented challenge states are considered benign compared to avoidance-oriented threat states because of higher levels of anabolic (dehydroepiandosterone, DHEA) relative to catabolic (cortisol) hormones (e.g., Mendes, Gray, Mendoza-Denton, Major, & Epel, 2007), dilation in the peripheral vasculature (e.g., Dienstbier, 1989), and rapid recovery to homeostasis after stress (e.g., Jamieson et al., 2014). Challenge/threat response patterns flow directly from cognitive appraisal processes that assess situational demands and perceived coping 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 exceed resources. The goal of this review is to overview theoretical and empirical work on appraisal processes in the context of the BPS model of challenge and threat and to suggest avenues for future research on challenge/threat appraisals with an emphasis on dynamics and integration with other theories of motivation.

At its core the BPS model of challenge and threat is a model of motivation. Challenge and threat appraisals and responses facilitate an approach (challenge) or avoidance (threat) orientation to stressors or task demands, respectively. Although research frequently conceptualizes challenge and threat sates as positive and negative, respectively, it is important to note that the BPS model is not necessarily a valanced model. A clear example of this can be observed in research on responses associated with the experience of anger. Anger is clearly negatively valanced, but approach motivated. When one examines the appraisal processes and physiological responses of individuals experiencing anger, these appear similar to responses in individuals who are “excited” or more classically challenged because of the concordance in

motivational-orientation between anger and positive challenge (e.g., Jamieson, Koslov, et al., 2013; see Blascovich & Mendes, 2010, for a review).

The motivational emphasis of the BPS model of challenge and threat makes it ideal for integration with emotion regulatory processes in the context of the *extended process model of emotion regulation* (Gross, 2015) or the *modal model of emotion* (Gross & Barrett, 2011). Such integrations can help inform future work on the BPS model that more fully captures the dynamical nature of challenge/threat appraisals across situations and across people. As highlighted in this review, challenge/threat appraisals fit well with the conceptualization of the 'valuation' process in the extended process model. Explicitly incorporating challenge/threat concepts into the valuation process has the potential to better explicate how appraisals of resources and demands can 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 of effects of valuations on emotions, behaviors, and behavioral responses in situations of high affective intensity.

Research on reappraising arousal has started to scratch the surface on utilizing challenge/ threat appraisals to regulate affective responses (see Jamieson et al., 2013 for a review). In fact, a number of distinct lines of research are emerging that suggest altering appraisal processes to capitalize on the plurality of stress responses is effective at improving health and performance outcomes (e.g., Brooks, 2014; Crum et al., 2013; Jamieson et al., 2010, John-Henderson et al., 2015). This review highlights the BPS-grounded arousal reappraisal method (see Jamieson, Mendes, & Nock, 2013 for a review), but similar lines of research demonstrate the effectiveness of reappraising anxiety as excitement (Brooks, 2014) and changing more general stress mindsets

(Crum et al., 2013), for example. These and other similar psycho-situational intervention approaches are examples of research using an established, well-validated model, such as the BPS model of challenge and threat, to develop interventions targeting mechanisms (e.g., resource appraisals). Process-focused interventions are much preferred to outcome-focused approaches that are less well grounded in psychophysiological theory (e.g., Lilienfeld, 2007). This perspective 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, Cuthbert, Garvey, Heinssen, Pine... & Wang).

More broadly, challenge/threat appraisal processes are relevant for myriad other models and theories of motivation, including achievement goal and implicit theory models. The iterative processes through which appraisals shape and are shaped by achievement goals is an unexplored area ripe for study. Research on this topic has the potential to refine our understanding of how achievement goals and appraisals operate to impact outcomes, particularly performance outcomes in achievement contexts. Although challenge/threat appraisals are best conceptualized as situation-specific processes, this does not mean that they are not subject to effects of more general belief systems. For example, altering implicit theories of personality can directly affect challenge/threat appraisal processes during motivated-performance situations (Yeager et al., in prep).

In the approximately 25 years 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 behavioral economics to name a few. The relationship between resource and demand appraisals is believed to mediate the link between motivated-performance situations and physiological, motivational, and behavioral responses. This review emphasizes the importance of challenge/ threat appraisal processes for predicting downstream outcomes and potential integrations with other theories and models of motivation. Researchers have just started exploring the dynamics of challenge/threat appraisals and developing process-focused interventions to optimize responses under acute stress. As always, further inquiries into these and other topics relevant to challenge and threat appraisals are needed to advance and extend theory.

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